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| Title: | Chemical Concentrations in Field Mice from Open-Detonation Firing Sites TA-36 Minie and TA-39 Point 6 at Los Alamos National Laboratory |
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# CHEMICAL CONCENTRATIONS IN FIELD MICE COLLECTED FROM OPEN-DETONATION FIRING SITES TA-36 MINIE AND TA-39 POINT 6 AT LOS ALAMOS NATIONAL LABORATORY

**P.R. Fresquez**

## ABSTRACT

Field mice (mostly *Peromyscus* spp.) were collected at two open-detonation (high explosive) firing sites—Minie at Technical Area (TA) 36 and Point 6 at TA-39—at Los Alamos National Laboratory in August of 2010 and in February of 2011 for chemical analysis. Samples of whole body field mice from both sites were analyzed for target analyte list elements (mostly metals), dioxin/furans, polychlorinated biphenyl congeners, high explosives, and perchlorate. In addition, uranium isotopes were analyzed in a composite sample collected from TA-36 Minie. In general, all constituents, with the exception of lead at TA-39 Point 6, in whole body field mice samples collected from these two open-detonation firing sites were either not detected or they were detected below regional statistical reference levels (99% confidence level), biota dose screening levels, and/or soil ecological chemical screening levels. The amount of lead in field mice tissue collected from TA-39 Point 6 was higher than regional background, and some lead levels in the soil were higher than the ecological screening level for the field mouse; however, these levels are not expected to affect the viability of the populations over the site as a whole.

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## INTRODUCTION

Small mammal mark-recapture studies were conducted at Los Alamos National Laboratory (LANL) at two open-detonation high explosive research and development firing sites—Minie at Technical Area (TA) 36 and Point 6 at TA-39—during August of 2010 (Bennett and Robinson 2011). The purpose of the mark-recapture studies was to evaluate the small mammal (field mice) species occurrence and population abundance at the open-detonation firing sites when compared to an undeveloped (control) site. Based on population abundance, species diversity and composition, sex ratios, and weights, the open-detonation firing sites do not appear to be adversely affecting small mammal population dynamics when compared to the undeveloped background site.

On the final day of trapping for the population study at the two detonation sites in 2010, all animals were euthanized and submitted for chemical analysis to investigate the

concentrations of various chemicals, particularly dioxin and furans, associated with open-detonation activities at LANL. Additional samples for chemical analyses were collected at both firing sites in February 2011. This chemical uptake analysis was conducted to gather information on the potential impact that the open-detonation operations conducted at TA-36 Minie and TA-39 Point 6 may have historically had on the sites. Field mice are effective indicators of contaminant presence due to their feeding and activity habits (i.e., burrowing) (Arthur et al. 1987), and at LANL they are used as the biota (radionuclide) dose (McNaughton 2006) and (chemical) uptake (Fresquez et al. 2010) models for terrestrial mammals because they have the smallest home range (~100 $m^2$).

## METHODOLOGY

### Site Descriptions

LANL is situated in northern New Mexico on the Pajarito Plateau (Figure 1), a series of finger-like mesas speared by east-to-west-oriented canyons. The mesa tops slope eastward from approximately 2377 m (7800 ft) to 1890 m (6200 ft). The surrounding land is largely undeveloped, including large tracts held by the Santa Fe National Forest, Bureau of Land Management, Bandelier National Monument, and San Ildefonso Pueblo.

The firing sites are in remote locations and specialize in experimental studies of the dynamic properties of high explosive materials under high-pressure and temperature conditions. The facilities that make up the explosives testing operations are used primarily for research, development, test operations, and detonator development and testing related to the US Department of Energy Stockpile Stewardship Program (DOE 2008).

TA-36 Minie (Solid Waste Management Unit [SWMU] 36-004[c]) is located near the head of Fence Canyon (Figure 2). TA-39 Point 6 (SWMU 39-004[c]) is located in the bottom of Ancho Canyon (Figure 3). Both of the firing sites involved within this study have been in use since the 1950s. The vegetation consists of piñon (*Pinus edulis* Engelm.)

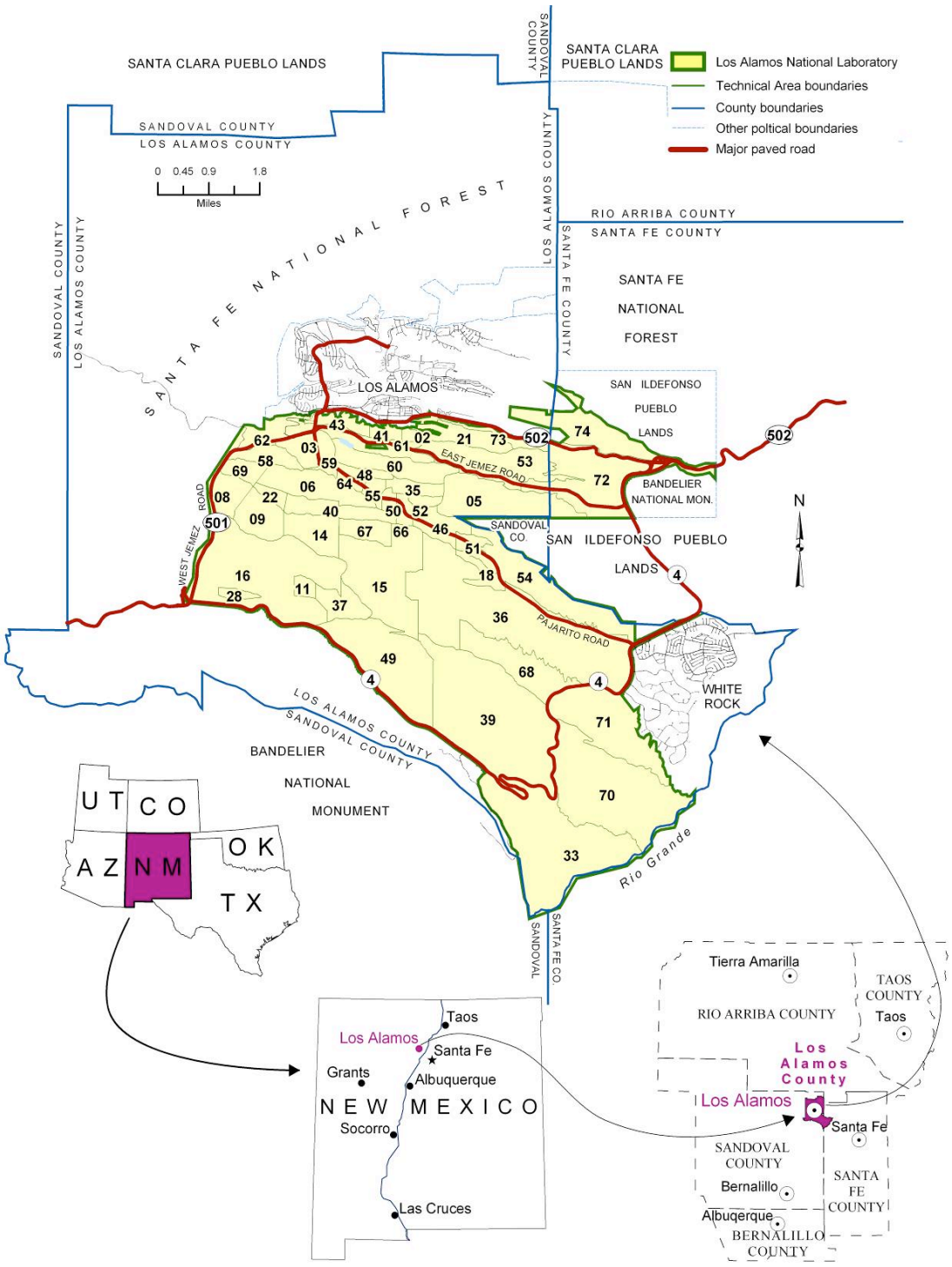


Figure 1. Location of Los Alamos National Laboratory (from Bennett and Robinson 2011)

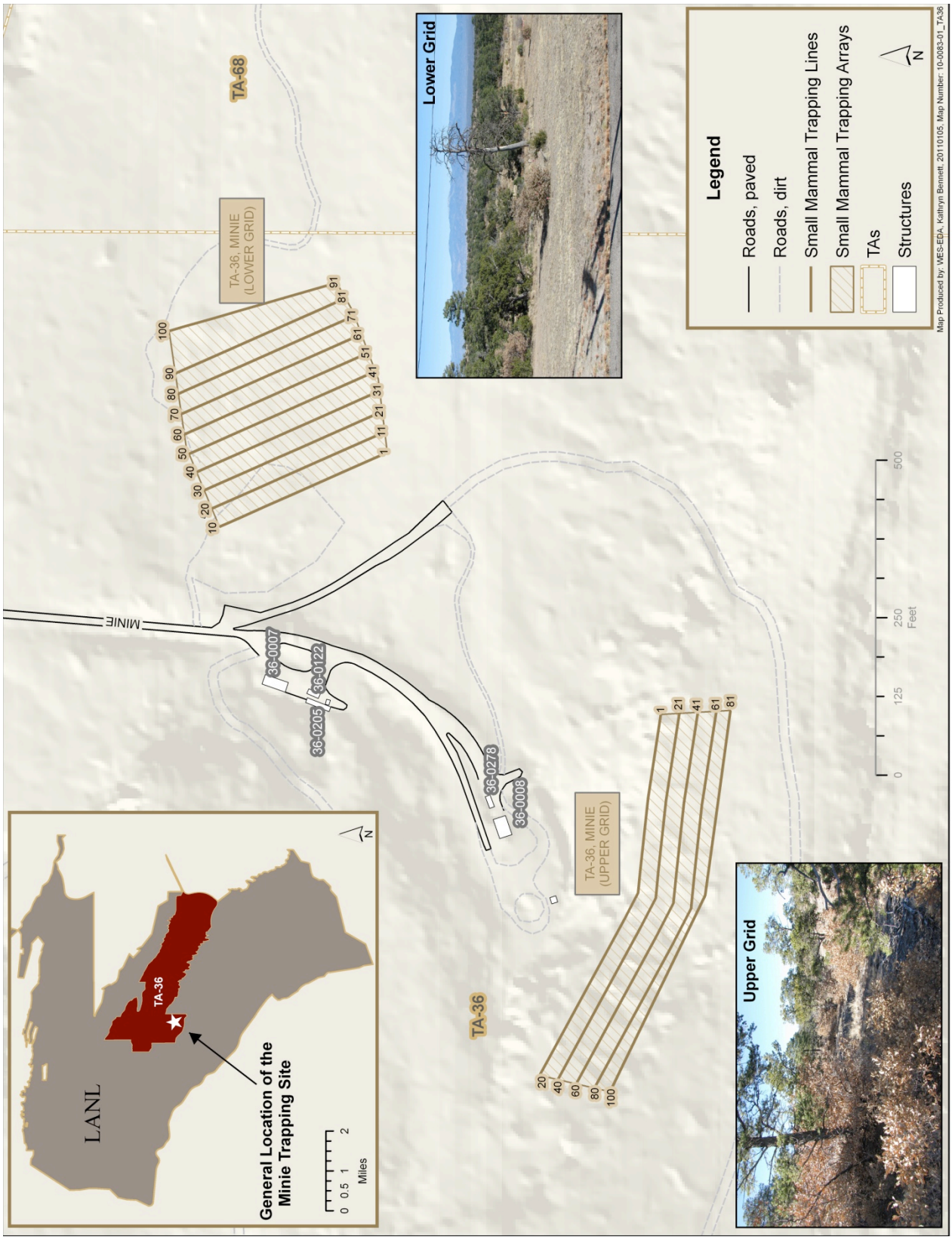


Figure 2. TA-36 Minie trapping location (from Bennett and Robinson 2011)

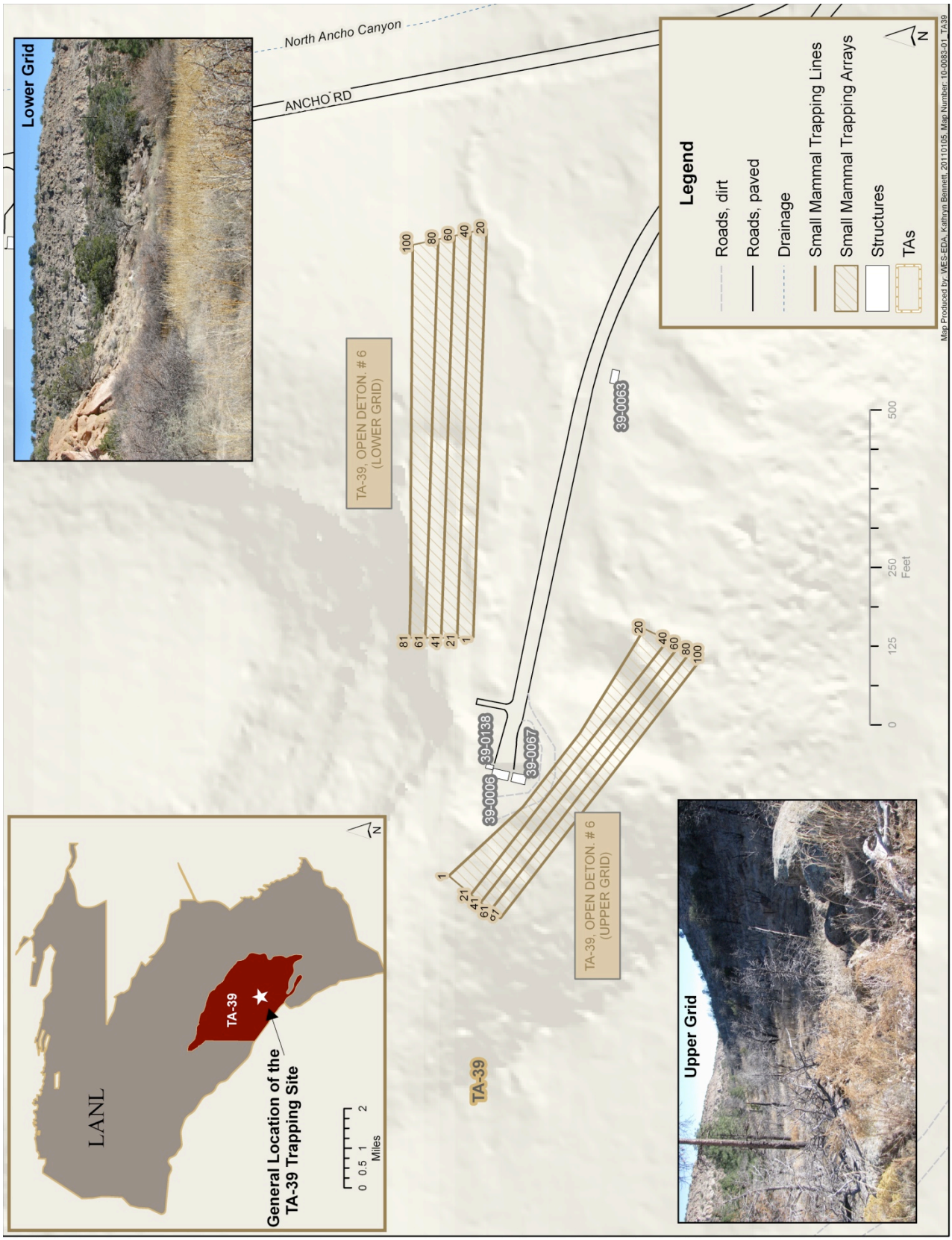


Figure 3. TA-39 Point 6 trapping location (from Bennett and Robinson 2011)

-(*Juniperus monosperma* [Englem.] Sarg.) with interspersed ponderosa pine (*Pinus ponderosa* C. Lawson) and gambel oak (*Quercus gambelii* Nutt.).

**Small Mammal Trapping**

Trapping grids, for the population study, were set up at TA-36 Minie and TA-39 Point 6 (see Figures 2 and 3). Each firing site was assigned two grids—lower and upper—with grid configuration based on topography of each site. The lower grids consisted of 10 lines of 10 traps with spacing of 10 m per trap and 10 m between each line, and these grids were situated downgradient of the firing site. The upper grids consisted of five lines of 20 traps with spacing of 10 m per trap and 10 m between each line, and these grids were situated adjacent and upgradient to the firing site. Each grid had 100 traps.

Trapping at each location took place over four consecutive nights. Traps were baited in the late afternoon with a molasses-coated horse feed and checked early each morning. Animals were collected and taken to a central location for processing. At the processing location, field mice were identified to species, weighed, sexed, and measured (total body, tail, hind foot, and ear). These data can be found in Bennett and Robinson (2011). Each animal was ear tagged and released. On the final day of trapping in 2010, all animals were euthanized, placed in double zip lock bags, and stored in a freezer at 4 degrees C. Additional samples for chemical analysis were collected in February 2011. All sample information can be found in the Appendix; the most common sample consisted of deer mice (*Peromyscus maniculatus*).

Captured mouse being weighed.

ALS (formally Paragon Analytics) Group analyzed the field mice (whole body) samples collected from TA-36 (Minie) for uranium-234, uranium-235, and uranium-238; and for target analyte list (TAL) elements (aluminum, barium, beryllium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, sodium, vanadium, zinc, antimony, arsenic, cadmium, lead, selenium, silver, thallium, and mercury) from both sites. Polychlorinated biphenyls (PCBs) (congeners, homologs, and totals) and dioxin/furans in whole body field mice from both sites were analyzed by Cape Fear Analytical Laboratory, Inc., and General Engineering Laboratories analyzed the samples for high explosives and perchlorate.

**Biota Comparison Levels**

Radionuclides and chemical concentrations in biota from Laboratory areas are first compared to regional statistical reference levels (RSRLs). RSRLs, which represent natural and fallout levels, are the upper-level background concentrations (mean plus three standard deviations = 99% confidence level) for radionuclides and chemicals calculated from biota that was collected from regional locations away from the influence of the Laboratory (over nine miles away) (DOE 1991). For radionuclides, TAL elements, high explosives, dioxin/furans, perchlorate, and PCBs in whole body field mice, RSRLs can be found in Fresquez (2009, 2011).

If the levels of radionuclides in field mice collected from potentially impacted areas are higher than the RSRLs, the concentrations are compared to (tissue) screening levels (SLs) and then to standards. Biota SLs were set at 10% (0.01-rad/day) of the standard for terrestrial animals (0.1-rad/day) (DOE 2002) by the dose assessment team at the Laboratory to identify the potential contaminants of concern (McNaughton 2006).

There are no regulatory SLs for chemicals in tissues of biota; so if chemicals in biota are higher than the RSRLs then the chemical concentration in the soil at the place of collection are compared with ecological screening levels (ESLs) (LANL 2010). ESLs are LANL derived and are designed to reflect the concentration of a chemical in the soil that is not expected to produce any adverse effects on selected biota receptors that commonly come into contact with soil or ingest biota that live in or on soil (i.e., they are the

concentrations that are protective of ecological receptors under chronic exposure conditions).

## RESULTS

### TA-36 Minie

a. Uranium Isotopes. The concentration of uranium-238 in a composite whole body field mouse sample (n = 5 subsamples) was the only uranium isotope out of the three that was detected in higher amounts than the RSRL (Table 1). The amount of uranium-238, however, was two orders of magnitude below the biota dose screening level. Based on the isotopic distribution of uranum-234 and uranium-238, the source of uranium was depleted uranium.

**Table 1. Uranium isotopes (pCi/g ash) in a composite whole body field mouse sample (n = 5) collected from TA-36 Minie in 2010. (Bold values are higher than 3TPU and the RSRL.)**

| Radionuclide[a] | Sample #3214 | 3TPU[b] | RSRL[c] | SL[d] |
|---|---|---|---|---|
| Uranium-234 | 0.066 | 0.025 | 0.11 | 46 |
| Uranium-235/236 | 0.0055 | 0.0069 | 0.0092 | 46 |
| Uranium-238 | **0.261** DU[e] | 0.072 | 0.098 | 46 |

[a]Method was by alpha spectrometry.
[b]Values are the total propagated uncertainty at the 99% confidence level.
[c]Regional Statistical Reference Level; this is the upper-limit regional background concentration (mean + 3 std dev) based on Fresquez (2009).
[d]Screening Level is based on 0.01 rad/day.
[e]DU = depleted uranium based on the distribution of U-234 to U238.
Sample #SFB-10-11-3214 contained five mice—three from the upper grid and two from the lower grid.

b. TAL Elements. Most TAL elements in field mice (n = 3) collected from TA-36 Minie were below RSRLs (Table 2). The only two elements that were higher than the RSRLs were barium in two out of the three samples and lead in three out of the three samples. However, based on the highest concentration of barium in the soil at TA-36 Minie (204 mg/kg) (Vigil-Holterman and Juarez 2011a), the level was below the ESL of 1800 mg/kg for the field mouse (LANL 2010). Similarly, the highest lead concentration detected in soil at TA-36 Minie was 44 mg/kg (Vigil-Holterman and Juarez 2011a) and is lower than the ESL for the field mouse of 120 mg/kg (LANL 2010).

**Table 2. TAL elements (mg/kg wet) in whole body field mice collected from TA-36 Minie and TA-39 Point 6 in 2010. (Bold values are higher than the RSRL.)**

| | TA-36 OD Minie | | | TA-39 OD Point 6 | | | |
|---|---|---|---|---|---|---|---|
| **Element[a]** | **3202/U[d]** | **3203/L** | **3204/U** | **3215/L** | **3216/U** | **3217/L** | **RSRL[b]** |
| Aluminum | 6.0 | 13 | 8.9 | 11 | 17 | 13 | 73 |
| Barium | **5.6** | 3.6 | **5.8** | **8.6** | **5.2** | 2.0 | 5.1 |
| Beryllium[c] | 0.00065 | 0.0015 | 0.00095 | 0.00090 | 0.00085 | 0.00075 | 0.016 |
| Calcium | 6800 | 6000 | 7700 | 8000 | 8100 | 7000 | 12624 |
| Chromium | 0.21 | 0.23 | 0.32 | 0.23 | 0.37 | 0.26 | 0.40 |
| Cobalt | 0.021 | 0.023 | 0.016 | 0.018 | 0.025 | 0.015 | 0.072 |
| Copper | 2.6 | 1.9 | 1.8 | 2.6 | 2.0 | 1.5 | 6.2 |
| Iron | 40 | 52 | 57 | 53 | 59 | 53 | 140 |
| Magnesium | 200 | 270 | 230 | 270 | 220 | 160 | 544 |
| Manganese | 0.94 | 1.7 | 0.94 | 1.5 | 1.2 | 0.97 | 7.6 |
| Nickel | 0.042 | 0.083 | 0.035 | 0.046 | 0.057 | 0.074 | 0.11 |
| Potassium | 2600 | 2600 | 2900 | 2400 | 2900 | 1700 | 3677 |
| Sodium | 1300 | 1000 | 1300 | 1100 | 1200 | 860 | 1920 |
| Vanadium | 0.0076 | 0.024 | 0.0064 | 0.013 | 0.027 | 0.015 | 0.14 |
| Zinc | 35 | 77 | 100 | 35 | 36 | 83 | 119 |
| Antimony | 0.034 | 0.084 | 0.030 | 0.043 | 0.066 | 0.12 | 0.17 |
| Arsenic | 0.0076 | 0.014 | 0.011 | 0.0060 | 0.0093 | 0.010 | 0.089 |
| Cadmium | 0.035 | 0.0039 | 0.0071 | 0.0020 | 0.010 | 0.015 | 0.039 |
| Lead | **0.50** | **0.66** | **0.99** | **3.0** | **1.0** | **0.82** | 0.49 |
| Selenium | 0.32 | 0.27 | 0.28 | 0.27 | 0.34 | **0.42** | 0.40 |
| Silver | 0.00087 | 0.0014 | 0.0010 | 0.00081 | 0.00087 | 0.0012 | 0.020 |
| Thallium | 0.0012 | 0.0020 | 0.0018 | 0.0027 | 0.0023 | 0.0027 | 0.0055 |
| Mercury | 0.0047 | 0.0017 | 0.0037 | 0.0013 | 0.0042 | 0.0017 | 0.013 |

[a]Al to Zn by method SW6010B and analyzed by inductively coupled plasma; Sb to Tl by method SW6020B and analyzed by inductively coupled plasma mass spectroscopy; Hg by method SW7471 and analyzed by cold vapor atomic adsorption.
[b]Regional Statistical Reference Level; this is the upper-limit regional background concentration (mean + 3 std dev) based on Fresquez (2009).
[c]All U flagged undetected (<minimum detection limit [MDL]) TAL elements were reported as one-half the MDL; all B flagged estimated values (>MDL but <RL) were reported.
[d]Sample number/grid location (U = upper, L = lower)

c. Dioxin and Furans. There were no dioxin or furan concentrations that were detected above the standard quantification limit (SQL) (i.e., reporting level) in any of the eight whole body field mouse samples (Table 3).

d. High Explosives and Perchlorate. There were no detections of high explosives above the SQL in any of the four whole body field mice samples at TA-36 Minie (Table 4). Similarly, all field mouse samples (n = 4) contained perchlorate concentrations below the RSRL.

e. Polychlorinated Biphenyls. Total PCBs in three of the five whole body field mice samples collected from TA-36 Minie were slightly higher than the RSRL calculated from non-urban sites (undisturbed grasslands) but quite lower than the RSRL estimated from field mice collected near an urban waste transfer station in Española, NM (Table 5). Nevertheless, the highest PCB amounts detected in soil at TA-36 Minie (Aroclor 1248 = 0.0054 mg/kg, Aroclor 1254 = 0.0036 mg/kg, and Aroclor 1260 = 0.021 mg/kg) (Vigil-Holterman and Juarez 2011a) were all below the ESLs for the deer mouse (Aroclor 1248 = 0.014 mg/kg, Aroclor 1254 = 0.88 mg/kg, and Aroclor 1260 = 20 mg/kg) (LANL 2010).

**TA-39 Point 6**

a. TAL Elements. Most TAL elements in whole body field mice from TA-39 Point 6 (n = 3) were below or similar to the RSRLs (see Table 2). As in field mice from TA-36 Minie, the only two TAL elements that were found to be higher than the RSRLs were barium in two of the three samples and lead in all three samples. Based on the highest barium concentration in soil at TA-39 Point 6 measured in 1995 (302 mg/kg) (LANL PRS Database) and in 2010 (99 mg/kg) (Vigil-Holterman and Juarez 2011b), the levels are well below the ESL of 1800 mg/kg for field mice (LANL 2010). Conversely, the highest lead concentrations detected in soil at TA-39 Point 6 in 1995 (978 mg/kg) (LANL PRS Database) and in 2010 (375 mg/kg) (Vigil-Holterman and Juarez 2011b) were higher than the ESL of 120 mg/kg (LANL 2010). Undoubtedly, the highest lead concentrations in soil at TA-39 Point 6 were probably associated with samples collected on or near the firing pad; however, based on the average soil lead concentration from two sampling

**Table 3. Dioxin and furan concentrations (pg/g wet) in whole body field mice samples collected from TA-36 Minie in 2010/11.**

| | Aug-10 | | | | | | | | | | Feb-11 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dioxin/Furan[a] | 3205/L[bc] | Lab Q | 3206/L | Lab Q | 3207/U | Lab Q | 3208/U | Lab Q | 3209/U | Lab Q | 5081/L | Lab Q | 5083/L | Lab Q | 5085/L | Lab Q |
| **Dioxins** | | | | | | | | | | | | | | | | |
| Tetrachlorodibenzodioxin[2,3,7,8-] | 0.175 | U | 0.501 | U | 0.173 | U | 0.482 | U | 0.535 | U | 0.084 | U | 0.0668 | U | 0.0734 | U |
| Tetrachlorodibenzodioxins (Total) | 0.175 | U | 0.501 | U | 0.173 | U | 0.482 | U | 0.535 | U | 0.084 | U | 0.0668 | U | 0.0734 | U |
| Pentachlorodibenzodioxin[1,2,3,7,8-] | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Pentachlorodibenzodioxins (Total) | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Hexachlorodibenzodioxin[1,2,3,4,7,8-] | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Hexachlorodibenzodioxin[1,2,3,6,7,8-] | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Hexachlorodibenzodioxin[1,2,3,7,8,9-] | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Hexachlorodibenzodioxins (Total) | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Heptachlorodibenzodioxin[1,2,3,4,6,7,8-] | 1.04 | J | 0.474 | U | 0.478 | U | 0.726 | U | 0.622 | J | 0.42 | U | 0.334 | U | 0.367 | U |
| Heptachlorodibenzodioxins (Total) | 4.6 | J | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.412 | J |
| Octachlorodibenzodioxin[1,2,3,4,6,7,8,9-] | 3.59 | J | 1.67 | J | 0.956 | U | 1.45 | U | 1.61 | J | 0.896 | J | 0.668 | U | 1.25 | J |
| **Furans** | | | | | | | | | | | | | | | | |
| Tetrachlorodibenzofuran[2,3,7,8-] | 0.165 | J | 0.258 | J | 0.222 | J | 0.311 | J | 0.359 | J | 0.257 | J | 0.156 | J | 0.211 | J |
| Tetrachlorodibenzofurans (Totals) | 0.379 | J | 0.493 | J | 0.468 | J | 0.311 | J | 0.698 | J | 0.464 | J | 0.289 | J | 0.188 | J |
| Pentachlorodibenzofuran[1,2,3,7,8-] | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Pentachlorodibenzofuran[2,3,4,7,8-] | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Pentachlorodibenzofurans (Totals) | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Hexachlorodibenzofuran[1,2,3,4,7,8-] | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Hexachlorodibenzofuran[1,2,3,6,7,8-] | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Hexachlorodibenzofuran[1,2,3,7,8,9-] | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |

**Table 3 (cont.)**

| | Aug-10 | | | | | | | | | | Feb-11 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Furans (cont.)** | **3205/L[bc]** | **Lab Q** | **3206/L** | **Lab Q** | **3207/U** | **Lab Q** | **3208/U** | **Lab Q** | **3209/U** | **Lab Q** | **5081/L** | **Lab Q** | **5083/L** | **Lab Q** | **5085/L** | **Lab Q** |
| Hexachlorodibenzofuran[2,3,4,6,7,8-] | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Hexachlorodibenzofurans (Total) | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Heptachlorodibenzofuran[1,2,3,4,6,7,8-] | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Heptachlorodibenzofuran[1,2,3,4,7,8,9-] | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Heptachlorodibenzofurans (Total) | 0.496 | U | 0.474 | U | 0.478 | U | 0.726 | U | 0.557 | U | 0.42 | U | 0.334 | U | 0.367 | U |
| Octachlorodibenzofuran[1,2,3,4,6,7,8,9-] | 0.992 | U | 0.949 | U | 0.956 | U | 1.45 | U | 1.11 | U | 0.84 | U | 0.668 | U | 0.734 | U |

[a]Method blank corrected data.
[b]Sample number/grid location (U = upper, L = lower).
[c]Results as related to the Laboratory Qualifier: Result followed by a blank space is a Detected value = result was above the reporting limit (RL); Result followed by a U is an Undetected value = result was below the minimum detectable level (MDL) (Shown); Result followed by a J is an Estimated value = result was above the MDL but below the RL.

**Table 4. High explosives (µg/kg wet) and perchlorate (mg/kg wet) in whole body field mice collected from TA-36 Minie and TA-39 Point 6 in 2010. (Bold values are higher than the RSRL.)**

| | | TA-36 OD Minie | | | | TA-39 OD Site 6 | | |
|---|---|---|---|---|---|---|---|---|
| **High Explosives/Perchlorate** | **RL[a]** | **3210/U[b]** | **3211/L** | **3212/L** | **3213/U** | **3221/L** | **3222/U** | **RSRL[c]** |
| 2,4-Diamino-6-nitrotoluene | 2000 | U[d] | U | U | U | U | U | |
| 2,6-Diamino-4-nitrotoluene | 2000 | U | U | U | U | U | U | |
| 3,5-Dinitroaniline | 1000 | U | U | U | U | U | U | |
| Amino-2,6-dinitrotoluene[4-] | 500 | U | U | U | U | U | U | |
| Amino-4,6-dinitrotoluene[2-] | 500 | U | U | U | U | U | U | |
| Dinitrobenzene[1,3-] | 500 | U | U | U | U | U | U | |
| Dinitrotoluene[2,4-] | 500 | U | U | U | U | U | U | |
| Dinitrotoluene[2,6-] | 500 | U | U | U | U | U | U | |
| HMX | 500 | U | U | U | U | U | U | |
| Nitrobenzene | 500 | U | U | U | U | U | U | |
| Nitrotoluene[2-] | 500 | U | U | U | U | U | U | |
| Nitrotoluene[3-] | 500 | U | U | U | U | U | U | |
| Nitrotoluene[4-] | 500 | U | U | U | U | U | U | |
| PETN | 1000 | U | U | U | U | U | U | |
| RDX | 500 | U | U | U | U | U | U | |
| TATB | 1000 | U | U | U | U | U | U | |
| Tetryl | 500 | U | U | U | U | U | U | |
| Trinitrobenzene[1,3,5-] | 500 | U | U | U | U | U | U | |
| Trinitrotoluene[2,4,6-] | 500 | U | U | U | U | U | U | |
| Tris (o-cresyl) phosphate | 1000 | U | U | U | U | U | U | |
| Perchlorate | 0.0040 | 0.028 | 0.012 | 0.012 | 0.096 | 0.12 | 0.088 | 0.19 |

[a]Reporting level (standard quantification limit).
[b]Sample number/grid location (U = upper, L = lower).
[c]Regional Statistical Reference Level; this is the upper-level background concentration (mean + 3 SD) based on data from Fresquez (2011).
[d]Laboratory Qualifier. (Detected) = result was above the reporting limit (RL); U (Undetected) = result was below the minimum detectable level (MDL); J (Estimated) = result was above the MDL but below the RL.

**Table 5. Polychlorinated biphenyl (PCB) homologs and totals (pg/g wet) in whole body field mice collected from TA-36 Minie in 2010/2011. (Total PCBs highlighted in bold are higher than the RSRL.)**

| | Aug-10 | | | | Feb-11 | | | | | | RSRL[c] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PCB Homolog/Total | 3205/L[ab] | Lab Q | 3206/L | Lab Q | 5080/L | Lab Q | 5084/L | Lab Q | 5082/L | Lab Q | Non-Urban | Urban |
| Total monoCB | 5.62 | U | 5.69 | U | 6.76 | U | 5.36 | U | 5.1 | U | | |
| Total diCB | 5.62 | U | 5.69 | U | 6.76 | U | 5.36 | U | 5.1 | U | | |
| Total triCB | 26.3 | | 5.69 | U | 6.76 | U | 5.36 | U | 5.1 | U | | |
| Total tetraCB | 5.62 | U | 5.69 | U | 6.76 | U | 5.36 | U | 5.1 | U | | |
| Total pentaCB | 73.8 | | 93.2 | | 19.7 | | 36.8 | | 15.2 | | | |
| Total hexaCB | 1140 | | 1860 | | 147 | | 443 | | 82.1 | | | |
| Total heptaCB | 1500 | | 4120 | | 163 | | 428 | | 88.4 | | | |
| Total octaCB | 540 | | 1850 | | 48.2 | | 164 | | 11.4 | | | |
| Total nonaCB | 130 | | 146 | | 6.76 | U | 12 | | 5.1 | U | | |
| Total decaCB | 66.2 | | 30.1 | | 6.76 | U | 5.36 | U | 5.1 | U | | |
| Total PCB | 3470 | | 8100 | | 378 | | 1080 | | 197 | | 885 | 28000 |

[a]Sample number/grid location (U = upper, L = lower).
[b]Result as related to Laboratory Qualifiers: Result followed by a blank space is a Detected value = result was above the standard quantification limit (SQL); Result followed by a U is an Undetected value = result was below the minimum detectable level (MDL) (shown); Result followed by a J is an Estimated value = result was above the MDL but below the SQL.
[c]Regional Statistical Reference Level; this is the upper-limit regional background concentration (mean + 3 std dev) based on Fresquez (2011).

periods over the entire site, the amount (82 mg/kg; n = 57) (LANL PRS Database, Vigil-Holterman and Juarez 2011b) was lower than the ESL for field mice.

b. Dioxin and Furans. Out of the six field mice samples collected in August of 2010 and February of 2011, only one sample and for only one compound, pentachlorodibenzofuran [2,3,4,7,8-], was detected above the SQL (Table 6). The amount (5.26 pg/g wet weight), however, was just above the reporting limit of 4.8 pg/g wet weight, and there were no detections of this compound above the reporting limit in soil samples collected from the site (Vigil-Holterman and Juarez 2011b); thus, these data in the tissue of one field mouse sample out of six may be a false positive.

c. High Explosives and Perchlorate. There were no detections of high explosives above the SQLs in any of the field mice samples (n = 2) collected at TA-39 Point 6 (see Table 4). Similarly, the amounts of perchlorate (n = 2) were below the RSRL.

d. Polychlorinated Biphenyls. Two out of five whole body field mouse samples collected from TA-39 Point 6 were higher in total PCBs than either of the RSRLs (Table 7). These two samples were collected from the upper grid, which is closer to the firing site, as compared to the other three samples being collected at the lower grid, which is further away. Nevertheless, the highest PCB amounts detected in soil at TA-39 Point 6 (Aroclor 1254 = 0.042 mg/kg and Aroclor 1260 = 0.018 mg/kg) (Vigil-Holterman and Juarez 2011b) were still below the ESLs for the deer mouse (Aroclor 1254 = 0.88 mg/kg and Aroclor 1260 = 20 mg/kg) (LANL 2010).

**CONCLUSIONS**

The tissues of the biota collected from TA-36 Minie indicated that analyzed concentrations were below the RSRLs or applicable SLs or soil comparisons. Similarly, at TA-39 Point 6, with the exception of lead, there were no detections of inorganic and organic chemicals in whole body tissues of field mice above RSRLs or applicable SLs or soil comparisons. Additionally, average lead concentrations over the TA-39 Point 6 site indicate that the site as a whole is not above ESLs for the field mouse. In conclusion, none of whole body tissue concentrations within the samples collected from TA-36 Minie or from TA-39 Point 6 appear to significantly impact the field mice population. In fact,

**Table 6. Dioxin and furan concentrations (pg/g wet) in whole body field mice samples collected from TA-39 Point 6 in 2010/2011.**

| | Aug-10 | | | | | | Feb-11 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dioxin/Furan[a]** | **3218/L[b,c]** | **Lab Q** | **3219/U** | **Lab Q** | **3220/U** | **Lab Q** | **5548/L** | **Lab Q** | **5550/L** | **Lab Q** | **5552/L** | **Lab Q** |
| **Dioxins** | | | | | | | | | | | | |
| Tetrachlorodibenzodioxin[2,3,7,8-] | 0.442 | U | 0.287 | U | 0.245 | U | 0.081 | U | 0.0845 | U | 0.0692 | U |
| Tetrachlorodibenzodioxins (Total) | 0.442 | U | 0.287 | U | 0.245 | U | 0.081 | U | 0.0845 | U | 0.0692 | U |
| Pentachlorodibenzodioxin[1,2,3,7,8-] | 0.487 | U | 0.484 | U | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Pentachlorodibenzodioxins (Total) | 0.487 | U | 0.484 | U | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Hexachlorodibenzodioxin[1,2,3,4,7,8-] | 0.487 | U | 0.484 | U | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Hexachlorodibenzodioxin[1,2,3,6,7,8-] | 0.487 | U | 0.484 | U | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Hexachlorodibenzodioxin[1,2,3,7,8,9-] | 0.487 | U | 0.484 | U | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Hexachlorodibenzodioxins (Total) | 0.487 | U | 0.484 | U | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Heptachlorodibenzodioxin[1,2,3,4,6,7,8-] | 0.487 | U | 1.1 | J | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Heptachlorodibenzodioxins (Total) | 0.487 | U | 1.1 | J | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Octachlorodibenzodioxin[1,2,3,4,6,7,8,9-] | 1.07 | J | 2.06 | J | 1.03 | J | 0.81 | U | 0.803 | U | 0.728 | J |
| **Furans** | | | | | | | | | | | | |
| Tetrachlorodibenzofuran[2,3,7,8-] | 0.345 | J | 0.323 | J | 0.655 | J | 0.177 | J | 0.169 | J | 0.208 | J |
| Tetrachlorodibenzofurans (Totals) | 0.633 | J | 0.434 | J | 0.655 | J | 0.499 | J | 0.492 | J | 0.421 | J |
| Pentachlorodibenzofuran[1,2,3,7,8-] | 0.487 | U | 0.484 | U | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Pentachlorodibenzofuran[2,3,4,7,8-] | 0.489 | J | **5.26** | | 0.773 | J | 0.405 | U | 0.402 | U | 0.346 | U |
| Pentachlorodibenzofurans (Totals) | 0.489 | J | **5.26** | | 0.773 | J | 0.405 | U | 0.402 | U | 0.346 | U |
| Hexachlorodibenzofuran[1,2,3,4,7,8-] | 0.487 | U | 0.484 | U | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Hexachlorodibenzofuran[1,2,3,6,7,8-] | 0.487 | U | 0.484 | U | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Hexachlorodibenzofuran[1,2,3,7,8,9-] | 0.487 | U | 0.484 | U | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |

**Table 6 (cont.)**

| | Aug-10 | | | | | | Feb-11 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Furans (cont.)** | **3218/L[b,c]** | **Lab Q** | **3219/U** | **Lab Q** | **3220/U** | **Lab Q** | **5548/L** | **Lab Q** | **5550/L** | **Lab Q** | **5552/L** | **Lab Q** |
| Hexachlorodibenzofuran[2,3,4,6,7,8-] | 0.487 | U | 0.571 | J | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Hexachlorodibenzofurans (Total) | 0.487 | U | 0.571 | J | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Heptachlorodibenzofuran[1,2,3,4,6,7,8-] | 0.487 | U | 0.484 | U | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Heptachlorodibenzofuran[1,2,3,4,7,8,9-] | 0.487 | U | 0.484 | U | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Heptachlorodibenzofurans (Total) | 0.487 | U | 0.484 | U | 0.495 | U | 0.405 | U | 0.402 | U | 0.346 | U |
| Octachlorodibenzofuran[1,2,3,4,6,7,8,9-] | 0.974 | U | 0.968 | U | 0.989 | U | 0.81 | U | 0.803 | U | 0.692 | U |

[a]Method blank corrected data.
[b]Sample number/grid location (U = upper, L = lower).
[c]Results as related to the Laboratory Qualifier: Result followed by a blank space (Detected) = result was above the reporting limit (RL); Result followed by a U (Undetected) = result was below the minimum detectable level (MDL) (Shown); Result followed by an J (Estimated) = result was above the MDL but below the RL.

**Table 7. Polychlorinated biphenyl (PCB) homologs and totals (pg/g wet) in whole body field mice collected from TA-39 Point 6 in 2010/2011. (Total PCBs highlighted in bold are higher than the RSRL.)**

| | Aug-10 | | | | Feb-11 | | | | | | RSRL[c] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PCB Homolog/Total | 3219/U[ab] | Lab Q | 3220/U | Lab Q | 5549/L | Lab Q | 5551/L | Lab Q | 5553/L | Lab Q | Non-Urban | Urban |
| Total monoCB | 4.77 | U | 3.42 | U | 5.99 | U | 5.97 | U | 5.6 | U | | |
| Total diCB | 4.77 | U | 3.42 | U | 5.99 | | 5.97 | U | 5.6 | | | |
| Total triCB | 5.06 | B | 49.8 | | 5.99 | | 5.97 | | 5.6 | | | |
| Total tetraCB | 9.72 | B | 41.5 | B | 5.99 | | 5.97 | | 5.6 | | | |
| Total pentaCB | 3370 | | 12100 | | 65.1 | | 34 | | 5.6 | | | |
| Total hexaCB | 44900 | | 16400 | | 471 | | 189 | | 65.9 | | | |
| Total heptaCB | 9820 | | 4070 | | 313 | | 71.7 | | 39.2 | | | |
| Total octaCB | 1020 | | 802 | | 130 | | 33.2 | | 10.7 | | | |
| Total nonaCB | 86.2 | | 90.1 | | 19.3 | | 5.97 | U | 5.6 | U | | |
| Total decaCB | 8.58 | | 3.42 | U | 5.99 | U | 5.97 | U | 5.6 | U | | |
| Total PCB | **59300** | | **33600** | | 998 | | 328 | | 116 | | 857 | 28000 |

[a]Sample number/grid location (U = upper, L = lower).
[b]Result as related to Laboratory Qualifiers: Result followed by a blank space is a Detected value = result was above the standard quantification limit (SQL); Result followed by a U is an Undetected value = result was below the minimum detectable level (MDL) (shown); Result followed by a J is an Estimated value = result was above the MDL but below the SQL.
[c]Regional Statistical Reference Level; this is the upper-limit regional background concentration (mean + 3 std dev) based on Fresquez (2011).
B = blank corrected.

Bennett and Robinson (2011) reported that the populations from these two detonation sites were similar to an undisturbed background location.

We acknowledge that the sample numbers for chemical analysis in some cases may be small and recommend more sampling over time.

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## APPENDIX

**Information on field mice collected at open-detonation firing sites TA-36 Minie and TA-39 Point 6**

| | | | | | | | Constituents Analyzed | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **TA** | **Species Name** | **Ear Tag #** | **Date Collected** | **Weight (g)** | **Sample #** | **Grid Location** | **Uranium Isotopes** | **Dioxin/ Furans** | **PCB Congeners** | **HE/ Perchlorate** | **TAL Elements** |
| | | | | | SFB10-11- | | | | | | |
| 36 | REME | 4033 | 8/13/10 | 20 | 3202 | Upper | | | | | X |
| 36 | PEMA | 4040 | 8/13/10 | 10.5 | 3203 | Lower | | | | | X |
| 36 | PEMA | 2 | 8/13/10 | 17 | 3204 | Upper | | | | | X |
| 36 | PEMA | 4029 | 8/10/10 | 17 | 3205 | Lower | | X | X | | |
| 36 | PEMA | 4028 | 8/13/10 | 17.5 | 3206 | Lower | | X | X | | |
| 36 | REME | 4036 | 8/13/10 | 11 | 3207 | Upper | | X | | | |
| 36 | REME | 3 | 8/13/10 | 7 | 3208 | Upper | | X | | | |
| 36 | REME | 4034 | 8/13/10 | 8.5 | 3209 | Upper | | X | | | |
| 36 | REME | | 8/10/10 | 14.5 | 3210 | Upper | | | | X | |
| 36 | PETR | 1 | 8/13/10 | 25 | 3211 | Lower | | | | X | |
| 36 | PETR | 4027 | 8/13/10 | 34 | 3212 | Lower | | | | X | |
| 36 | PEMA | 4037 | 8/13/10 | 19 | 3213 | Upper | | | | X | |
| 36 | 4 PEMA<br>1 NEME | 4043, 4032, 4030, 4035, 4048 | 8/13/10 | Composite | 3214 | 3U, 2L | X | | | | |
| | | | | | MICE36-11- | | | | | | |
| 36 | PETR | | 2/17/11 | 10 | 5080 | Lower | | | X | | |
| 36 | PEMA | | 2/15/11 | 15 | 5084 | Lower | | | X | | |
| 36 | PEBO | | 2/15/11 | 19 | 5085 | Lower | | X | | | |
| 36 | REME | | 2/17/11 | 11.5 | 5081 | Lower | | X | | | |
| 36 | PEMA | | 2/17/11 | 17 | 5082 | Lower | | | X | | |
| 36 | PEMA | | 2/17/11 | 15.5 | 5083 | Lower | | X | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 39 | PEMA | 4098 | 8/26/10 | 16.5 | 3215 | Lower | | | | | X |
| 39 | PEBO | 2602 | 8/26/10 | 19.5 | 3216 | Upper | | | | | X |
| 39 | PEMA | 4085 | 8/26/10 | 27 | 3217 | Lower | | | | | X |
| 39 | PEMA | 2603 | 8/26/10 | 10.5 | 3218 | Lower | X | | | | |
| 39 | PEMA | 4080 | 8/23/10 | 17 | 3219 | Upper | X | X | | | |
| 39 | PEMA | 4083 | 8/26/10 | 25 | 3220 | Upper | X | X | | | |
| 39 | PEMA | 4090 | 8/26/10 | 15.5 | 3221 | Lower | | | X | | |
| 39 | PEMA | 4082 | 8/26/10 | 12.5 | 3222 | Upper | | | X | | |
| 39 | PEMA | | 2/24/11 | 12.5 | MICE39-11-5550 | Lower | X | | | | |
| 39 | PEMA | | 3/1/11 | 19 | 5553 | Lower | | X | | | |
| 39 | PEMA | | 2/23/11 | 17 | 5549 | Lower | | X | | | |
| 39 | PEMA | | 2/23/11 | 12 | 5548 | Lower | X | | | | |
| 39 | PEMA | | 2/24/11 | 16 | 5551 | Lower | | X | | | |
| 39 | PEMA | | 2/24/11 | 13.5 | 5552 | Lower | X | | | | |

PEMA = deer mouse (*Peromyscus maniculatus*)
PETR = pinyon mouse (*Peromyscus truei*)
REME = western harvest mouse (*Reithrodontomys megalotis*)
PEBO = brush mouse (*Peromyscus boylii*)
NEME = Mexican wood rat (*Neotoma mexicana*)
Sample Coordinates:

TA-36, upper grid (X = 1631558 and Y = 1756103) and lower grid (X = 1632355 and Y = 1756697)
TA-39, upper grid (X = 1636020 and Y = 1746329) and lower grid (X = 1636562 and Y = 1746542)