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The Effects of the Cerro Grande Fire (Smoke and Fallout Ash) on Possible Contaminants in Soils and Crops Downwind of Los Alamos National Laboratory

Los Alamos
NATIONAL LABORATORY

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THE EFFECTS OF THE CERRO GRANDE FIRE (SMOKE AND FALLOUT ASH) ON POSSIBLE CONTAMINANTS IN SOILS AND CROPS DOWNWIND OF LOS ALAMOS NATIONAL LABORATORY

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ABSTRACT

Soils and crops were collected from farming areas located predominantly downwind of the Cerro Grande Fire (CGF) (and Los Alamos National Laboratory [LANL]) in northern New Mexico to determine the effects of smoke and fallout ash on possible contaminant levels of radionuclides, trace elements, and organic constituents (soils only). To this end, soils and crops from downwind areas were compared to soils and crops from farming areas located predominantly upwind of the fire and to regional (background) concentrations from past years. Results show the following: (1) All radionuclide concentrations in soils collected from downwind farming locations (Abiquiu, Embudo, Española, and Ojo Sarco) were low, most were nondetectable, statistically similar ($\alpha = 0.05$) to concentrations in soils upwind of the CGF (Pecos and Cochiti [Sile]), and were below upper-level regional background concentrations measured from past years. (2) Most trace elements, with the exception of a few elements at one soil/farm location downwind of the CGF, were within trace element concentrations in soils collected upwind of the CGF and were within upper-level regional background concentrations measured from past years. (3) Most organic constituents, with the exception of trace amounts of 1,2,3,4,6,7,8,9-octachlorodibenzo-p-dioxin (OCDD) and 4,4-dichlorodiphenyl-ethylene (4,4-DDE), in soils from all sites were nondetectable. OCDD and 4,4-DDE were detected in soils collected upwind as well as downwind of the CGF. (4) All radionuclides in crops collected from farming locations downwind of the CGF (0 to 2 miles from LANL [Los Alamos]; 8 to 12 miles from LANL [San Ildefonso/El Rancho]; and 15 to 30 miles from LANL [Abiquiu/Arroyo Seco/Embudo/Española Valley/La Puebla/Ojo Sarco]) were low and most were nondetectable. Also, these concentrations were within levels found in crops collected upwind of the CGF (Cochiti/Peña Blanca/Sile) and, for the most part, were statistically indistinguishable from crops collected before the CGF in 1999. (5) Most trace elements in crops collected downwind were not significantly higher than trace elements in crops from upwind locations, and most were similar to concentrations measured from past years. Overall, the CGF did not significantly affect the soil and crop resources of farming communities downwind of LANL.

INTRODUCTION

On May 4, 2000, the National Park Service started a prescribed burn on Cerro Grande peak within Bandelier National Mounument. The fire, located approximately 3.5 miles west of Los Alamos National Laboratory (LANL), quickly grew out of control and eventually burned nearly 50,000 acres of land administered by the U.S. Forest Service, LANL, Pueblo de San Ildefonso, and Santa Clara Pueblo (LANL, 2000) (Figure 1). The Cerro Grande Fire (CGF) was fully contained by June 6.

During the fire, prevailing winds pushed large amounts of smoke and fallout ash into many of the communities predominantly north and northeast of the fire. Concerns arose that because the fire burned over considerable amounts of LANL property (around 7,500 acres), soils and crops from farming areas downwind of the fire may have become contaminated (Theresa Connaughton, Santa Fe Farmers Market Task Force, personal communication, June 6, 2000). It is well known that some areas at LANL contain radionuclides and chemicals in soils and plants above background concentrations (Fresquez et al., 1998a; Gonzales et al., 1999). This paper reports the results of radionuclide and nonradionuclide constituents in soils and crops from local area farms predominantly downwind of the CGF (and LANL). (Note: LANL annually samples air, water, soils, foodstuffs, and biota within and around the Laboratory as part of the Environmental Surveillance Program [ESP] and, after the fire, many samples of these media were collected and reported. Concerning soils [from nonfarm areas], crops [at other farming locations not directly impacted by the CGF, e.g., the White Rock/Pajarito Acres area] and fish [downstream of LANL at Cochiti reservoir] sampling after the CGF as part of the ESP, results can be found in Fresquez et al., [2000] and Fresquez et al., [n.d.], respectively.)

MATERIALS AND METHODS

On June 19–21, 2000, scientists from LANL (the New Mexico Environment Department shared [split] samples) collected six garden soil surface samples from farms north, northeast, south, and southeast of the CGF (and LANL). Four of the farms were predominantly downwind of the CGF (Abiquiu, Embudo, Española, and Ojo Sarco), whereas, the other two were south (Cochiti [Sile]) and southeast (Pecos) of the fire and

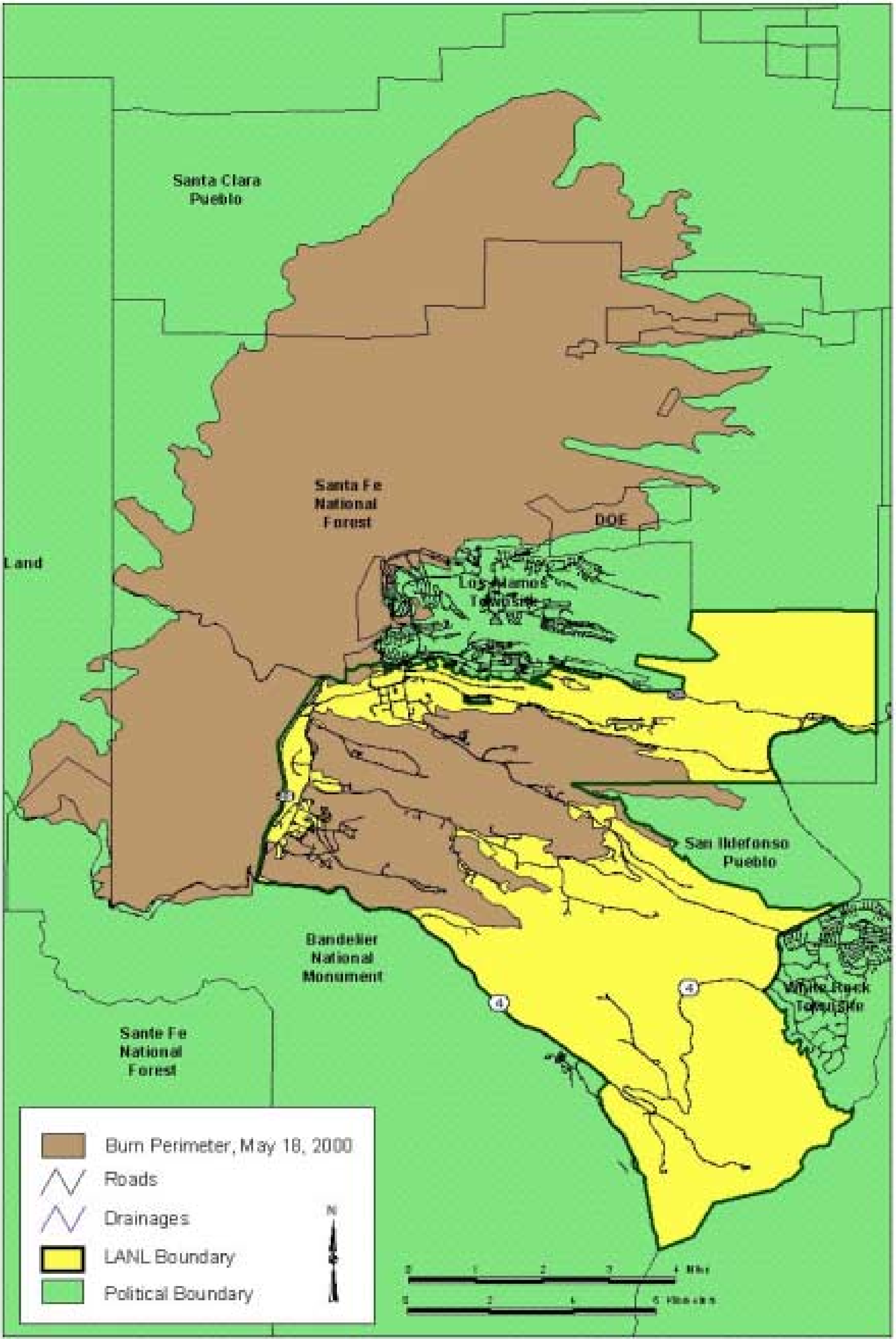

Figure 1: Cerro Grande Fire, total area burned.

not within the predominant wind direction (Figure 2). In addition, because Cochiti is downstream of LANL and crops are normally irrigated from the Rio Grande, soil was sampled after (as well as before) the irrigation season in September 2000. This was accomplished to determine the impacts of ash migrating downstream of LANL into the Rio Grande. The collection of 25 soil surface samples from (nonfarm) areas within and around LANL directly after the CGF are reported elsewhere (Fresquez et al., 2000).

For radiological, radioactivity, and trace element analysis, soil surface (0 to 2-inch depth) samples were collected with a Teflon scoop from five locations within the tilled portions of each of the six farms. All samples were placed into a large stainless steel bowl, mixed, and placed into the appropriate containers for transport and subsequent analysis; a 500-milliliter (mL) polybottle for radionuclides, a 125-mL polybottle for trace metals, a 125-mL polybottle for strontium-90 (^{90}Sr), a 500-mL amber glass bottle for organochlorine pesticides (PEST)/polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), and high explosives (HE), and a 125-mL amber glass bottle for dioxin (2,3,7,8-tetrachlorodibenzodioxin [TCDD]) and dioxinlike compounds.

All composite soil samples for radiological analysis were submitted to an environmental chemistry group at LANL (Analytical Chemistry Sciences [ACS]) for the analysis of tritium (^{3}H), cesium (^{137}Cs), plutonium (^{238}Pu and ^{239,240}Pu), americium (^{241}Am), and total uranium (^{tot}U) and gross alpha, beta, and gamma activity. Strontium-90 was analyzed by Paragon Analytics, Inc., of Fort Collins, CO. These elements were selected on the basis of their history of use at the Laboratory, activity, and decay mode (half-life), and all methods of analysis have been reported previously (Purtymun et al., 1980; Purtymun et al., 1987). Trace elements (those that are <1000 parts per million [ppm] in soil), silver (Ag), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), cobalt (Co), chromium (Cr), mercury (Hg), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), thallium (Th), and zinc (Zn), and the compound ion, cyanide (CN), were also analyzed by ACS. All methods of analysis have been previously reported (Fresquez et al., 1996). Soil samples collected for organic compounds were analyzed by Paragon Analytics, Inc., of Fort Collins, CO, for PEST (21 compounds), PCBs (7 compounds), HE (14 compounds), and PAHs (18 compounds) and Alta Analytical Laboratory, Inc., of

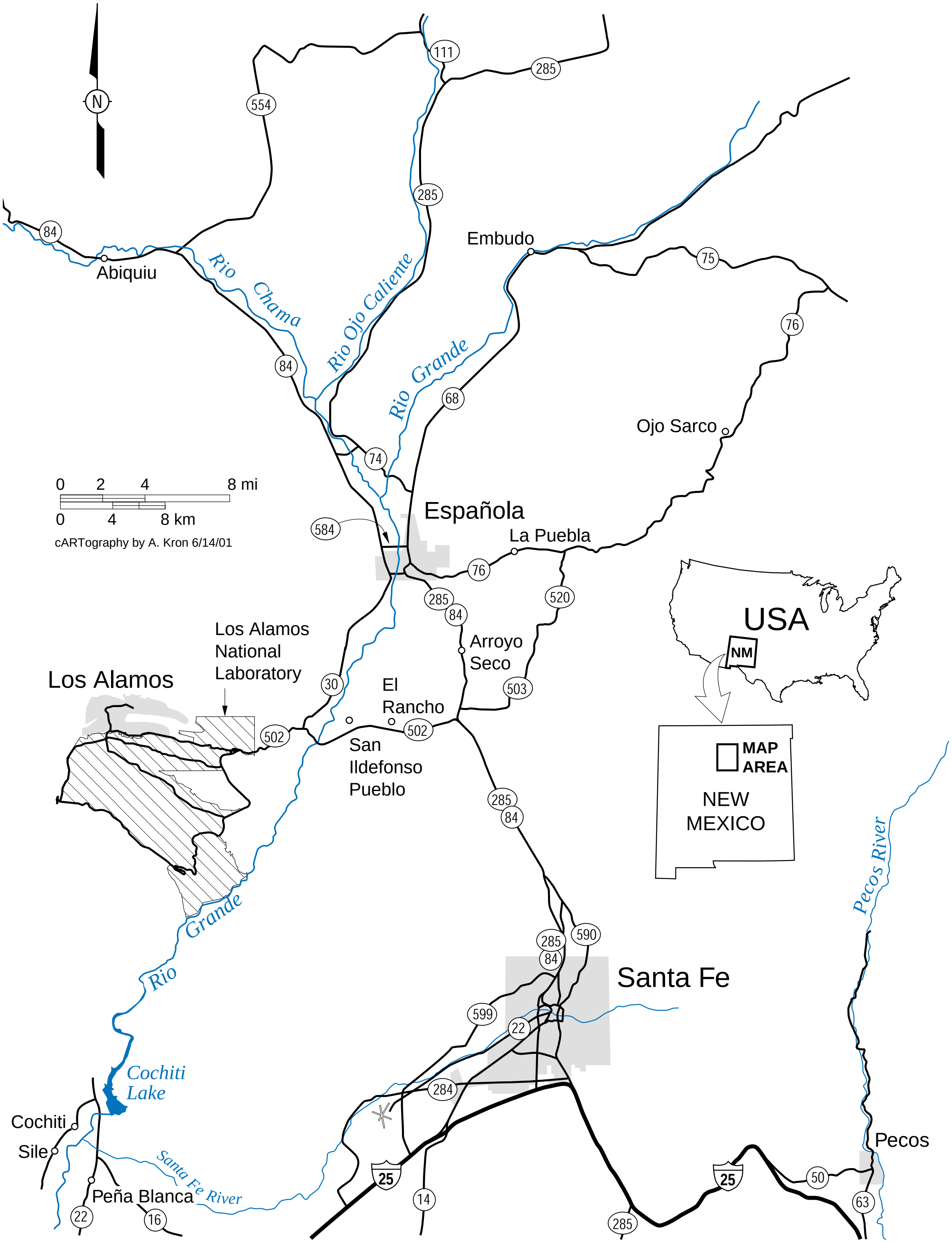

Figure 2. Sampling locations downwind and upwind of Los Alamos National Laboratory.

El Dorado Hills, CA, analyzed the soils for TCDD and dioxinlike compounds (7 compounds).

Crop samples were collected during the summer months after the fire from three general areas downwind of LANL; 0 to 2 miles in the Los Alamos townsite area, 8 to 12 miles in the San Ildefonso/El Rancho area, and 15 to 30 miles in the Abiquiu/Arroyo Seco/Embudo/Española Valley/La Puebla/Ojo Sarco areas. Samples were placed into three-gallon ziplock bags and transported to the Laboratory in locked containers cooled to 4°C. At the laboratory crop samples were washed thoroughly, ashed incrementally to 500°C, and placed into 500-mL polybottles for shipment to Paragon Analytics, Inc., where they were analyzed for the same radionuclides described for the soils. Trace elements were analyzed by ACS on samples that were dried in paper bags at 80°C for 48 hours. All methods of analysis for radionuclides (Fresquez et al., 1998b) and trace elements (Fresquez et al., 1999) in crops have been previously reported.

Soils and crops collected from farms downwind of the CGF were compared to (1) soils and crops from the Pecos and Cochiti areas and (2) past regional data collected as part of the ESP. (Note: The soils representing all of the farms were from tilled [ranged from the 0 to 12-inch depth] and fertilized areas, whereas the soils representing the ESP were from the top portion [0 to 2-inch depth] of undisturbed [nontilled and nonfertilized] areas.)

RESULTS AND DISCUSSION

Radionuclides and Radioactivity in Soils

All of the radionuclides in soils collected from local gardens predominantly downwind of the CGF were either nondetectable (a detectable value is one that is higher than three times the analytical uncertainty; this is a result that is significant at the 99% probability level), within concentrations in soils collected from farms not predominantly impacted by the fire (Cochiti and Pecos), or within the upper-level background concentrations measured in regional soils (Cochiti, Jemez, Embudo) collected as part of the ESP in past years (Table 1). Additionally, all radionuclides in soils collected from the Cochiti area after the irrigation season (September 2000) were similar to radionuclides in soils collected before the irrigation season (June 2000) and to radionuclides in soils collected from the Cochiti area from past years (Fresquez and Gonzales, 2000).

There was only one radioactivity (screening) measurement out of 18 that exceeded regional background concentrations. That measurement, gross gamma activity (5.5 [±0.6] picocuries per gram [pCi/g] dry) from one soil/farm sample, was just above the background concentration of 4.1 pCi/g dry; that level, however, was still less than 8.5 pCi/g dry measured from regional background soils in past years (Fresquez et al., 1996). (Note: Gross gamma is a screening measurement and it is the summation of all gammas recorded by an instrument.) Cesium-137, a gamma emitter, for this latter soil sample measured only 0.42 pCi/g dry and was within regional background concentrations, and a scan of the gamma spectroscopy output showed no other detectable human-made gamma emitters. Therefore, the slightly higher level of gross gamma activity in this one soil sample as compared to other regional sites was probably due to naturally occurring gamma emitters. Results of the current study are consistent with results of radionuclides and radioactivity in (split) soil samples collected from the same farm locations by the New Mexico Environment Department (Yanicak, 2001) and to three regional areas, 10 perimeter areas around LANL, and 12 areas within LANL directly after the CGF on June 1–19, 2000 (Fresquez et al., n.d.). In the latter study, no significant increases in radioactivity due to the fire from smoke and fallout ash (or any other causes) were observed as compared to soils collected in 1999.

Trace Elements (and Cyanide) in Soils

Four out of the 15 trace elements and cyanide in all soils were below the levels of detection (LOD) (Table 2). Of the 10 elements (and cyanide) that were above the LOD in soils collected from farms predominantly downwind of the CGF, all, with the exception of slightly higher cadmium and selenium concentrations at one farm location, were within the concentrations detected in soils collected from farming areas not predominantly downwind of the CGF and, for the most part, were within the range of trace elements and cyanide in soils collected as part of the ESP from regional areas. These data are similar to results obtained from split samples analyzed by the New Mexico Environment Department (Yanicak, 2001). Also, all trace elements in soils from local farms were within the lower range of elements normally encountered in soils from the continental United States (Bowen, 1979).

Trace elements in soils vary from one area to another, and their concentration is based on a number of factors (e.g., parent material, the degree of soil development, depth, climate, topography, and other factors). In addition, farming areas may contain slightly higher levels of some elements because of the fertilizers/composts that are used on them. Slight differences in trace elements between soils from disturbed (tilled) and undisturbed areas then were probably related to natural environmental factors, the depth of the soil sample collected (i.e., in the case of tilled soils, it was a function of transferring elements from the deeper depths to the surface), and/or to the addition of trace minerals with fertilization/composting. Tilled Embudo soil, for example, contained higher concentrations of many trace elements like chromium (11 ppm), nickel (10 ppm), and zinc (51 ppm) to name a few, than nontilled Embudo soil (chromium = 7 ppm, nickel = 5 ppm, and zinc = 23 ppm) collected directly after the fire on June 5, 2000 (Fresquez et al., 2000). And, in fact, all trace elements in nontilled Embudo soil were in concentrations very similar to past years.

Organic Compounds in Soils

No PCBs, HE, or PAHs were detected above reporting limits in any of the soil samples collected upwind or downwind of the CGF (Table 3). In addition, dioxin (TCDD) was not detected in any of the six soil samples.

Of the other less toxic dioxinlike compounds analyzed, only one, OCDD (1,2,3,4,6,7,8,9-octachlorodibenzo-p-dioxin), was detected; it was detected in all of the soils collected, including the two upwind samples. OCDD, the least toxic of the six dioxinlike compounds analyzed, is a by-product of natural (forest fires) and human-made (residential wood burning, municipal and industrial waste, etc.) sources. (Note: Recent studies show, however, that dioxin emissions from forest fires could represent resuspended material from aerial deposits rather than originally formed material.) And, the highest amount detected in soils from the local farms (22.4 parts per trillion [ppt], which is equal to 0.022 ppt toxicity equivalents [TEQ]) was very far below the Agency for Toxic Substances and Disease Registry's soil screening level of 50 ppt TEQs. The average soil concentration of dioxins in North America is 8.0 ± 6.0 ppt TEQ and uptake from water into food crops is insignificant because of the hydrophobic nature of these compounds (EPA, 1994).

Of the 21 PEST compounds analyzed, only trace amounts (in the parts per billion [ppb] range) of dichlorodiphenylethylene (4,4-DDE), a dichlorodiphenyltrichloroethane (DDT) breakdown product, were detected above reporting limits in two out of the six soil farm samples; one out of the two areas included a farm upwind of the CGF (and LANL). (Note: DDT was banned in 1972 and although its derivatives remain in soil for many years it is not readily taken up by most crop plants.) Since no pesticides, including DDT-related compounds, were detected in any of the soils, surface ash plus soil, or ash (bark) collected within LANL lands after the fire (Fresquez et al., 2000; Gonzales and Fresquez, n.d.), the source of 4,4-DDE in soils from these two farms was probably related to drift from the large-scale spraying operations conducted by the U.S. Forest Service on the Santa Fe National Forest in the 1960s (Brown et al., 1986). Small quantities of 4,4-DDE, for example, have been reported in soils from US Forest Service lands before the fire (Podolsky, 2000) and in surface ash plus soil in samples collected after the fire (Gonzales and Fresquez, n.d.). In addition, 4,4-DDE in fish collected in the Rio Grande upstream of LANL was detected before the fire (Gonzales et al., 1999).

Radionuclides in Crops

All radionuclide concentrations in fruits, vegetables, and grains collected from farming areas downwind of the CGF (perimeter and regional from LANL) were low, most were nondetectable, and the mean concentrations were statistically similar (using a Wilcoxon Rank Sum Test at the 0.05 probability level) to radionuclides in crops collected upwind of the CGF (Table 4). In addition, most radionuclides in crops collected downwind of the CGF were similar to concentrations of radionucides derived from regional background areas from past years.

Mean concentrations of radionuclides in crops collected from farming areas before (1999) and after the fire (2000) can be found in Table 5. In general, most radionuclides in crops at most sites collected after the CGF were statistically ($\alpha = 0.05$) similar to crops collected before the fire in 1999. Some radionuclides like cesium-137 and strontium-90 in crops collected at some sites, however, were higher in concentrations in 1999 than in 2000 and some radionuclides like tritium, plutonium-239, and americium-241 in crop samples collected at some sites in 2000 were higher in concentrations than in 1999. Crop samples in 1999 were analyzed by an internal chemistry laboratory at LANL (ACS); whereas, crop samples collected in 2000 were analyzed by Paragon Analytics of Fort Collins, CO. The differences in radionuclide concentrations, with the exception of tritium, which is probably related to Laboratory operations, in crops collected in 1999 and 2000, therefore, is probably related more to differing laboratory biases rather than to the effects of the CGF. We offer that conclusion based on the following reasons: (1) crops collected in 1999 had significantly higher concentrations of some radionuclides than crops collected in 2000, (2) crops collected upwind of the CGF (Cochiti/Peña Blanca/Sile) contained higher concentrations of plutonium-239 and americium-241 than crops collected downwind of the fire (Los Alamos townsite), (3) americium and especially plutonium is not readily taken up by plants (Whicker and Schultz, 1982), and (4) there were no significant increases in plutonium and americium in soils collected after the CGF in 2000 as compared to 1999 (Table 1).

Trace Elements in Crops

The trace elements silver, arsenic, beryllium, cadmium, chromium (for the most part), mercury, and thallium in crops from downwind farming locations were below the LOD (Table 6). These findings are not unexpected since metal uptake in plants is restricted in alkaline semiarid soil due to the formation of insoluble carbonate and phosphate complexes (Fresquez et al., 1991). In those cases where crop samples collected from downwind farming areas contained trace elements above the LOD (for barium, nickel, lead, selenium, and zinc), very few individual samples exceeded upper-level regional background concentrations. As a group, the levels of barium in downwind regional crops and lead and selenium in downwind perimeter (Los Alamos) crops were significantly higher ($\alpha = 0.05$) than in crops collected from upwind farming areas.

Table 7 shows trace elements in crops collected before (1999) and after (2000) the CGF. With the exception of selenium, which was significantly higher ($\alpha = 0.05$) in crops collected from all areas, including upwind areas, none of the other trace elements in crops collected after the CGF were significantly different from trace elements in crops collected before the fire. It is hard to say that selenium in crops increased in concentration because of the CGF because (1) selenium in crops collected upwind of the fire (Cochiti/Peña Blanca) also showed statistical differences between the two years, (2) very few other trace elements were elevated after the fire (Table 6), and (3) selenium in soil samples collected from downwind areas were generally not higher than selenium concentrations in soils collected from upwind sites (Table 2). Instead, the statistically higher concentrations of selenium in crops collected in 2000 from most sites as compared to crops collected in 1999 may be a result of analytical laboratory bias.

CONCLUSIONS

Overall, based on the available radionuclide, radioactivity, trace elements, and organics data, we can confidently conclude that the sampling found no significant impacts to the soil and crop resources of local area farmers downwind of the CGF (and LANL).

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Table 1. Radionuclide Concentrations (± Analytical Uncertainty) in Garden Surface (Tilled) Soils Collected Downwind and Upwind of the CGF in Northern New Mexico.

Location	^{3}H (pCi/mL)	^{90}Sr (pCi/g dry)	^{137}Cs (pCi/g dry)	^{tot}U (µg/g dry)	^{238}Pu (pCi/g dry)	^{239,240}Pu (pCi/g dry)	^{241}Am (pCi/g dry)	Alpha (pCi/g dry)	Beta (pCi/g dry)	Gamma (pCi/g dry)
Soils from Tilled Farming Areas Predominantly Downwind of the CGF										
Ojo Sarco	0.04	0.08	0.158	1.78	0.001	0.006	0.004	3.4	2.0	1.9
	(0.45)a	(0.09)	(0.033)	(0.18)	(0.000)	(0.001)	(0.001)	(1.1)	(0.8)	(0.2)
Embudo	0.00	0.04	0.124	1.22	0.002	0.006	0.002	2.7	2.0	1.7
	(0.45)	(0.09)	(0.035)	(0.12)	(0.001)	(0.001)	(0.001)	(0.9)	(0.8)	(0.2)
Española	0.06	0.02	0.036	1.94	0.000	0.011	0.012	3.1	2.4	1.9
	(0.45)	(0.09)	(0.022)	(0.19)	(0.000)	(0.002)	(0.002)	(1.0)	(0.9)	(0.2)
Abiquiu	0.03	0.11	0.420	2.44	0.007	0.013	0.003	2.4	1.9	5.5
	(0.45)	(0.09)	(0.055)	(0.24)	(0.001)	(0.002)	(0.001)	(0.9)	(0.7)	(0.6)
Soils from Tilled Farming Areas Not Predominantly Downwind of the CGF										
Cochiti	-0.17	0.04	0.122	2.06	0.002	0.003	0.001	2.8	2.5	3.4
(Sile) 6/00	(0.45)	(0.10)	(0.031)	(0.21)	(0.001)	(0.001)	(0.000)	(1.0)	(0.9)	(0.3)
Cochiti	0.06	-0.04	0.061	2.53	0.000	0.006	0.002	5.1	4.0	2.7
(Sile) 9/00	(0.41)	(0.04)	(0.021)	(0.25)	(0.000)	(0.001)	(0.001)	(1.8)	(1.5)	(0.3)
Pecos	-0.13	0.21	0.225	3.61	0.000	0.007	0.002	4.9	2.9	3.5
	(0.45)	(0.10)	(0.037)	(0.36)	(0.000)	(0.001)	(0.001)	(1.4)	(1.0)	(0.3)
Soils from Nontilled Areas Collected from Past Years (1995–1999)										
ULB[b]	0.61	0.71	0.51	3.30	0.008	0.019	0.013	8.4	7.2	4.1

[a](±1 analytical uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[b]ULB = upper-level background (mean plus two standard deviations; 95% confidence level) (Fresquez and Gonzales, 2000).

Table 2. Total Recoverable Trace Elements and Cyanide (μg/g [ppm]) in Garden (Tilled) Soils Collected Downwind and Upwind of the CGF in Northern New Mexico.[a]

Location	Silver	Arsenic	Barium	Beryllium	Cadmium	Cobalt	Chromium	Cyanide
Soils from Tilled Organic Farming Areas Predominantly Downwind of the CGF								
Ojo Sarco	<2.0[b]	4.5	160	0.94	<0.4	5.5	14.0	[c]
Embudo	<2.0	3.1	68	0.52	<0.4	4.2	11.0	<0.40
Española	<2.0	3.1	94	0.65	0.7	3.9	21.0	0.40
Abiquiu	<2.0	6.8	180	1.20	<0.4	7.0	20.0	0.40
Soils from Tilled Organic Farming Areas Not Predominantly Downwind of the CGF								
Cochiti (Sile) 6/00	<2.0	1.9	87	0.46	<0.4	3.3	6.6	<0.40
Cochiti (Sile) 9/00	<2.0	1.5	140		0.4	4.3	7.4	0.40
Pecos	<2.0	5.8	150	1.50	<0.4	11.0	31.0	0.60
Soils from Nontilled Areas Collected from Past Years (1992–1999)								
ULB[d]	<2.0	6.1	194	0.73	<0.4	6.7	14.7	0.50
Soils from Around the US[e]								
Range	0.01–8.0	<0.1–97	70–5,000	<1–15	0.01–2.0	0.5–30	3–2,000	
Mean	0.05	5.5	580	0.68	0.4	8	41	<5.0

Table 2 (Cont.).[a]

Location	Mercury	Nickel	Lead	Antimony	Selenium	Thallium	Zinc
Soils from Tilled Organic Farming Areas Predominantly Downwind of the CGF							
Ojo Sarco	<0.01[b]	12.0	12.2	<0.4	<0.4	<0.4	43
Embudo	<0.01	10.0	6.7	<0.4	<0.4	<0.4	51
Española	<0.01	12.0	7.8	<0.4	1.7	<0.4	52
Abiquiu	<0.01	16.0	13.2	<0.4	0.8	<0.4	60
Soils from Tilled Organic Farming Areas Not Predominantly Downwind of the CGF							
Cochiti (Sile) 6/00	<0.01	6.4	4.8	<0.4	<0.4	<0.4	22
Cochiti (Sile) 9/00	<0.01	2.8	5.8	<0.2	0.8	<0.4	54
Pecos	<0.01	20.0	20.0	<0.4	0.7	<0.4	100
Soils from Nontilled Areas Collected from Past Years (1992–1999)							
ULB[c]	0.04	10.5	14.0	<0.4	0.6	<0.4	49
Soils from Around the US[e]							
Range	<0.01–4.6	<5–700	<10–700	0.2–10	0.01–12	0.1–0.8	10–2,100
Mean	0.05	15	17	1.0	0.4	0.2	55

[a] Trace elements were analyzed using Environmental Protection Agency methods 6020 (Sb, Tl, Pb), 7000 (As, Se), 7471 (Hg), and 6010B (all others).

[b] Less than values means that the result was below the minimum level of detection.

[c] Sample lost in analysis, not analyzed, or outlier omitted. An outlier was omitted when the result was greater than three standard deviations of the mean (99% confidence level).

[d] ULB= upper-level background (mean plus two standard deviations; 95% confidence level) (Fresquez and Gonzales, 2000; Fresquez et al., n.d.)

[e] Bowen (1979).

Table 3. Organic Compounds in Garden (Tilled) Surface Soils Collected Upwind and Downwind of the CGF in Northern New Mexico.

Location	PEST[a]	PCBs[b]	HE[c]	Dioxins[d]	PAHs[e]
Soils from Tilled Farming Areas Predominantly Downwind of the CGF					
Ojo Sarco	ND[f]	ND	ND	OCDD (19.1 ppt)	ND
Embudo	ND	ND	ND	OCDD (13.6 ppt)	ND
Española	ND	ND	ND	OCDD (11.9 ppt)	ND
Abiquiu	4,4-DDE (63 ppb)	ND	ND	OCDD (22.4 ppt)	ND
Soils from Tilled Farming Areas Not Predominantly Downwind of the CGF					
Cochiti (Sile)	ND	ND	ND	OCDD (12.0 ppt)	ND
Pecos	4,4-DDE (21 ppb)	ND	ND	OCDD (9.9 ppt)	ND

[a] PEST= Pesticides (Alpha-BHC, Gamma-BHC [Lindane], Heptachlor, Aldrin, Beta-BHC, Delta-BHC, Heptachlor Epoxide, Endosulfan I, Gamma-Chloradane, Alpha-Chloradane, 4,4-DDE, Dieldrin, Endrin, 4,4-DDD, Endosulfan II, 4,4-DDT, Endrin Aldehyde, Methoxychlor, Endosulfan Sulfate, Endrin Ketone, Toxaphene).

[b] PCBs = Polychlorinated byphenyls (Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, Aroclor-1260).

[c] HE = High explosives (HMX, RDX, 1,3,5-Trinitrobenzene, 1,3-Dinitrobenzene, Tetryl, Nitrobenzene, 2,4,6-Trinitrotoluene, 4-Amino-2,6-DNT, 4-Amino-4,6-DNT, 2,6-Dinitrotoluene, 2,4-Dinitrotoluene, 2-Nitrotoluene, 4-Nitrotoluene, 3-Nitrotoluene).

[d] Dioxin and dioxinlike compounds (2,3,7,8-Tetrachlorodibenzo-p-dioxin [TCDD], 1,2,3,7,8-Pentachlorodibenzo-p-dioxin [PeCDD], 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin [HxCDD], 1,2,3,4,7,8- Hexachlorodibenzo-p-dioxin [HxCDD], 1,2,3,7,8,9- Hexachlorodibenzo-p-dioxin [HxCDD], 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin [HpCDD], 1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin [OCDD]).

[e] PAH = Polyaromatic hydrocarbons (Naphathalene, Acenaphthylene, 1-Methylnaphthalene, 2-Methylnaphthalene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthrancene, Benzo(g,h,I)perylene, Indeno(1,2,3-cd)pyrene).

[f] ND = Not detected above reporting limits.

Table 4. Radionuclide Concentrations in Crops Collected Upwind and Downwind of the CGF in Northern New Mexico.[a]

Location	^{3}H (pCi/mL)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Crops from Farming Areas Predominantly Downwind of the CGF							
Perimeter (0 to 2 mi) from LANL: Los Alamos							
Apple	0.28 (0.15)[b]	0.00 (18.0)	8.64 (1.08)	2.05 (0.88)	46.8 (19.8)	4.3 (13.3)	61.2 (28.8)
Apricot	0.40 (0.16)	6.56 (27.9)	16.40 (1.64)	10.66 (2.95)	-22.9 (60.7)	131.2 (90.2)	101.7 (65.6)
Cherry	0.23 (0.15)	17.64 (16.2)	5.88 (0.49)	4.02 (1.37)	-34.3 (27.4)	-5.9 (27.4)	84.3 (45.7)
Crab apple	0.33 (0.15)	-14.40 (8.8)	7.60 (0.80)	1.16 (0.60)	14.0 (14.4)	29.6 (17.0)	52.0 (24.0)
Peach	0.22 (0.15)	-3.80 (20.9)	9.88 (1.14)	4.10 (1.22)	34.2 (28.5)	28.1 (28.9)	129.2 (49.4)
Plum	0.46 (0.16)	-3.69 (20.9)	13.53 (1.85)	3.32 (1.48)	-12.3 (43.1)	33.2 (30.1)	41.8 (33.8)
Squash	0.15 (0.15)	26.20 (21.0)	9.17 (1.97)	2.62 (1.31)	157.2 (85.2)	65.5 (55.7)	128.4 (58.3)
Mean (std dev)	0.30 (0.11)	4.07 (13.9)	10.16 (3.62)	3.99 (3.13)	26.1 (65.0)	40.9 (45.9)	85.5 (36.7)
Perimeter (8 to 12 mi) from LANL:San Ildefonso (SI)/El Rancho (ER)							
Apple (SI/ER)	0.29 (0.15)	-2.16 (11.5)	0.72 (0.54)	1.91 (0.65)	26.3 (16.2)	0.0 (9.4)	23.0 (8.1)
Apricot (SI/ER)	0.27 (0.15)	-1.64 (25.4)	6.56 (0.82)	5.90 (2.22)	-1.6 (41.0)	90.2 (51.7)	14.8 (42.6)
Corn (SI/ER)	0.35 (0.15)	4.48 (13.8)	2.56 (0.64)	1.98 (0.83)	52.5 (28.8)	14.1 (19.5)	25.6 (21.4)
Peach (SI/ER)	0.39 (0.15)	3.80 (9.9)	6.84 (0.76)	7.45 (1.71)	-6.1 (18.6)	13.7 (18.6)	57.0 (33.4)
Squash (SI/ER)	0.32 (0.15)	-1.31 (28.2)	31.44 (3.28)	4.72 (1.71)	95.6 (50.4)	58.9 (38.7)	91.7 (40.6)
Mean (std dev)	0.32 (0.05)	0.63 (3.2)	9.62 (12.47)	4.39 (2.43)	33.3 (42.1)	35.4 (37.9)	42.4 (31.9)
Regional (15 to 30 mi) from LANL: Abiquiu (A)/Arroyo Seco (AS)/Embudo (E)/Española Valley (EV)/La Puebla (LP)/Ojo Sarco (OS)							
Apple (EV)	0.27 (0.15)	-2.16 (8.5)	1.08 (0.36)	1.37 (0.49)	-2.9 (10.1)	15.8 (12.2)	36.0 (23.4)
Apricot (EV)	0.24 (0.15)	21.32 (27.9)	3.28 (0.82)	7.22 (2.22)	68.9 (52.5)	124.6 (54.9)	109.9 (54.1)
Beet (OS)	-0.16 (0.15)	-2.64 (11.7)	15.40 (1.76)	4.84 (1.28)	30.8 (24.2)	17.6 (24.2)	48.8 (20.7)
Broccoli (OS)	0.40 (0.15)	11.97 (11.3)	[c]	31.12 (4.39)	58.5 (39.2)	13.3 (30.6)	53.2 (29.9)
Buckwheat (E)	0.32 (0.15)	2.04 (6.1)	35.70 (3.57)	[c]	23.5 (29.6)	39.8 (27.5)	102.0 (46.4)
Cherry (EV)	-0.40 (0.15)	-1.96 (16.2)	0.00 (0.49)	3.33 (1.37)	[c]	16.7 (21.6)	[c]
Chile (EV)	-0.08 (0.15)	-32.12 (35.8)	10.22 (1.83)	4.96 (1.79)	34.3 (30.3)	48.2 (23.7)	65.7 (40.2)
Corn (EV)	0.12 (0.15)	10.88 (14.7)	3.20 (0.64)	1.09 (0.61)	35.8 (21.8)	19.8 (17.6)	65.9 (24.6)
Cucumber (LP)	0.11 (0.15)	-3.99 (15.3)	58.52 (5.32)	8.65 (2.13)	-7.9 (26.6)	38.6 (27.3)	125.0 (61.9)
Lettuce (A)	0.05 (0.15)	5.00 (41.3)	[c]	27.75 (5.13)	80.0 (72.5)	160.0 (101.3)	185.0 (75.0)
Peach (AS)	0.10 (0.15)	-0.76 (15.2)	3.80 (0.38)	4.94 (1.33)	-19.0 (17.1)	24.3 (17.1)	-25.8 (17.8)
Plum (OS)	0.35 (0.15)	-13.53 (20.3)	1.23 (0.62)	4.06 (1.42)	22.1 (42.4)	28.3 (38.1)	20.9 (39.4)
Ruby Chard (OS)	0.38 (0.16)	-7.02 (13.7)	6.24 (0.78)	2.42 (0.94)	33.5 (22.6)	7.8 (17.6)	11.7 (26.1)
Squash (EV)	0.32 (0.16)	7.86 (22.9)	7.86 (0.66)	6.81 (2.03)	55.0 (59.6)	10.5 (43.9)	144.1 (78.6)
Squash (EV)	0.12 (0.15)	-17.03 (42.6)	17.03 (1.97)	13.36 (2.88)	-5.2 (26.9)	19.7 (26.9)	-5.2 (54.4)

Table 4 (Cont.).[a]

Location	**^{3}H (pCi/mL)**	**^{137}Cs (10^{-3} pCi/g dry)**	**^{90}Sr (10^{-3} pCi/g dry)**	**^{tot}U (ng/g dry)**	**^{238}Pu (10^{-5} pCi/g dry)**	**^{239}Pu (10^{-5} pCi/g dry)**	**^{241}Am (10^{-5} pCi/g dry)**
Sweet pea (A)	0.20 (0.15)	0.00 (15.2)	42.90 (3.90)	6.79 (1.60)	3.1 (32.4)	42.1 (39.0)	43.7 (23.8)
Tomato (LP)	0.03 (0.15)	-3.00 (18.0)	4.00 (0.50)	2.80 (1.25)	9.0 (20.5)	-13.0 (20.5)	0.0 (55.0)
Winter wheat (E)	0.00 (0.15)	0.60 (3.4)	2.80 (0.30)	1.72 (0.38)	8.2 (7.5)	-3.8 (4.2)	15.6 (6.3)
Mean (std dev)	0.13 (0.21)	-0.78 (12.7)	13.33 (17.30)	7.84 (8.70)	25.2 (28.5)	33.9 (42.8)	58.6 (57.7)
Crops from Farming Areas Not Predominantly Downwind of the CGF							
Regional (15 to 20 mi) from LANL:Cochiti (C)/Peña Blanca (PB)/Sile (S)							
Apricot (PB)	0.44 (0.16)	21.32 (28.7)	4.92 (0.82)	7.05 (2.38)	36.1 (45.1)	90.2 (51.7)	86.9 (77.1)
Cabbage (S)	0.36 (0.15)	15.00 (70.0)	47.50 (5.00)	5.00 (3.13)	-17.5 (75.0)	132.5 (96.3)	[c]
Cherry (C)	0.35 (0.15)	0.98 (26.5)	6.86 (0.98)	5.78 (1.62)	2.9 (22.1)	2.9 (22.1)	11.8 (37.2)
Chile (S)	0.13 (0.15)	-2.92 (12.1)	1.46 (1.10)	1.68 (0.88)	12.4 (24.5)	18.3 (24.5)	[c]
Lettuce (S)	0.32 (0.15)	10.00 (48.8)	50.00 (5.00)	89.75 (11.13)	-52.5 (90.0)	200.0 (113.8)	300.0 (137.5)
Nectarine (S)	0.11 (0.15)	-2.34 (14.4)	2.34 (0.39)	2.73 (1.56)	117.0 (46.8)	1.6 (21.5)	[c]
Peach (S)	0.01 (0.15)	-3.80 (11.4)	1.52 (0.38)	3.12 (1.26)	1.5 (23.9)	29.6 (25.1)	22.0 (19.8)
Tomato (S)	0.30 (0.15)	10.00 (17.0)	2.00 (0.50)	1.50 (1.25)	112.0 (50.0)	22.0 (30.5)	[c]
Mean (std dev)	0.25 (0.15)	6.03 (9.4)	14.58 (21.19)	14.58 (30.44)	26.5 (59.9)	62.1 (72.2)	105.2 (134.1)
Crops from Regional Background Areas Collected from Past Years (1994–1999)							
ULB[d]	0.55	88.50	136.4	26.8	30.0	41.2	70.3

Table 4 (Cont.).[a]

Location	^{234}U 10^{-3} pCi g dry	^{235}U 10^{-4} pCi g dry	^{238}U 10^{-3} pCi g dry
Crops from Farming Areas Predominantly Downwind of the CGF			
Perimeter (0 to 2 mi) from LANL: Los Alamos			
Apple	0.68 (0.31)	0.50 (1.73)	0.68 (0.27)
Apricot	2.13 (0.82)	9.68 (5.17)	3.44 (0.90)
Cherry	0.91 (0.41)	2.35 (2.40)	1.32 (0.42)
Crabapple	0.72 (0.24)	0.52 (1.22)	0.38 (0.19)
Peach	1.60 (0.46)	0.84 (1.67)	1.37 (0.38)
Plum	1.85 (0.62)	3.81 (2.83)	1.07 (0.46)
Squash	0.26 (0.53)	10.09 (4.06)	0.73 (0.38)
Mean (std dev)	1.16 (0.70)	3.97 (4.21)	1.28 (1.02)
Perimeter (8 to 12 mi) from LANL:San Ildefonso (SI)/El Rancho (ER)			
Apple (SI)	1.12 (0.25)	2.27 (1.17)	0.61 (0.20)
Apricot (ER)	2.13 (0.73)	-5.58 (3.20)	2.07 (0.71)
Corn (SI)	1.41 (0.38)	-1.79 (1.35)	0.69 (0.26)
Peach (SI)	2.43 (0.61)	4.71 (2.93)	2.43 (0.53)
Squash (SI)	2.49 (0.72)	9.56 (4.13)	1.43 (0.51)
Mean (std dev)	1.92 (0.62)	1.83 (5.84)	1.45 (0.81)
Regional (15 to 30 mi) from LANL: Abiquiu (A)/Arroyo Seco (AS)/Embudo (E)/Española Valley (EV)/La Puebla (LP)/Ojo Sarco (OS)			
Apple (EV)	0.49 (0.17)	0.86 (0.87)	0.44 (0.15)
Apricot (EV)	2.48 (0.72)	2.13 (3.45)	2.41 (0.70)
Beet (OS)	1.32 (0.40)	3.17 (1.96)	1.58 (0.40)
Broccoli Rabe (OS)	15.69 (1.86)	15.16 (5.79)	10.24 (1.40)
Buckwheat (E)	[c]	[c]	[c]
Cherry (EV)	0.68 (0.44)	2.94 (2.84)	1.09 (0.41)
Chile (EV)	2.41 (0.66)	-0.29 (3.25)	1.68 (0.55)
Corn (EV)	0.63 (0.24)	1.28 (1.38)	0.35 (0.19)
Cucumber (EV)	5.05 (0.87)	6.78 (3.66)	2.79 (0.67)
Lettuce (A)	14.25 (2.13)	3.25 (5.25)	9.25 (1.63)
Peach (AS)	2.81 (0.57)	3.50 (2.17)	1.60 (0.42)
Plum (OS)	1.40 (0.54)	-1.11 (1.97)	1.40 (0.45)
Ruby Chard (OS)	2.65 (0.51)	-0.62 (2.11)	0.81 (0.28)
Squash (EV)	3.93 (0.92)	3.01 (2.23)	2.36 (0.66)
Squash (EV)	5.90 (1.12)	2.36 (3.41)	4.45 (0.92)

Sweet pea (A)	4.13 (0.67)	1.95 (2.26)	2.26 (0.51)
Tomato (LP)	1.60 (0.60)	3.60 (2.80)	0.88 (0.38)
Winter wheat (E)	0.84 (0.15)	1.24 (0.59)	0.56 (0.12)
Mean (std dev)	3.90 (4.46)	2.90 (3.68)	2.60 (2.88)
Crops from Farming Areas Not Predominantly Downwind of the CGF			
Regional (15 to 20 mi) from LANL:Cochiti (C)/Peña Blanca (PB)/Sile (S)			
Apricot (PB)	3.12 (0.90)	4.26 (4.35)	2.31 (0.73)
Cabbage (S)	2.83 (1.14)	-6.75 (5.63)	1.78 (0.97)
Cherry (C)	1.37 (0.47)	6.86 (3.29)	1.85 (0.49)
Chile (S)	1.24 (0.44)	4.89 (2.52)	0.49 (0.25)
Lettuce (S)	38.75 (4.25)	10.25 (8.88)	30.00 (3.63)
Nectarine (S)	1.09 (0.47)	8.27 (3.47)	0.78 (0.47)
Peach (S)	1.90 (0.50)	6.08 (3.80)	0.94 (0.36)
Tomato (S)	0.70 (0.50)	8.60 (3.50)	0.37 (0.36)
Mean (std dev)	6.38 (13.11)	5.31 (5.26)	4.82 (10.20)
Crops from Regional Background Areas Collected from Past Years (1994–1999)			
ULB[d]	6.5	2.6	5.6

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[a] There were no statistical differences in any of the mean values from perimeter and regional downwind sampling sites as compared to upwind regional sampling sites at the 0.05 probability level using a Wilcoxon Rank Sum Test.

[b] (±1 analytical uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[c] Sample lost in analysis, not analyzed, or outlier omitted. An outlier was omitted when the result was greater than three standard deviations of the mean (99% confidence level).

[d] ULB = upper-level background concentration (mean + 2 std dev) based on data from 1994 to 1999 (Fresquez et al., 2001).

Table 5. Mean (± Standard Deviation) Radionuclide Concentrations in Crops Collected Upwind and Downwind and Before (1999) and After (2000) the CGF in Northern New Mexico.

Location	^{3}H (pCi/mL)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Crops from Farming Areas Predominantly Downwind of the CGF							
Perimeter (0 to 2 mi) from LANL: Los Alamos							
1999[a]	0.19 (0.36)	4.50 (6.6)	25.8 (59.5)	1.8 (1.3)	75.2 (50.0)	5.2 (16.8)	-5.01 (7.4)
2000	0.30 (0.11)	4.07 (13.9)	10.2 (3.6)	4.0 (3.1)	26.1 (65.0)	40.8 (45.9)	85.51 (36.7)*
Perimeter (0 to 9 mi) from LANL:San Ildefonso/El Rancho							
1999[a]	-0.12 (0.31)	-3.29 (20.5)	64.9 (69.6)	14.9 (13.6)	57.7 (73.6)	-11.9 (9.8)	-16.12 (14.0)
2000	0.32 (0.05)*[b]	0.63 (3.2)	9.6 (12.5)	4.4 (2.4)	33.3 (42.1)	35.4 (37.9)*	42.42 (31.9)*
Regional (15 to 30 mi) from LANL: Abiquiu/Arroyo Seco/Embudo/Española Valley/La Puebla/Ojo Sarco							
1999[a]	-0.03 (0.22)	8.49 (7.0)*[b]	175.2 (169.4)*	11.0 (10.1)	-17.1 (30.6)	4.1 (26.6)	-8.17 (15.0)
2000	0.13 (0.21)	-0.78 (12.7)	13.3 (17.3)	7.8 (8.7)	25.2 (28.5)*	33.9 (42.8)*	58.62 (57.7)*
Crops from Farming Areas Not Predominantly Downwind of the CGF							
Regional (5 to 10 mi) from LANL:Cochiti/Peña Blanca/Sile							
1999[a]	0.04 (0.29)	13.21 (15.3)	53.7 (31.5)*	2.0 (2.8)	97.4 (118.4)	-12.5 (18.6)	-6.14 (10.7)
2000	0.25 (0.15)	6.03 (9.4)	14.6 (21.2)	14.6 (30.4)	26.5 (59.9)	62.1 (72.2)*	105.18 (134.1)*

Table 5. (Cont.)

Location	^{234}U 10^{-3} pCi g dry	^{235}U 10^{-4} pCi g dry	^{238}U 10^{-3} pCi g dry
Crops from Farming Areas Predominantly Downwind of the CGF			
Perimeter (0 to 2 mi) from LANL: Los Alamos			
1999[a]	0.50 (0.61)	0.51 (1.06)	0.60 (0.43)
2000	1.16 (0.70)	3.97 (4.21)*	1.28 (1.02)
Perimeter (0 to 9 mi) from LANL:San Ildefonso/El Rancho			
1999[a]	6.02 (5.91)	1.65 (1.95)	4.97 (4.50)
2000	1.92 (0.62)	1.83 (5.84)	1.45 (0.81)
Regional (15 to 30 mi) from LANL: Abiquiu/Arroyo Seco/Embudo/Española Valley/La Puebla/Ojo Sarco			
1999[a]	4.47 (3.24)	1.65 (1.86)	3.63 (3.35)
2000	3.90 (4.46)	2.90 (3.68)	2.60 (2.88)
Crops from Farming Areas Not Predominantly Downwind of the CGF			
Regional (5 to 10 mi) from LANL:Cochiti/Peña Blanca/Sile			
1999[a]	0.60 (0.76)	-1.37 (1.25)	0.70 (0.90)
2000	6.38 (13.11)	5.31 (5.26)*	4.82 (10.20)

[a] Fresquez and Gonzales (2000).

[b] Means within the same column and location followed by an * were statistically different from each other a using a Wilcoxon Rank Sum Test at the 0.05 probability level.

Table 6. Total Recoverable Trace Element Concentrations (µg/g dry) in Crops Collected Upwind and Downwind of the CGF in Northern New Mexico.[a]

Location	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Se	Tl	Zn
Crops from Farming Areas Predominantly Downwind of the CGF												
Perimeter (0 to 2 mi) from LANL: Los Alamos												
Apple	1.0[b]	0.25[b]	2.90	0.10[b]	0.50[b]	0.50[b]	0.03[b]	4.1	2.5	1.00	0.20[b]	4.2
Apricot	1.0[b]	0.25[b]	4.50	0.10[b]	0.50[b]	3.20	0.03[b]	91.0	35.0	1.00	0.20[b]	7.6
Cherry	1.0[b]	0.25[b]	2.70	0.10[b]	0.50[b]	2.70	0.03[b]	23.0	4.3	1.40	0.20[b]	4.9
Crab A.	1.0[b]	0.25[b]	17.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	5.3	26.0	1.20	0.20[b]	5.7
Peach	1.0[b]	0.25[b]	2.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.0[b]	15.2	1.50	0.20[b]	9.1
Plum	1.0[b]	0.25[b]	2.30	0.10[b]	0.50[b]	3.30	0.03[b]	23.0	6.3	0.80	0.20[b]	4.6
Squash	1.0[b]	0.25[b]	5.20	0.10[b]	0.50[b]	0.50[b]	0.03[b]	3.1	5.4	1.40	0.20[b]	31.0
Mean	1.0	0.25	5.23	0.10	0.50	1.60	0.03	21.5	13.5	1.19	0.20	9.6
(std dev)	(0.0)	(0.00)	(5.32)	(0.00)	(0.00)	(1.38)	(0.00)	(32.0)	(12.5)*[c]	(0.26)*	(0.00)	(9.6)
Perimeter (8 to 12 mi) from LANL:San Ildefonso (SI)/El Rancho (ER)												
Apples (SI)	1.0[b]	0.25[b]	2.40	0.10[b]	0.49	0.67	0.03[b]	1.0[b]	2.6	0.50	0.20[b]	5.3
Apricot (ER)	1.0[b]	0.25[b]	2.30	0.10[b]	0.53	2.40	0.03[b]	5.3	1.1	0.50	0.20[b]	17.0
Corn (SI)	1.0[b]	0.25[b]	0.65	0.10[b]	0.65	0.25[b]	0.03[b]	1.0[b]	4.0	1.10	0.20[b]	25.0
Peach (SI)	1.0[b]	0.25[b]	1.70	0.10[b]	0.20[b]	2.10	0.03[b]	13.0	4.2	0.70	0.20[b]	12.0
Squash (SI)	1.0[b]	0.25[b]	11.00	0.10[b]	0.80	0.73	0.03[b]	1.0[b]	2.3	1.00	0.20[b]	26.0
Mean	1.0	0.25	3.61	0.10	0.53	1.23	0.03	4.3	2.8	0.76	0.20	17.1
(std dev)	(0.0)	(0.00)	(4.19)	(0.00)	(0.22)	(0.96)	(0.00)	(5.2)	(1.3)	(0.28)	(0.00)	(8.8)
Regional (15 to 30 mi) from LANL: Abiquiu (A)/Arroyo Seco (AS)/Embudo (E)/Española Valley (EV)/La Puebla (LP)/Ojo Sarco (OS)												
Apple (EV)	1.0[b]	0.25[b]	2.40	0.10[b]	0.50[b]	0.50[b]	0.03[b]	2.0	1.7	0.20[b]	0.20[b]	1.9
Apricot (EV)	1.0[b]	0.25[b]	9.30	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.0[b]	2.7	0.20[b]	0.20[b]	7.2
Beet (OS)	1.0[b]	0.25[b]	63.50	0.10[b]	0.50[b]	0.50[b]	0.03[b]	11.0	6.5	0.40	0.20[b]	18.1
Broccoli (OS)	1.0[b]	0.25[b]	141.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	2.0	0.7	0.50	0.20[b]	34.3
Cherry (EV)	1.0[b]	0.25[b]	2.60	0.10[b]	0.50[b]	0.50[b]	0.03[b]	9.0	2.1	0.20[b]	0.20[b]	4.6
Chile (EV)	1.0[b]	0.25[b]	2.40	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.0[b]	1.5	0.40	0.20[b]	19.1
Corn (EV)	1.0[b]	0.25[b]	0.60	0.10[b]	0.50[b]	0.50[b]	0.03[b]	5.0	20.8	0.20[b]	0.20[b]	20.9
Cucumber(LP)	1.0[b]	0.25[b]	21.70	0.10[b]	0.50[b]	0.50[b]	0.03[b]	3.0	0.6	0.20[b]	0.20[b]	29.9
Lettuce (A)	1.0[b]	0.25[b]	15.30	0.10[b]	1.00	0.50[b]	0.03[b]	1.0[b]	2.8	0.60	0.20[b]	59.2
Peach (AS)	1.0[b]	0.25[b]	2.90	0.10[b]	0.50[b]	0.50[b]	0.03[b]	2.0	0.6	0.40	0.20[b]	5.4
Peas (A)	1.0[b]	0.25[b]	4.60	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.0[b]	1.5	0.50	0.20[b]	36.3
Plum (OS)	1.0[b]	0.25[b]	4.40	0.10[b]	0.50[b]	9.00	0.03[b]	49.0	2.0	1.00	0.20[b]	10.1
R. Chard (OS)	1.0[b]	0.25[b]	42.10	0.10[b]	0.50[b]	0.50[b]	0.03[b]	6.0	3.2	0.50	0.20[b]	32.9
Squash (Ev)	1.0[b]	0.25[b]	9.50	0.10[b]	0.50[b]	0.50[b]	0.03[b]	3.0	0.6	0.60	0.20[b]	52.2

Table 6 (Cont.)

Location	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Se	Tl	Zn
Squash (EV)	1.0[b]	0.25[b]	5.20	0.10[b]	0.50[b]	0.50[b]	0.03[b]	3.0	2.1	0.20[b]	0.20[b]	24.7
Tomato (LP)	1.0[b]	0.03[b]	3.80	0.10[b]	0.50[b]	1.00	0.03[b]	47.0	14.4	0.20[b]	0.20[b]	19.1
Wheat (E)	1.0[b]	0.25[b]	2.80	0.10[b]	0.50[b]	0.50[b]	0.03[b]	5.0	11.0	0.40	0.20[b]	40.3
Mean	1.0	0.25	19.65	0.10	0.53	1.03	0.03	8.9	4.4	0.39	0.20	24.5
(std dev)	(0.0)	(0.00)	(35.46)*[c]	(0.00)	(0.12)	(2.06)	(0.00)	(15.0)	(5.7)	(0.22)	(0.00)	(16.7)*
Crops from Farming Areas Not Predominantly Downwind of the CGF												
Regional (5 to 10 mi) from LANL:Cochiti (C)/Peña Blanca (PB)/Sile (S)												
Apricot (PB)	1.0[b]	0.25[b]	1.40	0.10[b]	0.50[b]	1.40	0.03[b]	9.3	4.7	0.90	0.20[b]	7.7
Cabbage (S)	1.0[b]	0.25[b]	6.90	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.0[b]	4.0	0.80	0.20[b]	15.0
Cherry (C)	[d]	[d]	[d]	[d]	[d]	[d]	[d]	[d]	[d]	[d]	[d]	[d]
Chile (S)	1.0[b]	0.25[b]	0.91	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.0[b]	1.2	1.00	0.20[b]	22.0
Lettuce (S)	[d]	[d]	[d]	[d]	[d]	[d]	[d]	[d]	[d]	[d]	[d]	[d]
Nectarine (S)	1.0[b]	0.25[b]	1.40	0.10[b]	0.50[b]	1.90	0.03[b]	10.0	6.0	0.80	0.20[b]	10.0
Peach (S)	1.0[b]	0.25[b]	1.70	0.10[b]	0.50[b]	0.50[b]	0.03[b]	7.7	3.7	0.90	0.20[b]	5.9
Tomato (S)	1.0[b]	0.25[b]	1.90	0.10[b]	0.50[b]	1.30	0.03[b]	1.0[b]	1.9	0.90	0.20[b]	15.0
Mean	1.0	0.25	2.37	0.10	0.50	1.02	0.03	5.0	3.6	0.88	0.20	12.6
(std dev)	(0.0)	(0.00)	(2.25)	(0.00)	(0.00)	(0.60)	(0.00)	(4.4)	(1.8)	(0.08)	(0.00)	(5.9)
Crops from Regional Background Areas Collected from Past Years (1994–1999)												
ULB[e]	1.3	0.57	19.49	0.45	0.65	1.56	0.06	21.9	15.9	0.63	0.27	22.3

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[a] Analysis by Environmental Protection Agency Method 3051 for total recoverable metals.

[b] Less-than values were converted to one-half the concentration.

[c] Means within the same column followed by an * were statistically higher than regional crops collected upwind of the CGF using a using a Wilcoxon Rank Sum Test at the 0.05 probability level.

[d] Sample lost in analysis, not analyzed, or outlier omitted. An outlier was omitted when the result was greater than three standard deviations of the mean (99% confidence level).

[e] ULB = upper-level background concentration (mean + 2 std dev) based on data from 1994 to 1999.

Table 7. Mean (± Standard Deviation) Total Recoverable Trace Element Concentrations (µg/g dry) in Crops Collected Upwind and Downwind and Before (1999) and After (2000) the CGF in Northern New Mexico.

Location	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Se	Tl	Zn
Crops from Farming Areas Predominantly Downwind of the CGF												
Perimeter (0 to 2 mi) from LANL: Los Alamos												
1999[a]	1.0	0.25	4.7	0.10	0.50	0.50	0.03	3.4	9.2	0.20	0.20	16.2
	(0.0)	(0.00)	(3.1)	(0.00)	(0.00)	(0.00)	(0.00)	(6.5)	(8.9)	(0.00)	0.00	(18.4)
2000	1.0	0.25	5.2	0.10	0.50	1.60	0.03	21.5	13.5	1.19	0.20	9.6
	(0.0)	(0.00)	(5.3)	(0.00)	(0.00)	(1.38)	(0.00)	(32.0)	(12.5)	(0.26)*[b]	(0.00)	(9.6)
Perimeter (8 to 12 mi) from LANL:San Ildefonso/El Rancho												
1999[a]	1.0	0.25	7.7	0.10	0.50	0.50	0.03	4.6	6.9	0.20	0.20	19.6
	(0.0)	(0.00)	(9.0)	(0.00)	(0.00)	(0.00)	(0.00)	(7.0)	(5.1)	(0.00)	0.00	(10.3)
2000	1.0	0.25	3.6	0.10	0.53	1.23	0.03	4.3	2.8	0.76	0.20	17.1
	(0.0)	(0.00)	(4.2)	(0.00)	(0.22)	(0.96)	(0.00)	(5.2)	(1.3)	(0.28)*	(0.00)	(8.8)
Regional (15 to 30 mi) from LANL: Abiquiu/Arroyo Seco/Embudo/Española Valley/La Puebla/Ojo Sarco												
1999[a]	1.0	0.25	7.6	0.10	0.50	0.80	0.03	4.4	8.6	0.20	0.20	19.5
	(0.0)	(0.00)	(6.2)	(0.00)	(0.00)	(0.73)	(0.00)	(7.7)	(12.8)	0.00	(0.00)	(14.2)
2000	1.0	0.25	19.7	0.10	0.53	1.03	0.03	8.9	4.4	0.39	0.20	24.5
	(0.0)	(0.00)	(35.5)	(0.00)	(0.12)	(2.06)	(0.00)	(15.0)	(5.7)	(0.22)*	(0.00)	(16.7)
Crops from Farming Areas Not Predominantly Downwind of the CGF												
Regional (15 to 20 mi) from LANL:Cochiti/Peña Blanca/Sile												
1999[a]	1.0	0.25	4.4	0.10	0.50	0.72	0.03	2.3	4.8	0.20	0.20	19.0
	(0.0)	(0.00)	(7.1)	(0.00)	(0.00)	(0.49)	(0.00)	(1.2)	(3.2)	(0.00)	0.00	(12.0)
2000	1.0	0.25	2.4	0.10	0.50	1.02	0.03	5.0	3.6	0.88	0.20	12.6
	(0.0)	(0.00)	(2.3)	(0.00)	(0.00)	(0.60)	(0.00)	(4.4)	(1.8)	(0.08)*	(0.00)	(5.9)

[a] Fresquez and Gonzales (2000).

[b] Means within the same column and location followed by an * were statistically different from each other using a using a Wilcoxon Rank Sum Test at the 0.05 probability level.

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