

General TO: John Young
From: Barbara Toth

ASSESSMENT OF POTENTIAL RISKS FROM ENHANCED SURFACE WATER RUNOFF IN CY2001 DUE TO THE CERRO GRANDE FIRE

Interagency Flood Risk Assessment Team
Risk Assessment Working Group

Introduction

The Cerro Grande fire near Los Alamos, New Mexico, USA destroyed vegetation and burned soil in the area, which directly increased the potential for flooding in Los Alamos area canyons. These floods may transport contaminants and chemicals (including radionuclides) from LANL sites, the town of Los Alamos, and burned areas to potential receptors down the watershed. The purpose of the risk assessment done by the Interagency Flood Risk Assessment Team (IFRAT) is to characterize potential risk to the public associated with contaminants transported by flooding in the aftermath of the fire.

The model used for this risk assessment estimates potential risks to people exposed to concentrations of chemicals and radionuclides measured in ash, sediment, groundwater, storm water, and surface water. Sampling and analysis of surface water (including storm water), groundwater, sediment, soils, and fish in the areas that might be affected by floods in the Los Alamos/Pueblo watershed, the Rio Grande, and Cochiti Reservoir were conducted from June 2000 to October 2001 by numerous agencies. The IFRAT estimated two types of potential health impacts from exposure to these chemicals and radionuclides. These were risks of increased cancer incidence, given as a probability, and the potential of non-cancer health effects, expressed as a hazard index.

The assessment for year 2000 sampling data indicated little additional risk compared to conditions before the fire. However there was an increase in the potential for non-cancer effects from exposure to burned material moved through the canyons by floods. The same risk assessment has been completed using the sampling results from the summer and fall of 2001 to see if there have been changes in the potential risk and hazard over time

Details and Results of year 2001 Analysis

Residential, recreational, and irrigation exposure scenarios were developed for post-fire exposure to soil, sediment, and water that contain elevated concentrations of metals, radionuclides, and organic chemicals. The scenarios are summarized in the technical summary document "IFRAT Risk Model: Purpose, Construction and Results" available on the IFRAT website (<http://www.nmenv.state.nm.us/IFRAT/index.html>). The resident scenario estimates potential risk associated with a 30-year exposure to soil, sediment and water. The resident was located in Lower Los Alamos Canyon in the area directly downstream of possible post-fire effects. The Los Alamos/Pueblo Canyon watershed (which includes the Los Alamos, Pueblo, Guaje, and Rendija canyon basins) was also one of the drainages most severely burned during the Cerro Grande fire. The irrigation



scenario looks at risks from consumption of crops irrigated with river water containing material moved by floods as well as potential risks to the farmers irrigating the fields. The recreational scenario incorporates exposures through incidental swallowing of water and skin contact with water while swimming as well as eating fish from Cochiti Reservoir.

To evaluate potential risks from chemicals and radionuclides in floodwaters and in sediments deposited on canyon floodplains during floods, the maximum concentrations from the entire summer and fall data sets for each year were used in the risk assessment for that year. The sediment sampling results used to estimate the potential risks for 2001 came primarily from sediments that were deposited by floodwaters during the July 2nd rainstorm. The flooding from this storm was the largest seen in Los Alamos Canyon and Pueblo Canyon since the Cerro Grande fire, and was focused primarily in Pueblo Canyon. The water sampling results used to estimate the potential risks for 2001 were collected during sampling during a number of other floods in July, August, and September of 2001. Table 1 presents the maximum concentrations of inorganic chemicals and radionuclides detected in deposited sediment, shallow groundwater, surface water, and fish tissue during the 2001 sampling season.

Table 1. Maximum concentrations detected during 2001 sampling season

Compound	2001 Maximum concentration				
	Sediment (mg/kg)	Canyon max unfiltered storm water (mg/L)	Unfiltered Rio Grande water (mg/L)	Filtered Alluvial Ground water (mg/L)	Fish tissue (mg/kg wet weight) game and bottom
Inorganic					
aluminum	8590	1040	0.0258	ND ¹	ND ¹
antimony	ND ¹	0.0018	0.0019	ND ¹	ND ¹
arsenic	2.1	0.140	0.002	0.0061	ND ¹
barium	162	20	0.0982	0.32	0.68
beryllium	0.91	0.123	0.00099	ND ¹	ND ¹
boron	NA ²	0.210	0.0346	ND ¹	ND ¹
cadmium	0.27	0.024	0.000072	ND ¹	ND ¹
chromium (total)	5.4	0.487	ND ¹	0.0013	ND ¹
cobalt	4.3	0.386	ND ¹	0.0013	ND ¹
copper	11	0.793	ND ¹	0.0053	ND ¹
cyanide	NA ²	0.000028	ND ¹	ND ¹	ND ¹
iron	10,500	637	0.0113	ND ¹	ND ¹
manganese	722	76	0.0019	0.0002	ND ¹
mercury	0.05	0.0017	ND ¹	ND ¹	0.76
nickel	7	0.739	ND ¹	0.0036	ND ¹

2001 Maximum concentration					
Compound	Sediment (mg/kg)	Canyon max unfiltered storm water (mg/L)	Unfiltered Rio Grande water (mg/L)	Filtered Alluvial Ground water (mg/L)	Fish tissue (mg/kg wet weight) game and bottom
nitrate	NA ²	NA ²	0.00039	ND ¹	ND ¹
selenium	0.53	0.0345	0.0013	ND ¹	ND ¹
silver	0.29	0.307	ND ¹	ND ¹	ND ¹
thallium	ND ¹	0.010	0.00018	0.0025	ND ¹
uranium (total)	NA ²	0.137	0.0075	ND ¹	0.006
vanadium	11.5	0.631	0.0063	0.0084	ND ¹
zinc	53.3	3.29	0.0096	0.018	ND ¹
radionuclides	pCi/g	pCi/L	pCi/L	pCi/L	pCi/g dry
Americum-241	0.22	10	0.135	ND ¹	8.1E-04
Cesium-134	0.11	ND ¹	ND ¹	ND ¹	ND ¹
Cesium-137	1.88	65	ND ¹	ND ¹	4.8E-02
Cobalt-60	ND ¹	ND ¹	ND ¹	ND ¹	ND ¹
Europium-152	ND ¹	ND ¹	ND ¹	ND ¹	ND ¹
Plutonium-238	ND ¹	2	0.00293	ND ¹	1.2E-03
Plutonium-239	1.32	253	0.00846	ND ¹	5.0E-04
Ruthenium-106	ND ¹	ND ¹	ND ¹	ND ¹	ND ¹
Sodium-22	ND ¹	ND ¹	ND ¹	ND ¹	ND ¹
Strontium-90	0.689	25	0.449	ND ¹	4.5E-02
Thorium-228	2.28	467	0.184	ND ¹	ND ¹
Thorium-230	2.29	322	0.156	ND ¹	ND ¹
Thorium-232	2.33	391	0.278	ND ¹	ND ¹
Tritium	NA ²	NA ²	ND ¹	ND ¹	ND ¹
Uranium-234	2.59	354	0.198	5.25	5.8E-03
Uranium-235	0.2	15	0.0219	0.199	1.6E-03
Uranium-238	2.29	334	0.163	3.64	4.1E-03

¹ not detected in samples

² samples not analyzed for this compound

Most chemicals and radionuclides were detected at lower concentrations in the year 2001 samples of the deposited sediment and shallow ground water than in the year 2000 samples. Higher concentrations of some chemicals and radionuclides were found in unfiltered storm water samples because more sediment was carried by storm water in 2002. Slightly increased concentrations of cadmium and mercury were detected in deposited sediment samples in lower Los Alamos canyon; but the values were still at or below background values (0.4 mg/kg and 0.1 mg/kg, respectively). Selenium concentrations in 2001 sediment samples were above both background (0.3 mg/kg) and year 2000 concentrations. Because concentrations of other chemicals and radionuclides in these media decreased from 2000 to 2001, the total potential radiological and chemical risks for 2001 decreased for the resident scenario (Table 2). The potential for non-cancer

effects (the hazard index) also decreased for the resident scenario (Table 2). Potential risk and non-cancer hazard in the irrigation scenario remained essentially the same for 2001 as they were for pre-fire and summer 2000. Potential recreational risk from radionuclides and potential non-cancer effects from recreational decreased from 2000 to 2001. Chemical risk from recreational use in 2001 (attributable to arsenic detections in water used in the swimming scenario) was 1 in 1,000,000, which is considered a negligible level of excess risk.

Table 2. Summary of risk results for the IFRAT exposure scenarios

Scenario	Radiological risk		Chemical risk		Chemical hazard index (child) ^d	
	2000	2001	2000	2001	2000	2001
Irrigation - background only	6E-04 ^a	6E-04	3E-03	3E-03	45	45
Irrigation	6E-04	6E-04	3E-03	3E-03	46	46
Resident ^b - background only	7E-04	7E-04	3E-03	3E-03	58	58
Resident ^b - pre-fire	6E-04	6E-04	2E-03	2E-03	46	46
Resident ^b - post-fire	7E-04	6E-04	3E-03	2E-03	66	51
Recreational	5E-06	4E-06	0 ^c	1E-06	6	5

^a 1E-03 represents 1 chance in 1,000 of incurring a cancer over a lifetime; 1E-04 represents 1 chance in 10,000; 1E-05 represents 1 chance in 100,000; and 1E-06 represents 1 chance in 1,000,000

^b exposure scenario for a resident equals 6 years' exposure as a child plus 24 years' exposure as an adult

^c no chemical carcinogens were detected in Rio Grande or Cochiti fish in 2000

^d children have a higher potential than adults for exposure leading to non-cancer effects

The risk assessment of calendar year 2000 floods identified a number of chemicals and radionuclides as substantially contributing to the potential risks and hazards of exposure to materials moved through flooding. Key contributors to potential cancer risk both pre- and post-fire included strontium-90, thorium-228, cesium-137, arsenic, and chromium (VI). Primary contributors to the potential non-cancer effects (hazard index) were manganese and arsenic. These patterns also occurred in 2001 for both the resident and irrigation scenarios. Much of the potential exposure to these chemicals and radionuclides in the model occurred as result of uptake through plants grown in ash and sediment containing soil and subsequently consumed by people. This led to the recommendation that people avoid adding sediment and ash transported by the flood to their gardens. The irrigation scenario did not show similar elevated risk in either year for crops irrigated with water that may have some of this material in it. Recreational radiological risk and chemical hazard were unchanged from 2000 to 2001. No chemical carcinogens were detected in Rio Grande water or Cochiti fish in 2000, but 2001 sampling data for the Rio Grande contained detections of low concentrations of the chemical carcinogen arsenic which generated a negligible excess risk associated with swimming in this water.

The potential risk and hazard numbers in Table 2 are presented in the graphs at the end of this document. The total risk and hazard index estimates for the scenarios for exposure to background and pre-fire concentrations as well as potential risk and hazard for exposure to concentrations seen in the summer and fall of 2000 and 2001 are shown. Additional graphs show the incremental changes in risk and hazard from one year to the next. Estimates of potential radiological risk, chemical risk, and chemical hazard in the irrigation scenario remain essentially unchanged from pre-fire conditions through one and two years post-fire. Estimates of potential radiological risk, chemical risk, and chemical hazard in the resident scenario have decreased from 2000 to 2001.

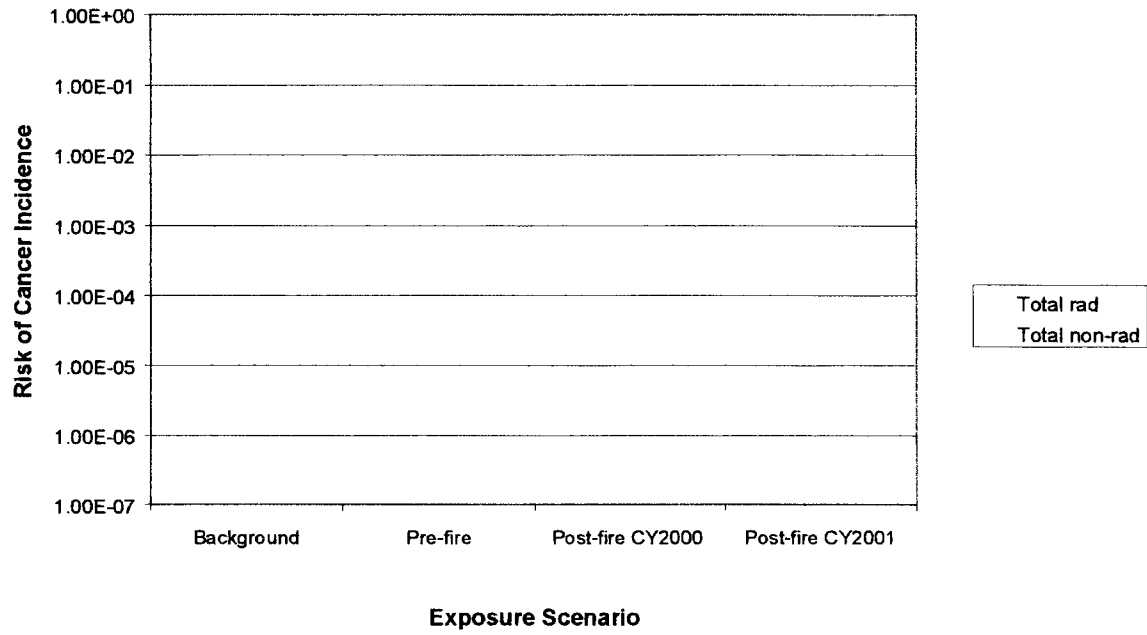
The changes seen from 2000 to 2001 in the concentrations of chemicals and radionuclides may reflect changing conditions in the Los Alamos/Pueblo watershed or the effects of floods on the system. The sediment data reflects potential exposure within the Los Alamos and Pueblo canyons, which is the canyon system most heavily impacted by the Cerro Grande fire. The results of calculations using Rio Grande water for the irrigation scenario, as well as calculations for the recreational and fish consumption scenarios reflect concentrations resulting from storm effects across all the canyons draining the Los Alamos National Laboratory and areas outside of the Laboratory.

The updated IFRAT risk assessment uses actual sampling concentrations to model estimates of risk to the public. An independent risk assessment concurrently conducted by the Risk Assessment Corporation (RAC) assesses potential risk from storm runoff and movement of materials by calculating estimates of potential concentrations in runoff from a mathematical model of the flooding and release sites. RAC uses those modeled numbers to calculate estimates of risk of potential future exposures. Because one study assesses potential long-term risk using currently measured concentrations in sediment and water and the other study calculates potential concentrations in sediment and water from which potential risks are estimated, the results of the two models are not directly comparable. However, the data used in the IFRAT risk assessment has been provided to RAC.

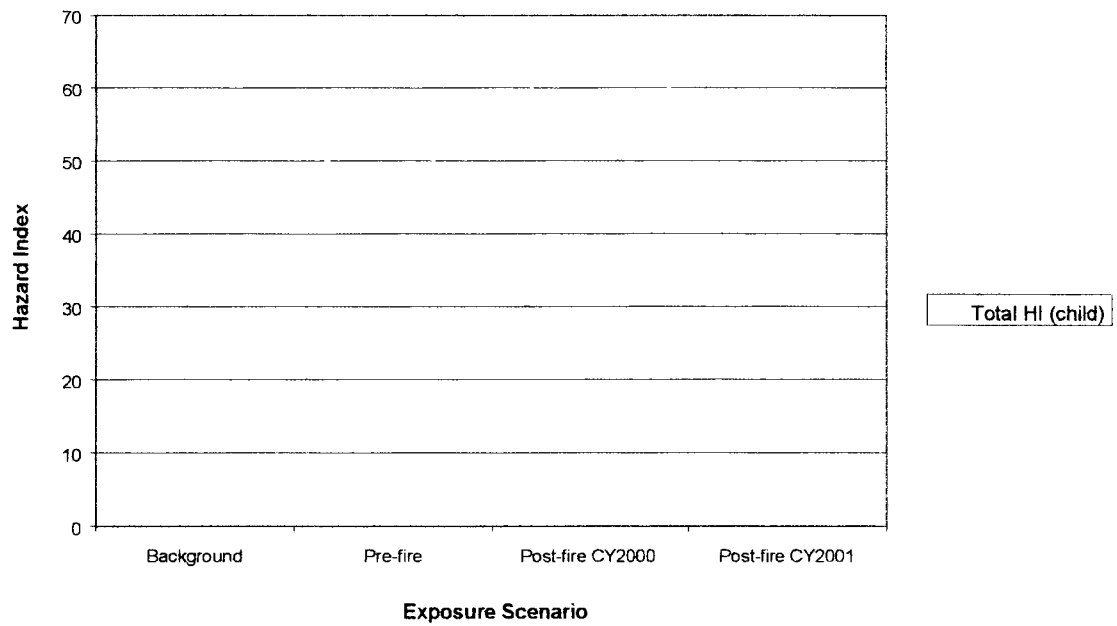
Conclusions

There were changes in the concentrations of chemicals and radionuclides from pre-fire to 2000 and from 2000 to 2001. Two years of data show some changes in concentration in sediment and water, but little change in potential risk and hazard associated with exposure to material in water and deposited with sediment by floods. The first two years of post-fire sampling indicate that potential risks and hazard remain essentially similar to pre-fire levels. Recommendations remain the same as presented at the July 2001 public meeting to avoid use of ash as an amendment in home gardens. Monitoring efforts will continue in 2002 to assess any potential changes and impacts from flooding related to the Cerro Grande fire.

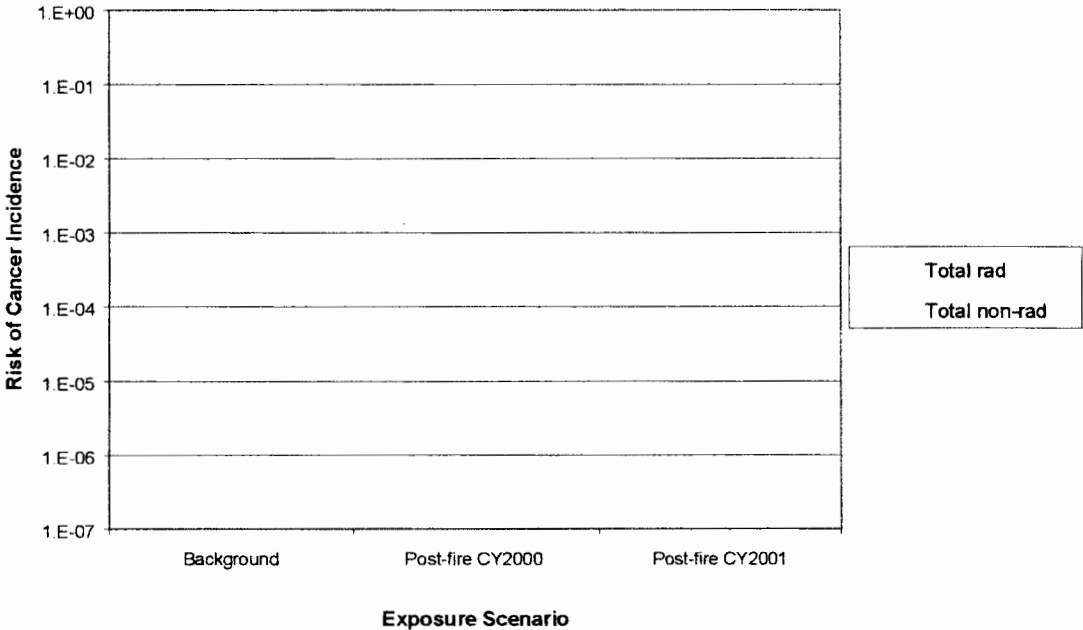
Health Risks - Lower Los Alamos Canyon Scenario



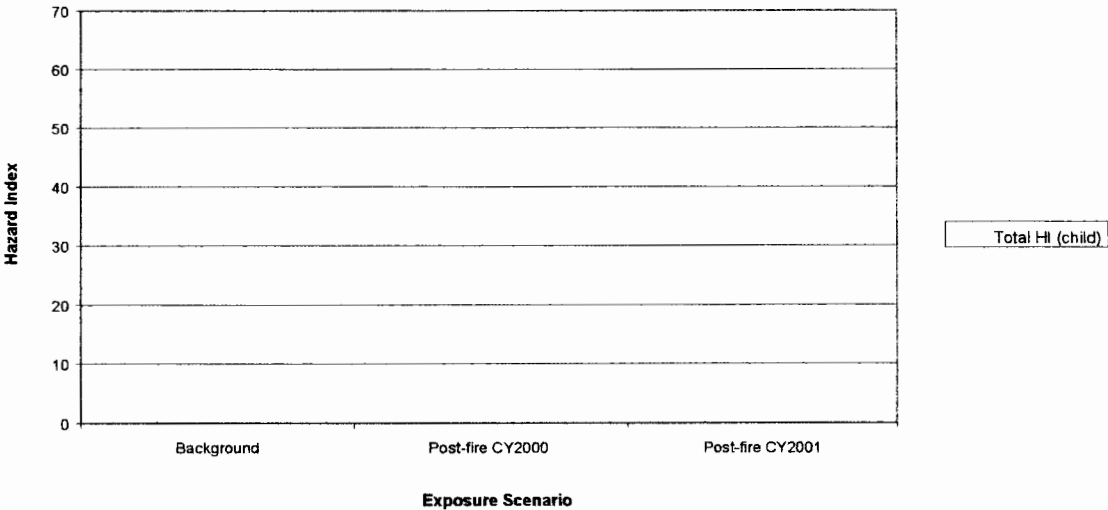
Hazard Index for Lower Los Alamos Canyon Scenarios



Health Risks - Irrigation Scenario



Hazard Index - Irrigation Scenario



A-0

Becky,

The proposed borehole location changes are fine with me.

Darlene

From: Becky-Coel Roback [mailto:becky_cr@lanl.gov]
Sent: Thursday, August 17, 2006 11:04 AM
To: Goering, Darlene, NMENV
Subject: FW: PCAA 00-039 revised SAP
Importance: High

Pueblo Canyon Aggregate
Area

Darlene--I left you a voice mail regarding this site. We are having a few issues with utilities (gas and water, primarily). Also, I was concerned that we did not put enough emphasis on characterization to the north, under the building, where I feel we do not have N&E. We are proposing moving some boreholes from the southwest, where we have clearly decreasing trends, to the northeast part of the site where we have our highest detects. I would like to discuss the attached figure and email below with you at your earliest convenience.

Thanks!

Becky

Becky Coel-Roback
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From: Strzempka, Joseph [mailto:Joseph.Strzempka@shawgrp.com]
Sent: Wednesday, August 09, 2006 5:07 PM
To: Becky-Coel Roback
Subject: FW: PCAA 00-039 revised SAP

Becky-

Attached please find the revised SAP for 00-039, the former dry cleaning facility. The figure and table have both been revised to reflect the changes in borehole locations. A summary of the changes includes:

- 1) moving borehole New #4 from the southwest area of the site to the northeast and pairing it with an angled borehole;
- 2) angled borehole New #1 will be advanced to a depth of approximately 72 ft bgs; this borehole must be moved slightly east to clearly avoid utility lines that run adjacent to the east side of the SWMU;
- 3) the vertical borehole (New #5) paired with New #1 will also be drilled to a depth of 72 ft bgs;
- 4) historical location 00-04055 will be drilled as an angled borehole to 60 linear ft bgs as well as its paired vertical borehole New #2;
- 5) New #4 will be a 50 ft vertical and paired borehole New #6 will be an angled borehole to 50 linear ft;
- 6) the only borehole that will require concrete coring is historical location 00-04073; the remaining boreholes will be advanced through asphalt.

This plan will include one "out of scope" angled borehole (New #6). I will provide costs in separate e-mail.

Please let me know if you have any questions with this revised SAP. Feel free to call me or Angela (661-5257) –

Joe

Table 4.12-1
SWMU 00-039 Proposed Soil and Tuff Samples

Location ID	Location Description	Sampling Justification	Depth (ft bgs)	Media Type	pH (SW-846 9045C)	Nitrates (EPA Method 300.0)	Cyanide (SW-846 9012A)	Perchlorate (EPA Method 314.0 and SW-846 8321A)	TAL Metals (SW-846 6010B)	VOCs (SW-846 8260B)	SVOCs (SW-846 8270C)	PCBs (SW-846 8082)	Gamma Spectroscopy (EPA Method 901.1)	Pesticides (SW-846 8081A)	TPH (SW-846 8015B)
00-04055	Angled borehole with a target depth of 60 ft bgs beneath historical location 00-04073	Sampling to define vertical extent of organic chemicals beneath plume area	0.5–1 (linear) 9.5–10 (linear) 19.5–20 (linear) 25.9–30 (linear) 39.5–40 (linear) 49.5–50 (linear) 59.5–60 (linear)	Soil Soil Tuff Tuff Tuff Tuff Tuff	—	—	—	—	—	X X X X X X X	X X X X X X X	—	—	—	X X X X X X X
New #1	Angled borehole with a target depth of approximately 72 ft bgs beneath historical location 00-04097 Paired with vertical borehole New #5	Sampling to define vertical extent of organic chemicals beneath assumed source area	0.5–1 (linear) 9.5–10 (linear) 19.5–20 (linear) 25.9–30 (linear) 39.5–40 (linear) 49.5–50 (linear) 59.5–60 (linear) 69.5–70 (linear)	Soil Soil Tuff Tuff Tuff Tuff Tuff Tuff	—*	—	—	—	—	X X X X X X X X	X X X X X X X X	—	—	—	X X X X X X X X
New #2	Vertical borehole with target depth of 30 ft bgs at historical sample location 00-04055 Paired with angled borehole 00-04055	Sampling to define vertical extent of organic chemicals	0–0.5 9.5–10 19.5–20 29.5–30 39.5–40 49.5–50 59.5–60	Soil Soil Tuff Tuff Tuff Tuff Tuff	—	—	—	—	—	X X X X X X X	X X X X X X X	—	—	—	X X X X X X X

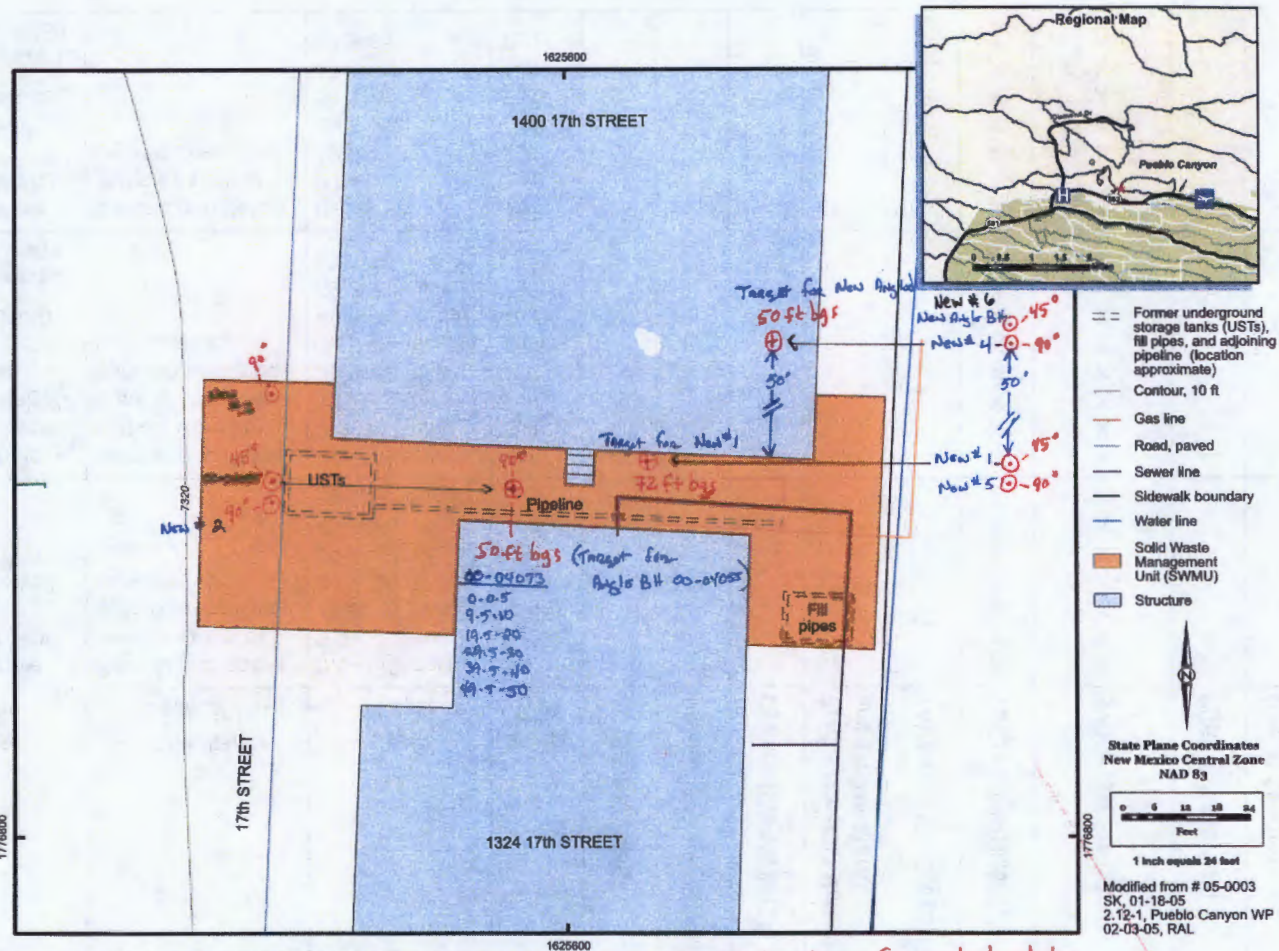


Figure 1.1-14. Location of SWMU 00-039, underground tanks

● Target Locations for angle boreholes
○ New borehole locations

Table 4.12-1 (continued)

Location ID	Location Description	Sampling Justification	Depth (ft bgs)	Media Type	pH (SW-846 9045C)	Nitrates (EPA Method 300.0)	Cyanide (SW-846 9012A)	Perchlorate (EPA Method 314.0 and SW-846 8321A)	TAL Metals (SW-846 6010B)	VOCs (SW-846 8260B)	SVOCs (SW-846 8270C)	PCBs (SW-846 8082)	Gamma Spectroscopy (EPA Method 901.1)	Pesticides (SW-846 8081A)	TPH (SW-846 8015B)
New #3	Vertical borehole in northwest area of site with target depth of 50 ft bgs	Sampling to define vertical extent of organic chemicals	0-0.5 9.5-10 19.5-20 29.5-30 39.5-40 49.5-50	Soil Soil Tuff Tuff Tuff Tuff	—	—	—	—	—	X X X X X X	X X X X X X	—	—	—	X X X X X X
New #4	Vertical borehole moved to northeast area of site from southwest area of site with target depth of 50 ft bgs Paired with angled borehole New #6	Sampling to define vertical extent of organic chemicals	0.5-1 9.5-10 19.5-20 25.9-30 39.5-40 49.5-50	Soil Soil Tuff Tuff Tuff Tuff	—	—	—	—	—	X X X X X X	X X X X X X	—	—	—	X X X X X X
New #5	Vertical borehole to target depth of 72 ft bgs Paired with angled borehole New #1	Sampling to define vertical extent of organic chemicals	0.5-1 9.5-10 19.5-20 25.9-30 39.5-40 49.5-50 59.5-60 69.5-70	Soil Soil Tuff Tuff Tuff Tuff Tuff Tuff	—	—	—	—	—	X X X X X X X X	X X X X X X X X	—	—	—	X X X X X X X X

Location ID	Location Description	Sampling Justification	Depth (ft bgs)	Media Type	pH (SW-846 9045C)	Nitrates (EPA Method 300.0)	Cyanide (SW-846 9012A)	Perchlorate (EPA Method 314.0 and SW-846 8321A)	TAL Metals (SW-846 6010B)	VOCs (SW-846 8260B)	SVOCs (SW-846 8270C)	PCBs (SW-846 8082)	Gamma Spectroscopy (EPA Method 901.1)	Pesticides (SW-846 8081A)	TPH (SW-846 8015B)
00-04073	Vertical borehole with target depth of 50 ft bgs NMED Approval with NOD comment	Sampling to define <u>vertical</u> extent of organic chemicals	0-0.5 9.5-10 19.5-20 29.5-30 39.5-40 49.5-50	Soil Soil Tuff Tuff Tuff Tuff	—	—	—	—	—	X X X X X X	X X X X X X	—	—	—	X X X X X X
New (#6)	Angled borehole with a target depth of 50 ft bgs below former dry cleaner facility Paired with vertical borehole New #4	Sampling to define vertical extent of organic chemicals	0-0.5 9.5-10 19.5-20 29.5-30 39.5-40 49.5-50	Soil Soil Tuff Tuff Tuff Tuff	—	—	—	—	—	X X X X X X	X X X X X X	—	—	—	X X X X X X

*— = Analysis will not be performed for this sample.