

TA-030

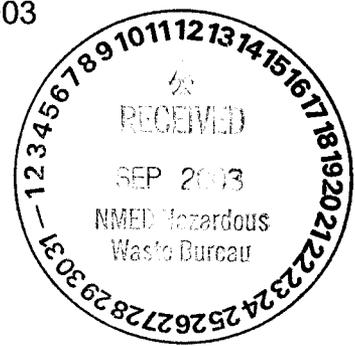


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Date: September 04, 2003  
Refer to: ER2003-0566



Mr. John Young, Corrective Action Project Leader  
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NMED – Hazardous Waste Bureau  
2905 Rodeo Park Drive East  
Building 1  
Santa Fe, NM 87505-6303

**SUBJECT: STATUS OF MORTANDAD CANYON SEDIMENT INVESTIGATIONS**

Dear Mr. Young:

Enclosed is a report entitled "Status of Mortandad Canyon Sediment Investigations" (LA-UR-03-5997) which briefly summarizes sediment investigations conducted to date under the "Work Plan for Mortandad Canyon" (LA-UR-97-3291). Also, enclosed is an electronic file on CD that includes analytical data from all sediment samples collected by the Risk Reduction and Environmental Stewardship - Remediation Services Project in Mortandad Canyon and its tributaries, and maps showing sample locations. A more complete presentation and assessment of data will occur in a future Mortandad Canyon Investigation Report, which will also include data on surface water and groundwater. This submission of data and maps fulfills a request you made in a letter dated December 12, 2002, and the report satisfies a request you made later.

This report and the accompanying electronic file contain data regarding radioactive materials, the management of which is regulated under the Atomic Energy Act and specifically excluded from regulation under the Resource Conservation and Recovery Act and the New Mexico Hazardous Waste Act. These data are provided to the New Mexico Environment Department for information purposes only.

Please contact Steven Reneau at (505) 665-3151 if you have any questions.

Sincerely,  
  
David McInroy, Deputy Project Director  
Remediation Services  
Los Alamos National Laboratory

Sincerely,  
  
David Gregory, Project Manager  
Department of Energy  
Los Alamos Site Operations



Mr. John Young  
ER2003-0566

-3-

September 4, 2003

DM/DG/SR/KR/dv

Enclosures: Status of Mortandad Canyon Sediment Investigations (LA-UR-03-5997)  
CD with Electronic Data (To Mr. John Young)  
GISLab Map M200739, M200747, M200741, M200737, M200760 (To Mr. John Young)

Cy:(w/enc)

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# **STATUS OF MORTANDAD CANYON SEDIMENT INVESTIGATIONS**

**Steven Reneau, Randy Ryt, Paul Drakos, and Terre Mercier**

**August 26, 2003**

**Los Alamos National Laboratory Report LA-UR-03-5997**

## **INTRODUCTION**

Investigations of potentially contaminated sediment deposits in Mortandad Canyon and its tributary canyons by the Los Alamos National Laboratory (LANL) Environmental Restoration (ER) Project (now the Risk Reduction and Environmental Stewardship-Remediation Services Project) Canyons team have been in progress since 1998. This work has been conducted following the "Work Plan for Mortandad Canyon" (the "work plan") (LANL 1997, 56835; LANL 1999, 62777), which was approved by the New Mexico Environment Department (NMED) in December 2002 (NMED 2002, 73830). Included in this work plan are investigations of potential contamination in sediment, surface water, and groundwater in Mortandad Canyon proper, as well as in Effluent Canyon, Ten Site Canyon, and an unnamed tributary canyon that heads in Technical Area (TA) 5 (hereafter referred to collectively as the "Mortandad Canyon reaches"). A short tributary to Ten Site Canyon, "Pratt Canyon", has been investigated separately as part of characterization activities at TA-35. This report summarizes analytical results from all sediment samples collected by the Canyons team to date in implementation of the work plan, as well as results from relevant sediment samples from the Mortandad Canyon reaches and from Pratt Canyon that were collected by other ER Project investigations in TA-5, TA-35, and TA-50. An accompanying electronic data file includes all analytical results from these samples.

This report and the electronic file contain data regarding radioactive materials, the management of which is regulated by the Department of Energy under the Atomic Energy Act. The radioactive materials are specifically excluded from regulation under the Resource Conservation Recovery Act and the Hazardous Waste Act. These data are provided to the NMED for informational purposes only.

## **FIELD INVESTIGATIONS**

Field investigations that include detailed geomorphic mapping, associated geomorphic characterization, and sediment sampling have been conducted in all reaches specified in the work

plan except reach M-7. In some of these reaches, two rounds of sampling have been conducted. Table 1 presents a summary of sediment sampling in Mortandad Canyon and tributary canyons, including the years in which samples were collected in each reach or subreach, and the number of samples collected for each analytical suite. The term "subreach" is used for subdivisions of or additions to the reaches discussed in the work plan; these subdivisions were made to facilitate more detailed evaluation of possible contributions from different potential release sites (PRSs) in the watershed. Table 1 includes samples collected by the Canyons team and also as part of other ER Project investigations. Sample locations are shown on the geomorphic maps listed in Table 2. Table 2 also includes a watershed map that shows the locations of all reaches.

Reach M-7 has not been investigated because it is a contingency reach only planned for investigation if results from upstream reaches indicated transport of contaminated sediments at least as far as reach M-6 or down Cañada del Buey into lower Mortandad Canyon (LANL 1997, 56835, p. 7-26). Results from reach CDB-4 in Cañada del Buey, immediately upstream from the LANL boundary (Drakos et al. 2000, 68739), and from reach M-6 (discussed below), do not indicate the presence of analytes at levels above background, and therefore no investigation is planned for reach M-7.

As part of the geomorphic characterization, field gross gamma radiation data were obtained from walkover surveys and from fixed-point measurements in a series of vertical profiles in selected reaches. Gamma radiation was targeted because cesium-137 (Cs-137) is a primary contaminant released from the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF) outfall and is a high-energy gamma emitter that is easily detected with field instruments. In addition, Cs-137 is expected to be collocated with other particle-bound contaminants released from the RLWTF. Walkover surveys were conducted in the entirety of reaches M-3 and M-4, and in parts of M-5 and TS-3, in 1999 and 2000. Other areas were not surveyed with this method either because concentrations of Cs-137 are too low to make screening data useful, or because the reaches are too brushy and/or rocky to allow efficient application of walkover surveys (e.g., E-1 and M-2). Characterization in reaches E-1, M-2, M-3, and M-4 included fixed-point measurements because Cs-137 concentrations in these reaches are high enough to make this a useful field technique. Some fixed-point beta-gamma radiation measurements were also made in reach TS-2 because these data had proved useful upstream in Pratt Canyon, but Sr-90 levels in TS-2 were found to be too low to make field radiation surveys useful there.

**Table 1**  
**Summary of ER Project Sediment Sampling In Mortandad Canyon**

Reach or Subreach	Reach Length (km)*	Source	Year of Sediment Sampling	Number of Samples Collected															
				Gamma Spec	H-3	Iso Pu	Iso Th	Iso U	Am-241	Sr-90	Metals	CN	Anions	Perchlorate	HE	PCBs	Pest	SVOCs	VOCs
E-1 East	0.30	Canyons	1998, 2001	40	15	40	10	15	5	40	40	5	10	10		15	15	15	10
		Other	1993	42	42	42		42		21	42					16		40	24
E-1 West		Canyons	1998, 2001	11	11	11	6	11	5	11	11	5	6	6		11	11	11	
M-1 East	0.26	Canyons	1998	6	6	6		6	6	6	6	6				6	6	5	
M-1 West		Canyons	1998	6	6	6		6	6	6	6	6				6	6	6	
M-2 East	1.01	Canyons	2001	42	10	42	10	10		42	42		10	10		10	10	10	7
M-2 West		Canyons	1998, 2001	63	20	63	10	20	10	63	63	10	10	10		20	20	20	9
		Other	1993	12	12	12		12		8	12					2		12	12
M-3	0.90	Canyons	1999, 2001	82	15	82	10	15		82	82		10	10		15	15	15	10
M-4	0.66	Canyons	1999, 2001	81	15	81	10	15		81	81			10		15	15	15	10
		Other	1995	1	1	21		21			21							21	21
M-5	0.56	Canyons	2000, 2001	13	14	13	14	13	7	14	13	7				13	13	13	
M-6	0.20	Canyons	2002	10		10		10		10	10	10						10	
MCW-1	0.24	Canyons	2002			8	8	8			8	8			8			8	
MCW-2 East	0.50	Canyons	2002			7	7	7			7	7			7			7	
MCW-2 North		Canyons	2002			9	9	9			9	9			9			9	
MCW-2 West		Canyons	2002			9	9	9			9	9			9			9	

Table 1 (continued)

Reach or Subreach	Reach Length (km)*	Source	Year of Sediment Sampling	Number of Samples Collected															
				Gamma Spec	H-3	Iso Pu	Iso Th	Iso U	Am-241	Sr-90	Metals	CN	Anions	Perchlorate	HE	PCBs	Pest	SVOCs	VOCs
Pratt Canyon	0.18	Other	1994, 1997, 1998	12	12	33		33	9	11	14	9	2			12	10	12	
TS-1 Central	0.59	Canyons	1999	4	4	4		4		4	4					4	4	4	
		Other	1993	59	59	59		59	1		59					1		59	59
TS-1 East	0.59	Canyons	1999	4	4	4		4		4	4					4	4	4	
TS-1 West		Other	1993	66	66	66		66	40		66					34		66	66
TS-2 Central	0.51	Canyons	1999	4	4	4		4		4	4					4	4	4	
		Other	1995			1		1											
TS-2 East	0.51	Canyons	1999	4	4	4		4		4	4					4	4	4	
		Other	1995			6		6											
TS-2 West	0.51	Canyons	1999	4	4	4		4		4	4					4	4	4	
TS-3		0.30	Canyons	2001	10	10	10	10	10		10	10					10	10	10

Note: Blank cells indicate no sample results for that analyte suite in that reach.

\* Length refers to area mapped and characterized, and may include multiple subreaches.

**Table 2**  
**Mortandad Canyon Geomorphic Maps**

Reach	GISLab Map #
Watershed map, showing locations of all reaches	m200739
M-1, E-1	m200747
M-2, TS-1, TS-2, Pratt Cyn	m200741
M-3, M-4, TS-3, MCW-1	m200737
M-5, M-6, MCW-2	m200760

### MODIFICATIONS TO WORK PLAN

During implementation of this work, several modifications have been made to the analytical suites and the investigation approach presented in the work plan. These modifications were in part discussed with NMED during preparatory stages for individual sampling events, and have in part been incorporated into subsequent work plans submitted to the NMED for other canyons as the Canyons investigation approach has evolved. Although not specified in the work plan, analytical data have been obtained in select reaches for high explosives (HE), isotopic thorium, perchlorate and other anions, and volatile organic compounds (VOCs) because these were judged to be potential data gaps based on process knowledge and/or previous data. In 1998 a reach "M-1 West" was added and investigated upstream of reach M-1 as shown in the work plan. M-1 West is located at the head of the canyon just east of Diamond Drive, and was investigated to better determine contaminant levels that would be associated with releases from TA-3. In 2001, a reach "M-2 East" was investigated downstream of reach M-2 as shown in the work plan. M-2 East is located downstream of the easternmost PRS at TA-35, and was investigated to better determine if TA-35 PRSs have had a measurable impact on sediments in Mortandad Canyon. Investigation of M-2 East was partially in support of planned ER Project work at TA-35 under the "Sampling and Analysis Plan for the Middle Mortandad/Ten Site Aggregate" (LANL 2002, 73092). Other objectives of the M-2 East investigation were to obtain additional data on contaminants released from TA-50, and to reduce the length of the non-sampled area between Effluent Canyon and reach M-3. An additional modification is that several reaches are shorter than the estimated minimum reach length of 0.5 km presented in the work plan (E-1, M-1, M-6, MCW-1, TS-3). Most of these reaches are shorter than 0.5 km because contaminants were expected to be present at low levels or to be absent (M-1, M-6, MCW-1, TS-3), and it was judged that shorter reaches would be adequate to obtain sufficient characterization data in the first phase of sampling. The exception, E-1, includes the entirety of the canyon between the TA-50 RLWTF outfall and Mortandad Canyon (0.2 km), and a short part of the upstream canyon with lower contaminant levels.

## **NATURE AND SOURCES OF CONTAMINANTS**

Inorganic, organic, and radionuclide analytes have been identified as chemicals of potential concern (COPCs) in the Mortandad Canyon reaches based on detected or non-detected analytical results that exceed sediment background values (BVs) for inorganic chemicals, or based on detected results for radionuclides and organic chemicals. The sediment BVs are presented in Rytli et al. (1998, 59730) and McDonald et al. (2003, 76084). Tables 3 through 5 present maximum concentrations in each reach for all COPCs in Mortandad Canyon sediment samples. Maximum concentrations are shown for the purpose of identifying COPCs and indicating general spatial trends in concentrations. For purposes of assessing risk, more representative concentrations can be used.

Table 3 presents the maximum values for either detected or non-detected inorganic analytes, and Tables 4 and 5 present maximum detected sample results for organic and radionuclide analytes, respectively. Highlighted values in these tables are concentrations or detection limits greater than BVs for inorganic and radionuclide analytes that have BVs, or detected values for analytes without BVs. These highlighted values indicate analytes that are considered a COPC in that reach. Separate columns are included for sample locations that have been removed either in an interim action (LANL 1997, 55834) or during maintenance of the sediment traps (WGII 2000, 70735). No HE analytes are shown in these tables because none were detected. Several organic analytes were eliminated as COPCs because they were not detected or were detected in less than 5% of the sample results in a sub-watershed; elimination of organic analytes that were detected less than 5% of the time follows the screening processes developed for Los Alamos and Pueblo Canyons in discussions with the NMED (Katzman 2002, 73667), and is also consistent with risk assessment guidance from the Environmental Protection Agency (EPA 1989, 08021) and NMED (NMED 2000, 70107). As used in this assessment, sub-watersheds consist of (1) upper reaches of Mortandad Canyon (M-1 through M-4) and Effluent Canyon (E-1); (2) lower Mortandad Canyon (M-5 and M-6); (3) Ten Site Canyon (TS-1 through TS-3) and Pratt Canyon; and (4) the unnamed tributary canyon that heads in TA-5 (MCW-1 and MCW-2). Some analytes (e.g., antimony) are identified as COPCs based on detection limits exceeding BVs in some samples. Other analytes retained as COPCs (e.g., Th-230) have only a single sample result reported to be greater than the BV.

**Table 3**  
**Maximum Values for Inorganic COPCs in Mortandad Canyon Sediment Samples**

Analyte Name	Background Value	M-1 West	M-1 East	E-1 West	E-1 East	M-2 West	M-2 East	M-3	M-4	M-4 (Removed)	M-5	M-6	MCW-1
Aluminum	15400	7800	26000	19000	11000	8200	5100	10300	9910	8620	6300	12420	13880
Antimony	0.83	[11]		[0.56]	0.69	[13]	0.51	0.8	[1.9]	[0.64]	0.69		
Arsenic	3.98	4.4	8.4	11	6.1	4.3	2.8	4	4.6	3.8	3	2.7	3.22
Barium	127	89	270	350	160	130	85	115	146	104	110	125	125
Beryllium	1.31	[0.93]	1.4	2.4	1	0.95	0.74	1	1.1	[1.2]	0.94	1.05	0.949
Boron	4.1	[46]	[40]	[60]	[39]	[35]							
Bromide	n/a			8.31	12.4	3.83	1.12	0.944					
Cadmium	0.4	[0.93]	[0.79]	[1.2]	2.2	0.8	0.074	0.25	0.19	[0.05]	0.14	[0.51]	[0.582]
Calcium	4420	2500	3600	5800	51000	22000	12000	5460	5180	3000	2700	2800	2490
Chloride	17.1			185	45.2	39.2	52.7	35.8					
Chromium	10.5	8.2	18	50	140	22	14	17.5	11.1	11.9	5.4	8.14	8.96
Cobalt	4.73	3.9	7.7	12	6	4.5	3.8	3.9	5.1	4.4	4.1	3.77	3.99
Copper	11.2	6	14	20	120	47	35	29	37.2	16.9	6.9	8.22	7.26
Cyanide (Total)	0.82	[0.93]	[0.79]	[1.2]	[0.78]	[0.7]					[0.53]	0.239	0.436
Fluoride	n/a			1.93	3.9	70.6	13.3	3.62					
Iron	13800	12000	21000	25000	13000	14000	10000	13900	14500	14700	11000	11690	12090
Lead	19.7	23	30	30	70	58	17	19.7	22.6	18.7	16	18.8	21.4
Lithium	n/a												
Magnesium	2370	1200	3400	2700	2200	1400	1100	1860	1870	1490	1300	2030	1990

Table 3 (continued)

Analyte Name	Background Value	M-1 West	M-1 East	E-1 West	E-1 East	M-2 West	M-2 East	M-3	M-4	M-4 (Removed)	M-5	M-6	MCW-1
Manganese	543	470	1300	2500	1700	530	390	429	470	481	430	385	378
Mercury	0.1	[0.19]	[0.16]	[0.24]	2.7	0.69	1.1	0.43	0.32	0.1	0.024	0.0126	0.0227
Nickel	9.38	5.3	11	11	48	8.7	6.9	7.4	8.3	6.9	5.7	6.54	6.89
Oxalate	n/a			46.5	25.8	19.3	15.8	12.8					
Perchlorate	n/a			[0.656]	[3.2]	0.959	[0.162]	0.162	[0.627]				
Selenium	0.3	[1.9]	[1.6]	[2.4]	[1.6]	[1.4]	0.59	0.73	0.78	0.81	0.56	[0.603]	[0.582]
Silicon	n/a												
Silver	1	[3.7]	[3.2]	[4.8]	8	[2.8]	2.7	0.34	7	0.29	[0.063]	0.0848	0.0929
Sodium	1470	140	190	450	1300	1700	410	599	193	114	85	134	759
Strontium	n/a												
Sulfate	58.2			232	204	181	99.9	96.2					
Thallium	0.73	[0.46]	[0.4]	[0.6]	1.6	0.8	[0.31]	0.72	[0.51]	[0.52]	[0.39]	0.201	0.23
Vanadium	19.7	16	37	30	16	16	12	15.2	16.5	31.1	14	16	18.2
Zinc	60.2	80	77	110	78	100	59	88.8	71.1	60.3	44	48.5	34.9

Table 3 (continued)

Analyte Name	Category	Background Value	MCW-2 North	MCW-2 West	MCW-2 East	TS-1 West	TS-1 West (Removed)	TS-1 Central	TS-1 East	Pratt Canyon	TS-2 West	TS-2 Central	TS-2 East	TS-3
Aluminum	All Results	15400	9470	10760	13300			10500	7320	5860	7270	7810	6960	7200
Antimony	All Results	0.83				[11.2]	[1.2]	[11.2]	0.54	[4.5]	0.73	0.68	0.67	0.4
Arsenic	All Results	3.98	2.49	3.64	3.28	4.7	3.9	3.9	3	[3.7]	3.2	3.5	3.3	3.2
Barium	All Results	127	80.9	93.7	113	160	230	132	94.5	80.5	86.8	90.2	103	120
Beryllium	All Results	1.31	0.696	0.667	0.821	2.8	2.7	1.2	0.72	0.86	0.79	0.9	0.76	0.92
Boron	All Results	4.1								[2.4]				
Bromide	All Results	n/a								[0.33]				
Cadmium	All Results	0.4	[0.532]	[0.5]	[0.53]	[1.2]	1.1	1.7	[0.02]	2.1	[0.01]	[0.02]	0.22	0.14
Calcium	All Results	4420	2290	3440	3820			2380	1850	1760	1680	1930	3070	2500
Chloride	All Results	17.1								8.5				
Chromium	All Results	10.5	6.34	7.24	8.59	10	20	9.3	6.8	6.8	6.3	7.4	9.8	9.1
Cobalt	All Results	4.73	2.74	3.09	3.39			5.9	4	3	3.6	4	5.5	4.5
Copper	All Results	11.2	9.03	11.5	8.92			12.9	119	13.2	7.5	15.4	27.2	19
Cyanide (Total)	All Results	0.82	0.359	1.37	[0.319]					[0.7]				
Fluoride	All Results	n/a								6.6				
Iron	All Results	13800	8900	10670	11370			28800	11900	8740	12500	13800	13900	13000
Lead	All Results	19.7	12.3	14.6	18	23.6	44	39.1	16.6	16.1	13	15.8	17	20
Lithium	All Results	n/a								4.3				
Magnesium	All Results	2370	1350	1680	2010			1760	1280	1140	1300	1370	1410	1400

Table 3 (continued)

Analyte Name	Category	Background Value	MCW-2 North	MCW-2 West	MCW-2 East	TS-1 West	TS-1 West (Removed)	TS-1 Central	TS-1 East	Pratt Canyon	TS-2 West	TS-2 Central	TS-2 East	TS-3
Manganese	All Results	543	342	417	375			414	322	344	396	377	373	570
Mercury	All Results	0.1	0.0207	0.044	0.0412	0.1	2	[0.1]	0.05	1.6	0.06	0.07	0.37	0.19
Nickel	All Results	9.38	4.09	4.6	5.65	9.9	3	58.9	5.4	11.5	5.8	6.1	7.5	8.1
Oxalate	All Results	n/a												
Perchlorate	All Results	n/a												
Selenium	All Results	0.3	[0.55]	[0.55]	[0.52]	[0.6]	[0.2]	[3]	1.6	[7.1]	0.77	1.1	0.75	0.62
Silicon	All Results	n/a								57.1				
Silver	All Results	1	0.09	[0.2]	0.097	3.5	33	[1.4]	[0.03]	[0.8]	[0.04]	1.3	6	4.4
Sodium	All Results	1470	95.5	97.6	119			157	93.1	[395]	121	101	372	100
Strontium	All Results	n/a								7.9				
Sulfate	All Results	58.2								24.2				
Thallium	All Results	0.73	0.159	0.219	0.128	[1.2]	2.3	[1]	[0.27]	[25.2]	[0.54]	[0.24]	[0.24]	[0.22]
Vanadium	All Results	19.7	11.5	14.2	16.3			25.9	15.2	11.9	14.9	15.7	21	17
Zinc	All Results	60.2	37	56.4	43.5			94	58.3	54.9	46.4	61	65.8	63

- Notes:
1. Blackened cells indicate maximum result is above BV in that reach.
  2. Blank cells indicate no sample results for that analyte in that reach.
  3. [ ] indicate a non-detected sample result.
  4. n/a = background value is not available.
  5. Units are mg/kg.

**Table 4**  
**Maximum Values for Organic COPCs in Mortandad Canyon Sediment Samples**

Analyte Name	M-1 West	M-1 East	E-1 West	E-1 East	M-2 West	M-2 East	M-3	M-4	M-4 (Removed)	M-5	M-6	MCW-1
Acenaphthene	ND	ND	ND	ND	ND	0.088	ND	0.29	ND	1.8	ND	ND
Acetone				0.1	0.034	0.085	0.046	0.069	0.016			
Aroclor-1260	0.053	ND	0.18	0.1	0.21	0.054	0.39	0.12	0.07	ND		
Aroclors (Mixed)				0.053	ND							
Benzo(a)anthracene	ND	ND	ND	ND	0.12	0.22	ND	0.58	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	0.11	0.16	ND	0.59	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	0.1	0.12	0.11	ND	0.6	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	0.13	0.069	ND	0.2	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	ND	ND	ND	0.16	0.4	0.091	ND	0.41	ND	ND	0.207	0.191
Chlorophenol[2-]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	0.16	0.21	ND	0.59	ND	ND	ND	ND
DDT[4,4'-]	ND	ND	0.0096	0.078	0.035	0.013	0.028	0.015	ND	ND		
Dichloroethene[cis-1,2-]				ND	ND			0.002	0.003			
Di-n-butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	0.17	0.21	0.26	0.59	0.15	1.5	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	0.089	ND	0.24	ND	ND	ND	ND
Isopropyltoluene[4-]				0.044	0.032	ND	0.026	ND	ND			
Phenanthrene	ND	ND	ND	0.12	0.23	0.56	0.11	1.5	ND	ND	ND	ND

Table 4 (continued)

Analyte Name	M-1 West	M-1 East	E-1 West	E-1 East	M-2 West	M-2 East	M-3	M-4	M-4 (Removed)	M-5	M-6	MCW-1
Pyrene	ND	ND	ND	ND	0.26	0.55	ND	1.4	0.42	ND	ND	ND
Tetrachloroethene				ND	ND	ND	ND	0.005	0.008			
Toluene				0.043	0.011	0.087	0.023	0.016	0.027			
Trichlorofluoromethane				0.019	0.022	0.0027	ND	0.0037	ND			
Trimethylbenzene[1,2,4-]				0.026	ND	ND	0.068	0.003	0.004			
Xylene[1,2-]								0.002	0.001			
Xylene[1,3-]								0.005	0.004			

Table 4 (continued)

Analyte Name	MCW-2 North	MCW-2 West	MCW-2 East	TS-1 West	TS-1 West (Removed)	TS-1 Central	TS-1 East	Pratt Canyon	TS-2 West	TS-2 Central	TS-2 East	TS-3
Acenaphthene	0.0108	ND	ND	ND	ND	0.51	ND	6.4	ND	ND	ND	ND
Acetone				0.056	ND	0.041						
Aroclor-1260				1.52	ND	0.63	0.13	0.6	0.058	0.086	0.11	0.076
Aroclors (Mixed)				1.52	6	ND		ND				
Benzo(a)anthracene	ND	ND	ND	0.91	ND	1.1	0.44	8.2	ND	ND	ND	0.059
Benzo(a)pyrene	ND	ND	ND	1.1	ND	1.2	0.85	7.3	ND	ND	ND	0.084
Benzo(b)fluoranthene	ND	ND	ND	1.5	ND	1.1	1.6	7.3	ND	ND	ND	0.09
Benzo(k)fluoranthene	ND	ND	ND	0.64	ND	1.13	0.25	3.1	ND	ND	ND	0.079
Bis(2-ethylhexyl)phthalate	0.17	0.0445	ND	1.1	0.56	ND	ND	ND	ND	ND	ND	0.094
Chlorophenol[2-]	0.024	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	1.1	ND	1.4	0.91	7.6	ND	ND	ND	0.087
DDT[4,4'-]						ND	ND	ND	ND	ND	ND	0.0095
Dichloroethene[cis-1,2-]				ND	ND	ND						
Di-n-butylphthalate	0.0406	ND	ND	2.6	ND	3	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	1.9	ND	2.4	1.7	24	0.46	0.36	ND	0.35
Fluorene	0.0195	ND	ND	ND	ND	0.47	ND	4.8	ND	ND	ND	ND
Isopropyltoluene[4-]				0.035	ND	ND						
Phenanthrene	ND	ND	ND	1	ND	3.1	0.81	30	ND	ND	ND	ND
Pyrene	ND	ND	ND	2	ND	2.4	2.2	22	0.5	0.66	ND	0.38

Table 4 (continued)

Analyte Name	MCW-2 North	MCW-2 West	MCW-2 East	TS-1 West	TS-1 West (Removed)	TS-1 Central	TS-1 East	Pratt Canyon	TS-2 West	TS-2 Central	TS-2 East	TS-3
Tetrachloroethene				ND	ND	ND						
Toluene				0.022	ND	ND						
Trichlorofluoromethane				ND	ND	ND						
Trimethylbenzene[1,2,4-]				ND	ND	ND						
Xylene[1,2-]												
Xylene[1,3-]												

- Notes: 1. Blackened cells indicate detected results in that reach.  
 2. Blank cells indicate no sample results for that analyte in that reach.  
 3. ND = analyte is not detected.  
 4. Units are mg/kg.

**Table 5**  
**Maximum Values for Radionuclide COPCs In Mortandad Canyon Sediment Samples**

Analyte Name	Background Value	M-1 West	M-1 East	E-1 West	E-1 East	M-2 West	M-2 East	M-3	M-4	M-4 (Removed)	M-5	M-6	MCW-1
Americium-241 <sup>a</sup>	0.04	ND	ND	0.157	642	524	211	223	112	20.7	ND	ND	
Cesium-134	n/a	ND	ND	ND	0.196	0.24	0.114	ND	ND	ND	ND	ND	
Cesium-137	0.9	ND	0.64	2.14	2530	870	557	298	276	43.5	0.93	0.409	
Cobalt-60	n/a	ND	ND	ND	5.22	2.45	0.5	1.47	0.445	ND	ND	ND	
Plutonium-238	0.006	0.04	0.048	0.417	88.7	203	113	40.9	32.2	8.41	ND	ND	ND
Plutonium-239	0.068	ND	0.042	30.1	1360	596	157	123	64.5	25.6	0.095	ND	ND
Sodium-22	n/a	ND	ND	ND	0.49	0.151	ND	ND	ND	ND	ND	ND	
Strontium-90	1.04	ND	ND	ND	273	35.9	20	8.6	9.64	3.5	0.4	0.304	
Thorium-230	2.29			1.15	0.93	1.2	1.34	1.22	1.24		1.46		2.44
Tritium	0.093	0.13	ND	ND	105	7.15	0.518	0.321	0.278	ND	0.055		
Uranium-234	2.59	0.649	1.306	2.41	16.04	14.7	1.57	1.83	1.6	1.43	1.52	1.25	2.13
Uranium-235 <sup>b</sup>	0.2	0.041	0.118	0.112	0.683	0.8	0.18	0.242	0.103	0.14	0.174	0.103	0.105
Uranium-238	2.29	0.678	1.44	2.65	7.125	10.7	1.81	1.64	1.52	1.44	1.62	1.21	2.04

Table 5 (continued)

Analyte Name	Background Value	MCW-2 North	MCW-2 West	MCW-2 East	TS-1 West	TS-1 West (Removed)	TS-1 Central	TS-1 East	Pratt Canyon	TS-2 West	TS-2 Central	TS-2 East	TS-3
Americium-241 <sup>a</sup>	0.04				1.82	170.9	2.3	ND	0.412	ND	ND	ND	ND
Cesium-134	n/a				ND	ND	ND	ND	ND	ND	ND	ND	ND
Cesium-137	0.9				3.59	72.83	3.19	0.65	25	0.48	0.45	0.87	1.22
Cobalt-60	n/a				1.30	0.91	ND	ND	0.368	ND	ND	ND	ND
Plutonium-238	0.006	0.0229	ND	ND	67.8	5190	16.8	3.63	0.02	1.52	2.209	1.351	1.55
Plutonium-239	0.068	0.026	0.038	0.0445	19.5	453	13.8	1.033	1.73	0.596	0.894	0.703	0.77
Sodium-22	n/a				ND	ND	ND	ND	ND	ND	ND	ND	ND
Strontium-90	1.04						ND	ND	118	6.7	2.54	8.3	3.1
Thorium-230	2.29	1.28	1.84	1.5									1.43
Tritium	0.093				1.50	19.1	0.303	ND	0.211	0.143	0.134	0.088	0.297
Uranium-234	2.59	1.16	1.28	1.21	2.735	5.295	2.469	1.262	2.1816	1.136	1.132	2.25	1.84
Uranium-235 <sup>b</sup>	0.2	0.108	0.0743	0.078	ND	ND	0.255	0.071	0.102	0.087	0.075	0.1	0.098
Uranium-238	2.29	1.1	1.33	1.33	3.049	2.67	3.006	1.333	1.899	1.193	1.121	2.37	1.75

- Notes: 1. Blackened cells indicate maximum result is above BV in that reach.  
 2. Blank cells indicate no sample results for that analyte in that reach.  
 3. ND = analyte is not detected.  
 4. n/a = background value is not available.  
 5. Units are pCi/g.

<sup>a</sup> Maximum from either alpha or gamma spectroscopy

<sup>b</sup> Maximum from alpha spectroscopy

Inorganic COPCs apparently have a variety of sources in the watershed, including the upstream parts of Mortandad Canyon (TA-3 and TA-48), Effluent Canyon upstream and downstream of the TA-50 RLWTF outfall, the upper part of Ten Site Canyon (TA-35 and/or TA-50), and Pratt Canyon. Table 3 shows that maximum concentrations for different inorganic COPCs are found in a variety of reaches, supporting the interpretation that there are a variety of sources.

Organic COPCs also apparently have a variety of sources in the watershed. Maximum results for polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) occur in Ten Site Canyon and Pratt Canyon (Table 4), indicating sources at TA-35 and/or TA-50. Among the organic chemicals detected in more than 5% of the sample results and retained as COPCs were acetone, toluene, and bis(2-ethylhexyl)phthalate, which are all considered to be common analytical laboratory contaminants by the EPA. These organic chemicals could therefore be due to field or analytical laboratory contamination and may not primarily represent releases from LANL PRSs.

The most important source for radionuclide COPCs in the Mortandad Canyon watershed is the TA-50 RLWTF outfall (located in Effluent Canyon), and maximum concentrations for most radionuclide COPCs occur in reach E-1 East or downstream in reach M-2 (Table 5). Secondary sources include discharges from TA-35 into Pratt Canyon and from TA-50 into the head of Ten Site Canyon.

## EXTENT OF CONTAMINANTS

In each reach, the potential lateral extent of contaminants distributed by floods is the extent of the "c" (post-1942 channel) and "f" (post-1942 floodplain) units on the geomorphic maps. The area occupied by these geomorphic units varies from 1 to 90 m in width, being least in parts of steep rocky reaches such as E-1 East and TS-2 East, and greatest in reaches M-3 and M-4. The estimated vertical extent of contaminants contained within post-1942 sediment deposits ranges from less than 5 cm to at least 1.5 m deep, representing the thickness of sediment deposited by floods since initial releases. Contaminants are expected to extend deeper into older sediments in some areas associated with the infiltration of effluent and storm water and with alluvial groundwater flow. However, the extent of subsurface contaminants is less well known than the lateral extent of contaminants that have been dispersed by floods. Collection of additional data to address the subsurface extent of contaminants is planned as part of the Mortandad Canyon groundwater work plan addendum (in preparation).

Available data suggest that the downstream extent of contaminants in Mortandad Canyon that were released from LANL sites and carried by floods may be somewhere between reaches M-4 and M-5, although there is some uncertainty here (as discussed below). From the perspective of potential human health exposure pathways, the most significant contaminant released into the

watershed prior to the first discharges from the TA-50 RLWTF in 1963 is strontium-90 (Sr-90), released from TA-35 into Pratt Canyon. Sr-90 has been detected at levels above the sediment BV (1.04 pCi/g) in M-4 and in upstream reaches, but not in M-5 or M-6. From a human health perspective, the most significant contaminant released from the TA-50 RLWTF that is associated with sediment is Cs-137. In sampling by the Canyons team, Cs-137 has also been detected in multiple samples at levels above the sediment BV (0.9 pCi/g) in M-4 and in upstream reaches, but only slightly higher than the BV in one sample in M-5 (0.93 pCi/g) and in no samples in M-6. In contrast, the Environmental Surveillance Program (ESP) reported Cs-137 above the BV in M-5 in 1997 and 2001 (2.58 and 3.16 pCi/g at station A-6; ESP 1998, 59904, p. 168; ESP 2002, 73806, p. 303), although below the BV in other years. We plan to resample station A-6 to see if these results can be confirmed and to help constrain the downstream extent of contamination.

Additional analytes have been detected at levels above BVs in either M-5 or M-6, but the spatial distributions of most of these do not indicate significant releases from any LANL PRS (e.g., no pattern of decreasing concentrations downstream, as seen for Cs-137, Sr-90, and other contaminants). Exceptions are plutonium-238 (Pu-238) and plutonium-239,240 (Pu-239,240), which are detected at low levels above BVs in M-5 but not in M-6, suggesting that for these analytes the downstream extent of flood-borne contaminants may be between M-5 and M-6. However, understanding the source of plutonium isotopes is complicated by the inference from regional soil data that plutonium may also be dispersed at levels above BVs by local stack emissions and/or by fugitive dust (Fresquez et al. 1998, 76063), and the results in M-5 may or may not record past flood transport.

Only three analytes have been retained as COPCs in reach M-6, and none of these can be clearly traced to LANL sources. These include two inorganic analytes, cadmium and selenium, which are retained only because detection limits for some samples exceed the BV. The third COPC, bis(2-ethylhexyl)phthalate, is considered by the EPA to be a common analytical laboratory contaminant, as discussed above, and the detected value in M-6 is not considered to represent releases from LANL.

## **TRANSPORT OF CONTAMINANTS**

The analytical data have been combined with geomorphic characterization data to develop preliminary contaminant inventories in the different reaches for key radionuclides, and to develop preliminary trends in contaminant concentrations in sediment deposits as a function of time of deposition. This information on contaminant inventories and concentrations is being used to refine the conceptual model of contaminant transport in the Mortandad Canyon watershed.

Figure 1 shows the preliminary estimate of the Cs-137 inventory between the TA-50 RLWTF outfall and reach M-6. Figure 1a shows the inventory by reach, normalized to units of mCi/km, and Figure 1b shows cumulative inventory, in units of mCi, that extrapolates between sampled reaches. Of the 1.5 Ci of Cs-137 estimated to be present in Effluent and Mortandad Canyons, about 50% is within the eastern 0.6 km of reach M-3. This is the area where Mortandad Canyon widens abruptly and floodwaters have historically spread across the valley bottom, causing sediments and associated contaminants to be deposited. This deposition is upstream from the sediment traps, supporting the interpretation that this part of Mortandad Canyon was a natural deposition area before construction of the sediment traps. These data revise the initial conceptual model in the work plan (LANL 1997, 56835; p. 7-21) that reach M-4 may contain the highest inventory of contaminants in the watershed.

The age of specific sediment deposits in reach M-4 with the highest concentrations of key radionuclides can be estimated based on their relation to sediment traps constructed in this reach, and to trees that have been dated by dendrochronology (tree-ring dating). The first sediment traps were excavated in 1976 and had filled in by 1983 (LANL 1997, 56835; p. 2-8). Unique isotope ratio signatures in these deposits, reflecting the variable release history of different radionuclides from the TA-50 RLWTF, have been used to estimate ages of sampled sediment deposits in upstream reaches (isotope ratios in the effluent at any point in time varied with both the nature of contemporary research at LANL and on the treatment process at the RLWTF). For example, sediment with the lowest ratios of Pu-239,240 to Pu-238 (0.4-0.7) and americium-241 (Am-241) to Pu-238 (0.3-0.5) are present in the lower layers of the early sediment traps and in slightly older sediment deposited just downstream before the traps were created. These sediment deposits also have the highest concentrations of Cs-137 and Pu-238 in reach M-4, indicating that the highest levels of these radionuclides occurred in sediment deposited ca. 1976. Effluent records from the RLWTF show that the peak releases of Pu-238 were in 1974-1975 (LANL 1997, 56835; p. 2-20, 2-21), in turn indicating that within a few years floods had transported these constituents downstream to reach M-4. The peak release of Cs-137 is less well constrained by discharge records, but the correspondence of Cs-137 and Pu-238 peaks in sediment deposits suggests that Cs-137 also had maximum releases ca. 1974-1975.

Somewhat different histories are seen for Am-241 and Pu-239,240. In reach M-4, the highest levels of these analytes occur in slightly younger sediments in the early sediment traps, after 1976 but no later than 1983. These sediments have the lowest ratios of Cs-137 to Am-241 (0.6-0.9) and Pu-239,240 to Am-241 (0.5-0.6). Effluent records from the RLWTF indicate that the peak releases for Am-241 and Pu-239,240 were in 1981-1983 (LANL 1997, 56835; p. 2-20, 2-21), also providing evidence that floods rapidly transported these constituents downstream to M-4. Younger sediment deposits (post-1983) have lower concentrations of these key radionuclides, reflecting reduced releases from the RLWTF. Barring an increase in releases from the RLWTF, concentrations in sediments carried by floods should stay well below the peak levels that occurred ca. 1976-1983.

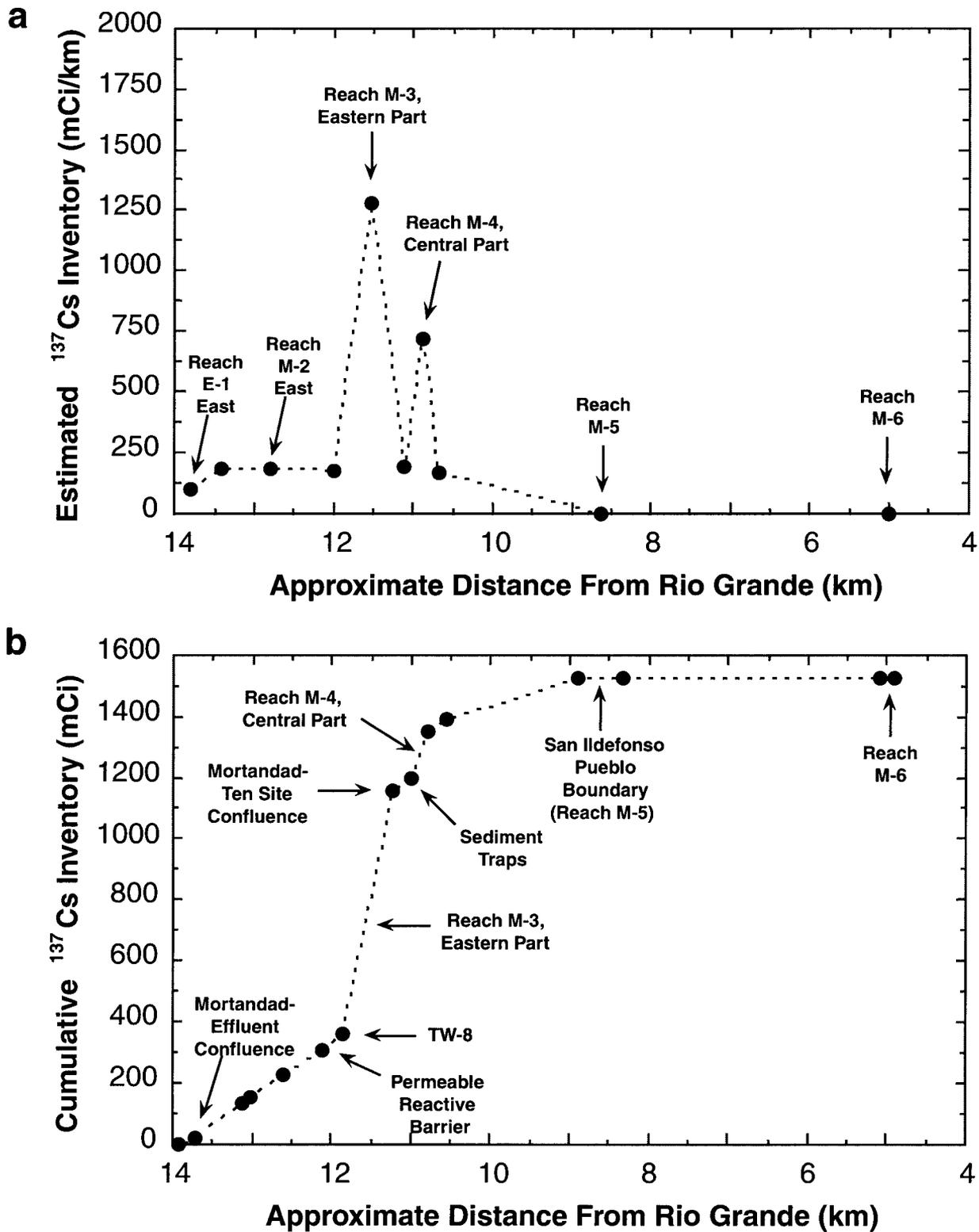


Figure 1. Preliminary estimate of Cs-137 inventory in Mortandad Canyon: (a) normalized inventory and (b) cumulative inventory

## REMAINING MORTANDAD CANYON ACTIVITIES

A series of tasks are required in Mortandad Canyon to complete the investigations presented in the work plan. These include collecting additional sediment samples to address uncertainties in the nature, extent, and concentration of COPCs; collecting surface water and groundwater samples; and potentially developing and implementing a biological investigation. Additional sampling of sediment in the Mortandad Canyon reaches is planned for Fall 2003, and may be followed by additional sampling in 2004 if data needs remain. Data needs for groundwater and surface water are being addressed in a separate groundwater work plan addendum (in preparation). Assessment of the potential need for a biological investigation is planned for Fall 2003, with implementation in 2004 if a biological investigation is deemed necessary. In addition to sampling associated with implementation of the Mortandad Canyon Work Plan, sampling planned at TA-35 as part of the NMED-approved Sampling and Analysis Plan for the Middle Mortandad/Ten Site Aggregate (LANL 2002, 73092), including in Pratt Canyon, will also contribute to understanding contamination in Mortandad Canyon.

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