Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
1:							
Silver	55	Very limited		Somewhat limited		Not limited	
		Low strength	1.00	Cutbanks cave	0.10		
		Shrink-swell	0.50				
Clovis	35	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
2:							
Clovis	35	Not limited		Somewhat limited		Not limited	
				Cutbanks cave	0.10		
Prieta	35	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Shrink-swell	0.50	Large stones content	0.43	Droughty	1.00
		Large stones content	0.43	Cutbanks cave	0.10	Large stones content	1.00
		Slope	0.04	Slope	0.04	Gravel content	0.08
						Slope	0.04
Silver	20	Very limited		Somewhat limited		Not limited	
		Low strength	1.00	Cutbanks cave	0.10		
		Shrink-swell	0.50				
3:							
Montecito	60	Very limited		Somewhat limited		Somewhat limited	
		Low strength	1.00	Cutbanks cave	0.10	Large stones content	0.01
		Shrink-swell	0.50				

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Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
3:							
Orejas	30	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Large stones content	0.67	Large stones content	0.67	Droughty	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Large stones content	0.99
4:							
Montecito	45	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Large stones content	0.01
Montecito, bouldery-	35	Very limited		Very limited		Very limited	
		Low strength	1.00	Slope	1.00	Large stones content	1.00
		Slope	1.00	Cutbanks cave	0.10	Slope	1.00
		Shrink-swell	0.50			Gravel content	0.05
10:							
Trail	85	Somewhat limited		Very limited		Somewhat limited	
		Flooding	0.40	Cutbanks cave	1.00	Droughty	0.27
				Depth to saturated zone	0.15		
11:							
Trail	85	Very limited		Very limited		Somewhat limited	
		Flooding	1.00	Cutbanks cave	1.00	Flooding	0.60
				Flooding	0.60	Droughty	0.08
				Depth to saturated zone	0.15		
13:							
Sandoval	65	Very limited		Very limited		Very limited	
		Depth to soft bedrock	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Low strength	1.00	Cutbanks cave	0.10	Droughty	0.59
		Shrink-swell	0.50				
Querencia	20	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		

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Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
15:							
Camino	40	Very limited		Somewhat limited		Not limited	
		Low strength	1.00	Too clayey	0.12		
		Shrink-swell	1.00	Cutbanks cave	0.10		
Sandoval	35	Very limited		Very limited		Very limited	
		Depth to soft bedrock	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Low strength	1.00	Cutbanks cave	0.10	Droughty	0.25
		Shrink-swell	0.50				
16:							
Prieta	30	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Droughty	0.99
		Large stones content	0.06	Large stones content	0.06	Large stones content	0.08
		Slope	0.04	Slope	0.04	Slope	0.04
17:							
Vessilla	35	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	0.04	Cutbanks cave	0.10	Droughty	1.00
				Slope	0.04	Slope	0.04
Menefee	25	Somewhat limited		Very limited		Very limited	
		Depth to soft bedrock	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Droughty	0.99
		Frost action	0.50	Slope	0.04	Slope	0.04
		Slope	0.04				
18:							
Sparham	85	Very limited		Somewhat limited		Very limited	
		Flooding	1.00	Flooding	0.60	Too clayey	1.00
		Low strength	1.00	Cutbanks cave	0.10	Sodium content	1.00
		Shrink-swell	0.50			Flooding	0.60

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Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
20:							
Gilco	85	Somewhat limited		Somewhat limited		Not limited	
		Flooding	0.40	Depth to saturated zone	0.15		
				Cutbanks cave	0.10		
21:							
Hackroy	25	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Low strength	1.00	Cutbanks cave	0.10	Droughty	1.00
		Shrink-swell	1.00				
		Frost action	0.50				
22:							
Aga	85	Somewhat limited		Very limited		Not limited	
		Flooding	0.40	Cutbanks cave	1.00		
				Depth to saturated zone	0.47		
23:							
Hickman	85	Very limited		Somewhat limited		Not limited	
		Low strength	1.00	Cutbanks cave	0.10		
		Shrink-swell	0.50				
		Flooding	0.40				
24:							
Orlie	45	Very limited		Somewhat limited		Not limited	
		Low strength	1.00	Cutbanks cave	0.10		
		Shrink-swell	0.50				
		Frost action	0.50				
Sparham	35	Very limited		Somewhat limited		Very limited	
		Flooding	1.00	Flooding	0.60	Too clayey	1.00
		Low strength	1.00	Too clayey	0.12	Sodium content	1.00
		Shrink-swell	1.00	Cutbanks cave	0.10	Flooding	0.60
25:							
Gilco	85	Somewhat limited		Somewhat limited		Not limited	
		Flooding	0.40	Depth to saturated zone	0.15		
				Cutbanks cave	0.10		

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
26:							
Orlie	85	Very limited		Somewhat limited		Not limited	
		Low strength	1.00	Cutbanks cave	0.10		
		Shrink-swell	0.50				
		Frost action	0.50				
27:							
Aga	85	Somewhat limited		Very limited		Not limited	
		Flooding	0.40	Cutbanks cave	1.00		
				Depth to saturated zone	0.47		
29:							
Trail	85	Somewhat limited		Very limited		Somewhat limited	
		Flooding	0.40	Cutbanks cave	1.00	Droughty	0.69
				Depth to saturated zone	0.15		
34:							
Ildefonso	55	Somewhat limited		Somewhat limited		Somewhat limited	
		Large stones content	0.70	Large stones content	0.70	Large stones content	0.92
				Cutbanks cave	0.10	Droughty	0.07
Witt	30	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
		Frost action	0.50				
47:							
Cascajo	85	Very limited		Very limited		Very limited	
		Slope	1.00	Cutbanks cave	1.00	Droughty	1.00
				Slope	1.00	Slope	1.00
						Gravel content	0.98
						Large stones content	0.61
51:							
Sparham	85	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Flooding	1.00	Flooding	0.60	Sodium content	1.00
		Low strength	1.00	Too clayey	0.12	Flooding	0.60
		Shrink-swell	1.00	Cutbanks cave	0.10	Salinity	0.13

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Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
52:							
Totavi	85	Somewhat limited		Very limited		Somewhat limited	
		Flooding	0.40	Cutbanks cave	1.00	Droughty	0.69
53:							
Witt	55	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
		Frost action	0.50				
Harvey	30	Very limited		Somewhat limited		Not limited	
		Low strength	1.00	Cutbanks cave	0.10		
		Shrink-swell	0.50				
54:							
Harvey	45	Somewhat limited		Somewhat limited		Somewhat limited	
		Shrink-swell	0.50	Slope	0.16	Slope	0.16
		Slope	0.16	Cutbanks cave	0.10		
Cascajo	40	Somewhat limited		Very limited		Very limited	
		Slope	0.16	Cutbanks cave	1.00	Droughty	1.00
				Slope	0.16	Gravel content	0.71
						Slope	0.16
						Large stones content	0.08
55:							
La Fonda	85	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
56:							
Ildefonso	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Large stones content	0.53	Large stones content	0.53	Large stones content	0.84
		Shrink-swell	0.50	Cutbanks cave	0.10	Droughty	0.01

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
58:							
Deama	45	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Droughty	1.00
		Large stones content	0.01	Large stones content	0.01	Carbonate content	1.00
						Large stones content	0.99
Elpedro	35	Very limited		Somewhat limited		Somewhat limited	
		Low strength	1.00	Cutbanks cave	0.10	Slope	0.04
		Shrink-swell	0.50	Slope	0.04		
		Frost action	0.50				
		Slope	0.04				
59:							
Harvey	35	Very limited		Somewhat limited		Not limited	
		Low strength	1.00	Cutbanks cave	0.10		
		Shrink-swell	0.50				
Ildefonso	35	Somewhat limited		Very limited		Somewhat limited	
		Slope	0.37	Cutbanks cave	1.00	Droughty	0.65
		Large stones content	0.02	Slope	0.37	Slope	0.37
				Large stones content	0.02	Large stones content	0.08
La Fonda	15	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
63:							
Placitas	85	Very limited		Very limited		Very limited	
		Slope	1.00	Depth to hard bedrock	1.00	Droughty	1.00
		Depth to hard bedrock	0.71	Cutbanks cave	1.00	Slope	1.00
				Slope	1.00	Depth to bedrock	0.71
						Gravel content	0.08

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
64:							
Skyvillage----------	40	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
				Cutbanks cave	0.10	Droughty	0.91
Ildefonso----------	35	Very limited		Very limited		Very limited	
		Slope	1.00	Cutbanks cave	1.00	Slope	1.00
				Slope	1.00	Droughty	0.88
						Gravel content	0.11
						Large stones content	0.05
65:							
Ildefonso----------	50	Very limited		Very limited		Very limited	
		Slope	1.00	Cutbanks cave	1.00	Slope	1.00
				Slope	1.00	Gravel content	0.99
						Droughty	0.92
						Large stones content	0.32
Harvey----------	30	Somewhat limited		Somewhat limited		Somewhat limited	
		Slope	0.84	Slope	0.84	Slope	0.84
		Shrink-swell	0.50	Cutbanks cave	0.10		
66:							
Zia----------	85	Not limited		Somewhat limited		Not limited	
				Cutbanks cave	0.10		
67:							
Sandoval----------	40	Very limited		Very limited		Very limited	
		Depth to soft bedrock	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Low strength	1.00	Slope	1.00	Slope	1.00
		Slope	1.00	Cutbanks cave	0.10	Droughty	0.98
		Shrink-swell	0.50				
Poley----------	35	Very limited		Very limited		Very limited	
		Low strength	1.00	Cutbanks cave	1.00	Slope	1.00
		Slope	1.00	Slope	1.00	Large stones content	0.92
		Shrink-swell	0.50			Gravel content	0.75

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
68:							
Penistaja	45	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
Querencia	35	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
71:							
Palon	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Cutbanks cave	0.10	Droughty	0.98
		Large stones content	0.05	Large stones content	0.05	Large stones content	0.46
72:							
Palon	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Large stones content	1.00	Large stones content	1.00	Droughty	0.99
		Frost action	0.50	Cutbanks cave	0.10		
74:							
Origo	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Large stones content	0.55	Large stones content	0.55	Droughty	1.00
		Frost action	0.50	Cutbanks cave	0.10	Gravel content	0.45
						Large stones content	0.08
Pavo	25	Somewhat limited		Very limited		Somewhat limited	
		Slope	0.84	Cutbanks cave	1.00	Slope	0.84
		Frost action	0.50	Slope	0.84		
75:							
Origo	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Large stones content	0.99	Cutbanks cave	1.00	Droughty	0.77
		Frost action	0.50	Large stones content	0.99		

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Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
82:							
Calaveras	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Cutbanks cave	0.10	Droughty	0.64
83:							
Calaveras	60	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Cutbanks cave	0.10	Droughty	0.56
		Large stones content	0.01	Large stones content	0.01		
85:							
Redondo	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Cutbanks cave	1.00	Droughty	0.06
86:							
Redondo	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Large stones content	0.53	Large stones content	0.53	Droughty	1.00
		Frost action	0.50	Cutbanks cave	0.10	Large stones content	0.20
87:							
Redondo	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Cutbanks cave	0.10	Droughty	0.91
						Large stones content	0.20
88:							
Totavi	45	Somewhat limited		Very limited		Somewhat limited	
		Flooding	0.40	Cutbanks cave	1.00	Droughty	0.20
Jemez	30	Somewhat limited		Very limited		Somewhat limited	
		Depth to hard bedrock	0.71	Depth to hard bedrock	1.00	Depth to bedrock	0.71
		Shrink-swell	0.50	Slope	0.16	Slope	0.16
		Frost action	0.50	Cutbanks cave	0.10		
		Slope	0.16				

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
91:							
Zia	85	Not limited		Very limited		Not limited	
				Cutbanks cave	1.00		
92:							
Galisteo, moderately saline, sodic	85	Very limited		Somewhat limited		Very limited	
		Low strength	1.00	Too clayey	0.12	Salinity	1.00
		Shrink-swell	1.00	Cutbanks cave	0.10		
93:							
Zia	85	Not limited		Somewhat limited		Not limited	
				Cutbanks cave	0.10		
95:							
El Rancho	85	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
97:							
El Rancho	85	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
		Frost action	0.50				
100:							
Orejas	40	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Large stones content	0.61	Large stones content	0.61	Droughty	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Large stones content	1.00
101:							
Blancot	55	Not limited		Somewhat limited		Not limited	
				Cutbanks cave	0.10		
Lybrook	25	Very limited		Somewhat limited		Very limited	
		Low strength	1.00	Cutbanks cave	0.10	Sodium content	1.00
		Shrink-swell	0.50				

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Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
102:							
Sparham	85	Very limited		Somewhat limited		Very limited	
		Flooding	1.00	Flooding	0.60	Sodium content	1.00
		Low strength	1.00	Cutbanks cave	0.10	Flooding	0.60
		Shrink-swell	0.50				
104:							
Cochiti	50	Very limited		Very limited		Very limited	
		Slope	1.00	Cutbanks cave	1.00	Slope	1.00
		Frost action	0.50	Slope	1.00	Droughty	0.07
				Too clayey	0.50	Large stones content	0.01
Montecito	30	Not limited		Very limited		Not limited	
				Cutbanks cave	1.00		
105:							
Menefee	30	Very limited		Very limited		Very limited	
		Slope	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Depth to soft bedrock	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Droughty	1.00
		Frost action	0.50				
106:							
Stumble	50	Very limited		Very limited		Very limited	
		Slope	1.00	Cutbanks cave	1.00	Slope	1.00
				Slope	1.00	Droughty	0.98
						Gravel content	0.92
Stumble, sandy	30	Somewhat limited		Very limited		Very limited	
		Flooding	0.40	Cutbanks cave	1.00	Droughty	1.00
						Gravel content	0.03
108:							
Embudo	85	Somewhat limited		Very limited		Somewhat limited	
		Slope	0.01	Cutbanks cave	1.00	Gravel content	0.01
				Slope	0.01	Slope	0.01
109:							
Embudo	50	Not limited		Very limited		Somewhat limited	
				Cutbanks cave	1.00	Droughty	0.50

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
109:							
Tijeras	35	Not limited		Very limited		Somewhat limited	
				Cutbanks cave	1.00	Droughty	0.01
110:							
Saido	40	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Salinity	0.13
111:							
Zia	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
				Cutbanks cave	0.10		
112:							
Tijeras	85	Not limited		Very limited		Somewhat limited	
				Cutbanks cave	1.00	Large stones content	0.01
114:							
San Mateo	40	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
		Flooding	0.40				
Zia	40	Not limited		Somewhat limited		Not limited	
				Cutbanks cave	0.10		
120:							
Pinavetes	85	Not limited		Very limited		Somewhat limited	
				Cutbanks cave	1.00	Droughty	0.99
129:							
Menefee	85	Very limited		Very limited		Very limited	
		Depth to soft bedrock	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Low strength	1.00	Slope	1.00	Slope	1.00
		Slope	1.00	Cutbanks cave	0.10	Droughty	0.17
		Shrink-swell	0.50				
		Frost action	0.50				
130:							
Pinavetes	45	Not limited		Very limited		Somewhat limited	
				Cutbanks cave	1.00	Droughty	0.69

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Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
130:							
Galisteo, moderately saline, sodic------	40	Very limited		Somewhat limited		Very limited	
		Low strength	1.00	Too clayey	0.12	Salinity	1.00
		Shrink-swell	1.00	Cutbanks cave	0.10	Sodium content	1.00
		Flooding	0.40				
142:							
Grieta----------	85	Somewhat limited		Very limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	1.00		
		Frost action	0.50				
143:							
Clovis----------	85	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
145:							
Grieta----------	55	Somewhat limited		Somewhat limited		Not limited	
		Frost action	0.50	Cutbanks cave	0.10		
Sheppard----------	40	Not limited		Very limited		Somewhat limited	
				Cutbanks cave	1.00	Droughty	0.09
146:							
Sedmar----------	85	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	0.01	Cutbanks cave	0.10	Droughty	1.00
				Slope	0.01	Slope	0.01
150:							
Doakum----------	55	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
Betonnie----------	35	Not limited		Somewhat limited		Not limited	
				Cutbanks cave	0.10		

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
162:							
Hackroy	45	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Low strength	1.00	Cutbanks cave	0.10	Droughty	1.00
		Shrink-swell	1.00				
		Frost action	0.50				
Nyjack	40	Somewhat limited		Very limited		Somewhat limited	
		Frost action	0.50	Cutbanks cave	1.00	Depth to bedrock	0.01
				Depth to soft bedrock	0.01		
163:							
Jemez	85	Somewhat limited		Very limited		Somewhat limited	
		Shrink-swell	0.50	Depth to hard bedrock	1.00	Depth to bedrock	0.01
		Frost action	0.50	Cutbanks cave	0.10	Slope	0.01
		Depth to hard bedrock	0.01	Slope	0.01		
		Slope	0.01				
170:							
San Mateo	85	Very limited		Somewhat limited		Very limited	
		Low strength	1.00	Cutbanks cave	0.10	Sodium content	1.00
		Shrink-swell	0.50				
		Flooding	0.40				
180:							
Councelor	40	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
				Cutbanks cave	0.10		
Eslendo	30	Very limited		Very limited		Very limited	
		Depth to soft bedrock	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Droughty	0.99
Mespun	25	Very limited		Very limited		Very limited	
		Slope	1.00	Cutbanks cave	1.00	Slope	1.00
				Slope	1.00	Droughty	0.29

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
183:							
Sheppard	85	Somewhat limited		Very limited		Somewhat limited	
		Slope	0.63	Cutbanks cave	1.00	Slope	0.63
				Slope	0.63	Droughty	0.09
185:							
Frijoles	90	Somewhat limited		Very limited		Very limited	
		Frost action	0.50	Cutbanks cave	1.00	Droughty	1.00
190:							
Zia	35	Somewhat limited		Somewhat limited		Somewhat limited	
		Slope	0.84	Slope	0.84	Slope	0.84
				Cutbanks cave	0.10		
Skyvillage	25	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
				Cutbanks cave	0.10	Droughty	0.96
191:							
Sheppard	85	Not limited		Very limited		Somewhat limited	
				Cutbanks cave	1.00	Droughty	0.09
200:							
Sedillo	85	Very limited		Very limited		Very limited	
		Slope	1.00	Cutbanks cave	1.00	Droughty	1.00
				Slope	1.00	Slope	1.00
						Large stones content	0.74
						Gravel content	0.06
201:							
Sedgran	35	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
				Cutbanks cave	0.10	Droughty	1.00
						Gravel content	1.00
						Large stones content	0.68

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
206:							
Pinitos	85	Very limited		Somewhat limited		Not limited	
		Low strength	1.00	Cutbanks cave	0.10		
		Shrink-swell	0.50				
		Frost action	0.50				
207:							
Penistaja	60	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
Zia	25	Not limited		Somewhat limited		Not limited	
				Cutbanks cave	0.10		
208:							
Sedillo	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
				Cutbanks cave	1.00	Gravel content	1.00
						Droughty	0.89
210:							
Ildefonso	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Large stones content	0.97	Large stones content	0.97	Large stones content	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Droughty	0.34
						Gravel content	0.09
211:							
Zia	45	Not limited		Somewhat limited		Not limited	
				Cutbanks cave	0.10		
Clovis	30	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
213:							
Pinavetes	55	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
				Cutbanks cave	1.00	Droughty	1.00
						Too sandy	0.50

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Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
215:							
Ess	60	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Large stones content	1.00
		Shrink-swell	0.50	Large stones content	0.33	Slope	1.00
		Frost action	0.50	Cutbanks cave	0.10	Droughty	0.65
		Large stones content	0.33			Gravel content	0.08
217:							
Witt	85	Somewhat limited		Somewhat limited		Not limited	
		Frost action	0.50	Cutbanks cave	0.10		
218:							
Ildefonso	85	Somewhat limited		Somewhat limited		Very limited	
		Large stones content	0.71	Large stones content	0.71	Large stones content	1.00
		Slope	0.01	Cutbanks cave	0.10	Droughty	0.80
				Slope	0.01	Gravel content	0.01
						Slope	0.01
220:							
Vessilla	30	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
				Cutbanks cave	0.10	Droughty	1.00
						Large stones content	0.01
Menefee	20	Very limited		Very limited		Very limited	
		Slope	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Depth to soft bedrock	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Droughty	0.99
		Frost action	0.50				

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
226:							
Galisteo, moderately saline, sodic------	85	Very limited		Somewhat limited		Very limited	
		Low strength	1.00	Cutbanks cave	0.10	Salinity	1.00
		Shrink-swell	0.50			Sodium content	1.00
227:							
Hagerman----------	65	Very limited		Very limited		Somewhat limited	
		Low strength	1.00	Depth to hard bedrock	1.00	Depth to bedrock	0.16
		Shrink-swell	0.50	Cutbanks cave	0.10		
		Depth to hard bedrock	0.15				
Bond----------	20	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Droughty	1.00
		Low strength	0.22			Large stones content	0.01
228:							
Winona----------	85	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Droughty	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Slope	1.00
						Carbonate content	1.00
						Gravel content	0.96
230:							
Skyvillage----------	35	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	0.63	Slope	0.63	Droughty	1.00
				Cutbanks cave	0.10	Slope	0.63
Sandoval----------	25	Somewhat limited		Very limited		Very limited	
		Depth to soft bedrock	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Slope	0.63	Slope	0.63	Droughty	0.99
		Shrink-swell	0.50	Cutbanks cave	0.10	Slope	0.63

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Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
231:							
Querencia	85	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
234:							
Querencia	60	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
Zia	20	Not limited		Somewhat limited		Not limited	
				Cutbanks cave	0.10		
235:							
Sandoval	85	Very limited		Very limited		Very limited	
		Depth to soft bedrock	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Low strength	1.00	Cutbanks cave	0.10	Droughty	0.05
		Shrink-swell	0.50	Slope	0.04	Slope	0.04
		Slope	0.04				
236:							
Sparank, moderately saline, sodic	85	Very limited		Somewhat limited		Very limited	
		Flooding	1.00	Flooding	0.60	Salinity	1.00
		Low strength	1.00	Too clayey	0.12	Sodium content	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Flooding	0.60
237:							
Sparank	85	Very limited		Somewhat limited		Somewhat limited	
		Flooding	1.00	Flooding	0.60	Flooding	0.60
		Low strength	1.00	Cutbanks cave	0.10		
		Shrink-swell	0.50				
240:							
Penistaja	45	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
Hagerman	35	Very limited		Very limited		Somewhat limited	
		Low strength	1.00	Depth to hard bedrock	1.00	Depth to bedrock	0.90
		Depth to hard bedrock	0.90	Cutbanks cave	0.10		
		Shrink-swell	0.50				

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
250:							
Pinavetes	90	Somewhat limited		Very limited		Somewhat limited	
		Slope	0.16	Cutbanks cave	1.00	Droughty	0.63
				Slope	0.16	Slope	0.16
262:							
Pastura	90	Somewhat limited		Very limited		Very limited	
		Depth to thin cemented pan	1.00	Depth to thin cemented pan	1.00	Depth to cemented pan	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Droughty	1.00
270:							
Blancot	40	Not limited		Somewhat limited		Not limited	
				Cutbanks cave	0.10		
Councelor	30	Not limited		Somewhat limited		Not limited	
				Cutbanks cave	0.10		
Tsosie	25	Very limited		Somewhat limited		Somewhat limited	
		Low strength	1.00	Cutbanks cave	0.10	Salinity	0.50
		Shrink-swell	0.50				
281:							
Carjo	90	Very limited		Very limited		Somewhat limited	
		Low strength	1.00	Depth to hard bedrock	1.00	Depth to bedrock	0.84
		Shrink-swell	1.00	Too clayey	0.12		
		Depth to hard bedrock	0.84	Cutbanks cave	0.10		
		Frost action	0.50				
282:							
Tocal	85	Somewhat limited		Very limited		Very limited	
		Depth to soft bedrock	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Droughty	0.87
		Frost action	0.50				
283:							
Mirand	45	Very limited		Very limited		Very limited	
		Low strength	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	1.00	Too clayey	0.50		
		Slope	1.00	Cutbanks cave	0.10		

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Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
283:							
Alanos	30	Very limited		Very limited		Very limited	
		Slope	1.00	Cutbanks cave	1.00	Slope	1.00
		Shrink-swell	0.50	Slope	1.00	Large stones content	0.88
		Frost action	0.50	Too clayey	0.12	Droughty	0.38
						Gravel content	0.01
290:							
Alanos	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	1.00	Cutbanks cave	1.00	Droughty	0.21
		Frost action	0.50	Too clayey	0.12		
300:							
Waumac	50	Somewhat limited		Very limited		Not limited	
		Frost action	0.50	Cutbanks cave	1.00		
Bamac	35	Not limited		Very limited		Very limited	
				Cutbanks cave	1.00	Droughty	1.00
						Gravel content	0.22
						Large stones content	0.01
301:							
Vastine	45	Very limited		Very limited		Somewhat limited	
		Frost action	1.00	Depth to saturated zone	1.00	Depth to saturated zone	0.19
		Flooding	0.40	Cutbanks cave	1.00		
		Depth to saturated zone	0.19				
Jarola	40	Somewhat limited		Very limited		Somewhat limited	
		Shrink-swell	0.50	Depth to saturated zone	1.00	Depth to saturated zone	0.19
		Frost action	0.50	Cutbanks cave	1.00		
		Flooding	0.40				
		Depth to saturated zone	0.19				

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Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
302:							
Tranquilar----------	50	Very limited		Somewhat limited		Not limited	
		Low strength	1.00	Depth to saturated zone	0.99		
		Shrink-swell	1.00	Too clayey	0.50		
		Frost action	0.50	Cutbanks cave	0.10		
Jarmillo----------	30	Somewhat limited		Somewhat limited		Not limited	
		Frost action	0.50	Cutbanks cave	0.10		
304:							
Cosey----------	45	Somewhat limited		Very limited		Somewhat limited	
		Frost action	0.50	Cutbanks cave	1.00	Slope	0.37
		Slope	0.37	Slope	0.37		
		Low strength	0.22				
Jarmillo----------	40	Somewhat limited		Somewhat limited		Somewhat limited	
		Frost action	0.50	Slope	0.37	Slope	0.37
		Slope	0.37	Cutbanks cave	0.10		
307:							
Flugle----------	60	Somewhat limited		Somewhat limited		Not limited	
		Frost action	0.50	Cutbanks cave	0.10		
Waumac----------	25	Somewhat limited		Somewhat limited		Not limited	
		Frost action	0.50	Cutbanks cave	0.10		
308:							
Cajete----------	85	Somewhat limited		Very limited		Somewhat limited	
		Frost action	0.50	Cutbanks cave	1.00	Droughty	0.20
311:							
Cosey----------	35	Somewhat limited		Very limited		Somewhat limited	
		Slope	0.84	Cutbanks cave	1.00	Slope	0.84
		Shrink-swell	0.50	Slope	0.84	Large stones content	0.01
		Frost action	0.50	Large stones content	0.03		
		Large stones content	0.03				

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Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
311:							
Tranquilar----------	30	Very limited		Somewhat limited		Not limited	
		Low strength	1.00	Depth to saturated zone	0.99		
		Shrink-swell	1.00	Too clayey	0.50		
		Frost action	0.50	Cutbanks cave	0.10		
Calaveras----------	25	Somewhat limited		Very limited		Somewhat limited	
		Slope	0.84	Cutbanks cave	1.00	Slope	0.84
		Frost action	0.50	Slope	0.84		
312:							
Royosa---------------	90	Not limited		Very limited		Somewhat limited	
				Cutbanks cave	1.00	Droughty	0.95
						Too sandy	0.50
314:							
Fragua---------------	40	Somewhat limited		Somewhat limited		Not limited	
		Frost action	0.50	Cutbanks cave	0.10		
Waumac---------------	30	Somewhat limited		Somewhat limited		Not limited	
		Frost action	0.50	Cutbanks cave	0.10		
Royosa---------------	25	Not limited		Very limited		Somewhat limited	
				Cutbanks cave	1.00	Droughty	0.92
317:							
Elpedro--------------	85	Somewhat limited		Somewhat limited		Not limited	
		Shrink-swell	0.50	Cutbanks cave	0.10		
		Frost action	0.50				
319:							
Bamac----------------	60	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
				Cutbanks cave	1.00	Droughty	1.00
						Gravel content	1.00
320:							
Sparham--------------	85	Very limited		Somewhat limited		Very limited	
		Flooding	1.00	Flooding	0.60	Sodium content	1.00
		Low strength	1.00	Too clayey	0.12	Flooding	0.60
		Shrink-swell	1.00	Cutbanks cave	0.10		

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
321:							
Waumac	60	Somewhat limited		Somewhat limited		Somewhat limited	
		Frost action	0.50	Cutbanks cave	0.10	Slope	0.01
		Slope	0.01	Slope	0.01		
Royosa	30	Not limited		Very limited		Somewhat limited	
				Cutbanks cave	1.00	Droughty	0.92
322:							
Fragua	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Cutbanks cave	1.00	Large stones content	0.99
						Gravel content	0.13
324:							
Atarque	25	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Droughty	0.99
Menefee	25	Very limited		Very limited		Very limited	
		Depth to soft bedrock	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Droughty	1.00
		Low strength	1.00	Cutbanks cave	0.10	Slope	1.00
		Shrink-swell	0.50				
		Frost action	0.50				
325:							
Espiritu	25	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.50	Cutbanks cave	1.00	Gravel content	0.45
		Frost action	0.50			Droughty	0.21
						Large stones content	0.16

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
325:							
Vessilla	25	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Cutbanks cave	0.10	Droughty	1.00
						Gravel content	0.54
						Large stones content	0.01
342:							
Waumac	35	Somewhat limited		Somewhat limited		Somewhat limited	
		Slope	0.84	Slope	0.84	Slope	0.84
		Frost action	0.50	Cutbanks cave	0.10		
Vessilla	25	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Droughty	1.00
				Cutbanks cave	0.10	Slope	1.00
345:							
Espiritu	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.50	Cutbanks cave	1.00	Droughty	0.47
		Frost action	0.50			Gravel content	0.38
						Large stones content	0.08
Bamac	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
				Cutbanks cave	1.00	Droughty	1.00
						Gravel content	1.00
						Large stones content	0.01

9715

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
346:							
Espiritu, cobbly----	70	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.50	Cutbanks cave	1.00	Large stones content	1.00
		Frost action	0.50	Large stones content	0.01	Droughty	0.92
		Large stones content	0.01				
Bamac----------	20	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
				Cutbanks cave	1.00	Droughty	1.00
						Gravel content	1.00
348:							
Wauquie----------	60	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Cutbanks cave	1.00	Gravel content	0.99
						Large stones content	0.68
						Droughty	0.58
353:							
Cochiti----------	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Cutbanks cave	1.00	Gravel content	1.00
						Large stones content	0.95
						Droughty	0.66
Espiritu----------	45	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Cutbanks cave	1.00	Droughty	1.00
						Gravel content	0.33
						Large stones content	0.16

USDA

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
354:							
Waumac Variant------	85	Somewhat limited		Very limited		Very limited	
		Depth to soft bedrock	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Frost action	0.50	Cutbanks cave	0.10	Droughty	1.00
		Slope	0.01	Slope	0.01	Gravel content	1.00
						Slope	0.01
358:							
Deama---------------	35	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Droughty	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Slope	1.00
						Carbonate content	1.00
						Gravel content	0.98
Elpedro-------------	25	Very limited		Very limited		Very limited	
		Low strength	1.00	Slope	1.00	Slope	1.00
		Slope	1.00	Cutbanks cave	0.10	Gravel content	0.78
		Shrink-swell	0.50				
		Frost action	0.50				
396:							
Atarque-------------	30	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Gravel content	1.00
		Low strength	0.22			Droughty	0.41
						Large stones content	0.32
Menefee-------------	30	Very limited		Very limited		Very limited	
		Slope	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Depth to soft bedrock	1.00	Slope	1.00	Slope	1.00
		Low strength	1.00	Cutbanks cave	0.10	Droughty	0.72
		Shrink-swell	0.50				
		Frost action	0.50				

071553

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
397:							
Cucho	25	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.50	Cutbanks cave	1.00	Gravel content	0.92
		Frost action	0.50	Depth to soft bedrock	0.03	Depth to bedrock	0.03
Vessilla	25	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Cutbanks cave	0.10	Droughty	1.00
						Gravel content	0.01
398:							
Espiritu	45	Very limited		Very limited		Very limited	
		Slope	1.00	Cutbanks cave	1.00	Slope	1.00
		Frost action	0.50	Slope	1.00	Droughty	0.91
						Gravel content	0.38
						Large stones content	0.08
Cucho	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Low strength	1.00	Cutbanks cave	0.10	Gravel content	0.99
		Shrink-swell	0.50	Depth to soft bedrock	0.03	Depth to bedrock	0.03
		Frost action	0.50				
399:							
Cucho	45	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Low strength	1.00	Cutbanks cave	0.10	Gravel content	0.99
		Shrink-swell	0.50	Depth to soft bedrock	0.03	Depth to bedrock	0.03
		Frost action	0.50				
Teco	35	Very limited		Very limited		Very limited	
		Low strength	1.00	Cutbanks cave	1.00	Slope	1.00
		Shrink-swell	1.00	Slope	1.00	Large stones content	0.68
		Slope	1.00	Too clayey	0.12	Gravel content	0.03
		Frost action	0.50				

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
405:							
Charo	50	Very limited		Very limited		Somewhat limited	
		Low strength	1.00	Depth to hard bedrock	1.00	Depth to bedrock	0.65
		Shrink-swell	1.00	Too clayey	0.50	Large stones content	0.46
		Depth to hard bedrock	0.64	Cutbanks cave	0.10	Gravel content	0.01
Charo, noncobbly	40	Very limited		Very limited		Somewhat limited	
		Low strength	1.00	Depth to hard bedrock	1.00	Depth to bedrock	0.01
		Shrink-swell	0.50	Too clayey	0.50	Large stones content	0.01
		Depth to hard bedrock	0.01	Cutbanks cave	0.10		
409:							
Santa Fe	85	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Droughty	1.00
						Gravel content	0.83
						Large stones content	0.01
410:							
Zia	85	Not limited		Somewhat limited		Not limited	
				Cutbanks cave	0.10		
414:							
Wauquie	85	Very limited		Very limited		Very limited	
		Slope	1.00	Cutbanks cave	1.00	Slope	1.00
		Shrink-swell	0.50	Slope	1.00	Droughty	0.82
		Frost action	0.50			Gravel content	0.18
						Large stones content	0.16

071557

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
417:							
Jocity	85	Very limited		Very limited		Not limited	
		Low strength	1.00	Cutbanks cave	1.00		
		Shrink-swell	0.50	Depth to saturated zone	0.15		
		Flooding	0.40				
418:							
Jocity	85	Very limited		Very limited		Not limited	
		Low strength	1.00	Cutbanks cave	1.00		
		Shrink-swell	0.50	Depth to saturated zone	0.15		
		Flooding	0.40				
419:							
Santa Fe	40	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Droughty	1.00
		Large stones content	0.01	Large stones content	0.01	Large stones content	1.00
						Gravel content	0.61
Wauquie	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Cutbanks cave	1.00	Droughty	1.00
		Large stones content	0.08	Large stones content	0.08	Gravel content	1.00
						Large stones content	0.99
420:							
Pinavetes	85	Not limited		Very limited		Very limited	
				Cutbanks cave	1.00	Droughty	1.00
421:							
Gilco, moderately saline, sodic	90	Somewhat limited		Somewhat limited		Very limited	
		Flooding	0.40	Depth to saturated zone	0.15	Salinity	1.00
				Cutbanks cave	0.10	Sodium content	1.00

07156

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
422:							
Vessilla	35	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Droughty	1.00
				Cutbanks cave	0.10	Slope	1.00
						Large stones content	0.01
Menefee	30	Somewhat limited		Very limited		Very limited	
		Depth to soft bedrock	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Shrink-swell	0.50	Cutbanks cave	0.10	Droughty	0.99
		Frost action	0.50				
Orlie	25	Very limited		Somewhat limited		Not limited	
		Low strength	1.00	Cutbanks cave	0.10		
		Shrink-swell	0.50				
		Frost action	0.50				
423:							
Gilco	85	Somewhat limited		Somewhat limited		Not limited	
		Flooding	0.40	Depth to saturated zone	0.15		
				Cutbanks cave	0.10		
426:							
Aga, moderately saline, sodic	85	Somewhat limited		Very limited		Very limited	
		Flooding	0.40	Cutbanks cave	1.00	Salinity	1.00
				Depth to saturated zone	0.15	Sodium content	1.00
427:							
Aga	85	Somewhat limited		Very limited		Not limited	
		Flooding	0.40	Cutbanks cave	1.00		
				Depth to saturated zone	0.47		

55169

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
428:							
Aga, moderately saline, sodic------	85	Somewhat limited		Very limited		Very limited	
		Flooding	0.40	Cutbanks cave	1.00	Salinity	1.00
				Depth to saturated zone	0.15	Sodium content	1.00
430:							
Trail---------------	85	Somewhat limited		Very limited		Somewhat limited	
		Flooding	0.40	Cutbanks cave	1.00	Droughty	0.08
431:							
Trail---------------	85	Somewhat limited		Very limited		Somewhat limited	
		Flooding	0.40	Cutbanks cave	1.00	Droughty	0.20
433:							
Peralta-------------	85	Somewhat limited		Very limited		Somewhat limited	
		Flooding	0.40	Cutbanks cave	1.00	Salinity	0.50
				Depth to saturated zone	0.99		
434:							
Peralta-------------	85	Somewhat limited		Very limited		Somewhat limited	
		Flooding	0.40	Cutbanks cave	1.00	Salinity	0.50
				Depth to saturated zone	0.99		
437:							
Peralta, moderately saline, sodic------	85	Somewhat limited		Very limited		Very limited	
		Flooding	0.40	Cutbanks cave	1.00	Salinity	1.00
				Depth to saturated zone	0.99	Sodium content	1.00
500:							
Osha----------------	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
				Cutbanks cave	1.00	Droughty	1.00
				Depth to hard bedrock	0.93	Gravel content	0.42

97150

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
503:							
Cajete	65	Very limited		Very limited		Very limited	
		Slope	1.00	Cutbanks cave	1.00	Gravel content	1.00
		Frost action	0.50	Slope	1.00	Slope	1.00
						Droughty	0.99
Cypher	25	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Cutbanks cave	0.10	Droughty	1.00
						Gravel content	0.96
						Large stones content	0.32
504:							
Orejas	40	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Shrink-swell	0.50	Slope	0.16	Droughty	1.00
		Slope	0.16	Cutbanks cave	0.10	Large stones content	1.00
						Slope	0.16
Guaje	35	Not limited		Very limited		Somewhat limited	
				Cutbanks cave	1.00	Droughty	0.99
600:							
Cypher	35	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Cutbanks cave	0.10	Droughty	1.00
						Large stones content	1.00
						Gravel content	0.01

USDA-SCS

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
601:							
Laventana	85	Somewhat limited		Very limited		Somewhat limited	
		Shrink-swell	0.50	Cutbanks cave	1.00	Droughty	0.30
		Frost action	0.50	Depth to hard bedrock	0.42	Slope	0.04
		Slope	0.04	Slope	0.04		
603:							
Laventana	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.50	Cutbanks cave	1.00	Droughty	0.01
		Frost action	0.50	Depth to hard bedrock	0.32		
Mirand	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	1.00	Too clayey	0.50	Large stones content	0.46
		Low strength	1.00	Cutbanks cave	0.10	Gravel content	0.36
604:							
Cypher	55	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50			Droughty	1.00
Mirand	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	1.00	Too clayey	0.12	Large stones content	0.38
		Low strength	0.22	Cutbanks cave	0.10	Gravel content	0.28
608:							
Osha, steep	60	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
				Cutbanks cave	1.00	Droughty	1.00
Osha	30	Very limited		Very limited		Very limited	
		Slope	1.00	Cutbanks cave	1.00	Droughty	1.00
				Slope	1.00	Slope	1.00
				Dense layer	0.50	Gravel content	0.01

07152

Table 10B.--Roads and streets, shallow excavations, and lawns and landscaping--continued

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
823:							
Gilco, unprotected--	85	Somewhat limited		Somewhat limited		Not limited	
		Flooding	0.40	Depth to saturated zone	0.15		
				Cutbanks cave	0.10		
827:							
Aga, unprotected----	85	Somewhat limited		Very limited		Not limited	
		Flooding	0.40	Cutbanks cave	1.00		
				Depth to saturated zone	0.47		
830:							
Trail, unprotected--	85	Somewhat limited		Very limited		Somewhat limited	
		Flooding	0.40	Cutbanks cave	1.00	Droughty	0.01
				Depth to saturated zone	0.15		
831:							
Trail, unprotected--	85	Somewhat limited		Very limited		Somewhat limited	
		Flooding	0.40	Cutbanks cave	1.00	Droughty	0.87
				Depth to saturated zone	0.15		
835:							
Peralta, unprotected	85	Very limited		Very limited		Somewhat limited	
		Flooding	1.00	Depth to saturated zone	0.99	Flooding	0.60
		Shrink-swell	0.50	Flooding	0.60	Salinity	0.50
				Cutbanks cave	0.10		
842:							
Peralta, moderately saline, sodic, unprotected--------	85	Somewhat limited		Very limited		Very limited	
		Shrink-swell	0.50	Depth to saturated zone	0.99	Salinity	1.00
		Flooding	0.40	Cutbanks cave	0.10	Sodium content	1.00

69759

Table 11A.--Sewage disposal

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
1:					
Silver	55	Very limited		Somewhat limited	
		Slow water movement	1.00	Slope	0.32
Clovis	35	Somewhat limited		Very limited	
		Slow water movement	0.46	Seepage	1.00
				Slope	0.32
2:					
Clovis	35	Very limited		Very limited	
		Slow water movement	1.00	Seepage	1.00
				Slope	0.92
Prieta	35	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Large stones content	0.43	Slope	1.00
		Slope	0.04	Large stones content	1.00
Silver	20	Very limited		Somewhat limited	
		Slow water movement	1.00	Slope	0.92
3:					
Montecito	60	Very limited		Somewhat limited	
		Slow water movement	1.00	Slope	0.32
Orejas	30	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Large stones content	0.67	Large stones content	1.00
				Slope	0.32
4:					
Montecito	45	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Slow water movement	0.46	Seepage	0.53
Montecito, bouldery-	35	Very limited		Very limited	
		Slow water movement	1.00	Seepage	1.00
		Slope	1.00	Slope	1.00

: 07164

Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
10:					
Trail	85	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Depth to saturated zone	0.40	Flooding	0.40
		Flooding	0.40		
11:					
Trail	85	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
		Depth to saturated zone	0.40	Seepage	1.00
13:					
Sandoval	65	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
				Slope	0.68
Querencia	20	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Slope	0.68
				Seepage	0.53
15:					
Camino	40	Very limited		Somewhat limited	
		Slow water movement	1.00	Slope	0.32
		Depth to bedrock	0.73	Depth to soft bedrock	0.32
Sandoval	35	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
				Slope	0.68
16:					
Rock outcrop	50	Not rated		Not rated	
Prieta	30	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Large stones content	0.06	Slope	1.00
		Slope	0.04	Large stones content	0.58
17:					
Vessilla	35	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Seepage, bottom layer	1.00	Slope	1.00
		Slope	0.04		

:07165

Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
17:					
Menefee	25	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	0.04	Slope	1.00
Rock outcrop	20	Not rated		Not rated	
18:					
Sparham	85	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
		Slow water movement	1.00		
20:					
Gilco	85	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Seepage	0.53
		Depth to saturated zone	0.40	Flooding	0.40
		Flooding	0.40		
21:					
Rock outcrop	60	Not rated		Not rated	
Hackroy	25	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
				Slope	0.68
22:					
Aga	85	Somewhat limited		Very limited	
		Depth to saturated zone	0.94	Seepage	1.00
		Slow water movement	0.46	Flooding	0.40
		Flooding	0.40	Depth to saturated zone	0.40
23:					
Hickman	85	Very limited		Somewhat limited	
		Slow water movement	1.00	Seepage	0.53
		Flooding	0.40	Flooding	0.40
24:					
Orlie	45	Very limited		Somewhat limited	
		Slow water movement	1.00	Seepage	0.53
				Slope	0.08
Sparham	35	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
		Slow water movement	1.00		

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
25:					
Gilco	85	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Seepage	0.53
		Depth to saturated zone	0.40	Flooding	0.40
		Flooding	0.40		
26:					
Orlie	85	Very limited		Somewhat limited	
		Slow water movement	1.00	Slope	0.32
27:					
Aga	85	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Depth to saturated zone	0.94	Flooding	0.40
		Flooding	0.40	Depth to saturated zone	0.40
29:					
Trail	85	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Depth to saturated zone	0.40	Flooding	0.40
		Flooding	0.40		
31:					
Riverwash	90	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
		Filtering capacity	1.00	Seepage	1.00
		Seepage, bottom layer	1.00		
33:					
Pits	100	Not rated		Not rated	
34:					
Ildefonso	55	Somewhat limited		Somewhat limited	
		Large stones content	0.70	Slope	0.68
		Slow water movement	0.46	Seepage	0.53
				Large stones content	0.29
Witt	30	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Seepage	0.53
				Slope	0.08

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
41:					
Dune land	100	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Seepage, bottom layer	1.00	Slope	1.00
		Slope	0.16		
47:					
Cascajo	85	Very limited		Very limited	
		Filtering capacity	1.00	Slope	1.00
		Slope	1.00	Seepage	1.00
51:					
Sparham	85	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
		Slow water movement	1.00	Depth to saturated zone	1.00
		Depth to saturated zone	1.00		
52:					
Totavi	85	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Seepage, bottom layer	1.00	Flooding	0.40
		Flooding	0.40	Slope	0.08
53:					
Witt	55	Very limited		Somewhat limited	
		Slow water movement	1.00	Seepage	0.53
				Slope	0.32
Harvey	30	Very limited		Very limited	
		Slow water movement	1.00	Seepage	1.00
				Slope	0.32
54:					
Harvey	45	Somewhat limited		Very limited	
		Slow water movement	0.46	Slope	1.00
		Slope	0.16	Seepage	0.53
Cascajo	40	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Slope	0.16	Slope	1.00
55:					
La Fonda	85	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Seepage	0.53
				Slope	0.08

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
56:					
Ildefonso	85	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Large stones content	0.53	Seepage	0.53
		Slow water movement	0.46	Large stones content	0.12
57:					
Badland	90	Not rated		Not rated	
58:					
Deama	45	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
		Large stones content	0.01	Seepage	0.53
Elpedro	35	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	0.04	Seepage	0.53
59:					
Harvey	35	Very limited		Somewhat limited	
		Slow water movement	1.00	Slope	0.92
				Seepage	0.53
Ildefonso	35	Somewhat limited		Very limited	
		Slope	0.37	Slope	1.00
		Large stones content	0.02	Seepage	1.00
La Fonda	15	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Slope	0.68
				Seepage	0.53
63:					
Placitas	85	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
				Seepage	1.00
64:					
Skyvillage	40	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
				Seepage	1.00
Ildefonso	35	Very limited		Very limited	
		Slope	1.00	Slope	1.00
				Seepage	1.00

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
65:					
Ildefonso	50	Very limited		Very limited	
		Slope	1.00	Slope	1.00
				Seepage	1.00
Harvey	30	Somewhat limited		Very limited	
		Slope	0.84	Slope	1.00
		Slow water movement	0.46	Seepage	1.00
66:					
Zia	85	Not limited		Very limited	
				Seepage	1.00
				Slope	0.68
67:					
Sandoval	40	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00
Poley	35	Very limited		Very limited	
		Slow water movement	1.00	Seepage	1.00
		Slope	1.00	Slope	1.00
68:					
Penistaja	45	Very limited		Somewhat limited	
		Slow water movement	1.00	Slope	0.68
				Seepage	0.53
Querencia	35	Somewhat limited		Very limited	
		Slow water movement	0.46	Seepage	1.00
				Slope	0.68
71:					
Palon	85	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00
		Large stones content	0.05	Large stones content	0.26
72:					
Palon	85	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00
		Large stones content	1.00	Large stones content	1.00

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
74:					
Origo	50	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00
		Large stones content	0.55	Large stones content	0.94
Pavo	25	Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00
		Slow water movement	1.00	Slope	1.00
		Slope	0.84		
75:					
Origo	85	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00
		Large stones content	0.99	Large stones content	1.00
82:					
Calaveras	85	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00
83:					
Calaveras	60	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00
		Large stones content	0.01		
Rubble land	20	Very limited		Very limited	
		Filtering capacity	1.00	Slope	1.00
		Slope	1.00	Large stones content	1.00
		Large stones content	1.00	Seepage	1.00
		Seepage, bottom layer	1.00		
85:					
Redondo	85	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
86:					
Redondo	85	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00
		Large stones content	0.53	Large stones content	0.37
87:					
Redondo	50	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00
				Large stones content	0.02
Rubble land	25	Very limited		Very limited	
		Filtering capacity	1.00	Slope	1.00
		Slope	1.00	Large stones content	1.00
		Large stones content	1.00	Seepage	1.00
		Seepage, bottom layer	1.00		
88:					
Totavi	45	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Seepage, bottom layer	1.00	Flooding	0.40
		Flooding	0.40	Slope	0.08
Jemez	30	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slow water movement	1.00	Slope	1.00
		Slope	0.16	Seepage	0.53
Rock outcrop	15	Not rated		Not rated	
91:					
Zia	85	Not limited		Very limited	
				Seepage	1.00
92:					
Galisteo, moderately saline, sodic	85	Very limited		Not limited	
		Slow water movement	1.00		
93:					
Zia	85	Not limited		Very limited	
				Seepage	1.00
				Slope	0.08

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
95:					
El Rancho	85	Somewhat limited		Very limited	
		Slow water movement	0.46	Seepage	1.00
97:					
El Rancho	85	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Seepage	0.53
100:					
Orejas	40	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
		Large stones content	0.61	Large stones content	1.00
Rock outcrop	40	Not rated		Not rated	
101:					
Blancot	55	Very limited		Very limited	
		Slow water movement	1.00	Seepage	1.00
				Slope	0.68
Lybrook	25	Very limited		Not limited	
		Slow water movement	1.00		
102:					
Sparham	85	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
		Slow water movement	1.00		
104:					
Cochiti	50	Very limited		Very limited	
		Slow water movement	1.00	Seepage	1.00
		Slope	1.00	Slope	1.00
Montecito	30	Not limited		Very limited	
				Seepage	1.00
				Slope	0.08
105:					
Badland	50	Not rated		Not rated	
Menefee	30	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00
106:					
Stumble	50	Very limited		Very limited	
		Filtering capacity	1.00	Slope	1.00
		Slope	1.00	Seepage	1.00

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
106:					
Stumble, sandy------	30	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Flooding	0.40	Slope	0.92
				Flooding	0.40
108:					
Embudo--------------	85	Somewhat limited		Very limited	
		Slope	0.01	Seepage	1.00
				Slope	1.00
109:					
Embudo--------------	50	Not limited		Very limited	
				Seepage	1.00
				Slope	0.92
Tijeras-------------	35	Not limited		Very limited	
				Seepage	1.00
				Slope	0.32
110:					
Rock outcrop--------	45	Not rated		Not rated	
Saido---------------	40	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Slow water movement	0.46	Seepage	0.53
111:					
Rock outcrop--------	50	Not rated		Not rated	
Zia-----------------	35	Very limited		Very limited	
		Slope	1.00	Slope	1.00
				Seepage	1.00
112:					
Tijeras-------------	85	Not limited		Very limited	
				Seepage	1.00
				Slope	0.08
114:					
San Mateo-----------	40	Very limited		Somewhat limited	
		Slow water movement	1.00	Flooding	0.40
		Flooding	0.40		
Zia-----------------	40	Not limited		Very limited	
				Seepage	1.00
				Slope	0.68
120:					
Pinavetes-----------	85	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
				Slope	0.32
124:					
Rock outcrop--------	90	Not rated		Not rated	

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
129:					
Menefee	85	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00
130:					
Pinavetes	45	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
				Slope	0.08
Galisteo, moderately saline, sodic	40	Very limited		Somewhat limited	
		Slow water movement	1.00	Flooding	0.40
		Flooding	0.40		
142:					
Grieta	85	Somewhat limited		Very limited	
		Slow water movement	0.46	Seepage	1.00
				Slope	0.08
143:					
Clovis	85	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Seepage	0.53
				Slope	0.08
145:					
Grieta	55	Not limited		Very limited	
				Seepage	1.00
				Slope	0.32
Sheppard	40	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
				Slope	0.92
146:					
Sedmar	85	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Seepage, bottom layer	1.00	Seepage	1.00
		Slope	0.01	Slope	1.00
150:					
Doakum	55	Very limited		Somewhat limited	
		Slow water movement	1.00	Seepage	0.53
				Slope	0.08
Betonnie	35	Not limited		Very limited	
				Seepage	1.00
				Slope	1.00

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
162:					
Hackroy	45	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
				Slope	0.08
Nyjack	40	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slow water movement	1.00	Seepage	1.00
				Slope	0.08
163:					
Jemez	85	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slow water movement	1.00	Slope	1.00
		Slope	0.01	Seepage	0.53
170:					
San Mateo	85	Very limited		Somewhat limited	
		Slow water movement	1.00	Flooding	0.40
		Flooding	0.40		
180:					
Councelor	40	Very limited		Very limited	
		Slow water movement	1.00	Seepage	1.00
		Slope	1.00	Slope	1.00
Eslendo	30	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00
Mespun	25	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Slope	1.00	Slope	1.00
183:					
Sheppard	85	Very limited		Very limited	
		Filtering capacity	1.00	Slope	1.00
		Slope	0.63	Seepage	1.00
185:					
Frijoles	90	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
				Slope	0.68
190:					
Zia	35	Somewhat limited		Very limited	
		Slope	0.84	Seepage	1.00
				Slope	1.00

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
190:					
Skyvillage----------	25	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Seepage	1.00
				Slope	1.00
Rock outcrop--------	15	Not rated		Not rated	
191:					
Sheppard----------	85	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
				Slope	0.92
200:					
Sedillo----------	85	Very limited		Very limited	
		Slope	1.00	Seepage	1.00
				Slope	1.00
201:					
Rock outcrop--------	55	Not rated		Not rated	
Sedgran----------	35	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
				Seepage	1.00
206:					
Pinitos----------	85	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
207:					
Penistaja----------	60	Somewhat limited		Very limited	
		Slow water movement	0.46	Seepage	1.00
				Slope	0.08
Zia----------	25	Not limited		Very limited	
				Seepage	1.00
				Slope	0.68
208:					
Sedillo----------	85	Very limited		Very limited	
		Slope	1.00	Slope	1.00
				Seepage	1.00
210:					
Ildefonso----------	85	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Large stones content	0.97	Large stones content	1.00
		Slow water movement	0.46	Seepage	0.53

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
211:					
Zia	45	Somewhat limited		Very limited	
		Slow water movement	0.46	Seepage	1.00
				Slope	0.92
Clovis	30	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Slope	0.68
				Seepage	0.53
213:					
Pinavetes	55	Very limited		Very limited	
		Filtering capacity	1.00	Slope	1.00
		Slope	1.00	Seepage	1.00
Rock outcrop	30	Not rated		Not rated	
215:					
Ess	60	Very limited		Very limited	
		Slope	1.00	Seepage	1.00
		Slow water movement	0.46	Slope	1.00
		Large stones content	0.33	Large stones content	1.00
Rock outcrop	30	Not rated		Not rated	
217:					
Witt	85	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Slope	0.68
				Seepage	0.53
218:					
Ildefonso	85	Somewhat limited		Very limited	
		Large stones content	0.71	Seepage	1.00
		Slope	0.01	Large stones content	1.00
				Slope	1.00
220:					
Rock outcrop	40	Not rated		Not rated	
Vessilla	30	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00		
Menefee	20	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
226:					
Galisteo, moderately saline, sodic------	85	Very limited		Not limited	
		Slow water movement	1.00		
227:					
Hagerman----------	65	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slow water movement	1.00	Slope	0.08
Bond----------	20	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
				Slope	0.68
228:					
Winona----------	85	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
				Seepage	0.53
230:					
Skyvillage----------	35	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	0.63	Slope	1.00
Sandoval----------	25	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	0.63	Slope	1.00
Rock outcrop--------	20	Not rated		Not rated	
231:					
Querencia----------	85	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Slope	0.68
				Seepage	0.53
234:					
Querencia----------	60	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Slope	0.68
				Seepage	0.53
Zia----------	20	Not limited		Very limited	
				Seepage	1.00
				Slope	0.68
235:					
Sandoval----------	85	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	0.04	Slope	1.00

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
236:					
Sparank, moderately saline, sodic------	85	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
		Slow water movement	1.00		
237:					
Sparank----------	85	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
		Slow water movement	1.00		
240:					
Penistaja----------	45	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Seepage	0.53
				Slope	0.08
Hagerman----------	35	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slow water movement	1.00	Slope	0.08
250:					
Pinavetes----------	90	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Slope	0.16	Slope	1.00
262:					
Pastura----------	90	Very limited		Very limited	
		Depth to cemented pan	1.00	Depth to cemented pan	1.00
				Seepage	0.53
				Slope	0.08
270:					
Blancot----------	40	Not limited		Very limited	
				Seepage	1.00
				Slope	0.32
Councelor----------	30	Not limited		Very limited	
				Seepage	1.00
Tsosie----------	25	Very limited		Very limited	
		Slow water movement	1.00	Seepage	1.00
281:					
Carjo----------	90	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Seepage, bottom layer	1.00	Seepage	1.00
				Slope	0.68

: 97180

Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
282:					
Tocal	85	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
				Slope	0.92
				Seepage	0.53
283:					
Mirand	45	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	1.00		
Alanos	30	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	1.00	Large stones content	0.03
290:					
Alanos	50	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	1.00	Seepage	0.53
Rock outcrop	30	Not rated		Not rated	
300:					
Waumac	50	Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00
				Slope	0.32
Bamac	35	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Seepage, bottom layer	1.00	Slope	0.32
301:					
Vastine	45	Very limited		Very limited	
		Depth to saturated zone	1.00	Seepage	1.00
		Seepage, bottom layer	1.00	Depth to saturated zone	1.00
		Slow water movement	0.46	Flooding	0.40
		Flooding	0.40		
Jarola	40	Very limited		Very limited	
		Depth to saturated zone	1.00	Seepage	1.00
		Seepage, bottom layer	1.00	Depth to saturated zone	1.00
		Slow water movement	0.46	Flooding	0.40
		Flooding	0.40	Slope	0.08

Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
302:					
Tranquilar----------	50	Very limited		Very limited	
		Slow water movement	1.00	Depth to saturated zone	1.00
		Depth to saturated zone	1.00	Slope	0.68
Jarmillo----------	30	Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00
		Slow water movement	1.00	Slope	0.68
304:					
Cosey----------	45	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	0.37	Seepage	0.53
Jarmillo----------	40	Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00
		Slope	0.37	Slope	1.00
307:					
Flugle----------	60	Not limited		Very limited	
				Seepage	1.00
				Slope	0.08
Waumac----------	25	Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00
				Slope	0.68
308:					
Cajete----------	85	Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00
				Slope	0.32
311:					
Cosey----------	35	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	0.84	Seepage	0.53
		Large stones content	0.03		
Tranquilar----------	30	Very limited		Very limited	
		Slow water movement	1.00	Depth to saturated zone	1.00
		Depth to saturated zone	1.00	Slope	1.00
				Seepage	0.53

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
311:					
Calaveras----------	25	Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00
		Slope	0.84	Slope	1.00
		Slow water movement	0.46		
312:					
Royosa----------	90	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Seepage, bottom layer	1.00	Slope	0.68
314:					
Fragua----------	40	Not limited		Very limited	
				Seepage	1.00
				Slope	0.68
Waumac----------	30	Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00
				Slope	0.68
Royosa----------	25	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Seepage, bottom layer	1.00	Slope	0.68
317:					
Elpedro----------	85	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Slope	0.68
				Seepage	0.53
319:					
Bamac----------	60	Very limited		Very limited	
		Filtering capacity	1.00	Slope	1.00
		Slope	1.00	Seepage	1.00
		Seepage, bottom layer	1.00		
Rock outcrop--------	25	Not rated		Not rated	
320:					
Sparham----------	85	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
		Slow water movement	1.00		
321:					
Waumac----------	60	Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00
		Slope	0.01	Slope	1.00

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
321:					
Royosa	30	Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00
		Filtering capacity	1.00	Slope	0.68
322:					
Fragua	85	Very limited		Very limited	
		Filtering capacity	1.00	Slope	1.00
		Slope	1.00	Seepage	1.00
		Depth to bedrock	0.94	Depth to soft bedrock	0.84
324:					
Rock outcrop	30	Not rated		Not rated	
Atarque	25	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
				Seepage	0.53
Menefee	25	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00
325:					
Rock outcrop	35	Not rated		Not rated	
Espiritu	25	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Slow water movement	0.46	Seepage	0.53
				Large stones content	0.01
Vessilla	25	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
342:					
Waumac	35	Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00
		Slope	0.84	Slope	1.00
Vessilla	25	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Seepage, bottom layer	1.00	Seepage	1.00
		Slope	1.00	Slope	1.00
Rock outcrop	20	Not rated		Not rated	

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
345:					
Espiritu----------	50	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Slow water movement	0.46	Seepage	1.00
Bamac----------	35	Very limited		Very limited	
		Filtering capacity	1.00	Slope	1.00
		Slope	1.00	Seepage	1.00
		Seepage, bottom layer	1.00		
346:					
Espiritu, cobbly----	70	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Slow water movement	0.46	Seepage	1.00
		Large stones content	0.01	Large stones content	0.39
Bamac----------	20	Very limited		Very limited	
		Filtering capacity	1.00	Slope	1.00
		Slope	1.00	Seepage	1.00
		Seepage, bottom layer	1.00		
348:					
Wauquie----------	60	Very limited		Very limited	
		Slope	1.00	Slope	1.00
				Seepage	1.00
Rock outcrop--------	20	Not rated		Not rated	
353:					
Cochiti----------	50	Very limited		Very limited	
		Filtering capacity	1.00	Slope	1.00
		Slope	1.00	Seepage	1.00
Espiritu----------	45	Very limited		Very limited	
		Filtering capacity	1.00	Slope	1.00
		Slope	1.00	Seepage	1.00
354:					
Waumac Variant------	85	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Seepage, bottom layer	1.00	Slope	1.00
		Slope	0.01		

Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
358:					
Deama	35	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
				Seepage	0.53
Elpedro	25	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	1.00	Seepage	0.53
Rock outcrop	25	Not rated		Not rated	
396:					
Atarque	30	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
Menefee	30	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00
Rock outcrop	25	Not rated		Not rated	
397:					
Rock outcrop	30	Not rated		Not rated	
Cucho	25	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00
		Slow water movement	1.00		
Vessilla	25	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00		
398:					
Espiritu	45	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Slow water movement	0.46	Seepage	1.00
Cucho	35	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00
		Slow water movement	1.00		

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
399:					
Cucho	45	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00
		Slow water movement	1.00		
Teco	35	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	1.00	Seepage	1.00
405:					
Charo	50	Very limited		Very limited	
		Slow water movement	1.00	Depth to hard bedrock	1.00
		Depth to bedrock	1.00	Slope	0.08
Charo, noncobbly	40	Very limited		Very limited	
		Slow water movement	1.00	Depth to hard bedrock	1.00
		Depth to bedrock	1.00		
409:					
Santa Fe	85	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
410:					
Zia	85	Not limited		Very limited	
				Seepage	1.00
414:					
Wauquie	85	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Slow water movement	0.46	Seepage	1.00
417:					
Jocity	85	Very limited		Very limited	
		Slow water movement	1.00	Seepage	1.00
		Depth to saturated zone	0.40	Flooding	0.40
		Flooding	0.40		
418:					
Jocity	85	Very limited		Very limited	
		Slow water movement	1.00	Seepage	1.00
		Depth to saturated zone	0.40	Flooding	0.40
		Flooding	0.40		

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
419:					
Santa Fe	40	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
		Large stones content	0.01	Seepage	0.53
				Large stones content	0.02
Wauquie	30	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Large stones content	0.08	Seepage	1.00
				Large stones content	0.78
Rock outcrop	20	Not rated		Not rated	
420:					
Pinavetes	85	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
421:					
Gilco, moderately saline, sodic	90	Somewhat limited		Very limited	
		Slow water movement	0.46	Seepage	1.00
		Depth to saturated zone	0.40	Flooding	0.40
		Flooding	0.40		
422:					
Vessilla	35	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Seepage, bottom layer	1.00	Seepage	1.00
		Slope	1.00	Slope	1.00
Menefee	30	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
				Slope	0.92
Orlie	25	Very limited		Somewhat limited	
		Slow water movement	1.00	Slope	0.32
423:					
Gilco	85	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Seepage	0.53
		Depth to saturated zone	0.40	Flooding	0.40
		Flooding	0.40	Slope	0.08

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
426:					
Aga, moderately saline, sodic------	85	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Depth to saturated zone	0.40	Flooding	0.40
		Flooding	0.40		
427:					
Aga----------	85	Somewhat limited		Very limited	
		Depth to saturated zone	0.94	Seepage	1.00
		Slow water movement	0.46	Flooding	0.40
		Flooding	0.40	Depth to saturated zone	0.40
428:					
Aga, moderately saline, sodic------	85	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Depth to saturated zone	0.40	Flooding	0.40
		Flooding	0.40		
430:					
Trail----------	85	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Flooding	0.40	Flooding	0.40
431:					
Trail----------	85	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Flooding	0.40	Flooding	0.40
433:					
Peralta----------	85	Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Slow water movement	0.46	Seepage	0.53
		Flooding	0.40	Flooding	0.40
434:					
Peralta----------	85	Very limited		Very limited	
		Depth to saturated zone	1.00	Seepage	1.00
		Seepage, bottom layer	1.00	Depth to saturated zone	1.00
		Slow water movement	0.46	Flooding	0.40
		Flooding	0.40		

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Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
437:					
Peralta, moderately saline, sodic	85	Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Slow water movement	0.46	Seepage	0.53
		Flooding	0.40	Flooding	0.40
500:					
Rock outcrop	40	Not rated		Not rated	
Osha	30	Very limited		Very limited	
		Filtering capacity	1.00	Slope	1.00
		Slope	1.00	Seepage	1.00
		Seepage, bottom layer	1.00	Depth to hard bedrock	0.93
		Depth to bedrock	0.98		
Rubble land	20	Very limited		Very limited	
		Filtering capacity	1.00	Slope	1.00
		Slope	1.00	Large stones content	1.00
		Large stones content	1.00	Seepage	1.00
		Seepage, bottom layer	1.00		
503:					
Cajete	65	Very limited		Very limited	
		Seepage, bottom layer	1.00	Slope	1.00
		Slope	1.00	Seepage	1.00
Cypher	25	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00
504:					
Orejas	40	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	0.16	Slope	1.00
Guaje	35	Not limited		Very limited	
				Seepage	1.00
				Slope	0.68
600:					
Rock outcrop	50	Not rated		Not rated	

Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
600:					
Cypher	35	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
				Seepage	0.53
601:					
Laventana	85	Somewhat limited		Very limited	
		Depth to bedrock	0.78	Slope	1.00
		Slow water movement	0.46	Seepage	0.53
		Slope	0.04	Depth to hard bedrock	0.42
603:					
Laventana	50	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Depth to bedrock	0.73	Seepage	0.53
		Slow water movement	0.46	Depth to hard bedrock	0.32
Mirand	35	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	1.00		
604:					
Cypher	55	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00
Mirand	30	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	1.00		
608:					
Osha, steep	60	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00
Osha	30	Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00
		Slope	1.00	Slope	1.00
823:					
Gilco, unprotected	85	Somewhat limited		Somewhat limited	
		Slow water movement	0.46	Seepage	0.53
		Depth to saturated zone	0.40	Flooding	0.40
		Flooding	0.40	Slope	0.08

Table 11A.--Sewage disposal--continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
827:					
Aga, unprotected----	85	Somewhat limited		Very limited	
		Depth to saturated zone	0.94	Seepage	1.00
		Slow water movement	0.46	Flooding	0.40
		Flooding	0.40	Depth to saturated zone	0.40
830:					
Trail, unprotected--	85	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Depth to saturated zone	0.40	Flooding	0.40
		Flooding	0.40		
831:					
Trail, unprotected--	85	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Depth to saturated zone	0.40	Flooding	0.40
		Flooding	0.40		
835:					
Peralta, unprotected	85	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
		Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Slow water movement	0.46	Seepage	0.53
842:					
Peralta, moderately saline, sodic, unprotected--------	85	Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Slow water movement	0.46	Seepage	0.53
		Flooding	0.40	Flooding	0.40
850:					
Water----------	95	Not rated		Not rated	
DAM:					
Dam----------	100	Not rated		Not rated	

Table 11B.--Landfills

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
1:							
Silver	55	Not limited		Not limited		Not limited	
Clovis	35	Not limited		Not limited		Not limited	
2:							
Clovis	35	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
Prieta	35	Very limited		Somewhat limited		Very limited	
		Depth to bedrock	1.00	Slope	0.04	Depth to bedrock	1.00
		Large stones content	0.43			Large stones content	0.43
		Slope	0.04			Gravel content	0.05
						Slope	0.04
Silver	20	Not limited		Not limited		Not limited	
3:							
Montecito	60	Not limited		Not limited		Not limited	
Orejas	30	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Large stones content	0.67			Large stones content	0.67
		Too clayey	0.50			Too clayey	0.50
						Gravel content	0.01
4:							
Montecito	45	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
Montecito, bouldery-	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00

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Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
10:							
Trail	85	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Seepage	1.00
		Too sandy	0.50	Flooding	0.40	Too sandy	0.50
		Flooding	0.40				
11:							
Trail	85	Very limited		Very limited		Very limited	
		Flooding	1.00	Flooding	1.00	Seepage	1.00
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Too sandy	0.50
		Too sandy	0.50				
13:							
Sandoval	65	Very limited		Not limited		Very limited	
		Depth to bedrock	1.00			Depth to bedrock	1.00
Querencia	20	Not limited		Not limited		Not limited	
15:							
Camino	40	Very limited		Not limited		Very limited	
		Depth to bedrock	1.00			Hard to compact	1.00
						Depth to bedrock	0.32
Sandoval	35	Very limited		Not limited		Very limited	
		Depth to bedrock	1.00			Depth to bedrock	1.00
16:							
Rock outcrop	50	Not rated		Not rated		Not rated	
Prieta	30	Very limited		Somewhat limited		Very limited	
		Depth to bedrock	1.00	Slope	0.04	Depth to bedrock	1.00
		Large stones content	0.06			Gravel content	0.07
		Slope	0.04			Large stones content	0.06
						Slope	0.04

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
17:							
Vessilla	35	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Seepage, bottom layer	1.00	Slope	0.04	Seepage	0.52
		Slope	0.04			Slope	0.04
Menefee	25	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Slope	0.04	Slope	0.04	Slope	0.04
Rock outcrop	20	Not rated		Not rated		Not rated	
18:							
Sparham	85	Very limited		Very limited		Very limited	
		Flooding	1.00	Flooding	1.00	Sodium content	1.00
		Excess sodium	1.00			Too clayey	0.50
		Too clayey	0.50				
20:							
Gilco	85	Very limited		Very limited		Not limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00		
		Flooding	0.40	Flooding	0.40		
21:							
Rock outcrop	60	Not rated		Not rated		Not rated	
Hackroy	25	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Too clayey	1.00			Too clayey	1.00
						Hard to compact	1.00
22:							
Aga	85	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Too sandy	1.00
		Too sandy	1.00	Flooding	0.40	Seepage	1.00
		Flooding	0.40				

557659

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
23:							
Hickman	85	Somewhat limited		Somewhat limited		Somewhat limited	
		Too clayey	0.50	Flooding	0.40	Too clayey	0.50
		Flooding	0.40				
24:							
Orlie	45	Not limited		Not limited		Not limited	
Sparham	35	Very limited		Very limited		Very limited	
		Flooding	1.00	Flooding	1.00	Too clayey	1.00
		Too clayey	1.00			Sodium content	1.00
		Excess sodium	1.00				
25:							
Gilco	85	Very limited		Very limited		Not limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00		
		Flooding	0.40	Flooding	0.40		
26:							
Orlie	85	Not limited		Not limited		Not limited	
27:							
Aga	85	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Too sandy	1.00
		Too sandy	1.00	Flooding	0.40	Seepage	1.00
		Flooding	0.40				
29:							
Trail	85	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Seepage	1.00
		Too sandy	0.50	Flooding	0.40	Too sandy	0.50
		Flooding	0.40				
31:							
Riverwash	90	Very limited		Very limited		Very limited	
		Flooding	1.00	Flooding	1.00	Too sandy	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	1.00
		Too sandy	1.00				

97 95

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
33:							
Pits	100	Not rated		Not limited		Not rated	
34:							
Ildefonso	55	Somewhat limited		Not limited		Somewhat limited	
		Large stones content	0.93			Large stones content	0.93
Witt	30	Not limited		Not limited		Not limited	
41:							
Dune land	100	Very limited		Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Too sandy	1.00
		Too sandy	1.00	Slope	0.16	Seepage	1.00
		Slope	0.16			Slope	0.16
47:							
Cascajo	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Seepage	1.00
		Too sandy	0.50			Slope	1.00
		Large stones content	0.06			Gravel content	0.90
						Too sandy	0.50
						Large stones content	0.06
51:							
Sparham	85	Very limited		Very limited		Very limited	
		Flooding	1.00	Flooding	1.00	Depth to saturated zone	1.00
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Sodium content	1.00
		Excess sodium	1.00			Too clayey	0.50
		Too clayey	0.50				
52:							
Totavi	85	Very limited		Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	1.00
		Too sandy	0.50	Flooding	0.40	Too sandy	0.50
		Flooding	0.40				

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Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
53:							
Witt	55	Not limited		Not limited		Not limited	
Harvey	30	Not limited		Not limited		Not limited	
54:							
Harvey	45	Somewhat limited		Somewhat limited		Somewhat limited	
		Slope	0.16	Slope	0.16	Slope	0.16
Cascajo	40	Very limited		Somewhat limited		Very limited	
		Too sandy	1.00	Slope	0.16	Too sandy	1.00
		Slope	0.16			Seepage	1.00
						Gravel content	0.84
						Slope	0.16
55:							
La Fonda	85	Not limited		Not limited		Not limited	
56:							
Ildefonso	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Large stones content	0.83			Large stones content	0.83
						Gravel content	0.01
57:							
Badland	90	Not rated		Very limited		Not rated	
				Depth to bedrock	1.00		
				Slope	1.00		
58:							
Deama	45	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
		Large stones content	0.01			Carbonate content	1.00
						Gravel content	0.09
						Large stones content	0.01
Elpedro	35	Somewhat limited		Somewhat limited		Somewhat limited	
		Slope	0.04	Slope	0.04	Slope	0.04

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
59:							
Harvey	35	Not limited		Not limited		Not limited	
Ildefonso	35	Very limited		Somewhat limited		Very limited	
		Too sandy	1.00	Slope	0.37	Too sandy	1.00
		Large stones content	0.56			Seepage	1.00
		Slope	0.37			Large stones content	0.56
						Slope	0.37
						Gravel content	0.36
La Fonda	15	Not limited		Not limited		Not limited	
63:							
Placitas	85	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Slope	1.00	Depth to bedrock	1.00
		Slope	1.00			Slope	1.00
						Gravel content	0.98
						Seepage	0.52
64:							
Skyvillage	40	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Slope	1.00	Depth to bedrock	1.00
		Slope	1.00			Slope	1.00
						Seepage	0.52
Ildefonso	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
						Gravel content	0.86
						Seepage	0.52
65:							
Ildefonso	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
						Gravel content	0.95
						Seepage	0.52
Harvey	30	Somewhat limited		Somewhat limited		Somewhat limited	
		Slope	0.84	Slope	0.84	Slope	0.84
						Seepage	0.52

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Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
66:							
Zia	85	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
67:							
Sandoval	40	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Slope	1.00	Depth to bedrock	1.00
		Slope	1.00			Slope	1.00
Poley	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
						Seepage	0.52
68:							
Penistaja	45	Not limited		Not limited		Not limited	
Querencia	35	Not limited		Not limited		Not limited	
71:							
Palon	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Gravel content	0.67
		Large stones content	0.12			Seepage	0.52
						Large stones content	0.12
72:							
Palon	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Large stones	1.00
		Large stones	1.00			Seepage	0.52
						Gravel content	0.01

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
74:							
Origo	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Large stones content	0.67
		Large stones content	0.67			Seepage	0.52
						Gravel content	0.39
Pavo	25	Very limited		Very limited		Somewhat limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Slope	0.84
		Slope	0.84	Slope	0.84	Seepage	0.52
75:							
Origo	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Large stones content	0.99
		Large stones content	0.99			Seepage	0.52
						Gravel content	0.01
82:							
Calaveras	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Gravel content	0.71
		Large stones content	0.02			Seepage	0.52
						Large stones content	0.02
83:							
Calaveras	60	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	0.52
		Large stones content	0.19			Large stones content	0.19
						Gravel content	0.05

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
83:							
Rubble land---------	20	Not rated		Very limited		Very limited	
				Slope	1.00	Slope	1.00
				Seepage	1.00	Seepage	1.00
						Large stones	1.00
85:							
Redondo-------------	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	0.52
						Gravel content	0.14
86:							
Redondo-------------	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Large stones content	0.93
		Large stones content	0.93			Seepage	0.52
						Gravel content	0.07
87:							
Redondo-------------	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	0.52
						Gravel content	0.08
Rubble land---------	25	Not rated		Very limited		Very limited	
				Slope	1.00	Slope	1.00
				Seepage	1.00	Seepage	1.00
						Large stones	1.00
88:							
Totavi--------------	45	Very limited		Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	1.00
		Too sandy	0.50	Flooding	0.40	Too sandy	0.50
		Flooding	0.40				

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
88:							
Jemez	30	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Slope	0.16	Slope	0.16	Slope	0.16
Rock outcrop	15	Not rated		Not rated		Not rated	
91:							
Zia	85	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
92:							
Galisteo, moderately saline, sodic	85	Not limited		Not limited		Very limited	
						Hard to compact	1.00
93:							
Zia	85	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
95:							
El Rancho	85	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
97:							
El Rancho	85	Not limited		Not limited		Not limited	
100:							
Orejas	40	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
		Large stones content	0.61			Large stones content	0.61
		Too clayey	0.50			Too clayey	0.50
						Gravel content	0.01
Rock outcrop	40	Not rated		Not rated		Not rated	
101:							
Blancot	55	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
Lybrook	25	Not limited		Not limited		Not limited	

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Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
102:							
Sparham	85	Very limited		Very limited		Very limited	
		Flooding	1.00	Flooding	1.00	Sodium content	1.00
		Excess sodium	1.00			Too clayey	0.50
		Too clayey	0.50				
104:							
Cochiti	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
						Gravel content	0.87
						Seepage	0.52
Montecito	30	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
105:							
Badland	50	Not rated		Very limited		Not rated	
				Slope	1.00		
				Depth to bedrock	1.00		
Menefee	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
106:							
Stumble	50	Very limited		Very limited		Very limited	
		Too sandy	1.00	Slope	1.00	Too sandy	1.00
		Slope	1.00			Seepage	1.00
						Slope	1.00
Stumble, sandy	30	Very limited		Somewhat limited		Very limited	
		Too sandy	1.00	Flooding	0.40	Too sandy	1.00
		Flooding	0.40			Seepage	1.00
108:							
Embudo	85	Somewhat limited		Somewhat limited		Very limited	
		Too sandy	0.50	Slope	0.01	Seepage	1.00
		Slope	0.01			Too sandy	0.50
						Slope	0.01

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
109:							
Embudo	50	Somewhat limited		Not limited		Very limited	
		Too sandy	0.50			Seepage	1.00
						Too sandy	0.50
Tijeras	35	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
						Gravel content	0.14
110:							
Rock outcrop	45	Not rated		Not rated		Not rated	
Saido	40	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
111:							
Rock outcrop	50	Not rated		Not rated		Not rated	
Zia	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
						Seepage	0.52
112:							
Tijeras	85	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
						Gravel content	0.01
114:							
San Mateo	40	Somewhat limited		Somewhat limited		Not limited	
		Flooding	0.40	Flooding	0.40		
Zia	40	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
120:							
Pinavetes	85	Very limited		Not limited		Very limited	
		Too sandy	1.00			Too sandy	1.00
						Seepage	1.00
124:							
Rock outcrop	90	Not rated		Not rated		Not rated	

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Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
129:							
Menefee	85	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Too clayey	0.50			Too clayey	0.50
130:							
Pinavetes	45	Somewhat limited		Not limited		Very limited	
		Too sandy	0.50			Seepage	1.00
						Too sandy	0.50
Galisteo, moderately saline, sodic	40	Somewhat limited		Somewhat limited		Very limited	
		Flooding	0.40	Flooding	0.40	Hard to compact	1.00
142:							
Grieta	85	Not limited		Not limited		Not limited	
143:							
Clovis	85	Not limited		Not limited		Not limited	
145:							
Grieta	55	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
Sheppard	40	Somewhat limited		Not limited		Very limited	
		Too sandy	0.50			Seepage	1.00
						Too sandy	0.50
146:							
Sedmar	85	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Seepage, bottom layer	1.00	Slope	0.01	Seepage	1.00
		Too sandy	0.50			Too sandy	0.50
		Slope	0.01			Slope	0.01
150:							
Doakum	55	Not limited		Not limited		Not limited	
Betonnie	35	Not limited		Not limited		Somewhat limited	
						Seepage	0.52

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Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
162:							
Hackroy	45	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Too clayey	1.00			Too clayey	1.00
						Hard to compact	1.00
Nyjack	40	Very limited		Not limited		Very limited	
		Depth to bedrock	1.00			Depth to bedrock	1.00
						Seepage	0.52
163:							
Jemez	85	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Slope	0.01	Slope	0.01	Slope	0.01
170:							
San Mateo	85	Somewhat limited		Somewhat limited		Not limited	
		Flooding	0.40	Flooding	0.40		
180:							
Councelor	40	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
						Seepage	0.52
Eslendo	30	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Slope	1.00	Depth to bedrock	1.00
		Slope	1.00			Slope	1.00
Mespun	25	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Seepage	1.00
		Too sandy	0.50			Slope	1.00
						Too sandy	0.50
183:							
Sheppard	85	Somewhat limited		Somewhat limited		Very limited	
		Slope	0.63	Slope	0.63	Seepage	1.00
		Too sandy	0.50			Slope	0.63
						Too sandy	0.50
185:							
Frijoles	90	Not limited		Not limited		Very limited	
						Seepage	1.00
						Gravel content	1.00

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
190:							
Zia	35	Somewhat limited		Somewhat limited		Somewhat limited	
		Slope	0.84	Slope	0.84	Slope	0.84
						Seepage	0.52
Skyvillage	25	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Slope	1.00	Depth to bedrock	1.00
		Slope	1.00			Slope	1.00
						Seepage	0.52
Rock outcrop	15	Not rated		Not rated		Not rated	
191:							
Sheppard	85	Somewhat limited		Not limited		Very limited	
		Too sandy	0.50			Seepage	1.00
						Too sandy	0.50
200:							
Sedillo	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
						Gravel content	0.91
						Seepage	0.52
201:							
Rock outcrop	55	Not rated		Not rated		Not rated	
Sedgran	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00			Slope	1.00
		Too sandy	0.50			Seepage	1.00
						Gravel content	0.94
						Too sandy	0.50
206:							
Pinitos	85	Not limited		Not limited		Not limited	
207:							
Penistaja	60	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
Zia	25	Not limited		Not limited		Somewhat limited	
						Seepage	0.52

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
208:							
Sedillo	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
						Gravel content	1.00
						Seepage	0.52
210:							
Ildefonso	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Large stones content	0.97			Large stones content	0.97
						Gravel content	0.01
211:							
Zia	45	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
Clovis	30	Not limited		Not limited		Not limited	
213:							
Pinavetes	55	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Too sandy	1.00			Too sandy	1.00
						Seepage	1.00
Rock outcrop	30	Not rated		Not rated		Not rated	
215:							
Ess	60	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Large stones content	0.14			Gravel content	0.36
						Large stones content	0.14
Rock outcrop	30	Not rated		Not rated		Not rated	
217:							
Witt	85	Not limited		Not limited		Not limited	

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
218:							
Ildefonso	85	Somewhat limited		Somewhat limited		Somewhat limited	
		Large stones content	0.70	Slope	0.01	Large stones content	0.70
		Slope	0.01			Seepage	0.52
						Gravel content	0.03
						Slope	0.01
220:							
Rock outcrop	40	Not rated		Not rated		Not rated	
Vessilla	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
		Seepage, bottom layer	1.00			Seepage	0.52
Menefee	20	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
226:							
Galisteo, moderately saline, sodic	85	Not limited		Not limited		Not limited	
227:							
Hagerman	65	Very limited		Not limited		Very limited	
		Depth to bedrock	1.00			Depth to bedrock	1.00
Bond	20	Very limited		Not limited		Very limited	
		Depth to bedrock	1.00			Depth to bedrock	1.00
228:							
Winona	85	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Slope	1.00	Depth to bedrock	1.00
		Slope	1.00			Slope	1.00
						Carbonate content	1.00
						Gravel content	0.93

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
102:							
230:							
Skyvillage	35	Very limited		Somewhat limited		Very limited	
		Depth to bedrock	1.00	Slope	0.63	Depth to bedrock	1.00
		Slope	0.63			Slope	0.63
						Seepage	0.52
Sandoval	25	Very limited		Somewhat limited		Very limited	
		Depth to bedrock	1.00	Slope	0.63	Depth to bedrock	1.00
		Slope	0.63			Slope	0.63
Rock outcrop	20	Not rated		Not rated		Not rated	
231:							
Querencia	85	Not limited		Not limited		Not limited	
234:							
Querencia	60	Not limited		Not limited		Not limited	
Zia	20	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
235:							
Sandoval	85	Very limited		Somewhat limited		Very limited	
		Depth to bedrock	1.00	Slope	0.04	Depth to bedrock	1.00
		Slope	0.04			Slope	0.04
236:							
Sparank, moderately saline, sodic	85	Very limited		Very limited		Not limited	
		Flooding	1.00	Flooding	1.00		
237:							
Sparank	85	Very limited		Very limited		Not limited	
		Flooding	1.00	Flooding	1.00		
240:							
Penistaja	45	Not limited		Not limited		Not limited	
Hagerman	35	Very limited		Not limited		Very limited	
		Depth to bedrock	1.00			Depth to bedrock	1.00

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
250:							
Pinavetes	90	Somewhat limited		Somewhat limited		Very limited	
		Too sandy	0.50	Slope	0.16	Seepage	1.00
		Slope	0.16			Too sandy	0.50
						Slope	0.16
262:							
Pastura	90	Somewhat limited		Not limited		Very limited	
		Depth to thin cemented pan	0.50			Depth to cemented pan	1.00
270:							
Blancot	40	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
Councelor	30	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
Tsosie	25	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
281:							
Carjo	90	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Seepage	1.00	Depth to bedrock	1.00
		Seepage, bottom layer	1.00	Depth to bedrock	1.00	Too clayey	1.00
		Too clayey	1.00			Hard to compact	1.00
282:							
Tocal	85	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
283:							
Mirand	45	Very limited		Very limited		Very limited	
		Too clayey	1.00	Slope	1.00	Too clayey	1.00
		Slope	1.00			Hard to compact	1.00
						Slope	1.00
Alanos	30	Very limited		Very limited		Very limited	
		Too clayey	1.00	Slope	1.00	Too clayey	1.00
		Slope	1.00			Slope	1.00
						Gravel content	0.92

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
290:							
Alanos	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Too clayey	1.00			Too clayey	1.00
						Gravel content	1.00
Rock outcrop	30	Not rated		Not rated		Not rated	
300:							
Waumac	50	Very limited		Very limited		Somewhat limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	0.52
Bamac	35	Very limited		Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	1.00
		Too sandy	0.50			Gravel content	0.90
						Too sandy	0.50
301:							
Vastine	45	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Seepage	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Gravel content	0.90
		Too sandy	0.50	Flooding	0.40	Depth to saturated zone	0.86
		Flooding	0.40			Too sandy	0.50
Jarola	40	Very limited		Very limited		Somewhat limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	0.86
		Seepage, bottom layer	1.00	Flooding	0.40		
		Flooding	0.40				
302:							
Tranquilar	50	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Too clayey	1.00
		Too clayey	1.00			Hard to compact	1.00
						Depth to saturated zone	0.24

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
302:							
Jarmillo	30	Very limited		Very limited		Somewhat limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Too clayey	0.50
		Too clayey	0.50				
304:							
Cosey	45	Somewhat limited		Somewhat limited		Somewhat limited	
		Too clayey	0.50	Slope	0.37	Too clayey	0.50
		Slope	0.37			Slope	0.37
						Gravel content	0.05
Jarmillo	40	Very limited		Very limited		Somewhat limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	0.52
		Slope	0.37	Slope	0.37	Slope	0.37
307:							
Flugle	60	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
Waumac	25	Very limited		Very limited		Somewhat limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	0.52
308:							
Cajete	85	Very limited		Very limited		Somewhat limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Gravel content	0.69
						Seepage	0.52
311:							
Cosey	35	Somewhat limited		Somewhat limited		Somewhat limited	
		Slope	0.84	Slope	0.84	Slope	0.84
		Large stones content	0.65			Large stones content	0.65
		Too clayey	0.50			Too clayey	0.50

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
311:							
Tranquilar----------	30	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Too clayey	1.00
		Too clayey	1.00			Hard to compact	1.00
						Depth to saturated zone	0.24
Calaveras----------	25	Very limited		Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	1.00
		Slope	0.84	Slope	0.84	Slope	0.84
		Too sandy	0.50			Too sandy	0.50
		Large stones content	0.01			Gravel content	0.08
						Large stones content	0.01
312:							
Royosa----------	90	Very limited		Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	1.00
		Too sandy	0.50			Too sandy	0.50
314:							
Fragua----------	40	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
Waumac----------	30	Very limited		Very limited		Somewhat limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	0.52
Royosa----------	25	Very limited		Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Too sandy	1.00
		Too sandy	1.00			Seepage	1.00
317:							
Elpedro----------	85	Not limited		Not limited		Not limited	

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
319:							
Bamac	60	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	1.00
		Too sandy	0.50			Gravel content	0.99
						Too sandy	0.50
Rock outcrop	25	Not rated		Not rated		Not rated	
320:							
Sparham	85	Very limited		Very limited		Very limited	
		Flooding	1.00	Flooding	1.00	Too clayey	1.00
		Too clayey	1.00			Sodium content	1.00
		Excess sodium	1.00				
321:							
Waumac	60	Very limited		Very limited		Somewhat limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	0.52
		Slope	0.01	Slope	0.01	Slope	0.01
Royosa	30	Very limited		Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Too sandy	1.00
		Too sandy	1.00			Seepage	1.00
322:							
Fragua	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Depth to bedrock	1.00			Seepage	1.00
		Too sandy	0.50			Depth to bedrock	0.84
						Too sandy	0.50
324:							
Rock outcrop	30	Not rated		Not rated		Not rated	
Atarque	25	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
324:							
Menefee	25	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Too clayey	0.50			Too clayey	0.50
325:							
Rock outcrop	35	Not rated		Not rated		Not rated	
Espiritu	25	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
						Gravel content	0.67
Vessilla	25	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
						Seepage	0.52
						Gravel content	0.07
342:							
Waumac	35	Very limited		Very limited		Somewhat limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Slope	0.84
		Slope	0.84	Slope	0.84	Seepage	0.52
Vessilla	25	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Seepage, bottom layer	1.00	Slope	1.00	Slope	1.00
		Slope	1.00			Seepage	0.52
Rock outcrop	20	Not rated		Not rated		Not rated	
345:							
Espiritu	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
						Seepage	0.52
						Gravel content	0.18

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
345:							
Bamac	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	1.00
		Too sandy	0.50			Gravel content	0.98
						Too sandy	0.50
346:							
Espiritu, cobbly	70	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Too sandy	0.50			Seepage	1.00
		Large stones content	0.01			Gravel content	0.74
						Too sandy	0.50
						Large stones content	0.01
Bamac	20	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	1.00
		Too sandy	0.50			Gravel content	0.58
						Too sandy	0.50
348:							
Wauquie	60	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
						Gravel content	1.00
						Seepage	0.52
Rock outcrop	20	Not rated		Not rated		Not rated	
353:							
Cochiti	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Too sandy	0.50			Seepage	1.00
						Gravel content	1.00
						Too sandy	0.50

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
353:							
Espiritu----------	45	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Too sandy	0.50			Seepage	1.00
						Gravel content	0.99
						Too sandy	0.50
354:							
Waumac Variant------	85	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Seepage, bottom layer	1.00	Slope	0.01	Gravel content	1.00
		Slope	0.01			Seepage	0.52
						Slope	0.01
358:							
Deama----------	35	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
						Carbonate content	1.00
						Gravel content	0.99
Elpedro----------	25	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
Rock outcrop--------	25	Not rated		Not rated		Not rated	
396:							
Atarque----------	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
		Too clayey	0.50			Too clayey	0.50
Menefee----------	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
		Too clayey	0.50			Too clayey	0.50
Rock outcrop--------	25	Not rated		Not rated		Not rated	
397:							
Rock outcrop--------	30	Not rated		Not rated		Not rated	

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
397:							
Cucho	25	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
		Too clayey	0.50			Gravel content	0.69
						Too clayey	0.50
Vessilla	25	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
		Seepage, bottom layer	1.00			Seepage	0.52
398:							
Espiritu	45	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
						Gravel content	0.95
						Seepage	0.52
Cucho	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
		Too clayey	0.50			Too clayey	0.50
399:							
Cucho	45	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
		Too clayey	0.50			Too clayey	0.50
Teco	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Hard to compact	1.00
						Slope	1.00
405:							
Charo	50	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Too clayey	1.00			Too clayey	1.00
						Hard to compact	1.00
Charo, noncobbly	40	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Too clayey	1.00			Too clayey	1.00

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Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
409:							
Santa Fe	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
						Gravel content	0.76
						Seepage	0.52
410:							
Zia	85	Not limited		Not limited		Somewhat limited	
						Seepage	0.52
414:							
Wauquie	85	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Seepage	1.00
						Slope	1.00
						Gravel content	0.42
417:							
Jocity	85	Very limited		Very limited		Not limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00		
		Flooding	0.40	Flooding	0.40		
418:							
Jocity	85	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Seepage	1.00
		Flooding	0.40	Flooding	0.40		
419:							
Santa Fe	40	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
		Large stones content	0.01			Gravel content	0.40
						Large stones content	0.01

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
419:							
Wauquie	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Too sandy	1.00			Too sandy	1.00
		Large stones content	0.08			Seepage	1.00
						Gravel content	1.00
						Large stones content	0.08
Rock outcrop	20	Not rated		Not rated		Not rated	
420:							
Pinavetes	85	Very limited		Not limited		Very limited	
		Too sandy	1.00			Too sandy	1.00
						Seepage	1.00
421:							
Gilco, moderately saline, sodic	90	Very limited		Very limited		Not limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00		
		Flooding	0.40	Flooding	0.40		
422:							
Vessilla	35	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Seepage, bottom layer	1.00	Slope	1.00	Slope	1.00
		Slope	1.00			Seepage	0.52
Menefee	30	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
Orlie	25	Not limited		Not limited		Not limited	
423:							
Gilco	85	Very limited		Very limited		Not limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00		
		Flooding	0.40	Flooding	0.40		

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
426:							
Aga, moderately saline, sodic------	85	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Too sandy	1.00
		Too sandy	1.00	Flooding	0.40	Seepage	1.00
		Flooding	0.40				
427:							
Aga-----------------	85	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Seepage	1.00
		Too sandy	0.50	Flooding	0.40	Too sandy	0.50
		Flooding	0.40				
428:							
Aga, moderately saline, sodic------	85	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Seepage	1.00
		Too sandy	0.50	Flooding	0.40	Too sandy	0.50
		Flooding	0.40				
430:							
Trail---------------	85	Somewhat limited		Somewhat limited		Very limited	
		Flooding	0.40	Flooding	0.40	Seepage	1.00
431:							
Trail---------------	85	Somewhat limited		Somewhat limited		Very limited	
		Too sandy	0.50	Flooding	0.40	Seepage	1.00
		Flooding	0.40			Too sandy	0.50
433:							
Peralta-------------	85	Very limited		Very limited		Somewhat limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Too sandy	0.50
		Too sandy	0.50	Flooding	0.40	Depth to saturated zone	0.47
		Flooding	0.40				

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
434:							
Peralta	85	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Seepage	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Too sandy	0.50
		Too sandy	0.50	Flooding	0.40	Depth to saturated zone	0.47
		Flooding	0.40				
437:							
Peralta, moderately saline, sodic	85	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Sodium content	1.00
		Excess sodium	1.00	Flooding	0.40	Too sandy	0.50
		Too sandy	0.50			Depth to saturated zone	0.47
		Flooding	0.40				
500:							
Rock outcrop	40	Not rated		Not rated		Not rated	
Osha	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Depth to bedrock	1.00	Seepage	1.00	Seepage	1.00
		Seepage, bottom layer	1.00	Depth to bedrock	0.94	Gravel content	1.00
		Too sandy	0.50			Depth to bedrock	0.94
						Too sandy	0.50
Rubble land	20	Not rated		Very limited		Very limited	
				Slope	1.00	Slope	1.00
				Seepage	1.00	Seepage	1.00
						Large stones	1.00
503:							
Cajete	65	Very limited		Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Slope	1.00
		Slope	1.00	Slope	1.00	Gravel content	0.90
						Seepage	0.52

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
5.3:							
Cypher	25	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
		Seepage, bottom layer	1.00			Gravel content	0.93
						Seepage	0.52
504:							
Orejas	40	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00	Depth to bedrock	1.00
		Too clayey	0.50	Slope	0.16	Too clayey	0.50
		Slope	0.16			Slope	0.16
						Gravel content	0.14
Guaje	35	Not limited		Not limited		Very limited	
						Gravel content	1.00
						Seepage	0.52
600:							
Rock outcrop	50	Not rated		Not rated		Not rated	
Cypher	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
						Gravel content	0.77
601:							
Laventana	85	Very limited		Somewhat limited		Somewhat limited	
		Depth to bedrock	1.00	Depth to bedrock	0.42	Gravel content	0.93
		Slope	0.04	Slope	0.04	Depth to bedrock	0.42
						Slope	0.04
603:							
Laventana	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Depth to bedrock	1.00	Depth to bedrock	0.32	Gravel content	0.53
						Depth to bedrock	0.32
Mirand	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Too clayey	0.50			Too clayey	0.50

Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
604:							
Cypher	55	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00	Slope	1.00
		Seepage, bottom layer	1.00			Gravel content	1.00
						Seepage	0.52
Mirand	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Too clayey	1.00			Too clayey	1.00
608:							
Osha, steep	60	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	1.00
		Too sandy	0.50			Gravel content	1.00
						Too sandy	0.50
Osha	30	Very limited		Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00	Seepage	1.00
		Slope	1.00	Slope	1.00	Gravel content	1.00
		Too sandy	0.50			Slope	1.00
						Too sandy	0.50
823:							
Gilco, unprotected	85	Very limited		Very limited		Not limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00		
		Flooding	0.40	Flooding	0.40		
827:							
Aga, unprotected	85	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Seepage	1.00
		Too sandy	0.50	Flooding	0.40	Too sandy	0.50
		Flooding	0.40				

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Table 11B.—Landfills--continued

Map symbol and soil name	Pct. of map unit	Trench sanitary landfill		Area sanitary landfill		Daily cover for landfill	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
830:							
Trail, unprotected--	85	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Seepage	1.00
		Too sandy	0.50	Flooding	0.40	Too sandy	0.50
		Flooding	0.40				
831:							
Trail, unprotected--	85	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Too sandy	1.00
		Too sandy	1.00	Flooding	0.40	Seepage	1.00
		Flooding	0.40				
835:							
Peralta, unprotected	85	Very limited		Very limited		Somewhat limited	
		Flooding	1.00	Flooding	1.00	Depth to saturated zone	0.47
		Depth to saturated zone	1.00	Depth to saturated zone	1.00		
842:							
Peralta, moderately saline, sodic, unprotected--------	85	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Sodium content	1.00
		Excess sodium	1.00	Flooding	0.40	Too clayey	0.50
		Too clayey	0.50			Depth to saturated zone	0.47
		Flooding	0.40				
850:							
Water----------	95	Not rated		Not rated		Not rated	
DAM:							
Dam----------	100	Not rated		Not rated		Not rated	

07227

Table 12A.--Source of gravel and sand

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The ratings given for the thickest layer are for the thickest layer above and excluding the bottom layer. The numbers in the value columns range from 0.00 to 0.99. The greater the value, the greater the likelihood that the bottom layer or thickest layer of the soil is a source of sand or gravel. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
1:					
Silver	55	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Clovis	35	Poor		Poor	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.00
2:					
Clovis	35	Poor		Poor	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.00
Prieta	35	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Silver	20	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
3:					
Montecito	60	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Orejas	30	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
4:					
Montecito	45	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Montecito, bouldery-	35	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
10:					
Trail	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.03
		Thickest layer	0.00	Bottom layer	0.06
11:					
Trail	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.10

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
13:					
Sandoval	65	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Querencia	20	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
15:					
Camino	40	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Sandoval	35	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
16:					
Rock outcrop	50	Not rated		Not rated	
Prieta	30	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
17:					
Vessilla	35	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
Menefee	25	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Rock outcrop	20	Not rated		Not rated	
18:					
Sparham	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
20:					
Gilco	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
21:					
Rock outcrop	60	Not rated		Not rated	
Hackroy	25	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
22:					
Aga	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.42

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
23:					
Hickman	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
24:					
Orlie	45	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Sparham	35	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
25:					
Gilco	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.01
26:					
Orlie	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
27:					
Aga	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.30
		Thickest layer	0.00	Bottom layer	0.79
29:					
Trail	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.10
31:					
Riverwash	90	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.84
		Thickest layer	0.00	Thickest layer	0.89
33:					
Pits	100	Not rated		Not rated	
34:					
Ildefonso	55	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Witt	30	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
41:					
Dune land	100	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.93
		Thickest layer	0.00	Thickest layer	0.93
47:					
Cascajo	85	Poor		Poor	
		Thickest layer	0.00	Bottom layer	0.00
		Bottom layer	0.00	Thickest layer	0.00

: 07230

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
51:					
Sparham	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
52:					
Totavi	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.10
		Thickest layer	0.00	Thickest layer	0.10
53:					
Witt	55	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Harvey	30	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
54:					
Harvey	45	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Cascajo	40	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.57
		Thickest layer	0.00	Bottom layer	0.57
55:					
La Fonda	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
56:					
Ildefonso	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
57:					
Badland	90	Not rated		Not rated	
58:					
Deama	45	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Elpedro	35	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
59:					
Harvey	35	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Ildefonso	35	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
59:					
La Fonda	15	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
63:					
Placitas	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.03
64:					
Skyvillage	40	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
Ildefonso	35	Poor		Fair	
		Thickest layer	0.00	Bottom layer	0.03
		Bottom layer	0.00	Thickest layer	0.03
65:					
Ildefonso	50	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.04
		Thickest layer	0.00	Thickest layer	0.04
Harvey	30	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
66:					
Zia	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.03
67:					
Sandoval	40	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Poley	35	Poor		Poor	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.00
68:					
Penistaja	45	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Querencia	35	Poor		Poor	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.00
71:					
Palon	85	Poor		Fair	
		Thickest layer	0.00	Bottom layer	0.03
		Bottom layer	0.00	Thickest layer	0.03
72:					
Palon	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03

: 07232

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
74:					
Origo	50	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.03
Pavo	25	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.03
75:					
Origo	85	Poor		Poor	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.00
82:					
Calaveras	85	Fair		Fair	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.25	Thickest layer	0.03
83:					
Calaveras	60	Poor		Poor	
		Thickest layer	0.00	Thickest layer	0.00
		Bottom layer	0.00	Bottom layer	0.00
Rubble land	20	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
85:					
Redondo	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.07
		Thickest layer	0.00	Thickest layer	0.07
86:					
Redondo	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
87:					
Redondo	50	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.07
		Thickest layer	0.00	Thickest layer	0.07
Rubble land	25	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
88:					
Totavi	45	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.04
		Thickest layer	0.00	Bottom layer	0.10
Jemez	30	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Rock outcrop	15	Not rated		Not rated	

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
91:					
Zia	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.03
92:					
Galisteo, moderately saline, sodic	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
93:					
Zia	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.10
95:					
El Rancho	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
97:					
El Rancho	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
100:					
Orejas	40	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Rock outcrop	40	Not rated		Not rated	
101:					
Blancot	55	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.03
Lybrook	25	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
102:					
Sparham	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
104:					
Cochiti	50	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
Montecito	30	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.03
		Thickest layer	0.00	Bottom layer	0.03
105:					
Badland	50	Not rated		Not rated	

: 07234

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
105:					
Menefee	30	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
106:					
Stumble	50	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.10
		Thickest layer	0.00	Bottom layer	0.58
Stumble, sandy	30	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.10
		Thickest layer	0.00	Bottom layer	0.47
108:					
Embudo	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.03
		Thickest layer	0.00	Bottom layer	0.10
109:					
Embudo	50	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.06
		Thickest layer	0.00	Bottom layer	0.12
Tijeras	35	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.06
110:					
Rock outcrop	45	Not rated		Not rated	
Saido	40	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
111:					
Rock outcrop	50	Not rated		Not rated	
Zia	35	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.03
112:					
Tijeras	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
114:					
San Mateo	40	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.03
Zia	40	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
120:					
Pinavetes	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.49
		Thickest layer	0.00	Bottom layer	0.79

: 07235

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
124:					
Rock outcrop	90	Not rated		Not rated	
129:					
Menefee	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
130:					
Pinavetes	45	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.10
		Thickest layer	0.00	Thickest layer	0.10
Galisteo, moderately saline, sodic	40	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
142:					
Grieta	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.10
143:					
Clovis	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
145:					
Grieta	55	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.06
		Thickest layer	0.00	Thickest layer	0.06
Sheppard	40	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.06
		Thickest layer	0.00	Thickest layer	0.06
146:					
Sedmar	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.10
150:					
Doakum	55	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Betonnie	35	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.03
162:					
Hackroy	45	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Nyjack	40	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.03

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
163:					
Jemez	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
170:					
San Mateo	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
180:					
Councelor	40	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
Eslendo	30	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Mespun	25	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.02
		Thickest layer	0.00	Bottom layer	0.07
183:					
Sheppard	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.06
		Thickest layer	0.00	Thickest layer	0.06
185:					
Frijoles	90	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.04
		Thickest layer	0.00	Bottom layer	0.04
190:					
Zia	35	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.03
Skyvillage	25	Poor		Poor	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.00
Rock outcrop	15	Not rated		Not rated	
191:					
Sheppard	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.06
		Thickest layer	0.00	Thickest layer	0.06
200:					
Sedillo	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.06
201:					
Rock outcrop	55	Not rated		Not rated	
Sedgran	35	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.12

: 07237

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
206:					
Pinitos	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
207:					
Penistaja	60	Poor		Poor	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.00
Zia	25	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
208:					
Sedillo	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
210:					
Ildefonso	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
211:					
Zia	45	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.03
Clovis	30	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.01
213:					
Pinavetes	55	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.79
		Thickest layer	0.00	Thickest layer	0.79
Rock outcrop	30	Not rated		Not rated	
215:					
Ess	60	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Rock outcrop	30	Not rated		Not rated	
217:					
Witt	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
218:					
Ildefonso	85	Poor		Poor	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.00
220:					
Rock outcrop	40	Not rated		Not rated	

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Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
220:					
Vessilla	30	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
Menefee	20	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
226:					
Galisteo, moderately saline, sodic	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
227:					
Hagerman	65	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Bond	20	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
228:					
Winona	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
230:					
Skyvillage	35	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
Sandoval	25	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Rock outcrop	20	Not rated		Not rated	
231:					
Querencia	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
234:					
Querencia	60	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Zia	20	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.03
235:					
Sandoval	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00

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Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
236:					
Sparank, moderately saline, sodic------	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
237:					
Sparank----------	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
240:					
Penistaja----------	45	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Hagerman----------	35	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
250:					
Pinavetes----------	90	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.06
		Thickest layer	0.00	Bottom layer	0.07
262:					
Pastura----------	90	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
270:					
Blancot----------	40	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
Councelor----------	30	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.04
Tsosie----------	25	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
281:					
Carjo----------	90	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
282:					
Tocal----------	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
283:					
Mirand----------	45	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
283:					
Alanos	30	Fair		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.50	Thickest layer	0.00
290:					
Alanos	50	Fair		Poor	
		Thickest layer	0.00	Bottom layer	0.00
		Bottom layer	0.12	Thickest layer	0.00
Rock outcrop	30	Not rated		Not rated	
300:					
Waumac	50	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Bamac	35	Poor		Fair	
		Thickest layer	0.00	Thickest layer	0.10
		Bottom layer	0.00	Bottom layer	0.10
301:					
Vastine	45	Fair		Fair	
		Thickest layer	0.00	Thickest layer	0.00
		Bottom layer	0.38	Bottom layer	0.10
Jarola	40	Fair		Fair	
		Thickest layer	0.00	Thickest layer	0.00
		Bottom layer	0.05	Bottom layer	0.03
302:					
Tranquilar	50	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Jarmillo	30	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
304:					
Cosey	45	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Jarmillo	40	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
307:					
Flugle	60	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.02
Waumac	25	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.10

: 07241

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
308:					
Cajete	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.03
		Thickest layer	0.00	Bottom layer	0.79
311:					
Cosey	35	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Tranquilar	30	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Calaveras	25	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.10
312:					
Royosa	90	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.07
		Thickest layer	0.00	Thickest layer	0.79
314:					
Fragua	40	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.03
		Thickest layer	0.00	Bottom layer	0.04
Waumac	30	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.06
Royosa	25	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.31
		Thickest layer	0.00	Thickest layer	0.31
317:					
Elpedro	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
319:					
Bamac	60	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.12
		Thickest layer	0.00	Thickest layer	0.12
Rock outcrop	25	Not rated		Not rated	
320:					
Sparham	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
321:					
Waumac	60	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.06

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
321:					
Royosa	30	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.31
		Thickest layer	0.00	Thickest layer	0.31
322:					
Fragua	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.06
		Thickest layer	0.00	Thickest layer	0.06
324:					
Rock outcrop	30	Not rated		Not rated	
Atarque	25	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Menefee	25	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
325:					
Rock outcrop	35	Not rated		Not rated	
Espiritu	25	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Vessilla	25	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
342:					
Waumac	35	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.06
Vessilla	25	Poor		Poor	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.00
Rock outcrop	20	Not rated		Not rated	
345:					
Espiritu	50	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.04
Bamac	35	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.10
		Thickest layer	0.00	Bottom layer	0.10
346:					
Espiritu, cobbly	70	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.10
Bamac	20	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.10
		Thickest layer	0.00	Thickest layer	0.12

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Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
348:					
Wauquie	60	Fair		Fair	
		Bottom layer	0.00	Thickest layer	0.03
		Thickest layer	0.25	Bottom layer	0.10
Rock outcrop	20	Not rated		Not rated	
353:					
Cochiti	50	Fair		Fair	
		Thickest layer	0.00	Thickest layer	0.00
		Bottom layer	0.25	Bottom layer	0.10
Espiritu	45	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.10
354:					
Waumac Variant	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
358:					
Deama	35	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Elpedro	25	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Rock outcrop	25	Not rated		Not rated	
396:					
Atarque	30	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Menefee	30	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Rock outcrop	25	Not rated		Not rated	
397:					
Rock outcrop	30	Not rated		Not rated	
Cucho	25	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Vessilla	25	Poor		Poor	
		Thickest layer	0.00	Thickest layer	0.00
		Bottom layer	0.00	Bottom layer	0.00
398:					
Espiritu	45	Poor		Fair	
		Thickest layer	0.00	Thickest layer	0.00
		Bottom layer	0.00	Bottom layer	0.04

: 07244

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
398:					
Cucho	35	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
399:					
Cucho	45	Poor		Poor	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.00
Teco	35	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
405:					
Charo	50	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Charo, noncobbly	40	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
409:					
Santa Fe	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
410:					
Zia	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.03
414:					
Wauquie	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.04
417:					
Jocity	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.10
418:					
Jocity	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.02
419:					
Santa Fe	40	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Wauquie	30	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.03
		Thickest layer	0.00	Bottom layer	0.29
Rock outcrop	20	Not rated		Not rated	

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
420:					
Pinavetes	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.10
		Thickest layer	0.00	Bottom layer	0.79
421:					
Gilco, moderately saline, sodic	90	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.01
422:					
Vessilla	35	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.03
Menefee	30	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Orlie	25	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
423:					
Gilco	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
426:					
Aga, moderately saline, sodic	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.07
		Thickest layer	0.00	Bottom layer	0.79
427:					
Aga	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.02
428:					
Aga, moderately saline, sodic	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.07
430:					
Trail	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.10
431:					
Trail	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.10
433:					
Peralta	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.01

: 07246

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
434:					
Peralta	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.06
		Thickest layer	0.00	Thickest layer	0.10
437:					
Peralta, moderately saline, sodic	85	Poor		Poor	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.00
500:					
Rock outcrop	40	Not rated		Not rated	
Osha	30	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.14
		Thickest layer	0.00	Thickest layer	0.14
Rubble land	20	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
503:					
Cajete	65	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.05
Cypher	25	Poor		Fair	
		Thickest layer	0.00	Thickest layer	0.00
		Bottom layer	0.00	Bottom layer	0.03
504:					
Orejas	40	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Guaje	35	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.03
		Thickest layer	0.00	Thickest layer	0.03
600:					
Rock outcrop	50	Not rated		Not rated	
Cypher	35	Poor		Poor	
		Thickest layer	0.00	Bottom layer	0.00
		Bottom layer	0.00	Thickest layer	0.00
601:					
Laventana	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
603:					
Laventana	50	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Mirand	35	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00

: 07247

Table 12A.--Source of gravel and sand--continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
604:					
Cypher	55	Poor		Fair	
		Thickest layer	0.00	Thickest layer	0.00
		Bottom layer	0.00	Bottom layer	0.03
Mirand	30	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
608:					
Osha, steep	60	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.06
		Thickest layer	0.00	Bottom layer	0.10
Osha	30	Fair		Fair	
		Thickest layer	0.25	Thickest layer	0.06
		Bottom layer	0.25	Bottom layer	0.13
823:					
Gilco, unprotected	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
827:					
Aga, unprotected	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.06
830:					
Trail, unprotected	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.02
831:					
Trail, unprotected	85	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.10
		Thickest layer	0.00	Bottom layer	0.79
835:					
Peralta, unprotected	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
842:					
Peralta, moderately saline, sodic, unprotected	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
850:					
Water	95	Not rated		Not rated	
DAM:					
Dam	100	Not rated		Not rated	

: 07248

Table 12B.--Source of reclamation material, roadfill, and topsoil

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.00 to 0.99. The smaller the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
1:							
Silver	55	Fair		Poor		Fair	
		Organic matter content low	0.02	Low strength	0.00	Too clayey	0.57
		Too clayey	0.98	Shrink-swell	0.87		
		Water erosion	0.99				
Clovis	35	Fair		Fair		Good	
		Organic matter content low	0.08	Shrink-swell	0.99		
		Carbonate content	0.97				
		Water erosion	0.99				
2:							
Clovis	35	Fair		Good		Fair	
		Organic matter content low	0.02			Too clayey	0.61
		Carbonate content	0.97				
		Too clayey	0.98				
		Water erosion	0.99				
Prieta	35	Poor		Poor		Poor	
		Stone content	0.00	Depth to bedrock	0.00	Rock fragments	0.00
		Droughty	0.00	Stone content	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Shrink-swell	0.87	Too clayey	0.64
		Organic matter content low	0.50			Slope	0.96
		Too clayey	0.98				
Silver	20	Fair		Poor		Fair	
		Organic matter content low	0.08	Low strength	0.00	Too clayey	0.64
		Too clayey	0.98	Shrink-swell	0.87		
		Water erosion	0.99				

612.29

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
3:							
Montecito----------	60	Fair		Poor		Fair	
		Organic matter content low	0.02	Low strength	0.00	Too clayey	0.52
		Too clayey	0.98	Shrink-swell	0.87		
Orejas----------	30	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Rock fragments	0.00
		Depth to bedrock	0.00	Shrink-swell	0.87	Depth to bedrock	0.00
		Organic matter content low	0.32	Cobble content	0.92	Too clayey	0.61
		Cobble content	0.33				
		Too clayey	0.98				
4:							
Montecito----------	45	Fair		Fair		Poor	
		Organic matter content low	0.02	Shrink-swell	0.87	Slope	0.00
		Too clayey	0.98	Slope	0.92	Too clayey	0.57
		Water erosion	0.99			Rock fragments	0.99
Montecito, bouldery-	35	Fair		Poor		Poor	
		Organic matter content low	0.50	Low strength	0.00	Slope	0.00
		Too clayey	0.98	Slope	0.92	Too clayey	0.64
		Water erosion	0.99	Shrink-swell	0.98	Rock fragments	0.95
10:							
Trail----------	85	Poor		Good		Good	
		Too alkaline	0.00				
		Organic matter content low	0.50				
		Droughty	0.79				
		Water erosion	0.99				
11:							
Trail----------	85	Poor		Good		Fair	
		Too alkaline	0.00			Too sandy	0.14
		Too sandy	0.14				
		Organic matter content low	0.50				

87250

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
13:							
Sandoval----------	65	Poor		Poor		Poor	
		Depth to bedrock	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Droughty	0.00	Low strength	0.00	Too clayey	0.52
		Organic matter content low	0.02	Shrink-swell	0.87		
		Too clayey	0.98				
Querencia----------	20	Fair		Fair		Good	
		Organic matter content low	0.05	Shrink-swell	0.87		
		Water erosion	0.99				
15:							
Camino----------	40	Poor		Poor		Poor	
		Too clayey	0.00	Low strength	0.00	Too clayey	0.00
		Organic matter content low	0.02	Shrink-swell	0.12		
		Water erosion	0.99	Depth to bedrock	0.68		
Sandoval----------	35	Poor		Poor		Poor	
		Depth to bedrock	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Too alkaline	0.00	Low strength	0.00	Sodium content	0.10
		Droughty	0.02	Shrink-swell	0.87	Too clayey	0.64
		Sodium content	0.10				
		Organic matter content low	0.50				
		Too clayey	0.98				
16:							
Rock outcrop--------	50	Not rated		Not rated		Not rated	
Prieta----------	30	Poor		Poor		Poor	
		Stone content	0.00	Depth to bedrock	0.00	Rock fragments	0.00
		Droughty	0.00	Stone content	0.02	Depth to bedrock	0.00
		Depth to bedrock	0.00	Shrink-swell	0.87	Too clayey	0.64
		Organic matter content low	0.50			Slope	0.96
		Too clayey	0.98				

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
17:							
Vessilla	35	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00			Slope	0.96
		Organic matter content low	0.12				
Menefee	25	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00			Too clayey	0.64
		Organic matter content low	0.50			Slope	0.96
		Too clayey	0.98				
Rock outcrop	20	Not rated		Not rated		Not rated	
18:							
Sparham	85	Fair		Poor		Fair	
		Too clayey	0.08	Low strength	0.00	Too clayey	0.06
		Organic matter content low	0.24	Shrink-swell	0.87	Sodium content	0.60
		Sodium content	0.60				
		Salinity	0.97				
		Water erosion	0.99				
20:							
Gilco	85	Fair		Good		Fair	
		Organic matter content low	0.08			Rock fragments	0.98
		Water erosion	0.99				
21:							
Rock outcrop	60	Not rated		Not rated		Not rated	
Hackroy	25	Poor		Poor		Poor	
		Too clayey	0.00	Depth to bedrock	0.00	Too clayey	0.00
		Droughty	0.00	Low strength	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Shrink-swell	0.12		
		Organic matter content low	0.08				

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
22:							
Aga	85	Fair		Good		Good	
		Organic matter content low	0.08				
		Water erosion	0.99				
23:							
Hickman	85	Fair		Poor		Fair	
		Organic matter content low	0.50	Low strength	0.00	Too clayey	0.64
		Too clayey	0.98	Shrink-swell	0.87		
24:							
Orlie	45	Fair		Fair		Fair	
		Organic matter content low	0.08	Shrink-swell	0.87	Too clayey	0.72
		Too clayey	0.98			Rock fragments	0.99
Sparham	35	Poor		Poor		Poor	
		Too clayey	0.00	Low strength	0.00	Too clayey	0.00
		Sodium content	0.00	Shrink-swell	0.12	Sodium content	0.00
		Organic matter content low	0.50			Salinity	0.00
		Salinity	0.88				
25:							
Gilco	85	Fair		Good		Good	
		Organic matter content low	0.32				
		Water erosion	0.99				
26:							
Orlie	85	Fair		Poor		Fair	
		Organic matter content low	0.18	Low strength	0.00	Too clayey	0.64
		Too clayey	0.98	Shrink-swell	0.87		
		Water erosion	0.99				

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
27:							
Aga	85	Poor		Good		Poor	
		Too sandy	0.00			Too sandy	0.00
		Organic matter content low	0.08				
		Droughty	0.81				
		Water erosion	0.99				
29:							
Trail	85	Poor		Good		Good	
		Wind erosion	0.00				
		Too alkaline	0.00				
		Organic matter content low	0.08				
		Droughty	0.35				
31:							
Riverwash	90	Poor		Good		Poor	
		Too sandy	0.00			Too sandy	0.00
		Droughty	0.00			Rock fragments	0.32
		Organic matter content low	0.12				
33:							
Pits	100	Not rated		Not rated		Not rated	
34:							
Ildefonso	55	Fair		Poor		Poor	
		Cobble content	0.08	Cobble content	0.00	Hard to reclaim (rock fragments)	0.00
		Organic matter content low	0.08			Rock fragments	0.00
		Droughty	0.83			Carbonate content	0.98
		Carbonate content	0.97				
Witt	30	Fair		Fair		Good	
		Organic matter content low	0.08	Shrink-swell	0.87		
		Water erosion	0.37				

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
41:							
Dune land----------	100	Poor		Good		Poor	
		Too sandy	0.00			Too sandy	0.00
		Wind erosion	0.00			Slope	0.84
		Droughty	0.00				
		Organic matter content low	0.00				
47:							
Cascajo----------	85	Poor		Fair		Poor	
		Droughty	0.00	Slope	0.32	Hard to reclaim (rock fragments)	0.00
		Organic matter content low	0.00	Cobble content	0.94	Rock fragments	0.00
		Too sandy	0.01			Slope	0.00
		Cobble content	0.94			Too sandy	0.01
51:							
Sparham----------	85	Poor		Poor		Poor	
		Too clayey	0.00	Wetness depth	0.00	Too clayey	0.00
		Organic matter content low	0.08	Low strength	0.00	Wetness depth	0.00
		Salinity	0.88	Shrink-swell	0.66	Sodium content	0.00
						Salinity	0.00
52:							
Totavi----------	85	Poor		Good		Fair	
		Wind erosion	0.00			Too sandy	0.01
		Too sandy	0.01				
		Organic matter content low	0.08				
		Droughty	0.35				
53:							
Witt----------	55	Fair		Fair		Good	
		Organic matter content low	0.08	Shrink-swell	0.87		
		Water erosion	0.90				

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
53:							
Harvey	30	Fair		Poor		Fair	
		Organic matter content low	0.68	Low strength	0.00	Too clayey	0.67
		Carbonate content	0.97	Shrink-swell	0.99		
		Too clayey	0.98				
		Water erosion	0.99				
54:							
Harvey	45	Fair		Fair		Fair	
		Organic matter content low	0.05	Shrink-swell	0.89	Slope	0.84
		Carbonate content	0.97				
Cascajo	40	Poor		Good		Poor	
		Too sandy	0.00			Too sandy	0.00
		Droughty	0.00			Rock fragments	0.00
		Organic matter content low	0.02			Hard to reclaim (rock fragments)	0.00
		Carbonate content	0.97			Slope	0.84
						Carbonate content	0.99
55:							
La Fonda	85	Fair		Fair		Good	
		Organic matter content low	0.08	Shrink-swell	0.87		
		Water erosion	0.99				
56:							
Ildefonso	85	Fair		Poor		Poor	
		Organic matter content low	0.08	Slope	0.00	Slope	0.00
		Cobble content	0.52	Cobble content	0.02	Hard to reclaim (rock fragments)	0.00
		Carbonate content	0.97	Shrink-swell	0.87	Rock fragments	0.00
		Droughty	0.99			Carbonate content	0.99
		Stone content	0.99				
57:							
Badland	90	Not rated		Not rated		Not rated	

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
58:							
Deama	45	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Slope	0.00
		Carbonate content	0.00	Slope	0.08	Depth to bedrock	0.00
		Depth to bedrock	0.00	Shrink-swell	0.87	Rock fragments	0.00
		Stone content	0.05			Carbonate content	0.08
Elpedro	35	Poor		Fair		Fair	
		Organic matter content low	0.00	Shrink-swell	0.98	Too clayey	0.52
		Water erosion	0.90			Slope	0.96
		Too clayey	0.98				
59:							
Harvey	35	Fair		Poor		Fair	
		Organic matter content low	0.08	Low strength	0.00	Too clayey	0.55
		Carbonate content	0.97	Shrink-swell	0.87	No carbonate limitation	0.99
		Too clayey	0.98				
		Water erosion	0.99				
Ildefonso	35	Poor		Fair		Poor	
		Droughty	0.00	Cobble content	0.29	Hard to reclaim (rock fragments)	0.00
		Organic matter content low	0.02			Rock fragments	0.00
		Cobble content	0.44			Slope	0.63
		Carbonate content	0.97				
La Fonda	15	Fair		Fair		Good	
		Organic matter content low	0.08	Shrink-swell	0.87		
		Water erosion	0.99				
63:							
Placitas	85	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Rock fragments	0.00
		Organic matter content low	0.08	Slope	0.02	Slope	0.00
		Depth to bedrock	0.29			Depth to bedrock	0.29
		Carbonate content	0.80			Carbonate content	0.99

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
64:							
Skyvillage----------	40	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Slope	0.92	Slope	0.00
		Organic matter content low	0.50				
Ildefonso----------	35	Fair		Fair		Poor	
		Organic matter content low	0.08	Slope	0.02	Rock fragments	0.00
		Droughty	0.12			Hard to reclaim (rock fragments)	0.00
		Carbonate content	0.97			Slope	0.00
65:							
Ildefonso----------	50	Fair		Fair		Poor	
		Droughty	0.09	Slope	0.08	Rock fragments	0.00
		Organic matter content low	0.50			Hard to reclaim (rock fragments)	0.00
		Carbonate content	0.97			Slope	0.00
Harvey----------	30	Fair		Fair		Fair	
		Organic matter content low	0.08			Slope	0.16
		Carbonate content	0.97			Carbonate content	0.99
		Water erosion	0.99				
66:							
Zia----------	85	Fair		Good		Good	
		Organic matter content low	0.08				
67:							
Sandoval----------	40	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Low strength	0.00	Slope	0.00
		Too alkaline	0.00	Shrink-swell	0.87	Too clayey	0.64
		Organic matter content low	0.50	Slope	0.92		
		Too clayey	0.98				
		Water erosion	0.99				

07259

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
66:							
Poley	35	Fair		Fair		Poor	
		Organic matter content low	0.02	Shrink-swell	0.99	Hard to reclaim (rock fragments)	0.00
		Too clayey	0.98			Slope	0.00
						Too clayey	0.55
						Rock fragments	0.98
68:							
Penistaja	45	Poor		Fair		Good	
		Wind erosion	0.00	Shrink-swell	0.87		
		Organic matter content low	0.02				
Querencia	35	Fair		Fair		Good	
		Organic matter content low	0.50	Shrink-swell	0.99		
71:							
Palon	85	Poor		Poor		Poor	
		Droughty	0.00	Slope	0.00	Slope	0.00
		Organic matter content low	0.08	Cobble content	0.39	Hard to reclaim (rock fragments)	0.00
		Cobble content	0.98			Rock fragments	0.00
72:							
Palon	85	Poor		Poor		Poor	
		Stone content	0.00	Slope	0.00	Slope	0.00
		Droughty	0.02	Stone content	0.00	Rock fragments	0.00
		Organic matter content low	0.50	Cobble content	0.00	Hard to reclaim (rock fragments)	0.00
		Cobble content	0.52				
		Too acid	0.74				
74:							
Origo	50	Poor		Poor		Poor	
		Droughty	0.00	Slope	0.00	Slope	0.00
		Organic matter content low	0.08	Cobble content	0.00	Hard to reclaim (rock fragments)	0.00
		Too acid	0.50			Rock fragments	0.00
		Cobble content	0.73				
		Stone content	0.99				

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
74:							
Pavo	25	Fair		Good		Fair	
		Organic matter content low	0.50			Slope	0.16
		Too acid	0.99				
		Water erosion	0.99				
75:							
Origo	85	Fair		Poor		Poor	
		Too acid	0.16	Slope	0.00	Slope	0.00
		Droughty	0.18	Cobble content	0.00	Hard to reclaim (rock fragments)	0.00
		Organic matter content low	0.18	Stone content	0.56	Rock fragments	0.00
		Cobble content	0.37				
		Stone content	0.54				
82:							
Calaveras	85	Fair		Poor		Poor	
		Droughty	0.06	Slope	0.00	Slope	0.00
		Organic matter content low	0.18	Cobble content	0.99	Hard to reclaim (rock fragments)	0.00
		Water erosion	0.99			Rock fragments	0.00
		Cobble content	0.99				
83:							
Calaveras	60	Fair		Poor		Poor	
		Organic matter content low	0.02	Slope	0.00	Slope	0.00
		Droughty	0.07	Cobble content	0.61	Hard to reclaim (rock fragments)	0.00
		Cobble content	0.88			Rock fragments	0.00
		Water erosion	0.99				
Rubble land	20	Not rated		Poor		Not rated	
				Slope	0.00		
				Stone content	0.00		
				Cobble content	0.13		

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Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
85:							
Redondo	85	Fair		Poor		Poor	
		Organic matter content low	0.05	Slope	0.00	Slope	0.00
		Droughty	0.39			Hard to reclaim (rock fragments)	0.00
		Too acid	0.84			Rock fragments	0.00
86:							
Redondo	85	Poor		Poor		Poor	
		Droughty	0.00	Slope	0.00	Slope	0.00
		Organic matter content low	0.05	Cobble content	0.00	Hard to reclaim (rock fragments)	0.00
		Cobble content	0.14			Rock fragments	0.00
		Too acid	0.84				
87:							
Redondo	50	Fair		Poor		Poor	
		Droughty	0.05	Slope	0.00	Hard to reclaim (rock fragments)	0.00
		Organic matter content low	0.50	Cobble content	0.66	Rock fragments	0.00
		Too acid	0.84			Slope	0.00
Rubble land	25	Not rated		Poor		Not rated	
				Slope	0.00		
				Stone content	0.00		
				Cobble content	0.50		
88:							
Totavi	45	Fair		Good		Fair	
		Too sandy	0.01			Too sandy	0.01
		Organic matter content low	0.08				
		Droughty	0.71				
Jemez	30	Fair		Poor		Fair	
		Organic matter content low	0.02	Depth to bedrock	0.00	Depth to bedrock	0.29
		Depth to bedrock	0.29	Shrink-swell	0.87	Slope	0.84
		Droughty	0.63				
		Water erosion	0.99				

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
88:							
Rock outcrop--------	15	Not rated		Not rated		Not rated	
91:							
Zia-----------------	85	Fair		Good		Good	
		Organic matter content low	0.08				
92:							
Galisteo, moderately saline, sodic------	85	Poor		Poor		Poor	
		Too clayey	0.00	Low strength	0.00	Too clayey	0.00
		Too alkaline	0.00	Shrink-swell	0.15	Salinity	0.00
		Organic matter content low	0.12			Sodium content	0.22
		Sodium content	0.22				
		Salinity	0.50				
		Water erosion	0.99				
93:							
Zia-----------------	85	Poor		Good		Good	
		Wind erosion	0.00				
		Organic matter content low	0.08				
95:							
El Rancho-----------	85	Fair		Fair		Good	
		Organic matter content low	0.02	Shrink-swell	0.99		
		Water erosion	0.99				
97:							
El Rancho-----------	85	Fair		Fair		Good	
		Organic matter content low	0.08	Shrink-swell	0.87		

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
100:							
Orejas	40	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Slope	0.00
		Depth to bedrock	0.00	Slope	0.00	Rock fragments	0.00
		Organic matter content low	0.32	Shrink-swell	0.87	Depth to bedrock	0.00
		Stone content	0.38			Too clayey	0.61
		Cobble content	0.96				
		Too clayey	0.98				
Rock outcrop	40	Not rated		Not rated		Not rated	
101:							
Blancot	55	Poor		Good		Good	
		Too alkaline	0.00				
		Organic matter content low	0.02				
Lybrook	25	Poor		Poor		Fair	
		Too alkaline	0.00	Low strength	0.00	Sodium content	0.22
		Organic matter content low	0.02	Shrink-swell	0.87	Too clayey	0.60
		Salinity	0.03				
		Sodium content	0.22				
		Too clayey	0.98				
		Water erosion	0.99				
102:							
Sparham	85	Poor		Poor		Poor	
		Sodium content	0.00	Low strength	0.00	Sodium content	0.00
		Organic matter content low	0.08	Shrink-swell	0.87	Salinity	0.00
		Salinity	0.88			Too clayey	0.64
		Too clayey	0.98				
		Water erosion	0.99				
104:							
Cochiti	50	Fair		Fair		Poor	
		Organic matter content low	0.02	Slope	0.92	Rock fragments	0.00
		Droughty	0.74	Shrink-swell	0.96	Hard to reclaim (rock fragments)	0.00
		Too acid	0.99			Slope	0.00

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Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
104:							
Montecito----------	30	Fair		Good		Good	
		Organic matter content low	0.02				
		Water erosion	0.99				
105:							
Badland----------	50	Not rated		Not rated		Not rated	
Menefee----------	30	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Slope	0.00
		Depth to bedrock	0.00	Slope	0.00	Depth to bedrock	0.00
		Organic matter content low	0.50			Too clayey	0.64
		Too clayey	0.98				
		Water erosion	0.99				
106:							
Stumble----------	50	Poor		Poor		Poor	
		Too sandy	0.00	Slope	0.00	Too sandy	0.00
		Droughty	0.00			Slope	0.00
		Organic matter content low	0.02			Rock fragments	0.50
Stumble, sandy------	30	Poor		Good		Poor	
		Too sandy	0.00			Too sandy	0.00
		Wind erosion	0.00			Rock fragments	0.02
		Droughty	0.00			Hard to reclaim (rock fragments)	0.97
		Organic matter content low	0.08				
108:							
Embudo----------	85	Fair		Good		Fair	
		Organic matter content low	0.02			Rock fragments	0.98
		Droughty	0.96				

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Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
109:							
Embudo	50	Fair		Good		Fair	
		Organic matter content low	0.02			Rock fragments	0.50
		Droughty	0.16			Hard to reclaim (rock fragments)	0.92
Tijeras	35	Fair		Good		Poor	
		Organic matter content low	0.02			Rock fragments	0.00
		Droughty	0.63			Hard to reclaim (rock fragments)	0.00
110:							
Rock outcrop	45	Not rated		Not rated		Not rated	
Saido	40	Fair		Fair		Poor	
		Organic matter content low	0.02	Slope	0.08	Slope	0.00
		Water erosion	0.90	Shrink-swell	0.87	Salinity	0.88
111:							
Rock outcrop	50	Not rated		Not rated		Not rated	
Zia	35	Fair		Fair		Poor	
		Organic matter content low	0.08	Slope	0.92	Slope	0.00
112:							
Tijeras	85	Fair		Good		Poor	
		Organic matter content low	0.05			Rock fragments	0.00
						Hard to reclaim (rock fragments)	0.92
114:							
San Mateo	40	Poor		Fair		Poor	
		Too alkaline	0.00	Shrink-swell	0.87	Salinity	0.00
		Salinity	0.03				
		Organic matter content low	0.08				

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Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
114:							
Zia	40	Fair		Good		Good	
		Organic matter content low	0.08				
120:							
Pinavetes	85	Poor		Good		Poor	
		Too sandy	0.00			Too sandy	0.00
		Wind erosion	0.00				
		Droughty	0.00				
		Too alkaline	0.00				
		Organic matter content low	0.50				
124:							
Rock outcrop	90	Not rated		Not rated		Not rated	
129:							
Menefee	85	Poor		Poor		Poor	
		Depth to bedrock	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Droughty	0.04	Low strength	0.00	Slope	0.00
		Organic matter content low	0.12	Slope	0.50	Too clayey	0.57
		Too clayey	0.98	Shrink-swell	0.87		
130:							
Pinavetes	45	Poor		Good		Fair	
		Wind erosion	0.00			Too sandy	0.01
		Too alkaline	0.00				
		Too sandy	0.01				
		Organic matter content low	0.08				
		Droughty	0.35				
Galisteo, moderately saline, sodic	40	Poor		Poor		Poor	
		Too clayey	0.00	Low strength	0.00	Too clayey	0.00
		Sodium content	0.00	Shrink-swell	0.12	Sodium content	0.00
		Too alkaline	0.00			Salinity	0.00
		Organic matter content low	0.08				
		Salinity	0.50				

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Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
142:							
Grieta	85	Fair		Fair		Fair	
		Organic matter content low	0.08	Shrink-swell	0.97	Carbonate content	0.99
		Carbonate content	0.97				
143:							
Clovis	85	Fair		Fair		Fair	
		Organic matter content low	0.01	Shrink-swell	0.87	Carbonate content	0.85
		Carbonate content	0.80				
145:							
Grieta	55	Poor		Good		Good	
		Wind erosion	0.00				
		Organic matter content low	0.08				
Sheppard	40	Poor		Good		Fair	
		Wind erosion	0.00			Too sandy	0.02
		Too sandy	0.02				
		Organic matter content low	0.02				
		Droughty	0.94				
146:							
Sedmar	85	Poor		Poor		Poor	
		Wind erosion	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Droughty	0.00				
		Depth to bedrock	0.00				
		Organic matter content low	0.50				
150:							
Doakum	55	Poor		Fair		Fair	
		Organic matter content low	0.00	Shrink-swell	0.87	Salinity	0.50
		Too alkaline	0.00				
		Water erosion	0.99				

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
150:							
Betonnie	35	Poor		Good		Good	
		Organic matter content low	0.00				
		Too alkaline	0.00				
162:							
Hackroy	45	Poor		Poor		Poor	
		Too clayey	0.00	Depth to bedrock	0.00	Too clayey	0.00
		Droughty	0.00	Low strength	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Shrink-swell	0.12		
		Organic matter content low	0.08				
Nyjack	40	Fair		Poor		Fair	
		Organic matter content low	0.08	Depth to bedrock	0.00	Rock fragments	0.12
		Too acid	0.99			Depth to bedrock	0.99
		Water erosion	0.99				
		Depth to bedrock	0.99				
163:							
Jemez	85	Fair		Poor		Fair	
		Organic matter content low	0.32	Depth to bedrock	0.00	Too clayey	0.61
		Too clayey	0.98	Shrink-swell	0.87	Depth to bedrock	0.99
		Water erosion	0.99				
		Depth to bedrock	0.99				
170:							
San Mateo	85	Poor		Poor		Fair	
		Too alkaline	0.00	Low strength	0.00	Too clayey	0.60
		Organic matter content low	0.05	Shrink-swell	0.87		
		Too clayey	0.98				
		Water erosion	0.99				
180:							
Councelor	40	Fair		Fair		Poor	
		Organic matter content low	0.02	Slope	0.82	Slope	0.00

6527.9

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
180:							
Eslendo	30	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Slope	0.82	Slope	0.00
		Organic matter content low	0.08			Too clayey	0.55
		Too clayey	0.98				
Mespun	25	Poor		Fair		Poor	
		Wind erosion	0.00	Slope	0.82	Slope	0.00
		Organic matter content low	0.12			Too sandy	0.38
		Too sandy	0.38				
		Droughty	0.74				
183:							
Sheppard	85	Poor		Good		Fair	
		Wind erosion	0.00			Too sandy	0.02
		Too sandy	0.02			Slope	0.37
		Organic matter content low	0.05				
		Droughty	0.94				
185:							
Frijoles	90	Poor		Good		Poor	
		Droughty	0.00			Hard to reclaim (rock fragments)	0.00
		Organic matter content low	0.01			Rock fragments	0.00
		Water erosion	0.37				
190:							
Zia	35	Fair		Good		Fair	
		Organic matter content low	0.08			Slope	0.16
Skyvillage	25	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Slope	0.08	Slope	0.00
		Organic matter content low	0.50				
Rock outcrop	15	Not rated		Not rated		Not rated	

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
191:							
Sheppard	85	Poor		Good		Fair	
		Wind erosion	0.00			Too sandy	0.02
		Too sandy	0.02				
		Organic matter content low	0.02				
		Droughty	0.94				
200:							
Sedillo	85	Poor		Good		Poor	
		Droughty	0.00			Hard to reclaim (rock fragments)	0.00
		Organic matter content low	0.12			Rock fragments	0.00
		Carbonate content	0.80			Slope	0.00
						Carbonate content	0.98
201:							
Rock outcrop	55	Not rated		Not rated		Not rated	
Sedgran	35	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Slope	0.00
		Depth to bedrock	0.00	Slope	0.00	Rock fragments	0.00
		Too sandy	0.06			Depth to bedrock	0.00
		Organic matter content low	0.08			Too sandy	0.06
206:							
Pinitos	85	Fair		Poor		Fair	
		Organic matter content low	0.02	Low strength	0.00	Too clayey	0.61
		Too clayey	0.98	Shrink-swell	0.87		
		Water erosion	0.99				
207:							
Penistaja	60	Fair		Good		Good	
		Organic matter content low	0.08				
		Water erosion	0.37				
Zia	25	Fair		Good		Good	
		Organic matter content low	0.08				

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
208:							
Sedillo	85	Fair		Poor		Poor	
		Organic matter content low	0.08	Slope	0.00	Slope	0.00
		Droughty	0.12			Hard to reclaim (rock fragments)	0.00
		Carbonate content	0.80			Rock fragments	0.00
						Carbonate content	0.93
210:							
Ildefonso	85	Poor		Poor		Poor	
		Stone content	0.00	Slope	0.00	Slope	0.00
		Organic matter content low	0.08	Stone content	0.00	Rock fragments	0.00
		Droughty	0.71	Shrink-swell	0.87	Hard to reclaim (rock fragments)	0.00
		Carbonate content	0.97			Carbonate content	0.99
211:							
Zia	45	Fair		Good		Good	
		Organic matter content low	0.24				
Clovis	30	Fair		Fair		Fair	
		Organic matter content low	0.08	Shrink-swell	0.87	Carbonate content	0.88
		Carbonate content	0.80				
213:							
Pinavetes	55	Poor		Poor		Poor	
		Too sandy	0.00	Slope	0.00	Slope	0.00
		Wind erosion	0.00			Too sandy	0.00
		Droughty	0.00				
		Too alkaline	0.00				
		Organic matter content low	0.08				
Rock outcrop	30	Not rated		Not rated		Not rated	

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
215:							
Ess	60	Fair		Poor		Poor	
		Organic matter content low	0.40	Slope	0.00	Rock fragments	0.00
		Droughty	0.64	Cobble content	0.23	Hard to reclaim (rock fragments)	0.00
		Stone content	0.97	Stone content	0.94	Slope	0.00
		No cobble limitation	0.99				
Rock outcrop	30	Not rated		Not rated		Not rated	
217:							
Witt	85	Fair		Good		Good	
		Organic matter content low	0.08				
		Water erosion	0.37				
218:							
Ildefonso	85	Fair		Poor		Poor	
		Organic matter content low	0.08	Cobble content	0.00	Hard to reclaim (rock fragments)	0.00
		Droughty	0.17			Rock fragments	0.00
		Cobble content	0.66			Carbonate content	0.99
		Carbonate content	0.97				
220:							
Rock outcrop	40	Not rated		Not rated		Not rated	
Vessilla	30	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Slope	0.00
		Depth to bedrock	0.00	Slope	0.00	Depth to bedrock	0.00
		Organic matter content low	0.12				
Menefee	20	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Slope	0.00
		Depth to bedrock	0.00	Slope	0.00	Depth to bedrock	0.00
		Organic matter content low	0.50			Too clayey	0.64
		Too clayey	0.98				

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Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
226:							
Galisteo, moderately saline, sodic------	85	Poor		Poor		Poor	
		Sodium content	0.00	Low strength	0.00	Sodium content	0.00
		Too alkaline	0.00	Shrink-swell	0.87	Salinity	0.00
		Too clayey	0.08			Too clayey	0.05
		Organic matter content low	0.08				
		Salinity	0.50				
		Water erosion	0.99				
227:							
Hagerman----------	65	Fair		Poor		Fair	
		Organic matter content low	0.18	Depth to bedrock	0.00	Too clayey	0.58
		Depth to bedrock	0.84	Low strength	0.00	Depth to bedrock	0.84
		Too clayey	0.98	Shrink-swell	0.87		
Bond----------	20	Poor		Poor		Poor	
		Wind erosion	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Droughty	0.00	Low strength	0.78		
		Depth to bedrock	0.00	Shrink-swell	0.87		
		Organic matter content low	0.82				
228:							
Winona----------	85	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Rock fragments	0.00
		Carbonate content	0.00	Shrink-swell	0.87	Depth to bedrock	0.00
		Depth to bedrock	0.00	Slope	0.92	Slope	0.00
		Organic matter content low	0.50			Carbonate content	0.00
						Salinity	0.50
230:							
Skyvillage----------	35	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00			Slope	0.37

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
230:							
Sandoval	25	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00			Slope	0.37
		Too alkaline	0.00			Too clayey	0.64
		Organic matter content low	0.50				
		Too clayey	0.98				
Rock outcrop	20	Not rated		Not rated		Not rated	
231:							
Querencia	85	Fair		Fair		Good	
		Organic matter content low	0.08	Shrink-swell	0.87		
		Water erosion	0.99				
234:							
Querencia	60	Fair		Good		Good	
		Organic matter content low	0.08				
		Water erosion	0.99				
Zia	20	Fair		Good		Good	
		Organic matter content low	0.08				
235:							
Sandoval	85	Poor		Poor		Poor	
		Depth to bedrock	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Too alkaline	0.00	Low strength	0.00	Sodium content	0.10
		Sodium content	0.10	Shrink-swell	0.87	Too clayey	0.64
		Droughty	0.11			Slope	0.96
		Organic matter content low	0.50				
		Too clayey	0.98				

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
236:							
Sparank, moderately saline, sodic------	85	Poor		Poor		Poor	
		Sodium content	0.00	Low strength	0.00	Sodium content	0.00
		Too alkaline	0.00	Shrink-swell	0.34	Salinity	0.00
		Organic matter content low	0.50			Too clayey	0.64
		Salinity	0.50				
		Too clayey	0.98				
		Water erosion	0.99				
237:							
Sparank----------	85	Fair		Poor		Fair	
		Organic matter content low	0.50	Low strength	0.00	Sodium content	0.60
		Sodium content	0.60	Shrink-swell	0.87	Too clayey	0.64
		Too clayey	0.98				
		Water erosion	0.99				
240:							
Penistaja----------	45	Fair		Good		Good	
		Organic matter content low	0.08				
Hagerman----------	35	Fair		Poor		Fair	
		Organic matter content low	0.02	Depth to bedrock	0.00	Depth to bedrock	0.10
		Depth to bedrock	0.10	Low strength	0.00	Too clayey	0.52
		Droughty	0.66	Shrink-swell	0.87		
		Too clayey	0.98				
250:							
Pinavetes----------	90	Poor		Good		Fair	
		Wind erosion	0.00			Too sandy	0.38
		Too alkaline	0.00			Slope	0.84
		Organic matter content low	0.08				
		Too sandy	0.38				
		Droughty	0.40				

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Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
262:							
Pastura	90	Poor		Poor		Poor	
		Droughty	0.00	Depth to cemented pan	0.00	Depth to cemented pan	0.00
		Depth to cemented pan	0.00	Shrink-swell	0.87	Rock fragments	0.50
		Organic matter content low	0.88				
		Water erosion	0.99				
270:							
Blancot	40	Fair		Good		Fair	
		Organic matter content low	0.01			Sodium content	0.40
		Sodium content	0.40				
Councelor	30	Fair		Good		Good	
		Organic matter content low	0.08				
Tsosie	25	Poor		Fair		Fair	
		Too alkaline	0.00			Salinity	0.50
		Organic matter content low	0.05			Sodium content	0.60
		Sodium content	0.60			Too clayey	0.64
		Too clayey	0.98				
		Water erosion	0.99				
281:							
Carjo	90	Poor		Poor		Poor	
		Too clayey	0.00	Depth to bedrock	0.00	Too clayey	0.00
		Depth to bedrock	0.16	Low strength	0.00	Depth to bedrock	0.16
		Droughty	0.36	Shrink-swell	0.75		
		Water erosion	0.37				
		Organic matter content low	0.50				
282:							
Tocal	85	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Shrink-swell	0.70		
		Water erosion	0.37				

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Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
283:							
Mirand	45	Poor		Poor		Poor	
		Too clayey	0.00	Low strength	0.00	Too clayey	0.00
		Organic matter content low	0.08	Shrink-swell	0.59	Slope	0.00
		Too acid	0.74	Slope	0.82		
Alanos	30	Fair		Fair		Poor	
		Organic matter content low	0.02	Slope	0.08	Rock fragments	0.00
		Droughty	0.68	Shrink-swell	0.41	Slope	0.00
		Too clayey	0.98	Low strength	0.78	Hard to reclaim (rock fragments)	0.08
						Too clayey	0.55
290:							
Alanos	50	Poor		Poor		Poor	
		Too clayey	0.00	Slope	0.00	Slope	0.00
		Organic matter content low	0.01	Shrink-swell	0.22	Too clayey	0.00
		Droughty	0.45			Hard to reclaim (rock fragments)	0.00
		Too acid	0.84			Rock fragments	0.00
		Water erosion	0.99				
Rock outcrop	30	Not rated		Not rated		Not rated	
300:							
Waumac	50	Poor		Good		Good	
		Wind erosion	0.00				
		Organic matter content low	0.08				
Bamac	35	Poor		Good		Poor	
		Droughty	0.00			Rock fragments	0.00
		Too sandy	0.01			Too sandy	0.01
		Organic matter content low	0.08			Hard to reclaim (rock fragments)	0.01

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
301:							
Vastine	45	Fair		Fair		Poor	
		Too sandy	0.01	Wetness depth	0.53	Rock fragments	0.00
		Organic matter content low	0.08			Hard to reclaim (rock fragments)	0.00
		Water erosion	0.90			Too sandy	0.01
		Droughty	0.91			Wetness depth	0.53
Jarola	40	Fair		Fair		Poor	
		Organic matter content low	0.08	Wetness depth	0.53	Hard to reclaim (rock fragments)	0.00
		Water erosion	0.90	Shrink-swell	0.99	Rock fragments	0.12
		Too acid	0.99			Wetness depth	0.53
302:							
Tranquilar	50	Poor		Poor		Poor	
		Too clayey	0.00	Low strength	0.00	Too clayey	0.00
		Too acid	0.16	Shrink-swell	0.16	Too acid	0.68
		Organic matter content low	0.24	Wetness depth	0.98	Wetness depth	0.98
		Water erosion	0.99				
Jarmillo	30	Fair		Poor		Good	
		Organic matter content low	0.08	Low strength	0.00		
		Too acid	0.99				
		Water erosion	0.99				
304:							
Cosey	45	Fair		Fair		Poor	
		Organic matter content low	0.02	Shrink-swell	0.97	Hard to reclaim (rock fragments)	0.00
		Water erosion	0.90			Rock fragments	0.00
		Too acid	0.99			Slope	0.63
Jarmillo	40	Fair		Good		Fair	
		Organic matter content low	0.08			Slope	0.63
		Water erosion	0.90				
		Too acid	0.99				

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
307:							
Flugle	60	Poor		Good		Fair	
		Organic matter content low	0.00			Too sandy	0.98
		Too sandy	0.98				
		Water erosion	0.99				
Waumac	25	Poor		Good		Good	
		Wind erosion	0.00				
		Organic matter content low	0.08				
308:							
Cajete	85	Fair		Good		Poor	
		Droughty	0.14			Rock fragments	0.00
		Organic matter content low	0.82			Hard to reclaim (rock fragments)	0.00
311:							
Cosey	35	Fair		Fair		Poor	
		Organic matter content low	0.02	Cobble content	0.55	Hard to reclaim (rock fragments)	0.00
		Cobble content	0.68	Shrink-swell	0.96	Rock fragments	0.00
		Water erosion	0.90			Slope	0.16
		Too clayey	0.98			Too clayey	0.52
		Droughty	0.99				
Tranquilar	30	Poor		Poor		Poor	
		Too clayey	0.00	Low strength	0.00	Too clayey	0.00
		Too acid	0.16	Shrink-swell	0.25	Too acid	0.68
		Organic matter content low	0.50	Wetness depth	0.98	Wetness depth	0.98
		Water erosion	0.90				
Calaveras	25	Fair		Good		Poor	
		Organic matter content low	0.01			Hard to reclaim (rock fragments)	0.00
		Droughty	0.76			Rock fragments	0.00
		Too acid	0.84			Slope	0.16
		Water erosion	0.90				
		Stone content	0.99				

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Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
312:							
Royosa	90	Poor		Good		Fair	
		Wind erosion	0.00			Too sandy	0.38
		Organic matter content low	0.08				
		Droughty	0.13				
		Too sandy	0.38				
314:							
Fragua	40	Poor		Good		Good	
		Wind erosion	0.00				
		Organic matter content low	0.02				
Waumac	30	Poor		Good		Good	
		Wind erosion	0.00				
		Organic matter content low	0.08				
Royosa	25	Poor		Good		Poor	
		Too sandy	0.00			Too sandy	0.00
		Wind erosion	0.00				
		Droughty	0.09				
		Organic matter content low	0.50				
317:							
Elpedro	85	Fair		Fair		Fair	
		Organic matter content low	0.02	Shrink-swell	0.87	Too clayey	0.55
		Too clayey	0.92				
		Water erosion	0.99				
319:							
Bamac	60	Poor		Poor		Poor	
		Droughty	0.00	Slope	0.00	Slope	0.00
		Organic matter content low	0.01			Rock fragments	0.00
		Too sandy	0.06			Hard to reclaim (rock fragments)	0.00
						Too sandy	0.06
Rock outcrop	25	Not rated		Not rated		Not rated	

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
320:							
Sparham	85	Poor		Poor		Poor	
		Too clayey	0.00	Low strength	0.00	Too clayey	0.00
		Sodium content	0.00	Shrink-swell	0.12	Sodium content	0.00
		Organic matter content low	0.08			Salinity	0.00
		Salinity	0.88				
		Water erosion	0.90				
321:							
Waumac	60	Poor		Good		Good	
		Wind erosion	0.00				
		Organic matter content low	0.08				
Royosa	30	Poor		Good		Poor	
		Too sandy	0.00			Too sandy	0.00
		Wind erosion	0.00				
		Droughty	0.09				
		Organic matter content low	0.50				
322:							
Fragua	85	Fair		Poor		Poor	
		Too sandy	0.02	Slope	0.00	Slope	0.00
		Organic matter content low	0.08	Depth to bedrock	0.16	Too sandy	0.02
		Droughty	0.62				
324:							
Rock outcrop	30	Not rated		Not rated		Not rated	
Atarque	25	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Shrink-swell	0.87	Slope	0.00
		Organic matter content low	0.08				

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
324:							
Menefee	25	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Slope	0.92	Slope	0.00
		Organic matter content low	0.50			Too clayey	0.64
		Too clayey	0.98				
325:							
Rock outcrop	35	Not rated		Not rated		Not rated	
Espiritu	25	Fair		Poor		Poor	
		Organic matter content low	0.08	Slope	0.00	Slope	0.00
		Droughty	0.88	Shrink-swell	0.87	Hard to reclaim (rock fragments)	0.00
				Cobble content	0.90	Rock fragments	0.00
Vessilla	25	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Slope	0.00
		Depth to bedrock	0.00	Slope	0.00	Depth to bedrock	0.00
		Organic matter content low	0.18			Rock fragments	0.00
342:							
Waumac	35	Poor		Good		Fair	
		Wind erosion	0.00			Slope	0.16
		Organic matter content low	0.08				
Vessilla	25	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Slope	0.08	Slope	0.00
		Organic matter content low	0.12				
Rock outcrop	20	Not rated		Not rated		Not rated	

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Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
345:							
Espiritu----------	50	Poor		Poor		Poor	
		Organic matter content low	0.00	Slope	0.00	Slope	0.00
		Droughty	0.70	Cobble content	0.99	Rock fragments	0.00
				Shrink-swell	0.99	Hard to reclaim (rock fragments)	0.46
Bamac----------	35	Poor		Poor		Poor	
		Droughty	0.00	Slope	0.00	Slope	0.00
		Too sandy	0.01			Rock fragments	0.00
		Organic matter content low	0.02			Hard to reclaim (rock fragments)	0.00
						Too sandy	0.01
346:							
Espiritu, cobbly----	70	Fair		Poor		Poor	
		Droughty	0.04	Slope	0.00	Slope	0.00
		Organic matter content low	0.08	Cobble content	0.70	Rock fragments	0.00
						Hard to reclaim (rock fragments)	0.00
Bamac----------	20	Poor		Poor		Poor	
		Droughty	0.00	Slope	0.00	Slope	0.00
		Too sandy	0.06			Rock fragments	0.00
		Organic matter content low	0.18			Hard to reclaim (rock fragments)	0.00
						Too sandy	0.06
348:							
Wauquie----------	60	Fair		Poor		Poor	
		Droughty	0.14	Slope	0.00	Slope	0.00
		Organic matter content low	0.18			Hard to reclaim (rock fragments)	0.00
						Rock fragments	0.00
Rock outcrop--------	20	Not rated		Not rated		Not rated	

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
353:							
Cochiti----------	50	Fair		Poor		Poor	
		Organic matter content low	0.02	Slope	0.00	Slope	0.00
		Droughty	0.17			Hard to reclaim (rock fragments)	0.00
		Too clayey	0.50			Rock fragments	0.00
						Too clayey	0.30
Espiritu----------	45	Poor		Poor		Poor	
		Droughty	0.00	Slope	0.00	Slope	0.00
		Too sandy	0.02	Cobble content	0.99	Hard to reclaim (rock fragments)	0.00
		Organic matter content low	0.08			Rock fragments	0.00
						Too sandy	0.02
354:							
Waumac Variant------	85	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Rock fragments	0.00
		Depth to bedrock	0.00			Depth to bedrock	0.00
		Organic matter content low	0.08				
358:							
Deama----------	35	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Rock fragments	0.00
		Carbonate content	0.00	Slope	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Shrink-swell	0.87	Carbonate content	0.00
		Organic matter content low	0.82			Slope	0.00
Elpedro----------	25	Fair		Poor		Poor	
		Organic matter content low	0.18	Low strength	0.00	Slope	0.00
		Too clayey	0.92	Slope	0.00	Too clayey	0.55
		Water erosion	0.99	Shrink-swell	0.87		
Rock outcrop--------	25	Not rated		Not rated		Not rated	

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
396:							
Atarque	30	Poor		Poor		Poor	
		Depth to bedrock	0.00	Depth to bedrock	0.00	Slope	0.00
		Droughty	0.00	Slope	0.00	Depth to bedrock	0.00
		Organic matter content low	0.02	Low strength	0.78		
				Shrink-swell	0.87		
Menefee	30	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Slope	0.00
		Depth to bedrock	0.00	Slope	0.00	Depth to bedrock	0.00
		Organic matter content low	0.12	Low strength	0.00	Too clayey	0.57
		Too clayey	0.98	Shrink-swell	0.87		
Rock outcrop	25	Not rated		Not rated		Not rated	
397:							
Rock outcrop	30	Not rated		Not rated		Not rated	
Cucho	25	Fair		Poor		Poor	
		Organic matter content low	0.01	Depth to bedrock	0.00	Slope	0.00
		Droughty	0.49	Slope	0.00	Rock fragments	0.00
		Too clayey	0.92	Shrink-swell	0.87	Too clayey	0.48
		Depth to bedrock	0.97			Depth to bedrock	0.97
Vessilla	25	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Slope	0.00	Slope	0.00
		Organic matter content low	0.18			Rock fragments	0.50
398:							
Espiritu	45	Poor		Poor		Poor	
		Droughty	0.00	Slope	0.00	Hard to reclaim (rock fragments)	0.00
		Organic matter content low	0.02			Rock fragments	0.00
						Slope	0.00

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Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
398:							
Cucho	35	Fair		Poor		Poor	
		Organic matter content low	0.08	Depth to bedrock	0.00	Slope	0.00
		Too clayey	0.92	Low strength	0.00	Too clayey	0.52
		Depth to bedrock	0.97	Slope	0.00	Depth to bedrock	0.97
		Water erosion	0.99	Shrink-swell	0.87		
399:							
Cucho	45	Fair		Poor		Poor	
		Organic matter content low	0.08	Depth to bedrock	0.00	Slope	0.00
		Too clayey	0.92	Low strength	0.00	Too clayey	0.52
		Depth to bedrock	0.97	Slope	0.00	Depth to bedrock	0.97
				Shrink-swell	0.87		
Teco	35	Poor		Poor		Poor	
		Too clayey	0.00	Low strength	0.00	Too clayey	0.00
		Organic matter content low	0.18	Slope	0.02	Slope	0.00
				Shrink-swell	0.48		
405:							
Charo	50	Poor		Poor		Poor	
		Too clayey	0.00	Depth to bedrock	0.00	Too clayey	0.00
		Organic matter content low	0.02	Low strength	0.00	Depth to bedrock	0.35
		Droughty	0.27	Shrink-swell	0.12		
		Depth to bedrock	0.35				
Charo, noncobbly	40	Poor		Poor		Poor	
		Too clayey	0.00	Depth to bedrock	0.00	Too clayey	0.00
		Organic matter content low	0.08	Low strength	0.00	Depth to bedrock	0.99
		Depth to bedrock	0.99	Shrink-swell	0.87	Rock fragments	0.99
		Water erosion	0.99				
409:							
Santa Fe	85	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Slope	0.00
		Depth to bedrock	0.00	Slope	0.00	Rock fragments	0.00
		Organic matter content low	0.50			Depth to bedrock	0.00

97286

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
410:							
Zia----------	85	Fair		Good		Good	
		Organic matter content low	0.08				
		Water erosion	0.99				
414:							
Wauquie----------	85	Fair		Fair		Poor	
		Organic matter content low	0.08	Slope	0.92	Rock fragments	0.00
		Droughty	0.09	Cobble content	0.99	Slope	0.00
						Hard to reclaim (rock fragments)	0.05
417:							
Jocity----------	85	Poor		Fair		Fair	
		Too alkaline	0.00	Shrink-swell	0.95	Too clayey	0.64
		Organic matter content low	0.08				
		Too clayey	0.98				
		Water erosion	0.99				
418:							
Jocity----------	85	Fair		Good		Fair	
		Organic matter content low	0.08			Too clayey	0.61
		Too clayey	0.98				
419:							
Santa Fe----------	40	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Slope	0.00
		Depth to bedrock	0.00	Slope	0.00	Rock fragments	0.00
				Shrink-swell	0.87	Depth to bedrock	0.00
Wauquie----------	30	Poor		Poor		Poor	
		Droughty	0.00	Slope	0.00	Slope	0.00
		Organic matter content low	0.02	Cobble content	0.50	Hard to reclaim (rock fragments)	0.00
						Rock fragments	0.00
Rock outcrop--------	20	Not rated		Not rated		Not rated	

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
420:							
Pinavetes	85	Poor		Good		Poor	
		Too sandy	0.00			Too sandy	0.00
		Wind erosion	0.00				
		Droughty	0.00				
		Too alkaline	0.00				
		Organic matter content low	0.08				
421:							
Gilco, moderately saline, sodic	90	Poor		Good		Poor	
		Sodium content	0.00			Sodium content	0.00
		Organic matter content low	0.08			Salinity	0.00
		Water erosion	0.37				
		Salinity	0.50				
422:							
Vessilla	35	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Slope	0.82	Slope	0.00
		Organic matter content low	0.12				
Menefee	30	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00			Too clayey	0.64
		Organic matter content low	0.50				
		Too clayey	0.98				
Orlie	25	Fair		Poor		Fair	
		Organic matter content low	0.08	Low strength	0.00	Too clayey	0.55
		Too clayey	0.98	Shrink-swell	0.87		
		Water erosion	0.99				
423:							
Gilco	85	Fair		Good		Fair	
		Organic matter content low	0.08			Rock fragments	0.98
		Water erosion	0.99				

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Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
426:							
Aga, moderately saline, sodic------	85	Poor		Good		Poor	
		Sodium content	0.00			Sodium content	0.00
		Organic matter content low	0.02			Salinity	0.00
		Too sandy	0.38			Too sandy	0.38
		Salinity	0.50				
		Droughty	0.81				
		Water erosion	0.99				
427:							
Aga-----------------	85	Fair		Good		Good	
		Organic matter content low	0.02				
		Water erosion	0.99				
428:							
Aga, moderately saline, sodic------	85	Poor		Good		Poor	
		Sodium content	0.00			Sodium content	0.00
		Organic matter content low	0.02			Salinity	0.00
		Water erosion	0.37			Too sandy	0.38
		Too sandy	0.38				
		Salinity	0.50				
		Droughty	0.97				
430:							
Trail---------------	85	Poor		Good		Fair	
		Too alkaline	0.00			Too sandy	0.01
		Too sandy	0.01				
		Organic matter content low	0.08				
		Droughty	0.48				
		Water erosion	0.99				

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Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
431:							
Trail	85	Poor		Good		Good	
		Wind erosion	0.00				
		Too alkaline	0.00				
		Organic matter content low	0.08				
		Droughty	0.88				
433:							
Peralta	85	Fair		Fair		Fair	
		Organic matter content low	0.08	Wetness depth	0.89	Sodium content	0.40
		Sodium content	0.40			Salinity	0.50
		Water erosion	0.99			Wetness depth	0.89
434:							
Peralta	85	Fair		Fair		Fair	
		Too sandy	0.01	Wetness depth	0.89	Too sandy	0.01
		Organic matter content low	0.02			Sodium content	0.40
		Water erosion	0.37			Salinity	0.50
		Sodium content	0.40			Wetness depth	0.89
437:							
Peralta, moderately saline, sodic	85	Poor		Fair		Poor	
		Sodium content	0.00	Wetness depth	0.89	Sodium content	0.00
		Organic matter content low	0.08			Salinity	0.00
		Salinity	0.50			Wetness depth	0.89
		Water erosion	0.99				
500:							
Rock outcrop	40	Not rated		Not rated		Not rated	
Osha	30	Poor		Poor		Poor	
		Droughty	0.00	Slope	0.00	Slope	0.00
		Too sandy	0.01	Depth to bedrock	0.07	Hard to reclaim (rock fragments)	0.00
		Organic matter content low	0.08			Rock fragments	0.00
						Too sandy	0.01

07296

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
500:							
Rubble land---	20	Not rated		Poor		Not rated	
				Slope	0.00		
				Stone content	0.00		
				Cobble content	0.00		
503:							
Cajete---	65	Fair		Fair		Poor	
		Droughty	0.04	Slope	0.68	Rock fragments	0.00
		Organic matter content low	0.82			Slope	0.00
						Hard to reclaim (rock fragments)	0.20
Cypher---	25	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Slope	0.00
		Depth to bedrock	0.00	Slope	0.00	Rock fragments	0.00
		Organic matter content low	0.32			Depth to bedrock	0.00
		Too acid	0.95				
504:							
Orejas---	40	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Rock fragments	0.00
		Depth to bedrock	0.00	Shrink-swell	0.87	Depth to bedrock	0.00
		Organic matter content low	0.12			Too clayey	0.57
		Too clayey	0.98			Slope	0.84
Guaje---	35	Fair		Good		Poor	
		Droughty	0.01			Rock fragments	0.00
		Organic matter content low	0.05			Hard to reclaim (rock fragments)	0.00
		Carbonate content	0.97				
600:							
Rock outcrop---	50	Not rated		Not rated		Not rated	

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
600:							
Cypher	35	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Slope	0.00
		Depth to bedrock	0.00	Slope	0.00	Rock fragments	0.00
		Organic matter content low	0.18			Depth to bedrock	0.00
		Too acid	0.95				
601:							
Laventana	85	Fair		Fair		Poor	
		Organic matter content low	0.08	Depth to bedrock	0.58	Rock fragments	0.00
		Droughty	0.28	Shrink-swell	0.87	Hard to reclaim (rock fragments)	0.00
		Too acid	0.99			Slope	0.96
603:							
Laventana	50	Fair		Poor		Poor	
		Organic matter content low	0.02	Slope	0.00	Slope	0.00
		Droughty	0.70	Depth to bedrock	0.68	Rock fragments	0.00
		Too acid	0.74	Shrink-swell	0.87	Hard to reclaim (rock fragments)	0.00
Mirand	35	Poor		Poor		Poor	
		Too clayey	0.00	Low strength	0.00	Slope	0.00
		Organic matter content low	0.12	Shrink-swell	0.12	Too clayey	0.00
				Slope	0.50	Rock fragments	0.18
604:							
Cypher	55	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Slope	0.00
		Depth to bedrock	0.00	Slope	0.00	Rock fragments	0.00
		Organic matter content low	0.02			Depth to bedrock	0.00
		Too acid	0.74				

07282

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
604:							
Mirand----------	30	Poor		Poor		Poor	
		Too clayey	0.00	Slope	0.00	Slope	0.00
		Organic matter content low	0.12	Shrink-swell	0.12	Too clayey	0.00
				Low strength	0.78	Rock fragments	0.32
						Hard to reclaim (rock fragments)	0.88
608:							
Osha, steep---------	60	Poor		Poor		Poor	
		Droughty	0.00	Slope	0.00	Slope	0.00
		Organic matter content low	0.02			Hard to reclaim (rock fragments)	0.00
		Too acid	0.99			Rock fragments	0.00
Osha----------	30	Poor		Fair		Poor	
		Droughty	0.00	Slope	0.68	Hard to reclaim (dense layer)	0.00
		Organic matter content low	0.08			Hard to reclaim (rock fragments)	0.00
						Rock fragments	0.00
						Slope	0.00
823:							
Gilco, unprotected--	85	Fair		Good		Fair	
		Organic matter content low	0.08			Rock fragments	0.98
		Water erosion	0.99				
827:							
Aga, unprotected----	85	Fair		Good		Good	
		Organic matter content low	0.01				
		Water erosion	0.99				
830:							
Trail, unprotected--	85	Poor		Good		Good	
		Too alkaline	0.00				
		Organic matter content low	0.08				
		Droughty	0.96				
		Water erosion	0.99				

Table 12B.--Source of reclamation material, roadfill, and topsoil--continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material		Potential source of roadfill		Potential source of topsoil	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
831:							
Trail, unprotected--	85	Poor		Good		Fair	
		Wind erosion	0.00			Too sandy	0.01
		Too alkaline	0.00				
		Too sandy	0.01				
		Droughty	0.03				
		Organic matter content low	0.08				
835:							
Peralta, unprotected	85	Fair		Fair		Fair	
		Organic matter content low	0.08	Wetness depth	0.89	Salinity	0.50
		Water erosion	0.99	Shrink-swell	0.93	Wetness depth	0.89
842:							
Peralta, moderately saline, sodic, unprotected--------	85	Poor		Fair		Poor	
		Sodium content	0.00	Shrink-swell	0.87	Sodium content	0.00
		Organic matter content low	0.08	Wetness depth	0.89	Salinity	0.00
		Salinity	0.50			Wetness depth	0.89
850:							
Water----------	95	Not rated		Not rated		Not rated	
DAM:							
Dam----------	100	Not rated		Not rated		Not rated	

Table 13.--Ponds and embankments

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
1:							
Silver	55	Somewhat limited Seepage	 0.04	Somewhat limited Piping	 0.01	Very limited Depth to water	 1.00
Clovis	35	Very limited Seepage	 1.00	Somewhat limited Piping Seepage	 0.80 0.01	Very limited Depth to water	 1.00
2:							
Clovis	35	Very limited Seepage	 1.00	Somewhat limited Piping Seepage	 0.99 0.01	Very limited Depth to water	 1.00
Prieta	35	Very limited Depth to bedrock	 1.00	Very limited Thin layer Large stones content	 1.00 0.43	Very limited Depth to water	 1.00
Silver	20	Somewhat limited Seepage	 0.04	Somewhat limited Piping	 0.01	Very limited Depth to water	 1.00
3:							
Montecito	60	Somewhat limited Seepage	 0.04	Somewhat limited Piping	 0.01	Very limited Depth to water	 1.00
Orejas	30	Very limited Depth to bedrock	 1.00	Very limited Thin layer Large stones content	 1.00 0.67	Very limited Depth to water	 1.00
4:							
Montecito	45	Somewhat limited Seepage Slope	 0.72 0.06	Somewhat limited Piping	 0.31	Very limited Depth to water	 1.00
Montecito, bouldery-	35	Very limited Seepage Slope	 1.00 0.06	Somewhat limited Piping Seepage	 0.75 0.03	Very limited Depth to water	 1.00

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
10:							
Trail	85	Very limited Seepage	 1.00	Somewhat limited Seepage	 0.06	Very limited Depth to water	 1.00
11:							
Trail	85	Very limited Seepage	 1.00	Somewhat limited Seepage	 0.10	Very limited Depth to water	 1.00
13:							
Sandoval	65	Somewhat limited Depth to bedrock	 0.66	Very limited Thin layer Piping	 1.00 0.08	Very limited Depth to water	 1.00
Querencia	20	Somewhat limited Seepage	 0.72	Somewhat limited Piping	 0.38	Very limited Depth to water	 1.00
15:							
Camino	40	Somewhat limited Depth to bedrock	 0.01	Somewhat limited Hard to pack Thin layer	 0.46 0.08	Very limited Depth to water	 1.00
Sandoval	35	Somewhat limited Depth to bedrock	 0.58	Very limited Thin layer Piping	 1.00 0.96	Very limited Depth to water	 1.00
16:							
Rock outcrop	50	Not rated		Not rated		Not rated	
Prieta	30	Very limited Depth to bedrock	 1.00	Very limited Thin layer Large stones content	 1.00 0.06	Very limited Depth to water	 1.00
17:							
Vessilla	35	Very limited Depth to bedrock	 1.00	Very limited Thin layer Seepage	 1.00 0.03	Very limited Depth to water	 1.00
Menefee	25	Somewhat limited Depth to bedrock	 0.84	Very limited Thin layer	 1.00	Very limited Depth to water	 1.00
Rock outcrop	20	Not rated		Not rated		Not rated	

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Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
18:							
Sparham	85	Somewhat limited		Very limited		Very limited	
		Seepage	0.04	Piping	1.00	Depth to water	1.00
				Salinity	0.03		
20:							
Gilco	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.41	Depth to water	1.00
21:							
Rock outcrop	60	Not rated		Not rated		Not rated	
Hackroy	25	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
				Hard to pack	0.06		
22:							
Aga	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.42	Cutbanks cave	1.00
						Depth to saturated zone	0.90
23:							
Hickman	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.05	Depth to water	1.00
24:							
Orlie	45	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.23	Depth to water	1.00
Sparham	35	Not limited		Very limited		Very limited	
				Piping	1.00	Depth to water	1.00
				Salinity	0.12		
25:							
Gilco	85	Somewhat limited		Very limited		Very limited	
		Seepage	0.72	Piping	0.99	Depth to water	1.00
				Seepage	0.01		
26:							
Orlie	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.04	Piping	0.01	Depth to water	1.00

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Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
27:							
Aga	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.79	Cutbanks cave	1.00
						Depth to saturated zone	0.90
29:							
Trail	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.10	Depth to water	1.00
31:							
Riverwash	90	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.93	Depth to water	1.00
33:							
Pits	100	Somewhat limited		Not rated		Not rated	
		Seepage	0.07				
34:							
Ildefonso	55	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Large stones content	0.70	Depth to water	1.00
				Seepage	0.03		
Witt	30	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.55	Depth to water	1.00
41:							
Dune land	100	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.93	Depth to water	1.00
47:							
Cascajo	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.25	Depth to water	1.00
		Slope	0.15				
51:							
Sparham	85	Somewhat limited		Very limited		Somewhat limited	
		Seepage	0.04	Depth to saturated zone	1.00	Slow refill	0.96
				Piping	1.00	Salinity and saturated zone	0.50
				Salinity	0.12	Cutbanks cave	0.10

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Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
52:							
Totavi	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.10	Depth to water	1.00
53:							
Witt	55	Somewhat limited		Very limited		Very limited	
		Seepage	0.72	Piping	0.99	Depth to water	1.00
Harvey	30	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Piping	0.75	Depth to water	1.00
				Seepage	0.03		
54:							
Harvey	45	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.66	Depth to water	1.00
Cascajo	40	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.79	Depth to water	1.00
55:							
La Fonda	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.50	Depth to water	1.00
56:							
Ildefonso	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Large stones content	0.53	Depth to water	1.00
		Slope	0.28	Seepage	0.05		
57:							
Badland	90	Very limited		Not rated		Not rated	
		Depth to bedrock	1.00				
		Slope	1.00				
58:							
Deama	45	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.21	Piping	1.00		
				Large stones content	0.01		
Elpedro	35	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.31	Depth to water	1.00

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
59:							
Harvey----------	35	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.12	Depth to water	1.00
Ildefonso----------	35	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.79	Depth to water	1.00
		Slope	0.01	Large stones content	0.02		
La Fonda----------	15	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.39	Depth to water	1.00
63:							
Placitas----------	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Thin layer	0.93	Depth to water	1.00
		Depth to bedrock	0.93	Seepage	0.03		
		Slope	0.24				
64:							
Skyvillage----------	40	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.06	Seepage	0.03		
Ildefonso----------	35	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
		Slope	0.24				
65:							
Ildefonso----------	50	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.04	Depth to water	1.00
		Slope	0.21				
Harvey----------	30	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
		Slope	0.01				
66:							
Zia----------	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00

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Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
67:							
Sandoval	40	Somewhat limited		Very limited		Very limited	
		Depth to bedrock	0.80	Thin layer	1.00	Depth to water	1.00
		Slope	0.06	Piping	0.06		
Poley	35	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Piping	0.70	Depth to water	1.00
		Slope	0.03	Seepage	0.03		
68:							
Penistaja	45	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.40	Depth to water	1.00
Querencia	35	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.01	Depth to water	1.00
71:							
Palon	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Large stones content	0.05	Depth to water	1.00
		Slope	0.28	Seepage	0.03		
72:							
Palon	85	Very limited		Very limited		Very limited	
		Seepage	1.00	Large stones content	1.00	Depth to water	1.00
		Slope	1.00	Seepage	0.38		
74:							
Origo	50	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Large stones content	0.55	Depth to water	1.00
		Slope	0.28	Seepage	0.03		
Pavo	25	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
		Slope	0.01				
75:							
Origo	85	Very limited		Very limited		Very limited	
		Seepage	1.00	Large stones content	0.99	Depth to water	1.00
		Slope	1.00	Seepage	0.10		

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
82:							
Calaveras----------	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.25	Depth to water	1.00
		Slope	0.28				
83:							
Calaveras----------	60	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.06	Depth to water	1.00
		Slope	0.99	Large stones content	0.01		
Rubble land--------	20	Very limited		Very limited		Very limited	
		Seepage	1.00	Large stones content	1.00	Depth to water	1.00
		Slope	0.99	Seepage	1.00		
85:							
Redondo------------	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.07	Depth to water	1.00
		Slope	0.28				
86:							
Redondo------------	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Large stones content	0.53	Depth to water	1.00
		Slope	1.00	Seepage	0.50		
87:							
Redondo------------	50	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.07	Depth to water	1.00
		Slope	1.00				
Rubble land--------	25	Very limited		Very limited		Very limited	
		Seepage	1.00	Large stones content	1.00	Depth to water	1.00
		Slope	1.00	Seepage	1.00		
88:							
Totavi-------------	45	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.10	Depth to water	1.00

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Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
88:							
Jemez	30	Somewhat limited		Somewhat limited		Very limited	
		Depth to bedrock	0.93	Thin layer	0.93	Depth to water	1.00
		Seepage	0.04	Piping	0.31		
Rock outcrop	15	Not rated		Not rated		Not rated	
91:							
Zia	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
92:							
Galisteo, moderately saline, sodic	85	Not limited		Very limited		Very limited	
				Hard to pack	1.00	Depth to water	1.00
				Salinity	0.50		
93:							
Zia	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.10	Depth to water	1.00
95:							
El Rancho	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
97:							
El Rancho	85	Somewhat limited		Not limited		Very limited	
		Seepage	0.72			Depth to water	1.00
100:							
Orejas	40	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.41	Large stones content	0.61		
Rock outcrop	40	Not rated		Not rated		Not rated	
101:							
Blancot	55	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Piping	0.88	Depth to water	1.00
				Seepage	0.03		

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
101:							
Lybrook	25	Somewhat limited		Very limited		Very limited	
		Seepage	0.04	Piping	1.00	Depth to water	1.00
				Salinity	0.97		
102:							
Sparham	85	Somewhat limited		Very limited		Very limited	
		Seepage	0.04	Piping	1.00	Depth to water	1.00
				Salinity	0.12		
104:							
Cochiti	50	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
		Slope	0.06				
Montecito	30	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
105:							
Badland	50	Very limited		Not rated		Not rated	
		Depth to bedrock	1.00				
		Slope	0.28				
Menefee	30	Somewhat limited		Very limited		Very limited	
		Depth to bedrock	0.84	Thin layer	1.00	Depth to water	1.00
		Slope	0.28	Piping	0.08		
106:							
Stumble	50	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.58	Depth to water	1.00
		Slope	0.28				
Stumble, sandy	30	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.47	Depth to water	1.00
108:							
Embudo	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.10	Depth to water	1.00
109:							
Embudo	50	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.12	Depth to water	1.00

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
109:							
Tijeras	35	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.06	Depth to water	1.00
110:							
Rock outcrop	45	Not rated		Not rated		Not rated	
Saido	40	Somewhat limited		Very limited		Very limited	
		Seepage	0.72	Piping	1.00	Depth to water	1.00
		Slope	0.21				
111:							
Rock outcrop	50	Not rated		Not rated		Not rated	
Zia	35	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
		Slope	0.06				
112:							
Tijeras	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
114:							
San Mateo	40	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.04	Salinity	0.97	Depth to water	1.00
				Seepage	0.03		
Zia	40	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.01	Depth to water	1.00
120:							
Pinavetes	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.79	Depth to water	1.00
124:							
Rock outcrop	90	Not rated		Not rated		Not rated	
129:							
Menefee	85	Somewhat limited		Very limited		Very limited	
		Depth to bedrock	0.58	Thin layer	1.00	Depth to water	1.00
		Slope	0.12				

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
130:							
Pinavetes	45	Very limited Seepage	 1.00	Somewhat limited Seepage	 0.10	Very limited Depth to water	 1.00
Galisteo, moderately saline, sodic	40	Not limited		Very limited Hard to pack Salinity	 1.00 0.50	Very limited Depth to water	 1.00
142:							
Grieta	85	Very limited Seepage	 1.00	Somewhat limited Seepage	 0.10	Very limited Depth to water	 1.00
143:							
Clovis	85	Somewhat limited Seepage	 0.72	Not limited		Very limited Depth to water	 1.00
145:							
Grieta	55	Very limited Seepage	 1.00	Somewhat limited Seepage	 0.06	Very limited Depth to water	 1.00
Sheppard	40	Very limited Seepage	 1.00	Somewhat limited Seepage	 0.06	Very limited Depth to water	 1.00
146:							
Sedmar	85	Very limited Depth to bedrock	 1.00	Very limited Thin layer Seepage	 1.00 0.10	Very limited Depth to water	 1.00
150:							
Doakum	55	Somewhat limited Seepage	 0.72	Somewhat limited Piping	 0.46	Very limited Depth to water	 1.00
Betonnie	35	Very limited Seepage	 1.00	Somewhat limited Seepage	 0.03	Very limited Depth to water	 1.00
162:							
Hackroy	45	Very limited Depth to bedrock	 1.00	Very limited Thin layer Hard to pack	 1.00 0.08	Very limited Depth to water	 1.00

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
162:							
Nyjack	40	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Piping	0.71	Depth to water	1.00
		Depth to bedrock	0.01	Thin layer	0.52		
				Seepage	0.03		
163:							
Jemez	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Thin layer	0.52	Depth to water	1.00
		Depth to bedrock	0.52	Piping	0.11		
170:							
San Mateo	85	Somewhat limited		Very limited		Very limited	
		Seepage	0.04	Piping	1.00	Depth to water	1.00
180:							
Councelor	40	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
		Slope	0.08				
Eslendo	30	Somewhat limited		Very limited		Very limited	
		Depth to bedrock	0.84	Thin layer	1.00	Depth to water	1.00
		Slope	0.08				
Mespun	25	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.07	Depth to water	1.00
		Slope	0.08				
183:							
Sheppard	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.06	Depth to water	1.00
		Slope	0.01				
185:							
Frijoles	90	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.04	Depth to water	1.00
190:							
Zia	35	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
		Slope	0.01				

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
190:							
Skyvillage----------	25	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.21	Seepage	0.01		
Rock outcrop--------	15	Not rated		Not rated		Not rated	
191:							
Sheppard------------	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.06	Depth to water	1.00
200:							
Sedillo-------------	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.06	Depth to water	1.00
		Slope	0.03				
201:							
Rock outcrop--------	55	Not rated		Not rated		Not rated	
Sedgran-------------	35	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.88	Seepage	0.12		
206:							
Pinitos-------------	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.04	Piping	0.01	Depth to water	1.00
207:							
Penistaja-----------	60	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.01	Depth to water	1.00
Zia-----------------	25	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.01	Depth to water	1.00
208:							
Sedillo-------------	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
		Slope	0.88				

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Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
210:							
Ildefonso	85	Somewhat limited		Somewhat limited		Very limited	
		Slope	0.99	Large stones content	0.97	Depth to water	1.00
		Seepage	0.72				
211:							
Zia	45	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
Clovis	30	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Seepage	0.01	Depth to water	1.00
213:							
Pinavetes	55	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.79	Depth to water	1.00
		Slope	0.28				
Rock outcrop	30	Not rated		Not rated		Not rated	
215:							
Ess	60	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Large stones content	0.33	Depth to water	1.00
		Slope	0.28				
Rock outcrop	30	Not rated		Not rated		Not rated	
217:							
Witt	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.50	Depth to water	1.00
218:							
Ildefonso	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Large stones content	0.71	Depth to water	1.00
				Seepage	0.03		
220:							
Rock outcrop	40	Not rated		Not rated		Not rated	

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
220:							
Vessilla	30	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.72	Seepage	0.03		
Menefee	20	Somewhat limited		Very limited		Very limited	
		Depth to bedrock	0.84	Thin layer	1.00	Depth to water	1.00
		Slope	0.72				
226:							
Galisteo, moderately saline, sodic	85	Somewhat limited		Very limited		Very limited	
		Seepage	0.04	Piping	1.00	Depth to water	1.00
				Salinity	0.50		
227:							
Hagerman	65	Somewhat limited		Somewhat limited		Very limited	
		Depth to bedrock	0.74	Thin layer	0.74	Depth to water	1.00
		Seepage	0.04	Piping	0.06		
Bond	20	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
228:							
Winona	85	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.06				
230:							
Skyvillage	35	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.01	Seepage	0.03		
Sandoval	25	Somewhat limited		Very limited		Very limited	
		Depth to bedrock	0.84	Thin layer	1.00	Depth to water	1.00
		Slope	0.01	Piping	0.04		
Rock outcrop	20	Not rated		Not rated		Not rated	
231:							
Querencia	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.50	Depth to water	1.00

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
234:							
Querencia	60	Somewhat limited		Not limited		Very limited	
		Seepage	0.72			Depth to water	1.00
Zia	20	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
235:							
Sandoval	85	Somewhat limited		Very limited		Very limited	
		Depth to bedrock	0.50	Thin layer	1.00	Depth to water	1.00
				Piping	0.95		
236:							
Sparank, moderately saline, sodic	85	Somewhat limited		Very limited		Very limited	
		Seepage	0.04	Piping	1.00	Depth to water	1.00
				Salinity	0.50		
237:							
Sparank	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.04	Piping	0.40	Depth to water	1.00
240:							
Penistaja	45	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.52	Depth to water	1.00
Hagerman	35	Somewhat limited		Somewhat limited		Very limited	
		Depth to bedrock	0.98	Thin layer	0.98	Depth to water	1.00
		Seepage	0.04	Piping	0.03		
250:							
Pinavetes	90	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.07	Depth to water	1.00
262:							
Pastura	90	Very limited		Very limited		Very limited	
		Depth to cemented pan	1.00	Thin layer	1.00	Depth to water	1.00
		Seepage	0.01	Piping	0.50		

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
270:							
Blancot	40	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Piping	0.60	Depth to water	1.00
				Seepage	0.03		
Councelor	30	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.04	Depth to water	1.00
Tsosie	25	Very limited		Very limited		Very limited	
		Seepage	1.00	Piping	1.00	Depth to water	1.00
				Seepage	0.03		
281:							
Carjo	90	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Thin layer	0.96	Depth to water	1.00
		Depth to bedrock	0.96	Piping	0.01		
282:							
Tocal	85	Somewhat limited		Very limited		Very limited	
		Depth to bedrock	0.69	Thin layer	1.00	Depth to water	1.00
				Piping	0.76		
283:							
Mirand	45	Somewhat limited		Not limited		Very limited	
		Slope	0.08			Depth to water	1.00
		Seepage	0.04				
Alanos	30	Somewhat limited		Somewhat limited		Very limited	
		Slope	0.21	Seepage	0.50	Depth to water	1.00
		Seepage	0.04				
290:							
Alanos	50	Somewhat limited		Somewhat limited		Very limited	
		Slope	0.50	Seepage	0.12	Depth to water	1.00
Rock outcrop	30	Not rated		Not rated		Not rated	
300:							
Waumac	50	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.01	Depth to water	1.00
Bamac	35	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.10	Depth to water	1.00

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
301:							
Vastine	45	Very limited		Very limited		Very limited	
		Seepage	1.00	Depth to saturated zone	0.99	Cutbanks cave	1.00
				Seepage	0.38	Depth to saturated zone	0.01
Jarola	40	Very limited		Very limited		Very limited	
		Seepage	1.00	Depth to saturated zone	0.99	Cutbanks cave	1.00
				Seepage	0.05	Depth to saturated zone	0.01
302:							
Tranquilar	50	Not limited		Somewhat limited		Very limited	
				Depth to saturated zone	0.68	Slow refill	1.00
				Hard to pack	0.31	Depth to saturated zone	0.14
						Cutbanks cave	0.10
Jarmillo	30	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Piping	0.75	Depth to water	1.00
304:							
Cosey	45	Somewhat limited		Not limited		Very limited	
		Seepage	0.72			Depth to water	1.00
		Slope	0.01				
Jarmillo	40	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
		Slope	0.01				
307:							
Flugle	60	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.02	Depth to water	1.00
Waumac	25	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.10	Depth to water	1.00
308:							
Cajete	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.79	Depth to water	1.00

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
311:							
Cosey	35	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Seepage	0.32	Depth to water	1.00
		Slope	0.01	Large stones content	0.03		
Tranquilar	30	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Depth to saturated zone	0.68	Slow refill	1.00
						Depth to saturated zone	0.14
						Cutbanks cave	0.10
Calaveras	25	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.10	Depth to water	1.00
		Slope	0.01				
312:							
Royosa	90	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.79	Depth to water	1.00
314:							
Fragua	40	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.04	Depth to water	1.00
Waumac	30	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.06	Depth to water	1.00
Royosa	25	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.31	Depth to water	1.00
317:							
Elpedro	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.22	Depth to water	1.00
319:							
Bamac	60	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.12	Depth to water	1.00
		Slope	0.72				
Rock outcrop	25	Not rated		Not rated		Not rated	

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Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
320:							
Sparham	85	Not limited		Very limited		Very limited	
				Piping	1.00	Depth to water	1.00
				Salinity	0.12		
321:							
Waumac	60	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.06	Depth to water	1.00
Royosa	30	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.31	Depth to water	1.00
322:							
Fragua	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Thin layer	0.26	Depth to water	1.00
		Slope	0.94	Seepage	0.06		
		Depth to bedrock	0.01				
324:							
Rock outcrop	30	Not rated		Not rated		Not rated	
Atarque	25	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.03				
Menefee	25	Somewhat limited		Very limited		Very limited	
		Depth to bedrock	0.87	Thin layer	1.00	Depth to water	1.00
		Slope	0.06	Piping	0.02		
325:							
Rock outcrop	35	Not rated		Not rated		Not rated	
Espiritu	25	Somewhat limited		Not limited		Very limited	
		Slope	0.97			Depth to water	1.00
		Seepage	0.72				
Vessilla	25	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.88				

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Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
342:							
Waumac	35	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.06	Depth to water	1.00
		Slope	0.01				
Vessilla	25	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.21	Seepage	0.01		
Rock outcrop	20	Not rated		Not rated		Not rated	
345:							
Espiritu	50	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.04	Depth to water	1.00
		Slope	0.72				
Bamac	35	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.10	Depth to water	1.00
		Slope	0.72				
346:							
Espiritu, cobbly	70	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.10	Depth to water	1.00
		Slope	0.41	Large stones content	0.01		
Bamac	20	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.12	Depth to water	1.00
		Slope	0.41				
348:							
Wauquie	60	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.25	Depth to water	1.00
		Slope	0.72				
Rock outcrop	20	Not rated		Not rated		Not rated	
353:							
Cochiti	50	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.25	Depth to water	1.00
		Slope	0.41				

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Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
353:							
Espiritu	45	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.10	Depth to water	1.00
		Slope	0.88				
354:							
Waumac Variant	85	Somewhat limited		Very limited		Very limited	
		Depth to bedrock	0.78	Thin layer	1.00	Depth to water	1.00
				Seepage	0.03		
358:							
Deama	35	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.88				
Elpedro	25	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.09	Depth to water	1.00
		Slope	0.64				
Rock outcrop	25	Not rated		Not rated		Not rated	
396:							
Atarque	30	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.72				
Menefee	30	Somewhat limited		Very limited		Very limited	
		Slope	0.72	Thin layer	1.00	Depth to water	1.00
		Depth to bedrock	0.69				
Rock outcrop	25	Not rated		Not rated		Not rated	
397:							
Rock outcrop	30	Not rated		Not rated		Not rated	
Cucho	25	Somewhat limited		Somewhat limited		Very limited	
		Slope	0.99	Thin layer	0.61	Depth to water	1.00
		Seepage	0.04				
		Depth to bedrock	0.02				
Vessilla	25	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.97	Seepage	0.01		

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
398:							
Espiritu	45	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.04	Depth to water	1.00
		Slope	0.59				
Cucho	35	Somewhat limited		Somewhat limited		Very limited	
		Slope	0.72	Thin layer	0.61	Depth to water	1.00
		Seepage	0.04				
		Depth to bedrock	0.02				
399:							
Cucho	45	Somewhat limited		Somewhat limited		Very limited	
		Slope	0.41	Thin layer	0.61	Depth to water	1.00
		Seepage	0.04				
		Depth to bedrock	0.02				
Teco	35	Very limited		Not limited		Very limited	
		Seepage	1.00			Depth to water	1.00
		Slope	0.24				
405:							
Charo	50	Somewhat limited		Somewhat limited		Very limited	
		Depth to bedrock	0.91	Thin layer	0.91	Depth to water	1.00
				Hard to pack	0.26		
Charo, noncobbly	40	Somewhat limited		Somewhat limited		Very limited	
		Depth to bedrock	0.56	Thin layer	0.56	Depth to water	1.00
				Hard to pack	0.03		
409:							
Santa Fe	85	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.41				
410:							
Zia	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
414:							
Wauquie	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.04	Depth to water	1.00
		Slope	0.06				

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Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
417:							
Jocity	85	Very limited		Very limited		Very limited	
		Seepage	1.00	Piping	1.00	Depth to water	1.00
				Seepage	0.10		
418:							
Jocity	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Piping	0.92	Depth to water	1.00
				Seepage	0.02		
419:							
Santa Fe	40	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.99	Seepage	0.06		
				Large stones content	0.01		
Wauquie	30	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.79	Depth to water	1.00
		Slope	0.88	Large stones content	0.08		
Rock outcrop	20	Not rated		Not rated		Not rated	
420:							
Pinavetes	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.79	Depth to water	1.00
421:							
Gilco, moderately saline, sodic	90	Somewhat limited		Very limited		Very limited	
		Seepage	0.72	Piping	1.00	Depth to water	1.00
				Salinity	0.50		
				Seepage	0.01		
422:							
Vessilla	35	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.08	Seepage	0.03		
Menefee	30	Somewhat limited		Very limited		Very limited	
		Depth to bedrock	0.84	Thin layer	1.00	Depth to water	1.00

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
422:							
Orlie	25	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.04	Piping	0.01	Depth to water	1.00
423:							
Gilco	85	Somewhat limited		Very limited		Very limited	
		Seepage	0.72	Piping	1.00	Depth to water	1.00
426:							
Aga, moderately saline, sodic	85	Very limited		Very limited		Very limited	
		Seepage	1.00	Piping	1.00	Depth to water	1.00
				Seepage	0.79		
				Salinity	0.50		
427:							
Aga	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.02	Cutbanks cave	1.00
						Depth to saturated zone	0.90
428:							
Aga, moderately saline, sodic	85	Very limited		Very limited		Very limited	
		Seepage	1.00	Piping	1.00	Depth to water	1.00
				Salinity	0.50		
				Seepage	0.07		
430:							
Trail	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.10	Depth to water	1.00
431:							
Trail	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.10	Depth to water	1.00

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
433:							
Peralta----------	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Depth to saturated zone	0.86	Cutbanks cave	1.00
				Piping	0.60	Slow refill	0.28
				Seepage	0.01	Depth to saturated zone	0.06
						Salinity and saturated zone	0.06
434:							
Peralta----------	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Depth to saturated zone	0.86	Cutbanks cave	1.00
				Piping	0.60	Depth to saturated zone	0.06
				Seepage	0.10	Salinity and saturated zone	0.06
437:							
Peralta, moderately saline, sodic------	85	Somewhat limited		Very limited		Very limited	
		Seepage	0.72	Piping	1.00	Cutbanks cave	1.00
				Depth to saturated zone	0.86	Salinity and saturated zone	0.78
				Salinity	0.50	Slow refill	0.28
				Seepage	0.01	Depth to saturated zone	0.06
500:							
Rock outcrop--------	40	Not rated		Not rated		Not rated	
Osha----------	30	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Thin layer	0.34	Depth to water	1.00
		Slope	1.00	Seepage	0.14		
		Depth to bedrock	0.33				
Rubble land---------	20	Very limited		Very limited		Very limited	
		Seepage	1.00	Large stones content	1.00	Depth to water	1.00
		Slope	1.00	Seepage	1.00		

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Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
503:							
Cajete	65	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.05	Depth to water	1.00
		Slope	0.10				
Cypher	25	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.88	Seepage	0.03		
504:							
Orejas	40	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
Guaje	35	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.03	Depth to water	1.00
600:							
Rock outcrop	50	Not rated		Not rated		Not rated	
Cypher	35	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.99				
601:							
Laventana	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Thin layer	0.11	Depth to water	1.00
		Depth to bedrock	0.10				
603:							
Laventana	50	Somewhat limited		Somewhat limited		Very limited	
		Slope	0.82	Thin layer	0.08	Depth to water	1.00
		Seepage	0.72				
		Depth to bedrock	0.08				
Mirand	35	Somewhat limited		Somewhat limited		Very limited	
		Slope	0.12	Piping	0.01	Depth to water	1.00
		Seepage	0.04				
604:							
Cypher	55	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.28	Seepage	0.03		

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
604:							
Mirand----------	30	Somewhat limited		Not limited		Very limited	
		Slope	0.72			Depth to water	1.00
608:							
Osha, steep---------	60	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.10	Depth to water	1.00
		Slope	0.97				
Osha----------	30	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.25	Depth to water	1.00
		Slope	0.10				
823:							
Gilco, unprotected--	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.72	Piping	0.50	Depth to water	1.00
827:							
Aga, unprotected----	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.06	Cutbanks cave	1.00
						Depth to saturated zone	0.90
830:							
Trail, unprotected--	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.02	Depth to water	1.00
831:							
Trail, unprotected--	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.79	Depth to water	1.00
835:							
Peralta, unprotected	85	Somewhat limited		Somewhat limited		Somewhat limited	
		Seepage	0.72	Depth to saturated zone	0.86	Slow refill	0.28
						Cutbanks cave	0.10
						Depth to saturated zone	0.06
						Salinity and saturated zone	0.06

Table 13.--Ponds and embankments--continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
842:							
Peralta, moderately saline, sodic, unprotected--------	85	Somewhat limited		Very limited		Somewhat limited	
		Seepage	0.72	Piping	1.00	Salinity and saturated zone	0.78
				Depth to saturated zone	0.86	Slow refill	0.28
				Salinity	0.50	Cutbanks cave	0.10
						Depth to saturated zone	0.06
850:							
Water----------	95	Not rated		Not rated		Not rated	
DAM:							
Dam----------	100	Not rated		Not rated		Not rated	

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Table 14.--Engineering properties

(Absence of an entry indicates that the data were not estimated.)

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
1:												
Silver	0-4	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	4-8	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	8-20	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	20-39	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	39-60	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
Clovis	0-3	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	3-20	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	20-40	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	40-60	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
2:												
Clovis	0-3	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	3-24	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	24-60	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
Prieta	0-3	Very stony loam	GC	A-2-4	20-50	0	50-70	40-60	30-50	15-35	15-30	5-20
	3-10	Very stony clay loam	GC	A-2-6	20-50	0	50-70	40-60	35-55	15-35	30-40	10-15
	10-14	Very stony clay loam	SC	A-2-6	15-35	0	65-85	55-75	40-60	20-40	30-40	10-15
	14-19	Very stony clay loam	GC	A-2-6	30-50	0	50-70	40-60	35-55	15-35	30-40	10-15
	19-60	Bedrock			---	---	---	---	---	---	---	---
Silver	0-8	Loam	CL	A-6	0	0-5	95-100	90-100	80-100	50-60	25-40	10-25
	8-30	Silty clay loam	CL	A-6	0	0-3	95-100	85-100	80-100	70-90	35-45	15-25
	30-60	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
3:												
Montecito	0-3	Fine sandy loam	SC-SM	A-4	0	0-9	90-100	85-100	75-85	35-50	20-30	4-7
	3-18	Clay loam	CL	A-6	0	0-6	90-100	85-100	80-95	70-90	35-50	15-25
	18-60	Clay loam	CL	A-6	0	0-3	90-100	85-100	80-95	70-90	35-50	15-25
Orejas	0-2	Cobbly loam	GC	A-6	0	15-40	60-80	60-80	50-70	30-50	20-35	10-20
	2-5	Very cobbly clay loam	GC	A-2-6	0	25-50	45-65	45-65	40-60	20-40	25-40	10-20
	5-14	Very cobbly clay loam	GC	A-2-6	0	30-50	45-65	45-65	40-60	20-40	25-40	10-20
	14-17	Very cobbly clay loam	GC	A-2-6	0	25-55	45-65	45-65	40-60	20-40	25-40	10-20
	17-19	Very gravelly clay loam	SC	A-2-6	0	0-15	80-100	50-70	40-60	20-40	25-40	10-20
	19-60	Bedrock			---	---	---	---	---	---	---	---
4:												
Montecito	0-3	Fine sandy loam	SC-SM	A-4	0	0-10	90-100	85-100	75-85	35-50	20-30	4-7
	3-22	Clay loam	CL	A-6	0	0-5	90-100	85-100	80-95	70-90	35-50	15-25
	22-60	Loam	CL	A-6	0	0-5	90-100	85-95	80-95	50-60	25-40	10-25
Montecito, bouldery	0-5	Extremely bouldery loam	GC-GM	A-1-b	10-35	20-45	30-50	30-45	25-40	15-25	20-30	4-7
	5-28	Clay loam	CL	A-6	0-3	0-6	90-100	85-95	80-90	70-90	35-50	15-25
	28-45	Loam	CL	A-6	0	0-5	90-100	85-95	80-90	50-60	25-40	10-25
	45-60	Sandy loam	SC-SM	A-2-4	0	0-5	90-100	85-95	60-80	25-45	20-30	4-7
10:												
Trail	0-6	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	6-30	Stratified loamy sand to sandy loam	SM	A-2-4	0	0	100	100	60-80	20-40	16-24	2-6
	30-45	Sand	SW-SM	A-2-4, A-3	0	0	100	100	60-80	0-20	0-0	NP
	45-60	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	15-20	NP-4
11:												
Trail	0-9	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	9-36	Stratified loamy sand to sandy loam	SM	A-2-4	0	0	100	100	60-80	20-40	15-20	NP-4
	36-60	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
13:												
Sandoval	0-2	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	2-6	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	6-10	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	10-15	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	15-60	Bedrock			---	---	---	---	---	---	---	---

Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
13:												
Querencia-------	0-4	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	4-12	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	12-24	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	24-60	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
15:												
Camino----------	0-2	Silty clay loam	CL	A-6	0	0	100	100	92-100	75-90	35-45	15-25
	2-5	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
	5-20	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
	20-51	Clay	CH	A-7-6	0	0	100	90-100	90-100	70-90	50-60	25-35
	51-60	Bedrock			---	---	---	---	---	---	---	---
Sandoval--------	0-2	Fine sandy loam	SC-SM	A-4	0	0-3	95-100	90-100	75-85	35-50	20-30	4-7
	2-17	Clay loam	CL	A-6	0	0	95-100	90-100	85-95	70-90	35-50	15-25
	17-60	Bedrock			---	---	---	---	---	---	---	---
16:												
Rock outcrop----	0-60	Bedrock			---	---	---	---	---	---	---	---
Prieta----------	0-5	Stony silt loam	SC, CL	A-4, A-6	0-15	0	80-100	70-90	60-80	40-60	20-30	10-15
	5-15	Very stony clay loam	SC	A-2-6	25-45	0	55-75	35-55	25-45	10-30	30-40	10-15
	15-19	Very stony clay loam	GC	A-2-6	30-50	0	50-70	40-60	30-50	10-30	30-40	10-15
	19-60	Bedrock			---	---	---	---	---	---	---	---
17:												
Vessilla--------	0-5	Sandy loam	SC-SM	A-2-4	0	0-5	100	100	60-80	25-45	20-30	4-7
	5-11	Sandy loam	SC-SM	A-2-4	0	0-6	90-100	85-100	55-75	25-45	20-30	4-7
	11-60	Bedrock			---	---	---	---	---	---	---	---
Menefee---------	0-3	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	3-10	Clay loam	CL	A-6	0	0	90-100	85-100	80-100	65-85	35-50	15-25
	10-60	Bedrock			---	---	---	---	---	---	---	---
Rock outcrop----	0-60	Bedrock			---	---	---	---	---	---	---	---
18:												
Sparham---------	0-7	Clay	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	7-20	Clay, clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	20-29	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	29-47	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	47-53	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	53-60	Clay loam	CL	A-6	0	0	100	85-100	80-90	70-90	35-50	15-25
20:												
Gilco-----------	0-6	Clay loam	CL	A-6	0	0	90-100	80-100	80-90	70-90	35-50	15-25
	6-60	Stratified fine sandy loam to loam	CL, SC-SM	A-6, A-4	0	0	90-100	80-100	80-90	50-60	25-40	10-25
21:												
Rock outcrop----	0-60	Bedrock			---	---	---	---	---	---	---	---
Hackroy---------	0-3	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
	3-12	Clay	CH	A-7-6	0	0	95-100	95-100	90-100	70-90	50-60	25-35
	12-60	Bedrock			---	---	---	---	---	---	---	---
22:												
Aga-------------	0-8	Silty clay loam	CL	A-6	0	0	100	100	95-100	85-95	35-40	15-20
	8-24	Loam	CL	A-4	0	0	95-100	90-100	65-95	40-70	20-25	5-10
	24-60	Sand	SW-SM, SM	A-3, A-2	0	0	90-100	85-100	50-80	5-30	0-0	NP
23:												
Hickman---------	0-4	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	4-12	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	12-49	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	49-60	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
24:												
Orlie-----------	0-2	Fine sandy loam	SC-SM	A-4	0	0	90-100	75-100	70-90	35-50	20-30	4-7
	2-25	Clay loam	CL	A-6	0	0	85-100	85-100	75-95	70-90	35-50	15-25
	25-60	Stratified sandy clay loam to clay loam	SC	A-6	0	0	90-100	85-100	75-90	40-50	25-35	10-20
Sparham---------	0-3	Clay	CH	A-7-6	0	0	90-100	85-95	80-90	70-90	50-60	25-35
	3-60	Silty clay	CL	A-7-6	0	0	100	85-100	80-100	75-95	40-50	15-25

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Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
25:												
Gilco	0-4	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	4-34	Stratified silt loam to loam to fine sandy loam	CL, CL-ML, SC-SM	A-6, A-4	0	0	100	100	80-100	50-60	20-40	4-25
	34-60	Stratified fine sandy loam to loam	CL-ML	A-4	0	0	100	100	80-100	50-60	20-30	4-7
26:												
Orlie	0-2	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	2-13	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	13-22	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	22-36	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-50	15-25
	36-50	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	50-60	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-50	15-25
27:												
Aga	0-10	Loam	CL	A-4	0	0	100	100	70-95	45-70	20-30	5-10
	10-23	Loam	CL	A-4	0	0	95-100	90-100	65-95	40-70	20-25	5-10
	23-43	Sand	SW-SM	A-2-4	0	0	100	100	65-80	0-20	0-0	NP
	43-60	Sand	SW-SM	A-2-4	0	0	100	85-95	65-80	0-20	0-0	NP
29:												
Trail	0-6	Loamy sand	SM	A-2-4	0	0	100	100	60-80	20-40	15-20	NP-4
	6-60	Stratified loamy sand to sandy loam	SM	A-2-4	0	0	100	100	60-80	20-40	14-23	2-4
31:												
Riverwash	0-6	Sand	SP-SM	A-3	0	0-4	79-100	78-100	59-77	4-7	0-14	NP
	6-60	Stratified coarse sand to sandy loam	SW-SM, SP, SP-SM	A-1, A-2, A-3	0	0-6	81-100	57-100	40-75	3-11	10-15	NP-3
33:												
Pits	0-60	Variable			---	---	---	---	---	---	---	---
34:												
Ildefonso	0-3	Cobbly loam	SC	A-6	3-10	15-30	65-85	60-75	40-60	30-50	25-35	10-20
	3-17	Cobbly loam	CL, GC	A-6	0	15-30	65-85	65-80	45-65	45-55	25-35	10-20
	17-60	Stratified very cobbly sandy loam to very cobbly loam	GC	A-2-4	0	43-65	50-70	40-60	20-30	15-30	20-30	6-13
Witt	0-3	Very fine sandy loam	CL, SC	A-4	0	0	100	100	80-100	40-60	25-35	5-15
	3-27	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	27-60	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
41:												
Dune land	0-6	Sand	SW-SM	A-2-4, A-3	0	0	100	100	50-70	0-15	5-15	NP
	6-60	Sand, fine sand	SM	A-2-4	0	0	100	100	50-80	0-25	5-15	NP
47:												
Cascajo	0-2	Very gravelly sandy loam	SC-SM	A-2-4	0	10-25	65-85	30-50	25-45	20-40	20-30	4-7
	2-5	Very gravelly sandy loam	SC-SM	A-2-4	0	10-25	70-90	35-50	25-45	20-40	20-30	4-7
	5-11	Very gravelly sandy loam	SC-SM	A-2-4	0	0-10	65-85	45-65	40-60	25-45	20-30	4-7
	11-23	Very gravelly loamy sand	SM	A-2-4	0	0-10	60-80	40-50	35-45	20-40	15-20	NP-4
	23-30	Very gravelly loamy sand	SM	A-1-b	0	0-20	55-75	35-55	30-45	15-35	15-20	NP-4
	30-60	Extremely cobbly loamy sand	GM	A-1-a	0	25-60	30-50	15-25	15-25	10-20	15-20	NP-4
51:												
Sparham	0-6	Clay loam	CL	A-6	0	0	100	90-100	85-95	65-85	35-50	15-25
	6-20	Clay loam	CL	A-6	0	0	100	95-100	90-100	70-90	35-50	15-25
	20-36	Clay	CH	A-7-6	0	0	100	95-100	90-100	70-90	50-60	25-35
	36-60	Clay loam	CL	A-6	0	0	100	95-100	90-100	70-90	35-50	15-25
52:												
Totavi	0-15	Loamy sand	SM	A-2-4	0	0	100	85-100	60-80	15-35	10-20	NP-4
	15-19	Loamy sand	SM	A-2-4	0	0	100	85-100	60-80	15-35	10-20	NP-4
	19-60	Loamy sand	SM	A-2-4	0	0	100	85-100	60-80	15-35	10-20	NP-4

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Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
53:												
Witt----------	0-3	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	3-6	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
	6-11	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	11-18	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	18-25	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	25-39	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
	39-53	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
	53-60	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
Harvey----------	0-10	Loam	CL	A-6	0	0	95-100	90-100	85-100	50-60	25-40	10-25
	10-28	Clay loam	CL	A-6	0	0	95-100	90-100	85-95	70-90	35-50	15-25
	28-42	Sandy clay loam	SC	A-6	0	0	90-100	85-95	75-90	40-50	25-35	10-20
	42-60	Sandy loam	SC-SM	A-2-4	0	0	95-100	90-100	60-80	25-45	20-30	4-7
54:												
Harvey----------	0-2	Fine sandy loam	SC-SM	A-4	0	0	95-100	90-100	75-85	35-50	20-30	4-7
	2-11	Fine sandy loam	SC-SM	A-4	0	0	100	95-100	75-85	35-50	20-30	4-7
	11-23	Clay loam	CL	A-6	0	0	90-100	85-95	80-90	70-90	35-50	15-25
	23-60	Sandy clay loam	SC	A-6	0	0	95-100	90-100	75-90	40-50	25-35	10-20
Cascajo---------	0-3	Very gravelly sandy loam	SC-SM	A-2-4	0	0-15	65-85	45-60	40-60	25-45	20-30	4-7
	3-9	Very gravelly sandy loam	SC-SM	A-2-4	0	0-15	70-90	50-65	45-65	25-45	20-30	4-7
	9-28	Very gravelly sand	SW-SM	A-1-b	0	0-15	60-80	40-60	35-45	0-20	0-0	NP
	28-60	Very gravelly sand	SW-SM	A-1-b	0	5-25	70-90	40-60	30-50	0-20	0-0	NP
55:												
La Fonda--------	0-4	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	4-26	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	26-60	Loam, clay loam	CL	A-6	0	0	100	95-100	85-100	50-60	25-40	10-25
56:												
Ildefonso-------	0-3	Cobbly loam	CL	A-6	0-5	15-30	70-85	60-80	45-65	40-60	25-40	10-25
	3-9	Cobbly loam	CL	A-6	0	10-30	70-85	65-80	50-70	50-65	25-40	10-25
	9-15	Very gravelly loam	SC	A-6	0	0-10	75-95	50-65	40-60	35-55	25-40	10-25
	15-60	Very cobbly loam	GC	A-2-6	5-10	35-55	40-55	40-55	25-35	20-35	25-40	10-25
57:												
Badland---------	0-60	Bedrock			---	---	---	---	---	---	---	---
58:												
Deama-----------	0-7	Very stony silt loam	ML	A-4	10-25	0-15	60-80	55-75	50-70	45-65	25-30	4-7
	7-14	Very cobbly silt loam	ML	A-4	5-12	5-20	70-85	50-65	50-65	45-65	25-30	4-7
	14-60	Bedrock			---	---	---	---	---	---	---	---
Elpedro---------	0-5	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	5-12	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	12-19	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	19-25	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	25-36	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	36-45	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
	45-60	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
59:												
Harvey----------	0-4	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	4-10	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	10-18	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	18-41	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	41-60	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
Ildefonso-------	0-2	Cobbly loam	CL	A-6	0	0-15	85-100	75-95	70-90	50-60	25-40	10-25
	2-8	Very gravelly loam	SC	A-4	0	0-20	80-100	40-60	40-55	40-50	20-30	7-10
	8-13	Very gravelly loam	SC	A-4	0	5-20	75-95	35-55	35-50	30-50	20-30	7-10
	13-32	Very cobbly sandy loam	GM	A-2-4	0	20-45	55-75	35-55	30-50	25-45	15-25	NP-4
	32-40	Very cobbly sandy loam	GM	A-2-4	0	20-50	50-70	35-55	30-50	25-45	15-25	NP-4
	40-60	Extremely cobbly sand	GW-GM	A-1-a	0	35-60	30-50	15-25	10-20	0-20	0-0	NP

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Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
59:												
La Fonda--------	0-3	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	3-7	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	7-14	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	14-26	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	26-42	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	42-60	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
63:												
Placitas--------	0-5	Gravelly loam	SC	A-2-4	0	0	100	60-80	45-60	15-35	20-30	5-20
	5-10	Very gravelly sandy loam	SM	A-1-b	0	0	100	50-70	30-50	10-30	10-25	NP-4
	10-27	Very gravelly sandy loam	SW-SM	A-1-b	0	0	100	35-55	15-35	0-20	10-25	NP-4
	27-60	Bedrock			---	---	---	---	---	---	---	---
64:												
Skyvillage------	0-4	Fine sandy loam	SC-SM	A-4	0	0-5	95-100	90-100	75-85	35-50	20-30	4-7
	4-11	Fine sandy loam	SC-SM	A-4	0	0-5	95-100	85-100	75-85	35-50	20-30	4-7
	11-18	Sandy loam	SC-SM	A-2-4	0	0-5	95-100	90-100	60-80	25-45	20-30	4-7
	18-60	Bedrock			---	---	---	---	---	---	---	---
Ildefonso-------	0-3	Gravelly sandy loam	SC-SM	A-2-4	0-3	0-15	70-85	55-75	50-70	25-45	20-30	4-7
	3-14	Very gravelly sandy loam	SM	A-2-4	0-3	5-15	65-85	40-60	35-55	25-45	15-25	NP-4
	14-60	Very gravelly sandy loam	GM	A-2-4	0-3	10-25	40-60	35-55	30-50	25-45	15-25	NP-4
65:												
Ildefonso-------	0-6	Very gravelly sandy loam	GM	A-1-a	0-3	0-25	40-55	35-50	25-35	10-20	15-25	NP-4
	6-38	Very gravelly sandy loam	GM	A-1-b	0-3	0-25	40-60	35-55	25-40	10-30	15-25	NP-4
	38-60	Very gravelly loam, very gravelly sandy loam	GM	A-1-b	0-3	10-25	40-60	35-55	25-50	10-40	15-25	NP-4
Harvey----------	0-4	Loam	CL	A-6	0	0	95-100	90-100	85-100	50-60	25-40	10-25
	4-23	Loam	CL	A-6	0	0	95-100	90-100	85-100	50-60	25-40	10-25
	23-36	Loam	CL	A-6	0	0	90-100	85-95	80-90	50-60	25-40	10-25
	36-60	Sandy loam	SC-SM	A-2-4	0	0	95-100	90-100	60-80	25-45	20-30	4-7
66:												
Zia-------------	0-4	Sandy loam	SC-SM	A-2-4	0	0	100	90-100	60-80	25-45	20-30	4-7
	4-60	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
67:												
Sandoval--------	0-2	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	2-11	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	11-60	Bedrock			---	---	---	---	---	---	---	---
Poley-----------	0-3	Very cobbly loam	SC	A-2-4	0	15-35	65-85	35-55	30-50	20-40	15-30	5-15
	3-12	Clay loam	CL	A-6	0	0	100	80-100	80-90	70-90	35-50	15-25
	12-17	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	17-21	Clay loam	CL	A-6	0	0	100	80-100	80-90	70-90	35-50	15-25
	21-40	Clay loam	CL	A-6	0	0-5	95-100	80-100	80-90	70-90	35-50	15-25
	40-60	Very gravelly sandy loam	GM	A-2-4	0	25-50	50-70	50-70	30-50	20-40	10-25	NP-4
68:												
Penistaja-------	0-2	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	15-20	NP-5
	2-15	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	15-27	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	27-38	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	38-60	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
Querencia-------	0-2	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	2-40	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	40-60	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
71:												
Palon-----------	0-6	Cobbly sandy loam	SC-SM	A-2-4	0-3	9-20	75-90	60-80	50-70	15-35	20-30	4-7
	6-27	Very cobbly sandy loam	SM	A-1-b	0-3	20-34	55-75	40-60	40-50	10-30	15-25	NP-4
	27-60	Extremely cobbly sandy loam	GW-GM	A-1-a	0-10	20-40	40-70	20-40	15-35	5-15	10-25	NP-4

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Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
72:												
Palon	0-2	Slightly decomposed plant material	PT	A-8	0	0	100	100	---	---	---	---
	2-4	Very cobbly sandy loam	GM	A-2-4	0-15	20-35	50-70	45-65	35-55	20-40	15-25	NP-4
	4-10	Extremely cobbly sandy loam	GW-GM	A-1-a	10-30	25-50	30-50	20-35	15-35	5-15	15-25	NP-4
	10-32	Extremely cobbly sandy loam	GM	A-1-a	15-35	20-50	30-45	20-40	15-35	10-20	15-25	NP-4
	32-53	Very cobbly sandy loam	GM	A-1-b	10-25	15-40	40-60	35-55	30-50	15-35	15-25	NP-4
	53-60	Very cobbly sandy loam	GM	A-1-b	5-20	10-35	50-70	45-65	35-55	15-35	15-25	NP-4
74:												
Origo	0-7	Very cobbly sandy loam	SM	A-1-b	0-3	0-15	75-90	50-70	40-60	15-35	10-20	NP-4
	7-28	Extremely cobbly sandy loam	GM	A-1-b	0	30-55	45-65	25-45	20-40	10-30	10-20	NP-4
	28-60	Extremely cobbly sandy loam	GM	A-1-b	0-15	25-40	50-65	30-45	15-35	10-30	10-20	NP-4
Pavo	0-9	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	9-12	Sandy loam	SC-SM	A-2-4	0	0-10	90-100	85-95	60-80	25-45	20-30	4-7
	12-25	Sandy loam	SC-SM	A-2-4	0	0	100	80-100	60-80	25-45	20-30	4-7
	25-35	Sandy loam	SC-SM	A-2-4	0	0-5	100	90-100	60-80	25-45	20-30	4-7
	35-45	Fine sandy loam	SC-SM	A-4	0	0	100	90-100	75-85	35-50	20-30	4-7
	45-50	Gravelly clay loam	CL, SC	A-6	0	0	90-100	60-80	60-70	40-60	35-50	15-25
	50-60	Sandy loam	SC-SM	A-2-4	0	0	85-100	75-95	60-80	25-45	20-30	4-7
75:												
Origo	0-1	Slightly decomposed plant material	PT	A-8	0	0	100	100	---	---	---	---
	1-6	Very cobbly sandy loam	GM	A-1-b	0-15	25-50	40-60	35-55	30-50	15-35	15-30	NP-4
	6-12	Very cobbly sandy loam	GM	A-1-b	0-15	20-50	40-60	35-55	25-45	15-35	15-30	NP-4
	12-32	Very cobbly sandy loam	GM	A-1-b	0-15	25-50	40-60	35-55	20-40	10-30	15-30	NP-4
	32-56	Very cobbly sandy loam	GM	A-1-b	0-15	25-50	40-60	40-60	30-50	10-30	15-30	NP-4
	56-60	Very cobbly loamy sand	GM	A-1-b	0-15	25-50	40-60	40-60	30-50	10-20	5-15	NP-4
82:												
Calaveras	0-2	Loam	SC	A-6	0	0-5	95-100	85-95	55-75	35-55	25-40	10-25
	2-6	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
	6-40	Very cobbly sandy loam	GP-GC	A-1-b	0-3	14-23	30-50	25-45	15-40	5-30	20-30	4-7
	40-60	Extremely cobbly coarse sandy loam	GC-GM	A-1-b	0-3	30-55	45-60	30-45	20-40	15-35	20-30	4-7
83:												
Calaveras	0-6	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	6-12	Sandy loam	SC-SM	A-4	0	0-5	95-100	85-95	55-75	35-55	20-30	4-7
	12-24	Very cobbly loam, very cobbly sandy loam	GC-GM	A-1-b	0-5	14-23	45-65	40-60	20-35	15-25	20-30	4-7
	24-60	Extremely cobbly coarse sandy loam, extremely cobbly loamy coarse sand	GC-GM	A-1-b	0-5	30-50	40-60	30-45	20-40	15-35	20-30	4-7
Rubble land	0-60	Fragmental material	GW	A-1-a	40-60	20-40	0-15	0-5	0-5	0	0-0	NP

Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
85:												
Redondo	0-2	Coarse sandy loam	SM	A-2-4	0	0	100	100	50-70	20-40	15-25	NP-4
	2-7	Coarse sandy loam	SM	A-2-4	0	0	100	100	50-70	20-40	15-25	NP-4
	7-15	Coarse sandy loam	SM	A-2-4	0	0-5	95-100	95-100	50-70	20-40	15-25	NP-4
	15-22	Coarse sandy loam	SM	A-2-4	0	0	100	95-100	50-70	20-40	15-25	NP-4
	22-29	Gravelly coarse sandy loam	SM	A-2-4	0	0	100	65-85	50-70	20-40	10-20	NP-4
	29-38	Very gravelly coarse sandy loam	SM	A-1-b	0-10	0-15	75-95	45-65	35-55	10-30	5-15	NP-4
	38-54	Extremely gravelly coarse sandy loam	SW-SM	A-1-a	0-15	0-15	70-90	10-30	0-20	0-10	5-15	NP-4
	54-60	Extremely cobbly coarse sandy loam	SW-SM	A-1-a	5-25	15-35	50-70	0-20	0-20	0-10	5-15	NP-4
86:												
Redondo	0-8	Cobbly coarse sandy loam	SM	A-2-4	0	10-20	80-90	70-80	50-70	20-40	15-25	NP-4
	8-13	Very cobbly coarse sandy loam	SM	A-2-4	0-5	10-30	70-80	50-70	40-60	20-40	15-25	NP-4
	13-34	Extremely cobbly coarse sandy loam	GW-GM	A-1-a	0-10	20-60	45-65	25-45	20-30	5-15	10-20	NP-4
	34-60	Extremely cobbly coarse sandy loam	GC-GM	A-1-a	0	40-80	25-45	20-40	15-25	5-15	10-20	NP-4
87:												
Redondo	0-6	Cobbly loam	CL, SC	A-4	0	10-20	80-90	70-90	60-80	40-60	20-30	5-15
	6-13	Very cobbly coarse sandy loam	SM	A-1-b	0	15-35	65-85	50-70	40-60	15-35	10-20	NP-4
	13-60	Very cobbly coarse sandy loam	SM	A-1-b	0	15-35	65-85	50-65	40-60	15-35	10-20	NP-4
Rubble land	0-60	Fragmental material	GW	A-1-a	50-60	20-30	0-10	0-5	0-5	0	0-0	NP
88:												
Totavi	0-12	Sandy loam	SC-SM	A-2-4	0	0	95-100	80-100	60-80	25-45	20-30	4-7
	12-60	Loamy sand	SM	A-2-4	0	0	100	85-100	55-75	15-35	10-20	NP-4
Jemez	0-6	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	6-13	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	13-19	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	19-27	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	27-60	Bedrock			---	---	---	---	---	---	---	---
Rock outcrop	0-60	Bedrock			---	---	---	---	---	---	---	---
91:												
Zia	0-16	Sandy loam	SC-SM	A-2-4	0	0	100	90-100	60-80	25-45	20-30	4-7
	16-22	Loamy sand	SM	A-2-4	0	0	100	100	60-80	15-35	15-20	NP-4
	22-35	Sandy loam	SC-SM	A-2-4	0	0	100	90-100	60-80	25-45	20-30	4-7
	35-60	Fine sandy loam	SC-SM	A-4	0	0	98-100	85-100	75-85	35-50	20-30	4-7
92:												
Galisteo, moderately saline, sodic	0-12	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	12-60	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
93:												
Zia	0-8	Loamy sand	SM	A-2-4	0	0	100	90-100	60-80	15-35	15-20	NP-4
	8-60	Sandy loam	SC-SM	A-2-4	0	0	100	90-100	60-80	25-45	20-30	4-7
95:												
El Rancho	0-5	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	5-20	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	20-38	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	38-60	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7

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Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
97:												
El Rancho-------	0-8	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	8-60	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
100:												
Orejas----------	0-5	Very stony loam	GC	A-2-4	5-25	10-30	50-70	50-70	40-50	20-40	20-30	7-10
	5-15	Very cobbly clay loam	GC	A-2-6	0-15	15-40	50-70	50-70	30-40	25-35	30-40	10-15
	15-19	Very cobbly clay loam	GC	A-2-6	0	20-50	50-70	45-65	30-45	25-40	30-40	10-15
	19-60	Bedrock			---	---	---	---	---	---	---	---
Rock outcrop----	0-60	Bedrock			---	---	---	---	---	---	---	---
101:												
Blancot---------	0-2	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	2-5	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	5-14	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	30-40	15-25
	14-23	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	23-40	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
	40-49	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	49-60	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
Lybrook---------	0-1	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	1-5	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	5-21	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	21-30	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	30-60	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
102:												
Sparham---------	0-7	Clay loam	CL	A-6	0	0	100	80-100	75-95	65-85	35-50	15-25
	7-29	Clay loam	CL	A-6	0	0	95-100	85-100	80-90	65-85	35-50	15-25
	29-60	Clay loam, silty clay loam	CL	A-6	0	0	100	90-100	85-95	75-95	35-45	15-25
104:												
Cochiti---------	0-7	Gravelly loam	CL	A-6	0	0-10	80-100	70-90	70-80	50-60	25-40	10-20
	7-12	Gravelly clay loam	CL	A-6	0	0-10	80-100	60-80	60-80	55-75	35-50	15-25
	12-20	Very gravelly clay	CH, SC	A-7-6	0	0-10	80-95	50-60	50-60	45-55	50-60	25-35
	20-29	Very gravelly clay loam	SC	A-6	0	0-10	80-95	50-60	50-60	40-50	35-50	15-25
	29-60	Very gravelly sandy loam	SC-SM	A-1-b	0	0-10	80-100	35-55	25-35	20-35	20-30	4-7
Montecito-------	0-3	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	3-9	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	9-15	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	15-22	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	22-37	Sandy loam, loam	SC-SM	A-2-4	0	0	90-100	85-100	60-80	25-45	20-30	4-7
	37-60	Gravelly sandy loam	SM	A-2-4	0	0	85-100	65-85	40-60	20-40	15-25	NP-4
105:												
Badland---------	0-60	Bedrock			---	---	---	---	---	---	---	---
Menefee---------	0-4	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	4-10	Clay loam	CL	A-6	0	0	90-100	85-100	80-100	70-90	35-50	15-25
	10-60	Bedrock			---	---	---	---	---	---	---	---
106:												
Stumble---------	0-4	Very gravelly fine sandy loam	SM	A-1-b	0	0	80-100	45-65	35-55	15-35	15-25	NP-4
	4-10	Gravelly fine sandy loam	SC-SM	A-4	0	0	90-100	65-85	55-75	35-50	20-30	4-7
	10-24	Loamy sand	SM	A-2-4	0	0	100	85-100	60-80	20-40	10-20	NP-4
	24-60	Gravelly coarse sand	SW-SM	A-2-4, A-3	0	0	90-100	70-90	65-80	0-20	0-0	NP
Stumble, sandy--	0-4	Gravelly loamy sand	SM	A-1-b	0	0	85-100	65-80	30-50	10-15	15-20	NP-4
	4-18	Loamy sand	SM	A-2-4	0	0	90-100	80-95	50-65	10-20	15-20	NP-4
	18-60	Gravelly coarse sand, gravelly loamy sand	SW-SM	A-1-b	0	0	80-100	65-80	20-40	5-10	10-15	NP-4

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Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
108:												
Embudo	0-6	Gravelly sandy loam	SC-SM	A-2-4	0	0	80-100	65-85	60-80	25-45	20-30	4-7
	6-30	Sandy loam	SC-SM	A-2-4	0	0	90-100	85-90	60-80	25-45	20-30	4-7
	30-60	Loamy sand	SC-SM	A-2-4	0	0	90-100	85-90	55-65	15-35	20-30	4-7
109:												
Embudo	0-4	Gravelly sandy loam	SC-SM	A-2-4	0	0	90-100	70-90	60-80	25-45	20-30	4-7
	4-12	Gravelly fine sandy loam	SC-SM	A-4	0	0	90-100	75-95	75-85	35-50	20-30	4-7
	12-30	Gravelly coarse sandy loam	SC-SM	A-2-4	0	0	85-95	70-90	60-80	15-35	20-30	4-7
	30-60	Gravelly loamy coarse sand	SM	A-2-4	0	0	90-100	60-80	55-65	10-20	10-20	NP-4
Tijeras	0-4	Gravelly fine sandy loam	SM	A-2-4	0	0	100	70-90	50-70	30-40	15-25	NP-4
	4-10	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	10-20	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	20-26	Gravelly sandy loam	SM	A-2-4	0	0	100	70-90	50-70	25-35	15-25	NP-4
	26-60	Very gravelly coarse sandy loam	SM	A-2-4	0	0	80-100	40-60	35-55	5-25	15-25	NP-4
110:												
Rock outcrop	0-60	Bedrock			---	---	---	---	---	---	---	---
Saido	0-5	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
	5-9	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
	9-15	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
	15-25	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
	25-60	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
111:												
Rock outcrop	0-60	Bedrock			---	---	---	---	---	---	---	---
Zia	0-5	Sandy loam	SC-SM	A-2-4	0	0	100	95-100	60-80	25-45	20-30	4-7
	5-60	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
112:												
Tijeras	0-3	Gravelly fine sandy loam	SC-SM	A-4	0	0-10	85-100	70-85	60-80	30-50	20-30	4-7
	3-14	Sandy clay loam	SC	A-6	0	0	95-100	80-95	70-90	30-50	25-35	10-20
	14-60	Gravelly sandy loam	SC-SM	A-2-4	0	0	85-100	60-80	40-60	25-45	20-30	4-7
114:												
San Mateo	0-7	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
	7-60	Stratified sandy loam to loam to clay loam to silty clay loam	CL, SC	A-6	0	0	100	90-100	80-100	40-60	25-40	10-25
Zia	0-3	Fine sandy loam	SC-SM	A-4	0	0	100	90-100	75-85	35-50	20-30	4-7
	3-60	Fine sandy loam	SC-SM	A-4	0	0	100	95-100	75-85	35-50	20-30	4-7
120:												
Pinavetes	0-10	Loamy sand	SM	A-2	0	0	100	100	60-80	15-35	15-20	NP-4
	10-35	Sand	SW-SM	A-3	0	0	100	100	65-80	0-20	0-0	NP
	35-60	Sand	SW-SM	A-3	0	0	100	85-100	65-80	0-20	0-0	NP
124:												
Rock outcrop	0-60	Bedrock			---	---	---	---	---	---	---	---
129:												
Menefee	0-5	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	5-10	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	10-17	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	17-60	Bedrock			---	---	---	---	---	---	---	---
130:												
Pinavetes	0-2	Loamy sand	SM	A-2-4	0	0	100	100	60-80	10-30	15-20	NP-4
	2-60	Loamy sand	SM	A-2-4	0	0	100	100	60-80	10-30	15-20	NP-4
Galisteo, moderately saline, sodic	0-2	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	2-60	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35

Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
142:												
Grieta----------	0-3	Fine sandy loam	SC-SM	A-4	0	0	100	90-100	75-85	35-50	20-30	4-7
	3-11	Fine sandy loam	SC-SM	A-4	0	0	90-100	85-100	75-85	35-50	20-30	4-7
	11-34	Sandy clay loam	SC	A-6	0	0	100	90-100	75-90	40-50	25-35	10-20
	34-48	Sandy clay loam	SC	A-6	0	0	90-100	90-100	75-90	40-50	25-35	10-20
	48-60	Loamy sand	SM	A-2-4	0	0	90-100	90-100	60-80	15-35	10-20	NP-4
143:												
Clovis----------	0-3	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	3-7	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	7-12	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	12-22	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	22-34	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	34-60	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
145:												
Grieta----------	0-7	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	15-20	NP-4
	7-14	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-25
	14-21	Sandy clay loam	SC	A-6	0	0	90-100	90-100	75-90	40-50	25-35	10-25
	21-38	Coarse sandy loam	SC-SM	A-2-4	0	0	90-100	85-100	55-75	20-40	15-30	4-7
	38-50	Coarse sandy loam	SC-SM	A-2-4	0	0	100	95-100	55-75	20-40	15-30	4-7
	50-60	Coarse sandy loam	SC-SM	A-2-4	0	0	100	95-100	55-75	20-40	15-30	4-7
Sheppard--------	0-5	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	5-15	NP-4
	5-27	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	5-15	NP-4
	27-60	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	5-15	NP-4
146:												
Sedmar----------	0-3	Loamy sand	SM	A-2-4	0	0	100	100	60-80	20-40	5-15	NP-4
	3-13	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
	13-18	Loamy sand	SM	A-2-4	0	0	100	100	60-80	20-40	5-15	NP-4
	18-60	Bedrock			---	---	---	---	---	---	---	---
150:												
Doakum----------	0-5	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	5-11	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	11-17	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	17-24	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	24-31	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	31-44	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	44-60	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
Betonnie--------	0-2	Fine sandy loam	SC-SM	A-4	0	0	90-100	80-95	75-85	35-50	20-30	4-7
	2-4	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	4-12	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	12-18	Sandy loam	SC-SM	A-2-4	0	0	95-100	80-95	60-80	25-45	20-30	4-7
	18-34	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
	34-60	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
162:												
Hackroy---------	0-3	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
	3-13	Clay	CH	A-7-6	0	0	95-100	95-100	85-95	70-90	50-60	25-35
	13-60	Bedrock			---	---	---	---	---	---	---	---
Nyjack----------	0-3	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	3-13	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	13-24	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	24-39	Gravelly sandy loam	SC-SM	A-2-4	0	0	75-95	65-85	60-80	25-45	2-30	4-7
	39-60	Bedrock			---	---	---	---	---	---	---	---
163:												
Jemez-----------	0-3	Loam	CL	A-6	0	0	100	90-100	80-100	50-60	25-40	10-25
	3-24	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	24-39	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	39-60	Bedrock			---	---	---	---	---	---	---	---
170:												
San Mateo-------	0-2	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	2-10	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	10-23	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	23-32	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	32-54	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	54-60	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25

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Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
180:												
Councelor-------	0-2	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	2-7	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	30-50	20-30	4-7
	7-37	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	30-50	20-30	4-7
	37-40	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	40-60	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
Eslendo---------	0-3	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	3-10	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	10-60	Bedrock			---	---	---	---	---	---	---	---
Mespun----------	0-6	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	15-20	NP-4
	6-60	Loamy sand	SM	A-2-4	0	0	100	100	60-80	15-35	15-20	NP-4
183:												
Sheppard--------	0-4	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	15-20	NP-4
	4-45	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	15-20	NP-4
	45-60	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	15-20	NP-4
185:												
Frijoles--------	0-3	Very fine sandy loam	CL-ML	A-4	0	0	100	100	80-100	45-60	20-30	4-7
	3-8	Very gravelly clay loam	CL	A-6	0	0	90-100	55-75	50-70	45-65	35-50	15-25
	8-13	Very gravelly clay loam	CL, SC	A-6	0	0	80-100	45-65	45-55	40-55	35-50	15-25
	13-20	Extremely gravelly sandy loam	SC-SM	A-1-b	0	0	60-80	20-40	20-30	15-25	20-30	4-7
	20-60	Fragmental material	SP	A-1-a	0	0	80-90	0-10	0-5	0-5	0-10	NP
190:												
Zia----------	0-5	Sandy loam	SC-SM	A-2-4	0	0	100	85-100	60-80	25-45	20-30	4-7
	5-28	Sandy loam	SC-SM	A-2-4	0	0	100	95-100	60-80	25-45	20-30	4-7
	28-60	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
Skyvillage------	0-2	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	2-11	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	11-16	Fine sandy loam	SC-SM	A-4	0	0	100	85-100	75-85	35-50	20-30	4-7
	16-60	Bedrock			---	---	---	---	---	---	---	---
Rock outcrop----	0-60	Bedrock			---	---	---	---	---	---	---	---
191:												
Sheppard--------	0-3	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	15-20	NP-4
	3-27	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	15-20	NP-4
	27-60	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	15-20	NP-4
200:												
Sedillo----------	0-4	Very cobbly sandy loam	SM	A-1-b	3-6	14-17	70-90	50-70	25-45	10-30	15-25	NP-4
	4-13	Very gravelly sandy clay loam	SC	A-2-4	0-3	5-15	80-100	50-70	30-50	20-40	20-30	5-15
	13-60	Extremely gravelly coarse sandy loam	SW-SM	A-1-a	0-10	10-20	70-90	30-50	10-20	5-15	15-25	NP-4
201:												
Rock outcrop----	0-60	Bedrock			---	---	---	---	---	---	---	---
Sedgran----------	0-4	Extremely gravelly loamy coarse sand	SW-SM	A-1-a	0	10-35	70-90	25-45	10-30	0-10	10-20	NP-4
	4-13	Very gravelly loamy coarse sand	SW-SM	A-1-b	0	0-10	90-100	45-65	20-40	5-20	10-20	NP-4
	13-60	Bedrock			---	---	---	---	---	---	---	---
206:												
Pinitos----------	0-4	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	4-10	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	10-27	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	27-39	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	39-60	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25

Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
207:												
Penistaja-------	0-3	Very fine sandy loam	CL-ML, SC-SM	A-4	0	0	100	100	80-100	40-60	20-30	4-7
	3-29	Sandy clay loam, clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	29-60	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
Zia-------------	0-5	Fine sandy loam	SC-SM	A-4	0	0	100	90-100	75-85	35-50	20-30	4-7
	5-60	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
208:												
Sedillo---------	0-2	Very gravelly fine sandy loam	SM	A-1-a	0	0	100	35-55	20-40	10-20	10-20	NP-4
	2-8	Very gravelly sandy clay loam	SC	A-2-4	0	0	100	40-60	30-40	20-30	15-30	5-15
	8-12	Very gravelly sandy loam	SM	A-1-a	0	0	100	40-60	20-40	10-20	10-20	NP-4
	12-60	Extremely gravelly sandy loam	SW-SM	A-1-a	0	0	100	30-50	15-35	5-15	10-20	NP-4
210:												
Ildefonso-------	0-3	Very stony loam	GC	A-6	35-50	0-10	40-65	35-55	35-50	35-45	20-30	4-20
	3-9	Very stony loam	GC	A-6	35-50	0-5	40-60	40-55	35-55	30-50	20-30	4-20
	9-60	Very stony loam	GC	A-6	35-50	5-15	45-55	40-55	40-50	35-50	20-30	4-20
211:												
Zia-------------	0-5	Sandy loam	SC-SM	A-2-4	0	0	100	90-100	60-80	25-45	20-30	4-7
	5-14	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
	14-33	Sandy loam	SC-SM	A-2-4	0	0	100	95-100	60-80	25-45	20-30	4-7
	33-46	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	46-60	Sandy loam	SC-SM	A-2-4	0	0	100	90-100	60-80	25-45	20-30	4-7
Clovis----------	0-5	Fine sandy loam	SC-SM	A-4	0	0	100	100	70-90	40-60	20-30	4-7
	5-60	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
213:												
Pinavetes-------	0-7	Sand	SW-SM	A-2-4, A-3	0	0	100	100	50-70	0-20	0-0	NP
	7-60	Stratified sand to loamy sand	SW-SM	A-2-4, A-3	0	0	100	100	71-76	0-20	0-0	NP
Rock outcrop----	0-60	Bedrock			---	---	---	---	---	---	---	---
215:												
Ess-------------	0-7	Very cobbly sandy loam	GC-GM	A-2-4	0-10	20-40	50-70	40-60	35-55	25-45	20-30	4-7
	7-15	Very cobbly sandy loam	GC-GM	A-2-4	0-10	20-35	55-75	45-65	40-55	25-45	20-30	4-7
	15-29	Very cobbly sandy clay loam	GC	A-6	0-15	15-35	50-70	40-60	40-50	35-45	25-35	10-20
	29-60	Very cobbly loam	GC	A-6	0-10	10-30	60-80	35-55	35-50	30-50	25-40	10-25
Rock outcrop----	0-60	Bedrock			---	---	---	---	---	---	---	---
217:												
Witt------------	0-2	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	2-9	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	9-60	Stratified very fine sandy loam to loam	CL, SC	A-6	0	0	100	100	85-100	40-60	25-40	10-25
218:												
Ildefonso-------	0-4	Very cobbly loam	GC	A-6	0-10	25-45	50-70	45-65	40-60	35-55	20-35	10-20
	4-8	Very cobbly loam	GC	A-6	0-10	30-50	45-65	40-60	40-60	30-50	20-35	10-20
	8-60	Very cobbly sandy loam	GC-GM	A-2-4	0-10	25-45	50-70	45-60	25-35	25-35	15-25	4-7
220:												
Rock outcrop----	0-60	Bedrock			---	---	---	---	---	---	---	---
Vessilla--------	0-2	Sandy loam	SC-SM	A-2-4	0	0-10	100	100	60-80	25-45	20-30	4-7
	2-10	Sandy loam	SC-SM	A-2-4	0	0-10	90-100	85-100	50-70	20-40	20-30	4-7
	10-60	Bedrock			---	---	---	---	---	---	---	---

Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
220:												
Menefee---------	0-2	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	2-10	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	10-60	Bedrock			---	---	---	---	---	---	---	---
226:												
Galisteo, moderately saline, sodic--	0-10	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	10-60	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
227:												
Hagerman--------	0-4	Fine sandy loam	SC-SM	A-4	0	0	95-100	90-100	75-85	35-50	20-30	4-7
	4-34	Clay loam	CL	A-6	0	0	95-100	90-100	85-95	70-90	35-50	15-25
	34-60	Bedrock			---	---	---	---	---	---	---	---
Bond------------	0-4	Loamy fine sand	SM	A-2-4	0	0-10	90-100	85-100	50-85	15-45	15-20	NP-4
	4-12	Sandy clay loam	CL	A-6	0	0-10	90-100	90-100	75-90	50-70	25-35	10-20
	12-60	Bedrock			---	---	---	---	---	---	---	---
228:												
Winona----------	0-2	Very channery fine sandy loam	SW-SM	A-1-a	0	10-20	60-80	35-55	15-35	5-15	10-20	NP-4
	2-13	Very channery loam	SC	A-2-4	0	0	70-90	45-65	35-45	15-35	15-35	5-15
	13-60	Bedrock			---	---	---	---	---	---	---	---
230:												
Skyvillage------	0-6	Sandy loam	SC-SM	A-2-4	0	0-5	95-100	85-100	60-80	25-45	20-30	4-7
	6-11	Sandy loam	SC-SM	A-2-4	0	0-5	95-100	85-100	60-80	25-45	20-30	4-7
	11-60	Bedrock			---	---	---	---	---	---	---	---
Sandoval--------	0-2	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	2-10	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	10-60	Bedrock			---	---	---	---	---	---	---	---
Rock outcrop----	0-60	Bedrock			---	---	---	---	---	---	---	---
231:												
Querencia-------	0-3	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	3-21	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	21-60	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
234:												
Querencia-------	0-3	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	3-25	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	25-60	Stratified loam to fine sandy loam	SC	A-4	0	0	100	100	80-90	40-50	20-40	5-15
Zia-------------	0-11	Sandy loam	SC-SM	A-2-4	0	0	100	90-100	60-80	25-45	20-30	4-7
	11-60	Sandy loam	SC-SM	A-2-4	0	0	100	95-100	60-80	25-45	20-30	4-7
235:												
Sandoval--------	0-2	Fine sandy loam	SC-SM	A-4	0	0	100	95-100	75-85	35-50	20-30	4-7
	2-16	Clay loam	CL	A-6	0	0	95-100	90-100	85-95	70-90	35-50	15-25
	16-19	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	19-60	Bedrock			---	---	---	---	---	---	---	---
236:												
Sparank, moderately saline, sodic--	0-2	Clay loam	CL	A-6	0	0	100	90-100	85-95	70-90	35-50	15-25
	2-10	Silty clay	CL	A-7-6	0	0	100	95-100	90-100	75-95	40-50	15-25
	10-24	Silty clay	CL	A-7-6	0	0	100	95-100	90-100	75-95	40-50	15-25
	24-40	Silty clay loam	CL	A-6	0	0	100	90-100	85-95	70-90	35-45	15-25
	40-44	Silty clay	CL	A-7-6	0	0	100	95-100	90-100	75-95	40-50	15-25
	44-60	Silty clay	CL	A-7-6	0	0	100	90-100	85-95	75-95	40-50	15-25
237:												
Sparank---------	0-4	Silty clay loam	CL	A-6	0	0	100	90-100	90-100	75-90	35-45	15-25
	4-60	Silty clay loam	CL	A-6	0	0	100	95-100	90-100	75-90	35-45	15-25
240:												
Penistaja-------	0-5	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	5-14	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	14-29	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	29-60	Stratified sandy clay loam to fine sandy loam to loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20

Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
240:												
Hagerman--------	0-2	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	2-9	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	9-24	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	24-60	Bedrock			---	---	---	---	---	---	---	---
250:												
Pinavetes-------	0-4	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	15-20	NP-4
	4-60	Loamy sand	SM	A-2-4	0	0	100	100	55-75	15-35	15-20	NP-4
262:												
Pastura---------	0-3	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	3-10	Gravelly loam	CL, SC	A-6	0	0	80-100	75-90	70-90	45-60	25-40	10-25
	10-14	Gravelly loam	CL	A-6	0	0	90-100	75-95	65-85	50-60	25-40	10-25
	14-60	Cemented material			---	---	---	---	---	---	---	---
270:												
Blancot---------	0-2	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	2-12	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	12-21	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	21-60	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
Councelor-------	0-2	Fine sandy loam	SC-SM	A-2-4	0	0	100	100	60-70	30-40	20-30	4-7
	2-60	Fine sandy loam, sandy loam	SC-SM	A-4	0	0	100	90-100	65-90	30-50	20-30	4-7
Tsosie----------	0-2	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	2-10	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	10-20	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	20-26	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	26-36	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	36-44	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
	44-55	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
	55-60	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
281:												
Carjo-----------	0-4	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	4-12	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	12-20	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
	20-25	Very fine sandy loam	CL-ML, SC-SM	A-4	0	0	100	100	80-90	40-60	20-30	4-7
	25-60	Bedrock			---	---	---	---	---	---	---	---
282:												
Tocal-----------	0-5	Very fine sandy loam	CL-ML, SC-SM	A-4	0	0	100	100	80-90	40-60	20-30	4-7
	5-8	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	8-11	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
	11-14	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
	14-60	Bedrock			---	---	---	---	---	---	---	---
283:												
Mirand----------	0-2	Slightly decomposed plant material	PT	A-8	0	0	100	100	---	---	---	---
	2-6	Loam	CL	A-6	0	0	95-100	90-100	85-100	50-60	25-40	10-25
	6-11	Clay loam	CL	A-6	0	0	90-100	85-95	80-95	70-90	35-50	15-25
	11-17	Gravelly clay loam	CL	A-6	0	0	90-100	80-95	75-90	65-85	35-50	15-25
	17-27	Clay loam	CL	A-6	0	0	90-100	85-95	80-90	70-90	35-50	15-25
	27-47	Clay	CH	A-7-6	0	0	90-100	80-100	80-95	70-90	50-60	25-35
	47-60	Clay loam	CL	A-6	0	0	95-100	85-100	80-95	70-90	35-50	15-25
Alanos----------	0-6	Cobbly loam	GC	A-6	0-5	15-30	65-85	60-70	40-60	25-50	25-40	10-25
	6-9	Cobbly loam	GC	A-6	0-5	15-30	65-85	60-70	40-60	25-50	25-40	10-25
	9-30	Extremely gravelly clay loam	GC, GP-GC	A-2-6	0-10	5-20	15-45	15-35	10-30	5-15	35-50	15-25
	30-60	Very gravelly clay	GC	A-7-6	0-10	0-10	55-75	50-60	40-60	30-50	50-60	25-35
290:												
Alanos----------	0-4	Loam	CL	A-6	0	0	90-100	85-95	80-90	50-60	25-40	10-25
	4-9	Loam	CL	A-6	0	0	90-100	85-95	80-90	50-60	25-40	10-25
	9-18	Very gravelly loam	SC	A-2-6	0	0	65-85	35-55	30-40	30-40	25-40	10-25
	18-26	Extremely gravelly clay	GC	A-2-7	0	10-30	35-55	15-35	10-30	10-20	50-60	25-35
	26-60	Extremely gravelly clay	GC	A-2-7	0	10-30	35-55	15-35	10-30	10-20	50-60	25-35

Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
290:												
Rock outcrop----	0-60	Bedrock			---	---	---	---	---	---	---	---
300:												
Waumac----------	0-3	Loamy sand	SM	A-2-4	0	0	100	100	60-80	20-40	15-20	NP-4
	3-31	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	31-60	Gravelly fine sandy loam	SC-SM	A-2-4	0	0	100	70-90	40-60	20-40	20-30	4-7
Bamac-----------	0-6	Gravelly loamy sand	SM	A-1-b	0	0-10	60-80	55-75	40-60	10-25	15-20	NP-4
	6-60	Stratified very gravelly coarse sand to very gravelly loamy sand	GW-GM	A-1	0	0-8	43-66	40-65	32-54	9-17	15-20	NP-4
301:												
Vastine---------	0-4	Silt loam	ML	A-6	0	0	100	100	89-99	73-83	31-45	10-17
	4-11	Loam	CL	A-6	0	0	100	100	84-94	60-70	26-41	10-17
	11-24	Loam	CL	A-6	0	0	76-100	75-100	63-94	45-70	26-39	10-17
	24-60	Very gravelly loamy sand	GP-GC	A-1	0	0-1	31-54	28-52	22-43	6-13	16-23	2-6
Jarola----------	0-9	Silt loam	CL, ML	A-6	0	0	100	100	89-99	73-83	28-43	10-17
	9-11	Silt loam	CL	A-6	0	0	100	100	89-99	73-83	27-40	10-17
	11-17	Silty clay loam	CL	A-6, A-7	0	0	100	100	96-100	85-92	38-47	19-25
	17-21	Clay loam	CL	A-6, A-7	0	0	100	100	88-95	68-75	37-46	19-25
	21-42	Gravelly sandy clay loam	SC	A-6	0	0	63-100	62-100	50-92	27-55	31-42	13-21
	42-60	Very gravelly sandy loam	SM, GC-GM	A-2-4, A-1-b	0	0	39-59	36-57	26-47	13-26	16-27	2-10
302:												
Tranquilar------	0-4	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	4-8	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	8-11	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	11-13	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	13-20	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
	20-34	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
	34-42	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
	42-50	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
	50-60	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
Jarmillo--------	0-4	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	4-13	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	13-20	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	20-26	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	26-36	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	36-41	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	41-51	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	51-60	Very fine sandy loam	CL-ML	A-4	0	0	100	100	80-90	40-60	20-30	4-7
304:												
Cosey-----------	0-9	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
	9-15	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
	15-28	Gravelly loam	CL	A-6	0	0-15	80-100	60-80	55-65	55-65	25-40	10-25
	28-34	Very gravelly sandy clay loam	SC	A-2-6	0	0-15	80-100	35-55	30-50	15-35	25-35	10-20
	34-60	Extremely cobbly clay loam	GC	A-2-6	0	35-60	50-70	25-35	25-35	25-35	35-50	15-25
Jarmillo--------	0-17	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
	17-33	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
	33-60	Sandy loam, loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
307:												
Flugle----------	0-3	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	3-7	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	7-12	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	12-19	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	19-60	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
Waumac----------	0-3	Loamy sand	SM	A-2-4	0	0	95-100	95-100	65-85	20-40	15-20	NP-4
	3-60	Stratified fine sandy loam to sandy loam	SC-SM	A-4	0	0	92-100	92-100	65-85	30-50	20-30	4-7

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Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
308:												
Cajete----------	0-7	Gravelly loam	CL	A-6	0	0	80-100	70-90	70-80	50-60	25-40	10-25
	7-15	Gravelly loam	CL	A-6	0	0	80-100	70-90	70-80	50-60	25-40	10-25
	15-33	Very gravelly sandy loam	SC-SM	A-2-4	0	0	75-95	50-70	45-55	25-45	20-30	4-7
	33-45	Very gravelly sand	SW-SM	A-1-b	0	0	70-90	40-60	30-50	0-15	0-0	NP
	45-49	Extremely gravelly sand	SW-SM	A-1-a	0	0	70-90	30-50	10-30	0-15	0-0	NP
	49-60	Very gravelly sand	SW-SM	A-1-a	0	0	80-90	40-60	10-30	0-15	0-0	NP
311:												
Cosey----------	0-13	Silt loam	ML	A-4	0-2	0-10	90-100	90-100	80-90	65-80	25-30	4-7
	13-24	Gravelly loam	SC	A-2-6	0-2	0-10	65-75	60-70	50-60	25-45	25-40	10-25
	24-60	Extremely cobbly clay loam	GC	A-2-6	0-15	35-65	30-45	30-45	25-45	15-35	35-50	15-25
Tranquilar------	0-14	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
	14-20	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
	20-42	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
	42-60	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
Calaveras-------	0-4	Silt loam	ML	A-4	0	0	100	90-100	90-100	70-90	25-30	4-7
	4-11	Silt loam	ML	A-4	0	0	100	85-100	85-95	70-85	25-30	4-7
	11-17	Gravelly silt loam	ML	A-4	0-10	0	90-100	65-85	60-80	55-75	25-30	4-7
	17-30	Very cobbly loam	SC	A-6	0-10	10-30	65-85	45-65	40-60	35-55	25-40	10-25
	30-39	Extremely cobbly coarse sandy loam	GC-GM	A-2-4	0-10	15-40	45-65	30-40	25-35	25-35	20-30	4-7
	39-60	Extremely cobbly loamy sand	GM	A-1-b	0-15	15-40	50-70	35-45	20-40	15-35	15-20	NP-4
312:												
Royosa----------	0-5	Sand	SW-SM	A-2-4, A-3	0	0	100	100	65-80	0-20	0-0	NP
	5-16	Sand	SW-SM	A-2-4, A-3	0	0	100	100	65-80	0-20	0-0	NP
	16-60	Loamy sand	SM	A-2-4	0	0	100	100	60-80	10-30	10-20	NP-4
314:												
Fragua----------	0-3	Loamy sand	SM	A-2-4	0	0	100	100	60-80	15-35	10-20	NP-4
	3-8	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
	8-24	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
	24-60	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
Waumac----------	0-3	Loamy fine sand	SM	A-2-4	0	0	100	95-100	65-85	20-40	15-20	NP-4
	3-60	Fine sandy loam	SC-SM	A-4	0	0	100	95-100	75-85	35-50	20-30	4-7
Royosa----------	0-7	Fine sand	SW-SM	A-2-4, A-3	0	0	100	100	65-80	0-20	0-0	NP
	7-60	Fine sand	SW-SM	A-2-4, A-3	0	0	100	100	65-80	0-20	0-0	NP
317:												
Elpedro---------	0-2	Loam	CL	A-6	0	0	95-100	90-100	85-95	50-60	25-40	10-25
	2-22	Silty clay loam	CL	A-6	0	0	95-100	90-100	90-100	75-90	35-45	15-25
	22-60	Loam	CL	A-6	0	0	95-100	90-100	85-95	50-60	25-40	10-25
319:												
Bamac-----------	0-4	Very gravelly loamy sand	GM	A-1-b	0	0	40-50	35-50	25-45	15-25	10-20	NP-4
	4-10	Loamy sand	SM	A-2-4	0	0-3	90-100	85-95	50-65	5-20	10-20	NP-4
	10-21	Very gravelly loamy coarse sand	GC-GM, GM	A-1-b	0	0	40-50	35-45	30-40	5-25	10-20	NP-4
	21-37	Very gravelly loamy coarse sand	SM	A-1-b	0	0	65-85	35-55	30-50	15-25	10-20	NP-4
	37-60	Very gravelly loamy coarse sand	SM	A-1-b	0	0	65-85	40-60	30-50	15-25	10-20	NP-4
Rock outcrop----	0-60	Bedrock			---	---	---	---	---	---	---	---
320:												
Sparham---------	0-9	Silt loam	ML	A-4	0	0	100	95-100	90-100	70-90	25-30	4-7
	9-32	Silty clay	CL	A-7-6	0	0	95-100	90-100	85-95	75-95	40-50	15-25
	32-60	Silty clay	CL	A-7-6	0	0	90-100	80-95	75-95	65-85	40-50	15-25
321:												
Waumac----------	0-3	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	15-20	NP-4
	3-60	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7

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Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
321:												
Royosa----------	0-12	Fine sand	SW-SM	A-2-4	0	0	100	100	65-80	0-20	0-0	NP
	12-60	Fine sand	SW-SM	A-2-4	0	0	100	100	65-80	0-20	0-0	NP
322:												
Fragua----------	0-3	Very cobbly fine sandy loam	GC-GM	A-4	0-5	20-30	60-80	45-65	40-60	35-50	20-30	4-7
	3-16	Sandy loam, fine sandy loam, very fine sandy loam	SC-SM	A-4	0	0-5	95-100	90-100	75-85	35-50	20-30	4-7
	16-45	Loamy fine sand	SM	A-2-4	0	0-5	95-100	90-100	65-85	20-40	10-20	NP-4
	45-60	Bedrock	---	---	---	---	---	---	---	---	---	---
324:												
Rock outcrop----	0-60	Bedrock	---	---	---	---	---	---	---	---	---	---
Atarque---------	0-3	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
	3-9	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	9-14	Sandy clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
	14-60	Bedrock	---	---	---	---	---	---	---	---	---	---
Menefee---------	0-2	Gravelly loam	CL	A-6	0	0	90-100	80-90	70-90	50-60	25-40	10-25
	2-9	Clay loam	CL	A-6	0	0	95-100	90-100	85-100	70-90	35-50	15-25
	9-60	Bedrock	---	---	---	---	---	---	---	---	---	---
325:												
Rock outcrop----	0-60	Bedrock	---	---	---	---	---	---	---	---	---	---
Espiritu--------	0-2	Very gravelly fine sandy loam	SC-SM	A-2-4	0-5	5-15	65-75	50-65	30-40	25-35	20-30	4-7
	2-20	Very gravelly sandy clay loam	GC	A-6	0-5	10-30	55-75	40-55	40-50	35-45	25-35	10-20
	20-60	Very gravelly loam	SC	A-6	0-5	10-30	65-85	40-50	35-45	30-45	25-40	10-25
Vessilla--------	0-1	Very gravelly sandy loam	SM	A-1-b	0	0-10	80-100	50-70	40-60	10-30	15-25	NP-4
	1-10	Gravelly loam	CL, SC	A-4	0	0-10	85-100	60-80	50-70	40-60	20-35	4-15
	10-60	Bedrock	---	---	---	---	---	---	---	---	---	---
342:												
Waumac----------	0-5	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	15-20	NP-4
	5-60	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
Vessilla--------	0-3	Fine sandy loam	SC-SM	A-2-4	0	0-5	95-100	85-95	70-80	30-40	20-30	4-7
	3-13	Fine sandy loam	SC-SM	A-2-4	0	0-5	95-100	85-95	60-80	25-40	20-30	4-7
	13-60	Bedrock	---	---	---	---	---	---	---	---	---	---
Rock outcrop----	0-60	Bedrock	---	---	---	---	---	---	---	---	---	---
345:												
Espiritu--------	0-6	Very gravelly fine sandy loam	SC-SM	A-4	0	0-20	75-90	50-70	40-50	35-45	20-30	4-7
	6-15	Very gravelly sandy clay loam	SC	A-6	0	0-20	80-100	50-70	45-55	35-45	25-35	10-20
	15-22	Very gravelly sandy clay loam	SC	A-6	0	0-20	70-90	45-60	45-55	35-45	25-35	10-20
	22-29	Very cobbly sandy clay loam	GC	A-6	0	15-30	60-70	45-55	40-50	35-45	25-35	10-20
	29-38	Very cobbly sandy clay loam	GC	A-6	0	15-30	60-80	40-60	40-60	35-45	25-35	10-20
	38-46	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	46-60	Very gravelly sandy loam	SC-SM	A-2-4	0	0-5	75-95	55-65	55-65	25-45	20-30	4-7
Bamac-----------	0-3	Very gravelly loamy sand	GM	A-1-b	0	0-10	45-55	40-50	35-45	15-25	10-20	NP-4
	3-30	Very gravelly loamy sand	GM, SW-SM	A-1-b	0	0-5	55-65	50-55	30-50	5-15	10-20	NP-4
	30-60	Stratified very gravelly loamy sand to loamy sand	SM	A-1-a	0	0-9	70-90	35-55	20-35	5-25	10-20	NP-4

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Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
346:												
Espiritu, cobbly	0-2	Extremely cobbly sandy loam	GC-GM	A-1-b	10-20	45-60	20-50	15-45	15-25	10-20	20-30	4-7
	2-24	Very gravelly sandy clay loam	SC	A-6	0-3	10-30	65-85	45-55	40-50	35-45	25-35	10-20
	24-36	Extremely gravelly sandy loam	GC-GM	A-2-4	0-3	15-30	50-70	30-50	30-45	25-45	20-30	4-7
	36-60	Very gravelly loamy sand	GM	A-2-4	0-3	15-30	55-75	35-55	30-50	20-40	15-20	NP-4
Bamac----------	0-3	Very gravelly loamy sand	GM	A-1-b	0	0-5	45-55	40-50	35-50	15-25	10-20	NP-4
	3-30	Very gravelly coarse sand, very gravelly loamy sand, very gravelly loamy coarse sand	GW-GM	A-1-b	0	0-5	45-55	40-50	20-40	5-15	10-20	NP-4
	30-45	Loamy sand	SM	A-2-4	0	0	100	100	60-80	20-40	10-20	NP-4
	45-60	Very gravelly loamy sand	GM	A-2-4	0	0-10	45-55	40-55	35-50	15-35	10-20	NP-4
348:												
Wauquie---------	0-2	Extremely gravelly sandy clay loam	SW-SC	A-2-4	0-10	10-20	60-80	30-45	20-30	5-15	15-25	4-15
	2-16	Very gravelly clay loam	SC	A-2-6	0-5	5-15	75-95	50-65	30-50	10-20	30-40	10-15
	16-40	Very gravelly sandy loam	GC-GM	A-1-b	0-3	5-15	35-55	30-50	20-40	5-15	10-25	NP-4
	40-60	Extremely gravelly loamy sand	SW-SM	A-1-a	0-3	10-20	60-80	30-45	10-20	5-10	5-15	NP-4
Rock outcrop----	0-60	Bedrock			---	---	---	---	---	---	---	---
353:												
Cochiti---------	0-4	Extremely gravelly loam	GC	A-2-6	0-5	15-30	20-35	15-30	15-25	10-20	25-40	10-25
	4-22	Very gravelly clay loam	GC	A-6	0-2	10-15	45-60	40-55	35-50	30-45	35-50	15-25
	22-60	Very gravelly loamy sand	GC-GM, GM	A-1-b	0-2	10-15	35-55	30-50	20-40	10-20	15-20	NP-4
Espiritu--------	0-3	Very gravelly loam	SC	A-6	0-5	5-15	70-90	50-70	40-60	30-50	25-40	10-25
	3-16	Very gravelly sandy clay loam	SC	A-6	0-5	5-15	75-95	50-70	40-60	30-50	25-35	10-20
	16-60	Extremely gravelly loamy sand	SM	A-1-a	0	15-25	60-80	30-45	20-40	5-20	10-20	NP-4
354:												
Waumac Variant--	0-3	Very gravelly sandy loam	SM	A-1-b	0	0	85-100	35-60	20-40	10-30	15-25	NP-4
	3-12	Very gravelly sandy loam	SM	A-1-b	0	0	85-100	35-65	20-40	10-30	15-25	NP-4
	12-60	Bedrock			---	---	---	---	---	---	---	---
358:												
Deama-----------	0-3	Very gravelly loam	GC	A-2-6	0-5	5-15	50-60	40-50	35-45	25-35	25-40	10-25
	3-19	Very gravelly loam	GC	A-2-6	0-3	5-15	50-60	40-50	35-45	25-35	25-40	10-25
	19-60	Bedrock			---	---	---	---	---	---	---	---
Elpedro---------	0-3	Very gravelly loam	CL, SC	A-6	0	0-5	80-90	50-65	45-65	40-60	25-40	10-25
	3-37	Silty clay loam	CL	A-6	0	0	95-100	90-100	85-95	75-90	35-45	15-25
	37-60	Loam, silt loam	CL	A-6	0	0	95-100	90-100	85-100	50-60	25-40	10-25
Rock outcrop----	0-60	Bedrock			---	---	---	---	---	---	---	---

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Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
396:												
Atarque---------	0-2	Extremely gravelly sandy loam	GC-GM	A-1-a	0-3	10-20	35-55	25-45	15-25	5-15	20-30	4-7
	2-16	Clay loam	CL, SC	A-6	0	0	100	100	80-95	40-60	35-50	15-25
	16-60	Bedrock	---	---	---	---	---	---	---	---	---	---
Menefee---------	0-2	Gravelly clay loam	CL	A-6	0	0-5	80-100	70-80	60-80	50-70	35-50	15-25
	2-14	Clay loam	CL	A-6	0	0	100	90-100	85-100	70-90	35-50	15-25
	14-60	Bedrock	---	---	---	---	---	---	---	---	---	---
Rock outcrop----	0-60	Bedrock	---	---	---	---	---	---	---	---	---	---
397:												
Rock outcrop----	0-60	Bedrock	---	---	---	---	---	---	---	---	---	---
Cucho-----------	0-2	Very gravelly clay loam	SC	A-6	0	0	70-90	45-65	40-60	35-55	35-50	15-25
	2-9	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	9-37	Very gravelly clay loam	SC	A-6	0	0	75-95	40-60	35-55	30-50	35-50	15-25
	37-60	Bedrock	---	---	---	---	---	---	---	---	---	---
Vessilla--------	0-2	Gravelly fine sandy loam	SC-SM	A-1-b	0	0	100	65-85	40-60	15-25	20-30	4-7
	2-11	Gravelly fine sandy loam	SC-SM	A-2-4	0	0	100	70-90	45-65	15-30	20-30	4-7
	11-60	Bedrock	---	---	---	---	---	---	---	---	---	---
398:												
Espiritu--------	0-4	Very gravelly fine sandy loam	SC-SM	A-4	0	5-15	70-90	50-70	35-55	30-50	20-30	4-7
	4-24	Very gravelly sandy clay loam	SC	A-2-6	0	5-15	70-90	50-70	40-60	25-45	25-35	10-20
	24-60	Extremely gravelly sandy loam	SC-SM	A-2-4	0	15-25	65-85	30-40	25-40	25-35	20-30	4-7
Cucho-----------	0-2	Very gravelly clay loam	SC	A-6	0	0	65-85	40-60	40-50	40-50	35-50	15-25
	2-37	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	37-60	Bedrock	---	---	---	---	---	---	---	---	---	---
399:												
Cucho-----------	0-2	Very gravelly clay loam	SC	A-6	0	0	80-100	40-60	35-55	30-50	35-50	15-25
	2-37	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	37-60	Bedrock	---	---	---	---	---	---	---	---	---	---
Teco------------	0-1	Very cobbly fine sandy loam	SM	A-2-4	0	10-30	70-90	55-75	45-65	20-40	15-25	NP-4
	1-7	Sandy clay	ML	A-7	0	0	100	100	75-95	60-80	35-55	15-20
	7-23	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
	23-40	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
	40-45	Very gravelly fine sandy loam	SM	A-1-b	0	5-15	80-95	50-70	20-40	10-20	15-25	NP-4
	45-60	Channery sandy clay loam	SC	A-2-4	0	0	85-100	65-85	45-65	20-40	20-30	4-15
405:												
Charo-----------	0-5	Cobbly loam	CL	A-6	0-5	5-20	70-80	60-70	50-60	45-55	25-40	10-25
	5-12	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
	12-15	Clay	CH	A-7-6	0	0	100	100	95-100	70-90	50-60	25-35
	15-25	Clay	CH	A-7-6	0	0-10	90-100	90-100	85-95	70-90	50-60	25-35
	25-28	Clay	CH	A-7-6	0	0-10	90-100	80-95	70-90	65-85	50-60	25-35
	28-60	Bedrock	---	---	---	---	---	---	---	---	---	---
Charo, noncobbly	0-8	Loam	CL	A-6	0-2	0-10	90-100	85-95	75-90	50-60	30-35	10-15
	8-38	Clay	CL, CH	A-7-6	0-2	0-10	90-100	85-95	80-90	70-90	40-60	20-30
	38-60	Bedrock	---	---	---	---	---	---	---	---	---	---
409:												
Santa Fe---------	0-3	Very gravelly sandy loam	SC-SM	A-1-b	0-5	0-5	90-100	45-65	25-45	10-20	20-30	4-7
	3-8	Very gravelly sandy clay loam	SC	A-2-6	0	5-15	80-100	45-65	35-55	15-35	25-35	10-20
	8-60	Bedrock	---	---	---	---	---	---	---	---	---	---

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Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
410:												
Zia	0-10	Loam	CL	A-6	0	0	100	95-100	85-100	50-60	25-40	10-25
	10-60	Stratified sandy loam to fine sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	16-27	4-7
414:												
Wauquie	0-3	Very gravelly fine sandy loam	SM	A-1-b	0-3	5-15	75-90	50-70	25-40	10-20	15-25	NP-4
	3-30	Very gravelly sandy clay loam	SC	A-2-4	0-3	10-20	70-90	50-60	25-45	10-30	20-30	4-15
	30-60	Stratified very gravelly sandy loam to very gravelly loamy coarse sand	SW-SM	A-1-b	0-5	16-30	70-90	45-65	15-35	11-25	10-25	NP-4
417:												
Jocity	0-10	Loam	CL	A-4	0	0	100	100	85-100	50-60	20-30	4-10
	10-26	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	30-40	10-15
	26-32	Loam	CL	A-4	0	0	100	100	85-100	50-60	25-35	4-15
	32-50	Sandy clay loam	SM	A-4	0	0	100	100	75-90	40-50	10-15	NP-4
	50-56	Sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	25-45	20-30	4-7
	56-60	Loamy sand	SM	A-2-4	0	0	100	100	60-80	15-35	15-20	NP-4
418:												
Jocity	0-12	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	12-30	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	30-60	Stratified loamy sand to sandy loam	SC-SM	A-2-4	0	0	100	100	60-80	20-40	15-25	NP-7
419:												
Santa Fe	0-9	Extremely cobbly coarse sandy loam	SP-SC	A-1-a	0-5	20-45	50-70	30-50	10-25	5-15	20-30	4-7
	9-16	Very gravelly sandy clay loam	SC	A-2-6	0-5	5-15	80-100	50-70	25-45	10-20	25-35	10-20
	16-60	Bedrock			---	---	---	---	---	---	---	---
Wauquie	0-4	Extremely cobbly fine sandy loam	SW-SM	A-1-a	0-10	15-30	60-80	15-35	5-15	0-10	10-20	NP-4
	4-11	Extremely cobbly sandy clay loam	SW-SC	A-2-4	0-10	15-35	60-80	15-35	5-15	0-15	15-25	4-15
	11-18	Extremely cobbly sandy clay loam	SW-SC	A-2-4	0-10	15-35	60-80	15-35	5-15	0-15	15-25	5-15
	18-29	Extremely cobbly sandy loam	SW-SM	A-1-a	0-10	15-35	60-80	10-30	5-15	0-10	15-25	NP-4
	29-60	Extremely cobbly sand	SW-SM	A-1-a	0-10	15-35	60-80	10-30	0-15	0-10	0-0	NP
Rock outcrop	0-60	Bedrock			---	---	---	---	---	---	---	---
420:												
Pinavetes	0-10	Loamy sand	SM	A-2-4	0	0	100	100	60-80	15-35	15-20	NP-4
	10-60	Sand	SW-SM	A-2-4	0	0	100	100	60-80	0-20	10-15	NP-3
421:												
Gilco, moderately saline, sodic	0-7	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	7-19	Very fine sandy loam	SC-SM	A-4	0	0	100	100	80-90	30-50	20-30	4-7
	19-60	Stratified fine sandy loam to loam	SC-SM, SC	A-4	0	0	84-100	83-100	80-90	40-60	25-35	4-12
422:												
Vessilla	0-1	Sandy loam	SC-SM	A-2-4	0	0-10	90-100	90-100	60-80	25-45	20-30	4-7
	1-15	Sandy loam	SC-SM	A-2-4	0	0-10	90-100	90-100	60-80	25-45	20-30	4-7
	15-60	Bedrock			---	---	---	---	---	---	---	---
Menefee	0-3	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	3-10	Clay loam	CL	A-6	0	0	90-100	85-100	85-100	70-90	35-50	15-25
	10-60	Bedrock			---	---	---	---	---	---	---	---

Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
422:												
Orlie	0-4	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	4-14	Clay loam, silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
	14-60	Silty clay loam	CL	A-6	0	0	100	100	95-100	75-90	35-45	15-25
423:												
Gilco	0-8	Loam	CL	A-6	0	0	85-100	80-100	80-90	50-60	25-40	10-25
	8-14	Loam	CL	A-6	0	0	90-100	85-100	80-90	50-60	25-40	10-25
	14-60	Stratified fine sandy loam to silt loam	CL	A-4	0	0	80-100	80-100	80-90	50-60	20-30	4-12
426:												
Aga, moderately saline, sodic	0-8	Loam	CL	A-6	0	0	100	100	85-95	65-80	25-35	10-25
	8-20	Loam	CL	A-6	0	0	100	100	85-95	55-70	25-35	10-25
	20-36	Loamy sand	SM	A-2-4	0	0	100	95-100	55-75	10-30	0-0	NP
	36-60	Gravelly sand	SW-SM	A-2-4, A-3	0	0	80-100	70-90	65-80	0-20	0-0	NP
427:												
Aga	0-8	Loam	CL	A-6	0	0	100	100	70-95	45-70	25-40	10-25
	8-28	Loam	CL	A-6	0	0	95-100	90-100	65-95	40-70	25-40	10-25
	28-60	Loamy fine sand	SM	A-2-4	0	0	95-100	90-100	50-80	20-40	15-20	NP-4
428:												
Aga, moderately saline, sodic	0-4	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	4-16	Very fine sandy loam	SC-SM	A-4	0	0	100	100	80-90	40-50	20-30	4-7
	16-22	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	22-60	Stratified sand to loamy sand	SM	A-2-4	0	0	100	95-100	60-80	18-30	0-0	NP
430:												
Trail	0-10	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	10-34	Loamy sand	SM	A-4	0	0	100	100	65-85	35-50	15-20	NP-4
	34-60	Stratified sand to fine sandy loam	SW-SM	A-2-4, A-3	0	0	100	100	60-80	0-20	0-0	NP
431:												
Trail	0-10	Loamy sand	SM	A-2-4	0	0	100	100	60-80	20-40	15-20	NP-4
	10-60	Stratified loamy sand to sand to gravelly sand to fine sandy loam	SC-SM	A-2-4	0	0	100	90-100	60-80	0-40	5-20	NP-7
433:												
Peralta	0-10	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	10-60	Stratified very fine sandy loam to fine sandy loam to loamy fine sand	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
434:												
Peralta	0-10	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	10-16	Very fine sandy loam	CL-ML	A-4	0	0	100	100	75-85	40-60	20-30	4-7
	16-20	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	20-28	Fine sandy loam	SC-SM	A-4	0	0	100	100	75-85	35-50	20-30	4-7
	28-40	Loamy sand	SM	A-2-4	0	0	100	100	65-85	15-35	15-20	NP-4
	40-45	Silt loam	ML	A-4	0	0	100	100	90-100	70-90	25-30	4-7
	45-60	Loamy fine sand	SM	A-2-4	0	0	100	100	65-85	20-40	15-20	NP-4
437:												
Peralta, moderately saline, sodic	0-4	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	4-60	Stratified loam to fine sandy loam to loamy sand	SC-SM	A-4	0	0	100	100	75-85	35-50	16-30	4-7
500:												
Rock outcrop	0-60	Bedrock			---	---	---	---	---	---	---	---

Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
500:												
Osha	0-10	Very gravelly coarse sandy loam	SM	A-1-b	0-2	0-5	80-95	50-70	40-60	15-35	10-25	NP-4
	10-20	Very gravelly coarse sandy loam	SM	A-1-b	0	0	70-90	50-70	40-60	15-35	10-25	NP-4
	20-43	Extremely gravelly loamy coarse sand, extremely gravelly coarse sandy loam	SW-SM	A-1-a	0	0	55-75	25-45	15-35	5-15	0-10	NP
	43-60	Bedrock			---	---	---	---	---	---	---	---
Rubble land	0-60	Fragmental material	GW	A-1-a	50-70	20-40	0-10	0-5	0-5	0	0-0	NP
503:												
Cajete	0-8	Extremely gravelly coarse sandy loam	SW-SC	A-1-a	0	0	55-75	30-50	5-15	5-10	20-30	4-7
	8-60	Very gravelly sandy loam	SC-SM	A-1-b	0	0	55-70	50-65	30-50	15-30	20-30	4-7
Cypher	0-3	Very gravelly loam	GC	A-6	0-3	10-15	40-60	35-55	30-50	30-50	25-40	10-25
	3-11	Very gravelly sandy loam	GC-GM	A-2-4	0-3	10-25	70-90	40-60	30-50	25-45	20-30	4-7
	11-15	Extremely gravelly sandy loam	GC-GM	A-2-4	0-10	10-30	40-60	30-40	25-35	20-35	20-30	4-7
	15-60	Bedrock			---	---	---	---	---	---	---	---
504:												
Orejas	0-2	Very cobbly loam	GC	A-2-4	0	15-45	50-70	50-70	40-50	20-45	20-30	7-10
	2-9	Very cobbly clay loam	SC	A-6	0	10-25	70-90	60-75	50-70	30-50	30-40	10-15
	9-17	Very gravelly clay loam	SC	A-2-6	0	0-10	75-90	50-70	50-70	25-50	30-40	10-15
	17-60	Bedrock			---	---	---	---	---	---	---	---
Guaje	0-4	Gravelly sandy loam	SC-SM	A-2-4	0	0	90-100	70-90	60-80	25-45	15-25	4-7
	4-12	Gravelly sandy loam	SC-SM	A-2-4	0	0-15	75-95	60-80	50-70	25-45	15-25	4-7
	12-17	Very gravelly sandy loam	GC-GM	A-1-b	0	0-10	35-55	30-50	20-35	10-30	15-25	NP-7
	17-45	Extremely gravelly sandy loam	SC-SM	A-1-b	0	0-10	80-100	25-45	10-25	5-20	15-25	NP-7
	45-60	Very gravelly sandy loam	SC-SM	A-2-4	0	0-10	80-100	35-55	30-50	25-35	15-25	NP-7
600:												
Rock outcrop	0-60	Bedrock			---	---	---	---	---	---	---	---
Cypher	0-4	Very cobbly loam	GC	A-2-6	0-5	30-55	45-65	45-55	35-55	25-45	25-40	10-25
	4-14	Very gravelly loam	GC	A-2-6	0-5	10-15	40-60	35-55	25-45	20-35	25-40	10-25
	14-16	Very gravelly loam	GC	A-2-6	0-5	10-15	40-60	35-55	25-45	20-35	25-40	10-25
	16-60	Bedrock			---	---	---	---	---	---	---	---
601:												
Laventana	0-5	Gravelly sandy loam	SC-SM	A-2-4	0	0-5	90-100	70-85	60-80	25-45	20-30	4-7
	5-9	Very gravelly loam	SC	A-2-4	0	0-10	85-100	45-65	40-60	20-40	20-35	4-15
	9-50	Very gravelly loam, very gravelly sandy clay loam	SC	A-2-4	0	0-5	60-80	45-55	30-50	15-35	15-35	4-15
	50-60	Bedrock			---	---	---	---	---	---	---	---

Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
603:												
Laventana-------	0-1	Slightly decomposed plant material	PT	A-8	0	0	100	100	---	---	---	---
	1-5	Very cobbly loam	GC	A-2-4	0-5	25-45	50-70	40-55	35-45	25-35	20-30	7-10
	5-12	Gravelly silt loam	CL-ML, SC-SM	A-4	0	0-10	75-95	65-85	55-65	40-60	20-30	4-7
	12-20	Very cobbly loam	GC	A-4	0	15-30	60-80	50-70	40-60	30-50	20-30	7-10
	20-31	Very gravelly loam	SC	A-2-4	0	0-20	70-90	40-60	35-55	20-40	20-30	7-10
	31-51	Very gravelly loam	SC	A-2-4	0	0-20	65-85	40-60	30-50	20-40	20-30	7-10
	51-60	Bedrock			---	---	---	---	---	---	---	---
Mirand----------	0-6	Very cobbly loam	SC	A-4	0-3	11-20	65-85	50-65	45-55	30-50	20-30	4-20
	6-27	Cobbly clay	CH, CL	A-7-6	0-2	0-15	80-90	70-80	70-80	50-70	40-60	20-30
	27-60	Sandy clay	ML	A-6, A-7	0-3	0-10	85-100	80-100	75-95	60-80	35-55	15-20
604:												
Cypher----------	0-1	Slightly decomposed plant material	PT	A-8	0	0	100	100	---	---	---	---
	1-4	Very gravelly loam	GC	A-2-6	0	5-15	40-60	35-55	30-40	25-35	25-40	10-25
	4-11	Very gravelly loam	GC	A-6	0	5-15	60-80	40-60	40-50	35-45	25-40	10-25
	11-19	Extremely gravelly sandy loam	GC-GM	A-1-b	0	5-15	40-60	10-20	10-20	10-20	20-30	4-7
	19-60	Bedrock			---	---	---	---	---	---	---	---
Mirand----------	0-4	Very cobbly loam	SC	A-4	0-3	11-17	70-90	50-65	45-65	35-45	20-35	4-20
	4-60	Cobbly clay	CL, SC	A-7-6	0-3	0-20	80-90	70-85	60-80	40-60	40-50	10-30
608:												
Osha, steep-----	0-3	Gravelly coarse sandy loam	SC-SM	A-2-4	0	0	90-100	70-90	50-70	15-35	15-25	NP-4
	3-8	Gravelly coarse sandy loam	SC-SM	A-2-4	0	0	100	70-90	50-70	15-35	15-25	NP-4
	8-16	Gravelly coarse sandy loam	SC-SM	A-2-4	0	0	85-100	70-90	50-70	15-35	15-25	NP-4
	16-32	Extremely gravelly coarse sandy loam	SW-SM	A-1-a	0	0	65-85	15-35	15-25	0-10	10-20	NP-4
	32-60	Extremely gravelly loamy coarse sand	SW-SM	A-1-a	0	0	50-70	10-30	5-15	0-10	5-15	NP
Osha------------	0-8	Gravelly coarse sandy loam	SM	A-1-b	0	0	80-100	65-85	30-45	20-30	15-20	NP-4
	8-16	Gravelly coarse sandy loam, very gravelly coarse sandy loam	GC-GM	A-1-b	0	0	35-55	30-50	20-35	10-30	15-20	NP-10
	16-32	Extremely gravelly coarse sandy loam	GC-GM	A-1-a	0	0	35-55	30-50	10-20	0-10	15-20	NP-10
	32-60	Extremely gravelly loamy coarse sand	GW, GP-GM	A-1-a	0	0	30-50	25-45	5-15	0-10	10-20	NP-4
823:												
Gilco, unprotected----	0-8	Loam	CL	A-6	0	0	85-100	80-100	80-90	50-60	25-40	10-25
	8-60	Stratified fine sandy loam to loam to silt loam	CL	A-6	0	0	85-100	80-100	80-90	50-60	25-40	10-25
827:												
Aga, unprotected	0-8	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	8-28	Loam	CL	A-6	0	0	95-100	90-100	80-90	50-60	25-40	10-25
	28-60	Loamy fine sand	SM	A-2-4	0	0	90-100	90-100	65-85	20-40	15-20	NP-4

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Table 14.--Engineering properties--continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In.				Pct.	Pct.					Pct.	
830: Trail, unprotected----	0-8	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	8-60	Stratified loamy sand to sand to sandy loam	SM	A-2-4	0	0	100	100	60-80	0-40	15-20	NP-7
831: Trail, unprotected----	0-10	Loamy sand	SM	A-2-4	0	0	100	100	60-80	20-40	15-20	NP-4
	10-30	Loamy sand	SM	A-2-4	0	0	100	100	60-80	20-40	15-20	NP-4
	30-60	Stratified sand to gravelly sand to sandy loam	SW-SM	A-2-4, A-3	0	0	100	90-100	60-80	0-20	0-0	NP
835: Peralta, unprotected----	0-6	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	6-16	Loam	CL	A-6	0	0	100	100	85-100	50-60	25-40	10-25
	16-60	Stratified sandy loam to clay loam	SC	A-6	0	0	100	100	75-90	40-50	25-35	10-20
842: Peralta, moderately saline, sodic, unprotected----	0-10	Clay loam	CL	A-6	0	0	100	100	90-100	70-90	35-50	15-25
	10-60	Stratified sandy clay loam to sandy loam to clay loam	CL	A-6	0	0	100	100	85-100	50-60	25-35	10-20
850: Water----------	---	---	---	---	---	---	---	---	---	---	---	---
DAM: Dam----------	---	---	---	---	---	---	---	---	---	---	---	---

Table 15.--Physical soil properties

(Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Wind erodibility index" apply only to the surface layer. Absence of an entry indicates that data were not estimated.)

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
1:														
Silver	0-4	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37	5	5	56
	4-8	5-20	45-65	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.37	.37			
	8-20	5-20	45-65	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
	20-39	25-45	25-45	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	39-60	25-45	25-45	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
Clovis	0-3	35-50	30-45	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	1.0-2.0	.37	.37	5	5	56
	3-20	25-40	20-45	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	20-40	50-70	10-25	20-30	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	40-60	60-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
2:														
Clovis	0-3	35-50	30-45	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	1.0-2.0	.37	.37	5	5	56
	3-24	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	24-60	55-75	10-35	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
Prieta	0-3	35-50	30-45	15-25	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	0.5-1.0	.10	.37	1	8	0
	3-10	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-1.0	.10	.32			
	10-14	25-45	25-45	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-0.5	.10	.32			
	14-19	25-45	25-45	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-0.5	.10	.32			
	19-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Silver	0-8	30-50	30-45	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37	5	5	56
	8-30	5-20	45-60	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.37	.37			
	30-60	5-20	45-65	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
3:														
Montecito	0-3	55-75	10-25	10-20	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.0	.28	.28	5	3	86
	3-18	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	18-60	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
Orejas	0-2	30-50	30-45	20-27	1.35-1.45	0.6-2	0.11-0.13	3.0-5.9	0.5-1.0	.20	.37	1	7	38
	2-5	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-1.0	.10	.32			
	5-14	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-0.5	.10	.32			
	14-17	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-0.5	.10	.32			
	17-19	25-45	25-45	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-0.5	.10	.32			
	19-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
4:														
Montecito	0-3	60-75	15-35	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.0	.28	.28	5	3	86
	3-22	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	22-60	35-50	30-45	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			
Montecito, bouldery	0-5	35-50	30-50	5-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	0.5-1.0	.05	.28	5	8	0
	5-28	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	28-45	30-50	30-45	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			
	45-60	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
10:														
Trail	0-6	10-20	45-60	28-35	1.15-1.35	6-20	0.19-0.21	3.0-5.9	0.5-1.0	.37	.37	5	4L	86
	6-30	60-85	2-25	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.0-1.0	.17	.17			
	30-45	90-100	0-5	0-5	1.55-1.65	6-20	0.03-0.05	0.0-2.9	0.0-0.5	.10	.10			
	45-60	75-90	0-15	5-10	1.45-1.55	6-20	0.09-0.10	0.0-2.9	0.0-0.5	.20	.20			
11:														
Trail	0-9	55-80	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.0	.28	.28	5	3	86
	9-36	75-95	0-15	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.0-1.0	.17	.17			
	36-60	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
13:														
Sandoval	0-2	55-75	10-25	10-20	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.5	.28	.28	2	3	86
	2-6	25-45	30-45	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	6-10	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	10-15	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	15-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
Querencia	0-4	50-70	10-25	20-30	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.5-1.5	.32	.32	5	4L	86
	4-12	30-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	12-24	30-50	30-45	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			
	24-60	30-50	30-45	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			
15:														
Camino	0-2	10-20	45-55	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.37	.37	4	4L	86
	2-5	15-40	15-40	40-50	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
	5-20	15-40	15-40	40-50	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
	20-51	15-40	15-40	40-50	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
	51-60	---	---	---	---	0.00-0.2	---	---	---	---	---			

Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
15:														
Sandoval	0-2	55-75	10-25	10-18	1.45-1.55	2-6	0.13-0.15	0.0-2.9	1.0-2.0	.28	.28	2	3	86
	2-17	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	17-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
16:														
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
Prieta	0-5	15-35	50-70	15-25	1.15-1.35	0.6-2	0.13-0.15	3.0-5.9	0.5-1.0	.24	.43	1	7	38
	5-15	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-1.0	.10	.32			
	15-19	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-0.5	.10	.32			
	19-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
17:														
Vessilla	0-5	55-75	15-35	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-1.0	.24	.24	1	3	86
	5-11	55-75	15-35	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	11-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Menefee	0-3	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	1.0-2.0	.32	.32	2	4L	86
	3-10	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	10-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
18:														
Sparham	0-7	20-45	15-35	40-50	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.5	.32	.32	5	4	86
	7-20	20-40	20-40	28-55	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.32	.32			
	20-29	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	29-47	5-20	45-60	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
	47-53	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	53-60	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
20:														
Gilco	0-6	25-40	25-40	27-32	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.32	.32	5	4L	86
	6-60	35-70	25-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.0-0.5	.37	.37			
21:														
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
Hackroy	0-3	55-75	5-30	10-18	1.45-1.55	2-6	0.11-0.13	0.0-2.9	1.0-2.0	.24	.24	1	3	86
	3-12	20-45	20-40	40-50	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
	12-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
22:														
Aga	0-8	5-20	45-60	28-35	1.55-1.65	0.2-0.6	0.19-0.21	3.0-5.9	0.5-0.8	.37	.37	3	4L	86
	8-24	35-50	30-50	8-18	1.45-1.55	0.6-2	0.14-0.16	0.0-2.9	0.1-0.3	.37	.37			
	24-60	90-100	0-10	0-12	1.40-1.50	6-20	0.07-0.09	0.0-2.9	0.1-0.3	.17	.17			
23:														
Hickman	0-4	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	2.0-4.0	.32	.32	5	4L	86
	4-12	50-70	5-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	1.0-1.5	.32	.32			
	12-49	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	49-60	50-75	5-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
24:														
Orlie	0-2	60-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	2.0-3.0	.28	.28	5	3	86
	2-25	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.32	.32			
	25-60	25-60	10-45	20-30	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
Sparham	0-3	10-40	20-40	40-55	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.5-1.5	.20	.20	5	4	86
	3-60	0-15	40-55	40-50	1.20-1.30	0.06-0.2	0.15-0.17	6.0-8.9	0.0-1.0	.24	.24			
25:														
Gilco	0-4	30-50	30-50	10-18	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37	5	4L	86
	4-34	15-75	20-70	10-18	1.35-1.45	0.6-2	0.13-0.15	0.0-2.9	0.0-0.5	.37	.37			
	34-60	35-70	15-50	10-18	1.35-1.45	0.6-2	0.13-0.15	0.0-2.9	0.0-0.5	.37	.37			
26:														
Orlie	0-2	30-50	30-55	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	2.0-3.0	.37	.37	5	6	48
	2-13	30-45	25-45	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.5	.32	.32			
	13-22	30-45	25-45	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.32	.32			
	22-36	10-20	45-65	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.37	.37			
	36-50	30-45	25-45	28-35	1.35-1.50	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	50-60	10-20	45-65	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
27:														
Aga	0-10	35-50	35-50	10-20	1.35-1.45	0.6-2	0.14-0.18	0.0-2.9	0.5-1.0	.37	.37	3	4L	86
	10-23	35-50	35-50	8-18	1.35-1.45	0.6-2	0.14-0.16	0.0-2.9	0.0-0.5	.37	.37			
	23-43	90-100	0-10	0-5	1.55-1.65	6-20	0.03-0.05	0.0-2.9	0.0-0.5	.17	.17			
	43-60	90-100	0-10	0-5	1.55-1.65	6-20	0.03-0.05	0.0-2.9	0.0-0.5	.17	.17			

Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
29:														
Trail	0-6	75-90	0-20	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.0-1.0	.17	.17	5	2	134
	6-60	55-85	10-30	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
31:														
Riverwash	0-6	95-100	0-10	0-1	1.65-1.75	6-20	0.03-0.04	0.0-2.9	0.0-0.1	.10	.10	2	5	220
	6-60	70-100	0-20	0-5	1.15-1.25	6-20	0.04-0.06	0.0-2.9	0.0-0.5	.10	.10			
33:														
Pits	0-60	---	---	---	---	0.2-0.6	---	---	---	---	---	--	8	0
34:														
Ildefonso	0-3	30-50	30-45	15-25	1.35-1.45	0.6-2	0.11-0.13	3.0-5.9	1.0-2.0	.20	.37	3	6	48
	3-17	30-50	30-45	15-25	1.35-1.45	0.6-2	0.11-0.13	3.0-5.9	0.5-1.0	.20	.37			
	17-60	35-70	15-50	10-20	1.40-1.50	0.6-2	0.06-0.08	0.0-2.9	0.0-0.5	.10	.32			
Witt	0-3	55-70	15-35	5-15	1.40-1.50	0.6-2	0.15-0.17	0.0-2.9	0.5-1.0	.55	.55	5	5	56
	3-27	30-50	30-45	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-1.0	.37	.37			
	27-60	30-50	35-45	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			
41:														
Dune land	0-6	90-100	0-10	0-1	1.65-1.75	6-20	0.03-0.04	0.0-2.9	0.0-0.1	.10	.10	5	1	220
	6-60	90-100	0-10	0-1	1.65-1.75	6-20	0.03-0.05	0.0-2.9	0.0-0.0	.10	.10			
47:														
Cascajo	0-2	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.5-1.0	.10	.24	3	6	48
	2-5	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.5-1.0	.10	.24			
	5-11	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
	11-23	75-95	0-15	5-10	1.45-1.55	6-20	0.04-0.06	0.0-2.9	0.0-0.5	.05	.17			
	23-30	75-95	0-15	5-10	1.45-1.55	6-20	0.04-0.06	0.0-2.9	0.0-0.5	.05	.17			
	30-60	75-95	0-15	5-10	1.45-1.55	6-20	0.01-0.03	0.0-2.9	0.0-0.5	.02	.17			
51:														
Sparham	0-6	25-45	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.32	.32	5	4	86
	6-20	25-45	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	20-36	20-40	20-40	40-50	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
	36-60	25-45	25-45	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
52:														
Totavi	0-15	75-90	0-15	5-10	1.50-1.60	6-20	0.06-0.08	0.0-2.9	0.0-1.0	.17	.17	5	2	134
	15-19	75-90	0-15	5-10	1.50-1.60	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
	19-60	75-90	0-15	5-10	1.50-1.60	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
53:														
Witt	0-3	35-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37	5	5	56
	3-6	5-25	60-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	0.5-1.0	.43	.43			
	6-11	0-15	50-70	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.37	.37			
	11-18	0-15	50-70	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.37	.37			
	18-25	0-15	50-70	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
	25-39	0-20	55-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	0.0-0.5	.43	.43			
	39-53	0-20	55-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	0.0-0.5	.43	.43			
	53-60	0-20	55-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	0.0-0.5	.43	.43			
Harvey	0-10	30-50	30-45	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37	5	4L	86
	10-28	25-45	25-45	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	28-42	50-70	10-30	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	42-60	55-75	10-35	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
54:														
Harvey	0-2	55-75	5-30	5-18	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.0	.28	.28	5	3	86
	2-11	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-1.0	.28	.28			
	11-23	30-45	30-45	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	23-60	50-70	10-30	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
Cascajo	0-3	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.5-1.0	.10	.24	2	6	48
	3-9	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.5-1.0	.10	.24			
	9-28	90-100	0-10	0-5	1.55-1.65	6-20	0.02-0.03	0.0-2.9	0.0-0.5	.02	.10			
	28-60	90-100	0-10	0-5	1.55-1.65	6-20	0.02-0.03	0.0-2.9	0.0-0.5	.02	.10			
55:														
La Fonda	0-4	30-50	30-45	20-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	1.0-2.0	.37	.37	5	4L	86
	4-26	30-50	30-45	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-1.0	.37	.37			
	26-60	25-45	25-45	20-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			

Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
56:														
Ildefonso	0-3	30-50	30-45	15-25	1.35-1.45	0.6-2	0.11-0.13	3.0-5.9	1.0-2.0	.20	.37	3	6	48
	3-9	30-50	30-45	15-25	1.35-1.45	0.6-2	0.11-0.13	3.0-5.9	0.5-1.2	.20	.37			
	9-15	30-50	30-45	15-25	1.35-1.45	0.6-2	0.08-0.10	3.0-5.9	0.0-1.0	.10	.37			
	15-60	30-50	30-45	15-25	1.35-1.45	0.6-2	0.08-0.10	3.0-5.9	0.0-0.5	.10	.37			
57:														
Badland	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	4	86
58:														
Deama	0-7	15-35	50-70	15-27	1.15-1.35	0.6-2	0.09-0.11	3.0-5.9	1.0-3.0	.15	.43	1	6	48
	7-14	15-35	50-70	15-27	1.15-1.35	0.6-2	0.09-0.11	3.0-5.9	0.5-1.0	.15	.43			
	14-60	---	---	---	---	0.00-0.2	---	---	---	---	---			
Elpedro	0-5	30-50	30-50	15-22	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37	5	5	56
	5-12	0-20	50-70	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
	12-19	0-20	50-70	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
	19-25	0-20	50-70	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
	25-36	0-20	50-70	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
	36-45	0-30	55-75	15-27	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	0.0-0.5	.43	.43			
	45-60	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.0-0.0	.37	.37			
59:														
Harvey	0-4	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37	5	4L	86
	4-10	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-1.0	.37	.37			
	10-18	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	18-41	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	41-60	50-70	5-25	20-30	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
Ildefonso	0-2	30-50	30-50	15-25	1.35-1.45	0.6-2	0.11-0.13	3.0-5.9	1.0-2.0	.20	.37	3	6	48
	2-8	30-50	30-50	15-25	1.35-1.45	0.6-2	0.08-0.10	3.0-5.9	0.5-1.5	.10	.37			
	8-13	30-50	30-50	15-25	1.35-1.45	0.6-2	0.08-0.10	3.0-5.9	0.5-1.0	.10	.37			
	13-32	55-75	15-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
	32-40	55-75	15-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
	40-60	90-100	0-10	0-5	1.55-1.65	6-20	0.01-0.02	0.0-2.9	0.0-0.5	.02	.10			
La Fonda	0-3	30-50	30-50	20-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	1.0-2.0	.37	.37	5	4L	86
	3-7	30-50	30-50	20-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.5	.37	.37			
	7-14	25-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.32	.32			
	14-26	30-50	30-50	20-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-1.0	.37	.37			
	26-42	30-50	30-50	20-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			
	42-60	30-50	30-50	20-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			
63:														
Placitas	0-5	30-50	30-50	10-20	1.35-1.45	0.6-2	0.10-0.12	0.0-2.9	1.0-2.0	.20	.37	2	6	48
	5-10	55-75	10-30	5-15	1.45-1.55	2-6	0.06-0.08	0.0-2.9	0.0-1.0	.10	.24			
	10-27	55-75	10-30	5-15	1.45-1.55	2-6	0.04-0.06	0.0-2.9	0.0-0.5	.10	.24			
	27-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
64:														
Skyvillage	0-4	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	1.0-2.0	.28	.28	1	3	86
	4-11	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-1.0	.28	.28			
	11-18	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	18-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Ildefonso	0-3	55-75	10-30	5-15	1.45-1.55	2-6	0.08-0.09	0.0-2.9	0.5-1.0	.15	.24	3	5	56
	3-14	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-1.0	.10	.24			
	14-60	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
65:														
Ildefonso	0-6	55-75	10-30	8-18	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.5-1.0	.10	.24	3	6	48
	6-38	55-75	10-30	8-18	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-1.0	.10	.24			
	38-60	40-75	10-40	8-18	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
Harvey	0-4	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37	5	4L	86
	4-23	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37			
	23-36	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			
	36-60	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
66:														
Zia	0-4	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-1.0	.24	.24	5	3	86
	4-60	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
67:														
Sandoval	0-2	30-50	30-50	15-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	1.0-2.0	.37	.37	2	4L	86
	2-11	25-40	30-45	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	11-60	---	---	---	---	0.00-0.02	---	---	---	---	---			

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Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
67:														
Poley	0-3	30-50	30-50	15-25	1.35-1.45	0.6-2	0.08-0.10	3.0-5.9	0.5-1.5	.10	.37	4	6	48
	3-12	25-40	25-40	28-35	1.35-1.45	0.06-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.32	.32			
	12-17	25-40	25-40	28-35	1.35-1.45	0.06-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	17-21	25-40	25-40	28-35	1.35-1.45	0.06-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	21-40	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	40-60	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
68:														
Penistaja	0-2	75-90	0-20	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.5-1.0	.20	.20	5	2	134
	2-15	50-70	5-25	20-30	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-1.0	.32	.32			
	15-27	50-70	5-25	20-30	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	27-38	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	38-60	50-70	5-25	20-30	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
Querencia	0-2	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.5	.28	.28	5	3	86
	2-40	50-70	10-25	20-30	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-1.0	.32	.32			
	40-60	55-75	15-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
71:														
Palon	0-6	55-75	15-35	5-15	1.45-1.55	2-6	0.08-0.10	0.0-2.9	1.0-3.0	.15	.24	2	5	56
	6-27	55-75	15-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-1.0	.10	.24			
	27-60	55-75	15-30	5-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.05	.24			
72:														
Palon	0-2	55-75	15-30	0-15	0.20-1.00	20-60	0.15-0.45	---	60-70	---	---	2	6	48
	2-4	55-75	15-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	1.0-3.0	.10	.24			
	4-10	55-75	15-30	5-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	0.5-1.5	.05	.24			
	10-32	55-75	15-30	5-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	0.0-1.0	.05	.24			
	32-53	55-75	15-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
	53-60	55-75	15-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
74:														
Origo	0-7	55-75	15-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	1.0-3.0	.10	.24	2	6	48
	7-28	55-75	15-30	5-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	0.0-1.0	.05	.24			
	28-60	55-75	15-30	5-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.05	.24			
Pavo	0-9	30-50	30-50	15-25	1.35-1.45	2-6	0.16-0.18	0.0-2.9	1.0-3.0	.37	.37	5	5	56
	9-12	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-1.5	.24	.24			
	12-25	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-1.0	.24	.24			
	25-35	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	35-45	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.28	.28			
	45-50	25-75	20-45	28-35	1.35-1.45	0.2-0.6	0.13-0.15	3.0-5.9	0.0-0.5	.15	.32			
	50-60	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.0	.24	.24			
75:														
Origo	0-1	---	---	0-15	0.20-1.00	20-60	0.15-0.45	---	60-70	---	---	2	6	48
	1-6	55-75	15-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	1.0-3.0	.10	.24			
	6-12	55-75	15-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-2.0	.10	.24			
	12-32	55-75	15-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-1.0	.10	.24			
	32-56	55-75	15-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
	56-60	75-90	0-20	5-10	1.45-1.55	6-20	0.04-0.06	0.0-2.9	0.0-0.5	.05	.20			
82:														
Calaveras	0-2	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37	2	5	56
	2-6	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-1.0	.24	.24			
	6-40	55-75	15-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
	40-60	55-75	15-30	5-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.05	.24			
83:														
Calaveras	0-6	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	1.0-1.5	.37	.37	2	5	56
	6-12	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-1.0	.24	.24			
	12-24	30-75	15-35	10-20	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
	24-60	55-80	5-30	5-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.05	.24			
Rubble land	0-60	---	---	0-0	2.00-2.35	20-99	0.00-0.02	0.0-2.9	0.0-0.1	---	---	--	8	0
85:														
Redondo	0-2	55-75	15-30	5-10	1.55-1.65	2-6	0.10-0.12	0.0-2.9	2.0-5.0	.20	.20	3	3	86
	2-7	55-75	15-30	5-10	1.55-1.65	2-6	0.10-0.12	0.0-2.9	1.0-3.0	.20	.20			
	7-15	55-75	15-30	5-10	1.55-1.65	2-6	0.10-0.12	0.0-2.9	0.5-1.5	.20	.20			
	15-22	55-75	15-30	5-10	1.55-1.65	2-6	0.10-0.12	0.0-2.9	0.0-1.0	.20	.20			
	22-29	55-75	15-30	5-10	1.55-1.65	2-6	0.09-0.10	0.0-2.9	0.0-0.5	.10	.20			
	29-38	55-75	15-30	5-10	1.55-1.65	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.05	.20			
	38-54	55-75	15-30	5-10	1.55-1.65	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.02	.20			
	54-60	55-75	15-30	5-10	1.55-1.65	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.02	.20			
86:														
Redondo	0-8	55-75	15-30	5-10	1.50-1.60	2-6	0.08-0.10	0.0-2.9	1.0-2.0	.10	.20	3	5	56
	8-13	55-75	15-30	5-10	1.50-1.60	2-6	0.05-0.07	0.0-2.9	0.0-1.0	.05	.20			
	13-34	55-75	15-30	5-10	1.50-1.60	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.02	.20			
	34-60	55-75	15-30	5-10	1.50-1.60	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.02	.20			

Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
87:														
Redondo	0-6	30-50	30-50	10-20	1.35-1.45	2-6	0.11-0.13	0.0-2.9	1.0-2.0	.20	.37	3	6	48
	6-13	55-75	15-30	5-10	1.50-1.60	2-6	0.04-0.06	0.0-2.9	0.5-1.5	.05	.20			
	13-60	55-75	15-30	5-10	1.50-1.60	2-6	0.04-0.06	0.0-2.9	0.0-1.0	.05	.20			
Rubble land	0-60	---	---	0-0	2.00-2.35	20-99	0.00-0.02	0.0-2.9	0.0-0.1	---	---	--	8	0
88:														
Totavi	0-12	55-75	15-30	5-10	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-1.0	.24	.24	5	3	86
	12-60	75-90	0-20	5-10	1.50-1.60	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
Jemez	0-6	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37	2	5	56
	6-13	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37			
	13-19	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	19-27	45-65	10-25	20-35	1.35-1.45	0.2-0.6	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	27-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
91:														
Zia	0-16	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-1.0	.24	.24	5	3	86
	16-22	75-90	0-20	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.0-1.0	.17	.17			
	22-35	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	35-60	55-75	15-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
92:														
Galisteo, moderately saline, sodic	0-12	5-20	45-65	30-40	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	1.0-2.0	.37	.37	5	4L	86
	12-60	15-40	20-40	40-50	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
93:														
Zia	0-8	75-85	0-20	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.5-1.0	.17	.17	5	2	134
	8-60	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
95:														
El Rancho	0-5	30-50	30-50	18-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37	5	4L	86
	5-20	50-70	5-25	20-27	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	20-38	50-70	5-25	20-27	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	38-60	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
97:														
El Rancho	0-8	25-40	25-40	30-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.32	.32	5	4L	86
	8-60	45-70	5-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
100:														
Orejas	0-5	35-50	30-50	15-25	1.35-1.45	0.6-2	0.08-0.10	3.0-5.9	0.5-1.0	.10	.37	1	7	38
	5-15	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-0.5	.10	.32			
	15-19	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-0.5	.10	.32			
	19-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
101:														
Blancot	0-2	55-75	15-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.0	.28	.28	5	3	86
	2-5	25-40	25-45	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.32	.32			
	5-14	25-40	25-45	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	14-23	25-40	25-45	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	23-40	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	40-49	10-20	45-60	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.0	.37	.37			
	49-60	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.0	.24	.24			
Lybrook	0-1	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.32	.32	5	4L	86
	1-5	10-20	45-60	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
	5-21	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	21-30	5-20	45-60	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
	30-60	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.14-0.18	3.0-5.9	0.0-0.5	.32	.32			
102:														
Sparham	0-7	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.5	.32	.32	5	4	86
	7-29	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	29-60	10-40	35-60	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
104:														
Cochiti	0-7	30-50	30-45	15-25	1.35-1.45	0.6-2	0.11-0.13	3.0-5.9	0.5-1.0	.20	.37	4	6	48
	7-12	25-40	25-40	30-40	1.35-1.45	0.2-0.6	0.13-0.15	6.0-8.9	0.5-1.0	.15	.32			
	12-20	10-40	15-40	40-60	1.15-1.35	0.06-0.2	0.06-0.08	6.0-8.9	0.0-0.5	.05	.20			
	20-29	25-40	25-40	30-40	1.35-1.45	0.2-0.6	0.09-0.11	6.0-8.9	0.0-0.5	.10	.32			
	29-60	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			

: 07354

Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
104:														
Montecito	0-3	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.5	.37	.37	5	5	56
	3-9	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.32	.32			
	9-15	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	15-22	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	22-37	40-75	10-40	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	37-60	55-75	10-35	5-15	1.45-1.55	2-6	0.08-0.10	0.0-2.9	0.0-0.5	.15	.24			
105:														
Badland	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	4	86
Menefee	0-4	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.5	.37	.37	2	4L	86
	4-10	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	10-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
106:														
Stumble	0-4	55-75	10-30	5-15	1.45-1.55	2-6	0.06-0.08	0.0-2.9	0.5-1.0	.10	.28	2	6	48
	4-10	55-75	10-30	5-15	1.45-1.55	2-6	0.09-0.11	0.0-2.9	0.0-1.0	.15	.28			
	10-24	75-90	0-15	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
	24-60	85-100	0-15	0-5	1.55-1.65	20-20	0.01-0.03	0.0-2.9	0.0-0.5	.05	.10			
Stumble, sandy	0-4	75-90	0-15	5-10	1.40-1.50	6-20	0.03-0.05	0.0-2.9	0.5-0.9	.10	.20	2	2	134
	4-18	75-90	0-15	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.1-0.3	.17	.20			
	18-60	75-100	0-15	1-6	1.45-1.55	20-20	0.01-0.03	0.0-2.9	0.1-0.3	.05	.10			
108:														
Embudo	0-6	55-75	15-30	5-15	1.45-1.55	2-6	0.08-0.09	0.0-2.9	0.0-0.5	.15	.24	3	5	56
	6-30	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	30-60	75-90	0-15	5-10	1.50-1.60	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
109:														
Embudo	0-4	55-75	15-30	5-15	1.45-1.55	2-6	0.08-0.09	0.0-2.9	0.5-1.0	.15	.24	3	5	56
	4-12	55-75	15-30	5-12	1.45-1.55	2-6	0.09-0.11	0.0-2.9	0.5-1.0	.15	.28			
	12-30	55-75	15-30	5-15	1.45-1.55	2-6	0.07-0.09	0.0-2.9	0.0-0.5	.10	.20			
	30-60	75-90	0-15	5-10	1.50-1.60	6-20	0.03-0.05	0.0-2.9	0.0-0.5	.10	.15			
Tijeras	0-4	55-75	15-30	5-15	1.45-1.55	2-6	0.09-0.11	0.0-2.9	0.0-1.0	.15	.28	4	5	56
	4-10	50-65	5-25	20-30	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-1.0	.32	.32			
	10-20	50-70	5-25	20-30	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	20-26	55-75	15-30	5-15	1.45-1.55	2-6	0.07-0.09	0.0-2.9	0.0-0.5	.15	.24			
	26-60	55-75	15-30	5-15	1.50-1.60	2-6	0.03-0.05	0.0-2.9	0.0-0.5	.05	.20			
110:														
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
Saido	0-5	0-30	55-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	0.5-1.5	.43	.43	2	4L	86
	5-9	0-30	55-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	0.5-1.0	.43	.43			
	9-15	0-30	55-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	0.0-1.0	.43	.43			
	15-25	0-30	55-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	0.0-0.5	.43	.43			
	25-60	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			
111:														
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
Zia	0-5	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-1.0	.24	.24	5	3	86
	5-60	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
112:														
Tijeras	0-3	55-75	10-30	5-15	1.45-1.55	2-6	0.09-0.11	0.0-2.9	0.0-1.0	.15	.28	4	5	56
	3-14	50-70	5-25	20-30	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	14-60	55-75	15-30	5-15	1.45-1.55	2-6	0.09-0.11	0.0-2.9	0.0-0.5	.15	.24			
114:														
San Mateo	0-7	55-75	15-30	10-20	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-1.0	.24	.24	5	3	86
	7-60	10-75	5-60	15-35	1.35-1.45	0.2-0.6	0.15-0.17	3.0-5.9	0.0-0.5	.32	.32			
Zia	0-3	55-75	15-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.0	.28	.28	5	3	86
	3-60	55-75	15-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
120:														
Pinavetes	0-10	75-90	0-15	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.5-1.0	.17	.17	2	2	134
	10-35	90-100	0-10	0-5	1.55-1.65	6-20	0.03-0.05	0.0-2.9	0.0-1.0	.10	.10			
	35-60	90-100	0-10	0-5	1.55-1.65	6-20	0.03-0.05	0.0-2.9	0.0-0.5	.10	.10			
124:														
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0

Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
129:														
Menefee	0-5	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.5	.32	.32	2	4L	86
	5-10	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	10-17	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	17-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
130:														
Pinavetes	0-2	75-90	0-15	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.5-1.0	.17	.17	2	2	134
	2-60	75-90	0-10	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
Galisteo, moderately saline, sodic	0-2	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	1.0-2.0	.32	.32	5	4L	86
	2-60	20-40	20-40	40-50	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
142:														
Grieta	0-3	55-75	5-25	10-18	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28	5	3	86
	3-11	55-75	5-25	10-18	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
	11-34	50-75	5-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	34-48	50-75	10-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	48-60	75-90	0-15	5-10	1.50-1.60	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
143:														
Clovis	0-3	55-75	15-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	1.0-2.0	.28	.28	5	3	86
	3-7	50-65	10-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.5-1.0	.32	.32			
	7-12	50-65	10-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	12-22	50-65	10-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	22-34	50-65	10-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	34-60	50-65	10-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
145:														
Grieta	0-7	75-95	0-15	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.0-0.5	.20	.20	5	2	134
	7-14	50-70	10-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	14-21	50-70	10-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	21-38	55-75	10-30	5-15	1.45-1.55	2-6	0.09-0.11	0.0-2.9	0.0-0.5	.20	.20			
	38-50	55-75	10-30	5-15	1.45-1.55	2-6	0.09-0.11	0.0-2.9	0.0-0.5	.20	.20			
	50-60	55-75	10-30	5-15	1.45-1.55	2-6	0.09-0.11	0.0-2.9	0.0-0.5	.20	.20			
Sheppard	0-5	75-90	0-15	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.0-0.5	.20	.20	5	2	134
	5-27	75-90	0-15	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.0-0.5	.20	.20			
	27-60	75-95	0-15	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.0-0.5	.20	.20			
146:														
Sedmar	0-3	75-95	0-15	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.5-1.0	.17	.17	1	2	134
	3-13	55-75	10-30	5-15	1.45-1.55	6-20	0.11-0.13	0.0-2.9	0.0-1.0	.24	.24			
	13-18	75-95	0-15	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
	18-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
150:														
Doakum	0-5	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.0	.28	.28	5	3	86
	5-11	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	11-17	50-75	10-30	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	17-24	50-75	10-30	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	24-31	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	31-44	30-50	30-50	10-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			
	44-60	30-50	30-50	10-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.0	.37	.37			
Betonnie	0-2	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.0	.28	.28	5	3	86
	2-4	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.0	.28	.28			
	4-12	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
	12-18	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	18-34	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	34-60	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.0	.24	.24			
162:														
Hackroy	0-3	55-75	10-30	10-18	1.45-1.55	2-6	0.11-0.13	0.0-2.9	1.0-2.0	.24	.24	1	3	86
	3-13	15-40	20-40	40-50	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
	13-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
Nyjack	0-3	30-50	30-50	20-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37	3	6	48
	3-13	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	13-24	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	24-39	55-75	10-30	5-15	1.45-1.55	2-6	0.08-0.10	0.0-2.9	0.0-0.5	.15	.24			
	39-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
163:														
Jemez	0-3	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37	2	5	56
	3-24	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	24-39	50-70	5-25	25-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	39-60	---	---	---	---	0.00-0.01	---	---	---	---	---			

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Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
170:														
San Mateo	0-2	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.5	.37	.37	5	4L	86
	2-10	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	10-23	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	23-32	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	32-54	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.15-0.17	3.0-5.9	0.0-0.5	.32	.32			
	54-60	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.15-0.17	3.0-5.9	0.0-0.5	.32	.32			
180:														
Councelor	0-2	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28	5	3	86
	2-7	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
	7-37	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
	37-40	25-45	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	40-60	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
Eslendo	0-3	25-45	30-50	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.32	.32	2	6	48
	3-10	25-45	30-50	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	10-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
Mespun	0-6	75-90	5-20	2-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.0-0.5	.20	.20	5	2	134
	6-60	70-85	5-20	3-8	1.45-1.55	6-20	0.07-0.09	0.0-2.9	0.0-0.5	.17	.17			
183:														
Sheppard	0-4	75-95	0-15	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.0-0.5	.20	.20	5	2	134
	4-45	75-95	0-15	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.0-0.5	.20	.20			
	45-60	75-95	0-15	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.0-0.5	.20	.20			
185:														
Frijoles	0-3	55-75	10-30	5-15	1.40-1.50	2-6	0.15-0.17	0.0-2.9	1.0-2.0	.55	.55	2	3	86
	3-8	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-1.0	.10	.32			
	8-13	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-0.5	.10	.32			
	13-20	55-75	10-30	10-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.05	.28			
	20-60	55-75	10-30	10-15	1.00-1.10	20-99	0.00-0.01	0.0-2.9	0.0-0.5	---	---			
190:														
Zia	0-5	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-1.0	.24	.24	5	3	86
	5-28	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-1.0	.24	.24			
	28-60	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
Skyvillage	0-2	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	1.0-2.0	.28	.28	1	3	86
	2-11	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-1.0	.28	.28			
	11-16	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
	16-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
191:														
Sheppard	0-3	75-95	0-15	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.0-0.5	.20	.20	5	2	134
	3-27	75-95	0-15	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.0-0.5	.20	.20			
	27-60	75-95	0-15	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.0-0.5	.20	.20			
200:														
Sedillo	0-4	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	1.0-2.0	.10	.24	2	6	48
	4-13	50-70	5-25	20-30	1.35-1.45	0.6-2	0.06-0.08	3.0-5.9	0.0-1.0	.10	.32			
	13-60	55-75	10-30	5-15	1.50-1.60	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.02	.20			
201:														
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
Sedgran	0-4	75-95	0-15	5-10	1.50-1.60	6-20	0.01-0.03	0.0-2.9	0.5-1.0	.02	.15	1	8	0
	4-13	75-95	0-15	5-10	1.50-1.60	6-20	0.03-0.05	0.0-2.9	0.0-0.5	.05	.15			
	13-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
206:														
Pinitos	0-4	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37	5	4	86
	4-10	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	10-27	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	27-39	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	39-60	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
207:														
Penistaja	0-3	55-75	15-30	5-15	1.45-1.55	2-6	0.15-0.17	0.0-2.9	1.0-2.0	.55	.55	5	3	86
	3-29	30-70	5-35	20-30	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-1.0	.32	.32			
	29-60	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
Zia	0-5	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.0	.28	.28	5	3	86
	5-60	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
208:														
Sedillo	0-2	55-75	10-30	5-15	1.45-1.55	2-6	0.06-0.08	0.0-2.9	0.5-1.0	.10	.28	3	6	48
	2-8	50-70	10-30	20-30	1.35-1.45	0.6-2	0.06-0.08	3.0-5.9	0.0-1.0	.10	.32			
	8-12	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
	12-60	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.05	.24			

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Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
210:														
Ildefonso	0-3	30-50	30-50	15-25	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	1.0-2.0	.10	.37	3	7	38
	3-9	30-50	30-50	15-25	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	0.5-1.0	.10	.37			
	9-60	30-50	30-50	15-25	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	0.0-0.5	.10	.37			
211:														
Zia	0-5	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-1.0	.24	.24	5	3	86
	5-14	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-1.0	.24	.24			
	14-33	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	33-46	50-70	10-25	20-30	1.35-1.45	0.6-2	0.14-0.16	0.0-2.9	0.0-0.5	.32	.32			
	46-60	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
Clovis	0-5	55-75	10-30	10-17	1.45-1.55	2-6	0.13-0.15	0.0-2.9	1.0-2.0	.28	.28	5	3	86
	5-60	50-70	5-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
213:														
Pinavetes	0-7	90-100	0-15	0-5	1.55-1.65	6-20	0.03-0.05	0.0-2.9	0.5-1.0	.10	.10	2	1	220
	7-60	75-100	0-15	0-5	1.55-1.65	6-20	0.04-0.06	0.0-2.9	0.0-0.5	.10	.10			
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
215:														
Ess	0-7	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	1.0-2.0	.10	.24	3	8	0
	7-15	55-75	10-30	8-18	1.45-1.55	2-6	0.05-0.07	0.0-2.9	1.0-1.5	.10	.24			
	15-29	50-70	10-25	20-30	1.35-1.45	0.6-2	0.06-0.08	3.0-5.9	0.5-1.0	.10	.32			
	29-60	30-50	30-50	10-20	1.35-1.45	0.6-2	0.08-0.10	0.0-2.9	0.0-0.5	.10	.37			
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
217:														
Witt	0-2	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37	5	5	56
	2-9	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			
	9-60	35-70	10-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.0-0.5	.55	.55			
218:														
Ildefonso	0-4	30-50	30-50	15-25	1.35-1.45	0.6-6	0.08-0.10	3.0-5.9	1.0-2.0	.10	.37	3	7	38
	4-8	30-50	30-50	15-25	1.35-1.45	0.6-6	0.08-0.10	3.0-5.9	0.5-1.0	.10	.37			
	8-60	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
220:														
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
Vessilla	0-2	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-1.0	.24	.24	1	3	86
	2-10	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	10-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Menefee	0-2	25-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.5	.32	.32	2	4L	86
	2-10	25-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	10-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
226:														
Galisteo, moderately saline, sodic	0-10	30-50	30-50	20-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	1.0-2.0	.37	.37	5	4L	86
	10-60	10-20	40-60	35-40	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
227:														
Hagerman	0-4	55-75	10-30	10-20	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.0	.28	.28	2	3	86
	4-34	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	34-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Bond	0-4	75-95	0-25	4-9	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.5-1.0	.20	.20	1	2	134
	4-12	50-70	10-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.5-1.0	.32	.32			
	12-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
228:														
Winona	0-2	55-75	10-30	5-15	1.45-1.55	2-6	0.03-0.05	0.0-2.9	1.0-2.0	.05	.28	1	6	48
	2-13	30-50	30-50	15-25	1.35-1.45	0.6-2	0.08-0.10	3.0-5.9	0.0-1.0	.10	.37			
	13-60	---	---	---	---	0.00-0.2	---	---	---	---	---			
230:														
Skyvillage	0-6	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	1.0-2.0	.24	.24	1	3	86
	6-11	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-1.0	.24	.24			
	11-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Sandoval	0-2	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	1.0-2.0	.32	.32	2	4L	86
	2-10	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	10-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0

Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
231:														
Querencia	0-3	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.5	.37	.37	5	4L	86
	3-21	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-1.0	.37	.37			
	21-60	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			
234:														
Querencia	0-3	55-75	10-30	10-20	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.5	.28	.28	5	3	86
	3-25	30-50	30-50	20-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-1.0	.37	.37			
	25-60	30-70	10-50	12-20	1.40-1.50	0.6-2	0.14-0.16	0.0-2.9	0.0-0.5	.32	.32			
Zia	0-11	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-1.0	.24	.24	5	3	86
	11-60	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
235:														
Sandoval	0-2	55-75	10-30	10-18	1.45-1.55	2-6	0.13-0.15	0.0-2.9	1.0-2.0	.28	.28	2	3	86
	2-16	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	16-19	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	19-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
236:														
Sparank, moderately saline, sodic	0-2	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	1.0-2.0	.32	.32	5	4L	86
	2-10	0-15	40-55	40-50	1.20-1.30	0.06-0.2	0.15-0.17	6.0-8.9	0.5-1.5	.24	.24			
	10-24	0-15	40-55	40-50	1.20-1.30	0.06-0.2	0.15-0.17	6.0-8.9	0.5-1.0	.24	.24			
	24-40	10-20	45-65	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.37	.37			
	40-44	0-15	40-55	40-50	1.20-1.30	0.06-0.2	0.15-0.17	6.0-8.9	0.0-0.5	.24	.24			
	44-60	0-15	40-55	40-50	1.20-1.30	0.06-0.2	0.15-0.17	6.0-8.9	0.0-0.5	.24	.24			
237:														
Sparank	0-4	10-20	45-60	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	1.0-2.0	.37	.37	5	4L	86
	4-60	10-20	45-60	28-35	1.15-1.35	0.06-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.37	.37			
240:														
Penistaja	0-5	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	1.0-2.0	.28	.28	5	3	86
	5-14	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.5	.32	.32			
	14-29	50-70	10-25	20-30	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-1.0	.32	.32			
	29-60	30-75	10-50	15-25	1.40-1.50	0.6-2	0.14-0.16	0.0-2.9	0.0-0.5	.32	.32			
Hagerman	0-2	55-75	10-30	10-20	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.0	.28	.28	2	3	86
	2-9	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	9-24	25-40	25-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	24-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
250:														
Pinavetes	0-4	75-95	0-15	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.5-1.0	.20	.20	2	2	134
	4-60	75-95	10-20	3-7	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
262:														
Pastura	0-3	30-50	30-50	20-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	1.0-2.0	.37	.37	1	4L	86
	3-10	30-50	30-50	20-27	1.35-1.45	0.6-2	0.11-0.13	3.0-5.9	0.0-1.5	.20	.37			
	10-14	30-50	30-50	20-27	1.35-1.45	0.6-2	0.11-0.13	3.0-5.9	0.0-0.5	.20	.37			
	14-60	---	---	---	---	0.00-0.6	---	---	---	---	---			
270:														
Blancot	0-2	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.0	.28	.28	5	3	86
	2-12	50-70	10-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	12-21	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	21-60	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
Councelor	0-2	55-75	10-30	5-15	1.50-1.60	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28	5	3	86
	2-60	55-75	10-30	5-15	1.50-1.60	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
Tsosie	0-2	20-45	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.5	.32	.32	5	4L	86
	2-10	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37			
	10-20	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	20-26	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	26-36	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	36-44	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	44-55	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	55-60	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
281:														
Carjo	0-4	30-50	30-50	10-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	2.0-4.0	.37	.37	2	5	56
	4-12	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	1.0-1.5	.32	.32			
	12-20	20-40	15-40	40-50	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
	20-25	55-75	10-30	5-10	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.55	.55			
	25-60	---	---	---	---	0.00-0.01	---	---	---	---	---			

Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
282:														
Tocal	0-5	55-75	10-30	5-15	1.45-1.55	0.6-2	0.15-0.17	0.0-2.9	1.0-2.0	.55	.55	2	3	86
	5-8	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.32	.32			
	8-11	15-40	10-35	40-50	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-1.0	.20	.20			
	11-14	15-35	50-70	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	0.0-0.5	.43	.43			
	14-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
283:														
Mirand	0-2	30-50	30-50	20-27	0.20-1.00	20-60	0.15-0.45	---	60-70	---	---	5	5	56
	2-6	30-50	30-50	20-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	1.0-3.0	.37	.37			
	6-11	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.5	.32	.32			
	11-17	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.17-0.19	3.0-5.9	0.0-1.0	.20	.32			
	17-27	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	27-47	15-40	10-40	40-55	1.15-1.35	0.2-0.6	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
	47-60	20-40	20-40	28-35	1.35-1.45	0.01-0.06	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
Alanos	0-6	30-50	30-50	15-25	1.35-1.45	0.6-2	0.11-0.13	3.0-5.9	0.5-1.0	.20	.37	3	7	38
	6-9	30-50	30-50	15-25	1.35-1.45	0.6-2	0.11-0.13	3.0-5.9	0.0-0.5	.20	.37			
	9-30	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.05-0.07	3.0-5.9	0.0-0.5	.05	.32			
	30-60	10-40	20-40	40-50	1.15-1.35	0.06-0.2	0.07-0.09	6.0-8.9	0.0-0.5	.05	.20			
290:														
Alanos	0-4	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37	3	6	48
	4-9	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37			
	9-18	30-50	30-50	15-25	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	0.0-0.5	.10	.37			
	18-26	10-40	20-40	40-50	1.15-1.25	0.06-0.2	0.04-0.06	6.0-8.9	0.0-0.5	.02	.20			
	26-60	10-30	20-40	40-50	1.15-1.25	0.06-0.2	0.04-0.06	6.0-8.9	0.0-0.5	.02	.20			
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
300:														
Waumac	0-3	75-95	0-15	5-10	1.55-1.65	6-20	0.06-0.08	0.0-2.9	0.5-1.0	.17	.17	5	2	134
	3-31	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
	31-60	55-75	10-30	5-15	1.45-1.55	2-6	0.09-0.10	0.0-2.9	0.0-0.5	.15	.28			
Bamac	0-6	75-95	0-15	5-10	1.55-1.65	6-20	0.04-0.06	0.0-2.9	0.5-1.0	.10	.17	3	4	86
	6-60	75-100	0-20	5-10	1.55-1.65	6-20	0.02-0.04	0.0-2.9	0.0-0.5	.05	.17			
301:														
Vastine	0-4	10-35	50-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	2.0-4.0	.43	.43	4	6	48
	4-11	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-2.0	.37	.37			
	11-24	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-1.0	.37	.37			
	24-60	75-95	0-15	5-10	1.45-1.55	6-20	0.02-0.04	0.0-2.9	0.0-0.5	.05	.17			
Jarola	0-9	10-35	50-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	1.0-3.0	.43	.43	5	5	56
	9-11	10-35	50-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	0.5-1.5	.43	.43			
	11-17	10-20	45-60	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.37	.37			
	17-21	30-50	30-50	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	21-42	50-70	10-25	20-30	1.35-1.45	0.6-2	0.11-0.13	3.0-5.9	0.0-0.5	.15	.32			
	42-60	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
302:														
Tranquilar	0-4	5-20	40-65	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	2.0-4.0	.37	.37	5	7	38
	4-8	5-20	40-65	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	1.0-2.0	.37	.37			
	8-11	5-20	40-65	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.5	.37	.37			
	11-13	5-20	40-65	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.5	.37	.37			
	13-20	10-40	15-40	40-60	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-1.0	.20	.20			
	20-34	10-40	15-40	40-60	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
	34-42	10-40	15-40	40-60	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
	42-50	10-40	15-40	40-60	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
	50-60	10-40	15-40	40-60	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
Jarmillo	0-4	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	2.0-4.0	.37	.37	5	5	56
	4-13	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	1.0-2.0	.37	.37			
	13-20	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37			
	20-26	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.0-0.5	.37	.37			
	26-36	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.0-0.5	.37	.37			
	36-41	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
	41-51	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	51-60	55-75	10-30	8-18	1.45-1.55	2-6	0.15-0.17	0.0-2.9	0.0-0.5	.55	.55			
304:														
Cosey	0-9	10-35	50-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	1.0-3.0	.43	.43	4	5	56
	9-15	10-35	50-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	1.0-1.5	.43	.43			
	15-28	30-50	30-50	10-20	1.35-1.45	0.6-2	0.11-0.13	0.0-2.9	0.0-1.0	.20	.37			
	28-34	50-75	5-25	20-35	1.35-1.45	0.6-2	0.06-0.08	3.0-5.9	0.0-0.5	.10	.32			
	34-60	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.05-0.07	3.0-5.9	0.0-0.5	.05	.32			
Jarmillo	0-17	10-35	50-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	2.0-4.0	.43	.43	5	5	56
	17-33	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-2.0	.24	.24			
	33-60	30-75	10-40	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			

: 07360

Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
307:														
Flugle	0-3	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	1.0-3.0	.37	.37	5	5	56
	3-7	50-75	10-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	7-12	50-75	10-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	12-19	50-75	10-25	20-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	19-60	55-75	10-30	10-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.0	.28	.28			
Waumac	0-3	75-95	0-15	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.5-1.0	.17	.17	5	2	134
	3-60	55-75	10-30	5-15	1.45-1.55	2-6	0.12-0.14	0.0-2.9	0.0-0.5	.28	.28			
308:														
Cajete	0-7	30-50	30-50	15-25	1.35-1.45	0.6-2	0.12-0.14	3.0-5.9	1.0-2.0	.20	.37	3	6	48
	7-15	30-50	30-50	15-25	1.35-1.45	0.6-2	0.12-0.14	3.0-5.9	1.0-1.5	.20	.37			
	15-33	55-75	10-30	5-15	1.45-1.55	2-6	0.06-0.08	0.0-2.9	0.5-1.0	.10	.24			
	33-45	90-100	0-10	0-5	1.55-1.65	6-20	0.01-0.03	0.0-2.9	0.5-1.0	.02	.10			
	45-49	90-100	0-10	0-5	1.55-1.65	6-20	0.01-0.03	0.0-2.9	0.0-0.5	.02	.10			
	49-60	90-100	0-10	0-5	1.55-1.65	6-20	0.01-0.03	0.0-2.9	0.0-0.5	.02	.10			
311:														
Cosey	0-13	10-35	50-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	1.0-3.0	.43	.43	4	5	56
	13-24	30-50	30-50	10-20	1.35-1.45	0.6-2	0.11-0.13	0.0-2.9	0.0-0.5	.20	.37			
	24-60	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.04-0.06	3.0-5.9	0.0-0.5	.05	.32			
Tranquilar	0-14	10-35	50-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	2.0-4.0	.43	.43	5	5	56
	14-20	10-35	50-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	0.0-2.0	.43	.43			
	20-42	10-40	10-40	40-60	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-1.0	.20	.20			
	42-60	10-40	10-40	40-60	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
Calaveras	0-4	10-35	50-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	1.0-1.5	.43	.43	3	5	56
	4-11	10-35	50-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	0.5-1.0	.43	.43			
	11-17	10-35	50-75	15-25	1.15-1.35	0.6-2	0.15-0.17	3.0-5.9	0.0-1.0	.24	.43			
	17-30	30-50	30-50	10-20	1.35-1.45	0.6-2	0.07-0.09	0.0-2.9	0.0-0.5	.10	.37			
	30-39	55-75	10-30	5-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.02	.20			
	39-60	75-95	0-15	5-10	1.45-1.55	6-20	0.01-0.03	0.0-2.9	0.0-0.5	.02	.17			
312:														
Royosa	0-5	90-100	0-15	0-5	1.55-1.65	20-20	0.03-0.05	0.0-2.9	1.0-2.0	.10	.10	2	1	220
	5-16	90-100	0-15	0-5	1.55-1.65	20-20	0.03-0.05	0.0-2.9	0.5-1.5	.10	.10			
	16-60	75-95	5-20	0-10	1.50-1.60	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
314:														
Fragua	0-3	75-95	0-15	5-10	1.50-1.60	6-20	0.07-0.09	0.0-2.9	1.0-2.0	.17	.17	5	2	134
	3-8	55-75	10-30	10-18	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	8-24	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	24-60	55-75	10-30	10-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
Waumac	0-3	75-95	0-15	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.5-1.0	.20	.20	5	2	134
	3-60	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
Royosa	0-7	90-100	0-10	0-5	1.55-1.65	6-20	0.05-0.07	0.0-2.9	1.0-2.0	.17	.17	2	1	220
	7-60	90-100	0-10	0-5	1.55-1.65	6-20	0.05-0.07	0.0-2.9	0.0-1.0	.17	.17			
317:														
Elpedro	0-2	30-50	30-50	15-22	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37	5	5	56
	2-22	0-20	50-70	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
	22-60	30-50	30-50	20-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			
319:														
Bamac	0-4	75-90	0-15	5-10	1.50-1.60	6-20	0.03-0.05	0.0-2.9	0.5-1.0	.05	.17	4	5	56
	4-10	75-90	0-15	5-10	1.50-1.60	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
	10-21	75-95	0-15	5-10	1.55-1.65	6-20	0.02-0.04	0.0-2.9	0.0-0.5	.05	.15			
	21-37	75-95	0-15	5-10	1.55-1.65	6-20	0.02-0.04	0.0-2.9	0.0-0.5	.05	.15			
	37-60	75-95	0-15	5-10	1.55-1.65	6-20	0.02-0.04	0.0-2.9	0.0-0.5	.05	.15			
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
320:														
Sparham	0-9	10-35	50-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	0.5-1.5	.43	.43	5	6	48
	9-32	0-20	40-55	40-50	1.20-1.30	0.06-0.2	0.15-0.17	6.0-8.9	0.0-1.0	.24	.24			
	32-60	0-20	40-55	40-50	1.20-1.30	0.06-0.2	0.15-0.17	6.0-8.9	0.0-0.5	.24	.24			
321:														
Waumac	0-3	75-95	0-15	5-10	1.50-1.60	6-20	0.08-0.10	0.0-2.9	0.5-1.0	.20	.20	5	2	134
	3-60	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			

Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
321:														
Royosa	0-12	90-100	0-15	0-5	1.55-1.65	6-20	0.05-0.07	0.0-2.9	1.0-2.0	.17	.17	2	1	220
	12-60	90-100	0-15	0-5	1.55-1.65	6-20	0.05-0.07	0.0-2.9	0.0-1.0	.17	.17			
322:														
Fragua	0-3	55-75	10-30	10-15	1.45-1.55	2-6	0.06-0.08	0.0-2.9	1.0-2.0	.10	.28	5	6	48
	3-16	55-75	10-30	10-18	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
	16-45	75-90	0-15	5-10	1.50-1.60	6-20	0.08-0.10	0.0-2.9	0.0-0.5	.17	.17			
	45-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
324:														
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
Atarque	0-3	55-75	10-30	10-18	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-1.0	.24	.24	1	3	86
	3-9	50-75	5-20	25-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	9-14	50-75	5-20	25-35	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	14-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Menefee	0-2	30-50	30-50	20-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.5	.20	.37	1	4L	86
	2-9	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	9-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
325:														
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
Espiritu	0-2	55-75	10-30	5-15	1.45-1.55	2-6	0.06-0.08	0.0-2.9	1.0-2.0	.10	.28	3	6	48
	2-20	50-70	5-25	25-35	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	0.0-0.5	.10	.32			
	20-60	30-50	30-50	15-25	1.35-1.45	0.6-2	0.08-0.10	3.0-5.9	0.0-0.5	.10	.37			
Vessilla	0-1	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.5-1.0	.10	.24	1	6	48
	1-10	30-50	30-50	10-20	1.35-1.45	0.6-2	0.11-0.13	0.0-2.9	0.0-0.5	.20	.37			
	10-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
342:														
Waumac	0-5	75-90	0-15	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.5-1.0	.20	.20	5	2	134
	5-60	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
Vessilla	0-3	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.5-1.0	.28	.28	1	3	86
	3-13	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
	13-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
345:														
Espiritu	0-6	55-75	10-30	5-15	1.45-1.55	2-6	0.06-0.08	0.0-2.9	1.0-2.0	.10	.28	3	6	48
	6-15	50-70	5-25	25-35	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	0.0-0.5	.10	.32			
	15-22	50-70	5-25	20-30	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	0.0-0.5	.10	.32			
	22-29	50-70	5-25	20-30	1.35-1.45	0.6-2	0.06-0.08	3.0-5.9	0.0-0.5	.10	.32			
	29-38	50-70	5-25	20-30	1.35-1.45	0.6-2	0.06-0.08	3.0-5.9	0.0-0.5	.10	.32			
	38-46	---	---	10-20	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
	46-60	55-75	10-30	10-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.0	.10	.24			
Bamac	0-3	75-90	0-15	5-10	1.55-1.65	6-20	0.02-0.03	0.0-2.9	0.5-1.0	.05	.17	4	5	56
	3-30	75-90	0-15	5-10	1.55-1.65	6-20	0.02-0.04	0.0-2.9	0.0-0.5	.05	.17			
	30-60	75-90	0-15	5-10	1.55-1.65	6-20	0.02-0.04	0.0-2.9	0.0-0.5	.05	.17			
346:														
Espiritu, cobbly	0-2	55-75	10-30	5-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	1.0-2.0	.05	.24	3	8	0
	2-24	50-70	5-25	25-35	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	0.0-0.5	.10	.32			
	24-36	55-75	10-30	10-18	1.45-1.55	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.10	.24			
	36-60	75-90	0-15	5-10	1.45-1.55	6-20	0.04-0.06	0.0-2.9	0.0-0.5	.05	.17			
Bamac	0-3	75-90	0-15	5-10	1.55-1.65	6-20	0.02-0.03	0.0-2.9	0.5-1.0	.05	.17	3	5	56
	3-30	75-100	0-20	5-10	1.55-1.65	6-20	0.02-0.04	0.0-2.9	0.0-0.5	.10	.15			
	30-45	75-90	0-15	5-10	1.55-1.65	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
	45-60	75-90	0-15	5-10	1.55-1.65	6-20	0.02-0.04	0.0-2.9	0.0-0.5	.05	.17			
348:														
Wauquie	0-2	50-70	5-25	20-30	1.35-1.45	0.6-2	0.03-0.05	3.0-5.9	0.5-1.0	.05	.32	3	6	48
	2-16	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-0.5	.10	.32			
	16-40	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
	40-60	75-90	0-15	5-10	1.45-1.55	6-20	0.03-0.04	0.0-2.9	0.0-0.5	.02	.17			
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
353:														
Cochiti	0-4	30-50	30-50	15-25	1.35-1.45	0.6-2	0.02-0.04	3.0-5.9	0.5-1.0	.05	.37	4	8	0
	4-22	20-40	20-40	30-40	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-0.5	.10	.32			
	22-60	75-90	0-15	5-10	1.45-1.55	6-20	0.04-0.06	0.0-2.9	0.0-0.5	.05	.17			

Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
353:														
Espiritu	0-3	30-50	30-50	15-25	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	1.0-2.0	.10	.37	3	8	0
	3-16	50-70	5-25	25-35	1.35-1.45	0.6-2	0.06-0.08	3.0-5.9	0.0-0.5	.10	.32			
	16-60	75-90	0-15	5-10	1.50-1.60	6-20	0.02-0.04	0.0-2.9	0.0-0.5	.02	.17			
354:														
Waumac Variant	0-3	55-80	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.5-1.0	.10	.24	2	6	48
	3-12	55-80	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
	12-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
358:														
Deama	0-3	30-50	30-50	18-27	1.35-1.45	0.6-2	0.06-0.08	3.0-5.9	1.0-3.0	.10	.37	1	6	48
	3-19	30-50	30-50	18-27	1.35-1.45	0.6-2	0.06-0.08	3.0-5.9	0.5-1.0	.10	.37			
	19-60	---	---	---	---	0.00-0.2	---	---	---	---	---			
Elpedro	0-3	30-50	30-50	15-22	1.35-1.45	0.6-2	0.08-0.10	3.0-5.9	0.5-1.0	.10	.37	5	7	38
	3-37	0-20	50-70	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
	37-60	10-50	30-80	20-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
396:														
Atarque	0-2	55-75	10-30	10-18	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-1.0	.05	.24	1	8	0
	2-16	20-40	20-40	25-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	16-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Menefee	0-2	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.13-0.15	3.0-5.9	0.5-1.5	.20	.32	2	4L	86
	2-14	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	14-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
397:														
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
Cucho	0-2	20-40	20-45	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.5-1.0	.10	.32	3	8	0
	2-9	20-40	20-45	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	9-37	20-40	20-45	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-0.5	.10	.32			
	37-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
Vessilla	0-2	55-75	10-30	5-15	1.45-1.55	2-6	0.09-0.10	0.0-2.9	0.5-1.0	.15	.28	1	5	56
	2-11	55-75	10-30	5-15	1.45-1.55	2-6	0.09-0.10	0.0-2.9	0.0-0.5	.15	.28			
	11-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
398:														
Espiritu	0-4	55-75	10-30	10-18	1.45-1.55	2-6	0.07-0.09	0.0-2.9	1.0-2.0	.10	.28	3	6	48
	4-24	50-70	5-25	25-35	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	0.0-0.5	.10	.32			
	24-60	55-75	10-30	10-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.05	.24			
Cucho	0-2	20-40	20-45	28-35	1.35-1.45	0.2-0.6	0.10-0.12	3.0-5.9	0.5-1.0	.10	.32	3	8	0
	2-37	0-20	45-65	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
	37-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
399:														
Cucho	0-2	20-40	20-45	28-35	1.35-1.45	0.2-0.6	0.10-0.12	3.0-5.9	0.5-1.0	.10	.32	3	8	0
	2-37	20-40	20-45	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	37-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
Teco	0-1	55-75	10-30	5-15	1.45-1.55	2-6	0.06-0.08	0.0-2.9	0.5-1.5	.10	.28	5	6	48
	1-7	45-60	0-15	35-55	1.35-1.45	0.2-0.6	0.15-0.17	6.0-8.9	0.5-1.0	.32	.32			
	7-23	10-40	15-40	40-50	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-1.0	.20	.20			
	23-40	10-40	15-45	40-50	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
	40-45	55-75	10-30	5-15	1.45-1.55	2-6	0.06-0.08	0.0-2.9	0.0-0.5	.10	.28			
	45-60	50-70	10-30	20-30	1.35-1.45	0.6-2	0.09-0.11	3.0-5.9	0.0-0.5	.15	.32			
405:														
Charo	0-5	30-50	30-50	20-27	1.35-1.45	0.6-2	0.11-0.13	3.0-5.9	0.5-1.0	.20	.37	2	8	0
	5-12	10-30	20-40	40-60	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.5-1.0	.20	.20			
	12-15	10-30	20-40	40-60	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
	15-25	10-30	20-40	40-60	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
	25-28	10-30	20-40	40-60	1.15-1.35	0.06-0.2	0.14-0.16	6.0-8.9	0.0-0.5	.20	.20			
	28-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Charo, noncobbly	0-8	30-50	30-50	20-27	1.30-1.40	0.6-2	0.16-0.18	0.0-2.9	0.5-0.9	.37	.43	2	6	48
	8-38	10-30	20-40	40-60	1.35-1.45	0.06-0.2	0.15-0.18	3.0-5.9	0.1-0.3	.28	.28			
	38-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
409:														
Santa Fe	0-3	55-75	10-30	10-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	1.0-2.0	.10	.24	1	6	48
	3-8	50-75	10-25	20-35	1.35-1.45	0.6-2	0.06-0.08	3.0-5.9	0.0-1.0	.10	.32			
	8-60	---	---	---	---	0.00-0.01	---	---	---	---	---			

: 07363

Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
410:														
Zia	0-10	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37	5	4L	86
	10-60	55-75	10-30	5-15	1.45-1.55	2-6	0.12-0.14	0.0-2.9	0.0-0.5	.28	.28			
414:														
Wauquie	0-3	55-75	10-30	5-15	1.45-1.55	2-6	0.06-0.08	0.0-2.9	0.5-1.0	.10	.28	3	6	48
	3-30	50-70	10-25	20-30	1.35-1.45	0.6-2	0.06-0.08	3.0-5.9	0.0-0.5	.10	.32			
	30-60	55-90	5-35	5-10	1.50-1.60	6-20	0.04-0.06	0.0-2.9	0.0-0.5	.05	.20			
417:														
Jocity	0-10	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37	5	4L	86
	10-26	5-20	45-65	28-35	1.15-1.35	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.37	.37			
	26-32	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.0-0.5	.37	.37			
	32-50	50-70	10-25	20-30	1.35-1.45	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.32	.32			
	50-56	55-75	15-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	56-60	75-90	0-20	5-10	1.45-1.55	6-20	0.07-0.09	0.0-2.9	0.0-0.5	.17	.17			
418:														
Jocity	0-12	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.32	.32	5	4L	86
	12-30	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.32	.32			
	30-60	55-90	5-35	3-10	1.45-1.55	2-20	0.08-0.10	0.0-2.9	0.0-0.5	.24	.24			
419:														
Santa Fe	0-9	55-75	10-30	5-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	1.0-2.0	.05	.24	1	8	0
	9-16	50-75	5-25	20-35	1.35-1.45	0.6-2	0.06-0.08	3.0-5.9	0.0-1.0	.10	.32			
	16-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Wauquie	0-4	55-75	10-30	5-15	1.45-1.55	2-6	0.03-0.05	0.0-2.9	0.5-1.0	.05	.28	3	8	0
	4-11	50-75	10-25	20-30	1.35-1.45	0.6-2	0.03-0.05	3.0-5.9	0.0-1.0	.05	.32			
	11-18	50-75	10-25	20-30	1.35-1.45	0.6-2	0.03-0.05	3.0-5.9	0.0-0.5	.05	.32			
	18-29	55-75	10-30	5-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.05	.24			
	29-60	90-100	0-10	0-5	1.55-1.65	6-20	0.01-0.01	0.0-2.9	0.0-0.5	.02	.10			
Rock outcrop	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
420:														
Pinavetes	0-10	75-90	0-15	3-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.5-1.0	.17	.17	2	2	134
	10-60	90-100	0-15	0-5	1.55-1.65	6-20	0.03-0.05	0.0-2.9	0.0-0.5	.10	.10			
421:														
Gilco, moderately saline, sodic	0-7	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37	5	4L	86
	7-19	55-75	10-30	10-18	1.40-1.50	2-6	0.14-0.16	0.0-2.9	0.0-0.5	.55	.55			
	19-60	30-70	10-50	10-18	1.40-1.50	0.6-2	0.14-0.16	0.0-2.9	0.0-0.5	.32	.32			
422:														
Vessilla	0-1	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.5-1.0	.24	.24	1	3	86
	1-15	55-75	10-30	5-15	1.45-1.55	2-6	0.11-0.13	0.0-2.9	0.0-0.5	.24	.24			
	15-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Menefee	0-3	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.5	.32	.32	2	4L	86
	3-10	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	10-60	---	---	---	---	0.00-0.02	---	---	---	---	---			
Orlie	0-4	30-50	30-50	20-27	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	2.0-3.0	.37	.37	5	6	48
	4-14	5-45	25-65	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.5	.37	.37			
	14-60	5-20	45-65	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-0.5	.37	.37			
423:														
Gilco	0-8	30-50	30-50	10-18	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37	5	4L	86
	8-14	30-50	30-50	10-18	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.0-0.5	.37	.37			
	14-60	15-70	20-70	10-18	1.35-1.45	0.6-2	0.15-0.17	0.0-2.9	0.0-0.5	.32	.32			
426:														
Aga, moderately saline, sodic	0-8	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37	3	4L	86
	8-20	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.0-0.5	.37	.37			
	20-36	75-90	0-25	0-10	1.50-1.60	6-20	0.03-0.05	0.0-2.9	0.0-0.5	.10	.10			
	36-60	90-100	0-10	0-5	1.55-1.65	6-20	0.03-0.05	0.0-2.9	0.0-0.5	.05	.10			
427:														
Aga	0-8	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37	3	4L	86
	8-28	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.0-0.5	.37	.37			
	28-60	75-90	0-25	0-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.0-0.5	.20	.20			

: 07364

Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
428:														
Aga, moderately saline, sodic------	0-4	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37	3	4L	86
	4-16	55-75	10-35	5-15	1.45-1.55	0.6-2	0.15-0.17	0.0-2.9	0.0-0.5	.55	.55			
	16-22	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.0-0.5	.37	.37			
	22-60	70-100	0-30	0-10	1.55-1.65	6-20	0.04-0.06	0.0-2.9	0.0-0.5	.17	.17			
430:														
Trail----------	0-10	30-50	30-50	10-20	1.35-1.45	2-6	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37	5	4L	86
	10-34	75-90	0-15	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
	34-60	55-100	0-40	0-5	1.45-1.55	6-20	0.03-0.05	0.0-2.9	0.0-0.5	.10	.10			
431:														
Trail----------	0-10	75-95	0-15	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.5-1.0	.17	.17	5	2	134
	10-60	50-100	0-45	0-10	1.45-1.55	2-20	0.06-0.12	0.0-2.9	0.0-0.5	.17	.17			
433:														
Peralta----------	0-10	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.0	.37	.37	5	4L	86
	10-60	55-95	0-30	10-20	1.45-1.55	0.6-2	0.13-0.15	0.0-2.9	0.0-0.5	.24	.24			
434:														
Peralta----------	0-10	30-50	30-50	15-25	1.35-1.45	0.6-2	0.16-0.18	3.0-5.9	0.5-1.5	.37	.37	5	4L	86
	10-16	55-75	10-30	5-15	1.45-1.55	2-6	0.15-0.17	0.0-2.9	0.5-1.0	.55	.55			
	16-20	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.0-1.0	.32	.32			
	20-28	55-75	10-30	5-15	1.45-1.55	2-6	0.13-0.15	0.0-2.9	0.0-1.0	.28	.28			
	28-40	75-95	0-15	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
	40-45	10-40	50-75	15-25	1.15-1.35	0.6-2	0.19-0.21	3.0-5.9	0.0-0.5	.43	.43			
	45-60	75-95	0-15	5-10	1.45-1.55	6-20	0.09-0.10	0.0-2.9	0.0-0.5	.20	.20			
437:														
Peralta, moderately saline, sodic------	0-4	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37	5	4L	86
	4-60	35-95	0-50	5-15	1.45-1.55	0.6-2	0.13-0.15	0.0-2.9	0.0-0.5	.28	.28			
500:														
Rock outcrop--------	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
Osha----------	0-10	55-75	10-30	5-10	1.50-1.60	2-6	0.04-0.06	0.0-2.9	1.0-2.0	.05	.20	3	5	56
	10-20	55-75	10-30	5-10	1.50-1.65	2-6	0.03-0.05	0.0-2.9	0.5-1.5	.05	.20			
	20-43	55-95	1-30	3-7	1.50-1.60	6-20	0.01-0.03	0.0-2.9	0.0-0.5	.05	.15			
	43-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Rubble land---------	0-60	---	---	0-0	---	20-99	0.00-0.02	0.0-2.9	0.0-0.1	---	---	--	8	0
503:														
Cajete----------	0-8	55-75	10-30	8-15	1.50-1.60	2-6	0.02-0.04	0.0-2.9	1.0-2.0	.05	.24	2	8	0
	8-60	55-75	10-30	10-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.5-1.0	.10	.24			
Cypher----------	0-3	30-50	30-50	10-20	1.35-1.45	0.6-2	0.07-0.09	0.0-2.9	0.5-1.0	.10	.37	1	7	38
	3-11	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
	11-15	55-75	10-30	5-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.05	.24			
	15-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
504:														
Orejas----------	0-2	30-50	30-50	15-25	1.35-1.45	0.6-2	0.08-0.10	3.0-5.9	0.5-1.0	.10	.37	1	7	38
	2-9	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-0.5	.10	.32			
	9-17	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.09-0.11	3.0-5.9	0.0-0.5	.10	.32			
	17-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Guaje----------	0-4	55-75	10-30	5-15	0.85-0.95	2-6	0.08-0.09	0.0-2.9	1.0-2.0	.15	.24	2	5	56
	4-12	55-75	10-30	5-15	0.85-0.95	2-6	0.08-0.09	0.0-2.9	0.5-1.0	.15	.24			
	12-17	55-75	10-30	5-15	0.85-0.95	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
	17-45	55-75	10-30	5-15	1.20-1.30	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.05	.24			
	45-60	55-75	10-30	5-15	1.25-1.35	2-6	0.05-0.07	0.0-2.9	0.0-0.5	.10	.24			
600:														
Rock outcrop--------	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	1	8	0
Cypher----------	0-4	30-50	30-50	10-20	1.35-1.45	0.6-2	0.08-0.10	0.0-2.9	0.5-1.0	.10	.37	1	7	38
	4-14	30-50	30-50	10-25	1.35-1.45	0.6-2	0.08-0.10	0.0-2.9	0.0-0.5	.10	.37			
	14-16	30-50	30-50	10-25	1.35-1.45	0.6-2	0.08-0.10	0.0-2.9	0.0-0.5	.10	.37			
	16-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
601:														
Laventana----------	0-5	55-75	10-30	5-15	1.45-1.55	2-6	0.08-0.10	0.0-2.9	1.0-2.0	.15	.24	3	5	56
	5-9	30-50	30-50	10-20	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	0.0-1.0	.10	.37			
	9-50	30-70	10-40	20-35	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	0.0-0.5	.10	.32			
	50-60	---	---	---	---	0.00-0.01	---	---	---	---	---			

Table 15.--Physical soil properties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In.	Pct.	Pct.	Pct.	g/cc	In./hr.	In./in.	Pct.	Pct.					
603:														
Laventana	0-1	30-50	30-50	15-25	0.20-1.00	20-60	0.15-0.45	---	60-70	---	---	3	8	0
	1-5	30-50	30-50	15-25	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	1.0-2.0	.10	.37			
	5-12	10-40	50-75	15-25	1.15-1.35	0.6-2	0.13-0.15	3.0-5.9	0.0-1.0	.24	.43			
	12-20	30-50	30-50	20-25	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	0.0-0.5	.10	.37			
	20-31	30-50	30-50	20-27	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	0.0-0.5	.10	.37			
	31-51	30-50	30-50	15-25	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	0.0-0.5	.10	.37			
	51-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Mirand	0-6	30-50	30-50	20-27	1.35-1.45	0.6-2	0.08-0.10	3.0-5.9	1.0-3.0	.10	.37	5	8	0
	6-27	10-35	20-40	40-60	1.15-1.35	0.06-0.2	0.10-0.12	6.0-8.9	0.0-1.0	.10	.20			
	27-60	45-60	0-15	35-50	1.35-1.45	0.2-0.6	0.15-0.17	6.0-8.9	0.0-0.5	.32	.32			
604:														
Cypher	0-1	30-50	30-50	10-20	0.20-1.00	20-60	0.15-0.45	---	60-70	---	---	1	7	38
	1-4	30-50	30-50	10-20	1.35-1.45	0.6-2	0.08-0.10	0.0-2.9	0.5-1.0	.10	.37			
	4-11	30-50	30-50	10-25	1.35-1.45	0.6-2	0.09-0.11	0.0-2.9	0.0-0.5	.10	.37			
	11-19	55-75	10-30	5-15	1.45-1.55	2-6	0.02-0.04	0.0-2.9	0.0-0.5	.05	.24			
	19-60	---	---	---	---	0.00-0.01	---	---	---	---	---			
Mirand	0-4	30-50	30-50	20-27	1.35-1.45	0.6-2	0.07-0.09	3.0-5.9	0.5-1.5	.10	.37	5	8	0
	4-60	10-35	20-40	40-50	1.15-1.35	0.06-0.2	0.10-0.12	6.0-8.9	0.0-0.5	.10	.20			
608:														
Osha, steep	0-3	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	1.0-2.0	.10	.20	3	6	48
	3-8	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-2.0	.10	.20			
	8-16	55-75	10-30	5-15	1.45-1.55	2-6	0.05-0.07	0.0-2.9	0.0-1.0	.10	.20			
	16-32	55-75	10-30	5-15	1.45-1.55	2-6	0.01-0.03	0.0-2.9	0.0-0.5	.05	.20			
	32-60	75-95	0-20	0-5	1.45-1.55	6-20	0.01-0.03	0.0-2.9	0.0-0.5	.05	.15			
Osha	0-8	55-75	10-30	4-10	1.60-1.65	2-6	0.08-0.10	0.0-2.9	0.5-1.5	.10	.20	3	5	56
	8-16	55-75	10-30	6-12	1.60-1.65	2-6	0.04-0.07	0.0-2.9	0.1-0.3	.10	.20			
	16-32	55-75	10-30	6-12	1.70-1.75	2-6	0.02-0.04	0.0-2.9	0.1-0.3	.02	.20			
	32-60	75-95	0-20	4-8	1.90-1.95	6-20	0.01-0.03	0.0-2.9	0.1-0.3	.02	.15			
823:														
Gilco, unprotected	0-8	30-50	30-50	10-18	1.35-1.45	0.6-2	0.15-0.17	0.0-2.9	0.5-1.0	.37	.43	5	4L	86
	8-60	10-70	10-70	10-18	1.35-1.45	0.6-2	0.15-0.17	0.0-2.9	0.0-0.5	.37	.37			
827:														
Aga, unprotected	0-8	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37	3	4L	86
	8-28	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.0-0.5	.37	.37			
	28-60	75-95	0-15	5-10	1.45-1.55	6-20	0.08-0.10	0.0-2.9	0.0-0.5	.20	.20			
830:														
Trail, unprotected	0-8	30-50	30-50	10-20	1.35-1.45	2-20	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37	5	3	86
	8-60	55-100	0-40	0-10	1.45-1.55	2-20	0.03-0.13	0.0-2.9	0.0-0.5	.17	.17			
831:														
Trail, unprotected	0-10	75-95	0-15	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.0-1.0	.17	.17	5	2	134
	10-30	75-95	0-15	5-10	1.45-1.55	6-20	0.06-0.08	0.0-2.9	0.0-0.5	.17	.17			
	30-60	55-100	0-30	0-5	1.45-1.55	6-20	0.03-0.05	0.0-2.9	0.0-0.5	.10	.10			
835:														
Peralta, unprotected	0-6	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.5-1.0	.37	.37	5	4L	86
	6-16	30-50	30-50	10-20	1.35-1.45	0.6-2	0.16-0.18	0.0-2.9	0.0-1.0	.37	.37			
	16-60	30-75	5-40	15-35	1.40-1.50	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.24	.24			
842:														
Peralta, moderately saline, sodic, unprotected	0-10	20-40	20-40	28-35	1.35-1.45	0.2-0.6	0.19-0.21	3.0-5.9	0.5-1.0	.32	.32	5	4L	86
	10-60	25-75	5-45	15-35	1.40-1.50	0.6-2	0.14-0.16	3.0-5.9	0.0-0.5	.28	.28			
850:														
Water	---	---	---	---	---	---	---	---	---	---	---	--	---	---
DAM:														
Dam	---	---	---	---	---	---	---	---	---	---	---	--	---	---

Table 16.--Chemical properties of the soils

(Absence of an entry indicates that data were not estimated.)

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
1:							
Silver	0-4	11-18	6.6-7.3	0-5	0	0.0-2.0	0-2
	4-8	16-24	7.4-7.8	0-5	0	0.0-2.0	0-2
	8-20	16-23	7.4-7.8	0-5	0	0.0-2.0	0-2
	20-39	16-23	7.4-7.8	0-5	0	0.0-2.0	0-2
	39-60	16-23	7.4-7.8	5-10	0	0.0-2.0	0-2
Clovis	0-3	12-18	6.6-7.8	5-10	0	0.0-2.0	0-2
	3-20	16-23	6.6-7.8	5-10	0	0.0-2.0	0-2
	20-40	12-20	7.9-8.4	15-20	0	0.0-2.0	0-2
	40-60	4.0-11	7.9-8.4	15-20	0	0.0-2.0	0-2
2:							
Clovis	0-3	12-18	6.6-7.8	5-10	0	0.0-2.0	0-2
	3-24	16-23	6.6-8.4	10-15	0	0.0-2.0	0-2
	24-60	4.0-11	7.9-8.4	15-20	0	0.0-2.0	0-2
Prieta	0-3	11-18	6.6-7.3	0-5	0	0.0-2.0	0-2
	3-10	16-24	7.4-7.8	0-5	0	0.0-2.0	0-2
	10-14	16-23	7.9-8.4	0-5	0	0.0-2.0	0-2
	14-19	16-23	7.9-8.4	10-14	0	0.0-2.0	0-2
	19-60	---	---	---	---	---	---
Silver	0-8	11-18	6.6-7.3	0-5	0	0.0-2.0	0-2
	8-30	16-24	7.4-7.8	0-5	0	0.0-2.0	0-2
	30-60	16-23	7.4-7.8	0-5	0	0.0-2.0	0-2
3:							
Montecito	0-3	6.5-13	6.6-7.3	0-5	0	0.0-2.0	0-2
	3-18	15-19	7.4-7.8	5-10	0	0.0-2.0	0-2
	18-60	15-19	7.9-8.4	5-10	0	0.0-2.0	0-2
Orejas	0-2	11-16	7.4-7.8	0	0	0.0-2.0	0
	2-5	15-19	6.6-7.3	5-10	0	0.0-2.0	0
	5-14	15-19	7.9-8.4	5-10	0	0.0-2.0	0
	14-17	15-19	7.9-8.4	5-10	0	0.0-2.0	0
	17-19	15-19	7.9-8.4	5-10	0	0.0-2.0	0
	19-60	---	---	---	---	---	---
4:							
Montecito	0-3	3.7-10	6.6-7.3	0-5	0	0.0-2.0	0-2
	3-22	15-19	7.4-8.4	5-10	0	0.0-2.0	0-2
	22-60	8.7-14	7.4-8.4	0-5	0	0.0-2.0	0-2

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
4:							
Montecito, bouldery--	0-5	3.7-10	6.6-7.3	0-2	0	0.0-2.0	0-2
	5-28	15-19	7.4-8.4	0-5	0	0.0-2.0	0-2
	28-45	8.7-14	7.4-8.4	0-10	0	0.0-2.0	0-2
	45-60	3.2-8.7	7.4-8.4	0-10	0	0.0-2.0	0-2
10:							
Trail----------	0-6	18-23	7.9-8.4	1-5	0	0.0-4.0	0-5
	6-30	3.1-7.8	8.5-9.0	1-5	0	0.0-4.0	0-5
	30-45	0.0-4.0	8.5-8.9	1-5	0	0.0-4.0	0-5
	45-60	3.1-7.4	8.5-8.9	1-5	0	0.0-4.0	0-5
11:							
Trail----------	0-9	4.0-11	7.9-8.4	1-5	0	0.0-4.0	0-5
	9-36	3.1-7.8	8.5-9.0	1-5	0	0.0-4.0	0-5
	36-60	3.1-11	8.5-9.0	1-5	0	0.0-4.0	0-5
13:							
Sandoval----------	0-2	7.4-15	7.9-9.0	0-5	0-5	2.0-4.0	0-5
	2-6	14-23	7.9-8.4	0-5	0-5	2.0-4.0	0-5
	6-10	14-22	7.9-8.4	5-10	0-5	2.0-4.0	0-5
	10-15	14-22	7.9-8.4	5-10	0-5	2.0-4.0	0-5
	15-60	---	---	---	---	---	---
Querencia----------	0-4	14-21	7.9-8.4	0-5	0	0.0-2.0	0-5
	4-12	16-24	7.9-8.4	5-10	0	0.0-2.0	0-5
	12-24	9.8-17	7.9-8.4	5-10	0	0.0-2.0	0-5
	24-60	9.8-17	7.9-8.4	5-10	0	0.0-2.0	0-5
15:							
Camino----------	0-2	19-24	7.4-7.8	0-5	0	0.0-2.0	0-5
	2-5	22-31	7.9-8.4	0-5	0	0.0-2.0	0-5
	5-20	22-31	7.9-8.4	0-5	0	0.0-2.0	0-5
	20-51	22-31	7.9-8.4	5-10	0	2.0-4.0	0
	51-60	---	---	---	---	---	---
Sandoval----------	0-2	7.8-14	8.5-9.0	0-5	5-10	2.0-4.0	8-13
	2-17	14-23	7.9-8.4	5-10	5-10	2.0-4.0	8-13
	17-60	---	---	---	---	---	---
16:							
Rock outcrop---------	0-60	---	---	---	---	---	---

97558

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
16:							
Prieta	0-5	11-18	6.6-7.3	0-5	0	0.0-2.0	0-5
	5-15	16-24	7.4-7.8	0-5	0	0.0-2.0	0-5
	15-19	16-23	7.9-8.4	3-8	0	0.0-2.0	0-5
	19-60	---	---	---	---	---	---
17:							
Vessilla	0-5	4.0-11	7.9-8.4	5-10	0	0.0-2.0	0
	5-11	3.1-11	7.9-8.4	5-10	0	0.0-2.0	0
	11-60	---	---	---	---	---	---
Menefee	0-3	19-25	7.9-8.4	0-2	0	0.0-2.0	0
	3-10	14-23	7.9-8.4	0-5	0	0.0-2.0	0
	10-60	---	---	---	---	---	---
Rock outcrop	0-60	---	---	---	---	---	---
18:							
Sparham	0-7	18-24	6.6-7.3	0-5	0	2.0-4.0	5-10
	7-20	18-34	7.4-7.8	0-5	0	2.0-4.0	5-10
	20-29	14-23	7.9-8.4	5-10	0	2.0-16.0	5-30
	29-47	14-22	7.4-7.8	5-10	0	2.0-16.0	5-30
	47-53	14-22	7.9-8.4	5-10	0	2.0-16.0	5-30
	53-60	14-22	7.9-8.4	5-10	0	2.0-16.0	5-30
20:							
Gilco	0-6	18-21	6.6-8.4	0-5	0	0.0-4.0	0-5
	6-60	5.7-14	6.6-8.4	5-10	0	0.0-4.0	0-5
21:							
Rock outcrop	0-60	---	---	---	---	---	---
Hackroy	0-3	7.3-13	6.6-7.8	0	0	0.0-2.0	0
	3-12	21-26	6.6-7.8	0	0	0.0-2.0	0
	12-60	---	---	---	---	---	---
22:							
Aga	0-8	18-23	6.6-8.4	0-5	0	0.0-2.0	0-5
	8-24	5.4-12	6.6-8.4	5-10	0	2.0-4.0	0-5
	24-60	0.0-8.3	6.6-8.4	5-10	0	2.0-4.0	0-5

GS2519

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
23:							
Hickman	0-4	20-26	7.9-8.4	0	0	0.0-2.0	0-5
	4-12	14-24	7.4-7.8	5-10	0	0.0-2.0	0-5
	12-49	14-23	7.4-7.8	5-10	0	0.0-2.0	0-5
	49-60	10-22	7.9-8.4	5-10	0	0.0-2.0	0-5
24:							
Orlie	0-2	4.6-12	7.9-8.4	0	0	0.0-2.0	0
	2-25	15-20	7.9-8.4	0-5	0	0.0-2.0	0
	25-60	11-16	7.9-8.4	5-10	0	2.0-4.0	0
Sparham	0-3	25-36	6.6-7.8	0-5	0	2.0-4.0	5-10
	3-60	19-32	7.4-8.4	5-10	0	2.0-16.0	5-30
25:							
Gilco	0-4	7.4-13	7.9-8.4	0-5	0	0.0-4.0	0-5
	4-34	5.7-12	7.9-8.4	5-10	0	0.0-4.0	0-5
	34-60	5.7-12	7.9-8.4	5-10	0	0.0-4.0	0-5
26:							
Orlie	0-2	8.1-15	7.9-8.4	0	0	0.0-2.0	0
	2-13	15-21	7.9-8.4	0-5	0	0.0-2.0	0
	13-22	15-20	7.9-8.4	0-5	0	0.0-2.0	0
	22-36	15-19	7.9-8.4	5-10	0	2.0-4.0	0
	36-50	15-19	7.9-8.4	5-10	0	2.0-4.0	0
	50-60	15-19	7.9-8.4	5-10	0	2.0-4.0	0
27:							
Aga	0-10	7.4-14	7.9-8.4	0-5	0	0.0-2.0	0-5
	10-23	4.7-12	7.9-8.4	5-10	0	2.0-4.0	0-5
	23-43	0.0-4.0	7.9-8.4	5-10	0	2.0-4.0	0-5
	43-60	0.0-4.0	7.9-8.4	5-10	0	2.0-4.0	0-5
29:							
Trail	0-6	3.1-7.8	7.9-8.4	1-5	0	0.0-2.0	0-5
	6-60	3.1-7.4	8.5-9.0	1-5	0	0.0-2.0	0-5
31:							
Riverwash	0-6	0.0-0.9	6.6-7.3	0-1	0-1	0.0-1.0	0-1
	6-60	---	6.6-7.3	0	0	0.0-2.0	0-1
33:							
Pits	0-60	---	---	---	---	---	---

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
34:							
Ildefonso	0-3	12-18	7.4-8.4	5-10	0	0.0-2.0	0-5
	3-17	11-18	7.9-8.4	15-20	0	0.0-4.0	0-5
	17-60	7.0-14	7.9-8.4	15-20	0	0.0-4.0	0-5
Witt	0-3	4.6-12	7.4-7.8	0-5	0	0.0-2.0	0-5
	3-27	9.8-18	7.9-8.4	0-5	0	0.0-2.0	0-5
	27-60	9.8-17	7.9-8.4	10-20	0	0.0-2.0	0-5
41:							
Dune Land	0-6	---	6.6-7.3	0-1	0-1	0.0-1.0	0-1
	6-60	---	6.6-7.3	0-1	0-1	0.0-1.0	0-1
47:							
Cascajo	0-2	4.6-12	7.4-7.8	0-10	0	0.0-2.0	0
	2-5	4.6-12	7.9-8.4	0-10	0	0.0-2.0	0
	5-11	4.0-11	7.9-8.4	0-10	0	0.0-2.0	0
	11-23	4.0-8.1	7.9-8.4	0-10	0	0.0-2.0	0
	23-30	4.0-8.1	7.9-8.4	0-5	0	0.0-2.0	0
	30-60	4.0-8.1	7.9-8.4	0-5	0	0.0-2.0	0
51:							
Sparham	0-6	18-23	6.6-7.3	0-5	0	2.0-8.0	0-5
	6-20	14-23	7.4-7.8	5-10	0	2.0-8.0	0-5
	20-36	19-30	7.9-8.4	5-10	0	2.0-16.0	5-30
	36-60	14-22	7.9-8.4	5-10	0	2.0-16.0	5-30
52:							
Totavi	0-15	2.5-7.3	6.6-7.3	0	0	0.0-2.0	0
	15-19	2.5-6.7	6.6-7.3	0	0	0.0-2.0	0
	19-60	2.5-6.7	6.6-7.3	0	0	0.0-2.0	0
53:							
Witt	0-3	8.1-15	7.9-8.4	0-5	0	0.0-2.0	0
	3-6	11-18	7.4-7.8	0-5	0	0.0-2.0	0
	6-11	16-24	7.4-7.8	0-5	0	0.0-2.0	0
	11-18	16-24	7.9-8.4	0-5	0	0.0-2.0	0
	18-25	16-23	7.9-8.4	3-8	0	0.0-2.0	0
	25-39	9.8-17	7.9-8.4	5-15	0	0.0-2.0	0
	39-53	9.8-17	7.9-8.4	5-15	0	0.0-2.0	0
	53-60	9.8-17	7.9-8.4	5-15	0	0.0-2.0	0

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
53:							
Harvey	0-10	11-18	7.4-8.4	5-10	0	0.0-2.0	0
	10-28	16-24	7.4-8.4	5-10	0	0.0-2.0	0
	28-42	12-23	7.9-8.4	15-20	0	0.0-2.0	0
	42-60	4.0-11	7.9-8.4	15-20	0	0.0-2.0	0
54:							
Harvey	0-2	4.6-14	7.4-8.4	5-10	0	0.0-2.0	0
	2-11	4.0-12	7.4-8.4	5-10	0	0.0-2.0	0
	11-23	16-23	7.9-8.4	15-20	0	0.0-2.0	0
	23-60	12-23	7.9-8.4	15-20	0	0.0-2.0	0
Cascajo	0-3	4.6-12	7.4-8.4	5-10	0-1	0.0-2.0	0
	3-9	4.6-12	7.4-8.4	5-10	0-1	0.0-2.0	0
	9-28	0.0-4.6	7.4-8.4	15-20	0-1	0.0-2.0	0
	28-60	0.0-4.6	7.9-8.4	15-20	0-1	0.0-2.0	0
55:							
La Fonda	0-4	15-20	7.4-8.4	0-5	0	0.0-2.0	0-5
	4-26	9.8-18	7.4-8.4	0-5	0	0.0-2.0	0-5
	26-60	12-18	7.4-8.4	10-15	0	0.0-2.0	0-5
56:							
Ildefonso	0-3	12-18	7.4-8.4	5-10	0	0.0-2.0	0
	3-9	11-18	7.4-8.4	5-10	0	0.0-2.0	0
	9-15	9.8-18	7.9-8.4	15-20	0	0.0-4.0	0
	15-60	9.8-17	7.9-8.4	15-20	0	0.0-4.0	0
57:							
Badland	0-60	---	---	---	---	---	---
58:							
Deama	0-7	11-24	7.4-8.4	10-30	0	0.0-2.0	0
	7-14	9.5-18	7.4-8.4	40-60	0	0.0-2.0	0
	14-60	---	---	---	---	---	---
Elpedro	0-5	9.0-14	7.4-7.8	5-15	0	0.0-2.0	0
	5-12	15-19	7.4-7.8	5-15	0	0.0-2.0	0
	12-19	15-19	7.9-8.4	5-15	0	0.0-2.0	0
	19-25	15-19	7.9-8.4	5-15	0	0.0-2.0	0
	25-36	15-19	7.4-7.8	5-15	0	0.0-2.0	0
	36-45	8.7-15	7.4-7.8	5-15	0	0.0-2.0	0
	45-60	6.0-11	7.4-7.8	5-15	0	0.0-2.0	0

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Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
59:							
Harvey	0-4	11-18	7.9-8.4	5-10	0	0.0-2.0	0
	4-10	9.8-18	7.9-8.4	5-10	0	0.0-2.0	0
	10-18	16-23	7.9-8.4	15-20	0	0.0-2.0	0
	18-41	16-23	7.9-8.4	15-20	0	0.0-2.0	0
	41-60	12-20	7.9-8.4	15-20	0	0.0-2.0	0
Ildefonso	0-2	12-18	7.4-8.4	5-10	0	0.0-2.0	0
	2-8	11-18	7.4-8.4	5-10	0	0.0-2.0	0
	8-13	11-18	7.4-8.4	5-10	0	0.0-2.0	0
	13-32	4.0-11	7.9-8.4	15-20	0	0.0-4.0	0
	32-40	4.0-11	7.9-8.4	15-20	0	0.0-4.0	0
	40-60	0.0-4.6	7.9-8.4	15-20	0	0.0-4.0	0
La Fonda	0-3	15-20	7.9-8.4	0-5	0	0.0-2.0	0-5
	3-7	14-19	7.9-8.4	0-5	0	0.0-2.0	0-5
	7-14	19-24	7.9-8.4	0-5	0	0.0-2.0	0-5
	14-26	12-19	7.9-8.4	0-5	0	0.0-2.0	0-5
	26-42	12-18	7.9-8.4	10-15	0	0.0-2.0	0-5
	42-60	12-18	7.9-8.4	10-15	0	0.0-2.0	0-5
63:							
Placitas	0-5	8.3-15	7.9-8.4	0-5	0	0.0-2.0	0-5
	5-10	4.0-12	7.9-8.4	0-5	0	0.0-2.0	0-5
	10-27	4.0-11	7.9-8.4	20-25	0	0.0-2.0	0-5
	27-60	---	---	---	---	---	---
64:							
Skyvillage	0-4	4.2-12	7.9-8.4	0-5	0	0.0-2.0	0
	4-11	3.1-11	7.9-8.4	5-10	0	0.0-2.0	0
	11-18	3.1-11	7.4-7.8	5-10	0	0.0-2.0	0
	18-60	---	---	---	---	---	---
Ildefonso	0-3	4.6-12	7.9-8.4	5-10	0	0.0-2.0	0
	3-14	4.0-12	7.9-8.4	5-10	0	0.0-2.0	0
	14-60	4.0-11	7.9-8.4	15-20	0	0.0-2.0	0
65:							
Ildefonso	0-6	6.7-14	7.4-7.8	5-10	0	0.0-2.0	0
	6-38	5.8-14	7.4-7.8	5-10	0	0.0-2.0	0
	38-60	5.8-13	7.9-8.4	15-20	0	0.0-2.0	0

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Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
65:							
Harvey	0-4	11-18	7.4-8.4	5-10	0	0.0-2.0	0
	4-23	11-18	7.9-8.4	15-20	0	0.0-2.0	0
	23-36	9.8-17	7.9-8.4	15-20	0	0.0-2.0	0
	36-60	4.0-11	7.9-8.4	15-20	0	0.0-2.0	0
66:							
Zia	0-4	4.0-11	7.4-8.4	0-5	0	0.0-2.0	0-5
	4-60	3.1-11	7.4-8.4	10-15	0	0.0-2.0	0-5
67:							
Sandoval	0-2	11-20	8.5-9.0	0-5	5-10	2.0-4.0	0
	2-11	14-23	7.9-8.4	5-10	5-10	2.0-4.0	0
	11-60	---	---	---	---	---	---
Poley	0-3	11-18	7.4-7.8	0-2	0-1	0.0-2.0	0
	3-12	19-24	7.4-7.8	0-2	0-1	0.0-2.0	0
	12-17	16-24	7.4-7.8	0-2	0-1	0.0-2.0	0
	17-21	16-23	7.9-8.4	0-10	0-1	0.0-2.0	0
	21-40	16-23	7.9-8.4	0-10	0-1	0.0-2.0	0
	40-60	4.0-11	7.4-7.8	0-10	0-1	0.0-2.0	0
68:							
Penistaja	0-2	4.6-8.3	7.4-7.8	0-5	0	0.0-2.0	0-2
	2-15	12-21	7.4-7.8	0-5	0	0.0-2.0	0-2
	15-27	12-20	7.4-7.8	5-10	0	0.0-2.0	0-2
	27-38	16-23	7.9-8.4	5-10	0	0.0-2.0	0-5
	38-60	12-20	7.4-7.8	5-10	0	0.0-2.0	0-5
Querencia	0-2	4.6-12	7.9-8.4	0-5	0	0.0-2.0	0-2
	2-40	12-21	7.9-8.4	5-10	0	0.0-2.0	0-2
	40-60	4.0-11	7.9-8.4	5-10	0	0.0-2.0	0-5
71:							
Palon	0-6	4.2-12	6.6-7.3	0	0	0.0-2.0	0
	6-27	3.2-8.7	6.6-7.3	0	0	0.0-2.0	0
	27-60	3.2-8.7	6.6-7.3	0	0	0.0-2.0	0
72:							
Palon	0-2	73-81	5.1-6.0	0	0	0.0-2.0	0
	2-4	4.2-12	6.6-7.3	0	0	0.0-2.0	0
	4-10	3.7-11	6.6-7.3	0	0	0.0-2.0	0
	10-32	3.2-8.7	6.6-7.3	0	0	0.0-2.0	0
	32-53	3.2-8.7	6.6-7.3	0	0	0.0-2.0	0
	53-60	3.2-8.7	6.6-7.3	0	0	0.0-2.0	0

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
74:							
Origo	0-7	4.2-12	6.6-7.3	0	0	0.0-2.0	0
	7-28	2.2-10	6.1-7.3	0	0	0.0-2.0	0
	28-60	---	4.5-5.0	0	0	0.0-2.0	0
Pavo	0-9	13-21	6.1-6.5	0	0	0.0-2.0	0
	9-12	5.0-13	6.6-7.3	0	0	0.0-2.0	0
	12-25	3.8-10	6.6-7.3	0	0	0.0-2.0	0
	25-35	3.8-10	6.6-7.3	0	0	0.0-2.0	0
	35-45	3.8-10	6.6-7.3	0	0	0.0-2.0	0
	45-50	19-23	6.1-6.5	0	0	0.0-2.0	0
	50-60	3.8-10	6.6-7.3	0	0	0.0-2.0	0
75:							
Origo	0-1	73-81	5.1-6.0	0	0	0.0-2.0	0
	1-6	4.2-12	6.1-6.5	0	0	0.0-2.0	0
	6-12	2.2-11	6.6-7.3	0	0	0.0-2.0	0
	12-32	3.2-8.7	6.6-7.3	0	0	0.0-2.0	0
	32-56	3.2-8.7	4.5-5.0	0	0	0.0-2.0	0
	56-60	1.0-3.2	4.5-5.0	0	0	0.0-2.0	0
82:							
Calaveras	0-2	6.7-13	5.6-7.3	0	0	0.0-2.0	0
	2-6	3.9-10	5.6-7.3	0	0	0.0-2.0	0
	6-40	2.5-9.2	5.6-7.3	0	0	0.0-2.0	0
	40-60	2.5-9.2	5.6-7.3	0	0	0.0-2.0	0
83:							
Calaveras	0-6	10-16	5.6-7.3	0	0	0.0-2.0	0
	6-12	3.9-10	5.6-7.3	0	0	0.0-2.0	0
	12-24	4.3-12	5.6-7.3	0	0	0.0-2.0	0
	24-60	2.5-9.2	5.6-7.3	0	0	0.0-2.0	0
Rubble Land	0-60	---	---	0	0	0	0
85:							
Redondo	0-2	4.6-9.4	6.1-6.5	0	0	0.0-2.0	0
	2-7	4.2-8.6	6.1-6.5	0	0	0.0-2.0	0
	7-15	3.7-7.8	5.6-6.0	0	0	0.0-2.0	0
	15-22	3.2-6.0	5.6-6.0	0	0	0.0-2.0	0
	22-29	3.2-6.0	5.6-6.0	0	0	0.0-2.0	0
	29-38	3.2-6.0	5.6-6.0	0	0	0.0-2.0	0
	38-54	3.2-6.0	5.6-6.0	0	0	0.0-2.0	0
	54-60	3.2-6.0	5.6-6.0	0	0	0.0-2.0	0

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
86:							
Redondo	0-8	4.2-8.1	6.1-6.5	0	0	0.0-2.0	0
	8-13	3.2-6.0	5.6-6.0	0	0	0.0-2.0	0
	13-34	3.2-6.0	5.6-6.0	0	0	0.0-2.0	0
	34-60	3.2-6.0	5.6-6.0	0	0	0.0-2.0	0
87:							
Redondo	0-6	7.3-14	6.1-6.5	0	0	0.0-2.0	0
	6-13	3.7-7.8	5.6-6.0	0	0	0.0-2.0	0
	13-60	3.2-6.0	5.6-6.0	0	0	0.0-2.0	0
Rubble Land	0-60	---	---	0	0	0	0
88:							
Totavi	0-12	2.5-7.3	6.6-7.3	0	0	0.0-2.0	0
	12-60	2.5-6.7	6.6-7.3	0-5	0	0.0-2.0	0
Jemez	0-6	9.0-15	7.4-7.8	0	0	0.0-2.0	0
	6-13	8.7-14	7.4-7.8	0	0	0.0-2.0	0
	13-19	15-19	7.4-7.8	0	0	0.0-2.0	0
	19-27	11-19	7.4-7.8	0	0	0.0-2.0	0
	27-60	---	---	---	---	---	---
Rock outcrop	0-60	---	---	---	---	---	---
91:							
Zia	0-16	4.0-11	7.4-8.4	0-5	0	0.0-2.0	0-5
	16-22	3.1-7.8	7.4-8.4	10-15	0	0.0-2.0	0-5
	22-35	3.1-11	7.4-8.4	10-15	0	0.0-2.0	0-5
	35-60	3.1-11	7.4-8.4	10-15	0	0.0-2.0	0-5
92:							
Galisteo, moderately saline, sodic	0-12	20-28	8.5-9.0	5-10	0	8.0-16.0	5-30
	12-60	19-30	8.5-9.0	5-10	0	8.0-16.0	5-30
93:							
Zia	0-8	4.0-7.8	7.4-8.4	0-5	0	0.0-2.0	0-5
	8-60	3.1-11	7.4-8.4	10-15	0	0.0-2.0	0-5
95:							
El Rancho	0-5	12-19	7.9-8.4	0	0	0.0-2.0	0-5
	5-20	10-18	7.9-8.4	0-5	0	0.0-2.0	0-5
	20-38	10-18	7.9-8.4	0-5	0	0.0-2.0	0-5
	38-60	3.1-11	7.9-8.4	0-5	0	0.0-2.0	0-5

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Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
97:							
El Rancho	0-8	19-23	7.9-8.4	0-5	0	0.0-2.0	0-5
	8-60	10-22	7.9-8.4	5-10	0	0.0-2.0	0-5
100:							
Orejas	0-5	9.0-15	7.4-7.8	0	0	0.0-2.0	0-5
	5-15	15-19	7.9-8.4	5-10	0	0.0-2.0	0-5
	15-19	15-19	7.9-8.4	5-10	0	0.0-2.0	0-5
	19-60	---	---	---	---	---	---
Rock outcrop	0-60	---	---	---	---	---	---
101:							
Blancot	0-2	4.6-12	7.9-8.4	0-3	0	0.0-2.0	0-5
	2-5	19-24	7.9-8.4	0-3	0	0.0-2.0	0-5
	5-14	16-23	7.9-8.4	0-3	0	0.0-2.0	0-5
	14-23	16-23	7.9-8.4	0-10	0	0.0-2.0	0-5
	23-40	4.0-11	7.9-8.4	0-2	0	2.0-4.0	0-5
	40-49	16-20	7.9-8.4	0-5	0	2.0-4.0	0-5
	49-60	4.0-9.8	8.5-9.0	0-5	0	2.0-4.0	0-5
Lybrook	0-1	18-23	7.9-8.4	0-5	0	2.0-4.0	5-10
	1-5	14-22	7.9-8.4	0-5	0	2.0-4.0	5-10
	5-21	14-22	7.9-8.4	0-5	0	2.0-4.0	5-30
	21-30	14-22	7.9-8.4	0-5	0	2.0-4.0	5-30
	30-60	14-22	9.0-10.0	5-10	0	5.0-25.0	15-50
102:							
Sparham	0-7	18-24	6.6-7.3	0-5	0	2.0-4.0	5-10
	7-29	14-23	7.4-7.8	5-10	0	2.0-16.0	5-30
	29-60	14-22	7.9-8.4	5-10	0	2.0-16.0	5-30
104:							
Cochiti	0-7	9.0-15	6.6-7.3	0	0	0.0-2.0	0
	7-12	16-22	6.1-6.5	0-5	0	0.0-2.0	0
	12-20	21-31	6.6-7.3	0-5	0	0.0-2.0	0
	20-29	16-21	6.6-7.3	0-5	0	0.0-2.0	0
	29-60	3.2-8.7	6.6-7.3	5-10	0	0.0-2.0	0
Montecito	0-3	9.0-16	6.6-7.3	0	0	0.0-2.0	0-2
	3-9	15-20	6.6-7.3	0-5	0	0.0-2.0	0-2
	9-15	15-19	7.4-7.8	0-5	0	0.0-2.0	0-2
	15-22	15-19	7.9-8.4	0-5	0	0.0-2.0	0-2
	22-37	3.2-8.7	7.9-8.4	5-10	0	0.0-2.0	0-2
	37-60	3.2-8.7	7.9-8.4	5-10	0	0.0-2.0	0-2

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
105:							
Badland	0-60	---	---	---	---	---	---
Menefee	0-4	11-18	7.4-8.4	0-2	0-1	0.0-2.0	0
	4-10	14-23	7.4-8.4	0-5	0-1	0.0-2.0	0
	10-60	---	---	---	---	---	---
106:							
Stumble	0-4	4.0-11	7.9-8.4	0-5	0	0.0-2.0	0-5
	4-10	3.1-11	7.4-7.8	5-10	0	0.0-2.0	0-5
	10-24	3.1-7.4	7.9-8.4	5-10	0	0.0-2.0	0-5
	24-60	0.0-4.0	7.9-8.4	5-10	0	0.0-2.0	0-5
Stumble, sandy	0-4	4.0-7.7	7.4-8.4	0-5	0	0.0-2.0	0-5
	4-18	3.6-7.1	7.9-8.4	5-10	0	0.0-2.0	0-5
	18-60	0.9-4.5	7.9-8.4	5-10	0	0.0-2.0	0-5
108:							
Embudo	0-6	4.0-11	6.6-7.8	0	0	0.0-2.0	0-5
	6-30	4.0-11	7.4-8.4	0	0	0.0-2.0	0-5
	30-60	4.0-8.1	7.4-8.4	0	0	0.0-2.0	0-5
109:							
Embudo	0-4	4.6-12	7.9-8.4	0	0	0.0-2.0	0-5
	4-12	4.6-9.7	7.9-8.4	0	0	0.0-2.0	0-5
	12-30	4.0-11	7.9-8.4	0-5	0	0.0-2.0	0-5
	30-60	4.0-8.1	7.9-8.4	0-5	0	0.0-2.0	0-5
Tijeras	0-4	4.0-12	7.9-8.4	0-5	0	0.0-2.0	0-5
	4-10	12-21	7.9-8.4	0-5	0	0.0-2.0	0-5
	10-20	12-20	7.9-8.4	5-10	0	0.0-2.0	0-5
	20-26	4.0-11	7.9-8.4	5-10	0	0.0-2.0	0-5
	26-60	4.0-11	7.9-8.4	5-10	0	0.0-2.0	0-5
110:							
Rock outcrop	0-60	---	---	---	---	---	---
Saido	0-5	11-18	7.9-8.4	0-5	10-20	2.0-8.0	0
	5-9	11-18	7.9-8.4	5-10	60-80	2.0-8.0	0
	9-15	9.8-18	7.9-8.4	5-10	60-80	2.0-8.0	0
	15-25	9.8-17	7.9-8.4	5-10	60-80	2.0-8.0	0
	25-60	9.8-17	7.9-8.4	5-10	30-50	2.0-8.0	0
111:							
Rock outcrop	0-60	---	---	---	---	---	---

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
111:							
Zia	0-5	4.0-11	7.4-8.4	0-5	0	0.0-2.0	0-5
	5-60	3.1-11	7.4-8.4	10-15	0	0.0-2.0	0-5
112:							
Tijeras	0-3	4.0-12	7.9-8.4	0-5	0	0.0-2.0	0-5
	3-14	12-20	7.9-8.4	0-5	0	0.0-2.0	0-5
	14-60	4.0-11	7.9-8.4	5-10	0	0.0-2.0	0-5
114:							
San Mateo	0-7	7.4-14	7.9-8.4	0-5	0	0.0-2.0	0-5
	7-60	8.1-22	8.5-9.0	5-10	0	5.0-30.0	0-5
Zia	0-3	4.0-11	7.4-8.4	0-5	0	0.0-2.0	0-5
	3-60	3.1-11	7.4-8.4	10-15	0	0.0-2.0	0-5
120:							
Pinavetes	0-10	4.0-7.8	7.9-8.4	1-5	0	0.0-2.0	0
	10-35	0.0-4.2	8.5-9.0	1-5	0	0.0-2.0	0
	35-60	0.0-4.0	7.9-8.4	1-5	0	0.0-2.0	0
124:							
Rock outcrop	0-60	---	---	---	---	---	---
129:							
Menefee	0-5	18-24	7.4-8.4	0-2	0-1	0.0-2.0	0
	5-10	14-23	7.4-8.4	0-5	0-1	0.0-2.0	0
	10-17	14-22	7.4-8.4	0-5	0-1	0.0-2.0	0
	17-60	---	---	---	---	---	---
130:							
Pinavetes	0-2	4.0-7.8	7.9-8.4	1-5	0	0.0-2.0	0
	2-60	3.1-7.4	8.5-8.9	1-5	0	0.0-2.0	0
Galisteo, moderately saline, sodic	0-2	19-25	8.5-9.0	5-10	0	8.0-16.0	13-30
	2-60	19-30	8.5-9.0	5-10	0	8.0-16.0	13-30
142:							
Grieta	0-3	7.0-13	7.4-8.4	0-5	0	0.0-2.0	0
	3-11	7.0-13	7.4-8.4	15-20	0	2.0-4.0	0
	11-34	12-23	7.4-8.4	15-20	0	2.0-4.0	0
	34-48	12-23	7.4-8.4	10-15	0	2.0-4.0	0
	48-60	4.0-8.1	7.4-8.4	10-15	0	2.0-4.0	0

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Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
143:							
Clovis	0-3	4.7-12	7.4-7.8	5-10	0	0.0-2.0	0-1
	3-7	14-24	7.9-8.4	20-25	0	0.0-2.0	0-1
	7-12	12-23	7.9-8.4	20-25	0	0.0-2.0	0-1
	12-22	12-23	7.9-8.4	20-25	0	0.0-2.0	0-1
	22-34	12-23	7.9-8.4	20-25	0	0.0-2.0	0-1
	34-60	12-23	7.9-8.4	20-25	0	0.0-2.0	0-1
145:							
Grieta	0-7	4.0-8.1	7.4-7.8	0-5	0	0.0-2.0	0-2
	7-14	12-23	7.9-8.4	0-10	0	2.0-4.0	0-2
	14-21	12-23	7.9-8.4	0-10	0	2.0-4.0	0-2
	21-38	4.0-11	7.9-8.4	10-15	0	2.0-4.0	0-2
	38-50	4.0-11	7.9-8.4	10-15	0	2.0-4.0	0-2
	50-60	4.0-11	7.9-8.4	10-15	0	2.0-4.0	0-2
Sheppard	0-5	3.1-7.4	7.9-8.4	0-5	0	0.0-2.0	0
	5-27	3.1-7.4	7.9-8.4	0-10	0	0.0-2.0	0
	27-60	3.1-7.4	7.9-8.4	0-10	0	0.0-2.0	0
146:							
Sedmar	0-3	4.0-7.8	6.6-7.3	0	0	0.0-2.0	0
	3-13	3.1-11	6.6-7.3	0	0	0.0-2.0	0
	13-18	3.1-7.4	6.6-7.3	0	0	0.0-2.0	0
	18-60	---	---	---	---	---	---
150:							
Doakum	0-5	4.6-12	7.9-8.4	0-5	0	0.0-2.0	0-2
	5-11	16-23	7.9-8.4	5-10	0	2.0-4.0	0-2
	11-17	12-23	7.9-8.4	5-10	0	2.0-4.0	0-2
	17-24	12-23	8.5-9.0	5-10	0	4.0-8.0	0-5
	24-31	16-23	8.5-9.0	5-10	0	4.0-8.0	0-5
	31-44	7.0-17	8.5-9.0	5-10	0	4.0-8.0	0-5
	44-60	7.0-15	8.5-9.0	5-10	0	4.0-8.0	0-5
Betonnie	0-2	4.6-12	7.9-8.4	0-5	0	0.0-2.0	0-2
	2-4	4.6-12	7.9-8.4	0-5	0	0.0-2.0	0-2
	4-12	4.0-11	7.9-8.4	0-5	0	0.0-2.0	0-2
	12-18	4.0-11	7.9-8.4	0-5	0	0.0-2.0	0-2
	18-34	4.0-11	8.5-9.0	0-10	0	0.0-2.0	0-5
	34-60	4.0-9.8	8.5-9.0	0-10	0	0.0-2.0	0-5

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
162:							
Hackroy	0-3	7.3-13	6.6-7.8	0	0	0.0-2.0	0
	3-13	21-26	6.6-7.8	0	0	0.0-2.0	0
	13-60	---	---	---	---	---	---
Nyjack	0-3	11-15	6.1-6.5	0	0	0.0-2.0	0
	3-13	15-19	6.6-7.3	0	0	0.0-2.0	0
	13-24	15-19	6.6-7.3	0	0	0.0-2.0	0
	24-39	3.2-8.7	6.6-7.3	0	0	0.0-2.0	0
	39-60	---	---	---	---	---	---
163:							
Jemez	0-3	9.0-15	6.6-7.8	0	0	0.0-2.0	0
	3-24	15-19	6.6-7.8	0	0	0.0-2.0	0
	24-39	14-19	6.6-7.8	0	0	0.0-2.0	0
	39-60	---	---	---	---	---	---
170:							
San Mateo	0-2	11-18	7.9-8.4	0-5	0	0.0-2.0	0-5
	2-10	14-23	8.5-9.0	5-10	0	0.0-2.0	0-5
	10-23	14-22	8.5-9.0	5-10	0	0.0-2.0	0-5
	23-32	14-22	7.9-8.4	5-10	0	0.0-2.0	0-5
	32-54	14-22	8.5-9.0	5-10	0	1.0-8.0	5-30
	54-60	14-22	8.5-9.0	5-10	0	1.0-8.0	5-30
180:							
Councelor	0-2	3.1-11	7.9-8.4	5-10	0	0.0-2.0	0-2
	2-7	3.1-11	7.9-8.4	5-10	0	2.0-4.0	0-2
	7-37	3.1-11	7.9-8.4	5-10	0	2.0-4.0	0-2
	37-40	14-22	7.9-8.4	5-10	0	2.0-4.0	0-2
	40-60	3.1-11	7.9-8.4	5-10	0	2.0-4.0	0-2
Eslendo	0-3	18-23	7.9-8.4	0	0	2.0-4.0	0-5
	3-10	14-22	7.9-8.4	0-5	0	2.0-4.0	0-5
	10-60	---	---	---	---	---	---
Mespun	0-6	1.4-7.4	7.9-8.4	5-10	0	0.0-2.0	0
	6-60	2.0-6.1	7.9-8.4	5-10	0	0.0-2.0	0
183:							
Sheppard	0-4	3.1-7.4	7.9-8.4	0-5	0	0.0-2.0	0
	4-45	3.1-7.4	7.9-8.4	0-10	0	0.0-2.0	0
	45-60	3.1-7.4	7.9-8.4	0-10	0	0.0-2.0	0

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
185:							
Frijoles	0-3	4.2-11	6.6-7.3	0	0	0.0-2.0	0
	3-8	8.8-20	6.6-7.3	0	0	0.0-2.0	0
	8-13	15-19	6.6-7.3	0	0	0.0-2.0	0
	13-20	6.0-8.7	6.6-7.3	0-5	0	0.0-2.0	0
	20-60	0.0-1.4	6.6-7.3	0	0	0.0-2.0	0
190:							
Zia	0-5	4.0-11	7.4-8.4	0-5	0	0.0-2.0	0
	5-28	3.1-11	7.4-8.4	5-12	0	0.0-2.0	0
	28-60	3.1-11	7.4-8.4	10-15	0	0.0-2.0	0
Skyvillage	0-2	4.2-12	7.9-8.4	0-5	0	0.0-2.0	0
	2-11	3.1-11	7.9-8.4	5-10	0	0.0-2.0	0
	11-16	3.1-11	7.4-7.8	5-10	0	0.0-2.0	0
	16-60	---	---	---	---	---	---
Rock outcrop	0-60	---	---	---	---	---	---
191:							
Sheppard	0-3	3.1-7.4	7.9-8.4	0-5	0	0.0-2.0	0
	3-27	3.1-7.4	7.9-8.4	0-10	0	0.0-2.0	0
	27-60	3.1-7.4	7.9-8.4	0-10	0	0.0-2.0	0
200:							
Sedillo	0-4	4.7-12	7.4-7.8	0-5	0	0.0-2.0	0-5
	4-13	12-21	7.4-7.8	5-10	0	0.0-2.0	0-5
	13-60	4.0-11	7.4-7.8	15-30	0	0.0-2.0	0-5
201:							
Rock outcrop	0-60	---	---	---	---	---	---
Sedgran	0-4	4.0-7.8	6.6-7.3	0	0	0.0-2.0	0
	4-13	3.1-7.4	7.4-7.8	0	0	0.0-2.0	0
	13-60	---	---	---	---	---	---
206:							
Pinitos	0-4	9.0-15	6.6-7.3	0-5	0	0.0-2.0	0
	4-10	15-19	6.6-7.3	5-10	0	0.0-2.0	0
	10-27	15-19	6.6-7.8	5-10	0	0.0-2.0	0
	27-39	15-19	7.4-7.8	8-12	0	0.0-2.0	0-2
	39-60	15-19	7.4-7.8	8-12	0	0.0-2.0	0-2

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Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
207:							
Penistaja	0-3	4.7-12	7.4-7.8	0-5	0	0.0-2.0	0-2
	3-29	12-21	7.4-7.8	5-10	0	0.0-2.0	0-2
	29-60	4.0-11	7.4-7.8	5-10	0	0.0-2.0	0-2
Zia	0-5	4.0-11	7.4-8.4	0-5	0	0.0-2.0	0-2
	5-60	3.1-11	7.4-8.4	0-5	0	0.0-2.0	0-2
208:							
Sedillo	0-2	4.6-12	7.4-7.8	0-5	0	0.0-2.0	0-5
	2-8	12-21	7.4-7.8	5-10	0	0.0-2.0	0-5
	8-12	4.0-11	7.4-7.8	20-25	0	0.0-2.0	0-5
	12-60	4.0-11	7.4-7.8	20-25	0	0.0-2.0	0-5
210:							
Ildefonso	0-3	12-18	7.4-8.4	5-10	0	0.0-2.0	0
	3-9	11-18	7.4-8.4	5-10	0	0.0-2.0	0
	9-60	9.8-17	7.9-8.4	15-20	0	0.0-4.0	0
211:							
Zia	0-5	4.0-11	7.4-7.8	0-5	0	0.0-2.0	0-2
	5-14	3.1-11	7.4-7.8	0-5	0	0.0-2.0	0-2
	14-33	3.1-11	7.4-7.8	5-10	0	0.0-2.0	0-2
	33-46	10-19	7.9-8.4	5-10	0	0.0-2.0	0-2
	46-60	3.1-11	7.9-8.4	5-10	0	0.0-2.0	0-2
Clovis	0-5	8.3-13	7.4-8.4	5-10	0	0.0-2.0	0-2
	5-60	12-23	6.6-8.4	20-25	0	0.0-2.0	0-2
213:							
Pinavetes	0-7	0.0-4.2	7.9-8.4	1-5	0	0.0-2.0	0
	7-60	0.0-4.0	8.5-8.9	1-5	0	0.0-2.0	0
Rock outcrop	0-60	---	---	---	---	---	---
215:							
Ess	0-7	5.4-14	6.1-7.8	0	0	0	0
	7-15	7.8-15	6.1-7.8	0	0	0	0
	15-29	15-22	6.1-7.8	0	0	0	0
	29-60	7.2-14	6.1-7.8	0	0	0	0
Rock outcrop	0-60	---	---	---	---	---	---

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
217:							
Witt	0-2	8.1-15	7.9-8.4	0-5	0	0.0-2.0	0-2
	2-9	9.8-17	7.9-8.4	0-5	0	0.0-2.0	0-2
	9-60	7.0-14	7.9-8.4	10-20	0	0.0-2.0	0-2
218:							
Ildefonso	0-4	12-18	7.4-8.4	5-10	0	0.0-2.0	0
	4-8	11-18	7.4-8.4	5-10	0	0.0-2.0	0
	8-60	4.0-11	7.9-8.4	15-20	0	0.0-4.0	0
220:							
Rock outcrop	0-60	---	---	---	---	---	---
Vessilla	0-2	4.0-11	7.9-8.4	5-10	0	0.0-2.0	0
	2-10	3.1-11	7.9-8.4	5-10	0	0.0-2.0	0
	10-60	---	---	---	---	---	---
Menefee	0-2	18-24	7.4-8.4	0-2	0-1	0.0-2.0	0
	2-10	14-23	7.4-8.4	0-5	0-1	0.0-2.0	0
	10-60	---	---	---	---	---	---
226:							
Galisteo, moderately saline, sodic	0-10	14-20	8.5-9.0	5-10	0	8.0-16.0	13-20
	10-60	14-22	8.5-9.0	5-10	0	8.0-16.0	13-20
227:							
Hagerman	0-4	8.1-15	6.6-7.8	0-5	0	0.0-2.0	0
	4-34	16-23	6.6-8.4	2-10	0	0.0-2.0	0
	34-60	---	---	---	---	---	---
Bond	0-4	3.8-7.6	7.4-7.8	0-5	0	0.0-2.0	0
	4-12	14-24	6.6-7.3	5-10	0	0.0-2.0	0
	12-60	---	---	---	---	---	---
228:							
Winona	0-2	4.6-13	7.4-7.8	5-10	0	2.0-4.0	0
	2-13	4.0-17	7.4-7.8	40-50	0	4.0-8.0	0
	13-60	---	---	---	---	---	---
230:							
Skyvillage	0-6	4.2-12	7.9-8.4	0-5	0	0.0-2.0	0
	6-11	3.1-11	7.4-7.8	5-10	0	0.0-2.0	0
	11-60	---	---	---	---	---	---

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
230:							
Sandoval	0-2	19-25	8.5-9.0	0-5	5-10	2.0-4.0	0-5
	2-10	14-23	7.9-8.4	5-10	5-10	2.0-4.0	0-5
	10-60	---	---	---	---	---	---
Rock outcrop	0-60	---	---	---	---	---	---
231:							
Querencia	0-3	11-18	7.9-8.4	0-5	0	0.0-2.0	0-5
	3-21	9.8-18	7.9-8.4	5-10	0	0.0-2.0	0-5
	21-60	9.8-17	7.9-8.4	5-10	0	0.0-2.0	0-5
234:							
Querencia	0-3	8.1-15	7.9-8.4	0-5	0	0.0-2.0	0-5
	3-25	12-19	7.9-8.4	5-10	0	0.0-2.0	0-5
	25-60	8.2-14	7.9-8.4	5-10	0	0.0-2.0	0-5
Zia	0-11	4.0-11	7.4-8.4	0-5	0	0.0-2.0	0-5
	11-60	3.1-11	7.4-8.4	10-15	0	0.0-2.0	0-5
235:							
Sandoval	0-2	7.8-14	8.5-9.0	0-5	5-10	2.0-4.0	8-13
	2-16	14-23	7.9-8.4	5-10	5-10	2.0-4.0	8-13
	16-19	14-22	7.9-8.4	5-10	5-10	2.0-4.0	8-13
	19-60	---	---	---	---	---	---
236:							
Sparank, moderately saline, sodic	0-2	19-25	8.5-9.0	0-5	0	8.0-16.0	13-30
	2-10	25-33	8.5-9.0	5-10	0	8.0-16.0	13-30
	10-24	25-32	7.9-8.4	5-10	0	8.0-16.0	13-30
	24-40	14-23	7.9-8.4	5-10	0	8.0-16.0	13-30
	40-44	19-30	7.9-8.4	5-10	0	8.0-16.0	13-30
	44-60	19-30	8.5-9.0	5-10	0	8.0-16.0	13-30
237:							
Sparank	0-4	19-25	7.4-8.4	0-5	0	2.0-4.0	5-10
	4-60	14-23	7.4-8.4	5-10	0	2.0-4.0	5-10
240:							
Penistaja	0-5	4.7-12	7.4-7.8	0-5	0	0.0-2.0	0-2
	5-14	19-24	7.4-7.8	0-5	0	0.0-2.0	0-2
	14-29	12-21	7.4-7.8	10-15	0	0.0-2.0	0-2
	29-60	9.8-17	7.4-7.8	10-15	0	0.0-2.0	0-2

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Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
240:							
Hagerman	0-2	8.1-15	7.9-8.4	0-5	0	0.0-2.0	0
	2-9	16-23	7.9-8.4	2-10	0	0.0-2.0	0
	9-24	16-23	7.9-8.4	2-10	0	0.0-2.0	0
	24-60	---	---	---	---	---	---
250:							
Pinavetes	0-4	4.0-7.8	7.9-8.4	1-5	0	0.0-2.0	0-5
	4-60	2.0-5.4	8.5-9.0	1-5	0	0.0-2.0	0-5
262:							
Pastura	0-3	15-20	7.9-8.4	5-10	0-1	0.0-2.0	0-5
	3-10	12-19	7.9-8.4	5-10	0-1	0.0-2.0	0-5
	10-14	12-18	7.9-8.4	10-15	0-1	0.0-2.0	0-5
	14-60	---	---	---	---	---	---
270:							
Blancot	0-2	4.6-12	7.9-8.4	0-5	0	0.0-2.0	0-2
	2-12	12-23	7.9-8.4	5-10	0	0.0-2.0	0-5
	12-21	16-23	7.9-8.4	5-10	0	0.0-2.0	5-13
	21-60	4.0-11	7.9-9.0	10-15	0	2.0-4.0	5-13
Councelor	0-2	3.1-11	7.9-8.4	5-10	0	0.0-2.0	0-5
	2-60	3.1-11	7.9-9.0	5-10	0	2.0-4.0	0-5
Tsosie	0-2	18-24	7.9-8.4	0-5	0	4.0-8.0	5-10
	2-10	11-17	8.5-9.0	5-10	0	4.0-8.0	5-10
	10-20	14-23	8.5-9.0	5-10	0	4.0-8.0	5-10
	20-26	14-22	8.5-9.0	5-10	0	4.0-8.0	5-10
	26-36	14-22	8.5-9.0	5-10	0	4.0-8.0	5-10
	36-44	3.1-11	7.9-8.4	5-10	0	4.0-8.0	5-10
	44-55	3.1-11	8.5-9.0	5-10	0	4.0-8.0	5-10
	55-60	3.1-11	8.5-9.0	5-10	0	4.0-8.0	5-10
281:							
Carjo	0-4	8.1-19	6.6-7.3	0	0	0.0-2.0	0
	4-12	17-21	6.6-7.3	0	0	0.0-2.0	0
	12-20	21-26	6.6-7.3	0	0	0.0-2.0	0
	20-25	3.2-6.0	7.4-7.8	0	0	0.0-2.0	0
	25-60	---	---	---	---	---	---

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Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
282:							
Tocal	0-5	4.2-11	6.6-7.3	0-1	0-1	0.0-2.0	0-2
	5-8	15-20	6.6-7.3	0-1	0-1	0.0-2.0	0-2
	8-11	21-26	6.6-7.3	0-1	0-1	0.0-2.0	0-2
	11-14	8.7-14	6.6-7.3	0-1	0-1	0.0-2.0	0-2
	14-60	---	---	---	---	---	---
283:							
Mirand	0-2	73-81	5.1-6.0	0	0	0.0-2.0	0
	2-6	13-19	6.6-7.3	0	0	0.0-2.0	0
	6-11	15-21	6.1-6.6	0	0	0.0-2.0	0
	11-17	15-19	6.6-7.3	0	0	0.0-2.0	0
	17-27	15-19	6.6-7.3	0	0	0.0-2.0	0
	27-47	21-28	6.1-6.5	0	0	0.0-2.0	0
	47-60	---	4.5-5.0	0	0	0.0-2.0	0
Alanos	0-6	9.0-15	5.6-7.3	0	0	0.0-2.0	0
	6-9	8.7-14	5.6-7.3	0	0	0.0-2.0	0
	9-30	15-19	5.6-7.3	0	0	0.0-2.0	0
	30-60	21-26	5.6-7.3	0	0	0.0-2.0	0
290:							
Alanos	0-4	9.0-15	6.6-7.3	0	0	0.0-2.0	0
	4-9	9.0-15	6.6-7.3	0	0	0.0-2.0	0
	9-18	8.7-14	5.6-6.0	0	0	0.0-2.0	0
	18-26	21-26	5.6-6.0	0	0	0.0-2.0	0
	26-60	21-26	5.6-6.0	0	0	0.0-2.0	0
Rock outcrop	0-60	---	---	---	---	---	---
300:							
Waumac	0-3	4.0-7.8	7.9-8.4	0-5	0	0.0-2.0	0-5
	3-31	3.1-11	7.9-8.4	5-10	0	0.0-2.0	0-5
	31-60	3.1-11	7.9-8.4	10-15	0	0.0-2.0	0-5
Bamac	0-6	4.0-7.8	7.9-8.4	0-5	0	0.0-2.0	0-5
	6-60	3.1-7.4	7.9-8.4	5-10	0	0.0-2.0	0-5
301:							
Vastine	0-4	14-22	6.6-7.3	0	0	0	0-5
	4-11	8.0-21	6.6-7.3	0	0	0	0-5
	11-24	10-17	6.6-7.3	0	0	0	0-5
	24-60	3.8-7.2	7.4-7.8	0	0	0.0-2.0	0-5

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
301:							
Jarola	0-9	13-21	6.1-6.5	0	0	0.0-2.0	0
	9-11	12-20	6.6-7.3	0	0	0.0-2.0	0
	11-17	19-25	6.6-7.3	0	0	0.0-2.0	0
	17-21	19-23	6.6-7.3	0	0	0.0-2.0	0
	21-42	14-20	6.6-7.3	0	0	0.0-2.0	0
	42-60	3.8-10	6.6-7.3	0	0	0.0-2.0	0
302:							
Tranquilar	0-4	22-29	6.1-6.5	0	0	0.0-2.0	0
	4-8	21-27	6.1-6.5	0	0	0.0-2.0	0
	8-11	19-26	6.1-6.5	0	0	0.0-2.0	0
	11-13	13-26	5.6-6.0	0	0	0.0-2.0	0
	13-20	---	5.1-5.5	0	0	0.0-2.0	0
	20-34	---	4.5-5.0	0	0	0.0-2.0	0
	34-42	---	4.5-5.0	0	0	0.0-2.0	0
	42-50	---	3.5-4.4	0	0	0.0-2.0	0
	50-60	---	4.5-5.0	0	0	0.0-2.0	0
Jarmillo	0-4	10.0-19	6.1-6.5	0	0	0.0-2.0	0
	4-13	9.2-17	6.1-6.5	0	0	0.0-2.0	0
	13-20	8.5-16	6.1-6.5	0	0	0.0-2.0	0
	20-26	7.2-14	6.6-7.3	0	0	0.0-2.0	0
	26-36	7.2-14	6.6-7.3	0	0	0.0-2.0	0
	36-41	3.8-10	6.6-7.3	0	0	0.0-2.0	0
	41-51	19-23	6.6-7.3	0	0	0.0-2.0	0
	51-60	5.8-12	6.6-7.3	0	0	0.0-2.0	0
304:							
Cosey	0-9	13-21	6.1-6.5	0	0	0.0-2.0	0
	9-15	13-20	6.1-6.5	0	0	0.0-2.0	0
	15-28	5.8-16	6.1-6.5	0	0	0.0-2.0	0
	28-34	14-23	6.1-6.5	0	0	0.0-2.0	0
	34-60	19-23	6.1-6.5	0	0	0.0-2.0	0
Jarmillo	0-17	14-22	6.1-6.5	0	0	0.0-2.0	0
	17-33	5.0-14	6.1-6.5	0	0	0.0-2.0	0
	33-60	3.8-10	6.6-7.3	0	0	0.0-2.0	0
307:							
Flugle	0-3	7.3-15	6.6-7.3	0	0	0.0-2.0	0
	3-7	11-19	6.6-7.3	0-5	0	0.0-2.0	0
	7-12	11-19	7.4-7.8	0-10	0	0.0-2.0	0
	12-19	11-19	7.4-7.8	0-10	0	0.0-2.0	0
	19-60	6.0-8.7	7.4-7.8	5-10	0	0.0-2.0	0

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Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
307:							
Waumac	0-3	4.0-7.8	7.9-8.4	0-5	0	0.0-2.0	0-5
	3-60	3.1-11	7.9-8.4	5-10	0	0.0-2.0	0-5
308:							
Cajete	0-7	10-17	6.6-7.3	0	0	0.0-2.0	0
	7-15	10-16	6.6-7.3	0	0	0.0-2.0	0
	15-33	3.9-10	6.6-7.3	0-5	0	0.0-2.0	0
	33-45	0.0-4.2	6.6-7.3	0-5	0	0.0-2.0	0
	45-49	0.0-3.9	7.4-7.8	0-5	0	0.0-2.0	0
	49-60	0.0-3.9	7.4-7.8	0-5	0	0.0-2.0	0
311:							
Cosey	0-13	13-21	6.1-7.3	0	0	0.0-2.0	0
	13-24	7.2-14	6.1-7.3	0	0	0.0-2.0	0
	24-60	19-23	6.1-7.3	0	0	0.0-2.0	0
Tranquilar	0-14	14-22	6.1-6.5	0	0	0.0-2.0	0
	14-20	8.0-21	5.6-6.5	0	0	0.0-2.0	0
	20-42	---	4.5-5.0	0	0	0.0-2.0	0
	42-60	---	4.5-5.0	0	0	0.0-2.0	0
Calaveras	0-4	10-16	6.1-6.5	0	0	0.0-2.0	0
	4-11	9.2-15	6.1-6.5	0	0	0.0-2.0	0
	11-17	5.9-15	6.1-6.5	0	0	0.0-2.0	0
	17-30	4.3-12	5.6-6.0	0	0	0.0-2.0	0
	30-39	2.5-9.2	6.6-7.3	0	0	0.0-2.0	0
	39-60	2.5-6.7	6.6-7.3	0	0	0.0-2.0	0
312:							
Royosa	0-5	0.0-4.5	7.4-7.8	0-3	0	0.0-2.0	0
	5-16	0.0-4.4	7.4-7.8	0-3	0	0.0-2.0	0
	16-60	0.0-7.4	7.4-7.8	0-3	0	0.0-2.0	0
314:							
Fragua	0-3	4.2-8.1	7.4-7.8	0	0	0.0-2.0	0
	3-8	6.0-10	7.4-7.8	0-5	0	0.0-2.0	0
	8-24	3.2-8.7	7.4-7.8	0-5	0	0.0-2.0	0
	24-60	6.0-8.7	7.4-7.8	5-10	0	0.0-2.0	0
Waumac	0-3	4.0-7.8	7.9-8.4	0-5	0	0.0-2.0	0-2
	3-60	3.1-11	7.9-8.4	5-10	0	0.0-2.0	0-2
Royosa	0-7	0.0-4.5	7.4-7.8	0-3	0	0.0-2.0	0
	7-60	0.0-4.2	7.4-7.8	0-3	0	0.0-2.0	0

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
317:							
Elpedro	0-2	9.0-14	7.4-7.8	5-15	0	0.0-2.0	0-5
	2-22	15-19	7.4-8.4	5-15	0	0.0-2.0	0-5
	22-60	11-15	7.4-8.4	5-15	0	0.0-2.0	0-5
319:							
Bamac	0-4	4.0-7.8	7.9-8.4	0-5	0	0.0-2.0	0-5
	4-10	3.1-7.4	7.9-8.4	5-10	0	0.0-2.0	0-5
	10-21	3.1-7.4	7.9-8.4	5-10	0	0.0-2.0	0-5
	21-37	3.1-7.4	7.9-8.4	5-10	0	0.0-2.0	0-5
	37-60	3.1-7.4	7.9-8.4	5-10	0	0.0-2.0	0-5
Rock outcrop	0-60	---	---	---	---	---	---
320:							
Sparham	0-9	11-18	6.6-7.3	0-5	0	2.0-4.0	5-10
	9-32	19-32	7.4-7.8	5-10	0	2.0-16.0	5-30
	32-60	19-30	7.9-8.4	5-10	0	2.0-16.0	5-30
321:							
Waumac	0-3	4.0-7.8	7.9-8.4	0-5	0	0.0-2.0	0-2
	3-60	3.1-11	7.9-8.4	5-10	0	0.0-2.0	0-2
Royosa	0-12	0.0-4.5	7.4-7.8	0-3	0	0.0-2.0	0
	12-60	0.0-4.2	7.4-7.8	0-3	0	0.0-2.0	0
322:							
Fragua	0-3	7.3-11	7.4-7.8	0	0	0.0-2.0	0
	3-16	6.0-10	7.4-7.8	0-5	0	0.0-2.0	0
	16-45	3.2-6.0	7.4-7.8	5-10	0	0.0-2.0	0
	45-60	---	---	---	---	---	---
324:							
Rock outcrop	0-60	---	---	---	---	---	---
Atarque	0-3	6.5-12	6.6-7.3	0	0	0.0-2.0	0
	3-9	14-19	6.6-7.8	0-5	0	0.0-2.0	0
	9-14	14-19	7.4-7.8	0-10	0	0.0-2.0	0
	14-60	---	---	---	---	---	---
Menefee	0-2	14-19	7.4-8.4	0-5	0-1	0.0-2.0	0
	2-9	14-23	7.4-8.4	0-5	0-1	0.0-2.0	0
	9-60	---	---	---	---	---	---

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
325:							
Rock outcrop---------	0-60	---	---	---	---	---	---
Espiritu-------------	0-2	4.2-11	7.4-7.8	0	0	0.0-2.0	0-5
	2-20	14-19	7.4-7.8	0	0	0.0-2.0	0-5
	20-60	8.7-14	7.4-7.8	0-5	0	0.0-2.0	0-5
Vessilla-------------	0-1	4.0-11	7.9-8.4	0	0	0.0-2.0	0
	1-10	5.7-14	7.9-8.4	5-10	0	0.0-2.0	0
	10-60	---	---	---	---	---	---
342:							
Waumac---------------	0-5	4.0-7.8	7.9-8.4	0-5	0	0.0-2.0	0-5
	5-60	3.1-11	7.9-8.4	5-10	0	0.0-2.0	0-5
Vessilla-------------	0-3	4.0-11	7.9-8.4	5-10	0	0.0-2.0	0
	3-13	3.1-11	7.9-8.4	5-10	0	0.0-2.0	0
	13-60	---	---	---	---	---	---
Rock outcrop---------	0-60	---	---	---	---	---	---
345:							
Espiritu-------------	0-6	4.2-11	7.4-7.8	0-1	0	0.0-2.0	0-5
	6-15	14-19	7.4-7.8	0-1	0	0.0-2.0	0-5
	15-22	11-16	7.4-7.8	0-1	0	0.0-2.0	0-5
	22-29	11-16	7.4-7.8	0-5	0	0.0-2.0	0-5
	29-38	11-16	7.4-7.8	0-5	0	0.0-2.0	0-5
	38-46	6.0-11	7.4-7.8	0-1	0	0.0-2.0	0-5
	46-60	6.0-8.7	7.4-7.8	0-1	0	0.0-2.0	0-5
Bamac----------------	0-3	4.0-7.8	7.9-8.4	0-5	0	0.0-2.0	0-5
	3-30	3.1-7.4	7.9-8.4	5-10	0	0.0-2.0	0-5
	30-60	3.1-7.4	7.9-8.4	5-10	0	0.0-2.0	0-5
346:							
Espiritu, cobbly-----	0-2	4.2-11	7.4-7.8	0	0	0.0-2.0	0-5
	2-24	14-19	7.4-7.8	0-5	0	0.0-2.0	0-5
	24-36	6.0-10	7.4-7.8	5-10	0	0.0-2.0	0-5
	36-60	3.2-6.0	7.4-7.8	5-10	0	0.0-2.0	0-5
Bamac----------------	0-3	4.0-7.8	7.9-8.4	0-5	0	0.0-2.0	0-5
	3-30	3.1-7.4	7.9-8.4	5-10	0	0.0-2.0	0-5
	30-45	3.1-7.4	7.9-8.4	5-10	0	0.0-2.0	0-5
	45-60	3.1-7.4	7.9-8.4	5-10	0	0.0-2.0	0-5

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
348:							
Wauquie	0-2	11-18	6.6-7.3	0-3	0	0.0-2.0	0
	2-16	15-19	6.6-7.3	0-3	0	0.0-2.0	0
	16-40	3.2-8.7	7.4-7.8	0-3	0	0.0-2.0	0
	40-60	3.2-6.0	7.4-7.8	0-3	0	0.0-2.0	0
Rock outcrop	0-60	---	---	---	---	---	---
353:							
Cochiti	0-4	9.0-15	6.6-7.3	0	0	0.0-2.0	0
	4-22	16-21	6.1-7.3	0-5	0	0.0-2.0	0
	22-60	3.2-6.0	6.6-7.8	5-10	0	0.0-2.0	0
Espiritu	0-3	10-17	7.4-7.8	0	0	0.0-2.0	0-5
	3-16	14-19	7.4-7.8	0-5	0	0.0-2.0	0-5
	16-60	3.2-6.0	7.4-7.8	5-10	0	0.0-2.0	0-5
354:							
Waumac Variant	0-3	4.0-11	7.4-7.8	0-5	0	0.0-2.0	0-5
	3-12	3.1-11	7.4-7.8	0-5	0	0.0-2.0	0-5
	12-60	---	---	---	---	---	---
358:							
Deama	0-3	13-24	7.9-8.4	10-30	0	0.0-2.0	0-5
	3-19	11-18	7.9-8.4	40-60	0	0.0-2.0	0-5
	19-60	---	---	---	---	---	---
Elpedro	0-3	9.0-14	7.4-7.8	5-15	0	0.0-2.0	0-5
	3-37	15-19	7.4-8.4	5-15	0	0.0-2.0	0-5
	37-60	11-15	7.4-8.4	5-15	0	0.0-2.0	0-5
Rock outcrop	0-60	---	---	---	---	---	---
396:							
Atarque	0-2	6.5-12	6.6-7.3	0	0	0.0-2.0	0-5
	2-16	14-19	6.6-7.8	0-5	0	0.0-2.0	0-5
	16-60	---	---	---	---	---	---
Menefee	0-2	18-24	7.4-8.4	0-5	0	0.0-2.0	0
	2-14	14-22	7.4-8.4	5-10	0	0.0-2.0	0
	14-60	---	---	---	---	---	---
Rock outcrop	0-60	---	---	---	---	---	---

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Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
397:							
Rock outcrop	0-60	---	---	---	---	---	---
Cucho	0-2	18-23	7.4-7.8	0-5	0	0.0-2.0	0
	2-9	14-22	6.6-7.3	10-15	0	0.0-2.0	0
	9-37	14-22	7.4-7.8	10-15	0	0.0-2.0	0
	37-60	---	---	---	---	---	---
Vessilla	0-2	4.0-11	7.9-8.4	0	0	0.0-2.0	0
	2-11	3.1-11	7.9-8.4	5-10	0	0.0-2.0	0
	11-60	---	---	---	---	---	---
398:							
Espiritu	0-4	7.3-13	7.4-7.8	0-1	0	0.0-2.0	0-2
	4-24	14-19	7.4-7.8	0-1	0	0.0-2.0	0-2
	24-60	6.0-8.7	7.4-7.8	0-1	0	0.0-2.0	0-2
Cucho	0-2	18-23	7.4-7.8	0-5	0	0.0-2.0	0
	2-37	14-22	6.6-7.8	10-15	0	0.0-2.0	0
	37-60	---	---	---	---	---	---
399:							
Cucho	0-2	18-23	7.4-7.8	0-5	0	0.0-2.0	0
	2-37	14-22	6.6-7.8	10-15	0	0.0-2.0	0
	37-60	---	---	---	---	---	---
Teco	0-1	3.7-11	7.4-7.8	0	0	0.0-2.0	0
	1-7	18-29	7.4-7.8	0-5	0	0.0-2.0	0
	7-23	21-26	7.4-7.8	0-5	0	0.0-2.0	0
	23-40	21-26	7.4-7.8	0-5	0	0.0-2.0	0
	40-45	3.2-8.7	7.4-7.8	8-13	0	0.0-2.0	0
	45-60	11-16	7.4-7.8	5-10	0	4.0-8.0	0
405:							
Charo	0-5	15-20	6.6-7.3	0	0	0.0-2.0	0
	5-12	26-38	6.6-7.3	0	0	0.0-2.0	0
	12-15	26-38	6.6-7.3	0	0	0.0-2.0	0
	15-25	26-38	7.4-7.8	0	0	0.0-2.0	0
	25-28	26-38	7.4-7.8	0	0	0.0-2.0	0
	28-60	---	---	---	---	---	---
Charo, noncobbly	0-8	15-20	6.6-7.3	0	0	0.0-2.0	0
	8-38	26-38	6.6-7.8	0	0	0.0-2.0	0
	38-60	---	---	---	---	---	---

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
409:							
Santa Fe	0-3	9.2-14	6.6-7.3	0	0	0.0-2.0	0
	3-8	14-23	6.6-7.3	0	0	0.0-2.0	0
	8-60	---	---	---	---	---	---
410:							
Zia	0-10	7.4-14	7.4-8.4	0-5	0	0.0-2.0	0-5
	10-60	3.1-11	7.4-8.4	10-15	0	0.0-2.0	0-5
414:							
Wauquie	0-3	3.7-10	6.6-7.3	0-5	0	0.0-2.0	0-5
	3-30	11-16	6.6-7.3	0-5	0	0.0-2.0	0-5
	30-60	3.2-6.0	7.4-7.8	5-10	0	0.0-2.0	0-5
417:							
Jocity	0-10	11-17	7.9-8.4	0	0	2.0-4.0	0
	10-26	14-23	7.9-8.4	1-5	0	2.0-4.0	0
	26-32	8.1-16	7.9-8.4	1-5	0	2.0-4.0	0
	32-50	10-19	7.9-8.4	1-5	0	2.0-4.0	0-5
	50-56	3.1-11	8.5-8.9	1-5	0	2.0-4.0	0-5
	56-60	3.1-7.4	7.9-8.4	1-5	0	2.0-4.0	0-5
418:							
Jocity	0-12	18-23	7.4-8.4	0	0	2.0-4.0	0
	12-30	14-22	7.4-8.4	1-5	0	2.0-4.0	0
	30-60	2.0-7.4	7.9-9.0	1-5	0	2.0-4.0	0-5
419:							
Santa Fe	0-9	5.4-14	6.6-7.3	0	0	0.0-2.0	0
	9-16	14-23	6.6-7.3	0	0	0.0-2.0	0
	16-60	---	---	---	---	---	---
Wauquie	0-4	3.7-10	6.6-7.3	0	0	0.0-2.0	0
	4-11	11-16	6.6-7.3	0-5	0	0.0-2.0	0
	11-18	11-16	6.6-7.3	0-5	0	0.0-2.0	0
	18-29	3.2-8.7	7.4-7.8	0-5	0	0.0-2.0	0
	29-60	0.0-3.2	7.4-7.8	5-10	0	0.0-2.0	0
Rock outcrop	0-60	---	---	---	---	---	---
420:							
Pinavetes	0-10	2.6-7.8	7.9-8.4	1-5	0	0.0-2.0	0-5
	10-60	0.0-4.0	8.5-8.9	1-5	0	0.0-2.0	0-5

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Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
421:							
Gilco, moderately saline, sodic	0-7	7.4-14	7.9-8.4	5-10	0	8.0-16.0	8-13
	7-19	5.7-12	7.9-8.4	5-10	0	8.0-16.0	13-30
	19-60	5.7-12	7.9-8.4	5-10	0	8.0-16.0	13-30
422:							
Vessilla	0-1	4.0-11	7.9-8.4	5-10	0	0.0-2.0	0
	1-15	3.1-11	7.9-8.4	5-10	0	0.0-2.0	0
	15-60	---	---	---	---	---	---
Menefee	0-3	18-24	7.4-8.4	5-10	0-1	0.0-2.0	0
	3-10	14-23	7.4-8.4	10-15	0-1	0.0-2.0	0
	10-60	---	---	---	---	---	---
Orlie	0-4	14-19	7.9-8.4	0	0	0.0-2.0	0
	4-14	8.8-21	7.9-8.4	0-5	0	0.0-2.0	0-2
	14-60	15-19	7.9-8.4	5-10	0	2.0-4.0	0-2
423:							
Gilco	0-8	7.4-13	6.6-8.4	0-5	0	0.0-4.0	0-5
	8-14	5.7-12	6.6-8.4	0-5	0	0.0-4.0	0-5
	14-60	5.7-12	6.6-8.4	5-10	0	0.0-4.0	0-5
426:							
Aga, moderately saline, sodic	0-8	7.4-14	6.6-8.4	5-10	0	8.0-16.0	13-30
	8-20	5.7-14	7.4-8.4	5-10	0	8.0-16.0	13-30
	20-36	0.0-7.4	7.4-8.4	5-10	0	8.0-16.0	13-30
	36-60	0.0-4.0	7.4-8.4	5-10	0	8.0-16.0	13-30
427:							
Aga	0-8	7.4-14	6.6-8.4	0-5	0	0.0-2.0	0-5
	8-28	5.7-14	6.6-8.4	5-10	0	2.0-4.0	0-5
	28-60	0.0-7.4	6.6-8.4	5-10	0	2.0-4.0	0-5
428:							
Aga, moderately saline, sodic	0-4	7.4-14	6.6-8.4	5-10	0	8.0-16.0	13-30
	4-16	3.1-11	7.4-8.4	5-10	0	8.0-16.0	13-30
	16-22	5.7-14	7.4-8.4	5-10	0	8.0-16.0	13-30
	22-60	0.0-7.4	7.4-8.4	5-10	0	8.0-16.0	13-30

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
430:							
Trail	0-10	7.4-14	7.9-8.4	1-5	0	0.0-4.0	0-5
	10-34	3.1-7.4	8.5-9.0	1-5	0	0.0-4.0	0-5
	34-60	0.0-4.0	8.5-9.0	1-5	0	0.0-4.0	0-5
431:							
Trail	0-10	4.0-7.8	7.9-8.4	1-5	0	0.0-4.0	0-5
	10-60	0.0-7.4	8.5-9.0	1-5	0	0.0-4.0	0-5
433:							
Peralta	0-10	11-17	7.4-7.8	0-5	0	4.0-8.0	5-13
	10-60	5.7-14	7.9-8.4	5-10	0	4.0-8.0	5-13
434:							
Peralta	0-10	11-18	7.4-7.8	0-5	0	4.0-8.0	5-13
	10-16	4.0-11	7.9-8.4	5-10	0	4.0-8.0	5-13
	16-20	14-23	7.9-8.4	5-10	0	4.0-8.0	5-13
	20-28	3.1-11	7.9-8.4	5-10	0	4.0-8.0	5-13
	28-40	3.1-7.4	7.9-8.4	5-10	0	4.0-8.0	5-13
	40-45	8.1-16	7.9-8.4	5-10	0	4.0-8.0	5-13
	45-60	3.1-7.4	7.4-7.8	5-10	0	4.0-8.0	5-13
437:							
Peralta, moderately saline, sodic	0-4	7.4-14	7.4-7.8	0-5	0	8.0-16.0	13-30
	4-60	3.1-11	7.9-8.4	5-10	0	8.0-16.0	13-30
500:							
Rock outcrop	0-60	---	---	---	---	---	---
Osha	0-10	5.4-10.0	6.6-7.3	0	0	0.0-2.0	0
	10-20	5.0-9.7	6.6-7.3	0	0	0.0-2.0	0
	20-43	2.3-5.2	6.6-7.3	0	0	0.0-2.0	0
	43-60	---	---	---	---	---	---
Rubble Land	0-60	---	---	0	0	0	0
503:							
Cajete	0-8	6.2-11	6.6-7.3	0	0	0.0-2.0	0
	8-60	6.7-10	6.6-7.3	0-5	0	0.0-2.0	0
Cypher	0-3	6.7-13	5.6-6.5	0	0	0.0-2.0	0
	3-11	2.5-9.2	5.6-6.5	0	0	0.0-2.0	0
	11-15	2.5-9.2	5.6-6.5	0	0	0.0-2.0	0
	15-60	---	---	---	---	---	---

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Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
504:							
Orejas	0-2	9.0-15	6.6-7.3	0	0	0.0-2.0	0-2
	2-9	15-19	7.4-7.8	5-10	0	0.0-2.0	0-2
	9-17	15-19	7.9-8.4	5-10	0	0.0-2.0	0-5
	17-60	---	---	---	---	---	---
Guaje	0-4	4.2-11	7.4-7.8	0-2	0	0.0-2.0	0-2
	4-12	3.9-10	7.4-7.8	0-2	0	0.0-2.0	0-2
	12-17	2.5-9.2	7.9-8.4	15-20	0	0.0-2.0	0-5
	17-45	2.5-9.2	7.9-8.4	15-20	0	0.0-2.0	0-5
	45-60	2.5-9.2	7.9-8.4	15-20	0	0.0-2.0	0-5
600:							
Rock outcrop	0-60	---	---	---	---	---	---
Cypher	0-4	6.7-13	5.6-6.5	0	0	0.0-2.0	0
	4-14	4.3-14	5.6-6.5	0	0	0.0-2.0	0
	14-16	4.3-14	5.6-6.5	0	0	0.0-2.0	0
	16-60	---	---	---	---	---	---
601:							
Laventana	0-5	4.2-11	6.1-6.5	0	0	0.0-2.0	0
	5-9	6.0-11	6.1-6.5	0	0	0.0-2.0	0
	9-50	11-19	6.1-7.3	0	0	0.0-2.0	0
	50-60	---	---	---	---	---	---
603:							
Laventana	0-1	73-81	5.1-6.0	0	0	0.0-2.0	0
	1-5	10-17	6.1-6.5	0	0	0.0-2.0	0
	5-12	8.7-14	6.1-6.5	0	0	0.0-2.0	0
	12-20	11-14	6.1-6.5	0	0	0.0-2.0	0
	20-31	11-15	6.1-6.5	0	0	0.0-2.0	0
	31-51	8.7-14	6.6-7.3	0	0	0.0-2.0	0
	51-60	---	---	---	---	---	---
Mirand	0-6	13-19	6.6-7.3	0	0	0.0-2.0	0
	6-27	21-31	6.6-7.3	0	0	0.0-2.0	0
	27-60	19-26	6.6-7.3	0	0	0.0-2.0	0
604:							
Cypher	0-1	73-81	5.1-6.0	0	0	0.0-2.0	0
	1-4	6.7-13	5.6-6.5	0	0	0.0-2.0	0
	4-11	4.3-14	5.6-6.5	0	0	0.0-2.0	0
	11-19	2.5-9.2	5.6-6.5	0	0	0.0-2.0	0
	19-60	---	---	---	---	---	---

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
604:							
Mirand	0-4	11-17	6.6-7.3	0	0	0.0-2.0	0
	4-60	21-26	6.6-7.3	0	0	0.0-2.0	0
608:							
Osha, steep	0-3	5.4-14	6.6-7.3	0	0	0.0-2.0	0
	3-8	3.4-14	6.1-6.5	0	0	0.0-2.0	0
	8-16	3.8-10	6.6-7.3	0	0	0.0-2.0	0
	16-32	3.8-10	6.6-7.3	0	0	0.0-2.0	0
	32-60	0.0-3.8	6.6-7.3	0	0	0.0-2.0	0
Osha	0-8	4.2-9.7	6.6-7.3	0	0	0.0-2.0	0
	8-16	4.5-8.5	6.6-7.3	0	0	0.0-2.0	0
	16-32	4.5-8.5	6.1-7.3	0	0	0.0-2.0	0
	32-60	3.1-5.8	6.1-7.3	0	0	0.0-2.0	0
823:							
Gilco, unprotected	0-8	7.4-13	6.6-8.4	0-5	0	0.0-4.0	0-5
	8-60	5.7-12	6.6-8.4	5-10	0	0.0-4.0	0-5
827:							
Aga, unprotected	0-8	7.4-14	6.6-8.4	0-5	0	0.0-2.0	0-5
	8-28	5.7-14	6.6-8.4	5-10	0	2.0-4.0	0-5
	28-60	3.1-7.4	6.6-8.4	5-10	0	2.0-4.0	0-5
830:							
Trail, unprotected	0-8	7.4-14	7.9-8.4	1-5	0	0.0-4.0	0-5
	8-60	0.0-7.4	8.5-9.0	1-5	0	0.0-4.0	0-5
831:							
Trail, unprotected	0-10	3.1-7.8	7.9-8.4	1-5	0	0.0-2.0	0-5
	10-30	3.1-7.4	8.5-9.0	1-5	0	0.0-2.0	0-5
	30-60	0.0-4.0	8.5-9.0	1-5	0	0.0-2.0	0-5
835:							
Peralta, unprotected	0-6	7.4-14	7.4-7.8	5-10	0	4.0-8.0	0-5
	6-16	5.7-14	7.9-8.4	5-10	0	4.0-8.0	0-5
	16-60	8.1-22	7.9-8.4	5-10	0	4.0-8.0	0-5
842:							
Peralta, moderately saline, sodic, unprotected	0-10	18-23	7.4-7.8	0-5	0	8.0-16.0	13-30
	10-60	8.1-22	7.9-8.4	5-10	0	8.0-16.0	13-30

Table 16.--Chemical properties of the soils--continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In.	meq/100 g	pH	Pct.	Pct.	mmhos/cm	
850:							
Water	---	---	---	---	---	---	---
DAM:							
Dam	---	---	---	---	---	---	---

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Table 17.--Soil features

(See text for definitions of terms used in this table. Absence of an entry indicates that the feature is not a concern or that data were not estimated.)

Map symbol and soil name	Restrictive layer		Potential for frost action	Risk of corrosion	
	Kind	Depth to top		Uncoated steel	Concrete
		In.			
1:					
Silver	---	---	Low	High	Low
Clovis	---	---	Low	High	Low
2:					
Clovis	---	---	Low	High	Low
Prieta	Bedrock (lithic)	10-20	Low	High	Low
Silver	---	---	Low	High	Low
3:					
Montecito	---	---	Low	High	Low
Orejas	Bedrock (lithic)	10-20	Low	Moderate	Low
4:					
Montecito	---	---	Low	High	Low
Montecito, bouldery	---	---	Low	High	Low
10:					
Trail	---	---	Low	High	Low
11:					
Trail	---	---	Low	High	Low
13:					
Sandoval	Bedrock (paralithic)	10-20	Low	High	Low
Querencia	---	---	Low	Moderate	Low
15:					
Camino	Bedrock (paralithic)	40-60	Low	High	Low
Sandoval	Bedrock (paralithic)	10-20	Low	High	Low
16:					
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
Prieta	Bedrock (lithic)	10-20	Low	High	Low
17:					
Vessilla	Bedrock (lithic)	4-20	Low	High	Low
Menefee	Bedrock (paralithic)	8-20	Moderate	High	Moderate
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
18:					
Sparham	---	---	Low	High	Low
20:					
Gilco	---	---	Low	High	Low
21:					
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
Hackroy	Bedrock (lithic)	8-20	Moderate	Moderate	Low

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Table 17.--Soil features--continued

Map symbol and soil name	Restrictive layer		Potential for frost action	Risk of corrosion	
	Kind	Depth to top		Uncoated steel	Concrete
		In.			
22:					
Aga	---	---	Low	High	Low
23:					
Hickman	---	---	Low	High	Low
24:					
Orlie	---	---	Moderate	High	Low
Sparham	---	---	Low	High	Low
25:					
Gilco	---	---	Low	High	Low
26:					
Orlie	---	---	Moderate	High	Low
27:					
Aga	---	---	Low	High	Low
29:					
Trail	---	---	Low	High	Moderate
31:					
Riverwash	---	---	---	---	---
33:					
Pits	---	---	---	---	---
34:					
Ildefonso	---	---	Low	High	Low
Witt	---	---	Moderate	High	Low
41:					
Dune land	---	---	---	---	---
47:					
Cascajo	---	---	Low	High	Low
51:					
Sparham	---	---	Low	High	Low
52:					
Totavi	---	---	Low	Moderate	Low
53:					
Witt	---	---	Moderate	High	Low
Harvey	---	---	Low	High	Low
54:					
Harvey	---	---	Low	High	Low
Cascajo	---	---	Low	High	Low
55:					
La Fonda	---	---	Low	High	Low
56:					
Ildefonso	---	---	Low	High	Low

Table 17.--Soil features--continued

Map symbol and soil name	Restrictive layer		Potential for frost action	Risk of corrosion	
	Kind	Depth to top		Uncoated steel	Concrete
		In.			
57:					
Badland	Bedrock (paralithic)	0-0	Low	High	Moderate
58:					
Deama	Bedrock (lithic)	10-20	Low	Moderate	Low
Elpedro	---	---	Moderate	High	Low
59:					
Harvey	---	---	Low	High	Low
Ildefonso	---	---	Low	High	Low
La Fonda	---	---	Low	High	Low
63:					
Placitas	Bedrock (lithic)	20-40	Low	High	Low
64:					
Skyvillage	Bedrock (lithic)	6-20	Low	Moderate	Low
Ildefonso	---	---	Low	High	Low
65:					
Ildefonso	---	---	Low	High	Low
Harvey	---	---	Low	High	Low
66:					
Zia	---	---	Low	High	Low
67:					
Sandoval	Bedrock (paralithic)	10-20	Low	High	Low
Poley	---	---	Low	High	Low
68:					
Penistaja	---	---	Low	High	Low
Querencia	---	---	Low	Moderate	Low
71:					
Palon	---	---	Moderate	Moderate	Moderate
72:					
Palon	---	---	Moderate	Moderate	Moderate
74:					
Origo	---	---	Moderate	High	High
Pavo	---	---	Moderate	Moderate	Low
75:					
Origo	---	---	Moderate	High	High
82:					
Calaveras	---	---	Moderate	Moderate	Moderate
83:					
Calaveras	---	---	Moderate	Moderate	Moderate
Rubble land	---	---	---	---	---

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Table 17.--Soil features--continued

Map symbol and soil name	Restrictive layer		Potential for frost action	Risk of corrosion	
	Kind	Depth to top		Uncoated steel	Concrete
		In.			
85:					
Redondo	---	---	Moderate	Moderate	Moderate
86:					
Redondo	---	---	Moderate	Moderate	Moderate
87:					
Redondo	---	---	Moderate	Moderate	Moderate
Rubble land	---	---	---	---	---
88:					
Totavi	---	---	Low	Moderate	Low
Jemez	Bedrock (lithic)	20-40	Moderate	Moderate	Low
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
91:					
Zia	---	---	Low	High	Low
92:					
Galisteo, moderately saline, sodic	---	---	Low	High	Low
93:					
Zia	---	---	Low	High	Low
95:					
El Rancho	---	---	Low	High	Low
97:					
El Rancho	---	---	Moderate	High	Low
100:					
Orejas	Bedrock (lithic)	10-20	Low	Moderate	Low
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
101:					
Blancot	---	---	Low	High	Low
Lybrook	---	---	Low	High	Low
102:					
Sparham	---	---	Low	High	Low
104:					
Cochiti	---	---	Moderate	Moderate	Low
Montecito	---	---	Low	High	Low
105:					
Badland	Bedrock (paralithic)	0-0	Low	High	Moderate
Menefee	Bedrock (paralithic)	8-20	Moderate	High	Moderate
106:					
Stumble	---	---	Low	High	Low
Stumble, sandy	---	---	Low	High	Low

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Table 17.--Soil features--continued

Map symbol and soil name	Restrictive layer		Potential for frost action	Risk of corrosion	
	Kind	Depth to top		Uncoated steel	Concrete
		In.			
108:					
Embudo	---	---	Low	High	Low
109:					
Embudo	---	---	Low	High	Low
Tijeras	---	---	Low	High	Low
110:					
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
Saido	---	---	Low	High	High
111:					
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
Zia	---	---	Low	High	Low
112:					
Tijeras	---	---	Low	High	Low
114:					
San Mateo	---	---	Low	High	Low
Zia	---	---	Low	High	Low
120:					
Pinavetes	---	---	Low	Moderate	Low
124:					
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
129:					
Menefee	Bedrock (paralithic)	8-20	Moderate	High	Moderate
130:					
Pinavetes	---	---	Low	Moderate	Low
Galisteo, moderately saline, sodic	---	---	Low	High	Low
142:					
Grieta	---	---	Moderate	High	Low
143:					
Clovis	---	---	Low	High	Low
145:					
Grieta	---	---	Moderate	High	Low
Sheppard	---	---	Low	High	Moderate
146:					
Sedmar	Bedrock (lithic)	6-20	Low	Moderate	Low
150:					
Doakum	---	---	Low	High	Low
Betonnie	---	---	Low	Moderate	Low
162:					
Hackroy	Bedrock (lithic)	8-20	Moderate	Moderate	Low

Table 17.--Soil features--continued

Map symbol and soil name	Restrictive layer		Potential for frost action	Risk of corrosion	
	Kind	Depth to top		Uncoated steel	Concrete
		In.			
162:					
Nyjack	Bedrock (paralithic)	20-40	Moderate	Moderate	Low
163:					
Jemez	Bedrock (lithic)	20-40	Moderate	Moderate	Low
170:					
San Mateo	---	---	Low	High	Low
180:					
Councelor	---	---	Low	Moderate	Low
Eslendo	Bedrock (paralithic)	4-20	Low	Moderate	Low
Mespun	---	---	Low	Moderate	Low
183:					
Sheppard	---	---	Low	High	Moderate
185:					
Frijoles	Abrupt textural change	15-30	Moderate	Moderate	Low
190:					
Zia	---	---	Low	High	Low
Skyvillage	Bedrock (lithic)	6-20	Low	Moderate	Low
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
191:					
Sheppard	---	---	Low	High	Moderate
200:					
Sedillo	---	---	Low	High	Low
201:					
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
Sedgran	Bedrock (lithic)	6-20	Low	Low	Low
206:					
Pinitos	---	---	Moderate	Moderate	Low
207:					
Penistaja	---	---	Low	High	Low
Zia	---	---	Low	High	Low
208:					
Sedillo	---	---	Low	High	Low
210:					
Ildefonso	---	---	Low	High	Low
211:					
Zia	---	---	Low	High	Low
Clovis	---	---	Low	High	Low
213:					
Pinavetes	---	---	Low	Moderate	Low
Rock outcrop	Bedrock (lithic)	0-0	---	---	---

: 07405

Table 17.--Soil features--continued

Map symbol and soil name	Restrictive layer		Potential for frost action	Risk of corrosion	
	Kind	Depth to top		Uncoated steel	Concrete
		In.			
215:					
Ess	---	---	Moderate	Moderate	Moderate
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
217:					
Witt	---	---	Moderate	High	Low
218:					
Ildefonso	---	---	Low	High	Low
220:					
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
Vessilla	Bedrock (lithic)	4-20	Low	High	Low
Menefee	Bedrock (paralithic)	8-20	Moderate	High	Moderate
226:					
Galisteo, moderately saline, sodic	---	---	Low	High	Low
227:					
Hagerman	Bedrock (lithic)	20-40	Low	High	Low
Bond	Bedrock (lithic)	6-20	Low	High	Low
228:					
Winona	Bedrock (lithic)	5-20	Low	High	Low
230:					
Skyvillage	Bedrock (lithic)	6-20	Low	Moderate	Low
Sandoval	Bedrock (paralithic)	10-20	Low	High	Low
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
231:					
Querencia	---	---	Low	Moderate	Low
234:					
Querencia	---	---	Low	Moderate	Low
Zia	---	---	Low	High	Low
235:					
Sandoval	Bedrock (paralithic)	10-20	Low	High	Low
236:					
Sparank, moderately saline, sodic	---	---	Low	High	Low
237:					
Sparank	---	---	Low	High	Low
240:					
Penistaja	---	---	Low	High	Low
Hagerman	Bedrock (lithic)	20-40	Low	High	Low
250:					
Pinavetes	---	---	Low	Moderate	Low

Table 17.--Soil features--continued

Map symbol and soil name	Restrictive layer		Potential for frost action	Risk of corrosion	
	Kind	Depth to top		Uncoated steel	Concrete
		In.			
262:					
Pastura	Petrocalcic	5-20	Low	High	Low
270:					
Blancot	---	---	Low	High	Low
Councelor	---	---	Low	Moderate	Low
Tsosie	---	---	Low	High	Low
281:					
Carjo	Bedrock (lithic)	20-40	Moderate	Moderate	Low
282:					
Tocal	Bedrock (paralithic)	8-20	Moderate	Moderate	Low
283:					
Mirand	---	---	Low	Moderate	Low
Alanos	---	---	Moderate	Moderate	Moderate
290:					
Alanos	---	---	Moderate	Moderate	Moderate
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
300:					
Waumac	---	---	Moderate	High	Low
Bamac	---	---	Low	High	Low
301:					
Vastine	---	---	High	High	Low
Jarola	---	---	Moderate	Moderate	Moderate
302:					
Tranquilar	---	---	Moderate	High	High
Jarmillo	---	---	Moderate	Moderate	Low
304:					
Cosey	---	---	Moderate	Moderate	Low
Jarmillo	---	---	Moderate	Moderate	Low
307:					
Flugle	---	---	Moderate	High	Low
Waumac	---	---	Moderate	High	Low
308:					
Cajete	---	---	Moderate	Moderate	Low
311:					
Cosey	---	---	Moderate	Moderate	Low
Tranquilar	---	---	Moderate	High	High
Calaveras	---	---	Moderate	Moderate	Moderate
312:					
Royosa	---	---	Low	Moderate	Low

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Table 17.--Soil features--continued

Map symbol and soil name	Restrictive layer		Potential for frost action	Risk of corrosion	
	Kind	Depth to top		Uncoated steel	Concrete
		In.			
314:					
Fragua	---	---	Moderate	Low	Low
Waumac	---	---	Moderate	High	Low
Royosa	---	---	Low	Moderate	Low
317:					
Elpedro	---	---	Moderate	High	Low
319:					
Bamac	---	---	Low	High	Low
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
320:					
Sparham	---	---	Low	High	Low
321:					
Waumac	---	---	Moderate	High	Low
Royosa	---	---	Low	Moderate	Low
322:					
Fragua	Bedrock (paralithic)	40-80	Moderate	Low	Low
324:					
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
Atarque	Bedrock (lithic)	8-20	Low	Moderate	Low
Menefee	Bedrock (paralithic)	8-20	Moderate	High	Moderate
325:					
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
Espiritu	---	---	Moderate	Low	Low
Vessilla	Bedrock (lithic)	4-20	Moderate	High	Low
342:					
Waumac	---	---	Moderate	High	Low
Vessilla	Bedrock (lithic)	4-20	Low	High	Low
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
345:					
Espiritu	---	---	Moderate	Low	Low
Bamac	---	---	Low	High	Low
346:					
Espiritu, cobbly	---	---	Moderate	Low	Low
Bamac	---	---	Low	High	Low
348:					
Wauquie	---	---	Moderate	Moderate	Low
Rock outcrop	Bedrock (lithic)	0-0	---	---	---

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Table 17.--Soil features--continued

Map symbol and soil name	Restrictive layer		Potential for frost action	Risk of corrosion	
	Kind	Depth to top		Uncoated steel	Concrete
		In.			
353:					
Cochiti	---	---	Moderate	Moderate	Low
Espiritu	---	---	Moderate	Low	Low
354:					
Waumac Variant	Bedrock (paralithic)	10-20	Moderate	Low	Low
358:					
Deama	Bedrock (lithic)	10-20	Low	High	Low
Elpedro	---	---	Moderate	High	Low
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
396:					
Atarque	Bedrock (lithic)	8-20	Low	Moderate	Low
Menefee	Bedrock (paralithic)	8-20	Moderate	High	Moderate
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
397:					
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
Cucho	Bedrock (paralithic)	20-40	Moderate	Moderate	Low
Vessilla	Bedrock (lithic)	4-20	Moderate	High	Low
398:					
Espiritu	---	---	Moderate	Low	Low
Cucho	Bedrock (paralithic)	20-40	Moderate	Moderate	Low
399:					
Cucho	Bedrock (paralithic)	20-40	Moderate	Moderate	Low
Teco	---	---	Moderate	High	Low
405:					
Charo	Bedrock (lithic)	20-40	Low	Moderate	Low
Charo, noncobbly	Bedrock (lithic)	20-40	Low	Moderate	Low
409:					
Santa Fe	Bedrock (lithic)	8-20	Low	Moderate	Low
410:					
Zia	---	---	Low	High	Low
414:					
Wauquie	---	---	Moderate	Moderate	Low
417:					
Jocity	---	---	Low	High	Moderate
418:					
Jocity	---	---	Low	High	Moderate
419:					
Santa Fe	Bedrock (lithic)	8-20	Low	Moderate	Low
Wauquie	---	---	Moderate	Moderate	Low

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Table 17.--Soil features--continued

Map symbol and soil name	Restrictive layer		Potential for frost action	Risk of corrosion	
	Kind	Depth to top		Uncoated steel	Concrete
		In.			
419:					
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
420:					
Pinavetes	---	---	Low	Moderate	Low
421:					
Gilco, moderately saline, sodic	---	---	Low	High	Low
422:					
Vessilla	Bedrock (lithic)	4-20	Low	High	Low
Menefee	Bedrock (paralithic)	8-20	Moderate	High	Moderate
Orlie	---	---	Moderate	High	Low
423:					
Gilco	---	---	Low	High	Low
426:					
Aga, moderately saline, sodic	---	---	Low	High	Low
427:					
Aga	---	---	Low	High	Low
428:					
Aga, moderately saline, sodic	---	---	Low	High	Low
430:					
Trail	---	---	Low	High	Low
431:					
Trail	---	---	Low	High	Low
433:					
Peralta	---	---	Low	High	Moderate
434:					
Peralta	---	---	Low	High	Moderate
437:					
Peralta, moderately saline, sodic	---	---	Low	High	High
500:					
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
Osha	Bedrock (lithic)	40-60	Low	Low	Low
Rubble land	---	---	---	---	---
503:					
Cajete	---	---	Moderate	Moderate	Low
Cypher	Bedrock (lithic)	10-20	Moderate	Moderate	Moderate
504:					
Orejas	Bedrock (lithic)	10-20	Low	Moderate	Low
Guaje	---	---	Low	High	Low

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Table 17.--Soil features--continued

Map symbol and soil name	Restrictive layer		Potential for frost action	Risk of corrosion	
	Kind	Depth to top		Uncoated steel	Concrete
		In.			
600:					
Rock outcrop	Bedrock (lithic)	0-0	---	---	---
Cypher	Bedrock (lithic)	10-20	Moderate	Moderate	Moderate
601:					
Laventana	Bedrock (lithic)	40-60	Moderate	Low	High
603:					
Laventana	Bedrock (lithic)	40-60	Moderate	Low	High
Mirand	---	---	Low	Moderate	Low
604:					
Cypher	Bedrock (lithic)	10-20	Moderate	Moderate	Moderate
Mirand	---	---	Low	Moderate	Low
608:					
Osha, steep	---	---	Low	Low	Low
Osha	---	---	Low	Low	Low
823:					
Gilco, unprotected	---	---	Low	High	Low
827:					
Aga, unprotected	---	---	Low	High	Low
830:					
Trail, unprotected	---	---	Low	High	Low
831:					
Trail, unprotected	---	---	Low	High	Moderate
835:					
Peralta, unprotected	---	---	Low	High	Moderate
842:					
Peralta, moderately saline, sodic, unprotected	---	---	Low	High	High
850:					
Water	---	---	---	---	---
DAM:					
Dam	---	---	---	---	---

: 07411

Table 18.--Water features

(Depths of layers are in feet. See text for definitions of terms used in this table. Estimates of the frequency of ponding and flooding apply to the whole year rather than to individual months. Absence of an entry indicates that the feature is not a concern or that data were not estimated.)

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
1:									
Silver	C	Jan-Dec	---	---	---	---	None	---	None
Clovis	B	Jan-Dec	---	---	---	---	None	---	None
2:									
Clovis	B	Jan-Dec	---	---	---	---	None	---	None
Prieta	D	Jan-Dec	---	---	---	---	None	---	None
Silver	C	Jan-Dec	---	---	---	---	None	---	None
3:									
Montecito	B	Jan-Dec	---	---	---	---	None	---	None
Orejas	D	Jan-Dec	---	---	---	---	None	---	None
4:									
Montecito	B	Jan-Dec	---	---	---	---	None	---	None
Montecito, bouldery	B	Jan-Dec	---	---	---	---	None	---	None
10:									
Trail	A	March	---	---	---	---	None	---	Rare
		April	4.0-6.0	>6.0	---	---	None	---	Rare
		May	4.0-6.0	>6.0	---	---	None	---	Rare
		June	4.0-6.0	>6.0	---	---	None	---	Rare
		July	4.0-6.0	>6.0	---	---	None	---	Rare
		August	4.0-6.0	>6.0	---	---	None	---	Rare
		September	4.0-6.0	>6.0	---	---	None	---	None
		October	4.0-6.0	>6.0	---	---	None	---	None
11:									
Trail	A	March	---	---	---	---	None	Brief	Occasional
		April	4.0-6.0	>6.0	---	---	None	Brief	Occasional
		May	4.0-6.0	>6.0	---	---	None	Brief	Occasional
		June	4.0-6.0	>6.0	---	---	None	Brief	Occasional
		July	4.0-6.0	>6.0	---	---	None	Brief	Occasional
		August	4.0-6.0	>6.0	---	---	None	Brief	Occasional
		September	4.0-6.0	>6.0	---	---	None	---	None
		October	4.0-6.0	>6.0	---	---	None	---	None

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Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
13:									
Sandoval	D	Jan-Dec	---	---	---	---	None	---	None
Querencia	B	Jan-Dec	---	---	---	---	None	---	None
15:									
Camino	C	Jan-Dec	---	---	---	---	None	---	None
Sandoval	D	Jan-Dec	---	---	---	---	None	---	None
16:									
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
Prieta	D	Jan-Dec	---	---	---	---	None	---	None
17:									
Vessilla	D	Jan-Dec	---	---	---	---	None	---	None
Menefee	D	Jan-Dec	---	---	---	---	None	---	None
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
18:									
Sparham	D	July	---	---	---	---	None	Brief	Occasional
		August	---	---	---	---	None	Brief	Occasional
		September	---	---	---	---	None	Brief	Occasional
		October	---	---	---	---	None	Brief	Occasional
20:									
Gilco	B	March	---	---	---	---	None	---	Rare
		April	4.0-6.0	>6.0	---	---	None	---	Rare
		May	4.0-6.0	>6.0	---	---	None	---	Rare
		June	4.0-6.0	>6.0	---	---	None	---	Rare
		July	4.0-6.0	>6.0	---	---	None	---	Rare
		August	4.0-6.0	>6.0	---	---	None	---	Rare
		September	4.0-6.0	>6.0	---	---	None	---	None
		October	4.0-6.0	>6.0	---	---	None	---	None
21:									
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
Hackroy	D	Jan-Dec	---	---	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
22:									
Aga	B	March	---	---	---	---	None	---	Rare
		April	3.5-5.0	>6.0	---	---	None	---	Rare
		May	3.5-5.0	>6.0	---	---	None	---	Rare
		June	3.5-5.0	>6.0	---	---	None	---	Rare
		July	3.5-5.0	>6.0	---	---	None	---	Rare
		August	3.5-5.0	>6.0	---	---	None	---	Rare
		September	3.5-5.0	>6.0	---	---	None	---	None
		October	3.5-5.0	>6.0	---	---	None	---	None
23:									
Hickman	B	March	---	---	---	---	None	---	Rare
		April	---	---	---	---	None	---	Rare
		May	---	---	---	---	None	---	Rare
		June	---	---	---	---	None	---	Rare
		July	---	---	---	---	None	---	Rare
		August	---	---	---	---	None	---	Rare
		Jan-Dec	---	---	---	---	None	---	None
24:									
Orlie	C	Jan-Dec	---	---	---	---	None	---	None
Sparham	D	July	---	---	---	---	None	Brief	Occasional
		August	---	---	---	---	None	Brief	Occasional
		September	---	---	---	---	None	Brief	Occasional
		October	---	---	---	---	None	Brief	Occasional
25:									
Gilco	B	March	---	---	---	---	None	---	Rare
		April	4.0-6.0	>6.0	---	---	None	---	Rare
		May	4.0-6.0	>6.0	---	---	None	---	Rare
		June	4.0-6.0	>6.0	---	---	None	---	Rare
		July	4.0-6.0	>6.0	---	---	None	---	Rare
		August	4.0-6.0	>6.0	---	---	None	---	Rare
		September	4.0-6.0	>6.0	---	---	None	---	None
		October	4.0-6.0	>6.0	---	---	None	---	None
26:									
Orlie	C	Jan-Dec	---	---	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
27:									
Aga	B	March	---	---	---	---	None	---	Rare
		April	3.5-5.0	>6.0	---	---	None	---	Rare
		May	3.5-5.0	>6.0	---	---	None	---	Rare
		June	3.5-5.0	>6.0	---	---	None	---	Rare
		July	3.5-5.0	>6.0	---	---	None	---	Rare
		August	3.5-5.0	>6.0	---	---	None	---	Rare
		September	3.5-5.0	>6.0	---	---	None	---	None
		October	3.5-5.0	>6.0	---	---	None	---	None
29:									
Trail	A	March	---	---	---	---	None	---	Rare
		April	4.0-6.0	>6.0	---	---	None	---	Rare
		May	4.0-6.0	>6.0	---	---	None	---	Rare
		June	4.0-6.0	>6.0	---	---	None	---	Rare
		July	4.0-6.0	>6.0	---	---	None	---	Rare
		August	4.0-6.0	>6.0	---	---	None	---	Rare
		September	4.0-6.0	>6.0	---	---	None	---	None
		October	4.0-6.0	>6.0	---	---	None	---	None
31:									
Riverwash	D	March	---	---	---	---	None	Long	Frequent
		April	---	---	---	---	None	Long	Frequent
		May	---	---	---	---	None	Long	Frequent
		June	---	---	---	---	None	Long	Frequent
		July	---	---	---	---	None	Long	Frequent
		August	---	---	---	---	None	Long	Frequent
		September	---	---	---	---	None	Long	Frequent
33:									
Pits	---	Jan-Dec	---	---	---	---	None	---	None
34:									
Ildefonso	B	Jan-Dec	---	---	---	---	None	---	None
Witt	B	Jan-Dec	---	---	---	---	None	---	None
41:									
Dune Land	A	Jan-Dec	---	---	---	---	None	---	None
47:									
Cascajo	A	Jan-Dec	---	---	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
51:									
Sparham	C	January	1.6-3.3	3.3-5.0	---	---	None	---	None
		February	1.6-3.3	3.3-5.0	---	---	None	---	None
		March	1.6-3.3	3.3-5.0	---	---	None	---	None
		June	2.5-3.3	3.3-5.0	---	---	None	---	None
		July	0.3-0.8	5.0-5.0	---	---	None	Brief	Occasional
		August	0.3-0.8	4.1-5.0	---	---	None	Brief	Occasional
		September	0.3-0.8	3.3-5.0	---	---	None	Brief	Occasional
		October	0.3-0.8	3.3-5.0	---	---	None	Brief	Occasional
		November	3.0-3.3	3.3-5.0	---	---	None	---	None
		December	3.0-3.3	3.3-5.0	---	---	None	---	None
52:									
Totavi	A	March	---	---	---	---	None	---	Rare
		April	---	---	---	---	None	---	Rare
		May	---	---	---	---	None	---	Rare
		June	---	---	---	---	None	---	Rare
		July	---	---	---	---	None	---	Rare
		August	---	---	---	---	None	---	Rare
		Jan-Dec	---	---	---	---	None	---	None
53:									
Witt	B	Jan-Dec	---	---	---	---	None	---	None
Harvey	B	Jan-Dec	---	---	---	---	None	---	None
54:									
Harvey	B	Jan-Dec	---	---	---	---	None	---	None
Cascajo	A	Jan-Dec	---	---	---	---	None	---	None
55:									
La Fonda	B	Jan-Dec	---	---	---	---	None	---	None
56:									
Ildefonso	B	Jan-Dec	---	---	---	---	None	---	None
57:									
Badland	D	Jan-Dec	---	---	---	---	None	---	None
58:									
Deama	D	Jan-Dec	---	---	---	---	None	---	None
Elpedro	B	Jan-Dec	---	---	---	---	None	---	None

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Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
59:									
Harvey	B	Jan-Dec	---	---	---	---	None	---	None
Ildefonso	B	Jan-Dec	---	---	---	---	None	---	None
La Fonda	B	Jan-Dec	---	---	---	---	None	---	None
63:									
Placitas	C	Jan-Dec	---	---	---	---	None	---	None
64:									
Skyvillage	D	Jan-Dec	---	---	---	---	None	---	None
Ildefonso	B	Jan-Dec	---	---	---	---	None	---	None
65:									
Ildefonso	B	Jan-Dec	---	---	---	---	None	---	None
Harvey	B	Jan-Dec	---	---	---	---	None	---	None
66:									
Zia	B	Jan-Dec	---	---	---	---	None	---	None
67:									
Sandoval	D	Jan-Dec	---	---	---	---	None	---	None
Poley	D	Jan-Dec	---	---	---	---	None	---	None
68:									
Penistaja	B	Jan-Dec	---	---	---	---	None	---	None
Querencia	B	Jan-Dec	---	---	---	---	None	---	None
71:									
Palon	B	Jan-Dec	---	---	---	---	None	---	None
72:									
Palon	B	Jan-Dec	---	---	---	---	None	---	None
74:									
Origo	B	Jan-Dec	---	---	---	---	None	---	None
Pavo	B	Jan-Dec	---	---	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
75:									
Origo	B	Jan-Dec	---	---	---	---	None	---	None
82:									
Calaveras	B	Jan-Dec	---	---	---	---	None	---	None
83:									
Calaveras	B	Jan-Dec	---	---	---	---	None	---	None
Rubble Land	A	Jan-Dec	---	---	---	---	None	---	None
85:									
Redondo	B	Jan-Dec	---	---	---	---	None	---	None
86:									
Redondo	B	Jan-Dec	---	---	---	---	None	---	None
87:									
Redondo	B	Jan-Dec	---	---	---	---	None	---	None
Rubble Land	A	Jan-Dec	---	---	---	---	None	---	None
88:									
Totavi	A	March	---	---	---	---	None	---	Rare
		April	---	---	---	---	None	---	Rare
		May	---	---	---	---	None	---	Rare
		June	---	---	---	---	None	---	Rare
		July	---	---	---	---	None	---	Rare
		August	---	---	---	---	None	---	Rare
		Jan-Dec	---	---	---	---	None	---	None
Jemez	C	Jan-Dec	---	---	---	---	None	---	None
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
91:									
Zia	B	Jan-Dec	---	---	---	---	None	---	None
92:									
Galisteo, moderately saline, sodic	D	Jan-Dec	---	---	---	---	None	---	None
93:									
Zia	B	Jan-Dec	---	---	---	---	None	---	None

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Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
95:									
El Rancho	B	Jan-Dec	---	---	---	---	None	---	None
97:									
El Rancho	B	Jan-Dec	---	---	---	---	None	---	None
100:									
Orejas	D	Jan-Dec	---	---	---	---	None	---	None
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
101:									
Blancot	B	Jan-Dec	---	---	---	---	None	---	None
Lybrook	D	Jan-Dec	---	---	---	---	None	---	None
102:									
Sparham	D	July	---	---	---	---	None	Brief	Occasional
		August	---	---	---	---	None	Brief	Occasional
		September	---	---	---	---	None	Brief	Occasional
		October	---	---	---	---	None	Brief	Occasional
104:									
Cochiti	C	Jan-Dec	---	---	---	---	None	---	None
Montecito	B	Jan-Dec	---	---	---	---	None	---	None
105:									
Badland	D	Jan-Dec	---	---	---	---	None	---	None
Menefee	D	Jan-Dec	---	---	---	---	None	---	None
106:									
Stumble	A	Jan-Dec	---	---	---	---	None	---	None
Stumble, sandy	A	March	---	---	---	---	None	---	Rare
		April	---	---	---	---	None	---	Rare
		May	---	---	---	---	None	---	Rare
		June	---	---	---	---	None	---	Rare
		July	---	---	---	---	None	---	Rare
		August	---	---	---	---	None	---	Rare
		Jan-Dec	---	---	---	---	None	---	None
108:									
Embudo	B	Jan-Dec	---	---	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
109:									
Embudo	B	Jan-Dec	---	---	---	---	None	---	None
Tijeras	B	Jan-Dec	---	---	---	---	None	---	None
110:									
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
Saido	B	Jan-Dec	---	---	---	---	None	---	None
111:									
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
Zia	B	Jan-Dec	---	---	---	---	None	---	None
112:									
Tijeras	B	Jan-Dec	---	---	---	---	None	---	None
114:									
San Mateo	B	March	---	---	---	---	None	---	Rare
		April	---	---	---	---	None	---	Rare
		May	---	---	---	---	None	---	Rare
		June	---	---	---	---	None	---	Rare
		July	---	---	---	---	None	---	Rare
		August	---	---	---	---	None	---	Rare
		Jan-Dec	---	---	---	---	None	---	None
Zia	B	Jan-Dec	---	---	---	---	None	---	None
120:									
Pinavetes	A	Jan-Dec	---	---	---	---	None	---	None
124:									
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
129:									
Menefee	D	Jan-Dec	---	---	---	---	None	---	None
130:									
Pinavetes	A	Jan-Dec	---	---	---	---	None	---	None

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Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
130:									
Galisteo, moderately saline, sodic	D	March	---	---	---	---	None	---	Rare
		April	---	---	---	---	None	---	Rare
		May	---	---	---	---	None	---	Rare
		June	---	---	---	---	None	---	Rare
		July	---	---	---	---	None	---	Rare
		August	---	---	---	---	None	---	Rare
		Jan-Dec	---	---	---	---	None	---	None
142:									
Grieta	B	Jan-Dec	---	---	---	---	None	---	None
143:									
Clovis	B	Jan-Dec	---	---	---	---	None	---	None
145:									
Grieta	B	Jan-Dec	---	---	---	---	None	---	None
Sheppard	A	Jan-Dec	---	---	---	---	None	---	None
146:									
Sedmar	D	Jan-Dec	---	---	---	---	None	---	None
150:									
Doakum	B	Jan-Dec	---	---	---	---	None	---	None
Betonnie	B	Jan-Dec	---	---	---	---	None	---	None
162:									
Hackroy	D	Jan-Dec	---	---	---	---	None	---	None
Nyjack	C	Jan-Dec	---	---	---	---	None	---	None
163:									
Jemez	C	Jan-Dec	---	---	---	---	None	---	None
170:									
San Mateo	B	March	---	---	---	---	None	---	Rare
		April	---	---	---	---	None	---	Rare
		May	---	---	---	---	None	---	Rare
		June	---	---	---	---	None	---	Rare
		July	---	---	---	---	None	---	Rare
		August	---	---	---	---	None	---	Rare
		Jan-Dec	---	---	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
180:									
Councelor	B	Jan-Dec	---	---	---	---	None	---	None
Eslendo	D	Jan-Dec	---	---	---	---	None	---	None
Mespun	A	Jan-Dec	---	---	---	---	None	---	None
183:									
Sheppard	A	Jan-Dec	---	---	---	---	None	---	None
185:									
Frijoles	C	Jan-Dec	---	---	---	---	None	---	None
190:									
Zia	B	Jan-Dec	---	---	---	---	None	---	None
Skyvillage	D	Jan-Dec	---	---	---	---	None	---	None
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
191:									
Sheppard	A	Jan-Dec	---	---	---	---	None	---	None
200:									
Sedillo	B	Jan-Dec	---	---	---	---	None	---	None
201:									
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
Sedgran	D	Jan-Dec	---	---	---	---	None	---	None
206:									
Pinitos	B	Jan-Dec	---	---	---	---	None	---	None
207:									
Penistaja	B	Jan-Dec	---	---	---	---	None	---	None
Zia	B	Jan-Dec	---	---	---	---	None	---	None
208:									
Sedillo	B	Jan-Dec	---	---	---	---	None	---	None
210:									
Ildefonso	B	Jan-Dec	---	---	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
211:									
Zia	B	Jan-Dec	---	---	---	---	None	---	None
Clovis	B	Jan-Dec	---	---	---	---	None	---	None
213:									
Pinavetes	A	Jan-Dec	---	---	---	---	None	---	None
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
215:									
Ess	B	Jan-Dec	---	---	---	---	None	---	None
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
217:									
Witt	B	Jan-Dec	---	---	---	---	None	---	None
218:									
Ildefonso	B	Jan-Dec	---	---	---	---	None	---	None
220:									
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
Vessilla	D	Jan-Dec	---	---	---	---	None	---	None
Menefee	D	Jan-Dec	---	---	---	---	None	---	None
226:									
Galisteo, moderately saline, sodic	D	Jan-Dec	---	---	---	---	None	---	None
227:									
Hagerman	C	Jan-Dec	---	---	---	---	None	---	None
Bond	D	Jan-Dec	---	---	---	---	None	---	None
228:									
Winona	D	Jan-Dec	---	---	---	---	None	---	None
230:									
Skyvillage	D	Jan-Dec	---	---	---	---	None	---	None
Sandoval	D	Jan-Dec	---	---	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
230:									
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
231:									
Querencia	B	Jan-Dec	---	---	---	---	None	---	None
234:									
Querencia	B	Jan-Dec	---	---	---	---	None	---	None
Zia	B	Jan-Dec	---	---	---	---	None	---	None
235:									
Sandoval	D	Jan-Dec	---	---	---	---	None	---	None
236:									
Sparank, moderately saline, sodic	D	July	---	---	---	---	None	Brief	Occasional
		August	---	---	---	---	None	Brief	Occasional
		September	---	---	---	---	None	Brief	Occasional
		October	---	---	---	---	None	Brief	Occasional
237:									
Sparank	D	July	---	---	---	---	None	Brief	Occasional
		August	---	---	---	---	None	Brief	Occasional
		September	---	---	---	---	None	Brief	Occasional
		October	---	---	---	---	None	Brief	Occasional
240:									
Penistaja	B	Jan-Dec	---	---	---	---	None	---	None
Hagerman	C	Jan-Dec	---	---	---	---	None	---	None
250:									
Pinavetes	A	Jan-Dec	---	---	---	---	None	---	None
262:									
Pastura	D	Jan-Dec	---	---	---	---	None	---	None
270:									
Blancot	B	Jan-Dec	---	---	---	---	None	---	None
Councelor	B	Jan-Dec	---	---	---	---	None	---	None
Tsosie	B	Jan-Dec	---	---	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
281:									
Carjo	C	Jan-Dec	---	---	---	---	None	---	None
282:									
Tocal	C	Jan-Dec	---	---	---	---	None	---	None
283:									
Mirand	D	Jan-Dec	---	---	---	---	None	---	None
Alanos	C	Jan-Dec	---	---	---	---	None	---	None
290:									
Alanos	B	Jan-Dec	---	---	---	---	None	---	None
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
300:									
Waumac	B	Jan-Dec	---	---	---	---	None	---	None
Bamac	A	Jan-Dec	---	---	---	---	None	---	None
301:									
Vastine	B	March	1.0-3.0	>6.0	---	---	None	---	Rare
		April	1.0-3.0	>6.0	---	---	None	---	Rare
		May	1.0-3.0	>6.0	---	---	None	---	Rare
		June	---	---	---	---	None	---	Rare
		July	---	---	---	---	None	---	Rare
		August	---	---	---	---	None	---	Rare
Jarola	C	March	1.0-3.0	>6.0	---	---	None	---	Rare
		April	1.0-3.0	>6.0	---	---	None	---	Rare
		May	1.0-3.0	>6.0	---	---	None	---	Rare
		June	1.0-3.0	>6.0	---	---	None	---	Rare
		July	---	---	---	---	None	---	Rare
		August	---	---	---	---	None	---	Rare
302:									
Tranquilar	C	March	1.5-4.0	>6.0	---	---	None	---	None
		April	1.5-4.0	>6.0	---	---	None	---	None
		May	1.5-4.0	>6.0	---	---	None	---	None
		June	1.5-4.0	>6.0	---	---	None	---	None
		July	1.5-4.0	>6.0	---	---	None	---	None
Jarmillo	B	Jan-Dec	---	---	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
304:									
Cosey	B	Jan-Dec	---	---	---	---	None	---	None
Jarmillo	B	Jan-Dec	---	---	---	---	None	---	None
307:									
Flugle	B	Jan-Dec	---	---	---	---	None	---	None
Waumac	B	Jan-Dec	---	---	---	---	None	---	None
308:									
Cajete	B	Jan-Dec	---	---	---	---	None	---	None
311:									
Cosey	B	Jan-Dec	---	---	---	---	None	---	None
Tranquilar	C	March	1.5-4.0	>6.0	---	---	None	---	None
		April	1.5-4.0	>6.0	---	---	None	---	None
		May	1.5-4.0	>6.0	---	---	None	---	None
		June	1.5-4.0	>6.0	---	---	None	---	None
		July	1.5-4.0	>6.0	---	---	None	---	None
Calaveras	B	Jan-Dec	---	---	---	---	None	---	None
312:									
Royosa	A	Jan-Dec	---	---	---	---	None	---	None
314:									
Fragua	B	Jan-Dec	---	---	---	---	None	---	None
Waumac	B	Jan-Dec	---	---	---	---	None	---	None
Royosa	A	Jan-Dec	---	---	---	---	None	---	None
317:									
Elpedro	B	Jan-Dec	---	---	---	---	None	---	None
319:									
Bamac	A	Jan-Dec	---	---	---	---	None	---	None
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None

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Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
320:									
Sparham	D	July	---	---	---	---	None	Brief	Occasional
		August	---	---	---	---	None	Brief	Occasional
		September	---	---	---	---	None	Brief	Occasional
		October	---	---	---	---	None	Brief	Occasional
321:									
Waumac	B	Jan-Dec	---	---	---	---	None	---	None
Royosa	A	Jan-Dec	---	---	---	---	None	---	None
322:									
Fragua	B	Jan-Dec	---	---	---	---	None	---	None
324:									
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
Atarque	D	Jan-Dec	---	---	---	---	None	---	None
Menefee	D	Jan-Dec	---	---	---	---	None	---	None
325:									
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
Espiritu	B	Jan-Dec	---	---	---	---	None	---	None
Vessilla	D	Jan-Dec	---	---	---	---	None	---	None
342:									
Waumac	B	Jan-Dec	---	---	---	---	None	---	None
Vessilla	D	Jan-Dec	---	---	---	---	None	---	None
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
345:									
Espiritu	B	Jan-Dec	---	---	---	---	None	---	None
Bamac	A	Jan-Dec	---	---	---	---	None	---	None
346:									
Espiritu, cobbly	B	Jan-Dec	---	---	---	---	None	---	None
Bamac	A	Jan-Dec	---	---	---	---	None	---	None

12119 : 97127

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
348:									
Wauquie	B	Jan-Dec	---	---	---	---	None	---	None
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
353:									
Cochiti	C	Jan-Dec	---	---	---	---	None	---	None
Espiritu	B	Jan-Dec	---	---	---	---	None	---	None
354:									
Waumac, variant	D	Jan-Dec	---	---	---	---	None	---	None
358:									
Deama	D	Jan-Dec	---	---	---	---	None	---	None
Elpedro	B	Jan-Dec	---	---	---	---	None	---	None
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
396:									
Atarque	D	Jan-Dec	---	---	---	---	None	---	None
Menefee	D	Jan-Dec	---	---	---	---	None	---	None
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
397:									
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
Cucho	C	Jan-Dec	---	---	---	---	None	---	None
Vessilla	D	Jan-Dec	---	---	---	---	None	---	None
398:									
Espiritu	B	Jan-Dec	---	---	---	---	None	---	None
Cucho	C	Jan-Dec	---	---	---	---	None	---	None
399:									
Cucho	C	Jan-Dec	---	---	---	---	None	---	None
Teco	C	Jan-Dec	---	---	---	---	None	---	None

071128

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
405:									
Charo	C	Jan-Dec	---	---	---	---	None	---	None
Charo, noncobbly	C	Jan-Dec	---	---	---	---	None	---	None
409:									
Santa Fe	D	Jan-Dec	---	---	---	---	None	---	None
410:									
Zia	B	Jan-Dec	---	---	---	---	None	---	None
414:									
Wauquie	B	Jan-Dec	---	---	---	---	None	---	None
417:									
Jocity	B	March	---	---	---	---	None	---	Rare
		April	4.0-6.0	>6.0	---	---	None	---	Rare
		May	4.0-6.0	>6.0	---	---	None	---	Rare
		June	4.0-6.0	>6.0	---	---	None	---	Rare
		July	4.0-6.0	>6.0	---	---	None	---	Rare
		August	4.0-6.0	>6.0	---	---	None	---	Rare
		September	4.0-6.0	>6.0	---	---	None	---	None
		October	4.0-6.0	>6.0	---	---	None	---	None
418:									
Jocity	B	March	---	---	---	---	None	---	Rare
		April	4.0-6.0	>6.0	---	---	None	---	Rare
		May	4.0-6.0	>6.0	---	---	None	---	Rare
		June	4.0-6.0	>6.0	---	---	None	---	Rare
		July	4.0-6.0	>6.0	---	---	None	---	Rare
		August	4.0-6.0	>6.0	---	---	None	---	Rare
		September	4.0-6.0	>6.0	---	---	None	---	None
		October	4.0-6.0	>6.0	---	---	None	---	None
419:									
Santa Fe	D	Jan-Dec	---	---	---	---	None	---	None
Wauquie	B	Jan-Dec	---	---	---	---	None	---	None
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
420:									
Pinavetes	A	Jan-Dec	---	---	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
421:									
Gilco, moderately saline, sodic	B	March	---	---	---	---	None	---	Rare
		April	4.0-6.0	>6.0	---	---	None	---	Rare
		May	4.0-6.0	>6.0	---	---	None	---	Rare
		June	4.0-6.0	>6.0	---	---	None	---	Rare
		July	4.0-6.0	>6.0	---	---	None	---	Rare
		August	4.0-6.0	>6.0	---	---	None	---	Rare
		September	4.0-6.0	>6.0	---	---	None	---	None
		October	4.0-6.0	>6.0	---	---	None	---	None
422:									
Vessilla	D	Jan-Dec	---	---	---	---	None	---	None
Menefee	D	Jan-Dec	---	---	---	---	None	---	None
Orlie	C	Jan-Dec	---	---	---	---	None	---	None
423:									
Gilco	B	March	---	---	---	---	None	---	Rare
		April	4.0-6.0	>6.0	---	---	None	---	Rare
		May	4.0-6.0	>6.0	---	---	None	---	Rare
		June	4.0-6.0	>6.0	---	---	None	---	Rare
		July	4.0-6.0	>6.0	---	---	None	---	Rare
		August	4.0-6.0	>6.0	---	---	None	---	Rare
		September	4.0-6.0	>6.0	---	---	None	---	None
		October	4.0-6.0	>6.0	---	---	None	---	None
426:									
Aga, moderately saline, sodic	B	March	---	---	---	---	None	---	Rare
		April	4.0-6.0	>6.0	---	---	None	---	Rare
		May	4.0-6.0	>6.0	---	---	None	---	Rare
		June	4.0-6.0	>6.0	---	---	None	---	Rare
		July	4.0-6.0	>6.0	---	---	None	---	Rare
		August	4.0-6.0	>6.0	---	---	None	---	Rare
		September	4.0-6.0	>6.0	---	---	None	---	None
		October	4.0-6.0	>6.0	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
427:									
Aga	B	March	---	---	---	---	None	---	Rare
		April	3.5-5.0	>6.0	---	---	None	---	Rare
		May	3.5-5.0	>6.0	---	---	None	---	Rare
		June	3.5-5.0	>6.0	---	---	None	---	Rare
		July	3.5-5.0	>6.0	---	---	None	---	Rare
		August	3.5-5.0	>6.0	---	---	None	---	Rare
		September	3.5-5.0	>6.0	---	---	None	---	None
		October	3.5-5.0	>6.0	---	---	None	---	None
428:									
Aga, moderately saline, sodic	B	March	---	---	---	---	None	---	Rare
		April	4.0-6.0	>6.0	---	---	None	---	Rare
		May	4.0-6.0	>6.0	---	---	None	---	Rare
		June	4.0-6.0	>6.0	---	---	None	---	Rare
		July	4.0-6.0	>6.0	---	---	None	---	Rare
		August	4.0-6.0	>6.0	---	---	None	---	Rare
		September	4.0-6.0	>6.0	---	---	None	---	None
		October	4.0-6.0	>6.0	---	---	None	---	None
430:									
Trail	A	March	---	---	---	---	None	---	Rare
		April	---	---	---	---	None	---	Rare
		May	---	---	---	---	None	---	Rare
		June	---	---	---	---	None	---	Rare
		July	---	---	---	---	None	---	Rare
		August	---	---	---	---	None	---	Rare
		Jan-Dec	---	---	---	---	None	---	None
431:									
Trail	A	March	---	---	---	---	None	---	Rare
		April	---	---	---	---	None	---	Rare
		May	---	---	---	---	None	---	Rare
		June	---	---	---	---	None	---	Rare
		July	---	---	---	---	None	---	Rare
		August	---	---	---	---	None	---	Rare
		Jan-Dec	---	---	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
433:									
Peralta	C	March	2.0-3.0	>6.0	---	---	None	---	Rare
		April	2.0-3.0	>6.0	---	---	None	---	Rare
		May	2.0-3.0	>6.0	---	---	None	---	Rare
		June	2.0-3.0	>6.0	---	---	None	---	Rare
		July	2.0-3.0	>6.0	---	---	None	---	Rare
		August	2.0-3.0	>6.0	---	---	None	---	Rare
		September	2.0-3.0	>6.0	---	---	None	---	None
		October	2.0-3.0	>6.0	---	---	None	---	None
434:									
Peralta	C	March	2.0-3.0	>6.0	---	---	None	---	Rare
		April	2.0-3.0	>6.0	---	---	None	---	Rare
		May	2.0-3.0	>6.0	---	---	None	---	Rare
		June	2.0-3.0	>6.0	---	---	None	---	Rare
		July	2.0-3.0	>6.0	---	---	None	---	Rare
		August	2.0-3.0	>6.0	---	---	None	---	Rare
		September	2.0-3.0	>6.0	---	---	None	---	None
		October	2.0-3.0	>6.0	---	---	None	---	None
437:									
Peralta, moderately saline, sodic	C	March	2.0-3.0	>6.0	---	---	None	---	Rare
		April	2.0-3.0	>6.0	---	---	None	---	Rare
		May	2.0-3.0	>6.0	---	---	None	---	Rare
		June	2.0-3.0	>6.0	---	---	None	---	Rare
		July	2.0-3.0	>6.0	---	---	None	---	Rare
		August	2.0-3.0	>6.0	---	---	None	---	Rare
		September	2.0-3.0	>6.0	---	---	None	---	None
		October	2.0-3.0	>6.0	---	---	None	---	None
500:									
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
Osha	B	Jan-Dec	---	---	---	---	None	---	None
Rubble Land	A	Jan-Dec	---	---	---	---	None	---	None
503:									
Cajete	B	Jan-Dec	---	---	---	---	None	---	None
Cypher	D	Jan-Dec	---	---	---	---	None	---	None
504:									
Orejas	D	Jan-Dec	---	---	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
504:									
Guaje	D	Jan-Dec	---	---	---	---	None	---	None
600:									
Rock outcrop	D	Jan-Dec	---	---	---	---	None	---	None
Cypher	D	Jan-Dec	---	---	---	---	None	---	None
601:									
Laventana	B	Jan-Dec	---	---	---	---	None	---	None
603:									
Laventana	B	Jan-Dec	---	---	---	---	None	---	None
Mirand	D	Jan-Dec	---	---	---	---	None	---	None
604:									
Cypher	D	Jan-Dec	---	---	---	---	None	---	None
Mirand	D	Jan-Dec	---	---	---	---	None	---	None
608:									
Osha, steep	B	Jan-Dec	---	---	---	---	None	---	None
Osha	B	Jan-Dec	---	---	---	---	None	---	None
823:									
Gilco, unprotected	B	March	---	---	---	---	None	---	Rare
		April	4.0-6.0	>6.0	---	---	None	---	Rare
		May	4.0-6.0	>6.0	---	---	None	---	Rare
		June	4.0-6.0	>6.0	---	---	None	---	Rare
		July	4.0-6.0	>6.0	---	---	None	---	Rare
		August	4.0-6.0	>6.0	---	---	None	---	Rare
		September	4.0-6.0	>6.0	---	---	None	---	None
		October	4.0-6.0	>6.0	---	---	None	---	None
827:									
Aga, unprotected	B	March	---	---	---	---	None	---	Rare
		April	3.5-5.0	>6.0	---	---	None	---	Rare
		May	3.5-5.0	>6.0	---	---	None	---	Rare
		June	3.5-5.0	>6.0	---	---	None	---	Rare
		July	3.5-5.0	>6.0	---	---	None	---	Rare
		August	3.5-5.0	>6.0	---	---	None	---	Rare
		September	3.5-5.0	>6.0	---	---	None	---	None
		October	3.5-5.0	>6.0	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
830:									
Trail, unprotected--------	A	March	---	---	---	---	None	---	Rare
		April	4.0-6.0	>6.0	---	---	None	---	Rare
		May	4.0-6.0	>6.0	---	---	None	---	Rare
		June	4.0-6.0	>6.0	---	---	None	---	Rare
		July	4.0-6.0	>6.0	---	---	None	---	Rare
		August	4.0-6.0	>6.0	---	---	None	---	Rare
		September	4.0-6.0	>6.0	---	---	None	---	None
		October	4.0-6.0	>6.0	---	---	None	---	None
831:									
Trail, unprotected--------	A	March	---	---	---	---	None	---	Rare
		April	4.0-6.0	>6.0	---	---	None	---	Rare
		May	4.0-6.0	>6.0	---	---	None	---	Rare
		June	4.0-6.0	>6.0	---	---	None	---	Rare
		July	4.0-6.0	>6.0	---	---	None	---	Rare
		August	4.0-6.0	>6.0	---	---	None	---	Rare
		September	4.0-6.0	>6.0	---	---	None	---	None
		October	4.0-6.0	>6.0	---	---	None	---	None
835:									
Peralta, unprotected------	C	March	2.0-3.0	>6.0	---	---	None	---	None
		April	2.0-3.0	>6.0	---	---	None	Long	Occasional
		May	2.0-3.0	>6.0	---	---	None	Long	Occasional
		June	2.0-3.0	>6.0	---	---	None	Long	Occasional
		July	2.0-3.0	>6.0	---	---	None	---	None
		August	2.0-3.0	>6.0	---	---	None	---	None
		September	2.0-3.0	>6.0	---	---	None	---	None
		October	2.0-3.0	>6.0	---	---	None	---	None
842:									
Peralta, moderately saline, sodic, unprotected----------	C	March	2.0-3.0	>6.0	---	---	None	---	Rare
		April	2.0-3.0	>6.0	---	---	None	---	Rare
		May	2.0-3.0	>6.0	---	---	None	---	Rare
		June	2.0-3.0	>6.0	---	---	None	---	Rare
		July	2.0-3.0	>6.0	---	---	None	---	Rare
		August	2.0-3.0	>6.0	---	---	None	---	Rare
		September	2.0-3.0	>6.0	---	---	None	---	None
		October	2.0-3.0	>6.0	---	---	None	---	None

Table 18.--Water features--continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.	Ft.				
850:									
Water	---	Jan-Dec	---	---	---	---	None	---	None
DAM:									
Dam	---	Jan-Dec	---	---	---	---	None	---	None

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Table 19.--Taxonomic classification of the soils

(An asterisk in the first column indicates a taxadjunct to the series. See text for a description of those characteristics that are outside the range of the series.)

Soil name	Family or higher taxonomic class
Aga	Coarse-loamy over sandy or sandy-skeletal, mixed, calcareous, mesic Typic Torrifluvents
Alanos	Clayey-skeletal, mixed Typic Eutroboralfs
Atarque	Loamy, mixed, mesic Lithic Haplustalfs
Bamac	Sandy-skeletal, mixed, mesic Typic Ustorthents
Betonnie	Coarse-loamy, mixed, mesic Ustalfic Haplargids
Blancot	Fine-loamy, mixed, mesic Ustalfic Haplargids
Bond	Loamy, mixed, mesic Lithic Ustollic Haplargids
Cajete	Ashy-skeletal, frigid Mollic Vitrandepts
Calaveras	Loamy-skeletal, mixed, frigid Dystric Eutrochrepts
Camino	Fine, mixed, mesic Ustollic Camborthids
Carjo	Fine, mixed Mollic Eutroboralfs
Cascajo	Sandy-skeletal, mixed, mesic Ustollic Calciorthids
Charo	Fine, mixed Typic Argiborolls
Clovis	Fine-loamy, mixed, mesic Ustollic Haplargids
Cochiti	Clayey-skeletal, mixed, mesic Aridic Haplustalfs
Cosey	Loamy-skeletal, mixed Typic Paleborolls
Councelor	Coarse-loamy, mixed, calcareous, mesic Ustic Torriorthents
Cucho	Fine-silty, mixed, calcareous, mesic Typic Ustorthents
Cypher	Loamy-skeletal, mixed, frigid Lithic Ustochrepts
Deama	Loamy-skeletal, carbonatic, mesic Lithic Calciustolls
Doakum	Fine-loamy, mixed, mesic Ustalfic Haplargids
El Rancho	Fine-loamy, mixed, calcareous, mesic Ustic Torriorthents
Elpedro	Fine-silty, mixed, mesic Aridic Haplustalfs
Embudo	Coarse-loamy, mixed, mesic Typic Camborthids
Eslendo	Loamy, mixed, calcareous, mesic, shallow Ustic Torriorthents
Espiritu	Loamy-skeletal, mixed, mesic Aridic Haplustalfs
Ess	Loamy-skeletal, mixed Argic Cryoborolls
Flugle	Fine-loamy, mixed, mesic Aridic Haplustalfs
Fragua	Coarse-loamy, mixed, mesic Aridic Haplustalfs
Frijoles	Loamy-skeletal over fragmental, mixed, mesic Aridic Haplustalfs
Galisteo	Fine, mixed, calcareous, mesic Ustic Torriorthents
Gilco	Coarse-loamy, mixed, calcareous, mesic Typic Torrifluvents
*Gilco	Coarse-loamy, mixed, calcareous, mesic Typic Torrifluvents
Grieta	Fine-loamy, mixed, mesic Typic Haplargids
Guaje	Medial-skeletal, mesic Aridic Ustochrepts
Hackroy	Clayey, mixed, mesic Lithic Haplustalfs
Hagerman	Fine-loamy, mixed, mesic Ustollic Haplargids
Harvey	Fine-loamy, mixed, mesic Ustollic Calciorthids
Hickman	Fine-loamy, mixed, calcareous, mesic Typic Ustifluvents
Ildefonso	Loamy-skeletal, mixed, mesic Ustollic Calciorthids
Jarmillo	Coarse-loamy, mixed Pachic Haploborolls
Jarola	Fine-loamy, mixed, frigid Typic Argialbolls
Jemez	Fine-loamy, mixed Mollic Eutroboralfs
Jocity	Fine-loamy, mixed, calcareous, mesic Typic Torrifluvents
La Fonda	Fine-loamy, mixed, mesic Ustollic Camborthids
Laventana	Loamy-skeletal, mixed Mollic Eutroboralfs
Lybrook	Fine, mixed, calcareous, mesic Ustic Torriorthents
Menefee	Loamy, mixed, calcareous, mesic, shallow Typic Ustorthents
Mespun	Mixed, mesic Ustic Torripsamments
Mirand	Fine, mixed Mollic Eutroboralfs
Montecito	Fine, mixed, mesic Aridic Haplustalfs
Nyjack	Fine-loamy, mixed, mesic Aridic Haplustalfs
Orejas	Clayey-skeletal, mixed, mesic Lithic Haplustalfs
Origo	loamy-skeletal, mixed Psammentic Cryoboralfs
Orlie	Fine-loamy, mixed, mesic Aridic Haplustalfs
Osha	Loamy-skeletal, mixed Typic Haploborolls
Palon	loamy-skeletal, mixed Psammentic Eutroboralfs
Pastura	Loamy, mixed, mesic, shallow Ustollic Paleorthids
Pavo	Fine-loamy, mixed Cryic Paleborolls
Penistaja	Fine-loamy, mixed, mesic Ustollic Haplargids

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Table 19.--Taxonomic classification of the soils--continued

Soil name	Family or higher taxonomic class
Peralta	Coarse-loamy, mixed, calcareous, mesic Typic Ustifluvents
Pinavetes	Mixed, mesic Ustic Torripsamments
Pinitos	Fine-loamy, mixed, mesic Aridic Haplustalfs
Placitas	Loamy-skeletal, mixed, mesic Ustollic Calciorthids
Poley	Fine, mixed, mesic Ustollic Haplargids
Prieta	Clayey-skeletal, mixed, mesic Lithic Ustollic Haplargids
Querencia	Fine-loamy, mixed, mesic Ustollic Camborthids
Redondo	Loamy-skeletal, mixed Typic Cryoboralfs
Royosa	Mixed, mesic Typic Ustipsamments
Saido	Coarse-silty, gypsic, mesic Typic Gypsiorthids
San Mateo	Fine-loamy, mixed, calcareous, mesic Ustic Torrifluvents
Sandoval	Loamy, mixed, calcareous, mesic, shallow Ustic Torriorthents
Santa Fe	Loamy-skeletal, mixed, mesic Lithic Argiustolls
Sedgran	Sandy-skeletal, mixed, mesic Lithic Ustic Torriorthents
Sedillo	Loamy-skeletal, mixed, mesic Ustollic Haplargids
Sedmar	Sandy, mixed, frigid Lithic Ustorthents
Sheppard	Mixed, mesic Typic Torripsamments
Silver	Fine, mixed, mesic Ustollic Haplargids
Skyvillage	Loamy, mixed, calcareous, mesic Lithic Ustic Torriorthents
Sparank	Fine, mixed, calcareous, mesic Ustic Torrifluvents
Sparham	Fine, mixed, calcareous, mesic Typic Ustifluvents
*Sparham	Fine, mixed, calcareous, mesic Typic Ustifluvents
Stumble	Mixed, mesic Typic Torripsamments
Teco	Fine, mixed, mesic Aridic Haplustalfs
Tijeras	Fine-loamy, mixed, mesic Typic Haplargids
Tocal	Clayey, mixed Lithic Eutroboralfs
Totavi	Ashy, frigid Mollic Vitrandepts
Trail	Sandy, mixed, mesic Typic Torrifluvents
Tranquilar	Very-fine, montmorillonitic, frigid Typic Argialbolls
Tsosie	Fine-loamy, mixed, calcareous, mesic Ustic Torriorthents
Vastine	Fine-loamy over sandy or sandy-skeletal, mixed, frigid Typic Haplaquolls
Vessilla	Loamy, mixed, calcareous, mesic Lithic Ustorthents
Waumac	Coarse-loamy, mixed, calcareous, mesic Typic Ustorthents
Waumac Variant	Ashy-skeletal, mesic, shallow Typic Ustorthents
Wauquie	Loamy-skeletal, mixed, mesic Aridic Haplustalfs
Winona	Loamy-skeletal, carbonatic, mesic Lithic Ustollic Calciorthids
Witt	Fine-silty, mixed, mesic Ustollic Haplargids
Zia	Coarse-loamy, mixed, calcareous, mesic Ustic Torriorthents

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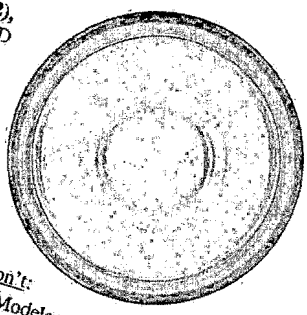
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Mortandad Canyon Investigation Report



Prepared by the Environmental Programs Directorate

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Mortandad Canyon Investigation Report

October 2006

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EXECUTIVE SUMMARY

This investigation report for Mortandad Canyon presents the results of studies conducted from 1998 to 2005 in Effluent, Mortandad, and Ten Site Canyons and in an unnamed tributary canyon that heads in Technical Area (TA) 05 of the Los Alamos National Laboratory (the Laboratory). Together these drainage systems comprise the Mortandad watershed. These canyons have received inorganic and organic chemicals and radionuclides since the Laboratory was established in 1943. Most of the contamination related to Laboratory releases is associated with effluent discharges, and discharges of contaminants have decreased over time. The investigations reported herein address sediment, surface water, groundwater, and biota potentially impacted by solid waste management units (SWMUs) and areas of concern (AOCs) located within the watershed. Investigations occurred along 18 km (11 mi) of canyon bottom downcanyon of SWMUs or AOCs. The objectives of the investigations included defining the nature and extent of chemicals of potential concern (COPCs) in sediment, surface water, and groundwater and assessing the potential risks to human health and the environment from these COPCs. The investigations also address the sources, fate, and transport of COPCs in the canyons and evaluate the need for additional characterization or remedial actions.

Sediment investigations included geomorphic mapping, associated geomorphic characterization, and sediment sampling in 27 investigation reaches located downcanyon from SWMUs or AOCs. Analytical data collected in this investigation are supplemented by data collected by the Laboratory's Environmental Surveillance Program and other Laboratory studies to aid in determining spatial and temporal trends in sediment contamination.

Surface water investigations included sampling of persistent water at nine locations in Effluent, Mortandad, and Ten Site Canyons, which are locations where water potentially occurs persistently enough to contribute to human health risks or to adverse ecological effects associated with potential chronic exposure. Surface water and groundwater sampling occurred concurrently in two sampling events to assess relations between these media and to characterize potential seasonal effects on hydrology and contaminant concentrations. Analytical data collected in this investigation are supplemented by Environmental Surveillance Program data to provide a longer period of record and a larger data set.

Groundwater investigations included installing nine alluvial wells, eight perched-intermediate groundwater wells and boreholes, and seven regional groundwater wells within the Mortandad watershed. Data from groundwater samples collected from these wells were supplemented with historical data from preexisting wells. Groundwater investigations also included surface and subsurface geophysical surveys, installation of piezometers, water-level measurements, vector probe and flux meter analyses, and analyses of core samples and vadose-zone pore water.

Sediment COPCs in the Mortandad watershed include 38 inorganic chemicals, 74 organic chemicals, and 17 radionuclides. Surface water and groundwater COPCs include 62 inorganic chemicals, 42 organic chemicals, and 16 radionuclides. These COPCs are derived from a variety of sources, including Laboratory SWMUs and AOCs, runoff from developed areas, and naturally occurring soil, sediment, and bedrock. Assessments in this report focus on the subset of these COPCs considered most important for the evaluation of potential ecological or human health risk. The relative importance of the COPCs was determined by comparing COPC concentrations with human health screening action levels and soil screening levels, ecological screening levels, U.S. Environmental Protection Agency Region 6 and Region 9 tap water values, or U.S. Department of Energy-Derived Concentration Guidelines for drinking water. The sources of the COPCs are also considered in these assessments to determine whether they partially or largely represent Laboratory sources.

The spatial distribution of contaminants in the Mortandad watershed, supported by effluent discharge data, indicates that the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF) outfall into Effluent Canyon, which has been active since 1963, is the most important source of contamination with respect to potential human health risk and groundwater impacts. Source areas for Laboratory-derived COPCs that are most important in the assessment of potential ecological risk include TA-48 outfalls into the head of Effluent Canyon and into Mortandad Canyon, the TA-50 RLWTF outfall, and additional releases from TA-50 or TA-35 into the head of Ten Site Canyon. The impacts of additional Laboratory sources (e.g., outfalls from the former TA-35 wastewater treatment plant, wastewater lagoons, and filter beds) are indicated by the characterization data, although the concentrations, extent, and inventory of COPCs from these sources are generally minor compared with the sources listed above.

Contaminants in sediment and alluvial groundwater that were originally released from the TA-50 RLWTF outfall are largely or entirely restricted to approximately 4 km (2.5 mi) of canyon bottom downcanyon from the outfall. The infiltration of stormwater into alluvium, particularly upcanyon from the confluence of Mortandad and Ten Site Canyons, results in a complete loss of surface water in most runoff events and deposition of contaminated sediment. The most important sediment deposition area is in the 0.6 km (0.4 mi) of canyon bottom west of the confluence (reach M-3E), and approximately 50% of the inventory of most radionuclides in sediments occurs there. No floods have been recorded crossing the Laboratory-San-Ildefonso Pueblo boundary since RLWTF discharges began in 1963, and only one event before 1963 is recorded as having reached the Laboratory boundary in August 1952.

Contaminant concentrations in sediment, surface water, and alluvial groundwater in the Mortandad watershed have generally decreased over time, indicating that the initial SWMU and AOC sources are no longer major contributors to contamination in canyons media. The canyon bottom sediment deposits contain the largest inventory of adsorbed contaminants that are susceptible to remobilization and transport in floods and are now the primary source for ongoing surface water and alluvial groundwater contamination. Therefore, any future efforts that may be required to address contaminants in canyons media should address the current distribution of contaminants in sediment and associated groundwater rather than the original source areas at Laboratory outfalls.

In contrast, contaminant concentrations in deeper perched-intermediate or regional groundwater have increased over time, indicating the migration of mobile constituents from the alluvial zone into the vadose zone and into deeper zones of saturation. Vadose-zone pore water concentration profiles indicate that these mobile contaminants have percolated in the subsurface. Currently, the majority of the mass of the nonsorbing contaminants nitrate, perchlorate, and tritium is located within the vadose zone, particularly beneath the area near and just east of the confluence of Mortandad and Ten Site Canyons. Chromium is present in the regional aquifer in one characterization well (R-28) above groundwater standards, and chromium, nitrate, perchlorate, and tritium have been measured above groundwater standards in one or more perched-intermediate depth groundwater wells. Iron and manganese have also been measured above drinking water standards in regional groundwater in one well (R-14) and nickel in another well (R-33), although available data indicate that these results represent naturally occurring constituents and not Laboratory-derived contamination.

A baseline ecological risk assessment conducted as part of this investigation evaluates the potential for adverse effects by assessing risks to omnivorous mammals, insect-eating birds, plants, earthworms, aquatic invertebrates, algae, and two threatened and endangered species: the Mexican spotted owl and the southwestern willow flycatcher. Multiple lines of evidence were used to evaluate potential adverse effects on these ecological receptors. Ecological effects data were collected using small-mammal trapping arrays, a cavity-nesting bird monitoring network, seedling germination tests, earthworm mortality tests, and sediment and water toxicity tests. The assessment lines of evidence are augmented by

breeding-bird field surveys, plant surveys, habitat analyses, and spatial modeling of wildlife exposure. The weight of evidence that these investigations provide indicates that no adverse effects to terrestrial and aquatic receptors exist from COPCs in the Mortandad watershed.

The site-specific human health risk assessment uses a trail-user exposure scenario to represent the present-day and reasonably foreseeable future land use in canyons throughout the Mortandad watershed. The assessment results indicate that for the trail-user scenario, no areas in the Mortandad watershed have contaminant concentrations greater than levels acceptable for noncarcinogens (hazard index of 1) or carcinogens (incremental cancer risk criterion of 1×10^{-5}) in sediment or water. However, the radionuclide dose for one area, reach E-1E in Effluent Canyon downcanyon from the TA-50 RLWTF outfall, exceeds the target dose limit of 15 mrem/yr. The calculated dose for reach E-1E, 52 mrem/yr (corresponding to a radiological risk of approximately 2×10^{-4}), is primarily related to external gamma radiation from cesium-137 in sediment. The radionuclide dose limit of 4 mrem/yr in water was not exceeded at any location. Reach E-1E is a short, steep, and rocky area that has no developed trail within the contaminated area, and it is unlikely that recreational users of the Mortandad watershed use this reach as much as is assumed in the trail-user scenario (1 h/d and 200 d/yrr). Other protectively biased assumptions are incorporated into the exposure assessment, also contributing to an overestimate of potential dose. In addition, the area is currently posted as a "soil contamination area," and posting also states that "access is restricted to workers on official business," further discouraging recreational use in reach E-1E. Therefore, no remedial action is proposed to reduce the potential radiation dose to recreational users of Effluent Canyon, although it is recommended that appropriate posting be maintained.

Evaluations of the changes in COPC concentrations over time for sediment, surface water, and alluvial groundwater indicate that concentrations are either relatively stable or are decreasing for contaminants derived from Laboratory SWMUs or AOCs. These decreases are associated with decreased concentrations in TA-50 RLWTF effluent and processes that remobilize, transport, and dilute sediment and waterborne constituents. Radioactive decay also contributes to decreasing concentrations for some radionuclides (e.g., cesium-137, strontium-90, and tritium). Therefore, the potential for impacts to human health or ecosystems from Laboratory-derived contaminants in these media is expected to continue to decrease.

Potential future changes in the vadose-zone contamination and concentrations of contaminants in perched-intermediate and regional groundwater are less well constrained, and a corrective measures evaluation (CME) is necessary to assess the need for remedial actions. The CME will assess the fate of the contaminant mass in the vadose zone and impacts to the regional groundwater where water-supply wells are located. A more detailed evaluation of chromium contamination in groundwater is currently in progress and will be addressed in pending reports to the New Mexico Environment Department. Monitoring in the Mortandad watershed will continue through the proposed CME process and is described in the Interim Facility-Wide Groundwater Monitoring Plan.

In summary, the results of this investigation indicate that human health risks are acceptable for present-day and foreseeable future land uses, assuming that recreational use of Effluent Canyon below the TA-50 RLWTF outfall continues to be discouraged. In addition, no adverse ecological effects were observed within terrestrial and aquatic systems in the Mortandad watershed. Therefore, corrective actions are not needed to mitigate unacceptable risks. However, a CME is proposed to address contamination in groundwater.

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1.0 INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) is a multidisciplinary research facility owned by the U.S. Department of Energy (DOE). The Laboratory is located in north-central New Mexico, approximately 90 km (60 mi) northeast of Albuquerque and 30 km (20 mi) northwest of Santa Fe. The Laboratory is currently investigating sites potentially contaminated by past operations to ensure that contaminants do not threaten human health or the environment. The sites under investigation are designated as solid waste management units (SWMUs) or areas of concern (AOCs). Contamination in canyon bottoms and in groundwater is being investigated on a watershed basis between the sources and the Rio Grande, the master drainage in the region, in addition to investigations at individual SWMUs and AOCs.

1.1 Purpose and Scope

This investigation report presents the results of studies conducted from 1998 to 2005 in Mortandad, Effluent, and Ten Site Canyons, and an unnamed tributary to Mortandad Canyon that heads in Technical Area (TA) 05 of the Laboratory. This area is collectively referred to in this report as the Mortandad watershed. The Mortandad watershed above its confluence with the Rio Grande also includes Cañada del Buey and Cedro Canyon, but these canyons are not addressed in this report. Cañada del Buey will be the subject of future investigations under the "Work Plan for Sandia Canyon and Cañada del Buey" (LANL 1999, 64617), and Cedro Canyon is located entirely on San Ildefonso Pueblo land and contains no SWMUs or AOCs. The portion of Mortandad Canyon east of New Mexico State Road (SR) 4 is also not addressed in this report for surface water or sediments because no evidence of contaminant transport past this point has been found (as discussed in Section 7.1.1.6 and in Reneau et al. 2003, 77103). Figure 1.1-1 shows the entire Mortandad watershed and the primary subwatersheds or basins, and Figure 1.1-2 shows more detail within the primary investigation area. The investigations reported herein address sediment, surface water, groundwater, and biota potentially impacted by SWMUs and AOCs located within the Mortandad watershed. These media are collectively referred to as canyons media in this report.

The investigations were conducted to fulfill the requirements of several documents. The "Work Plan for Mortandad Canyon" (hereafter, "the Mortandad Canyon work plan" or "the work plan") (LANL 1997, 56835) describes work scope and regulatory requirements for characterizing the Mortandad watershed for the former Environmental Restoration (ER) Project. It contains a background review of SWMUs and AOCs in the watershed, the history of releases, and a review of contaminant data collected before the work plan was prepared. The New Mexico Environment Department (NMED) approved the work plan in 2002 following the Laboratory's response to a request for supplemental information (RSI) (LANL 1999, 62777; NMED 2002, 73830). The requirement to implement the work plan was also included by reference in Section IV.B.2 ("Mortandad Canyon Watershed") of the Compliance Order on Consent (hereafter, the Consent Order), signed by NMED, DOE, the Regents of the University of California, and the State of New Mexico Attorney General on March 1, 2005.

The investigations conducted for the work plan also followed the technical strategy presented in the "Core Document for Canyons Investigations" (hereafter, "the canyons core document") (LANL 1997, 55622; LANL 1998, 57666). The canyons core document was prepared after a pilot study in Los Alamos and Pueblo Canyons was implemented in 1996, with the goal of standardizing the technical strategy for work in canyons. In 1988, NMED approved the core document following the Laboratory's response to an RSI (LANL 1998, 57666; NMED 1998, 58638).

Two additional documents have been prepared to supplement the work plan. The "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613), approved by NMED in 2004 (NMED 2004,

84463), was prepared to meet requirements in the then-draft Consent Order. This plan replaces the approach and scope of the groundwater and surface water investigations contained in the work plan. The "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308), approved by NMED in 2005 (NMED 2005, 92084), provides a detailed biota sampling and characterization plan for the Mortandad watershed. This plan satisfies the requirement in the work plan to prepare a biological sampling plan for the Mortandad watershed.

Results of investigations of intermediate and regional groundwater beneath the Mortandad watershed described in the Laboratory's "Hydrogeologic Workplan" (LANL 1998, 59599) are also included in this report. Results of an investigation of chromium contamination in groundwater beneath the Mortandad watershed (LANL 2006, 91987) are not included in this report and will instead be reported in an interim measures report scheduled to be completed in November 2006.

Data collected during the investigations included in this report are used to describe the nature and extent of contamination within the canyon bottom and in groundwater beneath the Mortandad watershed; to update the conceptual model for contaminant distribution and transport within the canyons and underlying groundwater; to assess present-day human health and ecological risk from contaminants within the canyons; to determine and recommend potential remedial actions, if needed, that may be appropriate to achieve or maintain site conditions at an acceptable risk level; and to provide support for decisions at SWMUs and AOCs. The assessments in this report are conducted using data collected since 1998 by the former ER Project to evaluate current environmental conditions. Data from prior investigations and from environmental surveillance sampling are used to help identify temporal trends in contamination and therefore help evaluate how potential risk may change in the future relative to present-day conditions.

This report addresses characterization and risk assessment on the spatial scale of an entire canyon system, encompassing approximately 18 km (11 mi) of canyon bottom downstream of SWMUs and AOCs. The characterization and assessment approach used in this investigation provides an integrating perspective on historical and current contaminant releases to the canyon floor and subsequent contaminant redistribution resulting from various transport processes. This approach facilitates the development of conceptual models that describes expected spatial and temporal trends in contaminant concentrations and inventory, thus supporting recommendations for long-term monitoring. The results also support the Laboratory's watershed approach by providing information on the extent of contamination associated with SWMUs and AOCs and SWMU and AOC aggregates in the watershed and by helping identify and prioritize remedial activities within the watershed. Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to NMED in accordance with DOE policy.

1.2 Organization of Investigation Report

This investigation report has the following sections. The outline follows a format approved by NMED on June 13, 2006 (Goering 2006, 93028). Section 1 is an introduction to the report and to the Mortandad watershed. Section 2 provides background information on the sources and history of contaminant releases, previous investigations of canyons media, and remediation activities that have occurred in the watershed. Section 3 describes the scope of activities in this investigation. Section 4 introduces the field investigations. Section 5 describes the regulatory context of this investigation. Section 6 presents screening-level assessments that identify chemicals of potential concern (COPCs) and that help focus subsequent sections on the subset of the most important COPCs for evaluating potential human health risk. Section 7 presents a physical system conceptual model, including discussions of the nature, sources, extent, fate, and transport of select COPCs that are most relevant for evaluating potential human health and ecological risk and contaminant transport. Section 8 presents baseline ecological and human

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health risk results and assessments. Section 9 presents conclusions and recommendations. Section 10 presents references cited in this report.

This report has the following appendixes. Appendix A provides a list of acronyms and abbreviations and a table showing conversion of metric units to U.S. customary units. Appendix B presents field investigation methods and results. Analytical results from this investigation are contained on a compact disk and are included as Appendix C. Appendix D presents supporting information on contaminant trends and inventory. Appendix E presents supporting information on statistics and risk. Appendix F presents an alluvial water-level study. Appendix G discusses subunit variability within alluvium, colluvium, and in the Cerro Toledo interval as it pertains to subsurface hydrology. Appendix H presents results of a resistivity study. Appendix I presents documentation of techniques used in the earthVision model. Appendix J discusses constraints on saturated thickness and lateral extent of perched-intermediate water beneath the Mortandad watershed. Appendix K presents the screening results of stormwater data collected at gage stations in the Mortandad watershed. Appendix L presents an analysis of temporal variability in water-levels observed at the intermediate-depth boreholes in the Mortandad watershed and its relation to surface flow events and barometric pressure changes. Preliminary infiltration investigation results are discussed in Appendix M. Appendix N presents an analysis of spatial variability of the regional water table and generation of a contour map of the water-table elevation. In Appendix O, variability in the regional water table elevation near the Mortandad Canyon is analyzed. Appendix P presents an analysis of variability in the pumping rate and hydraulic heads at the water-supply wells near the Mortandad Canyon.

1.3 Watershed Description

The portion of the Mortandad watershed addressed in this report includes Mortandad Canyon west of SR 4, Effluent Canyon, Ten Site Canyon, and an unnamed tributary canyon that heads in TA-05 (Figure 1.1-2). The watershed heads on the Pajarito Plateau on Laboratory land in TA-03, at an elevation of approximately 2255 m (7400 ft) above sea level (asl), and extends approximately 11 km (7 mi) to SR 4 on San Ildefonso Pueblo land at an elevation of approximately 1965 m (6450 ft) asl, approximately 5 km (3 mi) upcanyon from the Rio Grande. The watershed upcanyon of SR4 has a drainage area of 8.4 km^2 (3.3 mi^2), of which 60% is on Laboratory land and the remaining 40% is on San Ildefonso Pueblo land. Effluent Canyon heads in TA-48 and has a length of approximately 0.8 km (0.5 mi) and a drainage area of 0.3 km^2 (0.1 mi^2), entirely on Laboratory land. Ten Site Canyon heads in TA-50 and has a length of approximately 2.9 km (1.8 mi) and a drainage area of 0.9 km^2 (0.3 mi^2), entirely on Laboratory land. Ten Site Canyon includes a short tributary, referred to as Pratt Canyon, which heads in TA-35. The unnamed tributary canyon that heads in TA-05 has a length of approximately 2.8 km (1.7 mi) and a drainage area of 1.4 km^2 (0.6 mi^2), of which 41% is on Laboratory land and the remaining 59% is on San Ildefonso Pueblo land.

Bedrock geologic units exposed within Mortandad Canyon and tributary canyons upcanyon from SR 4 consist of Quaternary ignimbrites of the Otowi and Tshirege Members of the Bandelier Tuff. Pliocene basaltic rocks of the Cerros del Rio volcanic field and underlying geologic units are exposed farther downcanyon toward the Rio Grande (Griggs 1964, 8795; Smith et al. 1970, 9752; Dethier 1997, 49843; Gardner et al. 1999, 63492; Lavine et al. 2003, 92527). Geologic units within the watershed are discussed in more detail in Section 7 of this report.

A comprehensive overview of the biological setting of the Mortandad watershed is provided in the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308). Details on the hydrology are provided in Section 7 and Appendix B of this report.

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1.4 Current Land Use

The portion of the Mortandad watershed addressed in this report is located on DOE and San Ildefonso Pueblo lands. Currently, no active Laboratory operations occur in the canyon, except for environmental work such as sediment and water sampling and the discharge of effluent from five National Pollutant Discharge Elimination System (NPDES)-permitted outfalls (Figure 1.1-2 and Plate 1). NPDES outfall 051 discharges treated radioactive effluent from the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF) into Effluent Canyon. NPDES outfall 03A181 discharges treated cooling water from TA-55 into Effluent Canyon upcanyon from the RLWTF outfall. NPDES outfall 03A021 discharges treated cooling water from TA-03 into the head of Mortandad Canyon. NPDES outfall 03A022 discharges treated cooling water from TA-03 into the upper part of Mortandad Canyon. NPDES outfall 03A160 discharges treated cooling water from TA-50 into the upper part of Ten Site Canyon. There is currently no public access to the watershed on Laboratory land, although trails in the canyons are used by Laboratory personnel for recreational activities such as hiking, running, and bike riding. The portion of the Mortandad watershed on San Ildefonso Pueblo land is undeveloped and is used for traditional activities, including hunting and wood gathering.

2.0 BACKGROUND

Inorganic chemicals, organic chemicals, and radionuclides have been released into the Mortandad watershed from a variety of sources, primarily Laboratory operations in several TAs, since the Laboratory was established in 1943. Most of the contamination related to Laboratory releases is associated with effluent discharges, and releases of contaminants and radionuclides have decreased over time due to improvements in wastewater treatment processes and decreased effluent volumes. The contaminants and radionuclides have been dispersed downcanyon from their release sites in sediments, surface water, and alluvial groundwater. Subsequently, waterborne constituents have percolated into the subsurface and are observed in vadose-zone pore water. Some nonsorbing species are present in intermediate-perched water and in regional groundwater as well. The following sections summarize the sources and history of contaminant and radionuclide releases as well as investigations that address constituent distribution and concentration in canyons media. Remediation activities implemented to reduce contamination in the canyon bottom or in source areas are also discussed.

2.1 Sources and History of Contaminant Releases

This section describes known releases of inorganic chemicals, organic chemicals, and radionuclides that have contributed to contamination within the Mortandad watershed.

2.1.1 TA-50

The Laboratory's RLWTF located at TA-50 began operations in July 1963, and water treatment continues today. The RLWTF discharges treated wastewater to Mortandad Canyon through Effluent Canyon through an outfall that is currently permitted as NPDES outfall 051 [SWMU 50-006(d)] (Plate 1). The largest amount of contamination and radionuclides released to the Mortandad watershed has come from this outfall, which is interchangeably referred to in the remainder of this document at the TA-50 outfall, the RLWTF outfall, or the TA-50 RLWTF outfall. Radioactive liquid waste is treated in Building 50-1 at the RLWTF and transferred to one of two 80,000-L holding tanks located in Building 50-2. When one of the tanks is full, the contents are discharged. Before discharge, the treated wastewater is sampled and tested for radiological and nonradiological constituents. The wastewater is recycled through the treatment plant

until the parameters in the NPDES permit are met. The holding tanks discharge in batches, taking about 30 min per batch. Currently, less than one batch per day is released.

Liquid discharge volumes and associated radionuclide and nitrate releases recorded for the RLWTF from 1963 to 2005 are summarized in Table 2.1-1. This information was collected as part of the historical monitoring of the outfall (LANL 2002, 71301; LANL 2005, 91523; LANL 2006, 93925). Discharge volumes have ranged from the recent low value of 6.8×10^6 L/yr in 2005 to a high of 6.03×10^7 L/yr in 1968, as shown in Figure 2.1-1. Generally, the highest volumes were discharged before about 1981, and volumes have declined since then.

Radionuclides released with the TA-50 RLWTF effluent include americium-241, cesium-137, plutonium 238, plutonium-239,240, strontium-89,90, and tritium. From 1963 to 2004, discharge records indicate that a minimum total of approximately 0.156 Ci of americium-241, more than 2 Ci of cesium-137, more than 0.10 Ci of plutonium-238, nearly 0.2 Ci of plutonium-239,240, approximately 1.5 Ci of strontium-89,90, and approximately 823 Ci of tritium were discharged. Most of the radionuclides americium-241, cesium-137, plutonium-238, and plutonium-239,240 apparently were discharged between 1972 and 1983, although records are incomplete before 1973 (Table 2.1-1). Much of the cesium-137, strontium-90, and tritium have been lost since initial discharge by radioactive decay, although essentially all of the other radionuclides with longer half-lives remain in the watershed.

The variability in discharge volume and in contaminant releases over time (Table 2.1-1) reflects contemporaneous Laboratory operations whose wastewater was treated at the RLWTF, new wastewater treatment methods, and evolving regulatory requirements. Historic nitrate concentrations are compared with outfall volumes in Figure 2.1-1. These illustrate that time histories of released contaminant concentrations do not necessarily track those of outfall volumes. Advanced treatment technologies and stricter regulatory requirements have resulted in reduced contaminant concentrations in effluent. For example, a new reverse osmosis and ultrafiltration system began operating at the RLWTF in 1999 to remove additional radionuclides (except tritium) from the effluent and to ensure that the discharges meet DOE public dose guidelines. Also in 1999, the RLWTF instituted a program to restrict the discharge of nitrogenous wastes into the facility's collection system. The combination of these restrictions with the ultrafiltration system has decreased the nitrate (nitrate as nitrogen) effluent concentration to below 10 mg/L. Since 2000, tritium releases have also decreased because of segregation and evaporation of tritium-contaminated waste streams. The effects of these facility enhancements can be seen in the recent information given in Table 2.1-1.

Measurement of perchlorate releases in RLWTF liquid effluent began in 2000. That year, the RLWTF discharged 4.74 kg of perchlorate for an average concentration of 254 μg/L in the effluent. In 2001, 2.29 kg of perchlorate was released, resulting in an average concentration of 169 μg/L. In 2002, ion-exchange resins were installed at the RLWTF, and this addition has successfully reduced perchlorate in effluent to below the detection limit of 4 μg/L. Other inorganic chemicals released with RLWTF wastewater include chromium, fluoride, sodium, and chloride. Historic chromium releases since 1976 are shown in Figure 2.1-2; the estimated mass of chromium released since 1976 is 26 kg.

Fluoride is also released at the TA-50 RLWTF outfall. Highest effluent concentrations occurred between 1982 and 1990, ranging from about 6 mg/L to a maximum of 28 mg/L. Since 1999, enhanced fluoride treatment has kept effluent concentrations below the New Mexico groundwater standard of 1.6 mg/L. In 2005, the average effluent fluoride concentration was 0.24 mg/L (LANL 2006, 93925).

Before 1975, outfalls at TA-50 (other than the RLWTF) discharged into the head of Ten Site Canyon through drain lines originating in Buildings TA-50-1 and TA-50-2 (LANL 1997, 56835, pp. 2-22–2-23). In 1974, two unplanned releases of untreated waste occurred because of overflow of a sump in TA-50-2.

The drain lines were removed in 1982, and cesium-137, plutonium-239, ruthenium-106, strontium-89, strontium-90, and yitrium-90 were encountered during excavation of the lines. The area near the head of Ten Site Canyon was partially decontaminated in 1981. A Resource Conservation and Recovery Act (RCRA) field investigation (RCRA RFI) was performed in 1993 for SWMU 50-006(a). Soil samples were collected near the outfalls of the two former drain lines, on both banks of the drainage channel, and in the canyon drainage channel at a distance of about 1300 ft downstream from the TA-50 boundary. COPCs identified included polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and the radionuclides americium-241, cobalt-60, cesium-137, potassium-40, plutonium-238, plutonium-239,240, Ra-226, strontium-90, and thorium-232 (LANL 1997, 56835, pp. 2-22, 2-23).

2.1.2 TA-35

Historic outfalls located at TA-35 (Figure 1.1-2 and Plate 1), formerly called Ten Site, are sources of radionuclides and other contamination in the watershed. TA-35 is highly developed industrially, and stormwater runoff from paved areas may also contribute to contaminants in the watershed. The following paragraphs summarize source information compiled in the Mortandad Canyon Work Plan (LANL 1997, 56835).

From 1951 to 1963, treated wastewater containing radionuclides was discharged from the Ten Site Laboratory (Building TA-35-2) into Pratt Canyon (SWMU 35-003(d)-00), a small tributary of Ten Site Canyon. This wastewater originated while hot cells were used to prepare kilocurie sources of radioactive lanthanum (lanthanum-140) and barium (barium-140), waste from experimental reactors (Los Alamos power reactor experiment-1 and -2 and Los Alamos molten plutonium reactor experiment), plutonium research laboratories, and a tritium laboratory. During the operation of the TA-35 wastewater treatment plant (WWTP), approximately 2.7 × 106 gal. (10,220 m^3) of water were discharged to Pratt Canyon (LANL 1997, 56835). The total activity discharged was about 20 Ci gross-beta activity and 1.4 Ci of strontium-89 and strontium-90. The gross-beta activity consisted of a combination of barium-140, lanthanum-140, strontium-89, strontium-90, and trace amounts of cesium-137, ruthinium-106, plutonium, technetium-99, and uranium (Emelity 1958, 793; LANL 1997, 5683; Aeby 1952, 741; Aeby 1954, 742). Many of these radionuclides are short lived, and a decay-corrected inventory estimate made in 1996 considering barium-140, lanthanum-140, strontium-89, and strontium-90 calculated that approximately only 0.2 Ci of strontium-90 remained from the historic releases at TA-35 (LANL 1997, 56835). Unknown quantities of tritium were also disposed of from 1953 to 1974 (Rogers 1998, 59169, p. 2). In addition, chemicals such as nitric acid, strontium nitrate, iron sulfate, and ferric chlorate were released to Pratt Canyon either as wastewater constituents or as treatment chemicals. The TA-35 WWTP was closed in 1963, underwent initial decontamination and decommissioning (D&D) in 1984 and 1985 (Elder et al. 1986, 03089), and underwent further D&D in 1995 and 1996 (LANL 1997, 56835).

Sanitary septic systems that previously discharged from TA-35 were also a source of nitrates in the Mortandad watershed. From 1951 to 1975, two septic systems discharged to Mortandad Canyon and two discharged to Ten Site Canyon. These four systems had no documented releases of contaminants other than treated sewage (LANL 1997, 56835). From 1975 to 1992, the TA-35 sanitary septic sewage lagoons released treated effluent to Ten Site Canyon at NPDES-permitted outfall 10S. Records from 1987 to 1992 show that an average of 45,000 gal. was discharged daily (LANL 1997, 56835).

Photographic waste discharge, noncontact cooling water, and treated cooling water were also previously released at now inactive outfalls into Ten Site and Mortandad Canyons. Chromium may have been released with some cooling water, especially from NPDES-permitted outfall 04A-127.

Currently, only NPDES-permitted outfall 03A160 (Plate 1) discharges from TA-35. It discharges cooling tower blowdown associated with a large generator within Building TA-35-124 to Ten Site Canyon above reach TS-1W.

2.1.3 TA-48

Radiochemistry and nuclear medicine research has been conducted at TA-48 (Figure 1.1-2 and Plate 1), the Radiochemistry Site, since 1957. Discharges to Mortandad Canyon and to the head of Effluent Canyon from TA-48 are believed to have begun at about that time (LANL 1997, 56835). Historically, outfalls handling once-through cooling water and treated cooling tower blowdown have discharged to the canyons [SWMUs 48-007(a), 48-007(b), 48-007(d), 48-010)]; additional small wastewater sources such as floor, roof, and sink drains [SWMUs 48-007(c) and 48-007(f)] also existed. Soil samples collected at these sites in 1993, 1995, and/or 1997 showed the presence of radionuclides and inorganic chemicals. Some radionuclides observed were americium-241, cobalt-60, cesium-137, sodium-22, plutonium isotopes, ruthinium-106, and strontium-90 and uranium isotopes; some inorganic chemicals detected above background levels were barium, copper, lead, mercury, manganese, strontium, and zinc. Currently, no NPDES-permitted outfalls are present at TA-48.

In addition to liquid effluent, the air exhaust system at TA-48 vented acidic vapors (such as perchloric, hydrochloric, hydrofluoric, and nitric acids) that may have contributed contaminants to that watershed.

2.1.4 TA-03

A small portion of the southern part of TA-03, mainly near the Chemistry and Metallurgy Research (CMR) Building (Building TA-03-29) and the Materials Science Laboratory (Building TA-03-1698), is located in the upper reaches of the Mortandad watershed. Some unintentional spills to Mortandad Canyon have occurred, as summarized in the Mortandad Canyon Work Plan (LANL 1997, 56835).

- Six releases of cooling water from the new Sigma Building occurred before 1975; no information was reported regarding possible contaminants associated with the cooling water (Purtymun 1964, 11822).
- During summer 1974, two accidental releases from a radioactive liquid-waste line (near the CMR building) resulted in radioactive contamination of soil near the leaks, SWMU 03-054(e). The waste contained predominantly plutonium-238, with lesser concentrations of cesium-137, plutonium-239, strontium-89, and strontium-90. Remediation of soils was conducted in 1974 and 1984.

Treated cooling water and electroplating solutions were released at SWMU 03-049(a) starting in 1960. Trace amounts of metals (including chromium), acids, cyanide, and depleted uranium were likely released with electroplating rinse waters.

Currently, NPDES-permitted outfalls 03A021 (CMR Building seasonal cooling) and 03A022 (Sigma Complex seasonal cooling) discharge treated cooling water to the upper part of Mortandad Canyon at TA-03 (Plate 1).

In addition to the TA-03 sites located around Mortandad Canyon, it is possible that potassium chromate discharged from TA-03 into Sandia Canyon may be a source of chromium contamination observed in the regional aquifer at well R-28 in Mortandad Canyon (LANL 2006, 91987). Potassium chromate was used from approximately 1956 to 1972 as a corrosion inhibitor in the cooling towers that serviced the TA-03 Power Plant. Possible usage averaging 16.3 kg/d (35.9 lb/d) (DOE 1987, 52975) makes this the largest

known usage of chromium at the Laboratory. Cooling tower blowdown was discharged through an outfall to Sandia Canyon (currently NPDES-permitted outfall 01A001) at approximate rates of 128,000 to 288,000 gal./d. Chromium contamination is being further investigated under the "Interim Measures Work Plan for Chromium Contamination in Groundwater" (LANL 2006, 91987).

2.1.5 TA-55

TA-55 was established in 1973 for the plutonium-processing laboratory. Activities include chemical and metallurgical processes for recovering, purifying, and converting plutonium and other actinides into many compounds and forms. Waste streams are treated at the TA-50 RLWTF. NPDES-permitted outfall 03A181 (Plate 1) currently discharges to upper Effluent Canyon near reach E-1W and west of outfall 051. This outfall releases small volumes of treated blowdown from a cooling tower.

2.1.6 Other Technical Areas

SWMUs and AOCs at several other Laboratory TAs within the Mortandad watershed could have potentially contributed contamination to the canyon bottoms, including TA-60, former TA-04, TA-05, TA-52, former TA-42, and TA-63. Firing sites and outfalls at TA-05 that were active from approximately 1944 to 1959 are the only sources of potential contamination for an unnamed tributary canyon that joins Mortandad Canyon immediately east of the Laboratory-San Ildefonso Pueblo boundary (LANL 1997, 56835, p. 2-11).

2.1.7 Runoff from Developed Areas

The Laboratory's technical areas that surround Mortandad Canyon are industrially developed, including Laboratory facilities, storage locations, and parking lots. Runoff from developed areas transport various contaminants associated with urban areas into the canyons. Contaminants commonly found below developed areas include constituents in motor oil, gasoline, diesel, and asphalt, road salt, PCBs, heavy metals, and pesticides. PAHs, suspected carcinogens that are frequently associated with vehicle usage and asphalt, are a common class of contaminants associated with developed areas (Edwards 1983, 82302; Lopes and Dionne 1998, 82309; van Metre et al. 2000, 82262). Metals that have been identified as associated with runoff from roads include cadmium, chromium, copper, lead, nickel, and zinc (Walker et al. 1999, 82308; Breault and Granato 2000, 82310). Consistent with studies in other regions, investigations in other canyons in and near the Laboratory have identified various inorganic and organic COPCs as being associated with runoff from developed areas (LANL 2004, 87390, pp. 7-14, 7-16).

2.1.8 Cerro Grande Fire

In May 2000, the Cerro Grande fire burned a large part of the Mortandad watershed west of SR 4. Approximately 5.7 km^2 (1410 acres) of the watershed was within the burn perimeter (BAER 2000, 72659), comprising 68% of the watershed above the highway. Most of this area, 82%, was classified as low burn severity or not burned and the remainder as moderate burn severity. Various naturally occurring inorganic chemicals (e.g., barium, cobalt, and manganese) and anthropogenically created fallout radionuclides (e.g., cesium-137, plutonium-239,240, and strontium-90) were concentrated in Cerro Grande ash at levels exceeding that of background sediments before the fire, and the transport of ash has resulted in elevated levels of these analytes in post-fire sediment deposits in some canyons (Katzman et al. 2001, 72660; Kraig et al. 2002, 85536; LANL 2004, 87390). Elevated levels of inorganic chemicals and radionuclides that can be attributed to the transport of ash have also been found in stormwater samples in some canyons (Gallaher and Koch 2004, 88747). Post-fire changes in sediment or water chemistry may have

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occurred in the Mortandad watershed, although these effects are expected to be relatively minor compared with other canyons because of the low burn severity and because no layers of ash-rich sediment have been observed.

2.2 Contamination in Canyons Media

Contamination in sediment, surface water, and groundwater in the Mortandad watershed has been evaluated in many studies before this report, dating back to 1956 (Purtymun et al. 1965, 11847). This previous work documented the presence of elevated levels of inorganic chemicals, organic chemicals, and radionuclides in canyon media and has evaluated the potential effects of contaminants on biota. Some key studies, summarized below, provide background and supplemental data for the investigations presented in this report. Relevant information from these studies is also included in subsequent sections of this report.

2.2.1 U.S. Geological Survey

The U.S. Geological Survey (USGS) performed initial studies of contaminants in the Mortandad watershed, beginning with sampling and analyzing sediment below the TA-35 WWTP outfall into Pratt Canyon in 1956 (Purtymun et al. 1965, 11847) and continuing with studies in Effluent and Mortandad Canyons (Purtymun et al. 1966, 11848; Purtymun 1967, 8987; Purtymun and Kunkler 1967, 8888). This work provides documentation of contamination in the initial years of effluent discharge in the watershed and of downcanyon decreases in radionuclide concentration at that time.

2.2.2 Environmental Surveillance Program

The Laboratory's Environmental Surveillance Program (ESP) has sampled and analyzed sediments, surface water, and groundwater at numerous locations in the Mortandad watershed since 1969. This work, reported in annual Environmental Surveillance reports (e.g., ESP 2001, 71301; ESP 2002, 73876; ESP 2004, 83635; ESP 2004, 88421; ESP 2005, 92222) and in other reports (e.g., Purtymun 1971, 4795; Purtymun 1973, 4971; Purtymun 1974, 5476; Purtymun 1975, 11787; Purtymun et al. 1977, 11846; Purtymun et al. 1983, 6407; Devaurs and Purtymun 1985, 7415; Stoker et al. 1991, 7530; Ferenbaugh and Gladney 1997, 93715; Gallaher et al. 1997, 59165), supports the evaluation of long-term trends in contamination in different media and an understanding of the role of stormwater transport.

2.2.3 Environmental Science Group

The Laboratory's Environmental Science Group conducted a series of detailed studies of radionuclides in sediments within the Mortandad watershed in the 1970s; this group has also conducted ecological investigations in contaminated canyon-bottom areas (Hakonson et al. 1973, 4974; Hakonson and Bostick 1976, 29678; Hakonson et al. 1976, 8920; Nyhan et al. 1976, 11746; Nyhan et al. 1976, 11747; Nyhan et al. 1978, 5726; Hakonson et al. 1980, 8924; Nyhan et al. 1982, 7164). This work included documenting downstream changes in contaminant concentrations and relations between contaminant concentration and sediment particle size in the canyon below the RLWTF outfall into Effluent Canyon.

2.2.4 Ecology Group

The Laboratory's Ecology Group has conducted studies on the uptake of contaminants by biota in Mortandad Canyon. These studies include addressing potential uptake of contaminants by small mammals and plants (Bennett et al. 1996, 56035), peregrine falcons (Podolsky 2000, 73477), and an

initial ecotoxicological risk screen in Effluent and Mortandad Canyons (Gonzales and Newall 1996, 56045). Additional studies by the Ecology Group were conducted as part of this investigation and are summarized in Section 8.1.

2.2.5 Environmental Restoration Project

Since 1998, detailed studies of canyons media in the Mortandad watershed have been conducted by the former ER Project and successor organizations. Summaries of results of sediment investigations through 2003 have been presented previously (Reneau et al. 2003, 77103; LANL 2005, 89308). Supplemental data on contamination in canyons media are available through other ER Project reports (e.g., LANL 1995, 49925; LANL 1996, 54422; LANL 2005, 91699). The work presented in this investigation report builds on these previous studies.

2.2.6 NMED and EPA

NMED and the U.S. Environmental Protection Agency (EPA) and their subcontractors have collected and analyzed samples from canyons media in the Mortandad watershed as part of oversight activities (e.g., Hanlon-Mayer and Jacquez 2000, 82261; EPA 2001, 70669). These data provide supplemental information about contamination in the watershed.

2.3 Remediation Activities

Several remediation activities in the Mortandad watershed have reduced the potential for contaminant transport or reduced the concentrations or inventory of contaminants in canyon media. The activities most relevant to this investigation are summarized below.

2.3.1 Pratt Canyon

After removing structures at the former TA-35 WWTP at the head of Pratt Canyon in the early to mid-1980s [SWMUs 35-003(d,e,l,q)], backfill was placed at the head of the canyon to fill excavations and prevent erosion of potentially contaminated soil. Subsequent runoff events incised the backfill on the slope, leading to concerns about remobilizing contaminants such as strontium-90. In 1996, the ER Project conducted an interim action (IA) in Pratt Canyon to reduce the potential for erosion (LANL 1996, 55809). The IA activities included replacing fill in the incised channel, stabilizing the slope, and installing a berm to divert runoff from the slope.

2.3.2 Ten Site Canyon

Excavation of contaminated sediment from Ten Site Canyon reach TS-1W (Plates 1 and 3) occurred in an IA in 1996 (LANL 1997, 55834). This IA targeted a location in the stream channel where unusually high concentrations of plutonium-238 (5190 pCi/g) had been found in one sample, which is the maximum reported anywhere in the Mortandad watershed. This contamination was derived from accidental releases from TA-50 in 1974, designated SWMU/AOC 50-006(a). The site has been described as a "hummock," and the geomorphic setting indicates that the location was probably a sandbar next to a scour hole that formed below boulders in the channel. Only a single sample from this area had plutonium concentrations >100 pCi/g, suggesting that the 5190 pCi/g result was anomalous and included a small particle of plutonium. A total of 0.55 m^3 (0.72 yd^3) of sediment was removed in this IA.

2.3.3 Sediment Traps

Sediment deposits were excavated from sediment traps #1 and #3 in Mortandad Canyon reach M-4 (Plates 1 and 4) in June 2000 after the Cerro Grande fire (WGII 2000, 70735). This sediment removal was intended to increase capacity in trap #1 to prepare for possible post-fire floods and to remove some fine-grained sediment in trap #3. Excavation of a fill pile adjacent to trap #1 that resulted from prior trap maintenance activities in 1992 also occurred. An estimated 1680 m^3 (2200 yd^3) of sediment was removed in these activities. The contaminant inventory removed in these activities is probably relatively low, compared with the total inventory in reach M-4 because measured radionuclide concentrations in the traps and the fill piles were relatively low. In addition, much of the excavated volume probably consisted of sediment that predated contaminant releases in the watershed.

2.3.4 Permeable Reactive Barrier

In January and February 2003, the Laboratory installed a permeable reactive barrier (PRB) in Mortandad Canyon reach M-3W to evaluate in situ treatment of a suite of COPCs in shallow alluvial groundwater (Kaszuba et al. 2002, 93891; DBS&A 2006, 93888). The PRB was designed to remove americium-241, plutonium-238, plutonium-239,240, strontium-90, nitrate, and perchlorate. Because of their geochemical variability, no single treatment media was optimal for removing all of these COPCs. Consequently, a multiple-layer PRB was designed with multiple treatment zones arranged in series to sequentially remove each of the COPCs. The PRB employs a funnel-and-gate system with a sequential series of four reactive media cells. The funnel consists of a row of sheet piles driven through the alluvium and into the underlying bedrock that directs the alluvial groundwater so that it will flow through the four cells (the gate). The four reactive media cells, ordered by sequence of contact with the groundwater, consist of (1) gravel-sized scoria for colloidal removal; (2) mineral apatite (calcium phosphate) for removing metals and radionuclides; (3) biobarrier cell composed of 65% pecan shells and 10% cotton seed mixed with 25% pea gravel to deplete dissolved oxygen and break down nitrate, perchlorate, and potential RCRA organic compounds; and (4) gravel-sized limestone for pH buffering and anion adsorption. Performance monitoring of the PRB consisted of collecting several rounds of groundwater samples between 2003 and 2005 from the PRB sampling ports and nearby alluvial monitoring wells that were analyzed for major cations and anions and radionuclides (DBS&A 2006, 93888). These data indicated that successful treatment of COPCs occurred in the apatite and biobarrier cells. However, dissolved concentrations of key COPCs measured in the limestone cell and a downcanyon monitoring well—notably, perchlorate, nitrate, and strontium-90—were essentially equivalent to the untreated water upcanyon of the PRB. This pattern of chemical behavior was observed initially under very low alluvial saturation levels in 2003 that created stagnant groundwater flow conditions in the alluvium but also during higher saturation levels in 2004 and 2005 when normal groundwater flow conditions prevailed. Possible explanations for the apparent impaired performance include hydraulic bypass or errors associated with sampling techniques. The performance of the PRB is the subject of ongoing investigations to evaluate these issues.

3.0 SCOPE OF ACTIVITIES

The scope of activities in this report include investigations of sediment, surface water, groundwater, and biota in the Mortandad watershed, as presented in the Mortandad Canyon work plan and subsequent documents (LANL 1997, 96835; LANL 1999, 62777; LANL 2004, 82613; LANL 2005, 89308). These investigations are discussed below.

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3.1 Sediment Investigations

The sediment investigations presented in this report focused on characterizing the nature, extent, concentrations, and inventory of contaminants in post-1942 sediment deposits in a series of reaches in the Mortandad watershed. Data from these reaches are used to evaluate potential human health and ecological risks and to identify spatial trends in contamination at a watershed scale, including variations in contaminant concentration and inventory at increasing distances from source areas and temporal trends in contamination. The investigation methods are discussed in Section 4 and Appendix B, Section B-1, of this report; in the "Mortandad Canyon Work Plan" (LANL 1995, 96835; LANL 1999, 62777); and in the canyons core document (LANL 1997, 55622; LANL 1998, 57666).

The scope of this investigation originally included up to 13 investigation reaches in the Mortandad watershed, as presented in Section 7.2.4 of the work plan (LANL 1997, 55622; pp. 7-12–7-30). The scope of work subsequently increased, as discussed below, and a total of 27 investigation reaches have been characterized. Table 3.1-1 lists the sediment investigation reaches and the years in which samples were collected in each reach. Table 3.1-1 also provides abbreviations for reach names included in this report and the approximate length and distance of each reach from the Rio Grande, as well as additional information on the reaches. Figure 3.1-1 and Plate 1 show the location of the investigation reaches within the Mortandad watershed. Note that Pratt Canyon (reach PCYN), a short tributary to Ten Site Canyon below the former TA-35 WWTP, is included in Table 3.1-1, Figure 3.1-1, Plates 1 and 3, and in the physical system conceptual model in Section 7 for completeness but not in the screening assessment in Section 6 or in the risk assessments in Section 8. An evaluation of COPCs and potential risk in Pratt Canyon was completed as part of investigations at TA-35 (LANL 2005, 91867).

During implementation of the work plan in 1998 to 2004, additional investigation areas were added in the Mortandad watershed, and some reaches were subdivided to better identify contaminant sources and to characterize variations in contamination in these canyons. For example, reach TS-2 was subdivided into reaches TS-2 West, TS-2 Central, and TS-2 East, with reach boundaries placed at outfalls from specific SWMUs. Reaches M-3 and M-4 were subdivided to help evaluate variations in contaminant concentrations and inventory related to geomorphic variations in the canyon bottom, although data from all subdivisions of M-3 are evaluated together for risk assessment and also for all subdivisions of M-4. M-3 West consists of the relatively narrow upcanyon portion of M-3; M-3 East consists of the broader downcanyon portion that extends to the confluence with Ten Site Canyon. M-4 West consists of the part of Mortandad Canyon between the Ten Site Canyon confluence and sediment trap #3, M-4 Central consists of the area east of sediment trap #2 where radionuclide concentrations are relatively high, and M-4 East consists of the area farther east where radionuclide concentrations are relatively low.

In 1998, reach M-1 West was added and investigated upcanyon of reach M-1 as shown in the work plan, and the original M-1 was renamed M-1 East. M-1 West is located at the head of Mortandad Canyon just east of Diamond Drive and was investigated to better determine contaminant levels that would be associated with releases from TA-03. In 2001, reach M-2 East was investigated downcanyon of reach M-2 as shown in the work plan, and the original M-2 was renamed M-2 West. M-2 East is located downstream of the easternmost SWMU at TA-35 and was investigated to better determine if TA-35 SWMUs or AOCs have had a measurable impact on sediments in Mortandad Canyon. Investigation of M-2 East was partially in support of planned 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 nonsampled area between Effluent Canyon and reach M-3. In 2004, reaches E-1 Far West, M-1 Central, and M-5 West were added to the investigation. E-1 Far West is located at the head of Effluent Canyon, upcanyon of the westernmost TA-55 SWMU and was investigated to better determine

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relative contributions from TA-48 and TA-55. M-1 Central is located between M-1 West and M-1 East, upcanyon of the westernmost TA-48 SWMU and was investigated to better determine relative contributions from TA-03 and TA-48. M-5 West is located in the middle of a long previously unsampled part of Mortandad Canyon between M-4 and the San Ildefonso Pueblo boundary and was investigated to better determine the eastern extent of recognizable contamination; the previous reach M-5 was renamed M-5 East.

Sediment characterization was also conducted to support the biota investigations according to the study plan presented in the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308). This sampling was conducted to provide additional data to support the assessment of potential ecological effects from contamination found in sediment. This characterization included resampling previously sampled sediment layers in some reaches and collecting samples at new locations in other reaches. Details of the methodology are presented in Section B-3 of Appendix B.

3.2 Surface Water and Groundwater Investigations

The water investigations presented in this report focus on characterizing the nature, extent, and concentrations of contaminants in persistent surface water, alluvial groundwater, and perched-intermediate groundwater in and beneath the Mortandad Canyon watershed. Wells extending into the regional aquifer are also considered. Data from these components of the hydrogeologic system are used to evaluate potential human health and ecological risk as well as to identify spatial trends in contamination at a watershed scale, including variations in contaminant concentration at increasing distances from the source areas and as a function of seasonal and annual hydrologic variations. The data are also used to identify temporal trends in contamination. This work involved sampling persistent surface water; drilling and installing monitoring wells and piezometers; sampling new and preexisting groundwater wells; and measuring water level variations in all groundwater sources. Persistent surface water generally refers to effluent-supported flow, standing water in bedrock pools in the channel, snowmelt runoff, and other surface water not related to short-duration stormwater runoff (Section 7.2 further discusses the hydrology of the watershed). Figure 3.2-1 shows the locations of surface and groundwater sites that were sampled as part of this investigation. The investigation methods are discussed in Section 4.2 and Appendix B of this report. The scope of the investigation is described in the "Work Plan for Mortandad Canyon" (LANL 1997, 56835) and the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613). The investigation activities described above are discussed in the following sections.

3.2.1 Monitoring Well Installations

Nine alluvial monitoring wells were installed in Mortandad and Ten Site Canyons between 1998 and 2005 to fulfill the requirements of the "Work Plan for Mortandad Canyon" (LANL 1997, 56835) and the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613). Well completion diagrams and geologic logs for these wells are provided in the reports "Alluvial Groundwater Monitoring Well Completions, 1994-2001" (LANL 2001, 73307) and "Final MCA Wells, MCB Boreholes, and MCRES Boreholes Completion Report 2004–05 Mortandad Canyon Drilling Program, Los Alamos National Laboratory, Los Alamos, New Mexico, Project 49436" (Kleinfelder 2006a, Appendix 92486). Downhole gamma and induction logs were collected in several boreholes either before plugging and abandonment or before well installation. Other alluvial monitoring wells installed in Mortandad Canyon from 1960 to 1990 for surveillance monitoring were used in these investigations (Purtymun 1995, 45344). In 1994, 24 additional water balance wells were installed in Mortandad Canyon to investigate spatial and temporal changes in alluvial saturation (McLin 1997, 85422). Well completion diagrams and geologic logs for these early wells are compiled in Purtymun (1995, 45344) and McLin (1997, 85422). Figure 3.2-1 and Plate 1 show the locations of the alluvial monitoring wells in the Mortandad Canyon watershed.

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Eight intermediate perched monitoring wells and boreholes were installed in Mortandad Canyon in 2001 to fulfill the requirements of the "Work Plan for Mortandad Canyon" (LANL 1997, 56835) and in 2004 and 2005 to fulfill the requirements of the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613). Well completion diagrams and geologic logs for these wells are provided in the following reports: "Characterization Well MCOBT-4.4 and Borehole MCOBT-8.5 Completion Report" (Broxton et al. 2002, 76006) and "Final I Wells Completion Report 2004-05 Mortandad Canyon Drilling Program, Los Alamos National Laboratory, Los Alamos, New Mexico, Project 49436" (Kleinfelder 2006b, 92494, Appendix B). Downhole gamma and induction logs were collected in the boreholes either before plugging and abandonment or before well installation. Schlumberger, Inc., collected a more comprehensive suite of geophysical logs in three of the wells (Kleinfelder 2005, 90045; MCOBT-4.4, MCOBT-8.5, and MCOI-5). Figure 3.2-1 and Plate 1 show the locations of intermediate-perched monitoring wells and boreholes in the Mortandad Canyon watershed.

Three additional perched intermediate wells were identified in the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613) as contingent wells that could be installed if results from the seven other intermediate wells indicated the need for additional perched zone characterization. These included a well in upper Ten Site Canyon near R-14 (MCOI-2), a well on the bench south of Mortandad Canyon and south of GS-2 (MCOI-7), and a well on the mesa top south of Mortandad Canyon 1500 ft east of supply well PM-5 (MCOI-9). Intermediate well MCOI-2 was designed to investigate the occurrence of perched groundwater near the TA-35 outfall. Because no perched groundwater was encountered when drilling nearby well R-14, and the regional aquifer has not shown the presence of contaminants, including perchlorate, nitrate, and tritium, MCOI-2 was not considered essential for determining the nature and extent of contaminants in this area and was not discussed. Intermediate well MCOI-7 was not drilled after results from well MCOI-1 indicated there was insufficient groundwater to make a useful well in the narrow part of Mortandad Canyon between Effluent Canyon and TW-8. Intermediate well MCOI-9 was not drilled after results from borehole MCOI-10 indicated that perched groundwater does not extend under the mesa south of Mortandad Canyon.

Four regional groundwater characterization and monitoring wells were installed in Mortandad Canyon; two regional wells were installed in Ten Site Canyon; and one regional well was installed in Cedro Canyon from 1998 to 2005 to fulfill the requirements of the "Work Plan for Mortandad Canyon" (LANL 1997, 56835) and the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613). Well completion diagrams and geologic logs for these wells are provided in the following reports: "Revision 1 Well R-1 Completion Report, Los Alamos National Laboratory, Los Alamos, New Mexico" (Kleinfelder 2005a, 90045), "Characterization Well R-13 Completion Report" (LANL 2003a, 76060), "Characterization Well R-14 Completion Report" (LANL 2003b, 76062), "Characterization Well R-15 Completion Report" (Longmire 2001, 70103), "Revision 1 Well R-28 Completion Report, Los Alamos National Laboratory, Los Alamos, New Mexico" (Kleinfelder 2005b, 94042), "Final Completion Report Characterization Well R-33, Los Alamos National Laboratory, Los Alamos, New Mexico" (Kleinfelder 2005c, 94041), "Final Completion Report Characterization Well R-34, Los Alamos National Laboratory, Los Alamos, New Mexico (Kleinfelder 2004, 92199), "Final MCA Wells, MCB Boreholes, and MCRES Boreholes Completion Report 2004-05 Mortandad Canyon Drilling Program" Los Alamos National Laboratory, Los Alamos, New Mexico, Project No. 49436 (Kleinfelder 2006, 92486), and "Final I Wells Completion Report 2004–05 Mortandad Canyon Drilling Program, Los Alamos National Laboratory, Los Alamos, New Mexico, Project No. 49436" (Kleinfelder 2006, 92494). The last two reports listed above are provided in electronic format as part of Appendix B on the attached CD. Schlumberger, Inc., collected a comprehensive suite of geophysical logs in all of the regional well boreholes before well installation Kleinfelder 2005, 90045). TW-8 was installed in Mortandad Canyon in 1960 to determine the hydrologic characteristics of the Mortandad Canyon area and to monitor the regional aquifer for contaminants (Baltz et al.1963, 08402; Purtymun 1995, 45344). The well completion diagram and geologic log for TW-8 are

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summarized in Baltz et al. (1963, 08402) and Purtymun (1995, 45344). Historic water-quality data from TW-8 were used with data from the more recent characterization wells to examine spatial and temporal trends in contaminants as part of this investigation report. Figure 3.2-1 and Plate 1 show the locations of the regional groundwater characterization and monitoring wells in the Mortandad Canyon watershed.

3.2.2 Piezometer Installations

Six piezometers were installed in 2004 to fulfill the requirements of the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613). The piezometers were installed in Mortandad Canyon to collect information about groundwater flow directions, hydraulic gradients, saturated thicknesses, and extent of saturation in alluvial groundwater west of the confluence with Ten Site Canyon and east of the sediment traps. Well completion diagrams and geologic logs for these piezometers are provided in the report "Final MCA Wells, MCB Boreholes, and MCRES Boreholes Completion Report 2004-05 Mortandad Canyon Drilling Program, Los Alamos National Laboratory, Los Alamos, New Mexico, Project 49436" (Kleinfelder 2006a, 92486). Figure 3.2-1 and Plate 1 show the locations of the piezometers in the Mortandad Canyon watershed.

3.2.3 Surface Water and Groundwater Sampling

Since release of the "Work Plan for Mortandad Canyon" (LANL 1997, 56835), surface water, alluvial groundwater, intermediate-perched groundwater, and regional groundwater samples have been collected in the Mortandad Canyon watershed, supplementing years of data collected by the Laboratory's Environmental Surveillance Program. These investigations were conducted to address characterization requirements presented in the "Work Plan for Mortandad Canyon" (LANL 1997, 56835) and the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613) and to fulfill the requirements of the Laboratory's Environmental Surveillance Program. The "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613) updated the sampling approach initially presented in "Work Plan for Mortandad Canyon" (LANL 1997, 56835) by selecting wells and surface water locations for sampling based on bounding of key potential contaminant sources and collecting data useful for assessing human health and ecological risk.

Based on the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613), sampling of surface water and groundwater was coordinated to provide a "snapshot" in time to evaluate the relationship between constituents in surface water and various groundwater bodies. The snapshot sampling efforts were conducted in 2005 and included two sampling events that were scheduled to coincide with periods of relatively dry and wet hydrologic conditions. Surface water locations were selected from areas where persistent surface water was present. Surface water sampling was also conducted to support the biota investigations (LANL, 2005, 89308), discussed in Section 4.3.

The list of surface water sites and groundwater monitoring wells that were sampled as part of the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613) and the rationale for selecting each sample site are presented in Table 3.2-1. Other wells and surface water locations in the watershed were sampled as part of earlier investigations but are not included in Table 3.2-1. Figure 3.2-1 shows the locations of the sample sites listed in Table 3.2-1. Plate 1 shows those same locations as well as additional monitoring wells, surface water sampling locations, and production wells in the Mortandad Canyon watershed.

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3.2.4 Water-Level Measurements

Both manual and automated water-level data have been collected from alluvial monitoring wells, piezometers, intermediate-perched monitoring wells, and regional monitoring wells in the Mortandad watershed. A summary of water-level measurements for wells at LANL, including those in the Mortandad Canyon watershed, is given in the report "Groundwater Level Status Report for 2005, Los Alamos National Laboratory" (Allen and Koch 2006, 93652). Table 3.2-2a shows the list of wells and period of record for the manual water-level data for each well; Table 3.2-2b shows the list of wells and period of record for the automated water-level data for each well. Details of the field methodology and results are presented in Section B-2.2 of Appendix B.

3.2.5 Infiltration Investigation

An infiltration investigation is currently being conducted to fulfill requirements of the "Work Plan for Mortandad Canyon" (LANL 1997, 56835) and the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613). The purpose of the infiltration investigation is to constrain the various terms of the water budget to quantify water movement within the deep percolation contaminant transport pathway. These data will support future assessment of groundwater infiltration under varying conditions and for differing source-reduction scenarios (e.g., elimination of TA-50 discharges). To assess flow dynamics within the alluvial aquifer, system vector probes were installed in selected boreholes. Water content and matric potential sensors were also installed in other selected boreholes to analyze vadose-zone dynamics below alluvium. Instrumentation was also installed at locations in the canyon floor to assess percolation rates. Preliminary results for the infiltration study are discussed in Appendix M.

3.2.6 Surface Geophysics

Two surface-based direct-current (DC-) resistivity surveys were conducted in Mortandad Canyon in 2002 and 2004. The 2004 survey fulfills requirements of the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613). The objective of the resistivity surveys was to identify regions of higher conductivity beneath the canyon floor that may be related to perched alluvial groundwater and to zones of infiltration in subcropping bedrock units. The surveys were optimized to characterize variations in electrical conductivity in the upper 150 to 200 ft of the vadose zone. Details of the methodology and results for the resistivity surveys are provided in the reports "Pilot Geophysical Studies in Mortandad Canyon, Los Alamos National Laboratory, Los Alamos, NM, Job No. 1171" (Geophex 2002, 94040, Appendix B) and "DC Resistivity Profiling in Mortandad, Ten Site and DP Canyons, Los Alamos National Laboratory, Los Alamos, NM, Job No. 1247" (Geophex 2004, 84540, Appendix B). Locations of the resistivity survey lines are shown in Plate 1.

3.2.7 Characterization Core Holes

Thirteen of 16 planned characterization core holes were installed in Mortandad Canyon in 2004 and 2005 to fulfill the requirements of the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613). Two of the planned characterization core holes, MCB-3 and MCB-4, could not be installed because the sites are located in an inaccessible, deeply incised portion of Mortandad Canyon. Access to one site (MCB-13) was denied because it was located in a protected archeological area. Table 3.2-3 describes the characterization boreholes and provides information about their locations, purpose, and depths. Diagrams and geologic logs for these core holes are provided in the report "Final MCA Wells, MCB Boreholes, and MCRES Boreholes Completion Report 2004-05 Mortandad Canyon Drilling Program, Los Alamos National Laboratory, Los Alamos, New Mexico, Project 49436" (Kleinfelder 2006a, 92486, Appendix B). Additional core was collected during installation of intermediate-perched and

regional groundwater monitoring wells, described in Sections 3.2.2 and 3.2.3 above. Figure 3.2-1 and Plate 1 show the locations of the alluvial monitoring wells and piezometers in the Mortandad Canyon watershed.

3.2.8 RES Coreholes

Cores from four boreholes and from one regional aquifer well were collected to compare vertical electrical profiles from the 2002 surface-based DC-resistivity survey with moisture profiles and perched groundwater occurrences detected in boreholes. Table 3.2-3 describes the RES boreholes and provides information about their locations, purpose, and depths. These resistivity boreholes investigations fulfill the requirements of the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613). Diagrams and geologic logs for these boreholes are provided in the following reports: "Final MCA Wells, MCB Boreholes, and MCRES Boreholes Completion Report 2004-05 Mortandad Canyon Drilling Program, Los Alamos National Laboratory, Los Alamos, New Mexico, Project 49436" (Kleinfelder 2006a, 92486, Appendix B), "Characterization Well MCOBT-4.4 and Borehole MCOBT-8.5 Completion Report" (Broxton et al. 2002, 76006), and "Revision 1 Well R-28 Completion Report, Los Alamos National Laboratory, Los Alamos, New Mexico" (Kleinfelder 2005b, 94042). Figure 3.2-1 and Plate 1 show the locations of the three RES holes, MCOBT-4.4, and R-28.

3.3 Biological Investigations

The biological investigations presented in this report focused on characterizing the potential for adverse effects of contaminants in post-1942 sediment deposits and surface water on terrestrial and aquatic ecological receptors. These investigations fulfill the general objectives identified in the work plan (LANL 1997, 96835; LANL 1999, 62777) and in the canyons core document (LANL 1997, 55622; LANL 1998, 57666). These investigations build upon the results obtained from sediment and surface water characterization, and the basis for the investigation approach is documented in the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308). The investigation methods are discussed in Section 4.3 and Section B-3.0 in Appendix B of this report.

3.4 Deviations from Planned Activities

The sediment, surface water, groundwater, and biota investigations discussed in this report deviated in several respects from that proposed in the original plans. Most of the deviations consisted of additions to scope, such as the investigation of additional sediment investigation reaches that was discussed in Section 3.1. Other deviations resulted when the original work plan (LANL 1997, 56835; LANL 1999 62777) was superseded by later documents, such as the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613) or the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308). This section focuses on work proposed in the most recent, applicable document that was not accomplished or that was otherwise changed in a manner that has the potential to negatively affect the scope of this investigation.

Plans for drilling 9 alluvial wells, 16 characterization boreholes, 3 resistivity boreholes, and 7 intermediate wells were described in the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613). Four regional wells (R-1, R-28, R-33, and R-33) were also described in that plan; details of activities and well construction for these holes to the regional aquifer are described in dedicated borehole completion reports for each well (Kleinfelder 2004, 92199; Kleinfelder 2005a, 90045; Kleinfelder 2005b, 94042; Kleinfelder 2005c, 94041). Exceptions and modifications to the other alluvial wells as well as characterization boreholes, resistivity boreholes, and intermediate wells are detailed in Table 3.4-1. Among the alluvial wells installed, MCA-4 provided an adequate sample only for the first round of

sampling. Nearby, alluvial well MCO-2 has been sampled in instances where an adequate sample could not be obtained from MCA-4 (see Table 3.2-1), and data from both wells have been used to represent the alluvial system in Effluent Canyon upstream of the TA-50 outfall.

The biota investigation was completed as planned with several exceptions. It was planned to analyze earthworms used in the earthworm toxicity test for COPECs, but the analytical laboratory instead disposed of these samples, and analyses were not obtained. It was planned to collect aquatic invertebrates using a Hess sampler for taxonomic identification and comparison to NMED's draft "Stream Condition Index for New Mexico Wadeable Streams;" but flow was insufficient to use the Hess sampler. It was also planned to submit aquatic invertebrates obtained with a dip net for radiological analyses, but insufficient invertebrate mass was obtained for these analyses.

4.0 FIELD INVESTIGATIONS

Field investigations in the Mortandad watershed included investigations of sediment, surface water, groundwater, and biota. The approaches and methods of these investigations are briefly discussed in the following subsections. A more detailed discussion of the methods and the results of the field investigations is presented in Appendix B.

4.1 Sediment

Sediment investigations in the Mortandad watershed included detailed geomorphic characterization and sediment sampling in a series of discrete reaches, following the general process described in the NMED-approved work plan and canyons core document (LANL 1997, 55622; LANL 1997, 56835; LANL 1998, 57666; LANL 1999, 62777). The geomorphic characterization in most reaches included preparing a detailed geomorphic map delineating the horizontal extent of geomorphic units with varying physical characteristics, contaminant concentrations, and/or age. Field radiological screening measurements were used to help delineate geomorphic units in reaches where the levels of radionuclide contamination in post-1942 sediment exhibited higher levels of radiation than nearby pre-1943 sediment. The geomorphic characterization also included measuring the thicknesses of potentially contaminated post-1942 sediment deposits to estimate the volume of contaminated sediment and the contaminant inventory in each reach. Several methods were used to identify the bottom of post-1942 sediment deposits, including determining the depth of buried trees and associated buried soils, and noting the presence or absence of materials imported to the watershed after 1942 (e.g., quartzite gravel, plastic).

Field data on the volume and radiation levels in the different geomorphic units in a reach were used to help allocate samples for analysis at off-site laboratories. In most reaches, samples were collected in multiple phases, and analytical results from initial sampling phases were used to help guide subsequent sampling. Section B-1 of Appendix B includes a more detailed discussion of the investigation methods. All analytical results of the sediment sampling incorporated in this investigation report are presented in Appendix C on a CD included with this report.

Plates 2 to 5 present geomorphic maps for reaches in the Mortandad watershed and sample locations, field radiological measurement locations, and stratigraphic description locations within these reaches. The horizontal extent of contaminated or potentially contaminated sediment deposits in each reach is delineated by the extent of the channel ("c") and floodplain ("f") units in these maps. Section B-1 of Appendix B includes field investigation results, including field radiological screening results.

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4.2 Surface Water and Groundwater

The surface water and groundwater investigations in the Mortandad Canyon watershed are designed to define the nature and extent of contamination, to identify the physical and chemical processes controlling contaminant distributions, and to identify the transport pathways that could result in potential human health and ecological risk. This work includes sampling persistent surface water; drilling and installing monitoring wells and piezometers; sampling new and preexisting groundwater wells; and measuring water level variations in all groundwater sources. In addition, core was collected to characterize the distribution contaminants and moisture in rock units of the upper vadose zone. The investigation methods are discussed in Appendix B of this report. The scope of the investigation is described in the "Work Plan for Mortandad Canyon" (LANL 1997, 56835) and the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613).

4.2.1 Monitoring Well Installations

Nine alluvial wells, eight intermediate wells, and seven regional wells were installed to fulfill the requirements of the "Work Plan for Mortandad Canyon" (LANL 1997, 56835) and the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613). Detailed well completion reports describe the investigation methods, well completion diagrams, geologic logs, and borehole geophysical logs for these wells. These well completion reports are described in Section 3.2.1 of this investigation report. Table 3.2-1 provides information about the location, purpose, and depth of these wells.

4.2.2 Piezometer Installations

Piezometers were installed to evaluate groundwater flow directions, hydraulic gradients, saturated thicknesses, and extent of saturation in the alluvial groundwater system. The piezometers were installed at two locations, each containing three closely spaced piezometers to monitor water levels in the alluvial system. The piezometers consist of 0.8-in. I.D. (1.1-in. O.D.) PVC casings coupled to 1.4-in. O.D. prepacked screens surrounded with 10/20 sand. Slot sizes are 0.01 in., and the screens are 6 in. long. Slug tests were conducted in the completed piezometers.

One group of piezometers consisting of MCA-3a, MCA-3b, and MCA-3c (Figure 3.2-1) was installed in Mortandad Canyon west of the confluence with Ten Site Canyon. MCA-3a and MCA-3c were installed in the same borehole and are screened across the lower and upper parts of the alluvial system, respectively. MCA-3b was installed in an adjacent borehole, and it is screened across the middle portion of the alluvial system. Slug tests were conducted in the three piezometers.

The second group of piezometers consisting of MCA-3d, MCA-3e, and MCA-3f (Figure 3.2-1) was installed east of the sediment traps, near the eastern limit of persistent alluvial saturation. The three piezometers were installed in a single borehole to measure water levels in the upper (MCA-3f), middle (MCA-3e), and lower (MCA-3d) parts of the alluvial system. Slug tests were conducted in MCA-3d.

4.2.3 Surface Water and Groundwater Sampling

As described in Section 3.2, sampling of persistent surface water, alluvial groundwater, perched-intermediate groundwater, and regional groundwater was coordinated to provide a snapshot in time to evaluate the relationship between constituents in surface water and various groundwater bodies. Snapshot sampling was conducted in 2005 and included two sampling events that were scheduled to coincide with periods of relatively dry and wet hydrologic conditions. The first round of samples was collected in late April to mid-June during relatively dry conditions. The second round of samples was

collected in mid-August to mid-September during wet conditions, coinciding with the summer monsoon season. Samples were collected at designated locations described in the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613). Under this work plan, alluvial groundwater monitoring wells and surface water locations were sampled concurrently (typically within a period of less than 6 weeks) to obtain a comprehensive and current data set and a synoptic perspective of the hydrology and contaminants present in water within the watershed. A key objective was to characterize potential contaminant variability associated with variations in surface water and alluvial groundwater conditions. Sampling surface water and alluvial groundwater concurrently also allows for evaluating the relation between surface water and alluvial groundwater quality. Sampling was attempted at designated locations in each of the two sampling rounds, and samples were collected if sufficient water was present. Some additional surface water stations and wells, in addition to the designated locations required in the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613), were added to the rounds of snapshot sampling to replace dry sample locations and to provide more comprehensive water quality data for the watershed. Table 4.2-1 summarizes the sampling conducted during the two rounds required under the work plan, as well as other sampling conducted as part of Laboratory facility-wide surveillance sampling and during early RFI sampling in the watershed conducted under the "Work Plan for Mortandad Canyon" (LANL 1997, 56835).

Most of the surface water and groundwater samples were collected in accordance with ER Project standard operating procedures (SOPs), and a few were collected as part of annual surveillance monitoring using Water Quality and Hydrology (WQH) procedures. The procedures for sample collection are described in Appendix B, and the analytical results of the sampling are discussed in Appendix C and provided on a CD included with this report. With the exception of R-33, which had equipment problems, a water-level measurement was collected from each well before purging for a sampling event. The water-level measurements associated with sampling are also presented in Appendix F. Water-quality field parameters including pH, specific conductance, temperature, and turbidity were measured for each surface water and groundwater sample collected. Measurements of field parameters were taken as part of groundwater sampling to evaluate the effectiveness of purging. Field parameters data were also collected for surface water and groundwater samples to provide data potentially useful for evaluating contaminant variability. These field parameters were logged in a water-quality stabilization record form for each sample and are presented in tables in Section B-2 of Appendix B. The methodology for collecting field parameters and results is also described in Section B-2.0.

4.2.4 Water-Level Measurements

Historical and new water-level data were compiled for alluvial, intermediate, and regional wells in Mortandad Canyon. These data, which included both manual and automated measurements, allow interconnections between groundwater bodies to be assessed by comparing water-level responses with storm events and seasonal variations in precipitation. Water-level data are also collected to determine hydraulic gradients within groundwater bodies and to assess hydraulic conductivity. Details of the field methodology and results are presented in Section B-2.2 of Appendix B.

Systematic manual water-level measurements for selected alluvial observation wells (MCO series) began in 1960 to document seasonal water-level fluctuations in the alluvial groundwater system. In 1994, water balance wells were installed in Mortandad Canyon to investigate spatial and temporal changes in alluvial saturation (McLin et al. 1997, 85422). Manual water-level measurements were taken in selected water balance wells in 1995 and 1996 and automated, high-frequency water-level data were collected using pressure transducer probes from 1997 to 2005. Automated pressure transducer probes were also placed in the alluvial wells and piezometers installed in 2004 and 2005.

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Automated pressure transducers were also installed for acquisition of water levels in intermediate-perched groundwater. An automated pressure transducer has collected intermittent water-level data for intermediate-perched monitoring well MCOBT-4.4 since 2002. Automated pressure transducer probes were also placed in wells MCOI-4, MCOI-5, MCOI-6, and MCOI-8.

Water-level data for the regional aquifer wells includes both manual and automated water-level measurements. At first, water-level measurements were collected manually from the regional aquifer wells during water sampling events. In late 2004 and early 2005, automated pressure transducer probes were installed in all but one of the regional aquifer wells installed for the "Work Plan for Mortandad Canyon" (LANL 1997, 56835) and the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613). R-33 is the only regional well without an automated transducer because there is an equipment problem with the multiport sampling system. TW-8 has the longest period on record of all the regional aquifer wells. An automated pressure transducer was installed in TW-8 in 1992 and it has collected water-level data intermittently since then.

4.2.5 Infiltration Investigation

The "Work Plan for Mortandad Canyon" (LANL 1997, 56835) specifies that field-based work is needed to quantify the movement of water through the vadose zone (including the alluvial aquifer system). The Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613) also contains a requirement to assess subsurface water movement in the canyon. Therefore, the Mortandad Canyon infiltration study was implemented to understand spatial and temporal variability of the rates of water movement above, below, and within the alluvial aquifer system and to determine unsaturated zone fluxes in selected locations where no current alluvial water exists. Multiple approaches were used to address these goals, and these are described from shallowest to deepest below. Preliminary results of the infiltration investigation are discussed in Appendix M.

One potential pathway for contaminant transport and recharge in the canyon is percolation through the bottom of the streambed. To quantify this loss, instrumentation was installed at nine locations in the canyon to collect high-time-resolution temperature profiles down to about 180 cm below the stream channel. This method uses heat as a tracer to determine downward fluxes (Constantz et al. 2003, 94090). From the temperature data, the frequency and duration of streambed infiltration events can be determined and downward fluxes can be estimated.

Borehole data from Mortandad Canyon shows that the extent of perchlorate and nitrate contamination extends laterally well beyond the incised channel. Thus, it is important to quantify percolation in the floodplains and terraces as well as the channel. Twelve fiberglass wicktype flux meters were installed at various canyon locations (away from the channel) to measure downward unsaturated flow rates at a depth of approximately 100 cm below the canyon floor. At two of these locations, paired matric potential and water content sensors were also installed. These sensors are used to quantify downward fluxes that are below the detection level of the flux meters and also to quantify rates and durations of upward flux events.

Vector probes were installed in five boreholes (MCB-5, MCB-6, MCB-9, MCB-14, and MCRES-2) to assess flow dynamics within the alluvial aquifer system (see www.hydrotechnics.com for more information about the probes). The vector probes were emplaced in selected MCB and MCRES holes at depths thought to represent the most transmissive alluvial aquifer flow zones identified during drilling (typically above the alluvium/tuff contact). The vector probes provide quantitative information on flow rates and directions within the alluvial aquifer system and how they might vary with time.

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A series of volumetric water content and matric potential sensors were also installed in six boreholes (MCB-2, MCB-7, MCB-8, MCB-11, MCB-16, and MCRES-4) below the alluvium (within the tuff) to quantify fluxes in bedrock units. These sensors provide data on the spatial and temporal variability of deep fluxes within the canyon and help constrain recharge fluxes to the deeper intermediate-perched aquifer zone in the canyon.

4.2.6 Surface Geophysics

A DC-resistivity survey was conducted in Mortandad Canyon in summer 2002 to determine whether this geophysical method was an effective and appropriate means to identify zones of saturation and moisture within the alluvial and upper vadose zone systems (Geophex 2002, 94040, Appendix B). Geophysical survey lines are shown in Figure 4.2-1. Geophex conducted the geophysical surveys and prepared a summary report that was submitted to NMED on March 26, 2003 (Geophex 2002, 94040). Nine DC resistivity profiles were compiled in the middle portion of Mortandad Canyon. One profile was collected continuously along the centerline of the canyon from a point upstream of the PRB to a point near well R-13, a distance of 2830 m (9290 ft) to the east (Figure 4.2-1). The remaining profiles consisted of a series of transects across the canyon at selected locations. Profile depths of penetration varied according to the length of the line and the spacing of electrodes. In the upper reaches of the canyon, the shortest profile penetrated approximately 6 to 9 (20 to 30 ft) below ground surface (bgs). The longest profiles imaged to depths of over 60 m (200 ft) bgs.

A second DC resistivity survey was conducted by Geophex in December 2003 to cover additional parts of upper Mortandad Canyon that were not included by the 2002 survey (Geophex 2003, 84540). Geophysical survey lines are shown in Figure 4.2-1. One DC resistivity profile was completed for a distance of 1800 m (5904 ft) along the centerline of upper Mortandad Canyon from a point upstream of the PRB to the confluence with Effluent Canyon. A second profile was compiled for a distance of 220 m (722 ft) along the centerline of lower Effluent Canyon. A third profile was completed for a distance of 475 m (1558 ft) along the centerline of lower Ten Site Canyon from a point where the canyon becomes broad and flat eastward to the confluence with Mortandad Canyon. A fourth line is a north-south transect that extends 192 m (631 ft) across the mouth of Effluent Canyon into Mortandad Canyon.

4.2.7 Characterization Core Holes

A list of the characterization core holes and information about their locations, purpose, and depths are provided in Table 3.2-3. These core holes were drilled to depths ranging between 25 to 87 m (84 and 284 ft) in Effluent, Mortandad, and Ten Site Canyons. Cores collected from the boreholes were used to determine moisture content, adsorption capacity, and the nature and the extent of contamination in the alluvium and upper portions of the Bandelier Tuff/Cerro Toledo interval. Geologic and hydrologic data from these core holes also provide site-specific data for modeling hydrological and geochemical-contaminant transport mechanisms.

Core was collected using hollow-stem auger methods without the use of drilling fluids. Cores were collected from all major stratigraphic units, including the alluvium at a nominal sample interval of 3 m (10 ft) to determine contaminant distributions in the upper vadose zone. Samples were containerized to prevent moisture loss and were analyzed for moisture content, metals, anions, stable isotopes, and radionuclides. Where feasible, borehole gamma and induction logs were collected in uncased portions of the boreholes. In general, the core holes were plugged and abandoned with bentonite after reaching total depth. However, five of the boreholes were instrumented before being backfilled as part of infiltration investigations as described in Section 4.2.5.

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Analytical data for cores are discussed in Section 7.2.2. Appendix D contains plots of contaminated profiles in cores and in pore waters extracted from cores. Appendix B presents moisture profiles for the core holes.

4.2.8 RES Coreholes

The 2002 DC resistivity survey suggested that various moist zones might be mapped by the electrical profiles. The degree of saturation or moisture within these zones is not known and can only be confirmed by measuring the moisture content in the boreholes. The high resistivity areas are inferred to be either "dry" or "dryer" unconsolidated sediments or dry bedrock, for example, in the upper portions of the Bandelier Tuff. The dry bedrock zones vary in elevation across the deeper portions of the profiles. Vertical zones of lower resistivity appear to cut through dry bedrock zones and extend to greater depths in certain areas. These features are interpreted to be either "moist" or clay-rich fracture zones within the dryer bedrock.

Core holes MCRES-2, MCRES-3, MCRES-4 (Figure 3.2-1) targeted areas of low and high resistivity identified in the 2002 resistivity survey to evaluate the relationship between the electrical profiles and in situ moisture and physical property measurements determined from core. Core holes MCRES-3 and MCRES-4 are located near TW-8 in resistive and conductive zones, respectively. Near the confluence of Mortandad and Ten Ste Canyons, core was collected from MCRES-2 for comparison to the moisture profile collected from existing well MCOBT-4.4. The 2002 DC resistivity profile suggests that MCOBT-4.4 was drilled in an area where high conductivity extends to greater depths than at MCRES-2. Core was also collected from the upper 45 m (150 ft) of R-28 to evaluate conductivity data from a spot yet farther downcanyon. At R-28, a sharp electrical boundary at 24-m (80-ft) depth separates a conductive zone above from a resistive zone below. Core samples collected at a nominal interval of 3 m (10 ft) were analyzed for moisture content, grain size, porosity, and clay content.

4.3 Biota

Biological data were collected to evaluate the potential for adverse ecological effects from contaminants in sediment and surface water. Biota investigations in the Mortandad watershed included a range of activities, as presented in the NMED-approved "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308). Field investigations included studies of bird nest boxes, plant and bird surveys, collection of sediment samples for earthworm toxicity tests, seedling germination tests, aquatic toxicity tests, and collection of water samples for algae toxicity tests. The nest box study included adding nest boxes to an existing network, collecting data on occupancy, and collecting samples of eggs and insects for laboratory analyses. These activities are discussed in more detail in Section 8.1 and Section B-3.0 of Appendix B.

5.0 REGULATORY CRITERIA

This section provides information on the regulatory context, human health screening levels, ecological screening values, and water standards and screening levels.

5.1 Regulatory Context

Regulatory requirements governing the Laboratory's canyons investigations are discussed in Section 1.4 of NMED-approved canyons core document (LANL 1997, 55622, LANL 1998, 57666). In particular, these investigations address requirements of the Laboratory's Hazardous Waste Facility Permit (Module VIII) under RCRA, including "the existence of contamination and the potential for movement or transport to or

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within Canyon watersheds" (EPA 1990, 1585; EPA 1994, 44146). RCRA and the New Mexico Hazardous Waste Act (NMHWA) regulate releases of hazardous wastes and hazardous waste constituents. DOE Order 5400.1, "General Environmental Protection Program," establishes requirements for managing residual radioactivity at DOE facilities.

As a result of the operational history of sites in the Mortandad watershed, this investigation addresses both radioactive and hazardous components. NMED has authority under the NMHWA over the cleanup of hazardous wastes and hazardous constituents, while DOE has authority over the cleanup of radioactive contamination. Radionuclides are regulated under DOE Order 5400.5, "Radiation Protection of the Public and the Environment," and DOE Order 435.1, "Radioactive Waste Management."

The regulatory requirements for conducting investigations in the Mortandad watershed are incorporated into Module VIII through work plans approved by NMED. The approved work plans include the "Work Plan for Mortandad Canyon" (LANL 1997, 56835; LANL 1999, 62777), the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613), and the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308). Corrective actions at the Laboratory are subject to the Consent Order, which contains general requirements and those specific to the Mortandad watershed (Section IV.B.2, "Mortandad Canyon Watershed"). The Consent Order was issued pursuant to NMHWA, New Mexico Statutes Annotated (NMSA) 1978 § 74-4-10 and the New Mexico Solid Waste Act (NMSWA), NMSA 1978, § 74-9-36(D). The requirements of the Consent Order now supersede those of Module VIII.

Surface water discharges that are subject to a permit under Section 402 of the federal Clean Water Act, including stormwater discharges, are not regulated under the Consent Order. Requirements for stormwater monitoring are contained in a Federal Facility Compliance Agreement/Administrative Order (FFCA/AO) between EPA and DOE.

The assessments in this report are primarily risk based for all media and contaminants. Surface water and groundwater standards are used to support the assessment of nature and extent of contamination in canyons media. Concentrations of chemicals and radionuclides are compared with various risk-based screening levels, which are described in Sections 5.2 and 5.3. Applicable water standards are discussed in Section 5.4.

5.2 Human Health Screening Levels

In Section 6, soil screening levels (SSLs) for inorganic and organic chemicals and screening action levels (SALs) for radionuclides are media-specific concentrations derived for residential exposures. If environmental concentrations of contaminants are below SALs or SSLs, then the potential for adverse human health effects is considered highly unlikely. For sediment nonradionuclide COPCs with carcinogen or noncarcinogen endpoints, SSLs from revision 4.0 of NMED guidance (NMED 2006, 92513) were used if available. If values were not available from NMED then residential screening values were obtained from EPA Region 6 or EPA Region 9. The SSLs for noncarcinogens are based on a hazard quotient (HQ) of 1.0. The SSLs for carcinogens are based on a cancer risk level of 10^{-5} (10E-5). For nonradionuclide COPCs without NMED SSLs, approved surrogate values were used (NMED 2003, 81172). SALs for radionuclides were obtained from Laboratory guidance (LANL 2005, 88493). The radionuclide SALs for sediment have a target dose limit of 15 millirem per year (mrem/yr), which is consistent with guidance from DOE (DOE/AL 2000, 67153).

Human health screening levels for water are EPA Region 6 Human Health Medium Specific Screening Level (HHMSSL) tap water screening levels for carcinogens and noncarcinogens and DOE-Derived Concentration Guidelines (DCG) for radionuclides. The screening levels for carcinogens and

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noncarcinogens in water are based on the same HQ and cancer risk levels as the SSLs. The screening values for radionuclides in groundwater were calculated based on a target dose limit of 4 mrem/yr, which is the radiation dose limit for a public drinking water supply in DOE Order 5400.5, "Radiation Protection of the Public and the Environment." The screening values for radionuclides in surface water were calculated based on a target dose limit of 100 mrem/yr, which is the radiation dose limit for the general public from all sources in DOE Order 5400.5, "Radiation Protection of the Public and the Environment."

Additional information regarding the potential for human health risks from affected media in the Mortandad watershed is provided in Section 8.2.

5.3 Ecological Screening Levels

Ecological screening levels (ESLs) are used to determine chemicals of potential ecological concern (COPECs) for water and sediment data. The document "Screening Level Ecological Risk Assessment Methods, Rev. 2" (LANL 2004, 87630) contains information about how ESLs are derived. ESLs are developed for a suite of receptors designed to represent individual feeding guilds, such as invertivorous mammal or carnivorous bird. Receptors such as robins and kestrels are modeled with multiple diets to represent multiple feeding guilds. The representative concentration of each COPC was compared with ESLs from the ECORISK Database Versions 2.1 (LANL 2004, 87386) or 2.2 (LANL 2005, 90032).

Additional information regarding the potential for ecological risks from affected media in the Mortandad watershed is provided in Section 8.1.

5.4 Water Standards and Screening Levels

COPCs are identified by comparing concentrations in water with applicable water standards and screening values. All surface water sampling locations in the Mortandad watershed are designated ephemeral. Water standards that apply to ephemeral surface waters (not including stormwater runoff) include the following.

- Aquatic Acute Life (New Mexico Water Quality Control Commission [NMWQCC] Acute Aquatic Life criteria, New Mexico Administrative Code [NMAC] 20.6.4.900 (H), (I), and (J), effective July 2005. Hardness-dependent criteria are calculated using 100 mg/L $CaCO_3$.)
- Livestock Watering (NMWQCC Livestock Watering criteria, NMAC 20.6.4.900 (F) and (J), effective July 2005)
- Wildlife Habitat (NMWQCC Wildlife Habitat criteria, NMAC 20.6.4.900 (G) and (J), effective July 2005)
- Human Health Persistent (NMWQCC human health criteria for persistent toxic pollutants, NMAC 20.6.4.900 (J), effective July 2005. Human health criteria for toxic, carcinogenic, and persistent pollutants only)

Concentrations of radionuclides in surface water were compared with the following values to identify COPCs:

- DCG based on 100 mrem/yr

To identify COPCs in groundwater, comparisons to the lowest of the following standards were performed:

- Human Health (NMAC 20.6.2.3103.A: Human health standards)

- Other Standards for Domestic Water (NMAC 20.6.2.3103.B: Other standards for domestic water supply)
- EPA maximum contaminant levels (MCLs)

If none of the above standards exist for an analyte, the following values were compared with concentrations in groundwater to identify COPCs:

- DCG based on 4 mrem/yr
- EPA Region 6 HHMSSLs for tap water (EPA 2005, 91002)

Stormwater discharges are regulated under the federal Clean Water Act, and no applicable standards for stormwater are under the Consent Order. For informational purposes, available stormwater monitoring data for the Mortandad watershed are compared with water screening action levels (wSALs) established under the FFCA/AO. The wSAL for an analyte is designated as the lowest numeric criterion of the applicable NMWQCC water quality criteria (WQC) established in State of New Mexico Standards for Interstate and Intrastate Surface Waters (NMAC 20.6.4), if one exists. The wSALs for each contaminant are determined in stepwise fashion by evaluating, in the following order

- requirements for any FFCA-monitored segment that is included in a classified water of the state in 20.6.4.101 through 20.6.4.899 NMAC;
- requirements for any FFCA-monitored surface water that is not included in a classified water of the state in 20.6.4.101 through 20.6.4.899 NMAC; or
- *Federal Register,* EPA. Multi-Sector General Permit benchmark values for Sector K, Hazardous Waste Treatment, Storage, or Disposal Facilities.

Classified waters of the state that are described in NMAC 20.6.4.101 through 20.6.4.899 have segment-specific designated uses. Nonclassified surface waters are described as ephemeral (NMAC 20.6.4.97), intermittent (NMAC 20.6.4.98), or perennial (NMAC 20.6.4.99), each of which has designated uses. The designated uses for surface water are associated with use-specific WQC, including numeric criteria. Stormwater in the Mortandad watershed is described as nonclassified, ephemeral; the relevant list of wSALs and their bases are provided in Appendix C.

6.0 CANYONS CONTAMINATION

This section describes the methodology and results of analytical data screening assessments for samples collected to identify COPCs in sediment, surface water, groundwater, and core samples. Identifying COPCs forms the basis for evaluating contamination in canyons media. All COPCs identified in this section are evaluated in human health risk assessments in Section 8.2 and have been considered in developing the measures evaluated in the baseline ecological risk assessment in Section 8.1. A subset of these COPCs is discussed in the conceptual model in Section 7. Section 6.1 briefly describes how the data were prepared for the screening processes. Section 6.2 presents the screens for sediment, Section 6.3 presents the screens for surface water and groundwater, and Section 6.4 presents the screens for core samples. The term "sediment" includes all post-1942 sediment deposits in the canyon bottoms, including deposits in abandoned channels and floodplains as well as in active stream channels; therefore, sediment includes alluvial soils as defined in some other studies.

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6.1 Data Preparation

The data used in the following assessments were obtained from the Environmental Restoration Database (ERDB) and the Water Quality Database (WQDB) (on DVD as Attachment 1). All data are presented in Appendix C, Analytical Results (on CD).

Certain analytical results are not evaluated in the screens and subsequent risk assessments for the following reasons.

- Semivolatile organic compound (SVOC) results from samples analyzed by a volatile organic compound (VOC), PAH, or high explosives (HE) analytical method. These duplicate results are excluded from the screen because the VOC, PAH, and HE analytical methods provide lower detection limits than the SVOC method.
- Field duplicate results. These results are from samples obtained for quality assurance/quality control (QA/QC) purposes and not as primary characterization data.
- Isotopic thorium results by gamma spectroscopy. For sediment, these results are excluded because gamma spectroscopy analysis yields results that cannot be directly compared with sediment background values (BVs).
- Results from composite sediment samples collected to support ecological risk studies. These composite samples are used to support the ecological risk assessment in Section 8.1, but they cannot be compared with the other samples in this investigation; therefore, they have been excluded from the screens and from the subsequent human health risk assessments.
- Samples collected from material that has since been excavated (indicated by a "Y" in the excav_flag field in the Appendix C analytical results tables). These data are not representative of current site conditions, so they are excluded from the COPC identification process. However, these data are used in the conceptual site model in Section 7.1.
- Results from water samples collected before 2000. These results are not used in the COPC screens because in many instances the data do not have accompanying data packages for validation and are considered screening level. Also, concentrations in older data are not representative of current site conditions. However, pre-2000 data are used in the trend analyses presented in the conceptual site model in Section 7.2.

6.2 Contaminants in Sediment

This section presents the process for screening analytical results obtained from sediment samples collected in the Mortandad watershed. Samples collected and analyses performed by the analytical laboratories are presented in Table C-2.0-1 in Appendix C. Sample locations are presented in Plates 2 through 5. Analytical results were screened to develop a list of COPCs, as presented in Section 6.2.1.

6.2.1 Identification of Sediment COPCs

Sediment COPCs are identified by a screening process that includes comparing the maximum chemical concentrations by reach with Laboratory-specific sediment BVs (presented in LANL 1998, 59730). Analytes are retained as COPCs using rules specific to the class of analyte. This process is discussed below.

For inorganic chemicals, an analyte is retained as a COPC in a reach if

- the analyte has a BV and a detected or nondetected result in the reach exceeds the BV, or
- the analyte does not have a BV, but at least one detected result is in the reach.

For radionuclides, an analyte is retained as a COPC in a reach if

- the analyte has a BV and at least one detected result in the reach exceeds the BV, or
- the analyte does not have a BV but has at least one detected result in the reach.

There are no BVs for organic chemicals, and retaining an organic chemical as a COPC is based solely on detection status. For organic chemicals, an analyte is retained as a COPC in a reach if there is at least one detected result in the reach.

A total of 38 inorganic chemicals, 74 organic chemicals, and 17 radionuclides were retained as COPCs in sediment in the Mortandad watershed. Maximum sample results in each reach for these COPCs are presented in Tables 6.2-1, 6.2-2, and 6.2-3 for inorganic chemicals, organic chemicals, and radionuclides, respectively.

6.2.2 Comparison of Sediment COPC Concentrations to Residential SSLs and SALs

Maximum concentrations (including detection limits for inorganic chemicals) of sediment COPCs in each reach were compared with residential SSLs for inorganic and organic chemicals or residential SALs for radionuclides to identify which are most important for understanding potential human health risk. A total of three inorganic COPCs, two organic COPCs, and nine radionuclide COPCs have maximum concentrations exceeding residential SSLs or SALs in the Mortandad watershed, and these are included in the conceptual model for sediment in Section 7.1. These COPCs are highlighted in gray in Tables 6.2-1, 6.2-2, and 6.2-3.

6.3 Contaminants in Surface Water and Groundwater

This section presents the process for screening surface water and groundwater sample results from the Mortandad watershed. Samples collected and analyses performed by the analytical laboratories are presented in Table C-2.0-2 in Appendix C. Sample locations are presented in Plates 2 through 5. Analytical results from water samples were screened to develop a list of COPCs, as presented in Section 6.3.1.

6.3.1 Identification of Surface Water and Groundwater COPCs

There are no BVs for water data, and COPCs are identified by a screening process that is based only on the detection status. This process is performed for groups of data defined by field preparation (filtered or nonfiltered samples) and analyte type (inorganic chemicals, organic chemicals, and radionuclides). No organic chemical analyses were obtained from filtered water samples. An analyte is retained as a COPC for a location if the chemical has at least one detected result.

A total of 62 inorganic chemicals, 42 organic chemicals, and 16 radionuclides were retained as COPCs in surface water and/or groundwater in the Mortandad watershed. Maximum sample results at each sample location for these COPCs are presented in Tables 6.3-1 through 6.3-5.

6.3.2 Comparison of Water COPC Concentrations to Standards

Maximum detected concentrations of water COPCs by location and field preparation were compared with applicable water standards, as discussed in Section 5, to identify which are most important from a regulatory perspective. A total of six inorganic chemicals and one radionuclide have maximum detected concentrations in intermediate-depth or regional groundwater exceeding groundwater standards and are

discussed in the conceptual model for water in Section 7.2. COPCs exceeding standards are highlighted in gray in Tables 6.3-1 through 6.3-5.

6.4 Contaminants in Core Samples

This section presents the process for screening analytical results obtained from core samples collected in the Mortandad watershed. Samples collected and analyses performed by the analytical laboratories are presented in Table C-2.0-3 in Appendix C. Sample locations are presented in Plates 2 through 5. Analytical results were screened to develop a list of COPCs, as presented in Section 6.4.1.

6.4.1 Identification of Core COPCs

COPCs in core samples are identified by a screening process that includes comparing the maximum inorganic chemical or radionuclide concentrations by location and geologic unit with Laboratory-specific BVs presented in LANL (1998, 59730). Analytes are retained as COPCs using rules specific to the class of analyte. This process is discussed below.

For inorganic chemicals, an analyte is retained as a COPC in a borehole if

- the analyte has a BV and a detected or nondetected result in the geologic unit that exceeds the BV, or
- the analyte does not have a BV, but there is at least one detected result in the geologic unit.

For radionuclides, an analyte is retained as a COPC in a borehole if

- the analyte has a BV and at least one detected result in the geologic unit exceeds the BV, or
- the analyte does not have a BV but has at least one detected result in the geologic unit.

A total of 22 inorganic chemicals and 8 radionuclides were retained as COPCs in core samples in the Mortandad watershed. Maximum sample results at each borehole for these COPCs are presented in Tables 6.4-1 and 6.4-2 for inorganic chemicals and radionuclides, respectively. No organic chemical analyses were obtained from core samples, so there are no organic COPCs identified in the boreholes.

6.4.2 Comparison of Core COPC Concentrations to Residential SSLs and SALs

Maximum concentrations (including detection limits for inorganic chemicals) of COPCs by borehole and geologic unit were compared with residential SSLs for inorganic chemicals or residential SALs for radionuclides for purposes of comparison with results in other media. Only one inorganic COPC, iron, has a maximum result from a borehole exceeding residential SSLs. This result is highlighted gray in Table 6.4-1. No radionuclides exceeded residential SALs.

6.5 Summary

Table 6.5-1 presents a summary of the COPCs in sediment, water, and core samples collected from the Mortandad watershed to allow comparisons between media. Table 6.5-1 also indicates which COPCs have maximum results in the watershed exceeding SSLs, SALs, and standards.

7.0 PHYSICAL SYSTEM CONCEPTUAL MODEL

This section discusses aspects of the physical system conceptual model that are relevant for understanding the nature, sources, extent, fate, and transport of contaminants in the Mortandad watershed. The discussion on contaminants focuses on COPCs that are shown to be most important for evaluating potential present-day human health risk based on the comparisons with SALs, SSLs, and standards in Section 6 and that represent known contaminant releases into the watershed. These COPCs are included in evaluations of potential human health risk in Section 8.2. This section also includes discussion of other COPCs that were identified as study design COPECs and are relevant for evaluating potential present-day ecological risk. Some additional COPCs are discussed to provide insights into sources and trends of contaminants historically or otherwise important in the watershed, including some COPCs that were detected on San Ildefonso Pueblo land and that are relevant for understanding the downcanyon extent of Laboratory-derived contamination. As used in this section, "contaminants" refers to COPCs that are known to represent releases from Laboratory SWMUs or AOCs or other anthropogenic sources, whereas "COPC" is a more general term that also includes analytes identified in Section 6 that may or may not represent such releases.

The following discussion is divided into three sections. Section 7.1 describes spatial and temporal trends for contaminants in sediments and the fluvial processes controlling their distributions. Section 7.2 describes the hydrology of the watershed, including descriptions of surface water, alluvial groundwater, pore water, intermediate-perched groundwater and regional groundwater, and summarizes spatial and temporal trends for contaminants in these media. Together, the data presented in Sections 7.1 and 7.2 are used to identify contaminant sources and to understand contaminant transport away from the source areas. Section 7.3 presents a summary of the physical system conceptual model based on the combined contaminant and pathways data. Key aspects of the physical system conceptual model are shown in Figure 7.0-1. Supporting information about trends in hydrologic conditions and contaminant distributions that support the conceptual model is presented in Appendixes B, D, F, G, H, I, J, K, L, M, N, O and P.

In the following discussion, metric units followed by English units in parentheses are generally employed. However, some data such as transducer data for alluvial wells, precipitation data collected at TA-06, and streamflow gage data were all collected and reported in English units (feet, inches, and cubic feet per second, respectively). Because of the voluminous nature of these data, the original units are maintained in some graphs and tables.

7.1 Contaminants in Sediments

This section discusses general aspects of contaminants associated with sediment in the Mortandad watershed, including how the distribution and concentration of contaminants are affected by fluvial processes acting over decadal time periods after releases. Subsequent sections discuss details of the distribution and concentration of specific COPCs in sediment deposits in the watershed that are important for evaluating potential human health or ecological risk or the downcanyon transport of contaminants in floods. In this section, the term "contaminant" is used to refer to COPCs that are known to represent releases from Laboratory SWMUs or AOCs or other anthropogenic sources, whereas "COPC" is a more general term that also includes analytes identified in Section 6 that may or may not represent such releases. For example, some COPCs identified by comparison with BVs or detection limits may represent naturally elevated concentrations or false positives from analytical laboratories, as discussed below.

Most contaminants in sediment in the Mortandad watershed that were derived from Laboratory sources were originally released in wastewater from outfalls (Purtymun 1967, 11785; Purtymun 1971, 4795; Hakonson and Bostick 1976, 29678; Nyhan et al. 1982, 7164; LANL 1997, 56835). Because streambeds

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on the Pajarito Plateau are usually dry, effluent that did not infiltrate into soils between the outfalls and the channel generally infiltrated into the streambeds. The downcanyon extent of effluent flow varied with release volume and prior moisture conditions along the channel. Nyhan et al. (1978, 5726) reported that in the early 1970s, when the discharge volume was relatively high (Figure 2.1-1), effluent extended for 1.5 km (1 mi) or less downcanyon from the TA-50 RLWTF outfall, indicating that infiltration of effluent in Mortandad Canyon during this period generally occurred upcanyon from reach M-3W. Observations from the early to mid-1960s indicate that effluent sometimes reached M-3W when TA-48 and TA-50 were concurrently discharging wastewater (Purtymun 1967, 11785, p. 36). Discharge volume has been progressively decreasing since the early 1980s (Figure 2.1-1), and infiltration of effluent at present occurs over a shorter stretch of channel.

Once in the streambed, dissolved contaminants commonly adsorb to sediment particles or organic matter because of the geochemical behavior of most radionuclides, metals, and organic chemicals that are of concern in this investigation (Watters et al. 1983, 11888; Salomons and Forstner 1984, 82304; Lopes and Dionne 1998, 82309). Exceptions include perchlorate and tritium which are highly soluble, nonsorbing analytes that remain dissolved in water; as discussed in more detail in Section 7.2. Many contaminants preferentially bind to clay minerals or organic particles, but they will also bind to other mineral particles. Contaminants will preferentially bind to smaller particles because of their larger ratio of surface area to mass and greater electrostatic attractions, and Nyhan et al. (1976, 11747) have documented a general inverse relation between contaminant concentration and particle size of streambed sediment on the Pajarito Plateau. Preferential adsorption to finer particles and organic matter also occurs when wastewater infiltrates into soils on hillslopes. Because of the general inverse correlation of contaminant concentrations with sediment particle size, concentrations can be an order of magnitude higher in the finest-grained sediment deposits, which contain up to 80% or more silt and clay than in coarse-grained sediment deposits that contain < 5% silt and clay (Reneau et al. 2004, 93174; LANL 2004, 87390).

Once adsorbed to sediment particles in the streambed, contaminants can subsequently be redistributed by floods that scour the streambed and mobilize the bed sediment. Contaminants in the streambed that originated as solid particles will behave similarly to those originally released as dissolved components in wastewater. Contaminants associated with coarse-size fractions (coarse sand and coarser; >0.5 mm [0.02 in.]) are generally transported as bed load along the streambed, whereas contaminants associated with fine-size fractions (fine sand and finer; <0.25 mm [0.01 in.]) are generally transported in suspension (Malmon 2002, 76038, pp. 108–114; Malmon et al. 2004, 93018). Contaminants associated with medium sand (0.25–0.5 mm [0.01–0.02 in.]) can be either transported as bed load or as suspended load. The coarse sediment fractions typically travel shorter distances during a flood than fine fractions because of their interactions with other sediment particles on the streambed, and they are usually redeposited within the channel during waning stages of a flood. In areas where the channel is aggrading (raising its elevation through sediment deposition) and where there are no stream banks or where banks are low, coarse sediment can be deposited over adjacent floodplains. In floods that overtop stream banks or where there are no stream banks, some of the fine particles and associated contaminants carried in suspension are also deposited on adjacent abandoned channels or floodplains as flow depth, and velocity decreases relative to the main channel. In large flood events, contaminants can be distributed across the entire width of floodplains in canyon bottoms. In reaches where transmission losses into the streambed exceed discharge, all sediment is deposited. Additional fine particles are deposited on or infiltrate into the streambed during waning stages of flow to be potentially scoured and resuspended in subsequent events.

During floods, sediment from a variety of sources is mixed, changing contaminant concentrations longitudinally along a channel. Where runoff from a contaminant source area enters a stream draining noncontaminated or less-contaminated areas, contaminant concentrations in sediment carried by a flood typically decrease relative to the source area while they increase relative to areas upstream from the

contaminant source. Downcanyon, where runoff from tributaries draining noncontaminated or less-contaminated areas joins a stream in flood, concentrations may be further reduced. Some of the sediment transported in floods is eroded from the bed and banks of the channel, and this erosion can also change contaminant concentrations in a flood. As a flood from noncontaminated areas erodes contaminated sediment downcanyon from source areas, contaminant concentrations in transported sediment increase. Similarly, when a flood draining contaminated areas erodes noncontaminated or less-contaminated material along the channel, concentrations in transported sediment decrease. The net result is a general downcanyon decrease in contaminant concentrations in sediment with distance from a contaminant source area (e.g., Marcus 1987, 82301; Graf 1996, 55537; Reneau et al. 2004, 93174) and an increase in contaminant concentrations along main channels where significant amounts of contaminants are provided from tributaries (LANL 2004, 87390).

Contaminant concentrations in sediment carried in floods also change over time in relation to the history of contaminant releases. Concentrations are generally highest during the period of peak contaminant releases and decrease over time as a result of the mixing processes discussed above. Such decreases over time have been documented in the Los Alamos and Pueblo Canyon system (Malmon 2002, 76038, pp. 315–322; LANL 2004, 87390, pp. 7–8; Reneau et al. 2004, 93174, pp. 1216–1217), as well as in other regions (Lewin et al. 1977, 82306, p. 357; Rowan et al., 1995, 82303, p. 61). Removing or stabilizing contaminants in source areas can help accelerate these natural decreases in contaminant concentrations over time.

Multiple floods occurring over decadal time periods result in sediment deposits in each reach that have a range in age and particle size distribution and hence in contaminant concentration. Schematic cross sections illustrating the distribution of coarse and fine sediment in reaches in the Mortandad watershed are shown in Figures 7.1-1, 7.1-2, and 7.1-3. The term "coarse facies" is used to refer to sediment with median particle size in the less than 2-mm (0.08-in.) fraction of medium to very coarse sand, and these deposits commonly have a high gravel content. The term "fine facies" is used to refer to sediment with median particle size of silt to medium sand. The active channel (c1 geomorphic unit) is typically dominated by relatively young coarse facies sediment deposits. In some parts of the Mortandad watershed, cattail wetlands occur along the active channel (c1ct unit; e.g., reach E-1W in Figure 7.1-2), and fine facies sediment is commonly deposited in these areas where floodwaters spread and energy drops. Abandoned channels (c2 and c3 units), which are areas occupied by the channel sometime after 1942 but subsequently abandoned following channel migration and/or channel incision, typically include fine facies sediment overlying older coarse facies sediment. Abandoned channels can also include coarse deposits as the uppermost, youngest layer (e.g., reach M-4C in Figure 7.1-3). Post-1942 floodplains (f1 unit) typically include thinner layers of post-1942 fine facies sediment that bury pre-1943 soils. (See Section B-1 of Appendix B for additional discussion of sediment facies and geomorphic units.)

As shown in Figures 7.1-1 and 7.1-3, the layers with the highest contaminant concentration in a reach are typically at depth, buried by younger sediment layers with lower concentrations, although they can also occur at the surface (e.g., cesium-137 in reach M-3E, Figure 7.1-2). The highest concentrations can also occur in very small sediment deposits in narrow canyons close to the sources, including the watershed maximums for americium-241, cesium-137, and strontium-90 in reach E-1E and chromium in reach E-1FW (Figure 7.1-1). These figures also show how the relation of sediment layers to trees provides one means of estimating the thickness and age of different sediment layers (tree age determined from tree-ring dating [dendrochronology]; see Section B-1 (in Appendix B) for more discussion of field investigation methods). Plates 2 through 5 show the distribution of geomorphic units in the investigation reaches.

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Volumes of contaminated post-1942 sediment vary longitudinally along the canyons, resulting in part from variations in channel gradient and the width of post-1942 geomorphic units, as shown in Figure 7.1-4. Mortandad Canyon contains relatively large volumes of post-1942 sediment associated with wide areas of the canyon bottom near the Ten Site Canyon confluence. Width and volume of post-1942 sediment deposits in Mortandad Canyon increase beginning in reach M-3W, where the channel gradient decreases and the canyon bottom widens. Maximum volume is in reaches M-3E and M-4C, and the maximum average width of about 60 m (200 ft) is in M-4C. Other areas of locally high volume and width and lower gradient, relative to nearby reaches, include reaches E-1W, PCYN, TS-1C, and TS-3. In contrast, width and volume are generally lowest in relatively steep reaches, such as E-1FW, E-1E, and TS-2E.

Parts of Mortandad Canyon include discontinuous channels, features that are common in many arid and semiarid areas (Bull 1997, 93908) and that enhance the spreading and infiltration of floodwaters and the deposition of sediment and associated contaminants. Where channels end and runoff becomes unconfined, floodwaters can spread over large areas, such as M-4C and the western part of M-5W (Figure 3.2-1 and Plate 4). Runoff from these areas typically feed into headcuts, below which flow is again generally confined within narrow channels. Examples of the beginning of channels at headcuts occur in reaches M-4E and M-5W (Plate 4).

Most of the contaminants in sediments in Mortandad watershed occur in areas of post-1942 sediment deposition outside the active stream channels, as also seen in the Los Alamos and Pueblo watershed (LANL 2004, 87390; Reneau et al. 2004, 93174) and in Cañon de Valle (LANL 2003, 77965; Reid et al. 2005, 91247). At present, these deposits probably constitute the primary source for contaminants carried by floods, as observed in other regions (e.g., Rowan et al. 1995, 82303, pp. 63–64), with active channels and erosion from hillslopes constituting lesser sources. The concentration and inventory (amount) of contaminants in deposits outside the active channel vary longitudinally within the canyons. Concentrations are typically highest in fine sediment deposits near the sources that date to the period of contaminant releases and decrease in younger deposits, in coarser deposits, and downcanyon. Contaminant inventories display more irregular patterns than contaminant concentrations and are related to longitudinal variations in the volume, grain size, and age of sediment deposits within a canyon. Subsequent sections provide examples of the variations in contaminant concentration and inventory in sediment deposits within the Mortandad watershed.

Variations in background concentrations of some analytes in sediment can complicate the identification and evaluation of contaminants related to Laboratory releases. For example, background concentrations of fallout radionuclides in sediments have been shown to vary between regional rivers and reservoirs (McLin and Lyons 2002, 82305) and between these settings and canyons on the Pajarito Plateau (Ryti et al. 1998, 59730; McDonald et al. 2003, 76084). Background concentrations of some inorganic chemicals in sediments have also been shown to vary between different areas on the Pajarito Plateau as a result of local variations in soils or bedrock (Drakos et al. 2000, 68739). Because soils on the Pajarito Plateau have higher concentrations of many inorganic chemicals than sediments (Ryti et al. 1998, 59730), deposition of sediment derived from locally eroded soils provides a possible source for elevated concentrations of inorganic chemicals in sediments.

Mineralogic variations within naturally occurring sediment can also contribute to background variations, for example, the higher concentrations of many metals in black magnetite-rich sands on the Pajarito Plateau, such as iron, manganese, nickel, thallium, vanadium, and zinc (Reneau et al. 1998, 62050, pp. 12–14). Additional variations in background concentrations are the result of incorporation of ash transported from the Cerro Grande burn area, since ash contains higher concentrations of fallout radionuclides and many inorganic chemicals than pre-fire sediment (Katzman et al. 2001, 72660; Gallaher et al. 2002, 82265; Kraig et al. 2002, 85536; Johansen et al. 2003, 82312; LANL 2004, 87390).

Finally, concentrations of various inorganic and organic chemicals in sediment may be elevated near urbanized or industrial areas as a result of runoff from roads and other developed areas (Edwards 1983, 82302; Lopes and Dionne 1998, 82309; Walker et al. 1999, 82308; Breault and Granato 2000, 82310; van Metre et al. 2000, 82262), further complicating the identification and evaluation of contaminants related to Laboratory releases. The topics of variations in background concentration and contributions from developed areas as they relate to key contaminants in the Mortandad Canyon system are discussed in subsequent sections.

7.1.1 Radionuclides in Sediments

Nine radionuclides detected in sediments in the Mortandad watershed have maximum results greater than residential SALs and are more important for assessing potential human health risk: americium-241, cesium-137, cobalt-60, plutonium-238, plutonium-239,240, strontium-90, thorium-228, thorium-230, and thorium-232. This section focuses on spatial and temporal variations in radionuclides in the Mortandad watershed, and supporting information is included in Appendix D.

7.1.1.1 Sources and Spatial Variations in Radionuclide Concentrations

Radionuclides in sediments in the Mortandad watershed have several sources, as indicated by their spatial distribution, and concentrations typically decline downcanyon from the source areas. Subsequent discussions focus on the nine radionuclides that are most important for evaluating potential human health risk, based on comparison to residential SALs in Section 6.2.2: americium-241, cesium-137, cobalt-60, plutonium-238, plutonium-239,240, strontium-90, thorium-228, thorium-230, and thorium-232. Figure D-1.1.1 in Appendix D includes additional plots that show all sample results for radionuclide COPCs plotted against distance from the Rio Grande. Figure D-1.1.1 plots help to identify sources, although these data are biased high because fine-grained sediment layers from the most contaminated geomorphic units in a reach were preferentially sampled. In addition, these plots include some relatively high values from earlier sampling events that could not be replicated in later events.

Figures 7.1-5 to 7.1-10 show the estimated average concentrations of radionuclides whose concentrations and spatial trends indicate clear sources at Laboratory SWMUs or AOCs and whose maximum concentrations exceed residential SALs: americium-241, cesium-137, cobalt-60, plutonium-238, plutonium-239,240, and strontium-90. These are volume-weighted averages in post-1942 fine facies sediment in investigation reaches, where average radionuclide concentrations in a geomorphic unit in a reach are weighted by the volume of fine facies sediment in that unit, removing most of the bias introduced during sample collection. (Sample collection is biased toward geomorphic units and sediment facies with relatively high contaminant concentrations, as discussed in Section B-1 of Appendix B, and straight averages of all sample results from a reach are overestimates of true averages.) Averages for fine facies sediment are shown because average concentrations in this type of sediment are, with a few exceptions, higher than in coarse facies sediment, and fine facies deposits are therefore more important for evaluating risk. Average concentrations for both fine and coarse facies sediment in each reach are presented in Tables D-1.5-1 to D-1.5-6 (Appendix D). In Figure 7.1-10, the sediment BV for strontium-90 is shown for comparison; BVs are too low for the other radionuclides to show at the scales used in the figures.

The most important sources for radionuclide COPCs in the Mortandad watershed are the TA-50 RLWTF outfall into reach E-1E, the former TA-35 WWTP outfall into Pratt Canyon (reach PCYN), and the accidental releases in 1974 from TA-50 into the head of Ten Site Canyon (reach TS-1W), as shown in Figures 7.1-5 to 7.1-10. Average concentrations of americium-241, cesium-137, cobalt-60, and plutonium-239,240 are highest in reach E-1E in Effluent Canyon, and plutonium-238 and strontium-90 are

also present there above background concentrations. Average concentrations of plutonium-238 are highest in Ten Site Canyon between TA-50 and Pratt Canyon; americium-241, cesium-137, cobalt-60, plutonium-239,240, and strontium-90 have also been identified there as COPCs. Average concentrations of strontium-90 are highest in Pratt Canyon; and americium-241, cesium-137, cobalt-60, plutonium-238, and plutonium-239,240 have also been identified there as COPCs. Some of these radionuclide COPCs have been detected above BVs in other areas that suggest the possibility of additional sources, but concentrations are low, and no significant increase in average concentrations is indicated in Figures 7.1-5 to 7.1-10. If releases of radionuclides occurred from other SWMUs or AOCs, they were apparently small.

The pattern of downcanyon decline in radionuclide concentrations is notably different between the different sources, as shown in Figures 7.1-5 to 7.1-10. Downcanyon from the RLWTF outfall into Effluent Canyon, radionuclides generally show decreasing trends for about 3–4 km (1.9–2.5 mi), east of which their average concentrations are similar to background levels. In Ten Site Canyon, the highest concentrations of plutonium-238 are found within 1 km (0.6 mi) of the accidental releases from TA-50, and concentrations are much lower downcanyon—less than in Mortandad Canyon, which is an equal distance downcanyon from the RLWTF (Figure 7.1-8). Similarly, although the average concentration of strontium-90 is much higher in Pratt Canyon than in Effluent Canyon, concentrations are relatively low farther downcanyon in Ten Site Canyon compared with Mortandad Canyon above the Ten Site Canyon confluence (Figure 7.1-10). The occurrence of relatively low-gradient areas near the contaminant sources in Pratt and Ten Site Canyons, where sediment is preferentially deposited (Figure 7.1-4), contributes to the differences seen between canyons. The relatively small drainage areas of Pratt and upper Ten Site Canyons, compared with Mortandad Canyon below the Effluent Canyon confluence, also lead to smaller-magnitude floods and lower transport rates of sediment and associated contaminants from Pratt and upper Ten Site Canyons.

Several deviations from the general downcanyon decline in average radionuclide concentrations are seen in Figures 7.1-5 to 7.1-10 that reflect some of the complexity in the present distribution of contaminants. This complexity probably results at least in part from the combined effects of temporal variations in contaminant releases and spatial and temporal variations in downcanyon sediment erosion and deposition during floods in the subsequent decades, as documented previously in the Los Alamos and Pueblo watershed (LANL 2004, 87390; Reneau et al. 2004, 93174). For example, the higher average concentrations of cesium-137 and other radionuclides in reach M-3E than the concentrations that are immediately upcanyon in M-3W probably records preferential deposition of sediment in M-3E during the period of peak cesium-137 releases from the RLWTF and the general stability of these sediment deposits since that time (as discussed later). In contrast, analytical data from reach M-3W indicate that most of the sediment is younger, postdating the period of peak releases, recording either nondeposition or subsequent erosion of deposits from that time period. The higher average concentrations of cesium-137 and plutonium-238 in M-2E relative to M-2W may similarly record preferential deposition in M-2E during the period of peak releases of these radionuclides, in contrast to americium-241, cobalt-60, plutonium-239,240, and strontium-90, which have higher average concentrations in M-2W.

The general downcanyon decrease in average radionuclide concentrations discussed above applies only to historic sediment deposits that integrate the effects of changing discharge from the sources and downcanyon transport over decadal time frames. Samples collected from the active channel (c1 unit) and associated low surfaces (c1b unit) in 2004 from the TA-50 RLWTF outfall to near the confluence of Mortandad and Ten Site Canyons show a different pattern. This pattern indicates the primary source of radionuclides currently transported by floods is remobilization of sediment previously stored along the channel and in adjacent geomorphic units. Figure 7.1-11 shows that fine facies sediment adjacent to the channel in 2004 (median particle size of coarse silt to fine sand) had the lowest concentrations of cesium-137 in reach E-1E near the RLWTF outfall and that concentrations progressively increased

downcanyon. Cesium-137 concentrations in coarse facies sediment (median particle size of coarse to very coarse sand) were much lower than in the fine facies sediment but also showed relatively low concentrations near the outfall and higher concentrations downcanyon. Concentrations in fine facies sediment increased downcanyon in 2004 because of the erosion of sediment deposits along the channel containing relatively high concentrations of cesium-137. The relatively low concentrations in E-1E, close to the outfall in the reach with the highest concentrations of cesium-137 in older sediment deposits, suggest that most of the sediment in the active channel in this reach is derived from upcanyon of the RLWTF outfall, with relatively small contributions from bank erosion in E-1E. In contrast to the fine facies samples, cesium-137 concentrations in coarse facies samples are similar from M-2W to M-3E, except for a somewhat higher result in M-3W (Figure 7.1-11), suggesting that neither net enhancement nor dilution of cesium-137 is occurring over this 2-km stretch of canyon in coarse sediment associated with mixing of sediment from different sources.

Data from environmental surveillance sampling stations (e.g., ESP 2005, 92222), representing sediment collected from the stream channel, show the same lack of systematic variations in cesium-137 concentration between Effluent Canyon and the Ten Site Canyon confluence (reaches M-2W to M-3E) as seen in coarse facies samples from 2004. Figure 7.1-12 shows average concentrations of cesium-137 in samples collected over the 10-yr period from 1996 to 2005 at surveillance stations in Mortandad Canyon. Concentrations are relatively high and similar at the stations below Effluent Canyon (gaging station E200, reach M-2W), at well MCO-5 (reach M-3W), and above the sediment traps (gaging station E202, confluence of Mortandad and Ten Site Canyons). Concentrations decrease downcanyon from there to well MCO-9.5, west of reach M-5W, and are at background levels farther downcanyon. Cesium-137 concentrations are also at background levels in Mortandad Canyon above Effluent Canyon (Figure 7.1-12).

For several radionuclides that have maximum results above residential SALs, available data do not indicate clear sources at Laboratory SWMUs or AOCs and/or releases that were large enough to noticeably affect average concentrations in a reach. Specifically, thorium-228, thorium-230, and thorium-232 all have maximum values above sediment BVs, but average concentrations calculated for both fine and coarse facies sediment are generally less than background averages, as shown in Table D-1.5-7. Thorium-228 only had one result above the BV, from reach TS-1C in 2004 (sample CAMO-04-53373), and resampling of this sediment layer in 2005 yielded a result below the BV (sample CAMO-05-63743). Thorium-230 had only three results above the BV: two from TS-1C (samples CAMO-04-53373 and CAMO-04-53376) and one from reach MCW-1 (sample CAMO-03-49826). The MCW-1 result was only 7% higher than the BV (2.44 vs. 2.28 pCi/g), and resampling of the TS-1C sample layers in 2005 yielded thorium-230 results below the BV (samples CAMO-05-63743 and CAMO-05-63744). Thorium-232 had three results above BVs: one from M-1C and two from TS-1C. The M-1C result was less than twice the BV (3.48 vs. 2.33 pCi/g), and the TS-1C results were not confirmed upon the resampling discussed for thorium-228 and thorium-230. In summary, available data for these thorium isotopes do not clearly indicate sources at SWMUs or AOCs, and if releases occurred, they were too small to elevate average concentrations in a reach above background averages.

7.1.1.2 Collocation of Radionuclides

The different radionuclide COPCs are generally collocated in sediment deposits in the different reaches in the Mortandad watershed, primarily occurring in post-1942 sediment deposits and preferentially occurring in fine rather than coarse facies sediment. However, the maximum concentrations of each radionuclide may not occur in the same sediment layers in each reach because the relative concentrations of radionuclides in effluent released from outfalls varied over time both as a result of changes in research activities at the Laboratory and changes in wastewater treatment methods. These variations are

discussed further in Section 7.1.1.3. Additional variations result from the mixing of sediment and associated contaminants from different sources and possibly from variable geochemical behavior between radionuclides.

The best correlations between radionuclides downcanyon from the TA-50 RLWTF outfall generally occur between americium-241 and plutonium-239,240 and between cesium-137 and strontium-90, suggesting similar histories of release and transport for these pairs of radionuclides. Good correlations can also exist between other pairs of radionuclides in a reach, although in the complete data set more variability is present that indicates the presence of multiple populations of samples. As examples, Figure 7.1-13 presents scatter plots that show relations between select pairs of radionuclides in M-2E and in the entire data set from the RLWTF outfall through M-4. Both data sets show good correlations between cesium-137 and strontium-90. Correlations are also generally good between americium-241 and plutonium-239,240, although a scattering of samples with high results for plutonium-239,240 deviate from the general trend. Good correlations exist between cesium-137 and plutonium-238 in M-2E, but in the entire data set, distinct populations can be seen that record differences in the ratios between these radionuclides, and the overall correlation is poor. For comparison, relations between plutonium-238 and plutonium-239,240 are poor in both data sets. As discussed in Sections 7.1.1.3 and D-1.6 (Appendix D), populations of samples with different radionuclide ratios are associated with changes in the RLWTF release history and reflect sediment deposits of different age.

Plutonium-238 has maximum concentrations in the Mortandad watershed in Ten Site Canyon upcanyon from Pratt Canyon, and plutonium-239,240 is also elevated in the same reaches. The maximum measured concentrations of both plutonium-238 and plutonium-239,240 in Ten Site Canyon occur in the same sample (CAMO-04-53381), a subsurface layer of fine facies sediment in reach TS-1E. Similar but slightly lower values of both isotopes occur in a subsurface layer of fine facies sediment in reach TS-1C (CAMO-04-53378). These data support simultaneous release and similar behavior of these plutonium isotopes in this part of Ten Site Canyon.

Radionuclide concentrations in Ten Site Canyon show less collocation downcanyon from Pratt Canyon, consistent with mixing of sediment from different sources and variable release histories. The highest concentration of strontium-90 in Ten Site Canyon was measured in a fine facies sediment layer in reach TS-2E, about 420 m (1380 ft) downcanyon from Pratt Canyon. The highest plutonium-239,240 concentration in this part of Ten Site Canyon was measured in a different layer in TS-2E, and the highest plutonium-238 concentration downcanyon from Pratt Canyon was measured in a fine-grained sediment layer in TS-2W.

7.1.1.3 Temporal Variations in Radionuclide Concentration

Data from Mortandad Canyon show that the concentrations of radionuclides in both fine- and coarse-grained sediment generally decreased over time following peak contaminant releases. Some examples of these data are presented below. Additional plots of environmental surveillance data for key radionuclides are presented in Section D-1.2 of Appendix D.

Figure 7.1-14 shows time series of cesium-137 concentrations measured at three environmental surveillance stations in Mortandad Canyon since 1977, supplemented by active channel samples from the reach investigations in 1998 to 2005 and from investigations by the Environmental Science Group in 1972 and 1973 (Nyhan et al. 1978, 5726; results from 0–7.5-cm depth). During this period, concentrations in reach M-2W were highest in the 1970s, decreasing to near present values by 1985. Concentrations in reach M-3W were highest in the early 1970s, decreasing more gradually to near present values by 1995.

Concentrations in reach M-4W were highest from the late 1970s to the early 1980s, also decreasing to near present values by 1995. Cesium-137 concentrations have been relatively constant in the active channel at all three sites since about 1995. These data indicate that the effects of the discharge of cesium-137 from the RLWTF were most pronounced close to the source, but concentrations also decreased most rapidly there. Reductions in cesium-137 concentration over time in channel sediments were slower farther downcanyon, although concentrations have been relatively stable for 10 yr in these areas.

Data collected by the Environmental Science Group in 1972 and 1973 (Nyhan et al. 1978, 5726) document the high variability and high concentrations that existed in radionuclides in the active stream channel close to the RLWTF outfall during the early period of releases. Analyses from the Effluent Canyon channel include the highest reported cesium-137 concentrations from the Mortandad watershed, greater than 3000 pCi/g. Figure 7.1-15 plots the results of this sampling (0–7.5-cm depth) versus distance from the outfall and shows that cesium-137 concentrations varied by a factor of 6 in reach E-1E in a single year and also varied between years. In samples from two locations in reach M-2W, cesium-137 concentrations varied by a factor of 2 between 1972 and 1973. Farther downcanyon, in reaches M-2E and M-3W, cesium-137 concentrations were less variable between years. These data support the conceptual model first proposed by Purtymun et al. (1966, 11848; see also Purtymun 1971, 4795; Nyhan et al. 1978, 5726) that during periods of radioactive effluent release, radionuclides first build up in the stream channel alluvium where the effluent infiltrates into the bed. These radionuclides are subsequently remobilized by higher magnitude stormwater runoff events that scour the bed, being transported with sediment particles farther downstream. The high spatial and temporal variability seen in reaches E-1E and M-2W in Figure 7.1-15 is interpreted to correspond to the area where most of the effluent was infiltrating into the streambed and being periodically scoured, and the lower variability downcanyon is interpreted to largely record the effects of sediment mixing during subsequent downcanyon transport, although some direct contact with effluent was reported at the M-2E site (Nyhan et al. 1982, 7164, p. 532).

Figure 7.1-16 shows reconstructions of the concentrations of five key radionuclides in fine facies sediment in reaches M-3, M-4W, and M-4E near the confluence of Mortandad and Ten Site Canyons between 1960 and 2005. These reconstructions use data from sediment samples collected in this investigation and provide trends consistent with discharge records from the RLWTF. The basis for age estimates for individual sediment layers is discussed in Section D-1.6 in Appendix D. Plots for cesium-137 and strontium-90 have been adjusted for radioactive decay to show both estimated average concentrations at the time of deposition and average concentrations in 2006 when this report was written.

Americium-241 and plutonium-239/240 show very similar trends, with very low concentrations before 1975, well-defined maximum concentrations at ca. 1979–1983, and concentrations near current levels after about 1990 (Figure 7.1-16). Discharge records similarly show maximum releases of these radionuclides in 1981–1983 (LANL 1997, 56835, pp. 2-20, 2-21), which indicates rapid transport over the 3 km from the outfall to the confluence of Mortandad and Ten Site Canyons. Plutonium-238 is present at much lower concentrations, with an earlier peak at ca. 1975–1977 that is consistent with discharge records indicating peak releases in 1974–1975 (LANL 1997, 56835, pp. 2-20, 2-21). Plutonium-238 also has a secondary peak of slightly lower magnitude at ca. 1979–1983. Cesium-137 shows more variability in concentrations, with similar-magnitude peaks in the late 1960s and at ca. 1975–1977; no cesium-137 discharge data from the RLWTF are available from this period for comparison. Strontium-90 shows the highest concentrations in the late 1960s, which is consistent with discharge records that indicate the peak releases in 1964–1965 (LANL 1997, 56835, pp. 2-20, 2-21). Figure 7.1-16 shows that by 2006, concentrations of cesium-137 and strontium-90 in sediment deposits from the late 1960s have been

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reduced by about 60% due to radioactive decay. Both cesium-137 and strontium-90 show gradual decreases in concentration since about 1987, which may also be largely caused by radioactive decay.

7.1.1.4 Relations between Particle Size and Radionuclide Concentration

The particle size distribution of sediment deposits can have a strong influence on radionuclide concentrations because of the preferential tendency for radionuclides to adsorb onto small particles, although these relations can be obscured because of temporal variations in radionuclide release history and other factors (Reneau et al. 1998, 59160; Reneau et al. 2004, 93174; LANL 2004, 87390). General inverse relations between contaminant concentration and particle size within streambed sediment in Effluent and Mortandad Canyons were previously documented by Nyhan et al. (1976, 11747) for samples collected in the early 1970s. The data collected in this investigation provide additional insights into relations between particle size and radionuclide concentrations in the Mortandad watershed, as discussed below.

Figure 7.1-17 plots concentrations of select radionuclides in sediment samples from the Mortandad watershed against percent silt and clay content (percent in the <2-mm fraction of the sample). Cesium-137 is shown for plots in Effluent and Mortandad Canyons downcanyon from the TA-50 RLWTF outfall (reaches E-1E, M-2W, M-2E, M-3, and M-4), and strontium-90 is shown for Ten Site Canyon downcanyon from Pratt Canyon (reach TS-2). With one exception, radionuclide concentrations in these reaches are highest in fine facies sediment deposits with relatively high silt and clay content. The exception is reach M-2W, where cesium-137 concentrations are highest in coarse facies sediment collected from the c3 and f1g units, although within these samples there is a good correlation between cesium-137 and silt and clay content (Figure 7.1-17). The coarse facies deposits in c3 and f1g are interpreted to represent the active streambed during the period of highest cesium-137 discharges, with the high concentrations resulting from the direct interaction of effluent with streambed sediment. Lower concentrations in coarse facies sediment in other reaches suggest that sampled deposits did not have direct contact with effluent during this period.

The highest radionuclide concentrations in other reaches generally occur in deposits with relatively high silt and clay contents, although there is generally much scatter between radionuclide concentrations and silt and clay content in each reach (Figure 7.1-17). This variability probably results in part from the large temporal variations in radionuclide concentrations discussed in Section 7.1.1.3, combined with the mixing of sediment from different sources. Subsets of the data in a reach can display much more systematic relations, such as the good correlations between cesium-137 and silt and clay content in sediment from ca. 1990 to 2005 in M-3 and M-4 (Figure 7.1-17). The effect of deposit age can be seen in M-4, where the samples with the highest cesium-137 concentration (148–276 pCi/g) were from silt and clay-rich sediment deposited ca. 1974–1978. The relatively high cesium-137 concentrations in fine facies sediment in c3 and f1 units in E-1E and in c3 and f1g units in M-2E (Figure 7.1-17) probably also record sediment deposited during periods of high cesium-137 releases.

7.1.1.5 Radionuclide Inventory

Data collected in this investigation define the general geographic variations in the amount, or inventory, of radionuclides contained in sediment deposits in different parts of the Mortandad watershed. Table 7.1-1 summarizes the geographic distribution of americium-241, cesium-137, cobalt-60, plutonium-238, plutonium-239,240, and strontium-90 in sediment deposits in the watershed, which updates and expands on estimates of cesium-137 inventory in a previous report (Reneau et al. 2003, 77103). Supporting data for Table 7.1-1 are presented in Section D-1 of Appendix D. No inventories are estimated for reaches where these analytes are not COPCs (which would largely or entirely represent inventories associated

with background concentrations). Inventory estimates are also not shown for Mortandad Canyon above Effluent Canyon, Mortandad Canyon east of M-5E, or the unnamed tributary canyon that heads in TA-05 because these areas include less than 0.2% of the estimated inventory for each radionuclide. The inventory estimates in Table 7.1-1 are not adjusted for sediment removed during maintenance of the sediment traps in 2000 (WGII 2000, 70735), although the inventory removed is expected to be minor because of the low concentrations present in the traps and in adjacent fill piles. Estimated inventories are also not adjusted for radioactive decay, which would be more important than the maintenance activities for cesium-137, cobalt-60, and strontium-90 because of their relatively short half-lives (30.1, 5.27, and 28.8 years, respectively; Parrington et al. 1996, 58682). For example, radioactive decay would reduce the concentration of cesium-137 and strontium-90 in a layer sampled in 1998, the first year of this investigation, by about 17% by 2006, the date of this report. Estimates of the amount redistributed by floods since characterization was done are not included, although these will have resulted in some reduction in inventory in upcanyon reaches and increases in downcanyon reaches since this investigation began. Estimates of additions of radionuclides from the RLWTF outfall or from erosion from SWMUs or AOCs are also not included, although these are expected to be minor relative to the total watershed inventory in the canyon bottoms.

Table 7.1-1 shows that reach M-3E in Mortandad Canyon upcanyon from the Ten Site Canyon confluence contains the largest amounts of key radionuclides in the watershed, an estimated 50% to 55% of the americium-241, cesium-137, cobalt-60, and plutonium-239,240. Mortandad Canyon between Effluent Canyon and M-3E contains the second largest amounts of these radionuclides, and reach M-4 contains the third largest amounts. Effluent Canyon contains relatively small amounts of all radionuclides because of the small sediment volumes in the steep and narrow canyon below the TA-50 RLWTF outfall. Ten Site Canyon contains an estimated 33% of the plutonium-238, indicating the importance of the accidental releases in 1974 from TA-50 into the head of the canyon but contains relatively low percentages of the remaining radionuclides. Pratt Canyon is notable for strontium-90, containing an estimated 39% of the watershed inventory, although geomorphically Pratt Canyon is not as well characterized as other reaches and has more uncertainty in the strontium-90 inventory. Because sampling in Pratt Canyon was biased to layers with relatively high field radiation measurements, the total strontium-90 inventory is probably overestimated.

Figure 7.1-18 shows the inventory of cesium-137 in Effluent and Mortandad Canyons plotted against distance from the Rio Grande. The cesium-137 inventory in this figure is plotted both as a normalized inventory in each reach per kilometer of channel ([a] units of mCi/km) and as cumulative amounts from the TA-50 RLWTF outfall to reach M-6 adjacent to SR 4 ([b] units of mCi). The cumulative plot extrapolates between sampled reaches. Figure 7.1-18 shows the estimated inventories in coarse and fine facies sediment deposits as well as the total inventory. Cesium-137 was chosen for these plots because it is the most important radionuclide in the watershed from the perspective of potential human health risk, based on a comparison to residential SALs, and because it illustrates the distribution of a key radionuclide downcanyon from the major source area.

Figure 7.1-18 shows that the radionuclide inventory varies considerably between reaches and that essentially the entire inventory is confined to approximately 4 km (2.5 mi) of canyon between the TA-50 RLWTF outfall and reach M-5W. Most of the inventory is contained within fine facies sediment deposits, and an estimated 79% of the cesium-137 in Effluent and Mortandad Canyons is in deposits of fine facies sediment. The most significant area for cesium-137 inventory in Mortandad Canyon is in reach M-3E, 2.1 to 2.7 km (1.3 to 1.7 mi) downcanyon from the outfall. The inventory is relatively high in this reach because of the deposition of large amounts of sediment where the stream gradient decreases and the canyon bottom widens (Figure 7.1-4). Data from a gross-gamma radiation walkover survey clearly show

the general pattern of cesium-137 deposition in M-3E where floodwaters spread over the canyon bottom (Figure 7.1-19).

7.1.1.6 Flood Attenuation and Downcanyon Extent of Radionuclide Contamination

Gaging station records of stream discharge (e.g., Shaull et al. 2005, 92225; Shaull et al. 2006, 93735), observations made during this investigation, and historical records presented in the work plan (LANL 1997, 56835) indicate that floods generated from upper Mortandad Canyon, Effluent Canyon, and Ten Site Canyon significantly attenuate as they move downcanyon, recording transmission losses into the alluvium. For example, from 1997 to 2004, 16 stormwater events occurred with estimated peak discharges exceeding 10 ft^3/s) recorded at gaging station E200 in Mortandad Canyon, 30 m (100 ft) below the Effluent Canyon confluence, and no events of this size recorded at gaging station E202 2.5 km (1.5 mi) downcanyon, near the confluence of Mortandad and Ten Site Canyons (Shaull et al. 2005, 92225, pp. 49, 125). Field observations indicate that stormwater that reaches the west end of reach M-3E near test well TW-8 generally infiltrates into the alluvium completely before arriving at the Mortandad-Ten Site Canyon confluence 0.6 km (0.4 mi.) downcanyon. These observations are consistent with the occurrence of over 50% of the cesium-137 inventory in M-3E (Section 7.1.1.4), recording deposition of most of the historic sediment load as stormwater infiltrates into the alluvium in this reach. In this area, both the canyon bottom and the active channel widen substantially and the channel gradient decreases (Figure 7.1-4 and Table B-1.0-1 [in Appendix B]), which slows stormwater and enhances its ability to infiltrate.

The distribution of cesium-137 and other radionuclides indicates that stormwater that passed the Mortandad-Ten Site Canyon confluence also generally infiltrated into the alluvium within reach M-4, even before excavation of the current sediment traps in 1986 or the original smaller traps in 1976. The canyon bottom does not have a defined channel in M-4C, east of the sediment traps, and stormwater that reached this area historically spread over an area averaging about 60 m (200 ft) in width, further enhancing infiltration and sediment deposition. The estimated cesium-137 inventory in the first 210 m (690 ft) past the sediment traps, in M-4C, is 4 times as high as the inventory in the next 230 m (755 ft), in M-4E (Table D-1.4-2), documenting this deposition of sediment and associated contaminants. The construction of the sediment traps therefore helped enhance a process of infiltration and sediment deposition that was occurring previously.

Since construction of the current sediment traps in 1986, there are only five known occurrences of overflow: June 7, 1987; July 24, 1991; August 6, 1991; August 24, 2005; and August 25, 2006. The downcanyon extent of the 1987 flood is not known, but in 1997 it was reported to be the "largest runoff event in Mortandad Canyon since hydrologic studies began in the canyon in 1960" (LANL 1997, 56835, p. 3-77). In 1991 flow was reported to have extended 200 m (650 ft) past sediment trap #3 (EPG 1993, 23249; LANL 1997, 56835, pp. 3-80, 3-83), and in 2005 flow extended 85 m (280 ft) past the overflow point of sediment trap #3 before infiltrating into the alluvium (Plate 4). The largest flood since initial releases from the TA-50 RLWTF occurred on August 25, 2006, with flow extending to reach M-5E within 65 m (215 ft) of the Laboratory boundary.

Records of earlier flows are sparse, and only one known event has had possible flow to the Laboratory boundary in reach M-5E, in August 1952, when a record 11.2 in. of precipitation was recorded in Los Alamos in 1 month, and flow in this event may have extended to SR 4 below reach M-6 (LANL 1997, 56835, pp. 3-16, 3-81). This was before initial releases from the TA-50 RLWTF in 1963 but after releases began from the TA-35 WWTP into Pratt Canyon in 1951. An additional large runoff event was noted in November 1978, with flow as far east as well MCO-9, between reaches M-4E and M--5W (Purtymun 1994, 52951, pp. 132–135; LANL 1997, 56835, p. 3-77).

Radionuclides display the clearest evidence of contamination in sediment deposits in the Mortandad watershed from Laboratory releases, possessing the highest concentrations relative to BVs or detection limits and the most systematic downcanyon trends. Therefore, radionuclide data provide insight into the downcanyon extent of Laboratory-derived contaminants that have been transported by floods. Five radionuclides have been detected above BVs in sediment downcanyon of reach M-4E (cesium-137, plutonium-238, plutonium-239,240, strontium-90, and uranium-235), and one additional radionuclide without a BV has been detected east of M-4E (cesium-134). None of these radionuclides were identified as COPCs in reach M-6 near SR 4, indicating the absence of recognizable transport of Laboratory-derived contaminants past SR 4.

The eastern identified extent of strontium-90 above the BV is in reach M-5W, although only one sample had a result above the BV (CAMO-04-53299, 1.68 pCi/g, vs. BV of 1.04 pCi/g). The other five radionuclides are COPCs in reach M-5E at the Laboratory boundary, although with generally low detection frequencies and low values above BVs. Cesium-137 was detected in only 1 out of 23 samples slightly above the BV (sample CAMO-00-0033, 0.93 pCi/g vs. BV of 0.9 pCi/g). Plutonium-238 was detected in 2 out of 23 samples above the BV, with a maximum of 0.09 pCi/g (sample CAMO-04-53326, vs. BV of 0.006 pCi/g). Plutonium-239,240 was detected in 8 out of 23 samples above the BV, with a maximum of 0.13 pCi/g (sample CAMO-04-53326, vs. BV of 0.068 pCi/g). Uranium-235 was detected in 1 out of 10 samples above the BV, with a maximum of 0.27 pCi/g (sample CAMO-04-53325, vs. BV of 0.2 pCi/g). Cesium-134, without a BV, was detected in 4 out of 18 samples, with a maximum of 0.1 pCi/g (sample CAMO-04-53325). In summary, the available analytical data indicate possible transport of several radionuclide COPCs as far as reach M-5E but not as far as M-6. The highest values relative to BVs are for plutonium-238 and plutonium-239,240, and the highest detection frequency above BVs is for plutonium-239,240. 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 Laboratory stack emissions and/or by fugitive dust from Laboratory sites (Fresquez et al. 1998, 76063), and the plutonium results in M-5E may or may not record past flood transport.

7.1.1.7 Future Fate and Transport of Radionuclides in Sediment

The concentrations and distribution of radionuclides present in sediment deposits in the Mortandad watershed will continue to change over time as a result of redistribution by floods and radioactive decay, as well as from any additional effluent discharges. Available data show progressive decreases in radionuclide concentration over time, driven largely by decreasing releases from the RLWTF, combined with the effects of mixing of sediment from different sources during transport and radioactive decay for radionuclides with relatively short half-lives such as cesium-137, cobalt-60, and strontium-90. Barring significant increases in the discharge of radionuclides, concentrations can be expected to generally continue declining over time, with a simultaneous downstream redistribution of inventory toward the confluence of Mortandad and Ten Site Canyons. Therefore, the present state of the watershed represents "worst-case" conditions from the perspective of potential future radionuclide contamination.

7.1.2 Inorganic Chemicals in Sediments

Three inorganic chemicals detected in sediments in the Mortandad watershed have maximum concentrations greater than residential SSLs and are most important for assessing potential human health risk: arsenic, chromium, and iron. Additional inorganic chemicals detected in sediment samples are important for assessing potential ecological risk (e.g., copper, cyanide, lead, mercury, perchlorate, thallium, vanadium, and zinc), for understanding relations between COPCs in water and sediment (e.g., lead, manganese, perchlorate, and selenium), or for understanding potential off-site transport onto San Ildefonso Pueblo land (e.g., copper cyanide, and selenium). The spatial distribution of these

inorganic chemicals (discussed below) indicates that they are derived from a variety of sources, including Laboratory SWMUs or AOCs, roads and other developed areas, and naturally occurring soils and bedrock. Once in the canyon bottoms, most of these inorganic chemicals adsorb to sediment particles and organic matter, and their subsequent fate is expected to be similar to that of radionuclides discussed in Section 7.1.1. However, inorganic chemicals derived from runoff from developed areas or from erosion of natural soils in the watershed differ from radionuclides in that these chemicals will not show the same decreases over time, and the concentrations of constituents derived from runoff from developed areas may actually increase over time.

This section focuses on spatial variations in inorganic chemicals in the Mortandad watershed. Supporting information is included in Appendix D. Table D-1.7-1 presents average concentrations in each reach for inorganic chemicals that are discussed in this section, substituting one-half of the detection limit for nondetected sample results. Averages presented here are weighted by the volume of sediment in each geomorphic unit in each reach, as discussed in Section D-1.3. Table D-1.7-1 presents the upper and lower bounds on these averages using either the detection limit or zero for nondetects, respectively, which indicate uncertainties in the average values. This table shows that on average, concentrations of these inorganic chemicals are generally lower in coarse facies sediment than in fine facies sediment, and Figure 7.1-20 and the discussions in the following sections focus on data from fine facies sediment. Figure 7.1-16 and Table D-1.7-1 also indicate that considerable uncertainty in the average concentration of some inorganic chemicals exists in some reaches because of elevated detection limits and/or detected concentrations close to detection limits, such as selenium and thallium.

The plots in Figure 7.1-20 include both the BV for each inorganic chemical, which is an estimate of the upper level of background concentrations, and the average value from the background sediment data set, where available (averages from McDonald et al. 2004, 76084, Table 10, p. 49–50). The background averages are included to be consistent with the presentation of averages from potentially contaminated samples. The spatial distribution of inorganic chemicals indicates that several TAs have been important Laboratory sources for these constituents in the Mortandad watershed, as discussed below.

Average concentrations of arsenic in fine facies sediment are greater than the sediment BV in two reaches, E-1FW and M-1E, both downgradient from TA-48 SWMUs or AOCs (Figure 7.1-20), indicating a source at this TA. Decreasing concentrations are present downcanyon from these reaches, and arsenic concentrations are similar to background averages east of M-2W in Mortandad Canyon. Average arsenic concentrations in M-1W and TS-2E are also above background averages but below the BV, indicating possible sources in TA-03 and from the TA-35 sand filter-bed outfall (AOC C-35-007).

Chromium data indicate a clear source at TA-48, with maximum concentrations in the Mortandad watershed in reach E-1FW, at the head of Effluent Canyon, and decreasing concentrations downcanyon. These data are consistent with known usage of potassium dichromate as a corrosion inhibitor in cooling towers at TA-48, as discussed in Section 7.2.2.1. Average chromium concentrations in fine facies sediment in E-1FW are roughly 100 times greater than in the next highest reach, E-1E, and average concentrations are the same as background averages by the Mortandad-Ten Site Canyon confluence (reach M-4W), 3.3 km (2.0 mi) downcanyon (Figure 7.1-20). Data from M-1C and M-1E, where average concentrations are greater than the BV, indicate one or more additional sources from TA-03 and possibly TA-48 into Mortandad Canyon. An additional minor source is suggested at the TA-35 sand filter-bed outfall by data from TS-2E where average concentrations of chromium are greater than the background average and close to the BV. Analyses of seven samples from E-1FW and E-1W indicate that the chromium in sediment is dominated by trivalent chromium (chromium[III]), with <0.4% hexavalent chromium (chromium[V1]). This contrasts with data from groundwater that indicate a dominance of

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chromium(VI) in that media and is consistent with chemical reduction of chromium associated with the presence of organic carbon in sediments (Section 7.2.2.1).

Chromium is an important contaminant in the regional groundwater system beneath Mortandad Canyon (Section 7.2.2.1; LANL 2006, 91987), and the inventory of chromium present in sediment deposits in the Mortandad watershed as a result of Laboratory operations was estimated to allow comparison with the estimated amount released into the adjacent watershed of Sandia Canyon. The inventory estimates are presented in Table D-1.8-1 of Appendix D and indicate that about 75% of the anthropogenically added chromium in the watershed (subtracting background concentrations) is within Effluent Canyon, almost all above the TA-50 RLWTF outfall, and an additional 12% is within Mortandad Canyon downcanyon of the Effluent Canyon confluence. Most of the chromium associated with sediment has therefore been retained within sediment deposits near the source, with relatively small amounts transported farther downcanyon. The chromium inventory between the main source at TA-48 and SR 4 (reach M-6) is shown graphically in Figure 7-1-21. The inventory estimate indicates that an additional 11% of the watershed inventory is within Mortandad Canyon upcanyon from Effluent Canyon, and only about 1% is in Ten Site Canyon (Table D-1.8-1). About 60% of the estimated inventory is contained within fine facies sediment deposits, and 40% is contained in coarse facies deposits. The total estimated mass of anthropogenically-added chromium in sediment deposits in the Mortandad watershed is about 195 kg (430 lb) (Table D-1.8-1), which is <1% of the amount reported to have been released into Sandia Canyon (an average of 35.9 lb/d from 1950 to the mid-1970s or >100,000 lb; LANL 2006, 91987, p. 3).

A comparison of chromium concentrations with particle-size data indicates that the highest concentrations are in samples with high silt and clay content in reach E-1FW, indicating an affinity for fine-grained sediment particles, as seen with radionuclides (Figure 7.1-22). However, the highest concentration downcanyon in E-1W is in a sample of coarse facies sediment with relatively low silt and clay content. The high concentration in a coarse sediment sample in E-1W is interpreted to represent streambed sediment that was in direct contact with chromium-bearing effluent, as discussed for cesium-137 in M-2W in Section 7.1.1-5.

Chromium analyses obtained from the active channel between the TA-50 RLWTF outfall and the sediment traps in 1979 (Ferenbaugh and Gladney 1997, 93715) provide insights into both temporal and spatial trends in chromium concentration in Effluent and Mortandad Canyons. Figure 7.1-23 plots chromium results from 1979 as a function of distance from the RLWTF outfall and also shows average values from environmental surveillance samples (1992–2005) and active channel samples from the reach investigations (1998–2005). The 1979 data indicate much higher concentrations than at present and a progressive downcanyon decrease in concentrations, attaining present-day concentrations (below the background average) in reach M-3. The data indicate that chromium was being actively released into Effluent Canyon in 1979 or earlier and that by the early 1990s, little chromium was remaining in the active channel of Effluent or Mortandad Canyons downcanyon from the RLWTF outfall.

As with chromium, copper data indicate a clear source at TA-48, with maximum concentrations in the Mortandad watershed in reach E-1FW, and decreasing concentrations downcanyon. Average copper concentrations in fine facies sediment in E-1FW are roughly 5 times greater than in the next highest reach, E-1E, and remain above background averages through M-4 (Figure 7.1-20). Copper is not a COPC farther downcanyon. The spatial distribution of copper indicates additional sources into Ten Site Canyon from TA-35, with a local maximum in reach TS-2C below the outfalls from the TA-35 wastewater lagoons. Copper is not a COPC in TS-1W but is in TS-1C and downcanyon, indicating one or more sources at other TA-35 SWMUs or AOCs. Additional sources of copper into the upper part of Mortandad Canyon from TA-03 and TA-48 are indicated by average concentrations in fine facies sediment that exceed the background average in reaches M-1W and M-1E. The M-1W data may indicate a source from

road runoff, as copper is reported to be a common contaminant associated with vehicles (Breault and Granato 2000, pp. 48–49).

Cyanide has a maximum concentration in sediment samples in reach MCW-2W, on San Ildefonso Pueblo land below TA-05 SWMUs or AOCs. This was the only detected result above the BV (1.37 mg/kg in sample CAMO-03-49844, vs. BV of 0.82 mg/kg), and additional samples were collected in 2005 to see if this result could be confirmed. Resampling of that location and additional samples from two nearby locations in the same geomorphic unit yielded results below the BV (0.14 to 0.19 mg/kg, samples CAMO-05-63588, CAMO-05-63608, and CAMO-05-63609). There is therefore no evidence of cyanide from Laboratory SWMUs or AOCs impacting sediments in the Mortandad watershed.

Iron data suggest releases from the same sources as for arsenic and chromium, although average concentrations are generally within the background range and background variations at least partially affect the results. Only one reach, M-1E, has average concentrations in fine facies sediment slightly greater than the BV, indicating collocation with arsenic and chromium (Figure 7.1-20). Average concentrations in E-1FW and TS-2E are above background averages and suggest additional sources into the head of Effluent Canyon and into Ten Site Canyon, although average concentrations of iron are also greater than background averages in M-5W, downcanyon from significant Laboratory-derived contamination. The M-5W iron results above the BV are interpreted to represent a locally elevated background, as also found in Cañada del Buey, the next canyon to the south (Drakos et al. 2000, 68739).

Lead data indicate multiple sources in the upper parts of Effluent, Mortandad, and Ten Site Canyons. The average concentrations of lead in fine facies sediment are above the sediment BV in reaches E-1FW, M-1C, and M-1E and close to the BV in M-1W and TS-1C (Figure 7.1-20). Lead concentrations decrease downcanyon from these areas, and lead is not identified as a COPC downcanyon from M-4E. Lead is a common contaminant found below roads and other developed areas, and one source is leaded gasoline (Walker et al. 1999, 82308, p. 364; Breault and Granato 2000, 82310, p. 48; Callender and Rice 2000, 82307, p. 232). The distribution of lead in the Mortandad watershed suggests runoff from developed areas is one source, although releases from Laboratory SWMUs or AOCs is also possible, particularly from sites like TA-48 where the sediment data indicate releases of other metals (e.g., arsenic, chromium, copper, mercury, and vanadium).

Manganese data suggest releases from one or more sources in the Mortandad watershed, although background variability appears to be responsible for at least some of the results above the BV. Average manganese concentrations in fine facies sediment are greater than the BV in reaches M-1E and E-1W (Figure 7.1-20), suggesting releases from TA-48 and possibly TA-55. These are also reaches with relatively high concentrations of manganese in surface water (Section 7.2.2.1). Manganese is also elevated relative to background averages in E-1FW, E-1E, and TS-3. Although the elevated concentrations in E-1FW and E-1E suggest releases from one or more outfalls into Effluent Canyon, the TS-3 results apparently record background variations because manganese is not a COPC in the TS-2 reaches, closer to potential contaminant sources.

Mercury data indicate multiple sources in the Mortandad watershed, with the TA-50 RLWTF outfall into Effluent Canyon reach E-1E and the TA-35 sand filter-bed outfall into Ten Site Canyon reach TS-2E being most important (Figure 7.1-20). These two reaches and reaches M-2W and M-2E in Mortandad Canyon downcanyon from Effluent Canyon have average mercury concentrations in fine-grained sediment deposits greater than the BV, and several other reaches have averages greater than the background average, including E-1FW, M-1W, M-1E, and TS-2C. Data from these reaches indicate additional sources of mercury at TA-03, TA-35, and TA-48. Concentrations generally decrease downcanyon, and mercury was not identified as a COPC east of M-4.

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Perchlorate data from sediment are relatively sparse but indicate a recognizable source at the TA-50 RLWTF outfall into reach E-1E, consistent with effluent discharge records, and transport downcanyon into M-4 (Figure 7.1-20). Perchlorate was not detected in Effluent Canyon upcanyon from the RLWTF outfall or in Ten Site Canyon but was detected in every reach between the RLWTF outfall and the east end of M-4. The absence of detected perchlorate in sediment in Ten Site Canyon contrasts with its detection in a borehole in Pratt Canyon, as discussed in Section 7.2.2.1, that indicates releases from the former TA-35 WWTP. Perchlorate concentrations in sediment in the Mortandad watershed are low, with a maximum measured concentration of 0.959 mg/kg in reach M-2W (sample CAMO-01-0072). Average concentrations suggest a secondary peak in reach M-4E (Figure 7.1-20), although this is not considered to be reliable because of the low sample numbers and high frequency of nondetects (67% nondetects between the RLWTF outfall and the east end of M-4). The low-detection frequency and low concentrations in sediment samples are consistent with the high solubility of perchlorate and indicate a relatively small inventory in the near-surface sediment deposits in Mortandad Canyon.

Selenium is a COPC that exceeds the wSAL in stormwater in the Mortandad watershed and that NMED has requested be included in biota evaluations (NMED 2005, 92084). Selenium has been identified as a COPC in sediment in all reaches in the watershed except one (M-5W) and has detected results greater than the sediment BV of 0.3 mg/kg in most of the other reaches (except M-6, MCW-2N, and TS-1W, where nondetect values exceed the BV). Understanding the sources and distribution of selenium in the Mortandad watershed is complicated by elevated detection limits in many samples and by local background concentrations that appear to be greater than the BV. Selenium detection limits as high as 11.5 mg/kg have been provided by analytical laboratories for sediment samples from the Mortandad watershed, which results in large uncertainties in estimates of average concentrations, as shown in Figure 7.1-20. Elevated background levels are indicated by data from units with little or no evidence of Laboratory contamination, such as five samples from the area designated as f2?(Qt?) in reach M-4E. Selenium concentrations from this geomorphic unit average 0.37 mg/kg and range from 0.26 to 0.51 mg/kg. Data from the adjacent watershed of Cañada del Buey also indicate an elevated local background for selenium, and sediment from drainages with no upgradient SWMUs or AOCs has yielded selenium results as high as 1.2 mg/kg (Drakos et al. 2000, 68739). These data indicate local background concentrations of selenium significantly above the BV of 0.3 mg/kg and at least as high as 1.2 mg/kg. Review of the maximum detected selenium concentrations shows that they are geographically dispersed and do not indicate a clear Laboratory source, contrasting with the distribution of other inorganic chemicals discussed in this section. For example, the four detected selenium results that exceed 1 mg/kg (range of 1.1 to 1.6 mg/kg) were obtained from four different reaches (E-1E, M-1E, TS-1E, and TS-2C). Therefore, although selenium data indicate the possibility of releases from Laboratory SWMUs or AOCs, if releases occurred, they were apparently small in relation to local background levels; natural background variations may account for much or all of the elevated selenium results.

Thallium is a potentially important COPC for evaluating ecological risk, as discussed in Section 8.1. Thallium data suggest relatively small releases into Effluent Canyon from the TA-50 RLWTF and rapid downcanyon attenuation. Only five detected thallium results are above the BV of 0.73 mg/kg: three in reach E-1E and two in M-2W. In both reaches, the average thallium concentration in fine facies sediment is above the background average but well below the BV (Figure 7.1-20). Thallium is a COPC in only three other reaches (M-5E, TS-1W, and TS-1C) and only because detection limits for some samples are greater than the BV.

Vanadium is a potentially important COPC for evaluating ecological risk, as discussed in Section 8.1, and vanadium data indicate releases from multiple Laboratory sources. The average concentrations of vanadium in fine facies sediment are greater than the BV in reaches M-1E and E-1FW (Figure 7.1-20), both downcanyon from outfalls at TA-48 and indicating releases from this site into Mortandad Canyon and

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into the head of Effluent Canyon. Concentrations attenuate rapidly downcanyon from these reaches, and vanadium is not a COPC in either E-1E or M-2W. Vanadium concentrations are also elevated in Ten Site Canyon, with average concentrations being close to the BV in reach TS-2E, downcanyon from the TA-35 sand filter-bed outfall. Elevated concentrations in TS-1W, TS-1C, and TS-2W suggest additional sources into Ten Site Canyon from TA-50 and TA-35.

Zinc is a potentially important COPC for evaluating ecological risk, as discussed in Section 8.1, and zinc data indicate multiple sources in the Mortandad watershed. The highest average zinc concentrations in fine facies sediment are in reach M-1W at the head of Mortandad Canyon, and zinc concentrations progressively decrease downcanyon (Figure 7.1-20). Reach M-1W receives runoff from large areas of paved roads and parking lots, and zinc is commonly found in urban runoff; one important source for zinc is tire-wear particulates (Walker et al. 1999, 82308, p. 364; Breault and Granato 2000, 82310, p. 49; Callender and Rice 2000, 82307, p. 232). Similarly, the highest average concentrations of zinc in the Los Alamos and Pueblo watershed were found in the upper parts of Acid and DP Canyons, which also receive runoff from large paved areas (LANL 2004, 87390, p. 7-14). The average concentration of zinc in M-1W, about 85 mg/kg, is less than that found in reaches in upper Acid and DP Canyons, 100-130 mg/kg. A secondary maximum for zinc occurs in reach E-1FW at the head of Effluent Canyon, indicating a source in runoff from developed areas at TA-48 and/or releases from outfalls. In comparison to upper Mortandad and Effluent Canyons, Ten Site Canyon has lower levels of zinc in relation to background levels, with average concentrations in fine facies sediment being greater than the background average but less than the BV (Figure 7.1-20).

In summary, the sediment data indicate that inorganic chemicals in the Mortandad watershed have multiple sources, including Laboratory SWMUs or AOCs, runoff from developed areas, and naturally occurring soils. TA-48 is apparently the most important source for several metals, including arsenic, chromium, copper, vanadium, and possibly iron, and included releases into Mortandad Canyon and particularly into the head of Effluent Canyon. The TA-50 RLWTF outfall into Effluent Canyon is the most important source for mercury, perchlorate, and possibly thallium. The former sand filter-bed outfall from TA-35 into Ten Site Canyon is apparently a secondary source for several metals, such as arsenic, chromium, mercury, and vanadium. Runoff from developed areas is apparently the most important source of zinc and possibly lead. Some of the variations in concentrations of inorganic chemicals are also attributable to background variations, such as iron in reach M-5W and perhaps elsewhere and selenium in many reaches. Concentrations generally decrease downcanyon from the sources, and in some cases the contaminants are largely contained in sediment deposits near the sources, such as chromium in the upper part of Effluent Canyon. Remobilization of these chemicals by erosion will result in a progressive downcanyon shift of the inventory and accompanying decreases in concentrations, as discussed for radionuclides.

7.1.3 Organic Chemicals in Sediments

Two organic chemicals detected in sediments in the Mortandad watershed have maximum results greater than residential SSLs and are more important for assessing potential human health risk: the PCB Aroclor-1264 and the PAH benzo(a)pyrene. Additional organic chemicals detected in sediment samples are important for assessing potential ecological risk (e.g., bis(2-ethylhexyl)phthalate, di-n-butylphthalate, DDT[4,4-], and endrin aldehyde), for understanding relations between COPCs in water and sediment (e.g., bis(2-ethylhexyl)phthalate), or for understanding potential off-site transport onto San Ildefonso Pueblo land (e.g., acenaphthene, acetone, and bis(2-ethylhexyl)phthalate). These organic chemicals are derived from a variety of sources, including Laboratory SWMUs or AOCs and runoff from roads and other developed areas, as indicated by their spatial distribution (discussed below). Once in the canyon bottoms, most of these organic chemicals will adsorb to sediment particles and organic matter, and their

subsequent fate and transport by fluvial processes are expected to be similar to that for the radionuclides, which were discussed in detail in Section 7.1. Similar to some of the radionuclides, the organic chemicals discussed here have relatively short environmental half-lives associated with biodegradation and/or volatilization in the environment. Therefore, the concentrations will decrease over time unless contaminants are added to the canyon bottoms (such as from road runoff). However, the degradation rates are not well constrained and will vary with local environmental conditions.

This section focuses on spatial variations in organic chemicals in the Mortandad watershed, and supporting information is included in Appendix D. Table D-1.7-2 presents average concentrations in each reach for organic chemicals that are discussed in this section, substituting one-half of the detection limit for nondetected sample results. Table D-1.7-2 also presents the upper and lower bounds on these averages, using either the detection limit or zero for nondetects, respectively. This table indicates that on average, concentrations of these organic chemicals are lower in coarse than in fine facies sediment, and the discussions and figures in the following sections focus on data from fine facies sediment. Table D-1.7-2 also indicates that considerable uncertainty exists in the average concentration of organic chemicals in some reaches because of elevated detection limits.

7.1.3.1 PCBs

PCBs have low solubilities and a strong affinity for organic material and sediment particles (Chou and Griffin 1986, 83419). PCBs were widely used in electric transformers and other industrial applications (e.g., Walker et al. 1999, 82308, pp. 364–365), and their wide use is consistent with their spatial distribution in sediments in the Mortandad watershed. Figure 7.1-24 presents average concentrations of Aroclor-1260 and Aroclor-1254 in fine facies sediment in the Mortandad watershed, substituting one-half of the detection limit for nondetected sample results and showing upper and lower bounds on these averages. These data indicate that PCBs come from multiple sources in the watershed and that concentrations generally decrease downcanyon from these sources, as discussed below.

Aroclor-1260 has been detected in almost every reach in Effluent and Ten Site Canyons and in Mortandad Canyon as far east as M-4 but not farther downcanyon or in the unnamed tributary canyon that heads in TA-05. Aroclor-1260 has the highest average concentrations in reaches TS-1W and TS-1C, indicating one or more sources from TA-50 and possibly TA-35 into the upper part of Ten Site Canyon (Figure 7.1-24). These are also the only reaches with maximum concentrations above residential SSLs (1.37 and 1.3 mg/kg vs. an SSL of 1.12 mg/kg). Average concentrations of Aroclor-1260 decrease rapidly downcanyon in Ten Site Canyon. The data indicate additional sources into Effluent and Mortandad Canyons but at lower levels than in Ten Site Canyon.

Aroclor-1254 has a lower frequency of detection and was detected at lower concentrations and in fewer reaches than Aroclor-1260. The spatial distribution of Aroclor-1254 is somewhat different than for Aroclor-1260. Aroclor-1254 has the highest average concentrations in reach E-1FW (Figure 7.1-24), indicating the most important source for this PCB is TA-48, and concentrations decrease rapidly downcanyon in Effluent Canyon. Additional minor sources are indicated in upper Ten Site Canyon above reach TS-1W.

7.1.3.2 PAHs

PAHs have a range of chemical properties with some being less volatile and less soluble, and these chemicals are more likely to become adsorbed to and persist in sediments (Neff 1979, 83420). Some PAHs, such as naphthalene, are relatively volatile and should have the lowest affinity for sediments, whereas others, such as benzo(a)pyrene, are less volatile and less soluble and have a stronger affinity

for sediments. The different PAHs also have somewhat different spatial distributions in the Mortandad watershed, indicating different sources, as discussed below. Considerable uncertainty exists in the average concentrations of PAHs in some reaches because of elevated detection limits in data obtained from the SVOC analytical suite (method SW-846:8270C), although detection limits and associated uncertainties are lower in reaches with data obtained from the PAH analytical suite (method SW-846:8310).

Benzo(a)pyrene is the only PAH in the Mortandad watershed with concentrations above residential SSLs and has been detected in most reaches in Effluent and Ten Site Canyons and in Mortandad Canyon as far east as M-4 but not farther downcanyon or in the unnamed tributary canyon that heads in TA-05. Benzo(a)pyrene has the highest average concentrations at the head of Mortandad Canyon in reach M-1W, downcanyon from large paved areas and a major road in TA-03 (Diamond Drive) (Figure 7.1-25), consistent with a primary source in runoff from developed areas. Drainage from tar roofs is another possible source of benzo(a)pyrene and other PAHs in runoff from developed areas. A clear association between benzo(a)pyrene and runoff from developed areas was also seen in the Los Alamos and Pueblo watersheds (LANL 2004, 87390, p. 7-16), where average concentrations are up to several times higher than in the Mortandad watershed (the average concentration in fine facies sediment in reach AC-1 at the head of Acid Canyon is approximately 2.3 mg/kg, compared with approximately 0.7 mg/kg in M-1W). Benzo(a)pyrene is also notably elevated in reaches TS-1C and TS-1E in upper Ten Site Canyon (average of approximately 0.5 mg/kg, Figure 7.1-19), indicating a source from developed areas at TA-35 and/or TA-50. Lower concentrations are present in Effluent Canyon (average of approximately 0.2 mg/kg, Figure 7.1-19) and farther downcanyon in Mortandad Canyon.

Acenaphthene is the only PAH detected east of reach M-4, in reach M-5E, and the maximum detected concentration in the Mortandad watershed is also in M-5E (1.8 mg/kg). The apparent spatial distribution of acenaphthene is very irregular (Fig. 7.1-25), and the apparently elevated concentrations in M-5E are not considered reliable because of the absence of other evidence for significant transport of other contaminants this far downcanyon (Section 7.1.1.6). In addition, the elevated concentrations of acenaphthene in M-5E were obtained from the SVOC analytical method in 2000, and subsequent sampling in 2004 using the PAH method, with lower detection limits (0.025 mg/kg), did not provide any detected results. Interpretation of the acenaphthene results in upcanyon reaches is complicated by elevated detection limits and a high frequency of nondetects in many reaches, although the elevated results in M-1C are considered reliable because they were obtained with the PAH method, and the M-1C data had a relatively high-detection frequency (50%). These data therefore indicate a source for acenaphthene in upper Mortandad Canyon, such as runoff from developed areas as inferred for benzo(a)pyrene, and perhaps other less important sources in Effluent and Ten Site Canyons (Figure 7.1-25).

7.1.3.3 Other SVOCs

Besides PAHs, several other SVOCs are important in the Mortandad watershed for assessing potential human health or ecological risk, understanding sources of COPCs in water, or assessing potential transport off-site onto San Ildefonso Pueblo land. Sources and average concentrations of these SVOCs are typically uncertain, as discussed below.

Bis(2-ethylhexyl)phthalate was identified by ECORSK9 modeling as being the most important COPEC for the Mexican spotted owl, a T&E species (Gonzales et al. 2006, 93786). This SVOC also exceeds drinking water standards and has been detected in sediment samples collected on San Ildefonso Pueblo land. As shown in Figure 7.1-26, bis(2-ethylhexyl)phthalate displays no clear spatial trends in fine facies sediment, and the estimated average concentrations have much uncertainty associated with high frequencies of

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nondetects (82% in sediment samples in the watershed) and with detection limits that are similar to reported detected values. Anomalies in the data set also indicate many of the detected values are suspect and/or do not represent releases from Laboratory SWMUs or AOCs. For example, five out of nine samples from reach M-6 are reported as detects, and the estimated average concentration here is similar to in upcanyon reaches closer to potential sources (Figure 7.1-26), but there are no detects in the next two upcanyon reaches (M-5W and M-5E) and no evidence for transport of other COPCs as far downcanyon as M-6. EPA has identified bis(2-ethylhexyl)phthalate as a common laboratory contaminant (EPA 1989, 8021, p. 5-16), which may explain some of the results. Therefore, although the available bis(2-ethylhexyl)phthalate data indicate the possibility of releases from SWMUs or AOCs, because of uncertainties in the data set, no sources can be clearly identified, and concentrations in sediment in the watershed are poorly constrained.

Di-n-butylphthalate was identified by ECORSK9 modeling as being the most important COPEC for the western bluebird and southwestern willow flycatcher, a T&E species (Gonzales et al. 2006, 93786). This SVOC has a high frequency of nondetects in sediment samples from the Mortandad watershed (99.5% nondetects) and was detected only in three reaches (MCW-2N, TS-1W, and TS-1C). As with bis(2-ethylhexyl)phthalate, di-n-butylphthalate displays no clear spatial trends in fine facies sediment (Figure 7.1-26), and the estimated average concentrations have much uncertainty associated both with the low detection frequency and detection limits that are similar to reported detected values. EPA has also identified di-n-butylphthalate as a common laboratory contaminant (EPA 1989, 8021, p. 5-16). Therefore, although the available di-n-butylphthalate data indicate the possibility of releases from SWMUs or AOCs, because of uncertainties in the data set no sources can be clearly identified, and concentrations in sediment in the watershed are poorly constrained. It is possible that the detected values at least in part reflect artifacts of the laboratory analyses (e.g., false positives).

7.1.3.4 Pesticides

Several pesticides in sediments have been identified as potentially important in assessing ecological risk in the Mortandad watershed. These organic chemicals have low solubilities and a strong affinity for organic material and sediment particles (Pionke and Chesters 1973, 83423; Nowell et al. 1999, 83422). The spatial distribution of pesticides in sediments in the Mortandad watershed indicates that these analytes have multiple sources at the Laboratory, which is consistent with their expected dispersed use in pest-control efforts. However, understanding their spatial distribution and sources is in part complicated by a high frequency of nondetects and detected concentrations close to detection limits. As two examples, Figure 7.1-27 presents average concentrations of DDT and endrin aldehyde in fine facies sediment in the reaches, substituting one-half of the detection limit for nondetected sample results and showing upper and lower bounds on these averages.

DDT is the pesticide with the highest aquatic HQ in the Mortandad watershed. It was detected at low concentrations in many reaches, although it has a relatively low detection frequency in the watershed (84% nondetects). The data suggest that the highest concentrations are in Mortandad Canyon from Effluent Canyon to reach M-3W, although much uncertainty is present associated with the influence of nondetects (Figure 7.1-27). Ten Site Canyon has detects only in reach TS-3 and not in upcanyon reaches closer to sources, indicating the apparent spatial patterns may not be reliable. Effluent Canyon reach E-1FW also has no detects of DDT, although downcanyon reaches do.

Endrin aldehyde is the pesticide with the highest terrestrial HQ in the Mortandad watershed. Endrin aldehyde has a low frequency of detection in sediment samples in the Mortandad watershed (97% nondetects) and was detected only in reaches E-1E, M-1C, M-2W, and M-3. Sources for endrin aldehyde are uncertain, and its spatial distribution does not display clear trends, showing the highest

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concentrations in reaches M-2W and M-3 (Figure 7.1-27). Average concentrations are also uncertain because of detected values that are similar to the detection limits.

7.1.3.5 VOCs

VOCs have been detected in many reaches within the Mortandad watershed at low concentrations, but their spatial distribution is irregular and it is not certain to what degree the reported detects represent releases from SWMUs or AOCs or instead artifacts of the analyses (e.g., false positives). Detects in downcanyon reaches (M-5W and M-5E), at similar or greater concentrations than in upcanyon reaches closer to potential sources, indicate that at least some of these results do not represent releases from the Laboratory. Examples are discussed below for acetone, benzene, and methylene chloride.

Acetone has been detected in most reaches within the Mortandad watershed, with the highest average concentrations in fine facies sediment in M-1E and E-1FW below TA-48, suggesting releases from this TA (Figure 7.1-28). Acetone data also suggest releases from one or more sites into Ten Site Canyon, with estimated highest average concentrations in TS-1C and TS-2E. However, acetone concentrations are also relatively high in M-5W and M-5E, and it seems unlikely that the M-5W and M-5E data represent transport of acetone from Laboratory sites because these reaches are downcanyon of significant transport of radionuclide COPCs (Section 7.1.1.6). EPA has identified acetone as a common laboratory contaminant (EPA 1989, 8021, p. 5-16), and some of the results may represent false positives.

Benzene has also been detected downcanyon in M-5E in a single sample (CAMO-04-53325, 0.0006 mg/kg), at a concentration similar to in upcanyon reaches closer to potential sources. Of the nine detects in sediment samples from the Mortandad watershed (4% detection frequency), six are from Ten Site Canyon, with a maximum from TS-2E (CAMO-04-53394, 0.0008 mg/kg). The benzene data therefore indicate possible releases from Laboratory sites into Ten Site Canyon, although the detect in M-5E indicates that at least some of the data represent artifacts of the laboratory analyses.

Methylene chloride has been detected in five reaches in the Mortandad watershed (M-3, M-4, M-5W, M-5E, and TS-1C), and the maximum concentrations and the highest frequency of detects are in reaches M-5W and M-5E (Figure 7.1-28). Other reaches closer to potential sources have only single detects, at lower concentrations. The apparent spatial distribution of methylene chloride is therefore inconsistent with releases from Laboratory sites and subsequent downcanyon transport by floods. EPA has identified methylene chloride as a common laboratory contaminant (EPA 1989, 8021, p. 5-16), and these data largely or entirely represent artifacts of the laboratory analyses.

7.2 Conceptual Models for Hydrology and Contaminant Transport in Groundwater

The hydrology of the Mortandad watershed is described in Section 7.2.1 and includes surface water, alluvial groundwater, pore water in the upper vadose zone, intermediate-perched water, and regional groundwater. Contaminant distributions and transport processes are described in Sections 7.2.2 and summarized in Section 7.3.

7.2.1 Watershed Hydrology

The Mortandad watershed heads in the central part of the Pajarito Plateau in TA-03 and extends east southeast for 15.8 km (9.8 mi) to the Rio Grande (Plate 1). The watershed has a catchment area of about 15.5 km^2 (6 mi^2), which is relatively small compared with larger watersheds that head in the mountains, such as the Los Alamos and Pueblo Canyons watershed. The Mortandad watershed has no naturally perennial reaches. As a result, the surface water, alluvial groundwater, unsaturated zone and

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intermediate-perched zone hydrology of the Mortandad watershed is largely controlled by the location and discharge volumes of anthropogenic water sources and by runoff from developed (e.g., paved) Laboratory technical areas. The subsequent distribution of surface water, sediments, groundwater, and contaminants is strongly influenced by the canyon geology and topography.

The Mortandad drainage heads entirely within the upper units of the Tshirege Member of the Bandelier Tuff. From its headwaters, the stream channel drops about 300 m (1000 ft) over a 13-km (8-mi) passage to the bluffs above White Rock Canyon, with an additional 245-m (800-ft) drop in elevation along the last ~3 km (~1.8 mi) of steep channel to the Rio Grande. Along the 13-km (8-mi) segment of shallower gradient, the stream channel cuts progressively down section through the Tshirege Member of the Bandelier Tuff, Cerro Toledo deposits, the Otowi Member of the Bandelier Tuff, and perhaps some minor amounts of Puye Formation fanglomerate that wedge out eastward on top of Cerros del Rio lava flows. The steep channel near the Rio Grande cuts through resistant Cerros del Rio lavas capping poorly consolidated stream gravels (Totavi Lentil) and Santa Fe Group sediments. These relations are illustrated in the conceptual hydrogeologic cross section in Figure 7.0-1.

For the purposes of the following hydrologic discussion, the Mortandad Canyon watershed on Laboratory property is subdivided into five canyon segments based on their hydrogeologic characteristics. The locations of these hydrologic segments are shown in Figure 7.2-1. These five segments include the

- Upper Mortandad Canyon hydrologic segment extending from the headwaters near Diamond Drive to the confluence with Effluent Canyon,
- Effluent Canyon hydrologic segment extending from the headwaters of Effluent Canyon to the confluence with Mortandad Canyon,
- Middle Mortandad Canyon hydrologic segment extending from the confluence with Effluent Canyon to the confluence with Ten Site Canyon,
- Ten Site Canyon hydrologic segment extending from the headwaters of Ten Site Canyon to the confluence with Mortandad Canyon, and
- Lower Mortandad Canyon hydrologic segment property extending from the confluence of Ten Site Canyon to the eastern Laboratory boundary.

7.2.1.1 Surface Water Hydrology

The conceptual model for surface water hydrology is based on gaging station data, outfall discharge records, and visual observations. Figure 7.2-1 shows the locations and modes of surface water occurrences throughout the watershed and the current locations of Laboratory NPDES outfalls and surface water gages. Canyon reaches defined for sediment sampling and their designations are also shown since they provided the basis for documenting visual observations of surface water occurrence.

The primary sources of surface water in the Mortandad watershed, aside from seasonal runoff and snowmelt, are currently five NPDES outfalls (Figure 7.2-1):

- TA-03-29, CMR Building (NPDES outfall EPA03A-021)
- TA-03-2274, Sigma Building (NPDES outfall EPA03A-022)
- TA-55-6, Plutonium Facility Complex (NPDES outfall EPA03A-181)
- TA-50-1, Radioactive Liquid Waste Treatment Facility (NPDES outfall 051)
- TA-35-124, Large Generator (NPDES outfall EPA03A-160)

The TA-03 outfalls consist of treated water associated with cooling at the CMR and Sigma Buildings and provide seasonal, intermittent discharges (generally April or May through October) to the upper Mortandad Canyon hydrologic segment above reach M-1W. The TA-55 outfall provides intermittent discharge of treated cooling water to upper Effluent Canyon above reach E1-W. Historically, each outfall discharged about 38 L/min ($6.3x10^{-4}$ m^3/s) (LANL1997, 57236), but discharges are discontinuous, variable, and seasonal. The TA-50 outfall consists of treated effluent discharges from the RLWTF into reach E-1E. Since 1997, the RLWTF discharges have averaged approximately 37.4 cubic meters per day (m^3/d). However, these discharges have decreased significantly in recent years from an average 63.7 m^3/d L/d in 1998 to an average 17.3 m^3/d in 2006 (through September 4, 2006). The TA-35 outfall discharges cooling tower blowdown associated with a large generator to Ten Site Canyon above reach TS-1W. These outfalls combined provide a significant component of surface water flow in the watershed beyond that produced by naturally occurring runoff and snowmelt. Annual discharge totals for the Mortandad outfalls from 2004 to 2005 are shown in Table 7.2-1 (LANL 2004, 94068; LANL 2005, 94073).

A total of five streamflow gaging stations are operated within the Mortandad watershed (Figure 7.2-1), from which data are regularly reported (Shaull et al. 2005, 92225; Shaull et al. 2006, 93735). Gage E200 is located in the uppermost portion of the middle Mortandad Canyon hydrologic segment approximately 30 m (100 ft) below the confluence of Effluent Canyon and 230 m (755 ft) below the TA-50 RLWTF outfall. This gage records the sum of natural runoff plus RLWTF effluent and TA-55 outfall discharges. Gage E202 is located at the boundary between the middle and lower Mortandad Canyon hydrologic segments upstream of the sediment traps at the Ten Site confluence. This gage only occasionally measures flow during extreme runoff events and records no flow most of the time. Gage E2015 is located in the Ten Site Canyon hydrologic segment approximately 400 m (1310 ft) upstream from E202. This gage has recorded only occasional minor intermittent flows since October 2000. Gage E203 is located in the lower Mortandad Canyon hydrologic segment at the outlet to sediment trap #3, approximately 260 m (850 ft) downstream from E202, and gage E204 is located in the lower Mortandad Canyon hydrologic segment approximately 15 m (50 ft) upstream from the Laboratory/San Ildefonso Pueblo boundary. Gage E203 has been continuously dry since October 1996 except for two recent sediment trap overflow events on August 24, 2005 (Shaull et al. 2006, 93735, pp. 44-45,) and August 25, 2006. Gage E204 has been continuously dry since October 1993, but there has been no known flow at San Ildefonso boundary since RLWTF discharges began in 1963. Table 7.2-2 shows the number and percentage of days with recorded flow at each streamflow gaging station. These data show the effects of infiltration losses on surface water between the middle and lower Mortandad Canyon hydrologic segments. Whereas gage E200 recorded flow for 75% of the days of record, E202 recorded flow for only 14% of the days of record, while E203 and E204 have been continuously dry during the period of record.

Since gage E200 is the uppermost reported streamflow gage in the watershed, a comparison of outfall discharges to the streamflow measured at gage E200 was made to assess the magnitude of the component of outfall discharges to total flow in the canyon (Figure 7.2-2). These data illustrate a variable relation between the volumes of outfall discharges and recorded flow at E200. The RLWTF is the only outfall whose flow reaches gage E200; flow from the others stops upcanyon, while the TA-35 effluent enters Mortandad Canyon below the gage (actually never making it out of Ten Site Canyon) and does not contribute to streamflow at E200. Data from 2004 and 2005 show streamflow significantly exceeding outfall volumes for the four contributing outfalls; these years had fairly normal natural runoff volumes. The RLWTF outfall percentage of flow at E200 was 4% and 9% during 2004 and 2005, respectively.

Surface water occurrences were determined from a series of field observations made during site visits to the various sediment sampling reaches in the canyon between June 2003 and September 2005 (Reneau, 2005). Canyon reaches with surface water observations are subdivided into ranges of percentage of observations with surface water present. Reaches identified in 100% of the observations are considered

"perennial" where water flow is continuous throughout most of the year. Reaches identified in 50%–99% of the observations are considered "intermittent" where the stream channel is predominantly dry throughout much of the year but have some extended periods of flow from snowmelt runoff, spring discharge, or groundwater discharge associated with high groundwater levels. Reaches identified in 1%-49% of the observations are considered "ephemeral" where the stream channel is predominantly dry throughout most of the year but may experience short periods of flow (i.e., hours to days) in response to storm events, particularly summer thunderstorms.

Approximately 87% of the Mortandad watershed upstream from the boundary with San Ildefonso Pueblo burned in the Cerro Grande fire of 2000 (BAER 2000, 72659). However, the burn was of low intensity and little to no change is surface water flow was recorded in the years immediately following the fire. Gage records indicate similar peak discharges before and after the fire (Shaull et al. 2003, 76042).

Upper Mortandad Canyon Hydrologic Segment

In upper Mortandad Canyon, above the confluence of Effluent Canyon, welded tuffs underlying the stream channel are relatively impermeable and limit the amount of infiltration along the stream channel. Persistent surface water originates primarily at TA-03 from runoff events (snowmelt and rainfall) and from seasonal outfall discharges from noncontact cooling water. Reach M-1W is indicated in Figure 7.2-1 as a perennial reach with surface water present during 100% of the observations made during the 2003-2005 surveillance period. Reach M-1W is downstream from NPDES outfall EPA03A-021 from the CMR Building in TA-03 and also receives runoff from extensive paved areas at the head of the watershed. Water was always observed in bedrock pools in the east part of M-1W and was usually observed in a bedrock area closer to the outfall and in the middle of the reach downstream from a headcut into alluvium where a small cattail wetland is supported. Plunge pools occur where the stream channel becomes steeper as the drainage incises into the upper part of Tshirege unit Qbt 2. Intermittent flow conditions exist below reach M-1W, as indicated by observations in reaches M-1C (below TA-48) and M-1E. A small cattail wetland exists adjacent to the stream channel below TA-48, and cattail wetlands are also present in reach M-1E where the stream has a bedrock channel as the canyon steepens eastward. Relatively deep and persistent bedrock pools are present downstream from reach M-1E. Historically, other outfalls from TA-48 have also contributed to surface water in this canyon segment. No gage is located within this canyon segment, but 79% of the observations made in reach M-1E indicate the intermittent presence of surface water there while 50% of the observations in reach M-1C indicated intermittent water associated with a fluctuating water table in the alluvium.

Effluent Canyon Hydrologic Segment

In Effluent Canyon, welded tuff bedrock underlying the stream channel limits infiltration along the stream channel. Intermittent flow occurs in reach E1F-W with surface water present during 75% of the observations. Here, water is fed by storm runoff that supports willows and cattails. Perennial flow is indicated in reaches E-1W (fed by the TA-55 outfall) and E-1E (fed by the TA-55 and TA-50 outfalls). Surface water was present during 100% of the observations made in these reaches between 2003 and 2005.

The TA-50 RLWTF has discharged to Effluent Canyon since 1963 at NPDES-permitted outfall EPA 051. Annual effluent discharge volumes have ranged from a high of 60.28 million liters (60,280 m^3) in 1968 to 6.93 million liters (6,930 m^3) in 2005 (Table 2.1-1 and Figure 2.1-1). Discharges are released from two 79,000-L (79-m^3) holding tanks. Effluent is released from one tank at a time when full. Timing of releases is variable, ranging from over 2 weeks between releases to daily releases over several consecutive days. Usually only one release occurs during a day, but occasionally two or three releases are made in a single

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day. Between 1997 and September 2006, releases occurred an average of 3 d/wk. Historically, seasonal variability in discharge volumes has been significant, but quarterly release volumes have been relatively consistent since 2005 (Figure 7.2-3).

Effluent Canyon also receives stormwater runoff from portions of TA-48, TA-55, and TA-35, which contributes to a small wetland at the head of the canyon between TA-48 and the discharge point for the TA-50 outfall.

Middle Mortandad Canyon Hydrologic Segment

From west to east in the middle Mortandad Canyon hydrologic segment, bedrock becomes progressively less welded and more permeable, and canyon-bottom alluvium thickens. Surface flow generally infiltrates in the eastern part of this segment. Outfall discharges from Effluent Canyon are a major source of surface water to the middle Mortandad Canyon hydrologic segment below the confluence with Effluent Canyon and above the confluence with Ten Site Canyon (Figure 7.2-2). These discharges comprise a significant percentage of the flow at gage E200, which measures surface flow entering the middle Mortandad Canyon hydrologic segment from both the Effluent Canyon and upper Mortandad Canyon hydrologic segments. Based on visual observations between 2003 and 2005, indicating that surface water was present during 100% of the observations in reach M-2W, surface water flow in the middle Mortandad Canyon hydrologic segment is indicated as perennial in reach M-2W for a distance of approximately 570 m (1870 ft) below the Effluent Canyon confluence (fed by the TA-55 and TA-50 outfalls and road runoff) (Figures 7.2-1 and 7.0-1). Surface water in reach M-2W, however, is typically discontinuous, with stretches with no surface water, and water was present partly as bedrock pools and emergence from saturated alluvium rather than as a through-flowing stream. The region of surface water flow coincides with relatively thin alluvium in a channel underlain by the welded portions of Qbt 2. However, gage E200 has recorded flow for 75.4% of the days during its period of record since 1995, indicating that persistent surface flow is not uninterrupted in this canyon segment. Intermittent flow occurs in reach M-2E with surface water present as discontinuous flowing water and pools during 78% of the observations made during 2003–2005 surveillance period. No flow was observed below reach M-2E during the 2003–2005 observations, indicating the point below which water has infiltrated into the thickening canyon bottom alluvium or is lost to evaporation. Beyond reach M-2D, surface water is ephemeral in response to high discharge volumes or to upstream runoff. Only infrequently, generally following severe summer thunderstorms, does surface water exit the middle canyon. This is illustrated in Figure 7.2-4 which depicts the hydrographs for streamflow measured in reported gages during 2005 and 2006. The hydrograph for gage E202 shows that this gage recorded flow on only 11 of the 587 days of record during this period. Except for a larger flood event on August 24, 2005, during which the mean daily discharge was about 48 liters per second (L/s [1.7 cfs]), only minor flow events from about 1 to 6 L/s (0.04 to 0.2 cfs) mean daily discharge were measured at E202 during the 2005–2006 period (through August 14, 20/06).

Gage E200 provides the most consistent record of persistent flow in the watershed. A comparison of cumulative daily TA-50 effluent and gage E200 streamflow discharge volumes since 1997 is shown in Figure 7.2-5. From mid-1997 to 2000, the cumulative TA-50 discharges were roughly half of the total flow recorded at E200. Since 2001, the rate of discharge from TA-50 has declined while total runoff at E200 has increased. Notable flow increases were recorded at E200 in January 2002 and January-March 2004 associated with snowmelt or flood events. By August 2006, cumulative discharges from TA-50 were only about 19% of the cumulative total flow at E200 for the period from 1997 to August 2006.

A comparison of seasonal (quarterly) discharge volumes since 1997 for the TA-50 outfall and the E200 gage is shown in Figure 7.2-6. The streamflow volume for the quarter ending on 3/31/04 is literally off the chart in this figure. The total streamflow volume recorded at E200 during this quarter exceeded

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175,000 m^3, which is nearly 5 times greater than the total flow at E200 in any other quarter since 1997. Otherwise, the highest quarterly streamflow totals are generally associated with spring snowmelt runoff and summer-fall monsoon rains while lower streamflow amounts are generally recorded in the winter, though several exceptions to this pattern are present (e.g., occasional high winter flows and low summer-fall flows). After the RLWTF discharges peaked in 1999, a subtle seasonal pattern of higher discharges in the summer and lower discharges in the winter is apparent for the TA-50 outfall, while the declining trend in discharge volume is clearly evident. The seasonal TA-50 percentage of E200 streamflow discharge is shown in Figure 7.2-7. Data from the second quarter of 1998 and the second and third quarters of 2000 were compromised by extended periods of equipment failure at E200 and are thus excluded from this graph. A clear pattern of seasonality for this parameter is not readily apparent from these data. Examining the extreme conditions for this parameter shows that the highest proportions of TA-50 contributions to total flow (exceeding 80%) occurred in the first and fourth quarters of 1997, the third quarter of 2000, the second quarter of 2004, and the first quarter of 2006. These occurrences are related to drought conditions leading to abnormally low inputs of naturally occurring runoff or snowmelt during these periods and not a regular seasonal variation. The lowest proportions of TA-50 contributions to total flow (less than 8%) occurred in the fourth quarter of 2001 and first quarter of 2002, the fourth quarter of 2003 and first quarter of 2004, and the first and third quarters of 2005. A relatively low proportion of TA-50 flow was also recorded in the fourth quarter of 2004 (about 14%). An inconsistent seasonal pattern is thus apparent during the winters of 2001–2002, 2003–2004, and 2004–2005 when higher runoff occurred leading to low relative contributions of outfall discharges to total flow. This analysis indicates that winter runoff is frequently (since 2001) a significant contributor to total surface flow in the upper and middle watershed.

The seasonal TA-50 outfall percentage of E200 flow since 1997 is summarized in Table 7.2-3. The mean and median percentages are nearly equal for the first and second quarters at about 41% and 47%, respectively. The third quarter exhibits the lowest proportion of TA-50 flow with mean and median percentages of about 23% and 25%, respectively, illustrating the effects of monsoonal rains to total flow in the watershed. The fourth quarter proportion of TA-50 flow has a mean percentage of about 34% but a median value of about 28%. These data suggest that overall, surface water flowing from the upper Mortandad Canyon hydrologic segment generated by naturally occurring runoff makes up a large percentage of E200 flow during the summer and fall. In addition, building cooling-water discharges from the CMR and Sigma Buildings at TA-03 may also contribute seasonally. The proportion of TA-50 flow during the summer and fall is only about one-fourth of the total streamflow, whereas during the winter and spring seasons, the TA-50 discharges comprise nearly half of the total flow recorded at gage E200. The annual averages clearly show the declining influence of the TA-50 outfall on surface flow in the watershed. Whereas in 1997 the TA-50 outfall comprised 63% of the flow recorded at E200, by 2005, its contribution was only 21%.

Ten Site Canyon Hydrologic Segment

Pratt Canyon is a small tributary to Ten Site Canyon, which is a tributary to Mortandad Canyon. Before 1963, Pratt Canyon received effluent from the TA-35 Waste Water Treatment Plant (Section 2.1). Purtyman (2002, 11787) reported that historical effluent discharges from Pratt Canyon to Ten Site Canyon were insufficient to reach Mortandad Canyon as surface flow.

Surface flow conditions in the Ten Site Canyon hydrologic segment are currently recorded at gage E2015, which is located near the mouth of canyon (Figure 7.2-1). As seen in Figure 7.2-4, mean daily flows recorded at E2015 seldom exceed 3 L/s (0.1 ft^3/s), and the gage is dry most of the time. As noted in Table 7.2-2, flow was recorded in this gage on only 11% of the days during its period of record (since 2000). Virtually all of this flow is attributed to runoff from paved areas, but the current TA-35 outfall (03A-160) releases into the head of Ten Site Canyon and may also contribute. As depicted in

Figure 7.2-1, surface water conditions range from intermittent in reaches TS-1W, TS-1C, and TS-2E to ephemeral in reaches TS-1E, TS-2W, and TS-2C. During the period of visual surveillance in 2003–2005, reaches TS-1W, TS-1C, and TS-2E contained surface water during 69%, 58%, and 73% of the observations, respectively. Relatively persistent water was found in depressions between boulders or scour holes (TS-1W and TS-1C), and in shallow bedrock depressions (TS-1E). Reaches TS-1E, TS-2W, and TS-2C contained surface water during 41%, 31%, and 17% of the observations, respectively. Although occasional small flows were recorded at gage E2015, no water was ever observed in reach TS-3.

Lower Mortandad Canyon Hydrologic Segment

Surface water is ephemeral and occurs infrequently in the lower Mortandad Canyon hydrologic segment. This canyon segment is characterized by a broad flat canyon floor with an indistinct drainage system. It contains thick alluvial deposits (up to 30 m [100 ft]) that rapidly imbibe the rare surface water flows that reach this part of the canyon.

No visual observations of surface water were ever made below the confluence with Ten Site Canyon during the 2003–2005 surveillance period. However, an exception flood event did occur in August 2006. As noted in Table 7.2-2, gage E202, which records flow entering this section of the canyon, recorded measurable flow during only about 14% of the days during its period of record (since 1997). As illustrated in Figure 7.2-4, flows are infrequent and normally very small, with the exception of occasional major flood events. When flow occurs, the water is routed through three sediment traps dug into the alluvial channel. The sediment traps dam the water into retention basins so that contaminated sediments settle, and the impounded surface water then infiltrates into the permeable alluvium. Gage E203 (Figure 7.2-1), located below the sediment traps, has never recorded flow during its period of record since 1996. Before 2005, the sediment traps were generally continuously dry since December 1997 except for a post-fire event in the upper sediment trap on May 26-29, 2001. Since then, the upper sediment trap has filled with water on August 24, 2005 and August 25, 2006. Gage E204 (Figure 7.2-1) at the Laboratory boundary with San Ildefonso Pueblo has also never recorded flow during its period of record (since 1993). Stream flow extended nearly to the Laboratory boundary for a major flood that occurred on August 25, 2006 (after the streamflow gage data for this report were compiled). Clearly, however, surface water flow in the lower Mortandad Canyon hydrologic segment is a rare event.

In the lower Mortandad Canyon Hydrologic Segment from the San Ildefonso boundary to the Rio Grande, flow is probably derived from local rainfall events and/or flow from tributaries entering Mortandad Canyon below the Laboratory boundary. Although no documented flow measurements in this reach are available, the stream channel shows evidence of at least occasional flow in places, and tributaries like Cedro Canyon have likely fed water locally into lower Mortandad Canyon. Flow is ephemeral only to the confluence of Cañada del Buey. Intermittent or perennial flow occurs from the Cañada del Buey, confluence to the Rio Grande, fed by White Rock WWTP discharges.

7.2.1.2 Alluvial Groundwater

Surface water infiltrates into the canyon bottom alluvial sediments until its downward movement is impeded by zones of lower permeability, usually weathered tuff, forming a perched alluvial aquifer with intermittently varying levels of saturation. The alluvial groundwater conceptual model is based on water-level responses to precipitation and streamflow data, and to effluent discharge. In addition, recent field observations have added to the conceptual understanding of the alluvial groundwater system, indicating that the system is complex and heterogeneous. In much of the watershed, a perched zone of saturation exists at the base of the alluvium where it overlies less permeable bedrock. Otherwise, the

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alluvium above and adjacent to the perched zone is unsaturated. Figure 7.2-8 shows the extent of the alluvial groundwater based on average alluvial water levels for the summer of 2005. Figure 7.2-9 is an isopach map showing thickness variations in the alluvium from the confluence of Mortandad and Ten Site Canyons to the eastern Laboratory boundary. Figure 7.2-10 shows the distribution of geologic units beneath the alluvium in the same area.

A series of plots, shown in Appendix F, present time series of water levels at selected alluvial wells. These time series are discussed in the following sections to illustrate the relationship of alluvial water-level fluctuations to precipitation and runoff events. Historically, effluent discharges from the TA-50 RLWTF have represented a large percentage of the watershed water balance. However, they have steadily declined since 1998 to where they comprised only about 10% of the flow recorded at gage E200 in 2005 (Figure 7.2-2). Whereas historically the main volume of the alluvial groundwater body may have been fairly steady, it has gradually become more dependent on recharge from naturally occurring runoff as the influence of outfall discharges throughout the watershed has diminished. This has resulted in highly variable saturation conditions in the alluvium with notable transient responses to recharge from major runoff events.

In addition to temporal variations, the model also addresses spatial variations in the nature of the water-level record and the relation of water-level responses to precipitation and streamflow. A series of plots, shown in Appendix F, also incorporate these data to describe the system. The plots include daily precipitation measured at the TA-06 meteorological station located on Two-Mile Mesa, approximately 970 m (3180 ft) south-southwest of the headwaters of the upper Mortandad Canyon hydrologic segment, as well as mean daily discharge measured at streamflow gaging stations E200 and E202. The TA-06 precipitation record, obtained from the Laboratory meteorological database (http://weather.lanl.gov), was chosen because it is the station closest to the upper part of the watershed, which is the main source area for runoff.

The following discussion describes variations in alluvium thickness and downcanyon changes in suballuvium geology for the Mortandad watershed. Results of the alluvial water-level study are also summarized from Appendix F. The reader is referred to Appendix F for a detailed discussion of spatial and temporal variations in water-level data for the alluvial wells in each of the hydrologic segments in the watershed.

Upper Mortandad Canyon Hydrologic Segment

Alluvium is generally thin in the upper Mortandad Canyon hydrologic segment. The thickness of alluvium is about 1 m (3 ft) at MCO-0.6, located below TA-48 approximately 780 m (2560 ft) above the Effluent Canyon confluence, and 1.8 m (5.9 ft) at MCA-1, located approximately 70 m (230 ft) above the Effluent Canyon confluence (Figure 3.2-1, Plate 1). Alluvium is underlain by poorly welded to nonwelded tuffs of Tshirege unit Qbt 3 in the westernmost part of this hydrologic segment and by strongly welded tuffs of Tshirege unit Qbt 2 in the central and eastern parts of this hydrologic segment (Figure 7.0-1).

Since mid-2005, the alluvial groundwater system has typically been dry or nearly dry in the late winter, spring, and early summer seasons until recharged by summer storm runoff. The thin alluvium results in a limited ability to store groundwater. As a result, alluvial saturation levels in the upper canyon areas respond nearly instantly to recharge from runoff events, and recession of water levels is generally rapid afterwards.

Effluent Canyon Hydrologic Segment

Alluvium in the Effluent Canyon hydrologic segment is generally less than 1 to 2 m (3 to 6 ft) thick, and portions of the stream flow in a bedrock channel. Alluvium is 1.6 m (5.4 ft) thick in the wetlands at MCA-4, but the stream forms a steep-walled channel with little alluvium east of the wetlands. Alluvium is underlain by poorly welded to nonwelded tuffs of Tshirege unit Qbt 3 in the headwaters of this drainage and by strongly welded tuffs of Tshirege unit Qbt 2 in the central and eastern parts of this hydrologic segment.

Hydrograph data (Appendix F) show similar aquifer behavior to that seen in the upper Mortandad Canyon hydrologic segment. Alluvial water levels rise rapidly in response to stormwater runoff events associated with summer and fall precipitation events, and the groundwater responses occur virtually instantaneously, correlating well with the streamflow record at gaging station E200. However, alluvial saturation levels are more persistent in the Effluent Canyon hydrologic segment due to the TA-50 and TA-55 outfalls that contribute to recharge that provides a base flow saturation level of generally 0.3 to 0.6 m (1 to 2 ft).

Middle Mortandad Canyon Hydrologic Segment

Alluvium is generally thin in the western half of the middle Mortandad Canyon hydrologic segment, and it becomes progressively thicker from approximately the center of the segment to the confluence with Ten Site Canyon to the east (Figure 7.2-9). Alluvium is about 1.8 m (6 ft) thick at MCA-5 at the upper end of the segment, 8.8 m (29 ft) thick at MCB-5, and 18 m (60 ft) thick at RES-2 near the confluence with Ten Site Canyon. Because of the inaccessible terrain, there are no boreholes between MCA-5 and MCB-5 (Figure 3.2-1, Plate 1), and there is no information on the thickness of alluvium in that part of the canyon. The thin alluvium in the western half of the middle Mortandad Canyon hydrologic segment overlies strongly welded tuffs of Tshirege unit Qbt 2. The thickening alluvium in the eastern half of the middle Mortandad Canyon hydrologic segment overlies progressively older and more porous bedrock units in a downcanyon direction, including the poorly welded tuffs at the base of Qbt 2, nonwelded tuffs in Qbt 1v and Qbt 1g, and poorly consolidated sediments of the Cerro Toledo interval (Figures 7.0-1 and 7.2-8).

The alluvial groundwater in the middle Mortandad Canyon hydrologic segment is a transitional zone between the dynamically responding behavior of the upper canyon segments and a more stable and slowly responding system in the lower canyon segments. In the upper part of the middle Mortandad Canyon hydrologic segment (about 200 m [655 ft] below the Effluent Canyon confluence), a thin perched aquifer is restricted within a narrow bedrock channel and has little capacity for aquifer storage. This results in highly transient saturation conditions with instant responses to runoff recharge events followed by rapid recessions (generally a few days). Here the alluvial aquifer was dry about half the time (during the winter and spring seasons) since mid-2005.

Farther downcanyon (about 400 m [1310 ft] above the Ten Site confluence), intermittent and variable saturation levels still exist. A time lag of several weeks between a major surface runoff event and a corresponding rise in the water level indicates that alluvial groundwater recharge in this canyon segment is primarily from groundwater underflow that was recharged by infiltration of runoff further upcanyon. Only after persistent levels of alluvial saturation are maintained do flood events result in nearly instantaneous water-level rises showing the influence of rapid recharge from local infiltration.

Near the Ten Site confluence, the delayed recharge effect is more pronounced with time lags of several months between major streamflow events and alluvial groundwater recharge responses. Also, much longer recessional limbs (weeks to months) in the alluvial hydrographs from this area reflect an enlarged aquifer storage capacity attributable to the deepening package of alluvial sediments present beneath the widening canyon floor. Most water movement in the alluvial aquifer near the Ten Site confluence is

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probably lateral within the alluvium, but some percolation losses from the base of the alluvium are also possible.

Ten Site Canyon Hydrologic Segment

Alluvium is relatively thin in the western half of the Ten Site Canyon hydrologic segment. This alluvium overlies poorly welded to nonwelded tuffs of Tshirege unit Qbt 3 in the headwaters of the canyon and strongly welded tuffs of Tshirege unit Qbt 2 near well R-14 (Plate 1). In the eastern part of the Ten Site Canyon hydrologic segment, as the canyon exits the hard tuffs of Tshirege unit Qbt 2, the valley floor flattens and broadens eastward, and the alluvium becomes significantly thicker. At well TSCO-6 the alluvium is 6.5 m (21.3 ft) thick, and at R-33 the alluvium is 20 m (66 ft) thick (Figure 7.2-9). Alluvium in the eastern half of the Ten Site Canyon hydrologic segment overlies progressively older bedrock units in a downcanyon direction, including the poorly welded tuffs at the base of Qbt 2, nonwelded tuffs in Qbt 1v and Qbt 1g, and poorly consolidated sediments of the Cerro Toledo interval (Figure 7.2-10).

Alluvial well TSWB-6 has been dry during every measurement event since its installation in 1994. Newly installed well TSCA-6 encountered alluvial water but the period of record is too short to evaluate the hydrograph. Therefore, no water-level data for Ten Site Canyon are summarized here.

Lower Mortandad Canyon Hydrologic Segment

Alluvium reaches its maximum thickness in the lower Mortandad Canyon hydrologic segment (Figure 7.2-9). From west to east, the thickness of alluvium varies from 21.2 m (69.5) ft at MCB-8, 25 m (82 ft) at MCB-10, 34.3 m (112.5 ft) at MCOBT-8.5, and 32.8 m (107.5 ft) at MCA-9 (Figure 3.2-1, Plate 1). From the vicinity of R-15 to the San Ildefonso Pueblo boundary, the alluvium-filled basin is asymmetric, with deeper alluvium occurring beneath the northern part of the canyon floor (Figure 7.2-9). Drill-hole data and cross-canyon resistivity profiling (see Section 7.2.1.3 and Appendix H) support the interpretation of asymmetry in the alluvial-filled basin, with gentler suballuvial slopes to the south and steeper slopes to the north. Mass-wasting apparently contributed to the alluvial fill along the steep north wall of the canyon; colluvial blocks up to 3 m (10 ft) in diameter are intercalated with fluvial sediments at MCOBT-8.5 (Broxton et al., 2002, 76006). Alluvium is underlain by Cerro Toledo fluvial deposits in the western part of the lower Mortandad Canyon hydrologic segment and by Otowi Member ash flow tuffs in the central and eastern parts (Figure 7.2-10).

In the lower Mortandad Canyon hydrologic segment, where alluvial groundwater is most prevalent, time lags of 5 to 6 months between runoff events and recharge responses in the alluvial aquifer are typical. Greater aquifer storage is available because of the thickening alluvial sediments causing long recessional limbs in alluvial hydrographs of up to 2 years. Infiltration losses from the alluvium in this canyon segment limit the extent of saturation. The downgradient extent of alluvial saturation occurs near a point about 700 m (2300 ft) below the Ten Site confluence where infiltration losses from the alluvium have led to less than fully saturated conditions spanning time periods of several years. In the easternmost wells with alluvial saturation, time lags of 8 to 17 months for response to upstream recharge events have been observed.

7.2.1.3 Vadose Zone

The vadose zone is defined as the region between the land surface and the top of the regional aquifer (see Figure 7.0-1). The vadose zone is about 365 m (1200 ft) thick beneath the upper Mortandad Canyon hydrologic segment and 245 m (800 ft) thick beneath the eastern portion of the lower Mortandad Canyon hydrologic segment. The discussion in this section will focus on the unsaturated portions of the vadose

zone. Sections 7.2.1.2 and 7.2.1.4 provide detailed descriptions of the alluvial groundwater and intermediate-perched zones, respectively, which are saturated intervals located within the vadose zone. This subsection initially focuses on the shallow vadose zone (i.e., from the land surface through the Bandelier Tuff), and then concludes by discussing the deep vadose zone (including the Cerros del Rio basalts and the Puye Formation, Figure 7.0-1). In addition, specific discussions of flux meter measurements and VECTOR in situ permeable flow sensor data collected in the Mortandad watershed are presented in Appendix M.

Volumetric Water Content

One of the most important hydrologic characteristics of the vadose zone is water content, and volumetric water content profiles for recent Mortandad boreholes are shown in Appendix B. The borehole profile data show that water contents vary widely with depth as well as up and down and laterally across the canyon. For example, in MCB-7, volumetric water contents range from less than 5% to saturation (e.g., 40%–50%) within the alluvium. Variability such as this plays an important role in the rates of water and contaminant movement in the canyon because fluxes in unsaturated media (both vertical and lateral) are strongly controlled by water content. As a demonstration of this variability, average volumetric water contents are summarized for each borehole by stratigraphic unit (and in one case by depth interval) in Table 7.2-4. Boreholes are also ordered from upcanyon (at the top of the table) to downcanyon so that along-canyon values can be compared. Note that MCB-15 is in Ten Site Canyon, and MCI-1 and MCI-10 were not drilled in the Mortandad Canyon bottom.

A cross section showing the spatial distribution volumetric water content along the axis of Mortandad Canyon is shown in Figure 7.2-11. This figure shows an interpolated representation of all available volumetric water content data collected in the Mortandad watershed as of 2005. The contours indicate that a large fraction of the vadose-zone moisture is located near and below the confluence of Mortandad Canyon and Ten Site canyons. This area is represented in Figure 7.0-1 as the zone of greatest percolation of alluvial groundwater to the deeper vadose zone, as represented by the large vertical arrows. This area coincides with zones containing persistent and intermittent alluvial groundwater and the only occurrences of intermediate-depth perched groundwater that show influences from Mortandad sources. Much of this wetter area is underlain by thick alluvium overlying the Cerro Toledo interval with locally high moisture contents (Figures 7.0-1, 7.2-9, and 7.2-10). Together, these data suggest alluvial groundwater is the source of enhanced percolation to the underlying rocks of the vadose zone. The loosely consolidated sediments of the Cerro Toledo interval may facilitate deep percolation in this area.

Alluvial groundwater is often perched at or near the contact between alluvium and underlying Cerro Toledo deposits. However, high moisture contents (as well as soluble contaminants such as perchlorate) commonly extend downward into the underlying Cerro Toledo deposits (Figure 7.2-11 and 7.2-12). Moisture and contaminant profiles indicate that the base of saturation does not represent a no-flow barrier. Rather, elevated values for moisture and soluble contaminants persist into deeper bedrock units that are not fully saturated.

Table 7.2-4 compares moisture contents for rocks of the upper vadose zone on a unit-by-unit basis. From these data, it is evident that the 0–6-m (0–20-ft) depth interval has the lowest overall water contents. Water contents at this depth are affected greatly by evapotranspiration (evaporation plus transpiration) losses, and the 0–6-m (0–20-ft) depth interval likely has the largest temporal variability, especially close to the ground surface, because of the dynamics between evapotranspiration, infiltration, and percolation. These data suggest that although the RLWTF outfall and runoff provide significant water to the canyon, evapotranspiration still plays a large role in the canyon water balance. Additional evidence for this control is described later in the discussion on stable isotope profiles.

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Deep alluvium (>6 m [>20 ft]) shows a great deal of variability in volumetric water content, much of which is related to the presence or absence of alluvial saturation. There is a suggestion that water contents decrease in the deep alluvium in locations near the Laboratory boundary (i.e., MCOBT-8.5 and R-28); however, MCB-16 has a relatively high average water content of 21%.

Tshirege Member unit Qbt 2 (>6 m [>20 ft]) was observed in only two canyon bottom holes (MCB-1 and MCB-2), and average water contents vary between 10% and 24%. MCB-1 is located in Effluent Canyon above the TA-50 RLWTF outfall, and MCB-2 is located at the confluence of Mortandad and Effluent canyons (Plate 1). None of the Qbt 2 samples in these two boreholes had water contents over 25%, and both boreholes were dry when drilled. Thus, the strongly welded nature Qbt 2 and the upper canyon hydrological conditions appear to inhibit the formation of shallow perched saturated zones in this setting.

Tshirege Member unit Qbt 1 has a similar range of average water contents to Tshirege unit Qbt 2; however, Qbt 1 was observed in more boreholes. One interesting note is that a horizon of nearly saturated or saturated tuff was observed in MCB-2 near the contact of Tshirege subunits Qbt 1v and Qbt 1g. Similar occurrences of enhanced moisture at the Qbt 1v/Qbt 1g contact have been observed in other parts of the Laboratory (e.g., borehole 49-2-700-1 at TA-49, Stimac et al., 2002, p.7).

The Cerro Toledo interval has some of the highest average water contents presented in Table 7.2-4. Some of these water contents may be high because of leakage from the alluvial perched horizons during drilling. However, the number of observed high values indicates that the Qct is one of the wetter units within the canyon.

The Otowi Member average water contents tend to center around the high teens to low twenties, indicating that the Otowi is 30%–40% saturated (assuming 45% porosity) from R-1 to near the Laboratory boundary. However, the specific water-content profiles for boreholes MCB-14, MCOI-6, MCOI-8, R-1 and R-15 (Appendix B) show extensive intervals with water contents approaching thirty. These wells are located in an area with persistent alluvial groundwater and are shown in Figure 7.0-1 as being located in the region of enhanced vadose-zone flow.

In contrast to the upper vadose zone described above, there is much less information available about the deeper vadose zone (e.g., the Cerros del Rio basalts and the Puye Formation). Only one hole was cored within the deep zone, and no core data exist for the Puye Formation in Mortandad Canyon. At R-15, volumetric water contents in the basalt are less than 10% from about 150 to 215 m (500 to 700 ft) (Longmire et al. 2001, 70103). Below the intermediate perched zone, water contents increase to about 30% near the contact with the Puye Formation. The basalt units are difficult to characterize because they can have a wide range of porosities and hydraulic conductivities, depending on whether the basalts are massive or fractured, or if interflow/paleosol zones are present. Fracture porosity is a possible route for fast transport through the basalts. The closest proxies for the deep vadose zone in Mortandad Canyon are R-12 and R-9 in Sandia and Los Alamos canyons, respectively. R-12 and R-9 water contents in the Cerros del Rio basalts are generally similar to the 150 to 215 m (500–700 ft) zone at R-15 (i.e., <10%; Broxton et al., 2001a, 2001b). However, R-12 water contents increase to over 20% in interflow zones at basalt subunit contacts. At R-12 and R-9, water contents are also around 10% in the clay-poor sedimentary deposits in the upper part of the Puye Formation. In the lower Puye Formation (near the regional aquifer), water contents increase to 30%–40% in clay-rich sedimentary deposits. The Puye deposits beneath Mortandad Canyon are most similar to the clay-poor deposits in the upper Puye Formation at R-9 and R-12.

The water contents in rocks beneath Mortandad and Ten Site canyons (i.e., MCB-15) are generally higher than is observed beneath mesa locations on the Pajarito Plateau. For example, MCI-10, a mesa borehole adjacent to Mortandad Canyon, has the lowest water contents observed in this investigation for Tshirege

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unit Qbt 1 and the Otowi Member (Table 7.2-4). Thus, higher fluxes are expected to be confined to those areas beneath Mortandad Canyon and are not expected to extend beneath the adjacent mesas. These results are consistent with observations made in other areas of the Laboratory, which show that canyons are often wetter than mesa locations (Birdsell et al., 2005, 92048; Newman 1996, 59118)

Oxygen and Hydrogen Stable Isotope Profiles

Pore water oxygen ($\delta^{18}O$) and hydrogen (δD) stable isotopes are another set of data that provide insights on vadose zone processes within Mortandad Canyon. These data were described previously by Longmire et al. (2001, 70103) and Broxton et al. (2002, 76006). They are useful in vadose zone studies because they are sensitive indicators of processes such as evaporation and mixing. Stable isotope profiles were collected from core samples from R-15, MCOBT-4.4, and MCOBT-8.5; $\delta^{18}O$ depth profiles are shown in Figure 7.2-13. The figures show two key features. The first feature is that all three holes show a zone in the shallow alluvium (Qal) where pore waters are isotopically heavy (less negative). For example, R-15 has a $\delta^{18}O$ of –5 ‰ in the shallow alluvium, and the MCOBT holes have values in the –7 to –8 ‰ range. As discussed by Broxton et al. (2002, 76006), such values are characteristic of waters that have undergone evaporation. Mortandad Canyon alluvial well samples collected in 1999 and 2005 range from –6 to -12 ‰. Some of the heavier values may be related to evaporated waters that are generated during water treatment and are subsequently released through outfalls to the canyon. However, the heavier alluvial aquifer values are also consistent with the low water contents observed in the shallow tuffs and alluvium (e.g., <6 m [<20 ft] in Table 7.2-4). Thus, it is likely that evaporative losses within the canyon are an important part of the canyon water budget. Although the stable isotopes are not sensitive to transpiration, the substantial amount of vegetation (including ponderosa pines) in the canyon indicates that there is also large water loss through transpiration. Thus, evapotranspiration (evaporation plus transpiration) must play a significant role in the canyon water budget despite the additions of water from runoff and five operating outfalls.

The second feature in the isotope profiles (Figure 7.2-13) is the shift from isotopically heavy values near the surface to relatively constant but significantly lighter values with depth. The reduction of variation in isotope values (with a few exceptions) occurs within the Qct and Qbo, and values are similar to the average annual precipitation values for the plateau (–10 to –11 ‰). Seasonal- and precipitation event-based variations in the isotopic composition of water inputs to the canyon are substantial based on the Mortandad alluvial data discussed above and on other studies on the plateau (e.g., LANL 1998, 59891; Newman et al. 1998, 76883). Thus, the shallow parts of the Mortandad Canyon profiles likely reflect some of this variation. In addition, isotope values at and below the base of the alluvium may contain alluvial groundwater from an upcanyon effluent source that flowed laterally to the particular location. After about 15 m (50 ft), much of the variation is dampened out. This reduction of variability in the deeper parts of the profiles indicates that substantial mixing occurs as water from different sources (i.e., effluent, runoff and evaporated precipitation, all from different time periods) moves through the upper vadose zone. Mixing is an important aspect of the canyon hydrology because it means that variations in contaminant inputs over time will be substantially smoothed out as well.

Surface DC Resistivity Survey

Surface DC resistivity surveys of the Mortandad watershed were conducted in 2002 and 2003 (Geophex,Ltd., 2003, 84540, Appendix B) and are summarized in Appendix H. This technique allows for noninvasive interrogation of large portions of the subsurface and can potentially identify conductive zones that may be related to moisture distribution (see Section 3.2). Figure 7.2-14 shows the survey results for the line run in the narrow section of the middle Mortandad Canyon hydrologic segment, from the

confluence with Effluent Canyon to just past well MCB-5. The survey results are compared with gravimetric moisture and perchlorate concentration profiles with depth at three wells.

In Effluent Canyon downcanyon of the TA-50 RLWTF outfall, thin alluvium overlies strongly welded tuff that forms an impermeable barrier to infiltration. The surface DC resistivity profile down the axis of the canyon (Geophex Ltd., 2003, 84540) indicated that the rocks beneath the channel are highly resistive (perhaps drier) below depths of a few feet.

In the western portion of the middle Mortandad Canyon hydrologic segment, between MCA-5 and MCB-5, resistivity profiling (Geophex 2003, 84540) indicates deepening of an upper conductive horizon as the stream channel progressively cuts down section through bedrock tuffs that are strongly welded (middle of Tshirege unit Qbt 2) into the poorly welded tuffs at the base of Tshirege unit Qbt 2 and in Tshirege unit Qbt 1v (Figure 7.2-14). The resistivity data suggest that infiltration is restricted to relatively shallow depths in the western portion of the middle Mortandad Canyon hydrologic segment. Nevertheless, core moisture profiles at MCOI-1, drilled along the Qbt 2 bench within the canyon, show that moisture can accumulate along deeper small scale features such as the Tshirege Qbt 1v/Qbt 1g contact, albeit with no evidence of associated contamination (Figure 7.2-14).

In the lower part of the Ten Site Canyon hydrologic segment, the surface DC resistivity profile down the axis of the lower canyon (Geophex 2004, 84540; see Appendix H) indicates that the rocks beneath the channel are moderately conductive at depths of 15 to 30 m (50 to 100 ft).

The eastern part of the middle Mortandad Canyon hydrologic segment and the western part of the lower Mortandad Canyon hydrologic segment from R-1 to approximately the location of MCOBT-8.5 include the most abundant and widespread shallow conductive intervals in electrical profiling (resistivity <100 ohm-m). Much of this conductive structure is beneath alluvium and within the Cerro Toledo deposits (see Appendix H). In this section of the canyon, the axial alluvial deposits thicken from about 10 to 33 m (30 to 110 ft). The contact between base of alluvium and the Cerro Toledo deposits is irregular, indicating branching channels cut into the top of the Cerro Toledo interval. Stratigraphy within the Cerro Toledo interval is complex and may lead to locally variable hydrogeologic properties at the base of alluvium (see Appendix G for discussion of heterogeneity in alluvium/colluvium and the Cerro Toledo interval).

7.2.1.4 Intermediate-Perched Zones in Mortandad Canyon

This section describes the physical setting of intermediate-depth perched groundwater in Mortandad Canyon. These perched groundwater bodies represent local areas of saturation in the deeper parts of the vadose zone and are too small for use as municipal water supplies. Nonetheless, they are of interest because (1) their chemical and isotopic characteristics help constrain groundwater transport rates through the vadose zone; (2) perching horizons may facilitate, divert, slow, or stop vertical migration of groundwater through the vadose zone, or they may indicate the presence of a fast subsurface pathway, depending on their hydraulic characteristics; and (3) they can be used as vadose-zone monitoring points that provide early warning of contaminants approaching the regional aquifer. The following descriptions of intermediate perched zones in Mortandad Canyon are modified from the recent paper by Robinson et al. (2005, 91682). Additional discussion about the constraints on saturated thickness and lateral extent of these perched zones relevant to Mortandad Canyon is provided in Appendix J.

Two groups of wells encounter perched water within the Cerros del Rio basalts beneath Mortandad Canyon. In one set of wells, MCOBT-4.4 and MCOI-4 near the Ten Site Canyon confluence, a thin perched zone occurs at a depth of about 160 m (520 ft), within the clay-rich basaltic rubble at the top of the Cerros del Rio basalts (Figure 7.0-1). The saturated thickness of this zone is approximately 1 m (3 ft). The mean water elevation is 1925.0 m (6315.7 ft) for MCOBT-4.4 and 1925.0 m (6317.1 ft) for MCOI-4.

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Appendix J provides a discussion of temporal water-level fluctuations in the two wells. The apparent perching horizon at this location is a massive lava flow with few fractures. The massive lava causes perching because it lacks sufficient permeability at the existing level of saturation to drain the influx of new water. Fractures within the massive perching lava apparently do not conduct substantial groundwater flux. The inability of fractures to drain the perched zone is probably due to a combination of factors including the sealing of fractures by clay minerals and/or the limited number of fractures along the flow paths (flux along the fractures is smaller than the infiltration rate feeding the perched zone). Contaminant concentrations in groundwater in both wells vary over time (see Sections 7.2.2 and 7.2.3.), indicating water in the perched zone is flowing along a hydraulic gradient (i.e., not static).

About 350 m (1150 ft) downcanyon, a second group of wells, including MCOI-5, MCOI-6, and R-15, encountered perched water in the lower part of the Cerros del Rio basalt (Figure 7.0-1). The depth to water is 210 m (689 ft) at MCOI-5 and 202 m (664 ft) at MCOI-6. At R-15, the depth to water is poorly constrained by data collected during the drilling program, but it probably occurs between 197 m (646 ft) and 222 m (729 ft) (see Appendix J for more discussion of R-15 water-level data). The equivalent water elevations are 1869 m (6130.4 ft) at MCOI-5, 1874 m (6147.1 ft) at MCOI-6, and between 1857 and 1882 m (6091 and 6173.6 ft) at R-15. Minimum saturated thicknesses are 16.8 m (55 ft) at MCOI-5 and 21.9 m (72 ft) at MCOI-6; at R-15 estimates of saturated thickness range between 4.9 m (16 ft) and 30 m (99 ft). The perched water occurs in a combination of fractured and porous media. The fractured media consist of dense, massive lava flows cut by high-angle cooling fractures. These fractured lava flows are separated by nearly horizontal beds of porous interflow breccias. The variable static water levels and differences in saturated thicknesses within these closely spaced wells may be caused by the heterogeneous nature of perched groundwater systems located within basaltic rocks. This heterogeneity can reflect poor hydrologic communication among fractures, partial drainage of poorly connected perched zones during drilling, or spatial and temporal variability in the infiltration rate feeding the perched zone at the time of drilling. At R-15, the perching horizon appears to be clay-rich, flow-base rubble or underlying silty basaltic sands. The perched zones at MCOI-5 and MCOI-6 were probably not fully penetrated during drilling, and the perching horizons in these boreholes are uncertain.

Because of their different geologic settings, the perched groundwater occurrences at MCOBT-4.4/MCOI-4 and R-15/MCOI-5/MCOI-6 probably represent two unrelated groundwater bodies of limited lateral extent along the canyon axis (Figures 7.0-1 and 7.2-11). Based on the distribution of water-bearing vs. dry boreholes, the lateral extent of these perched groundwater bodies is probably less than 450 m (1500 ft).

A potential intermediate perched water zone was noted while drilling well MCOI-8, located about 325 m (1100 ft) upcanyon of the Ten Site Canyon confluence. A well was installed in the lower Cerros del Rio basalt where saturation was considered most likely based on borehole water-level measurements, video logs, and induction logs. Water-level measurements made since well installation indicate that water is present in the well sump but not in the screen. At the time of this report it is uncertain whether intermediate-perched groundwater is present at MCOI-8. A continuous-record water-level transducer is installed, and water levels are being monitored.

Other potential intermediate-perched water zones were also noted in the well completion report for boreholes MCRES-4 and MCB-7 (Kleinfelder 2006, 92486; Appendix B). At MCRES-4, possible perched water was noted in the lower Tshirege Member (Qbt 1g) between 21.3 and 22.9 m (70 and 75 ft). At MCB-7, the completion report indicates perched water occurred in the lower Tshirege Member (Qbt 1g) between 21 and 22.6 m (69 and 74 ft) and in the Cerro Toledo interval between 25.6 and 27.1 m (84 and 89 ft). Both boreholes encountered alluvial groundwater systems and there were problems sealing off the alluvial water from the deeper parts of the boreholes. Because of these problems, the intermediate-

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perched groundwater at MCRES-4 and MCB-7 are considered possible, but poorly constrained, occurrences.

Figure 7.0-1 shows deep perched water within the lower Cerros del Rio lavas based on evidence from drill holes R-12 and R-10/10A, which are located in lower Sandia Canyon near the Laboratory boundary. There are no wells in this part of Mortandad Canyon, and it is not known whether these perched waters extend beneath the eastern part of the Mortandad watershed. Sources of the deep perched water observed at R-12 and R-10/10A are poorly constrained, but water-quality data indicate that these groundwaters do not contain contaminants associated with the Mortandad hydrologic system.

Water-level fluctuations in some of the perched intermediate zones were observed in 2005 following large rainstorms. These were originally hypothesized as rapid flow from the surface to the intermediate locations. However, the water-level fluctuations are probably not caused by infiltration of surface water during flood events but are a result of barometric pressure effects, as discussed in Appendix L.

7.2.1.5 Regional Aquifer Model

The water table of the regional aquifer, which lies approximately 300 m (1000 ft) below the canyon floor in Mortandad Canyon occurs within Miocene pumiceous sedimentary deposits that underlie the Pliocene Puye Formation. At a larger scale, the regional aquifer comprises several sedimentary and volcanic hydrostratigraphic units of varying thickness, lateral extent, and permeability. The hydraulic conductivity of aquifer rocks is highly heterogeneous and averages approximately 1 m/d (3 ft/d) at a regional scale. The regional aquifer is a complex hydrogeological structure that includes confined and unconfined zones that are characterized by a spatially varying degree of hydraulic communication.

The shallow portion of the regional aquifer near the water table is predominantly under phreatic (unconfined) conditions. The phreatic zone is mainly encountered in the Puye Formation and the underlying pumiceous sedimentary deposits and has limited thickness (approximately 30 to 50 m [100 to 165 ft]). The groundwater flow and transport in this zone are believed to generally follow the shape of the regional water table. The flow directions are then east-southeast, toward the Rio Grande. The hydraulic gradient along the regional water table is relatively steep; on the order of 0.01. The shape of the regional water table (i.e., the flow directions in the phreatic zone) is predominantly controlled by the existing areas of regional recharge (the Jemez Mountains with some contributions on the Pajarito Plateau) and discharge (springs in White Rock Canyon and the Rio Grande). The impact of Pajarito Plateau water-supply pumping on the flow directions in the phreatic zone is negligible (Appendix O).

The deep portion of the regional aquifer is predominantly under confined conditions. Water-supply pumping is performed predominantly in the deep portion of the regional aquifer. The pumping has negligible impact on the flow directions in the phreatic zone above beneath the Mortandad watershed because of poor hydraulic communication (Appendix O). The boundary between the shallow phreatic and the deep confined zones is not well defined. The hydraulic separation is caused by stacking highly stratified, gently dipping sedimentary deposits made up of individual beds characterized by highly variable hydraulic permeabilities and varying spatial extents. These strata are encountered in the Puye Formation and Santa Fe Group (Figure 7.0-1). Therefore, the boundary between the shallow phreatic and the deep confined zones is not a well-defined aquitard but instead represents the net effect of stacked beds with variable hydraulic properties, resulting in a vertical permeability that is at least 3 orders of magnitude lower than the horizontal permeability parallel to the bedding. For all the practical purposes, this causes a dominant hydraulic separation between the shallow phreatic and the deep confined aquifer zones that can be considered to be equivalent to an "aquitard." However, the poor hydraulic communication does not necessarily preclude the possibility for contaminants to migrate through the "aquitard.". Because of

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pumping in the deep aquifer, there is a substantial vertical component of the hydraulic gradient between the shallow phreatic and the deep confined zones. This creates the possibility for groundwater flow and contaminant migration through the aquitard along hydraulic windows by shortcutting between the layering.

A regional representation of the water-table elevation is shown Figure 7.2-15. Similar spatial analysis of the hydraulic pressures in the deep portion of the regional aquifer is not feasible because of limited data.

Appendix N provides a spatial analysis of water-table variability and discusses the assumptions implemented in the generation of a regional water-table map (Figure 7.2-15). Appendix O provides analysis of temporal variability of water-table elevations measured at the monitoring boreholes near Mortandad Canyon (R-1, R-11, R-13, R-15, and R-28). Appendix P discusses the available information for the pumping-rate variability at the water-supply wells. These appendixes provide more detailed analyses of the potential impact of water-supply pumping on the groundwater flow and transport directions in the shallow phreatic zone of the regional aquifer. More details about this conceptual model of groundwater flow and transport beneath the Pajarito Plateau can be found in (Vesselinov 2005, 89753; Vesselinov 2005, 90040; Vesselinov 2004, 90117).

7.2.2 Contaminant Transport

Contaminant transport in the Mortandad watershed generally occurs along the pathways depicted in Figure 7.0-1. Adsorbing contaminants adhere to sediment to become part of the sediment load, as described in Section 7.1, and either stay relatively close to the release location or are transported down the canyon with surface flow events. Nonadsorbing species travel with water and follow the same flow paths that water takes. Weakly adsorbing constituents may travel with sediments or with water but generally migrate more slowly than nonadsorbing species. Strongly adsorbing species may travel with sediment or adsorb onto immobile rock surfaces. Therefore, adsorptive contaminants tend to exhibit retarded migration in the environment, and the nonadsorbing species are those that are detected in vadose-zone porewater and deeper groundwater zones.

The sections of this report that follow describe the nature and extent of COPCs in water. For each COPC, its current distribution in water is described and time histories are presented to illustrate the evolution of the COPC in the environment. The following format is used to describe these distributions.

- For surface water and alluvial groundwater, box plots showing recent (2000 to 2005) concentration data at different locations are used to define current COPC distributions throughout the watershed. Then time series plots give longer records in these waters to show concentration responses to long-term changes in effluent concentrations from the TA-50 RLWTF. In addition, shorter time series from 2000 to 2005 are presented to describe more recent concentration responses to treatment-plant enhancements and to flood events.
- For the vadose zone, contaminant distributions are described based on vadose-zone pore-water concentrations or contaminant masses as estimated from core samples. Time series concentrations are available for some perched-intermediate zones, and contaminant trends for these groundwaters are discussed.
- For the regional aquifer, time series plots present trends in concentration data for those few mobile contaminants that are observed in that zone.

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A full series of plots in Appendix D provides a comprehensive overview of the spatial and temporal trends of COPCs in the Mortandad watershed. The discussion and supporting plots below provides additional information on the spatial and temporal distributions of these contaminants in key areas of the watershed.

- Box plots show concentration data between 2000 and 2005 for surface water and alluvial groundwater at sampling locations from west to east in relation to distance from the Rio Grande. These plots are useful for describing the present-day spatial distribution of COPCs and are also useful for identifying both the historical source(s) of each contaminant and the present-day "secondary" source areas. Three watershed segments are plotted. (1) The Effluent and Mortandad Canyons segment covers locations from the head of Effluent Canyon to the Mortandad Canyon confluence and then follows Mortandad Canyon eastward to the Rio Grande. (2) The Mortandad Canyon segment covers locations from the head of Mortandad Canyon to the confluence with Effluent Canyon and eastward to reach M-2E (Plate 1). (3) The Ten Site Canyon segment covers locations from the head of Ten Site Canyon to the confluence with Mortandad Canyon at well MCA-2. The sampling locations included in the plots were selected to bound known or suspected contaminant sources and generally include locations that have enough data to show variability in contaminant concentrations. The upper and lower ends of the boxes are the 75th and 25th percentiles of the data distribution, and upper and lower lines outside the boxes indicate 90th and 10th percentiles, respectively. Nondetect values are included in the plots. The paired numbers below each box indicate the number of detects (left) and nondetects (right) at each location. Detected values are represented in the plots with filled symbols, and the nondetect values are open symbols.
- Time series plots show available concentration data for surface water station E200 (and its nearby precursor GS-1) and many alluvial wells throughout the watershed for their full periods of record, which covers over a 40-yr period at many locations. Time series plots are also presented for regional wells and perched intermediate wells. Although these records are quite short, some apparent trends can be observed.
- Contaminant depth profiles show concentration as a function of corehole depth for porewater and solid-phase core. Samples for these analyses were collected when the boreholes were drilled and subsequently analyzed.

Overall, the spatial distributions of inorganic chemical and radionuclide concentrations indicate only a few key sources of the COPCs observed in groundwater and vadose-zone pore water, as described in Section 2.1. The most important source is the outfall from the TA-50 RLWTF into Effluent Canyon. Other sources include the former TA-35 WWTP outfall in Ten Site Canyon, possible discharges from cooling towers and radiochemistry laboratories at TA-48 in Effluent Canyon west of the TA-50 outfall (Plate 1) and in Mortandad Canyon west of gage E200, and sources at TA-03 with releases into upper Mortandad Canyon above the Effluent confluence. The cooling towers for the TA-03 power plant in the Sandia watershed may also have been a potential source of contaminants, especially chromium, to the groundwater beneath Mortandad Canyon.

Monitoring wells in the regional aquifer consist of both single- and multi-screen construction. Groundwater chemistry data from the single-screen completions are representative of predrilling conditions. However, two multi-screen wells do not provide fully representative data for the groundwater, especially for certain constituents subject to dissolution and desorption resulting from the affects of reducing conditions (e.g., chromium iron, perchlorate, and nitrate). The two affected wells/screens are R-14, screen 2 and R-33, screen 2.

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7.2.2.1 Inorganic Chemicals in Water

Several inorganic chemicals are identified in Section 6 as being COPCs in water. Subsections below present a discussion of the spatial distribution and conceptual model for these COPCs.

Nitrate and perchlorate are the most mobile of the inorganic chemicals historically released in the watershed. Nitrate and perchlorate concentrations have been measured in surface water, and in alluvial, perched-intermediate and regional groundwaters. Their presence has also been observed in vadose-zone pore water collected from core samples from several boreholes drilled in and around Mortandad Canyon (Plate 1) since 1998. These combined results provide a comprehensive picture of subsurface contaminant distributions and migration at various locations in the watershed. In light of these results, this subsection first discusses contaminant nature and extent characteristics specific to nitrate and perchlorate within the watershed. The distributions of these nonadsorbing contaminants yield key information about subsurface pathways. The nitrate and perchlorate results in particular are useful because of the high mobility of these contaminants in the subsurface (i.e., they move at similar rates to subsurface pore water). Thus, their distribution is likely to bound the subsurface extent of other nonadsorbing contaminants that have followed the same migration pathway.

Nitrate

Nitrate is detected in surface water, alluvial and perched-intermediate groundwater, and the regional aquifer beneath Mortandad Canyon. There are both natural and anthropogenic sources of nitrate within the watershed, with Laboratory-derived nitrate produced from the dissociation of nitric acid that is neutralized before discharge. The other Laboratory source of nitrate is from treated sewage effluent in which nitrate concentrations are typically less than 5 mg/L due to denitrification taking place before discharge. Natural nitrate is common on the Pajarito Plateau and in the American Southwest (Walvoord et al., 2003, 93787). Thus, detectible levels of nitrate do not necessarily mean that contamination is present. However, it is clear that for many locations in the Mortandad watershed, the nitrate concentrations are elevated and related to historical Laboratory releases. Under oxidizing conditions, nitrate is mobile as an anion in groundwater and does not significantly adsorb onto clay minerals, ferric (oxy)hydroxide, solid organic matter, and other naturally occurring adsorbents. In the presence of denitrifying bacteria and reactive solid and dissolved organic carbon, nitrate becomes reduced to nitrogen gas. Other types of nitrate-reducing bacteria are capable of reducing nitrate to ammonium under oxygen-depleted conditions. In the discussion that follows, nitrate concentrations are based on different sampling and analysis techniques to obtain the largest data sets. Results for nitrate and nitrate plus nitrite are combined because nitrite is generally a very small part of the measured concentration. Filtered and nonfiltered results are also combined because filtration has little to no effect on nitrate concentration. Nitrate concentrations in the discussions that follows are reported in the units "Nitrate (as N, mg/L)," unless otherwise noted.

Nitrate in Surface Water and Alluvial Groundwater

Nitrate transport within the surface water and alluvial groundwater is controlled by the flow paths in these systems, which spread the contaminant laterally down the canyon, as described in Sections 7.2.1.1 and 7.2.1.2. The spatial trends in recent (2000–2005) nitrate concentrations in surface water and alluvial groundwater are shown in the box plots of Figures 7.2-16(a-c). In upper Mortandad Canyon (Figure 7.2-16[a]), in upper Effluent Canyon (Figure 7.2-16(b) above the TA-50 outfall, and in Ten Site Canyon (Fig. 7.2-16[c]), the nitrate concentrations are low (<1 mg/L), indicating that there are no recent sources contributing to the nitrate mass already in those canyon segments. However, nitrate concentrations increase in Effluent Canyon (Figure 7.2-16[b]) below the TA-50 RLWTF outfall and in

Mortandad Canyon below the confluence with Effluent Canyon (Figure 7.2-16[a]), indicating that the TA-50 RLWTF outfall continues to be the primary source of nitrate to the watershed.

Figure 7.2-17 is a time series plot covering the period 1960 through 2005. It shows the annual nitrate concentration in TA-50 effluent and the resulting concentrations at alluvial wells MCO-3, MCO-5, MCO-6, MCO-7 and MCO-7.5. The outfall nitrate concentrations averaged over 200 mg/L from 1981 to 1995, with maximum concentration approaching 500 mg/L. During this same period, nitrate concentrations in the alluvial wells were elevated with many measurements over 100 mg/L (as N). After 1995, outfall concentrations dropped below 100 mg/L, and from 2000 to 2004, the average outfall concentration was less than 3 mg/L due to improvements in wastewater treatment at the TA-50 RLWTF and concurrent source reduction implemented at Laboratory facilities that have their wastewater treated at the RLWTF. Correspondingly, concentrations in the alluvial wells have declined.

Nitrate concentrations increase spatially from west to east in Mortandad Canyon below the Effluent Canyon confluence from well MCO-5 to approximately well MCO-7.5. The trend is indicative of a dilution lag in the alluvial aquifer from west to east since improved nitrate removal began at the RLWTF in late 1999 (Section 2.1.1). The lag is due, in part, to distance from the outfall, but the increasing alluvial storage from west to east (Section 7.2.1.2) is probably a more important factor. To illustrate this, Figure 7.2-18 is a time series plot analogous to Figure 7.2-17, but it covers the period of low nitrate effluent concentrations, 2000 through 2004–2005. At well pair MCO-3/MCA-5 (Plate 1), which is located in the westernmost portion of the middle Mortandad Canyon hydrologic segment and has little alluvial storage, the concentration decline occurs almost immediately in 2000 following the drop in effluent concentration. At wells MCO-5 and MCO-6, near the eastern end of the middle Mortandad Canyon hydrologic segment, where the canyon is still narrow but the alluvium starts to thicken, the decline is delayed slightly with the greatest change in 2000 and 2001. Finally, nitrate concentrations at wells MCO-7 and MCO-7.5 have declined slowly since 2000. These wells are located in the lower Mortandad Canyon hydrologic segment where the highest amount of alluvial storage occurs. Nitrate concentrations at these distal locations should continue to decline in response to lower treated effluent concentrations and to periodic high runoff events. With few exceptions, the recent surface water and alluvial groundwater nitrate concentrations are less than the EPA Region 6 tap water MCL of 10 mg/L (Figure 7.2-17 and Figures 7.2-16[a–c]). In alluvial groundwater, these exceptions are two values at well MCO-7 (12.5 and 10.9 mg/L in February 2000 and August 2001, respectively) and one value at well MCO-7.5 (18 mg/L in 2000).

Nitrate in Vadose-Zone Pore Water and Perched-Intermediate Groundwater

Nitrate has migrated from the surface water and alluvial groundwater into the deeper vadose-zone, probably since effluent releases began in the watershed at TA-35 in 1951. Depth profiles of pore-water nitrate concentrations reflect the combined releases to the watershed (Appendix D, Figures D-2.3-1 through D-2.3-21). Nitrate was detected in every core hole analyzed in the watershed, and vadose-zone pore-water concentrations sometimes exceed 100 mg/L. The historic concentrations of nitrate in the alluvial groundwater (from 1960, these are shown in Figure 7.2-17) became the nitrate source for the deeper vadose zone in areas where perched-alluvial groundwater was present.

Figure 7.2-19 depicts the vadose-zone nitrate concentration along a longitudinal cross section through Mortandad Canyon. The figure shows nitrate concentrations measured from pore water and groundwater collected from representative characterization boreholes and regional and perched intermediate wells in the watershed. These data are also spatially interpolated using a minimum-tension technique (as implemented in the earthVision software, see Appendix I) to evaluate a generalized distribution of the concentrations between boreholes and wells, which can be used to describe characteristics about nature and extent of nitrate and migration pathways beneath the canyon.

Figure 7.2-20 depicts the distribution of nitrate mass along a longitudinal cross section through Mortandad Canyon. This mass distribution is estimated by multiplying the pore water and groundwater nitrate concentrations (Figure 7.2-19) and volumetric water content (Figure 7.2-11). Approximately 198,000 kg of nitrate has been reported as being released through the TA-50 RLWTF outfall into the Mortandad watershed from 1963 to 2005 (see Table 2.1-1). The distribution of mass, as estimated using the earthVision model (Figure 7.2-20, Appendix I), was used to estimate the current nitrate mass as it now exists distributed within and beneath the canyon, including nitrate in the alluvial groundwater, the unsaturated pore water (including alluvium), and the perched-intermediate zones. The estimated mass is approximately 228,000 kg nitrate (as N). Table 7.2-5 shows the mass distribution by strata. The estimated mass using in situ concentrations is 15% higher than the estimate made from outfall records (which also contains some inherent uncertainty), showing that the model technique provides a reasonable method for estimating in situ mass. Nearly the entire mass (99.7%) is estimated to be in the vadose-zone pore water within and stratigraphically above the Otowi member (Qbo). Only 0.1% and 0.2% of the nitrate mass are estimated to be in the alluvial groundwater and perched intermediate groundwater, respectively.

In terms of vertical extent, there is a region of elevated nitrate concentrations and mass located in approximately the upper 90 m (300 ft) of the vadose zone that extends into the mid- to lower-Otowi Member, as described above. In particular, nitrate has migrated into the Otowi Member at locations between about MCB-5 and MCOBT-8.5 (Figure 7.2-19). This is also the zone where the Otowi Member has elevated water content (Section 7.2.1, Figure 7.2-11 and Appendix B), alluvial groundwater is persistent to intermittent, perched-intermediate groundwater is observed, and apparent greater vadose-zone fluxes (Appendix M) are present. The broad zone of fairly well-defined contaminant extent is consistent with the general conceptual model of transport depicted in Figure 7.0-1.

The vertical migration of nitrate in the vadose zone west of MCB-5 is poorly constrained because of the inaccessibility of drill rigs to this part of Mortandad Canyon. However, the presence of thin alluvium over less permeable bedrock units 500 to 1000 m (1640 to 3280 ft) west of MCB-5 probably limits infiltration in that portion of the canyon. Borehole MCB-1 (Plate 1), located in Effluent Canyon above the TA-50 outfall, has very little nitrate (maximum pore-water concentration less than 1 mg/L, Figure D-2.3-1), reflecting the lack of a nitrate source and/or no migration pathway. At MCB-2, located east of the RLWTF outfall near the Mortandad Canyon confluence, observed pore-water nitrate concentrations remain low (less than 21 mg/L, Figure D-2.3-2) despite the presence of a nitrate source. Transport at this location is considered to be dominated by lateral surface water flow resulting in very little infiltration and vadose-zone transport. There is a marked change near the eastern end of the middle Mortandad Canyon hydrologic segment, where the canyon begins to widen and alluvium thickens around borehole MCB-5. From MCB-5 and further downcanyon to about MCOBT-8.5, elevated concentrations and vadose-zone mass are observed as described above.

The zone of low nitrate concentration and mass between MCOBT-8.5 and R-28 in Figures 7.2-19 and 7.2-20 is of interest. This zone likely contains a greater mass of nitrate than shown in the figures. Nitrate was detected within this zone in core holes MC-1 and MC-2, which were drilled as characterization boreholes for the proposed Advanced Hydrotest Facility (AHF). However, because of sample preservation problems (described in Appendix M), the nitrate pore-water concentrations are not accurate and were not used to generate the visualized nitrate distributions. Thus, the zone of elevated nitrate may extend east of MCOBT-8.5 toward R-28, at least down to the top of the Otowi Member, which was the maximum depth of the MC boreholes.

From R-28 east to MCB-16, near the Laboratory boundary, the frequency of high nitrate concentrations (above 100 mg/L) is substantially lower, especially when compared with the area between R-1 and MCBT-8.5. At R-28, there was only one nitrate detection above 100 mg/L. Pore-water concentrations of

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nitrate are also low at MCB-16, except for three detections above 100 mg/L in an approximately 30-ft interval in the unsaturated alluvium (Figure D-2.3-13).

In order to bound the migration rates that have led to the current distribution of the main nitrate mass observed in the Mortandad watershed, several studies have estimated transport velocities based on vadose-zone chemical distributions. Estimates of vertical transport velocities of nitrate, based on a release of unique isotopically light nitrogen from October 1986 to September 1989, range between 2.5 and 2.9 m/yr (8.2 and 9.5 ft/yr) for wells MCOBT-4.4 and MCOBT-8.5, respectively (Broxton et al. 2002, 76006). Estimates of transport rates based on peak tritium releases to the canyon suggest that vertical transport rates have declined substantially from a possible maximum of 11 m/y (36.1 ft/y) in the late 1970s to about 1.36 m/yr (4.46 ft/yr) in 1999 (Kwicklis et al 2005, 90069). Finally, calibration to nitrate profiles in R-15 and MCOBT-8.5 yield approximate transport velocities of 6 m/y (20 ft/yr) in 1968 to 1.2 m/y (4 ft/yr) in 2002 (Birdsell et al. 2005, 92048). These studies apply to nonadsorbing constituents, such as nitrate, perchlorate and tritium, and indicate that vadose-zone transport velocities were greater in the past and over time have declined in response to declining outfall volumes.

Elevated nitrate concentrations are observed in perched-intermediate zones located beneath Mortandad Canyon. The presence of deep contamination indicates that there are some preferential pathways through the vadose zone that have transported comparatively small masses of nitrate to depths below the Otowi Member and beyond the main mass of the nitrate contamination. Nitrate concentrations have increased slightly from 13.2 to 16.2 mg/L in filtered samples within the perched-intermediate zone at well MCOBT-4.4 from 2002 to 2005 (Figure 7.2-21). This may indicate advancing nitrate-contaminated vadose-zone waters. Nitrate is also observed in perched-intermediate groundwaters at wells MCOI-4, MCOI-5, and MCOI-6 where reported nitrate concentrations for filtered samples over two sampling rounds in 2005 were 13 and 14.2 mg/L, 3.07 and 4.22 mg/L, and 13.7 and 16.8 mg/L, respectively (Figures D-2.2-16[f], D-2.2-17[f], D-2.2-18[f]).

In Ten Site Canyon, pore-water nitrate concentrations from the core collected at R-14 (Figure D-2.3-19), at the head of the canyon, and MCB-15 (Figure D-2.3-12), at the lower end of the canyon near the Mortandad Canyon confluence, are consistently low (less than 10 mg/L). However, pore-water concentrations exceed 1000 mg/L in the shallow part of borehole 35-2028 in Pratt Canyon, while concentrations are less than 4 mg/L below 12 m (69 ft) in this borehole. The 35-2028 results are indicative of releases to the Ten Site drainage; however, the vertical extent of nitrate is interpreted to be a function of relatively small mass and/or the lack of a continuous aqueous driver in Pratt and Ten Site Canyons.

Nitrate in the Regional Aquifer

Anthropogenic nitrate has been detected in the regional aquifer beneath Mortandad Canyon. Nitrate concentrations in filtered samples occur at 2 to 2.5 mg/L at R-15 during the 2000 to 2005 period, as shown in Figure 7.2-22. Isotopic analyses of the groundwater at R-15 suggest that nitrate is not significantly fractionated, having $\delta^{15}N$ ratios ranging from –0.8 to +1.3‰ (Longmire 2002, 72614). These values are characteristic of nitrate derived from neutralized nitric acid (Broxton et al. 2001, 71252), most likely released from TA-50 RLWTF. Nitrate concentrations varied from 3.10 to 4.89 mg/L at R-28 in 2005, as shown in Figure 7.2-23. These are the highest concentrations of nitrate measured in the regional aquifer beneath Mortandad Canyon. $\delta^{15}N$ values for several samples collected from R-28 ranged from 5.51 to +11.88‰, suggesting that nitrate is fractionated and was derived from a sewage source enriched in nitrogen-15 (Clark and Fritz 1997, 59168). Two potential sources of sewage-derived nitrate include the TA-35 lagoons within Ten Site Canyon and sanitary effluent discharges into Sandia Canyon. The Sandia Canyon source is considered most likely caused by the collocation at R-28 of chromium contamination

also thought to have its source in Sandia Canyon. The vadose-zone moisture content and nitrate profiles (Figures 7.2-11 and 7.2-19) at these two wells support the concept of different transport pathways (and hence possible different sources) for the nitrate in the regional aquifer at these locations. Elevated moisture contents and pore-water nitrate concentrations from core obtained during drilling of R-15 extent down into the Otowi Member and into a perched-intermediate zone within the Cerros del Rio basalt, indicating further downward migration of water and nitrate to the regional aquifer from the TA-50 source. Drier conditions and very little nitrate are observed in the vadose zone at R-28, indicating little vertical migration at that location. Nitrate in the regional aquifer at R-28 probably entered the regional aquifer upgradient and arrived at the well by horizontal flow within the regional aquifer.

Several other regional aquifer wells sampled during this investigation had nitrate concentrations of less than 1.0 mg/L including R-1, R-13, R-14, R-33, R-34, and TW-8. Concentrations of nitrate plus nitrite(N) were less than analytical detection (<0.05 mg/L) in four samples collected at R-14. The majority of groundwater samples analyzed from R-14 contained detectable nitrate plus nitrite. The nondetections are most likely due to the presence of residual drilling fluid in screen 2.

The spatial extent of nitrate detected in the regional aquifer correlates with the nitrate mass observed in the vadose zone.

Perchlorate

Perchlorate is detected in surface water, alluvial and perched-intermediate groundwater, and the regional aquifer beneath Mortandad Canyon. Perchlorate has been discharged into Mortandad Canyon from the TA-50 RLWTF outfall probably since 1963. The primary source of perchlorate is from perchloric acid ($HClO_4$), a strong oxidizing acid used in actinide research and processing at the Laboratory. Perchlorate is mobile and stable as an anion in groundwater and does not significantly adsorb onto clay minerals, ferric (oxy)hydroxide, solid organic matter, nor other naturally occurring adsorbents. Filtered and nonfiltered results are combined in the discussions that follow because filtration has little to no effect on measured perchlorate concentration.

Perchlorate in Surface Water and Alluvial Groundwater

Perchlorate travels laterally downcanyon with the surface water and alluvial groundwater in the watershed. The spatial trends in recent (2000–2005) perchlorate concentrations in surface water and alluvial groundwater are shown in the box plots of Figures 7.2-24 (a–c). In upper Mortandad Canyon (Figure 7.2-24(a)), in upper Effluent Canyon (Figure 7.2-24(b)), and in Ten Site Canyon (Figure 7.2-24(c)) the perchlorate concentrations are low (<10 μg/L), indicating that there are no recent perchlorate sources contributing to the perchlorate mass already in these canyon segments. The perchlorate concentration at surface water station E-1E SW in Effluent Canyon (Figure 7.2-24(b)) does not show an increase to indicate a TA-50 RLWTF outfall source; however, these data were all collected in 2005, approximately 3 yr after perchlorate treatment was improved at the TA-50 RLWTF and concentrations were greatly reduced in effluent (see Section 2.1.1). Perchlorate concentrations are higher in Mortandad Canyon beyond the confluence with Effluent Canyon (Figure 7.2-24(a)), indicating that previous perchlorate releases from the TA-50 RLWTF outfall were the primary source of perchlorate to the watershed. Figure 7.2-24(b) shows a trend of increasing concentration spatially from west to east in Mortandad Canyon beyond the Effluent Canyon confluence similar to that observed for nitrate. As for nitrate, this trend is indicative of a dilution lag in the alluvial aquifer from west to east since improved perchlorate removal began at the RLWTF in 2002 (see Section 2.1.1), with the lag being a function of both the distance from the outfall and the volume of alluvial groundwater storage.

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Figure 7.2-25 is a time series plot covering the period 2000 through 2005 when perchlorate concentrations were regularly measured and removal of perchlorate from the TA-50 RLWTF effluent occurred. The plot shows annual perchlorate concentration in the effluent and the resulting concentrations at alluvial wells MCO-3, MCO-5, MCO-6, MCO-7, and MCO-7.5. Outfall perchlorate concentrations have dropped from 257 and 305 µg/L in 2000 and 2001, respectively, to nondetect since 2003 (LANL 2005, 91523). Correspondingly, concentrations in the alluvial wells have declined to values ranging from about 10 to 50 µg/L in 2005. Alluvial concentrations should continue to decline in response to the greatly reduced perchlorate concentrations in the effluent, with a lag similar to those seen in the nitrate responses at corresponding alluvial wells (Figure 7.2-18).

Perchlorate in Vadose-Zone Pore Water and Perched-Intermediate Groundwater

Perchlorate has migrated from the surface water and alluvial groundwater into the vadose zone. The vertical extent of perchlorate contamination in the vadose zone is similar to nitrate in most of Mortandad Canyon, as depicted in Figure 7.2-26 and in Appendix D (Figures D-2.3-1 through D-2.3-21). The collocation is likely an indication of the same release site (TA-50 RLWTF) and similar release histories. Within a given borehole, perchlorate and nitrate concentrations are often highly correlated with depth (for example, see Figures D-2.3-16 and D-2.3-20), and within some boreholes, correlation coefficients between perchlorate and nitrate are above 0.9. These correlations suggest a similar long-term release history for the two contaminants and similar transport rates in the vadose zone. Correlations tend to be poorer in the alluvium. However, this is a zone where variable mixing of recharge water and some denitrification is likely occurring (LANL 2005, 91696). In contrast, there is no evidence for natural perchlorate degradation in Mortandad Canyon (e.g., no chlorate and chlorite, byproducts of perchlorate degradation).

Until 1999, no records were kept for perchlorate in the TA-50 RLWTF effluent. The present-day distribution of perchlorate mass is estimated from the interpolated concentration data shown in Figure 7.2-26 in the same manner that is used to estimate the nitrate mass (Appendix I). Table 7.2-5 lists the approximate in situ perchlorate mass as 1248 kg and includes the distribution by stratigraphic interval. As for nitrate, nearly the entire perchlorate mass (95.6%) is estimated to be in the vadose-zone pore water within and stratigraphically above the Otowi Member. Only 2.6% and 1.7% of the mass are estimated to be in the alluvial groundwater and perched-intermediate groundwater, respectively.

The vadose-zone distribution of perchlorate is also quite similar to that of nitrate. Perchlorate concentrations are mostly below analytical detection in Effluent Canyon (MCB-1 and MCB-2, Figures D-2.3-1 and D-2.3-2), but concentrations are significantly higher where the canyon widens near the Ten Site Canyon confluence (from MCB-5 downcanyon), which also supports the conceptual model shown in Figure 7.0-1. There is one notable exception to the similarity in horizontal extent between nitrate and perchlorate. In contrast to nitrate, the zone of little to no perchlorate beyond borehole MCOBT-8.5 depicted in Figure 7.2-26 is probably real. In fact, pore-water perchlorate results suggest that there is not much perchlorate from approximately AHF borehole MC-1 eastward to the Laboratory boundary. Pore-water concentrations for boreholes MC-1, -2, -3, and MCB-16 (Figure D-2.3-13) show no perchlorate detections, and there were only two isolated detections in pore water in R-28 (Figure D-2.3-21). Note that the sample preservation problems with the AHF MC boreholes mentioned in Appendix M would increase estimated concentrations.

It is possible that a continuous area of perchlorate contamination occurs in the vadose zone between MCOBT-8.5 and R-28 in the mid- to lower-Otowi Member because the MC holes were only drilled to the top of the Otowi Member. However, the limited detections and low perchlorate concentrations at R-28

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suggest that the zone of contamination becomes discontinuous somewhere between MCOBT-8.5 and R-28.

Perchlorate also occurs in perched-intermediate groundwater beneath Mortandad Canyon. Perchlorate concentrations increased from 32.1 to 256 µg/L at perched-intermediate well MCOBT-4.4 sampled from 2001 to 2005 (Figure 7.2-21). Concentrations of perchlorate collected at MCOI-4 varied from 134 to 159 µg/L during 2005 (Figure D-2.2-16(g)). Perchlorate concentrations at MCOI-4 are lower than those observed at MCOBT-4.4, even though the two wells are close to each other and screened across the same zone in the Puye Formation. At well MCOI-5, perchlorate concentrations generally increased from 81.6 to 104 µg/L during 2005 (Figure D-2.2-17(g)). Concentrations of perchlorate at MCOI-6 varied from 159 to 246 µg/L during 2005 (Figure D-2.2-18(g)).

Occurrence of perchlorate in Ten Site Canyon is different than that observed for nitrate. Although nitrate was observed at low concentrations (<10 mg/L) in core collected for well R-14 in upper Ten Site Canyon, perchlorate concentrations are elevated to a depth of 90 m (300 ft) with maximum pore water concentrations over 200 µg/L (Figure D-2.3-19). Perchlorate was also detected in pore water down to 27 m (90 ft) in borehole 35-2028 in Pratt Canyon, and some concentrations exceeded 500 µg/L. In addition, there were two chlorate detections in the upper 27-m (90-ft) zone, and these are the only chlorate detections observed in the entire Mortandad watershed borehole data set. It is possible that the chlorate is an in situ perchlorate degradation product. It is also possible that it is a remnant of an older radiochemistry process similar to that used at TA-21. This difference in observations for nitrate and perchlorate indicates that there was not a Ten Site Canyon nitrate source that was correlated to the apparent perchlorate source.

The R-14 and 35-2028 results show that there were historical releases of perchlorate into the Ten Site drainage, likely through Pratt Canyon. This is also supported by the results from MCB-15 at the bottom of Ten Site Canyon where perchlorate concentrations up to 37 µg/L in pore water are observed (Figure D-2.3-12). The MCB-15 profile shows that there are two distinct intervals of perchlorate contamination, one extending from 3 to 6 m (11 to 21 ft) (and possibly shallower) and the other extending from 40 to 46 m (131 to 151 ft) (and possibly deeper). The upper zone is within the alluvium and does not extend past the contact with unit Qbt1g tuff. The top of the deeper zone lies roughly 9 m (30 ft) below the top of the Otowi Member. It is not clear why these isolated zones are present, but there are some alternative hypotheses. The shallow zone probably developed from surface water infiltration or episodic alluvial groundwater migration within Ten Site Canyon, similar to that observed in Mortandad Canyon. An explanation for the contamination in the deeper interval is less clear. It could represent a deeper, but separate, flow path within Ten Site Canyon or a lateral southward flow component from Mortandad Canyon, given the proximity between the two canyons.

Perchlorate in the Regional Aquifer

Perchlorate released from TA-50 has migrated to the regional aquifer in Mortandad Canyon. The highest concentrations of perchlorate were measured at R-15. Concentrations of perchlorate at R-15 generally increased from 4.71 to 6.39 µg/L from 2003 to 2005 (Figure 7.2-22). Concentrations of perchlorate at R-28 ranged from 0.99 to 1.13 µg/L during 2005 (Figure 7.2-23). Concentrations of perchlorate are observed at R-1, R-13, R-33, R-34, and TW-8 (see Appendix D, Section D-2.2) were much lower than those observed at R-15 and R-28. Detectable concentrations of perchlorate, analyzed by liquid chromatography-mass spectrometry/mass spectrometry (EPA SW846 modified Method 6850) to obtain a lower detection limit, ranged from 0.12 to 0.48 µg/L at R-1, R-13, R-14, R-33, R-34, and TW-8. Concentrations of perchlorate were less than analytical detection (<0.05 µg/L) in three samples collected at R-14 (screen 2). The nondetects of low-level perchlorate are most likely due to the presence of residual

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drilling fluid in screen 2, R-14. The spatial extent of perchlorate detected in the regional aquifer correlates with the perchlorate mass observed in the vadose zone.

Chromium

Chromium is detected in surface water, alluvial and perched-intermediate groundwater, and the regional aquifer beneath Mortandad Canyon. Chromium speciation controls its mobility in groundwater.

- Chromium(VI) is soluble as anions and is subsequently mobile in oxidizing groundwater. Chromium(VI), in the form of potassium dichromate ($K_2Cr_2O_7$), was used in cooling towers at the TA-03 power plant as a corrosion inhibitor from approximately 1956 to 1972 (LANL 2006, 91987), and cooling tower blowdown (effluent) was released into Sandia Canyon. It may have been used in other cooling towers at TA-03, TA-35 and TA-48 with blowdown released directly to the Mortandad watershed as well. Chromic acid may also have been used in electroplating operations at facilities on Sigma Mesa at TA-03 (LANL 2006, 91987). Both potassium dichromate and chromic acid dissociate to the anions CrO_4^{2-} and $HCrO_4^-$, which are hypothesized to be the dominant mobile species in surface water and groundwater. Chromium(VI) is the dominant species when concentrations of chromium in filtered and nonfiltered sample pairs are similar.
- Chromium(VI) can be reduced to chromium(III) in the presence of reducing agents, such as solid organic matter present within wetlands and alluvial sediments and ferrous iron within glass, silicates, and oxides in the alluvium and Cerros del Rio basalt. Once reduced, the chromium(III) is insoluble and precipitates from solution as amorphous or crystalline $Cr(OH)_3$ and co-precipitates with ferric iron as $(Fe_xCr_{1-x})(OH)_3$ (Rajet et al 1987, 91686; Raji and Zachara 1986, 91684) and is subsequently much less mobile in groundwater. Below pH 7, chromium(III) is stable as a cation that adsorbs onto solid organic matter. In any of these phases, chromium(III) is associated with suspended particles present in nonfiltered samples. Chromium(III) is the dominant species when chromium concentrations in nonfiltered samples exceed those in filtered samples.

The role of speciation on chromium mobility will be further evaluated under the "Interim Measures Work Plan for Chromium Contamination in Groundwater" (LANL 2006, 91987) and under subsequent related work plans as appropriate.

Chromium in Surface Water and Alluvial Groundwater

The spatial trends in recent (2000–2005) total (nonspeciated) chromium(III and VI) concentrations in surface water and alluvial groundwater are shown in box plots in Appendix D, Figures D-2.1-7 through D-2.1-9, for different portions of the Mortandad watershed. Box plots for both filtered (dissolved) and nonfiltered (dissolved and suspended fractions) samples are presented separately because filtration tends to remove trivalent chromium from the sample and thus allows speciation information to be gleaned from the total chromium analyses, as discussed above. The spatial distributions of chromium concentrations shown in Figures D-2.1-7 through D-2.1-9 indicate that chromium in surface water and alluvial groundwater in the Mortandad watershed are predominantly, if not entirely, Laboratory derived.

At the heads of Mortandad Canyon (Figure D-2.1-7) and Effluent Canyon (Figure D-2.1-8), and throughout Ten Site Canyon (FigureD-2.1-9), total chromium concentrations in surface water and alluvial groundwater are higher than at downstream locations, indicating that separate chromium sources are discernible in reaches at the heads of these canyons. At each of these locations, chromium(III) dominates over chromium(VI) in the surface water and alluvial groundwater samples because the nonfiltered fraction constitutes the majority of total chromium. In upper Mortandad Canyon, the highest chromium concentrations occur in surface water below TA-03 within reach M-1W where total chromium was

observed at 27.5 µg/L in a nonfiltered water sample. In Effluent Canyon, the highest concentration of total chromium is 100 µg/L in a nonfiltered alluvial groundwater sample collected at MCO-2/MCA-4 west of (above) the TA-50 outfall. In Ten Site Canyon, total chromium is identified in surface water within reaches TS-1C, TS-2C, and TS-2E (Figure D-2.1-9). The maximum detected concentration of total chromium is 20.8 µg/L in surface water in reach TS-1C. The higher apparent presence of chromium(III) in the upper portions of these canyon segments indicates that the chromium(III) is relatively immobile and is probably related to the presence of chromium(III)-contaminated sediments redistributed downcanyon of small historical sources at TA-03, TA-48, and TA-35 (Section 2.1). The predominance of chromium(III) in that area is also likely related to the several small wetlands that exist within the canyon floor in that area. The concentrations and frequency of detection generally decrease east of the TA-50 RLWTF outfall in Effluent Canyon and in Mortandad Canyon past the confluence with Effluent Canyon. From reach E-1W eastward, low-detected concentrations of total chromium occur in surface water and alluvial groundwater. Although chromium(III) dominates in the samples, detection of chromium in both filtered and nonfiltered samples indicates the co-occurrence of chromium(III and VI) in the surface water and groundwater samples. Concentrations in filtered samples of both surface water and alluvial groundwater do not exceed 50 µg/L or 100 µg/L, the NMWQCC groundwater standard and EPA Region 6 drinking water MCL, respectively.

Chromium in Vadose-Zone Pore Water and Perched-Intermediate Groundwater

The hypothesis for chromium transport in the vadose zone is that chromium(VI) migrates from the alluvial groundwater into the vadose zone and travels as the mobile anions CrO_4^{2-} and $HCrO_4^-$. Chromium(VI) can be reduced to chromium(III) along vadose zone flow paths by naturally occurring minerals and volcanic glass that act as reducing agents. Ferrous iron concentrated within the Cerros del Rio basalt is considered to be another potential reductant for chromium(VI). Once reduced, chromium(III) precipitates from solution or adsorbs onto ferric (oxy)hydroxide and clay minerals.

Analytical results for chromium and iron measured on vadose-zone core samples are plotted in Appendix D, Figures D-2.4-1 through D-2.4-21. Potential anthropogenic chromium was identified in the core samples at concentrations exceeding background for the Bandelier Tuff-Cerro Toledo Interval (2.24 to 7.14 mg/kg) and/or sediments (10.5 mg/kg) (Ryti et al. 1998, 59730) at MCB-2, -7, -8, -9, -10, -11, -12, -14, -15, and -16, R-14, and R-15. Chromium is found concentrated at or near the interfaces of the alluvium with Unit Qbt1g and of Unit Qbt1g with the Cerro Toledo Interval (Figures D-2.4-1 through 2.4-21). The highest concentration of anthropogenic chromium (440 mg/kg) was detected in core collected at R-15 at a depth of 37 m (120 ft) at the contact between the Cerro Toledo Interval and Otowi Member of the Bandelier Tuff (Figures D-2.4-20 and D-2.4-21) (Longmire et al. 2001, 70103). With respect to the MCB boreholes, the highest concentration of anthropogenic chromium (71 mg/kg) was detected at MCB-14 at a depth of 66 m (215 ft) (Figure D-2.4-11) within the Otowi Member of the Bandelier Tuff. In fact, MCB-14 contains the greatest chromium mass of any borehole with five measured chromium concentrations above 15 mg/kg over the depth interval 52 to 82 m (170 to 270 ft). Excluding the sample from core collected at R-15, core samples from the remainder of the boreholes did not have chromium concentrations exceeding 15 mg/kg. Concentrations of chromium are within background at MCB-1, MCB-5, and MCB–6.

Analysis conducted on core samples did not differentiate chromium(III) from chromium(VI). However, because of the ability of iron-bearing minerals to reduce and then adsorb chromium(III), the co-occurrence of chromium and iron is indicative of adsorbed chromium(III). The chromium and iron profiles (Figures D-2.4-1 through D-2.4-21) indicate a strong correlation between chromium and iron, that is, higher chromium concentrations are collocated with higher iron concentrations, meaning that the chromium is likely relatively immobile. Under acidic pH conditions, CrO_4^{2-} and $HCrO_4^-$ adsorb onto ferric

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(oxy)hydroxide to a greater extent than under alkaline pH conditions. Therefore, chromium(VI) may partly account for some of the association between iron and chromium in the unsaturated zone.

Elevated chromium(VI) concentrations are observed in perched-intermediate zones located beneath Mortandad Canyon. The presence of deep contamination indicates that there are some preferential pathways through the vadose zone that have transported comparatively small masses of chromium to depths below the Otowi Member. Perched-intermediate wells sampled during 2005 include MCOI-4, MCOI-5, MCOI-6 (Figures D-2.2-16[a], D-2.2-17[a], and D-2.2-18[a]), and MCOI-8, whereas MCOBT-4.4 (Figure 7.2-21) was sampled from 2001 to 2005. The data show spatially variable results with chromium(VI) dominating in some of the perched zones and chromium(III) at others.

Concentrations of total chromium in filtered and nonfiltered samples decreased from 53.3 to 37.4 µg/L and 53.6 to 41.4 µg/L, respectively, at perched-intermediate well MCOBT-4.4 during 2002 and 2003 (Figure D-2.2-15[a]). Concentrations of total chromium in filtered and nonfiltered samples were similar, indicating that chromium(VI) dominants over chromium(III) at MCOBT-4.4.

Concentrations of total chromium in nonfiltered samples collected at MCOI-4 in 2005 have decreased from 135 to 61.3 µg/L (Figure D-2.2-16[a]) and sample turbidity decreased from 31.9 to 18 nephelometric turbidity units (NTUs). Total chromium in filtered samples increased from 25 to 29.4 µg/L in the samples during 2005. Concentrations of total chromium in nonfiltered samples initially exceeded those in filtered samples suggesting that chromium(III) dominates.

Concentrations of total chromium in nonfiltered samples collected at MCOI-5 in 2005 decreased from 770 to 545 µg/L (Figure D-2.2-17[a]) and sample turbidity decreased from 83.6 to 16.6 NTU. This well is located on the south side of Mortandad Canyon near regional aquifer well R-15. Concentrations of total chromium in filtered samples at the well also decreased from 3.5 to 3.1 µg/L. This suggests that chromium(III) dominates and that chromium(VI) represents a small fraction not removed from solution by adsorption and/or precipitation processes.

Concentrations of total chromium in nonfiltered samples at MCOI-6 in 2005 were 52.2 to 58.9 µg/L (Figure D-2.2-18[a]) and sample turbidity was 4.86 and 6.41 NTU. Concentrations of total chromium in filtered samples collected at the well also increased from 48.4 to 58.2 µg/L, suggesting that chromium(VI) dominates. Variation in total chromium in nonfiltered samples is caused by the presence of suspended particles that probably contain natural and anthropogenic chromium(III). Well MCOI-8 was sampled for chromium in 2006, and analytical results will be reported in the "Chromium Interim Measures Report."

Overall, perched-intermediate groundwaters from MCOBT-4.4, MCOI-4, and MCOI-6 have elevated chromium(VI), represented by total chromium concentrations in filtered samples, ranging from 25 to 58 µg/L that is most likely anthropogenic. Suspended particles in these samples probably contain both natural and anthropogenic chromium(III). Chromium(VI) concentrations, represented by total chromium concentrations in filtered samples in intermediate groundwater from MCOI-5 are low at 3.5 µg/L or less. This well may not be impacted by anthropogenic sources.

Chromium in the Regional Aquifer

Regional aquifer wells sampled during this investigation included R-1, R-13, R-14, R-15, R-28, R-33, R-34, and TW-8 (see Appendix D, Section 2.2). Concentrations of total chromium within the regional aquifer in the Puye Formation are the highest beneath the axis of Mortandad Canyon at R-28 (Figure 7.2-23) and decrease to the southeast and southwest at R-13 (Figure D-2.2-20[a]) and R-15. (Figure 7.2-22).

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Concentrations of total chromium at R-15 varied from 3.6 to 14.7 µg/L in nonfiltered samples collected from 1999 to 2005 (Figure D-2.2-22[a]). Concentrations of total chromium varied from 2.6 to 7.9 µg/L in filtered samples at the well (Figure 7.2-22 and D-2.2-22[a]). Concentrations of total chromium at R-28 generally increased from 375 to 404 µg/L (Figure 7.2-23) and from 389 to 416 µg/L (Figure D-2.2-23[a]) in filtered samples and nonfiltered samples, respectively, collected during 2005. These are the highest concentrations of total chromium(III, VI) and chromium(VI) measured in the regional aquifer beneath the Laboratory. Detectable concentrations of total chromium in nonfiltered and filtered samples ranged from 2.73 to 12.3 µg/L and from 0.93 to 8.2 µg/L, respectively, at R-1, R-13, R-14, R-33, and R-34 (Appendix D, Section D-2.2). Concentrations of total chromium varied from 3.36 to 7.92 µg/L in nonfiltered samples collected at TW-8 from 2001 to 2005 (Figure D-2.2-26[a]). Concentration of total chromium in three filtered samples were less than analytical detection (<1 µg/L) at R-14 (Figure D-2.2-21[a]) in 2004 and 2005. The majority of water samples from R-14 contained detectable total chromium. The nondetection of total chromium is most likely due to the presence of residual drilling fluid in screen 2, R-14.

Iron

Solid and aqueous species of iron occur within stream sediments, alluvial and perched-intermediate groundwater, the regional aquifer, and unsaturated and saturated rock. Under oxidizing and circumneutral pH conditions, such as in the Mortandad watershed, ferric iron precipitates from solution typically as insoluble ferric (oxy)hydroxide and ferric oxide (hematite) (Langmuir 1997, 56037). Iron is stable in the +II (ferrous) and +III (ferric) oxidation states in aqueous solution and forms complexes with hydroxide, sulfate, chloride, and bicarbonate. These complexes influence the solubility of iron(II, III) solids. Ferric (oxy)hydroxide is an important adsorbent for many trace elements and radionuclides, including americium, arsenic, cadmium, chromate, cobalt, lead, nickel, plutonium, selenium, thorium, uranium, and zinc. The specific surface area of hydrated ferric hydroxide (ferrihydrite) is 600 m^2/g as compared with that of quartz having a value of 0.14 m^2/g (Langmuir 1997, 56037). Iron(III) dominates over iron(II) when concentrations of iron in nonfiltered samples exceed those of filtered samples. Iron and manganese have similar chemical properties, and iron is typically collocated with manganese in sections of the Mortandad watershed. Under reducing conditions enhanced by the presence of residual organic-based drilling fluids, iron(III) solids dissolve and iron(II) aqueous species and solids becomes stable. Desorption of trace elements can take place during reductive dissolution of ferric (oxy)hydroxide, resulting in an increase of these solutes in groundwater.

Iron in Surface Water and Alluvial Groundwater

The spatial trends in total (nonspeciated) iron(II and III) concentrations in surface water and alluvial groundwater from 2000-2005 are shown in box plots in Appendix D, Figures D-2.1-10 through D-2.1-12, for different portions of the Mortandad watershed. Box plots for both filtered (dissolved) and nonfiltered (dissolved and suspended fractions) samples are presented separately to help differentiate speciation. The highest concentrations of total iron in nonfiltered samples are measured within reach M-1W (25.5 mg/L, Figure D-2.1-10) in upper Mortandad Canyon just east of TA-03 (Plate 1) and at well MCO-2/MCA-4 (26 mg/L) in Effluent Canyon (Figure D-2.1-11). Most of the iron at these locations occurs as a precipitate associated with suspended material because concentrations of total iron in nonfiltered samples are greater than total iron in filtered samples. Surface water at reach E-1W is also elevated (approximately 5 mg/L in both nonfiltered and filtered samples). Concentrations of total iron are much lower in surface water and alluvial groundwater within Mortandad Canyon east of the Effluent Canyon confluence (Figure D-2.1-11). These distributions indicate sources at the head of Mortandad Canyon in TA-03 and to Effluent Canyon west of the TA-50 RLWTF outfall.

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In Ten Site Canyon, the highest concentration of iron is identified in surface water within reach TS-1C (Figure D-2.1-12). Iron(III) precipitate(s) associated with suspended material dominate within this reach because concentrations of total iron in nonfiltered samples greatly exceed dissolved iron in the surface-water samples. Concentrations of total iron in nonfiltered samples decrease downcanyon to the Mortandad confluence (Figure D-2.1-12). Concentrations of iron detected in surface water in reach TS-1C are possibly related to the presence of iron-contaminated sediments redistributed down canyon of the TA-35 source. Ferric chloride and ferric sulfate were identified as chemicals present in the TA-35 wastewater or used to treat the wastewater before discharge (LANL 1997, 56835).

Iron in Vadose-Zone Pore Water, Perched-Intermediate Groundwater, and the Regional Aquifer

Analytical results for iron measured on vadose-zone core samples are plotted in Figures D-2.4-1 through D-2.4-21. Background concentrations of iron range from 0.37 to 1.45 wt% within the Bandelier Tuff and are 1.38 wt% in sediments (McDonald et al. 2003, 76084; Ryti et al. 1998, 59730). Background concentrations of iron are observed at MCB-1, MCB-2, MCB-5, MCB-6, MCB-14, and MCB-16, R-14, and R-15. Concentrations of iron exceeding background occur at MCB-7, MCB-8, MCB-9, MCB-10, MCB -11, MCB -12, and MCB-15, which could be represented by a combination of anthropogenic and natural iron in the forms of ferric (oxy)hydroxide, Fe_2O_3 (hematite) and Fe_3O_4 (magnetite) The co-occurrence of iron and chromium, as discussed in the chromium section above, suggests that adsorption processes are important in concentrating chromium within the vadose zone.

Anthropogenic forms of iron discharged from the Laboratory most likely have not migrated to perched-intermediate zones and the regional aquifer because of the elements' low solubility under circumneutral pH and oxidizing conditions dominant in the subsurface. Distributions of natural iron in the deeper saturated zones are controlled by specific hydrogeochemical conditions including redox conditions, groundwater composition, and aquifer mineralogy. Biologically induced breakdown of drilling fluids results in reductive dissolution of ferric (oxy)hydroxide and hematite (LANL 2005, 91533). Concentrations of total dissolved and total iron range from 2.33 and 4.50 mg/L and 4.24 and 6.85 mg/L, respectively, at R-14 (screen 2). Elevated concentrations of dissolved iron show the presence of residual drilling fluid at the well.

Fluoride

Fluoride has been detected in surface water, alluvial and perched-intermediate groundwater, and the regional aquifer within the Mortandad watershed. There are both natural and anthropogenic sources of fluoride within the watershed, with Laboratory-derived fluoride produced from the dissociation of hydrofluoric acid that is neutralized before discharge. Fluoride has been released at the TA-50 RLWTF outfall, but since 2000, effluent concentrations have been below the New Mexico WQCC groundwater standard of 1.6 mg/L, and in 2005 the average concentration had dropped to 0.24 mg/L (LANL 2006, 93925). Fluoride is mobile in groundwater as an anion and does not significantly adsorb onto clay minerals, ferric (oxy)hydroxide, solid organic matter, and other naturally occurring adsorbents. In the presence of calcium, fluoride precipitates from solution as CaF_2 (fluorite), and its solubility is independent of pH.

Fluoride in Surface Water and Alluvial Groundwater

Fluoride travels laterally downcanyon with surface water and alluvial groundwater in the watershed. The spatial trends in recent (2000–2005) fluoride concentrations in nonfiltered samples of surface water and alluvial groundwater are shown in box plots in Appendix D, Figures D-2.1-13 through D-2.1-15, for different portions of the Mortandad watershed. Fluoride was detected in all surface water samples

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collected within upper Mortandad Canyon west of the Effluent confluence (Figure D-2.1-13). The highest concentration of fluoride was 0.72 mg/L measured in reach M-1W. Concentrations of fluoride decrease in surface water to the Effluent Canyon confluence and then increase downcanyon (Figure D-2.1-14). The maximum concentrations of fluoride are 1.92 mg/L at wells MT-1 and MT-3 in 2005, just slightly over the New Mexico WQCC groundwater standard of 1.6 mg/L. In Ten Site Canyon, detectable concentrations of fluoride are low, ranging between 0.03 and 0.42 mg/L in surface water samples. Effluent from the TA-50 RLTWF has been a source of fluoride to the watershed. However, it appears that fluoride has also entered the watershed at TA-03 and may have come from TA-48 (to both Mortandad and Effluent canyons) as well.

The overall distribution of fluoride concentrations in surface water and alluvial groundwater is very similar to that observed for nitrate. That is, fluoride concentrations increase spatially from west to east in Mortandad Canyon beyond the Effluent Canyon confluence. As for nitrate, the trend is indicative of a dilution lag in the alluvial aquifer from west to east since improved effluent quality in 2000 (Section 2.1.1). The lag is caused by the distance from the outfall and to increasing alluvial storage from west to east (Section 7.2.1.2). Time series plots for surface water at gage E200 (Figure D-2.2-1[b]) and several alluvial wells (e.g., Figures D-2.2-6[b], D-2.2-7[b], D-2.2-9[b]) show a decline in fluoride concentrations since 2000. In 2005, only the most distal alluvial wells, MCOBT-7.5, MT-1, and MT-3 have concentrations slightly over the New Mexico WQCC groundwater standard (1.92 mg/L vs. 1.6 mg/L). None of the surface water or alluvial water concentrations is currently above the EPA Region 6 tap water standard of 4 mg/L. Over time, fluoride concentrations at the alluvial wells will decline even further in response to improved effluent quality at the TA-50 outfall and to dilution by occasional surface water runoff events.

Fluoride in Vadose-Zone Pore Water and Perched-Intermediate Groundwater

Fluoride appears to have mobility similar to nitrate in the vadose zone and is present in vadose-zone pore water into the Otowi Member and at a few locations is present in perched-intermediate groundwater. For instance, at wells MCOBT-4.4 and MCOBT-8.5, pore-water concentrations of fluoride range from approximately 4 to 20 mg/L throughout the Otowi Member (Broxton et al. 2002, 76006). Concentrations of fluoride have varied within the perched-intermediate zones from 2002 to 2005, which may be indicative of natural conditions with a slight impact from the TA-50 outfall. Concentrations of fluoride in filtered and nonfiltered samples slightly varied from 0.4 to 0.42 mg/L at MCOBT-4.4 during 2002 and 2003. At MCOI-4, concentrations of fluoride in nonfiltered samples varied from 0.21 to 0.24 mg/L. At MCOI-5, concentrations of fluoride in filtered and nonfiltered samples increased from 0.24 to 0.33 mg/L. Concentrations of fluoride in filtered and nonfiltered samples at MCOI-6 increased slightly from 0.54 to 0.59 mg/L during 2005.

Fluoride in the Regional Aquifer

Fluoride within the regional aquifer beneath Mortandad Canyon is generally variable within a narrow concentration range. Concentrations ranged from 0.01 to 0.48 mg/L, representing natural conditions within the regional aquifer.

Lead

Lead is a naturally occurring trace metal found in surface water and groundwater environments. It is also a widespread environmental contaminant associated with industrial discharges, bullets, batteries, leaded gasoline, paint, solder, and other waste forms or chemicals. Lead is stable in the +II oxidation state in aqueous solution (Langmuir 1997, 56037) and forms complexes with hydroxide, sulfate, chloride, and bicarbonate. Lead also precipitates from solution in the form of hydroxide, carbonate, sulfate, and

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phosphate minerals. Lead strongly adsorbs onto ferric (oxy)hydroxide through surface complexation reactions (Langmuir 1997, 56037) under circumneutral pH conditions. Lead is very immobile in groundwater if it occurs as a cation and is not complexed with organic ligands or anions.

Lead in Surface Water and Alluvial Groundwater

The spatial trends in recent (2000–2005) lead concentrations in nonfiltered samples of surface water and alluvial groundwater are shown in box plots in Appendix D, Figures D-2.1-16 through D-2.1-18. The two highest concentrations of lead measured within the Mortandad watershed, exceeded 30 µg/L and 27 µg/L in nonfiltered surface water samples collected in upper Ten Site Canyon (Figure D-2.1-18) and upper Mortandad Canyon (Figure D-2.1-16), respectively. Concentrations of lead in nonfiltered surface water samples lower substantially downcanyon. In Effluent Canyon, the highest concentration of lead (22 µg/L) was measured in a nonfiltered alluvial groundwater sample collected at well MCO-2/MCA-4 above the TA-50 RLWTF outfall (Figure D-2.1-17). A dissolved concentration of lead of 3.5 µg/L was measured at alluvial well MCO-2/MCA-4, located above the Mortandad Canyon confluence. The sources of lead at these locations, which are all near the head of their respective canyons, are most likely anthropogenic, originating from TA-35, TA-03 and TA-48 discharges, respectively, and/or atmospheric and roadside deposition of leaded gasoline that contains tetraethyl lead. Most of the lead within the watershed is associated with suspended material because concentrations of this metal in nonfiltered samples are greater than that found in filtered samples. Concentrations of dissolved lead in surface water and alluvial groundwater within the watershed are less than the New Mexico WQCC groundwater standard of 50 µg/L and the EPA Region 6 tap water standard of 15 µg/L.

Lead in Vadose-Zone Pore Water, Perched-Intermediate Groundwater, and the Regional Aquifer

Anthropogenic forms of lead discharged from the Laboratory most likely have not migrated substantially into the vadose zone and have not reached perched-intermediate zones and the regional aquifer because of the element's high capacity to adsorb onto surfaces of aquifer material containing smectite and ferric (oxy)hydroxide. At well R-15, lead analyses of vadose-zone core samples showed lead within the Bandelier tuff and the Cerro Toledo interval (Longmire et al. 2001, 70103). However, this was attributed to naturally occurring elements within the tuff samples. Detectable concentrations of lead in nonfiltered samples from perched-intermediate zones ranged from 0.56 to 13.8 µg/L at MCOI-4, MCOI-5, MCOI-6, and MCOI–8 and MCOBT-4.4. Dissolved (filtered) concentrations of lead are generally not detected (upper detection limit of 0.5 µg/L) within perched-intermediate zones and the regional aquifer. When detected, dissolved concentrations of this trace metal are less than 0.3 µg/L. Distributions of natural lead in the deeper saturated zones are controlled by specific hydrogeochemical conditions including groundwater composition and aquifer mineralogy. Elevated concentrations of lead may occur in wells resulting from corrosion of components and solder associated with electrical wiring.

Manganese

Manganese is stable in the +II, +III, and +IV oxidation states in aqueous solution in which a large stability field for dissolved Mn(II) occurs (Langmuir 1997, 56037). Manganese (III, IV) solids are stable under oxidizing conditions typical of aquatic environments with little or no dissolved or solid organic matter. Manganese(IV) solids are considered to be important minerals present within aquifer and vadose material in the watershed based on oxidizing conditions. Manganese(IV) solids are important adsorbents for many trace elements similar to that of ferric (oxy)hydroxide (Langmuir 1997, 56037). Manganese (III, IV) oxides are less abundant than ferric (oxy)hydroxide and hematite in aquifer material and surface sediments at the Laboratory based on much higher concentrations of iron (in the weight percent range) than

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manganese (in the parts per million range). Manganese has a spatial distribution that is, in part, similar to that of iron in sections of the watershed.

It is widely accepted that bacterially mediated reduction of manganese depends upon sediment moisture conditions, the availability of labile organic carbon, and the presence of poorly crystalline manganese oxides (Lovley 1991, 85523; Lovley and Chapelle 1995, 85506). In wetlands within upper Mortandad Canyon, dissolved and solid organic matter are concentrated in sections with abundant vegetation including grasses, shrubs, cattails, and coniferous and deciduous trees. Persistent saturated conditions in these reaches ensure environmental stability for microbial communities, and abundant manganese oxides associated with volcanic rocks, especially weathered tuffs, on the Pajarito Plateau provide optimal conditions for manganese reduction in wetland pore water. In addition, the slow oxidation kinetics of manganese and the progressively longer residence time of stagnant water within wetlands result in an accumulation of soluble manganese (Hem 1981, 85505).

Manganese in Surface Water and Alluvial Groundwater

The spatial trends in recent (2000–2005) manganese concentrations in nonfiltered and filtered samples of surface water and alluvial groundwater are shown in box plots in Appendix D, Figures D-2.1-19 through D-2.1-21. Concentrations of manganese in filtered and nonfiltered surface water samples range from 6.3 to 958 µg/L and from 7.4 to 1080 µg/L, respectively, within Effluent Canyon. Concentrations of manganese in filtered and nonfiltered alluvial groundwater samples range from 1510 to 2266 µg/L and from 1670 to 2375 µg/L, respectively, at MCA-4. Concentrations of manganese exceeding 2 mg/L are associated with both nonfiltered and filtered samples in surface water in reach M-1E and in alluvial groundwater at MCO-0.6 (Figure D-2.1-19), both located in or near wetland areas in upper Mortandad Canyon west of the Effluent Canyon, and in alluvial groundwater collected from MCO-2/MCA-4 within Effluent Canyon west of the TA-50 RLWTF outfall (Figures D-2.1-20). The presence of abundant wetlands in upper Effluent Canyon and Mortandad Canyon suggests that the manganese observed in this portion of the watershed is naturally occurring. Concentrations of manganese sharply decrease immediately east of the TA-50 outfall and remain low throughout Mortandad Canyon. Most of the detectable manganese is stable as soluble manganese(II) based on similar concentrations within filtered and nonfiltered samples. Concentrations of manganese in filtered and nonfiltered surface water samples range from 1.67 to 33.7 µg/L and from 2.5 to 108 µg/L, respectively, within Mortandad Canyon. Concentrations of manganese in filtered and nonfiltered alluvial groundwater samples range from 0.296 to 7.6 µg/L and from 0.296 to 45.6 µg/L, respectively, within Mortandad Canyon.

In Ten Site Canyon, manganese is identified in surface water within reaches TS-1C and TS-2E (Figure D-2.1-21). The maximum concentrations of total manganese in filtered and nonfiltered water samples are 449 and 1690 µg/L, respectively, in surface water in reach TS-1C. This distribution suggests that particulates of manganese(III, VI) oxides occur within the reach, and the surface water is moderately oxidizing. The maximum concentrations of total manganese in filtered and nonfiltered samples are 875 and 887 µg/L, respectively, in surface water in reach TS-2E. This distribution suggests that manganese(II) is stable and that reductive dissolution of manganese(III, IV) oxides has taken place within the reach. It is not clear whether the manganese in Ten Site Canyon represents a natural condition or a Laboratory source of manganese.

Manganese within Perched-Intermediate Groundwater and the Regional Aquifer

Any anthropogenic forms of manganese that may have been released by the Laboratory most likely have not migrated to perched intermediate zones and the regional aquifer because of the elements' low solubility under circumneutral pH and oxidizing conditions dominating in the subsurface. Distributions of

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natural manganese in the deeper saturated zones are controlled by specific hydrogeochemical conditions including redox conditions, groundwater composition, and aquifer mineralogy. Biologically induced breakdown of drilling fluids results in reductive dissolution of manganese oxide (LANL 2005, 91533).

Nickel

Nickel is stable in the +II oxidation state in aqueous solution as Ni^{2+}, $NiHCO_3^+$, and $NiCO_3^0$ (Langmuir 1997, 56037). Free or noncomplexed Ni^{2+} is stable under acidic pH conditions, whereas the complexes $NiHCO_3^+$ and $NiCO_3^0$ are stable under circumneutral pH conditions in the presence of total carbonate alkalinity. Nickel(II) solids, including $Ni(OH)_2$ and $NiCO_3$, are stable under a wide range of redox conditions. Natural nickel is concentrated within the Cerros del Rio lavas, ranging between 35 and 154 ppm (Vaniman et al. 2002, 72615) and is a trace element associated with olivine, basaltic glass, and weathering products such as ferric (oxy)hydroxide, smectite, and iddingsite. Nickel(II) adsorbs onto ferric (oxy)hydroxide and clay minerals (Langmuir 1997, 56037) through surface complexation and cation exchange reactions, respectively.

Elevated concentrations of nickel in filtered and nonfiltered samples were measured at MCOI-5 and R-33 (screen 1) during one or two sampling rounds conducted in 2005. Well MCOI-5 was sampled on June 9 and September 9, 2005. Concentrations of nickel in filtered and nonfiltered samples were 55.8 and 62.2 µg/L and 414 and 282 µg/L, respectively, at MCOI-5. Concentrations of iron in the same filtered and nonfilter samples were 62.4 and 69.8 µg/L and 6980 and 4360 µg/L, respectively, at MCOI-5. Concentrations of iron in nonfiltered samples suggest the presence of iron-rich solid phases associated with suspended material. Turbidity values were 83.6 and 16.6 NTU in the two samples collected on June 9 and September 9, 2005, respectively. Well MCOI-5 is completed within Puye Formation/Cerros del Rio basalt. One hypothesis for explaining the elevated nickel concentrations at MCOI-5 is that natural adsorbents for nickel and other metals such as ferric (oxy)hydroxide, olivine, smectite, and volcanic glass are present as suspended particles.

Well R-33 was sampled on June 24 and 27 and September 14 and 15, 2005. Concentrations of nickel were 168 and 25.1 µg/L, respectively, in filtered and nonfiltered samples collected on June 24, 2005, at R-33 (screen 1) using EPA Method SW-846-6010B. The analytical result for nickel in the filtered sample is suspect because it is greater than that for the nonfiltered sample. The turbidity measured for the sample was 24.1 NTU. Concentrations of iron in the same filtered and nonfilter samples were 163 and 251 µg/L, respectively, which were also analyzed by using EPA Method SW-846-6010B. Other samples collected at R-33 in September 2005 did not show any discrepancies within metal analyses.

7.2.2.2 Organic Chemicals in Water

Aroclor-1260

Aroclor-1260 generally was not detected in surface water and alluvial groundwater samples collected within the Mortandad watershed (Appendix D, Figures D-2.1-22 through D-2.1-24). The maximum instrument detection limit (IDL) for aroclor-1260 was 1.4 µg/L. Arochlor-1260, however, was detected at a concentration of 1.1 µg/L in one nonfiltered surface water sample collected in Ten Site Canyon within reach TS-1C (Figure D-2.1-24). Aroclor-1260 is not considered to be a widespread COPC in surface water or alluvial groundwater within the watershed.

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Bis(2-ethylhexyl)phthalate

Bis(2-ethylhexyl)phthalate was detected between concentrations of 0.5 and 7 µg/L in nonfiltered surface water and alluvial groundwater samples within Mortandad Canyon (Appendix D, Figures D-2.1-25 through D-2.1-27). The highest concentration of bis(2-ethylhexyl)-phthalate was measured at well MT-1. The maximum practical quantitation limit (PQL) for bis(2-ethylhexyl)-phthalate is 22 µg/L. Detects of bis(2-ethylhexyl)-phthalate are typically less than the PQLs but are above the minimum detection limit (MDL) of 0.5 µg/L. Bis(2-ethylhexyl)phthalate was observed in regional well R-15 from 2000 to 2005 and in R-33 in 2005 at ranges of 2 to less than 11 µg/L. Bis(2-ethylhexyl)phthalate is a component of plastics and could be derived from several sources, including bailers used during sample collection, Laboratory discharges and runoff, and analytical laboratories in which water samples come in contact with plastic during analysis.

1,4-Dioxane

Perched-intermediate groundwater has shown detections of 1,4-dioxane at MCOI-4 (53.3 and 50.8 µg/L) and MCOI-6 (52.2 and 56.4 µg/L). Other wells sampled in the Mortandad watershed did not contain detectable concentrations of 1,4-dioxane. The analytical detection limit for recent samples analyzed for 1,4-dioxane is 50 µg/L using gas chromatography-mass spectrometry. 1, 4-dioxane is completely miscible in aqueous solution and does not adsorb onto solid surfaces. 1, 4-dioxane is used as a solvent for cellulosics and a wide range of organic products including lacquers, paints, varnishes, paint and varnish removers, cleaning and detergent preparations, cements, cosmetics, deodorants, and fumigants (Verschueren 1983, 63044). The source(s) of 1,4-dioxane have not been identified.

7.2.2.3 Radionuclides in Water

Several radionuclides are identified in Section 6 as being COPCs in surface water, alluvial and perched-intermediate groundwater and/or the regional aquifer in the Mortandad watershed. These include tritium, strontium-90, plutonium-238, plutonium-239,240, and americium-241. A series of plots in Appendix D provides a high-level overview of the spatial trends of the radionuclide COPCs in the Mortandad watershed. The discussion below provides additional information on the spatial distribution of these contaminants in key areas of the watershed. Overall, the spatial distribution of radionuclide concentrations indicates only a few key sources of contaminants in water. The most important sources include the TA-50 outfall within Effluent Canyon and the former TA-35 WWTP outfall adjacent to reach TS-1C in Ten Site Canyon (Plate 1). Ash from the Cerro Grande fire may be a potential minor source of radionuclide constituents measured in water.

Tritium

Tritium is detected in surface water, alluvial groundwater, perched-intermediate groundwater, and the regional aquifer in Mortandad Canyon. Tritium has been discharged into the Mortandad watershed from approximately 1953 to 1974 at TA-35 and since 1963 at the TA-50 RLWTF (see Section 2.1). Tritium is a radioactive isotope of hydrogen with a relatively short half-life of 12.32 yr, which decays to helium-3 with the emission of a beta particle (Clark and Fritz 1997, 59168). It is extremely mobile because it can replace hydrogen within a water molecule and travel as groundwater.

Tritium in Surface Water and Alluvial Groundwater

Tritium travels laterally down canyon with the surface water and alluvial groundwater in the watershed. The spatial trends in recent (2000–2005) tritium concentrations in surface water and alluvial groundwater

are shown in the box plots of Figures D-2.1-28 through D-2.1-30. Tritium concentrations are low (< 1000 pCi/L) in upper Mortandad Canyon (Fig. D-2.1-28), in upper Effluent Canyon (Fig. D-2.1-29), and in Ten Site Canyon (Fig. D-2.1-30) indicating that there is little, if any, recent tritium disposal contributing to these canyon segments. The highest concentrations of tritium in surface water are observed at gage E200 with two detections greater than the groundwater MCL of 20,000 pCi/L. All other surface water and alluvial groundwater detections, except for one high value at well pair MCO-3/MCA-5, are far below the MCL.

Figure 7.2-27 is a time series plot covering the period 1967 through 2005. It shows the annual tritium concentration in TA-50 RLTWF effluent and the resulting concentrations at alluvial wells MCO-3/MCA-5, MCO-5, MCO-6, MCO-7 and MCO-7.5. From 1976 to 1992, the outfall tritium concentrations averaged over 300,000 pCi/L, with maximum concentration exceeding 3,000,000 pCi/L. During this same period, tritium concentrations in the alluvial wells were elevated with many values over 20,000 pCi/L. Since 2001, outfall concentrations have dropped below 20,000 pCi/L. Correspondingly, concentrations of tritium have decreased in surface water and alluvial groundwater.

Current concentrations of tritium in alluvial groundwater are generally higher in the Mortandad Canyon segment between wells MCO-3/MCA-5 and MCO-7.5 (Figure D-2.1-29) are lower east of MCO-7.5. Previous releases from the TA-50 RLWTF are the likely source of tritium. Similar to nitrate and perchlorate, tritium demonstrates a trend of increasing concentration spatially from west to east in Mortandad Canyon beyond the Effluent Canyon confluence. Again, this trend is indicative of a dilution lag in the alluvial aquifer from west to east since improved tritium removal began in 2000 (see Section 2.1.1), with the lag being a function of both the distance from the outfall and localized alluvial storage. To illustrate this, Figure 7.2-28 is a time series plot analogous to Figure 7.2-27, but it covers the period of low tritium effluent concentrations, 2000 through 2004/2005. The observed decline in tritium concentration over time is completely analogous to that observed for nitrate. That is, at the westernmost well pair MCO-3/MCA-5, the concentration decline occurs almost immediately in 2000 after the drop in effluent concentration. At wells MCO-5 and MCO-6, the decline is delayed slightly with the greatest change in 2000 and 2001. Finally, tritium concentrations at the most distal wells, MCO-7 and MCO-7.5, have declined slowly since 2000. Tritium concentrations at these distal locations should continue to decline in response to lower effluent concentrations

Tritium in Vadose-Zone Pore Water and Perched-intermediate Zones

Tritium has migrated from the surface water and alluvial groundwater into the vadose zone. Figures D-2.3-22 through D-2.3-42 show the distribution of tritium concentrations in core samples collected at the MCB-, MCOI- and R- boreholes or wells in the Mortandad watershed. These values are presented here as pore-water concentrations. Both the vertical and horizontal (downcanyon) extent of tritium in the vadose zone is similar to that of nitrate and perchlorate in most of the canyon. This is demonstrated by comparing vadose-zone concentrations for tritium (Figures D-2.3-22 through D-2.3-42) to analogous profiles for nitrate and perchlorate (Figures D-2.3-1 through D-2.3-21). Tritium was detected in core samples collected at 9 of the 13 MCB- boreholes and at MCOI-6, MCOI-8, and MCOI-10, R-1, R-14, R-15, and R-28. A maximum concentration of 3.75×10^6 pCi/L of tritium was measured at MCB-10 at a depth of 18 m (60 ft) within the alluvium. Samples collected at MCB-9, MCB-10, and MCB-11 also had peak concentrations of detectable tritium within the alluvium. At MCB-5, MCB-6, and MCB-7, and R-1, peak concentrations of detectable tritium occur within the Bandelier Tuff, Unit Qbt1g. Peak concentrations of detectable tritium occur within the Cerro Toledo Interval at MCB-8 and MCB-12. The deepest pore-water measurements were observed in the Otowi Member in MCB-14, MCOI-6, MCOI-8, R-1, and R-15, which coincides with that part of Mortandad Canyon below the confluent with Ten Site Canyon and represented as an area with the enhanced deep percolation (Figure 7.0-1). At some locations

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(e.g., MCB-14 in Figure D-2.3-32; R-1 in Figure D-2.3-39), tritium does not extend as deep as nitrate and perchlorate, which might be due to radioactive decay in the deepest (and oldest) vadose-zone porewater within the Bandelier Tuff. Tritium was not detected at MCB-1 and MCB-2, west of the RLTWF outfall within Effluent Canyon, or at MCB-15, MCB-16, MCOI-1, or MCOI-10.

Tritium is observed in perched-intermediate groundwater. Concentrations of tritium within saturated portions of the Puye Formation and Cerros del Rio basalt are the highest beneath the axis of Mortandad Canyon east of the confluence with Ten Site Canyon. Concentrations of tritium at MCOBT-4.4 ranged from 9700 to 14,900 pCi/L from 2001 to 2003, when tritium concentrations generally increased over time (Figure 7.2-21). The concentration of tritium was 21,007 pCi/L in a sample collected from the well during 2005. Concentrations of tritium at MCOI-4 varied from 11,700 to 12,900 pCi/L, whereas lower concentrations of tritium occur at MCOI-5 ranging from 4310 to 5370 pCi/L during 2005 (Figures D-2.2-16[I] and D-2.2-17[I]). Concentrations of tritium at MCOI-6 varied from 12,200 to 13,100 pCi/L (Figure D-2.2-18[I]). The concentration of tritium measured at MCOI-8 was 137 pCi/L, confirming that recharge from surface water or perched alluvial groundwater infiltrates to perched-intermediate zones immediately west of the Ten Site confluence.

Tritium in the Regional Aquifer

Based on available data, concentrations of tritium within the regional aquifer in the Puye Formation are the highest beneath the axis of Mortandad Canyon at R-28 and decrease to the south at R-15. Concentrations of tritium at R-28 increased from 152 to 181 pCi/L during 2005 (Figure 7.2-23). These are the highest concentrations of tritium measured in the regional aquifer within Mortandad Canyon. Concentrations of tritium at R-15 increased from 1.12 to 31 pCi/L from 1999 to 2005 (Figure 7.2-21). Concentrations of tritium at regional aquifer well TW-8 varied from 4.21 to 140 pCi/L from 2003 to 2005 (Figure D-2.2-26[I]). TW-8 was drilled by the cable tool method and was completed in 1960, which may have resulted in leakage of alluvial groundwater down the well casing. R-1, a replacement well for TW-8, was drilled 75 m (246 ft) west of TW-8 does not contain tritium (Figure D-2.2-19[I]). Concentrations of tritium are slightly above the IDL of 0.29 pCi/L, using electrolytic enrichment, at R-1 and R-14 (screen 1) (Figures D-2.2-19[I] and D-2.2-21[I]). Concentrations of tritium are less than analytical detection at wells R-13, R-14 (screen 2), R-33, and R-34 (Figures D-2.2-20[I], D-2.2-21[I], D-2.2-24[I], D-2.2-25[I]).

Strontium-90

Strontium-90 has a half-life of 28.78 y and decays to yttrium-90 through emission of a beta particle. Strontium-90 reversibly adsorbs onto sediments containing clay minerals through cation exchange reactions (Langmuir 1997, 56037). Strontium is stable in the +II oxidation state in aqueous solution. Strontium forms complexes with bicarbonate ($SrHCO_3^+$, $SrCO_3^0$) under near-neutral pH conditions. Cationic forms of strontium are considered to be less mobile than neutral forms under alkaline pH conditions because cation exchange dominates over anion exchange (Langmuir 1997, 56037). Stable or natural strontium and strontium-90 precipitates from solution as $SrCO_3$ (strontianite), which has an aqueous solubility of $10^{-9.27}$ moles/L (6.63×10^6 pCi/L) (Langmuir 1997, 56037). Therefore, precipitation is another potential process for removing strontium-90 from solution. Surface water and groundwater have much higher concentrations of stable strontium than of strontium-90, which enhances precipitation of $SrCO_3$ within the watershed for long periods of time exceeding 30 years.

Strontium-90 in Surface Water and Alluvial Groundwater

The spatial trends of current (2000 through 2005) strontium-90 concentrations in both nonfiltered and filtered surface water and alluvial groundwater samples are shown in box plots in Appendix D, Figures

D-2.1-31 through D-2.1-33. These plots indicate that the TA-50 RLWTF outfall and former discharges from the TA-35 WWTP are important Laboratory sources of strontium-90 within the Mortandad watershed. Dissolved strontium-90 makes up approximately 50% to 90% of total strontium-90 within surface water and alluvial groundwater in the Mortandad watershed, suggesting that this radionuclide reversibly adsorbs onto sediments through cation exchange reactions. In Mortandad Canyon, concentrations of strontium-90 are generally higher in surface water at location E200 east of the confluence with Effluent Canyon and in reach M-2E and in alluvial water in the segment of Mortandad Canyon between wells MCO-3/MCA-5 and MCO-6 (Figure D-2.1-32). In Effluent Canyon, concentrations in surface and alluvial groundwater are elevated east of the RLWTF outfall, which is clearly a source of strontium-90 to the watershed. The maximum concentration of strontium-90 in surface water is approximately 48 pCi/L measured in surface water in Mortandad Canyon at location E200. The highest concentration of strontium-90 was 81.6 pCi/L at MCO-5, the alluvial groundwater monitoring well located east of the PRB and west of the confluence with Ten Site Canyon (Figure D-2.1-32). Concentrations of total strontium-90 sharply decrease downcanyon to less than 4 pCi/L at alluvial well MCO-7 and other wells farther to the east. Groundwater mixing and/or an increase in the adsorptive capacity of the alluvium (silt-sized material) may explain concentration decreases of strontium-90 between alluvial wells MCO-6 and MCO-7. Persistent surface water was uncommon in this portion of the Mortandad watershed during the investigation period; therefore, contamination was generally limited to alluvial groundwater.

The spatial distribution of strontium-90 concentrations in surface water in Ten Site Canyon above the Mortandad Canyon confluence indicate that the bulk of strontium-90 has migrated downcanyon to reach TS-2E (Figure D-2.1.33). The highest concentration of total strontium-90 within this reach is 21.3 pCi/L. A portion of the strontium-90 released from TA-35 WWTP, however, occurs in upper Ten Site Canyon in surface water within reach TS-1C with a maximum concentration of 7 pCi/L.

Figure 7.2-29 is a time series plot for strontium-90 covering the period 1963 through 2005. It shows the annual strontium-90 concentration in RLWTF effluent and the concurrent concentrations at alluvial wells MCO-3/MCA-5, MCO-5, MCO-6, MCO-7, and MCO-7.5. The strontium-90 concentrations in the outfall averaged 380 pCi/L from 1963 to 1989, with a maximum concentration of 1725 pCi/L. During this same period, strontium-90 concentrations in the alluvial wells were elevated with many measurements over the MCL of 8 pCi/L. Concentrations at the alluvial wells that are located closest to the TA-50 outfall, MCO-3 and MCO-5, tend to rise in response to outfall releases. Those wells farther downcanyon, MCO-7 and MCO-7.5, have relatively constant, low concentrations of strontium-90. It is likely that adsorption onto various adsorptive phases within alluvial sediments retards further strontium-90 transport. After 1993, outfall concentrations dropped below 10 pCi/L, and from 2000 to 2004, the average outfall concentration has been less than 4 pCi/L due to source reduction implemented by the waste generators before entering the TA-50 RLWTF and through cation exchange and/or reverse osmosis treatment at the facility. Correspondingly, concentrations in the alluvial wells have declined. The rate of decline of strontium-90 concentrations in alluvial groundwater is controlled by concentration decreases in the TA-50 effluent, by cation exchange and dilution in the environment, and by radioactive decay.

Figure 7.2-30 shows the alluvial aquifer response to strontium-90 source reduction for the period 2000 through 2005, when outfall concentrations dropped to below 4 pCi/L. This response is not similar to that observed for nitrate, perchlorate, or tritium, which showed a lag in dilution at alluvial wells located farther from the source. Here the more distal wells (MCO-7 and MCO-7.5) maintain low concentrations because they were not elevated in the first place. Concentrations at wells MCO-3/MCA-5, MCO-5, and MCO-6 are slowly declining in response to the source reduction. This response may be delayed by desorption of strontium-90 from the sediment and alluvial load.

Strontium-90 in Vadose-Zone Pore Water, Perched-Intermediate Groundwater, and the Regional Aquifer

Plots of concentration versus depth for strontium-90, shown in Figures D-2.4-22 through D-2.4-38, indicate that this radionuclide is concentrated within the alluvium and at the alluvium/bedrock contact. Higher concentrations of strontium-90 are observed in alluvial groundwater indicating that a fraction of this radionuclide adsorbs onto alluvial material, as discussed above. Strontium-90 was detected in core samples collected at MCB-5, MCB -6, MCB-7, and R-1 at depths less than 11 m (35 ft). The maximum concentration of strontium-90 is approximately 1.16 pCi/g measured at borehole MCB-5 at a depth of 6 m (20 ft) within the alluvium. The strontium-90 values shown in these plots are generally below the analytic detection limit, as indicated by the open blue triangles. Concentrations of strontium-90 in core samples were less than analytical detection at MCB-1, MCB-2, MCB-8, MCB-9, MCB-10, MCB-11, MCB-12, MCB-14, MCB-15, MCB-16, R-14, R-15, and R-28. Strontium-90 is not consistently detected within perched-intermediate zones and the regional aquifer within the Mortandad watershed due to its ability to adsorb onto silt- and clay-sized material present within the alluvium and weathered Bandelier Tuff.

Plutonium-238 and Plutonium-239,240

The half-life of plutonium-238 is 87.7 yr, and the isotope decays to uranium-234 by emission of an alpha particle (Parrington et al. 1996, 58682). The half-lives of plutonium-239 and plutonium-240 are 2.410×10^4 and 6.56×10^3 yr, respectively, and they decay to uranium-235 and uranium-236, respectively, by emission of alpha particles (Parrington et al. 1996, 58682). Plutonium strongly adsorbs onto sediments containing clay minerals and ferric (oxy)hydroxides (Langmuir 1997, 56037) through surface complexation reactions. Plutonium is stable in the +III, +IV, +V, and +VI oxidation states in aqueous solution. Plutonium(III, V, and VI) forms complexes with bicarbonate (for example, near pH 7, $PuCO_3^+$, $PuO_2CO_3^-$, $PuO_2(CO_3)_2^{2-}$, and $PuO_2CO_3^0$). Plutonium(IV and V) hydrolyzes to form $Pu(OH)_4^0$ and PuO_2^+. Plutonium(V and VI) complexes are considered to be the most stable in oxidizing surface water and alluvial groundwater within the Mortandad watershed based on the co-occurrence of nitrate, perchlorate, chromium(III, VI), and solid organic matter in the sediments. Cationic forms of complexed plutonium are considered to be less mobile than anionic forms under alkaline pH conditions because most adsorbents tend to have net-negative surface charges (Langmuir 1997, 56037). Plutonium(IV) oxide, consisting of plutonium-239, is characterized by low aqueous solubility of $10^{-35.38}$ moles/L ($6.15 \times 1\ 0^{-23}$ pCi/L) at pH 7, calculated using thermodynamic data cited in Langmuir 1997 (56037); therefore, precipitation from the aqueous phase provides another potential process for removing plutonium from solution.

Plutonium-238 and -239 in Surface Water and Alluvial Groundwater

The spatial trends in plutonium-238 and plutonium-239 concentrations in surface water and alluvial groundwater from 2000–2005 are shown in box plots for different portions of the Mortandad watershed in Appendix D, Figures D-2.1-34 through D-2.1-36 and Figures D-2.1-37 through D-2.1-39, respectively. Detections of plutonium-238 and plutonium-239,240 occur in both filtered and nonfiltered samples throughout the Mortandad watershed, but the highest concentrations are from nonfiltered surface water samples, indicating the preference for plutonium to adsorb to fine-grained sediment and solid organic matter and the presence of plutonium-contaminated suspended solids in the samples.

The distributions of detected values of plutonium-238 and plutonium-239,240 are attributed to two primary sources: the TA-50 RLWTF outfall and the former TA-35 WWTP outfall (Section 2.1). In Mortandad Canyon, the highest frequency of detected plutonium-238 and plutonium-239 concentrations occurs in surface water immediately east of the TA-50 outfall within reach E-1E and below the Mortandad

confluence at gage E200. The concentrations and frequency of detection decrease immediately downcanyon. From monitoring well MCO-3/MCA-5 down Mortandad Canyon, only scattered detected concentrations occur in surface water and alluvial groundwater. Overall, a higher frequency of detection occurs in nonfiltered samples, indicating the presence of plutonium-contaminated suspended solids in the samples.

In Ten Site Canyon, above the confluence with Pratt Canyon, plutonium-238 was detected in filtered and nonfiltered surface water samples within reaches TS-1C and TS-1E with maximum detected concentrations of 0.234 and 1.79 pCi/L, respectively (Figures D-2.1-33 and D-2.1-36). Maximum concentrations of plutonium-239 detected in filtered and nonfiltered surface water samples were 0.0712 and 0.79 pCi/L, respectively, in the same reaches (Figures D-2.1-36 and D-2.1-39). Concentrations of both plutonium-238 and plutonium-239 are less than detection east of reach TS-1C within Ten Site Canyon. The limited concentrations of plutonium detected in surface water in reach TS-1C are probably related to the presence of plutonium-contaminated sediments redistributed downcanyon from the TA-35 sources (Section 7.1).

Appendix D, Section D-2.2, shows a time series plot for plutonium-238 and plutonium-239 covering the period 1963 through 2005 for surface water gage E200 and the entire series of alluvial wells. These plots show the highest concentrations of plutonium occurred just downstream of the TA-50 outfall in surface water at gage E200 and in alluvial groundwater in well MCO-3. Concentrations decline rapidly down canyon because of adsorption of plutonium onto sediments and alluvial deposits. Maximum plutonium concentrations in surface and alluvial groundwater occurred during the 1980s when releases were highest (Table 2.1-1). Surface water and alluvial groundwater concentrations of plutonium-238 and plutonium-239 are currently both less than 7 pCi/L in nonfiltered samples and less than 2.5 pCi/L in filtered samples.

Plutonium-239,240 in Vadose-Zone Pore Water, Perched-Intermediate Groundwater, and the Regional Aquifer

Figures D-2.4-22 through D-2.4-38 show the distribution of plutonium-239 concentrations in core samples collected from Mortandad Canyon and Ten Site Canyon. Both plutonium and americium adsorb onto solid surfaces, and these two actinides are generally collocated in the core samples, although plutonium was detected at a higher frequency in samples at depth. Plutonium-239 was detected in core holes MCB-5, MCB-6, MCB-7, MCB-9, MCB--10, R-1, and R-14. Plutonium-239 was detected at a concentration of 0.03 pCi/g at a maximum depth of 61 m (200 ft) within the Cerro Toledo interval at R-14. This occurrence could be attributed to translocation or downward movement during coring operations at R-14. The maximum concentration of plutonium-239 was 1.16 pCi/g measured at core hole MCB-7 at a depth of 3 m (10 ft) within the alluvium. Several samples from MCB-5, MCB-7, MCB-9, and MCB-10, contained detectable plutonium-239 at depths suggesting that colloid transport under saturated and unsaturated flow conditions has taken place. Plutonium-239 was not detected at core holes MCB-1, MCB-2, MCB-8, MCB-11, MCB-12, MCB-15, MCB-16, R-14, R-15, and R-28.

Plutonium-239,240 is not frequently detected within perched-intermediate zones and the regional aquifer within the Mortandad watershed due to its ability to strongly adsorb onto silt- and clay-sized material present within stream channels, alluvium, and weathered Bandelier Tuff. Possible detections of plutonium-239, 240 within deep saturated zones occur in nonfiltered samples, and transport mechanisms may include adsorption onto colloids migrating through fractured media.

Americium-241

Americium-21 has a half-life of 432.7 yr and decays to neptunium-237 through emission of an alpha particle. Americium is stable in the +III oxidation state in aqueous solution (Langmuir 1997, 56037). Americium-241 very strongly adsorbs onto sediments containing clay minerals and ferric (oxy)hydroxide, through cation exchange and surface complexation reactions (Langmuir 1997, 56037). Americium forms complexes with bicarbonate. At pH 7, it is stable as $AmCO_3^+$ at a partial pressure of CO_2 gas = 10^{-2} bar, typical of groundwater. Under surface water conditions with a partial pressure of CO_2 gas = $10^{-3.5}$ bar, americium is mainly stable as $AmOH^{2+}$ at pH 7 (Langmuir 1997, 56037). Americium-241 precipitates from solution as $AmOHCO_3$, and its solubility minimum is $10^{-8.7}$moles/L (1.64×10^6 pCi/L) at pH 8.3. Adsorption of americium-241 onto clay minerals and ferric (oxy)hydroxide is the dominant process taking place in the watershed for removing this actinide from solution.

Americium-241 in Surface Water and Alluvial Groundwater

The spatial trends in americium-241 concentrations in surface water and alluvial groundwater from 2000 to 2005 are shown in box plots for different portions of the Mortandad watershed in Appendix D, Figures D-2.1-40 through D-2.1-42. The release history of americium-241 from the TA-50 RLWTF is similar to that of plutonium-239,240, even though less americium-241 was released in comparison to plutonium-239,240 (Table 2.1-1 and LANL 1997, 56835). The spatial distribution of americium-241 in water is similar to plutonium-239 in that highest concentrations detected in water are near the TA-50 source, and the concentrations and frequency of detection decrease rapidly downcanyon (Figures D-2.1-40 through D-2.1-41). In Effluent Canyon, the highest frequency of detected americium-241 concentrations occurs in surface water in reach E-1E below the TA-50 outfall and at gage E200 immediately east of the confluence with Mortandad Canyon. From monitoring well MCO-3/MCA-5 down Mortandad Canyon, detected concentrations occur in surface water and alluvial groundwater. Overall, a higher frequency of detection occurs in nonfiltered samples, indicating the presence of americium-contaminated suspended solids in the samples.

A smaller source of americium-241 occurred at the TA-35 WWTP. In Ten Site Canyon, americium-241 is identified in surface water only within reach TS-1C at a maximum total concentration of 0.2 pCi/L (Figure D-2.1-42). The concentrations of americium-241 detected in water in Ten Site Canyon are probably related to the presence of americium-contaminated sediments redistributed down canyon of the TA-35 source.

Appendix D, Section D-2.2, shows time series plot for americium-241 covering the period 1963 through 2005 for surface water gage E200 and the entire series of alluvial wells. The trend shown in these plots is very similar to that for plutonium in that the highest concentrations of americium occurred just downstream of the TA-50 outfall in surface water at gage E200 and in alluvial groundwater in well MCO-3. Concentrations decline rapidly downcanyon because of adsorption onto sediments and alluvial deposits. Recent nonfiltered samples show that surface water concentrations are less than 15 pCi/L, and alluvial groundwater concentrations are less than 5 pCi/L at MCO-3 and decline rapidly downcanyon from there.

Americium-241 in Vadose-Zone Pore Water, Perched-Intermediate Groundwater, and the Regional Aquifer

Figures D-2.4-22 through D-2.4-38 show the distribution of americium-241 concentrations in core samples with depth collected at the MCB holes in Mortandad Canyon. Americium-241 was infrequently detected in core samples collected at MCB-5, -6, -7, -8, and -14. This actinide was detected (0.04 pCi/g) at a maximum depth of 68.6 m (225 ft) within the Bandelier Tuff at MCB-14. This occurrence could be

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attributed to translocation or downward movement during coring operations at MCB-14. Detectable concentrations of americium-241 typically occurred at depths less than 9.1 m (30 ft) within the alluvium due to its strong affinity for ferric (oxy)hydroxide and clay minerals. Core hole MCB-8 contained one detect of americium-241 at a depth of 27 m (90 ft), which may have resulted from coring operations. Core hole MCB-14 contained detectable concentrations of americium-241 at 12 and 21 m (40 and 70 ft) within the alluvium and at the contact of the alluvium-Cerro Toledo interval, respectively. The maximum concentration of americium 241 was approximately 1.05 pCi/g measured at core hole MCB-7 at a depth of 3 m (10 ft) within the alluvium. Americium-241 was not detected in samples collected from core holes MCB-1, MCB-2, MCB-9, MCB-10, MCB-11, MCB-12, MCB -13, MCB-15, and MCB-16.

Americium-241 is not consistently detected within perched-intermediate zones and the regional aquifer (see Appendix D, Section D-2.2) within the Mortandad watershed due to its ability to strongly adsorb onto silt- and clay-sized material present within the alluvium and weathered Bandelier Tuff. Possible detections of americium-241 within deep saturated zones occur in nonfiltered samples and transport mechanisms may include adsorption onto colloids migrating through fractured media.

7.3 Summary of Physical System Conceptual Model

This section summarizes the main elements of the physical system conceptual model whose individual elements were discussed in more detail in Sections 7.1 and 7.2. The primary focus of this section is the fate and transport of contaminants released from the TA-50 RLWTF because it is identified as the main source of contaminants in the Mortandad watershed. Other significant sources such as TA-35 and TA-48 are discussed at length in Sections 7.1 and 7.2, and the conceptual model discussed below also applies to the fate and transport of contaminants from these sources. Figure 7.0-1 illustrates key aspects of the physical system conceptual model.

Most contaminants in the Mortandad watershed are derived from Laboratory sources that released wastewater from outfalls into tributary drainages of Mortandad Canyon. Contaminants include radionuclides, inorganic chemicals, and organic chemicals as detailed in Sections 7.1 and 7.2. The mobility of contaminants is controlled by the geochemical characteristics of each contaminant and the geochemical properties of the medium along transport pathways (aqueous solubility, speciation, oxidation/reduction, precipitation/dissolution, adsorption/desorption, microbial and mineralogical characteristics of sediments and aquifer material). The nature and volume of effluent released from outfalls varied over time as a result of changes in research activities at the Laboratory, changes in wastewater treatment methods, and changes in environmental standards. As a result, the present-day distribution of contaminants in the watershed reflects the geochemical properties of individual contaminants, the complex history of releases from multiple Laboratory sites, and hydrological and mineralogical properties of aquifer material. Redistribution of contaminants by surface water, sediment transport, and groundwater is an ongoing process within the Mortandad watershed.

Initially, contaminants are transported from their release sites dissolved in water or adsorbed onto sediment particles and solid organic material. Some contaminants are deposited in soils between outfalls and stream channels, but most are transported down tributary drainages into the main canyon system by surface-water flow and sediment transport. Once adsorbed onto sediment particles in the streambed, contaminants are redistributed by floods that scour the streambed and mobilize the bed sediment. Contaminants associated with coarse-size fractions (coarse sand and coarser) are generally transported as bed load along the streambed, whereas contaminants associated with fine-size fractions (fine sand and finer) are generally transported in suspension. These include cesium-137, americium-241, plutonium-238, plutonium-239,240, chromium(III), lead, mercury, and PCBs. Contaminants are generally collocated in the sediment deposits, primarily occurring in post-1942 sediment deposits and preferentially

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occurring in fine rather than coarse facies sediment. During floods, sediment from a variety of sources, much of it not contaminated, is mixed, changing contaminant concentrations longitudinally along the channel. The net result is a general downcanyon decrease in contaminant concentrations in sediment with distance from a contaminant source area (Figure 7.0-1). In general, the inventory of contaminants in sediments increases in downcanyon areas, primarily because post-1942 sediment accumulated in thicker and more extensive deposits where the canyon floor widens eastward. Most of the contaminant inventory in Mortandad Canyon occurs in reach M-3E, upcanyon from the Ten Site Canyon confluence. A notable exception to this trend is the deposition of chromium in Effluent Canyon close to its release site at TA-48.

In Effluent Canyon, the transport of contaminants by surface water is facilitated where thin alluvium overlies relatively impermeable bedrock in the stream channel; this limits the amount of infiltration along the stream channel and results in greater movement of surface water downcanyon. The downcanyon extent of surface water flow varies with effluent discharge rates, runoff from storm events and snowmelt, and prior moisture conditions along the channel. In Mortandad Canyon below the Effluent Canyon confluence, surface water infiltrates the Mortandad Canyon channel where the alluvium thickens and groundwater storage capacity increases (Figure 7.0-1). The maximum extent of persistent surface water occurred in the 1960s to early 1970s when effluent discharge volumes were highest. During this time, surface flow generally extended about 1.5 km (1 mi) or less downcanyon from the TA-50 RLWTF outfall. Discharge volume from the TA-50 RLWTF outfall has progressively decreased since the early 1980s, and today persistent surface water flow generally extends only about 600 m (1970 ft) below the Effluent Canyon confluence (Figure 7.0-1). Runoff from storm events and snowmelt sometimes causes ephemeral flow and episodic infiltration to occur as far east as the sediments traps (and rarely farther downcanyon), but these events are infrequent. Contaminant concentrations in surface water have decreased over time in response to improved treatment technologies employed at the TA-50 RLWTF, especially since 2000.

Infiltration of surface water in the stream channel recharges alluvium within the watershed. Stable isotope data suggest that some surface water and shallow subsurface moisture is lost through evapotranspiration. The remaining water recharges alluvial groundwater that generally accumulates in the lower part of the alluvial deposits, most often perching on weathered bedrock units. Perched alluvial groundwater is a major pathway for the downcanyon transport of soluble contaminants. In Mortandad Canyon, the thickest and most persistent perched alluvial groundwater occurs between MCB-5, where the canyon begins to widen eastward to MCB-11 located east of the sediment traps (Figure 7.0-1). Alluvial groundwater occurs on an intermittent basis as far east as alluvial well MT-4 (Figure 3.2-1). Well hydrographs suggest that the alluvial groundwater levels respond relatively quickly to precipitation events in areas closest to zones of surface water infiltration and that significant lag times may occur at the eastern limit of alluvial saturation. These data support the interpretation that the alluvial groundwater system is recharged by infiltration of persistent and intermittent surface water in gradually thickening alluvium west of MCB-5 and that underflow within the alluvium is the dominant recharge process for alluvial groundwater farther down canyon. Saturation is not uniformly distributed within the alluvium, and in some cases, dry boreholes were drilled next to a location or well where alluvial groundwater was encountered. Similarly, hydrographs for adjacent alluvial wells frequently respond at different times to precipitation events and runoff events. These observations suggest that alluvial groundwater flows along preferential pathways within the highly heterogeneous alluvium and that the aquifer may resemble a network of cross-connected channels rather than a continuous zone of saturation at the base of alluvium. Contaminant concentrations in alluvial groundwater have decreased over time in response to improved treatment of effluent at the TA-50 RLWTF. Concentrations in alluvial groundwater currently account for an estimated 0.1% of the nitrate mass and 2.8% of the perchlorate mass in the watershed. Although overall concentrations are declining, there is a trend of increasing concentration for mobile constituents downcanyon from well MCO-5 to approximately well MCO-7.5 (Figure 3.2-1). This trend is indicative of a lag in the response of alluvial groundwater to the application of improved effluent treatment technologies.

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The lag is related in part to distance from the outfall, but increasing alluvial storage from west to east is probably a more important factor. Concentrations at more distal locations will continue to decline in response to lower effluent concentrations and to further dilution by runoff events.

Deeper infiltration of alluvial groundwater into bedrock units results in the vertical transport of contaminants into the suballuvium vadose zone. Transport of contaminants to these deeper zones is generally limited to soluble constituents such as nitrate, perchlorate, fluoride, tritium, sulfate, and chromium(VI). Contaminant profiles from core holes indicate that maximum contaminant concentrations of these mobile constituents and most of the contaminant mass (an estimated 96.6% of the nitrate mass and 94.6% of the perchlorate mass) occurs in bedrock units in the upper half of the vadose zone in the region extending from MCB-5 on the west to MCOBT.8.5 on the east (Figure 7.0-1). The Otowi Member of the Bandelier Tuff accounts for an estimated 55.8% of the nitrate mass and 67.7% of the perchlorate mass in Mortandad Canyon. The western extent of vadose-zone contamination is poorly constrained because Mortandad Canyon is inaccessible to drilling between the Effluent Canyon confluence and MCB-5. Thinning of alluvium over less permeable tuffs 500 to 1000 m (1640 to 3280 ft) west of MCB-5 probably controls the western limit of significant alluvial groundwater infiltration. The eastern extent of vadose-zone contamination is constrained by core hole data from MCOBT-8.5 and R-28. The greatest mass of contamination in the vadose zone occurs beneath the portion of the canyon that contains the thickest and most persistent alluvial groundwater. Bedrock units such as Tshirege unit Qbt 1g, the Cerro Toledo interval, and the Otowi Member underlie the alluvium in this area, and because of their porous nature, alluvial groundwater is able to percolate through these units. Moisture associated with vadose-zone contamination is elevated relative to other parts of the canyon, but the rocks are generally not fully saturated. Movement of moisture and contaminants probably occurs as gravity-driven porous flow. Estimates of vertical transport velocities of nitrate based on a release of unique isotopically light nitrogen from October 1986 to September 1989 range between 2.5 and 2.9 m/y (8.2 and 9.5 ft/y). Estimates of transport rates based on peak tritium releases to the canyon suggest that vertical transport rates have declined substantially from about 11 m/yr (36.1 ft/y) in the late 1970s to about 1.36 m/yr (4.46 ft/y) today. Finally, calibration to nitrate profiles in R-15 and MCOBT-8.5 yield approximate transport velocities of 6 m/yr (20 ft/yr) in 1968 to 1.2 m/yr (4 ft/yr) in 2002. These studies apply to mobile constituents and indicate vadose-zone transport velocities were greater in the past and that over time, transport velocities decreased as discharges to the watershed from outfalls declined. Adsorbing constituents have much slower transport rates and are generally not present within the suballuvium vadose zone.

A thin zone (<1m [<3 ft]) of perched-intermediate groundwater occurs within the clay-rich basaltic rubble at the top of the Cerros del Rio basalt near the Mortandad–Ten Site Canyon confluence (Figure 7.0-1). A thicker zone (up to 21.9 m [72 ft]) of perched saturation occurs near the base of the Cerros del Rio basalt near R-15. These perched-intermediate zones probably represent two unrelated groundwater bodies of limited lateral extent along the canyon axis (Figure 7.0-1). Based on the distribution of boreholes encountering perched-intermediate groundwater, the lateral extent of these groundwater bodies is probably less than 450 m (1500 ft). Contaminant concentrations within these perched zones show increasing trends over time, indicating that limited masses of the most mobile constituents (nitrate, perchlorate, chromium(VI), and tritium) have migrated from upgradient areas through the vadose zone along preferential pathways. Concentrations in perched-intermediate groundwater currently account for only an estimated 0.10% of the nitrate mass and 1.6% of the perchlorate mass in Mortandad Canyon. Perched-intermediate groundwater percolates into the Puye Formation, resulting in further vertical transport of contaminants into the lower vadose zone (Figure 7.0-1). Mobile constituents percolate through the lower vadose zone, reaching the regional water table.

The water table of the regional aquifer lies approximately 300 m (984 ft) below the canyon floor in Mortandad Canyon (Figure 7.0-1). The regional aquifer is a complex, heterogeneous system that includes

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confined and unconfined zones. Hydraulic communication between these zones is uncertain and spatially variable. The shallow portion of the regional aquifer (along the water table) is predominantly under phreatic (unconfined) conditions and has limited thickness (approximately 30–50 m [98–164 ft]). The groundwater flow and transport directions in this zone generally follow the gradient of the regional water table; the flow is east/southeast toward White Rock Canyon springs and the Rio Grande. The shape of the regional water table is predominantly controlled by areas of regional recharge (Sierra de los Valles and some Pajarito Plateau canyons) and discharge (White Rock Canyon springs and the Rio Grande). The deep portion of the regional aquifer is predominantly under confined conditions, and it is heavily stressed by Pajarito Plateau water-supply pumping. The pumping likely has a small impact on the flow directions in the phreatic zone because of poor hydraulic communication (cf. Appendix O). Capture of contaminants by supply well PM-3 seems unlikely because of this poor vertical hydraulic communication. However, the poor hydraulic communication does not preclude the possibility that some contaminant migration may occur between the shallow and deep zones. Between the two zones, the hydraulic gradient has a substantial vertical component due to water-supply pumping, creating the possibility that downward contaminant flow may occur along hydraulic windows and possibly along filter packs in water-supply wells. However, upward vertical gradients near PM-3 might provide natural protection against entry of contaminants from the phreatic zone into the well screen. Mobile contaminants, including nitrate, perchlorate, chromium(VI), and tritium, are observed only in the shallow zone of the regional aquifer beneath the Mortandad watershed. Some wells, such as R-15 and R-28, show increasing contaminant concentrations over time, suggesting breakthrough of mobile constituents from the vadose zone is increasing over time. Differences in nitrate isotopic ratios for some wells (e.g., R-28 vs. R-15) indicate that contamination in regional groundwater beneath Mortandad Canyon includes contributions from mixed source areas. The future pathways of contaminant movement from these locations should follow the groundwater flow direction along the regional water table. The contaminant flow should be to the east without substantial temporal changes due to seasonal effects.

8.0 RISK ASSESSMENTS

This section presents the methods used to evaluate the potential for adverse ecological and human health risks from COPCs in sediment and surface water. Risk characterization results, uncertainty analysis, and risk assessment summary are also provided for each assessment.

8.1 Baseline Ecological Risk Assessment

Biological data were collected in the Mortandad watershed to evaluate the potential for adverse ecological effects from contaminants in sediment and persistent surface water. A biological investigation work plan was developed based on the application of the eight-step EPA ecological risk assessment guidance for Superfund (ERAGS) (EPA 1997, 59370) to COPECs in sediment and persistent surface water (LANL 2005, 89308).

Steps 1 and 2 of ERAGS include the screening-level ecological risk assessment (SLERA) (LANL 2004, 87630), which identifies COPECs and ecological receptors potentially at risk. Ecological screening results based on the comparison of ecological screening levels (ESLs) with available sediment and water data are provided in the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308) and in Appendix E-1. Also presented in the biota investigation work plan is a comparison of available data with DOE biota concentration guidelines (BCGs) for radionuclides (DOE 2002, 85637; DOE 2004, 85639). These screening-level assessments identified COPECs and formed the basis for proceeding to the baseline ecological risk assessment (ERAGS Steps 3 to 8).

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Steps 3 and 4 of ERAGS comprise problem formulation and study design, which include refining the list of COPECs, developing a conceptual exposure model, selecting assessment endpoints, and selecting associated measures of effect and exposure. The study design required for these measures was included in the biota investigation work plan (LANL 2005, 89308). Aspects of study design were modified based on field verification of the design (ERAGS Step 5) and on comments received from NMED (NMED 2005, 92084). Deviations to the original biota work plan are discussed in Section 8.1.2. ERAGS Steps 6 and 7 comprise the implementation of the study design, analysis of ecological exposure and effects, and risk characterization. ERAGS Step 8 is risk management and the conclusions that may lead to risk management activities are documented in Section 9.

8.1.1 Problem Formulation

This section addresses the baseline ecological risk assessment problem formulation, which is Step 3 of ERAGS. A problem formulation was presented in Appendix D of the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308, pp. D-1–D-3). Problem formulation includes refinement of the list of COPECs, a literature search on known ecological effects, the conceptual exposure model, and the selection of assessment endpoints. Additional samples have been collected since the initial problem formulation in the biota investigation work plan, and new COPECs have been identified; therefore the problem formulation elements are updated and presented in the following sections.

8.1.1.1 Refinement of COPEC list

The third step of the ERAGS process involves refinement of the COPEC list from the screening to focus on those COPECs that have the largest impact on the potential ecological risk. As explained in the SLERA methods document (LANL 2004, 87630, p. 31), the criterion for retaining a COPC as a COPEC is a HQ greater than 0.3. The ESL screening excludes only COPCs with an HQ less than or equal to 0.3, which are COPCs for which no potential for ecological risk exists. To determine whether areas of the canyon may pose a risk to ecological receptors, and therefore what areas should be included within the scope of the biota investigation, the criterion of an HQ greater than 3 was used. An HQ greater than 3 represents levels that may impact receptors and is therefore appropriate for determining which COPECs should be included in site-specific biota studies in the Mortandad watershed. This criterion of 3 is based on the geometric mean of the ratio between the no observed adverse effect level (NOAEL) and the lowest observed adverse effect level (LOAEL) (Dourson and Stara 1983, 73474). Concentrations corresponding to LOAELs represent levels where impacts to individuals or populations may occur, and these levels represent a more appropriate criterion for determining which COPECs should be included in site-specific biota analyses to assess if impacts to ecological receptors have actually occurred. The same criterion of an HQ greater than 3 was used to refine the list of COPECs for the baseline studies conducted in Los Alamos and Pueblo Canyons (LANL 2004, 87390, p. 8-2). Receptors representing threatened and endangered (T&E) species are evaluated versus an HQ greater than 1 to ensure protection of each individual within the population.

Selection of study design COPECs for soil was based on comparison of the maximum detected concentrations in all geomorphic units within a reach with the minimum soil ESL. Active channel sediments may be exposed due to the transient nature of water flow in the channels in this watershed; therefore concentrations in the active channel geomorphic unit (c1) were included in the screening for terrestrial receptors. The COPECs for soil identified in the biota investigation work plan are: arsenic, barium, cadmium, chromium, copper, total cyanide, lead, manganese, mercury, selenium, silver, thallium, vanadium, zinc, americium-241, cesium-137, plutonium-238, plutonium-239, strontium-90, Aroclor-1254, Aroclor-1260, acenaphthene, chrysene, naphthalene, di-n-butyl phthalate, and endrin aldehyde (LANL 2005, 89308). Study design COPECs for sediment were chosen based on a comparison of maximum

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detected concentrations in geomorphic unit c1 (the active channel sediments) with the ESLs for sediment. The study design COPECs in sediment identified in the biota investigation work plan include: aluminum, arsenic, barium, copper, mercury, silver, vanadium, acenaphthene, acetone, anthracene, Aroclor-1260, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, alpha-chlordane, gamma-chlordane, chrysene, 4,4-DDT, di-n-butylphthalate, dibenz(a,h) anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, 4,4'-methoxychlor, 2-methylnaphthalene, naphthalene, phenanthrene, and pyrene. Study design COPECs for water were based on the comparison to ESLs and DOE BCGs. Study design COPECs for water identified in the biota investigation work plan are: aluminum, barium, cadmium, copper, cyanide (total), lead, manganese, silver, zinc, americium-241, and radium-226.

After its review of the biota investigation work plan, NMED requested considering gross alpha and selenium as COPECs in all evaluations (NMED 2005, 92084). There is no ESL for gross alpha, but gross alpha has an NMED surface water standard in 20.6.4 NMAC. Therefore, gross alpha was evaluated through screening of surface water against this standard. Individual alpha-emitting radionuclides were screened against the ESLs and DOE BCGs for each individual radionuclide. In the screening conducted for the biota investigation work plan (LANL 2005, 89308), selenium was designated as a study design COPEC only for plants. In response to NMED's concerns the evaluation of the results of each field study and the modeling of COPEC ingestion through the food chain to avian and mammalian receptors includes selenium.

Subsequent to the screening against minimum ESLs, the study design COPECs were screened against the ESLs for individual receptors to determine which COPECs should be addressed by each of the field measures. Table D-6.0-1 of the biota investigation work plan (LANL 2005, 89308) lists the COPECs for individual receptors; these subsets of COPECs were used to determine the appropriate analytical suites and locations for each measure. The COPECs and analytical suites associated with each measure are described in the discussion of each individual field measure in Section 8.1.2. The receptors potentially at risk from exposure to soil COPECs include plants, soil invertebrates (earthworms), small mammals, mammalian carnivores, omnivorous birds, and carnivorous birds representing a T&E species, the Mexican spotted owl (*Strix occidentalis lucida*). Receptors at potential risk from exposure to sediment include the swallow (which also represents a T&E species, the southwestern willow flycatcher [*Empidonax traillii extimus*]), the bat, and the aquatic community (which represents a number of aquatic species). Receptors at potential risk from exposure to COPCs in water also included representatives of the aquatic community (aquatic invertebrates and algae).

Screening Against ESLs and BCGs for 2005 Sediment and Water Data

Sediment samples were collected in 20 of the investigation reaches in the Mortandad watershed and in the background reach in Los Alamos Canyon in 2005 after preparation of the biota investigation work plan. The concentrations of COPCs in these samples were screened against ESLs and BCGs to determine if any new study design COPECs (COPECs with an HQ >3) were identified by the additional sampling. Screening the data from 2005 samples was conducted with ECORISK Database Version 2.2 (LANL 2005, 90032); the screening documented in the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308) used the version of the ESL database that was current at the time that the report was written, ECORISK Database Version 2.1 (LANL 2004, 87386). The tables for this screening are presented in Section E-1.2 of Appendix E. The section below includes a discussion of the results of the screening and whether new COPECs were identified based on higher detected maximum concentrations or a decrease in the ESL between the versions of the database.

Additional COPECs for Soil

Tables E-1.2-1 to E-1.2-3 in Appendix E show the HQs for soil COPECs based on the screening of the 2005 samples. The maximum detected concentrations of analytes in soil for these samples are available in the data files in Appendix C.

Soil samples from two reaches with the highest concentrations of chromium were analyzed for hexavalent chromium in 2005. n reach E-1FW, the HQ for both the earthworm and the plant for hexavalent chromium was 5.8. Based on other study design COPECs, reach E-1FW was already included in the plant and earthworm toxicity studies that includes metals; therefore, no additional studies are necessary based on the designation of hexavalent chromium as a study design COPEC.

The SVOC bis (2-ethylhexyl) phthalate is also a new COPEC for soil based on the screening of the data from the 2005 samples; bis (2-ethylhexyl) phthalate is a COPEC in soil for reach TS-1C. The ESL for bis (2-ethylhexyl) phthalate in the ECORISK Database Version 2.2 (LANL 2005, 90032) is lower for terrestrial avian receptors than in the previous version of the database (LANL 2004, 87386) due to a revision to the transfer factor EPA recommended for calculating the dose to avian receptors (LANL 2005, 90032). Bis (2-ethylhexyl) phthalate is a COPEC in sediment only for reach TS-1C. Additional nest boxes were added to reach TS-1C in 2005 as part of the field studies. Therefore the existing studies for the Mortandad watershed include the potential effects of this and other COPECs on avian receptors.

Existing study design COPECs for soil, particularly inorganic COPECs, were designated as study design COPECs for additional reaches as a result of the screening of data from the 2005 samples: cadmium and lead in E-1FW, chromium and copper in TS-2E, manganese in TS-1E, vanadium in TS-1W, and Aroclor-1254 in E-1E. Mercury is now a study design COPEC in a number of additional reaches because of an updated transfer factor EPA recommended for calculating the ESL for avian species (LANL 2005, 90032), and the current ESL is one-fourth of the ESL used for the original screening in the biota investigation work plan. The additional reaches for which mercury is a COPEC are M-1E, M-2W, M-2E, and M-3. Some existing study design COPECs were also detected at higher concentrations in reaches in which they were already study design COPECs. These COPECs were already considered in the study designs for other reaches and were not detected at concentrations greatly exceeding the concentrations detected in earlier samples. Therefore, no additional studies are indicated for these COPECs based on the screening of the new data.

Additional COPECs for Sediment

Tables E-1.2-4 to E-1.2-6 in Appendix E show the HQs for sediment COPECs based on the screening of the 2005 samples. The maximum detected concentrations of COPCs in sediment for these samples are available in the data files in Appendix C.

Based on the screening of 2005 samples iron is a study design COPEC in active channel sediments. No iron ESL for sediment was available at the time of the screening against ESLs in the biota investigation work plan; the new ESL is based on exposure to aquatic community organisms (LANL 2005, 90032). Based on the screening of the 2005 sediment data, iron would be a study design COPEC in reaches E-1W, M-1E, and M-4. The HQs for all three reaches are similar, and reach E-1W was already included in the study for ecological risk to the aquatic community (the *Chironomus tentans* laboratory toxicity assay). Therefore the existing field studies for the Mortandad watershed address this additional COPEC.

The SVOC bis (2-ethylhexyl) phthalate is also a new COPEC based on the screening of the 2005 sediment data, combined with revisions to ESLs. The ESL for bis(2-ethylhexyl) phthalate in the ECORISK Database Version 2.2 (LANL 2005, 90032) is lower for the avian receptor (the violet green swallow)

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exposed to sediment than the ESL in the previous version of the database due to a revision in the transfer factor EPA recommended for calculating the dose to avian receptors. Bis(2-ethylhexyl)phthalate is a COPEC in sediment only for reach TS-1C. Additional nest boxes were added to reach TS-1C in 2005 as part of the field studies. Therefore, the existing studies for the Mortandad watershed include the potential effects of this and other COPECs on avian receptors.

Several existing study design COPECs for sediment are designated as study design COPECs for additional reaches based on the screening of the 2005 sediment data. Anthracene is now a study design COPEC for aquatic community organisms in sediment in two additional reaches, E-1E and M-2W. Mercury is now a study design COPEC for avian receptors in reach M-1E in addition to the existing reaches for which it was already a study design COPEC. These COPECs were considered in the study designs for aquatic community and avian species in other reaches and were not detected at concentrations greatly exceeding the concentrations in earlier samples. Therefore, no additional studies are indicated for these COPECs based on the screening of data from the 2005 sediment samples.

Additional COPECs in Surface Water

Samples of nonfiltered nonstormwater (nonstormwater includes base flow, snowmelt, and persistent pools), filtered nonstormwater, and filtered stormwater were collected from individual water locations within the Mortandad watershed in 2005. Tables E-1.2-7 to E-1.2-12 in Appendix E show the HQs for surface water COPECs based on the screening of the 2005 samples. The maximum detected concentrations of analytes in surface water for these samples are available in the data files in Appendix C.

In the filtered nonstormwater samples (see Tables E-1.2-7 and E-1.2-8 [Appendix E]), two additional surface water COPECs were designated. Cobalt had an HQ of 4.7 for the maximum detected concentration in reach E-1FW. E-1FW was not included in the aquatic studies, but these surface water screening results are unlikely to indicate a widespread ecological risk within the watershed as the HQ in only one reach exceeded 3. Iron, which did not have an ESL for water at the time of the screening presented in the biota investigation work plan, is designated as a study design COPEC for reaches E-1FW, E-1W, and M-1W. Reaches E-1W and M-1W were already included in studies both for toxicity to aquatic invertebrates and toxicity to algae. (Radium-226 was already a study design COPEC for water based on the screening conducted by subwatershed for the biota investigation work plan.) The screening of the 2005 samples confirmed that radium-226 should be considered as a study design COPEC for reaches E-1E, M-1W, M-1E, and M-2W.

In the nonfiltered nonstormwater (see Tables E-1.2-9, E-1.2-10, and E-1.2-11 [Appendix E]), cobalt is also designated as a new study design COPEC in reaches E-1FW and TS-1W. Iron was designated as a new study design COPEC in reaches E-1FW, E-1W, M-1W, M-1E, TS-1C, and TS-1W. Radium-226 was already a study design COPEC for water based on the screening conducted for the biota investigation work plan. The screening of the 2005 samples confirmed that radium-226 should be considered as a study design COPEC for reaches E-1W, M-1W, and M-2W.

No new COPECs were detected in the filtered stormwater samples from 2005; the HQs for filtered stormwater are shown in Table E-1.2-12.

8.1.1.2 Literature Search in Known Ecological Effects

The following is a synopsis of the screening ecological receptors with the highest HQs (HQ >3) and the feeding guilds they represent. This section reviews both the original COPECs from the biota investigation

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work plan and the new COPECs designated based on the screening of the 2005 data. The toxic effects are based on toxicity studies used as the basis for the ESLs as described in the ECORISK Database Version 2.2 (LANL 2005, 90032) and are summarized in Appendix E in Tables E-1.1-2 through E-1.1-7. The section below also reports the count of sediment investigation reaches in which the study design COPECs are located. The names of these reaches and HQs for screening against individual receptors can be found in Tables D-2.2.1 through 2.2.10 of the biota investigation work plan (LANL 2005, 89328, pp. D-31– D-41).

Mammals

Soil Pathway Receptors

The deer mouse as a representative for mammalian omnivores had HQs greater than 3 for four COPECs: arsenic, manganese, thallium and naphthalene. Study design COPECs were found in 6 of the 23 reaches.

The montane shrew as a representative for mammalian invertevores had HQs greater than 3 for seven COPECs: arsenic, cadmium, manganese, thallium, vanadium, chrysene and naphthalene. Study design COPECs were found in 10 of the 23 reaches.

The red fox as a representative for mammalian carnivores had HQs greater than 3 for three COPECs: cesium-137, Aroclor-1254, and Aroclor-1260. Study design COPECs were found in 4 of the 23 reaches.

Sediment Pathway Receptors

The occult little brown myotis bat as a representative for mammalian aerial insectivores had HQs greater than 3 for three COPECs: aluminum, arsenic, and naphthalene. Study design COPECs were found in 4 of the 23 reaches.

Birds

Soil Pathway Receptors

The American robin (with invertevore diet) as a representative for avian invertevores had HQs greater than 3 for 10 COPECs: copper, lead, mercury (inorganic), silver, vanadium, zinc, Aroclor-1254, bis-2-ethylhexylphthalate, di-n-butyl phthalate, and cyanide (total). Study design COPECs were found in 13 of the 23 reaches.

The American kestrel (with flesh diet) as a representative for avian carnivores had HQs greater than 3 for three COPECs: mercury (inorganic), cesium-137, and Aroclor-1254. Study design COPECs were found in 1 of the 23 reaches.

Sediment Pathway Receptors

The violet green swallow as a representative for avian aerial insectivores had HQs greater than 3 for nine COPECs, including aluminum, barium, cadmium, copper, mercury (inorganic), silver, vanadium, zinc, and cyanide (total). Study design COPECs were found in 14 of the 23 reaches.

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Terrestrial Plants

The terrestrial plant as a representative of primary producers had HQs greater than 3 for 12 COPECs, including barium, chromium (total), hexavalent chromium, copper, manganese, selenium, silver, thallium, vanadium, zinc, acenaphthene, and endrin aldehyde. Study design COPECs were found in all of the 23 reaches.

Terrestrial Invertebrates

The earthworm as a representative of invertebrate detritivores had HQs greater than 3 for six COPECs: chromium (total), hexavalent chromium, copper, mercury (inorganic), americium-241, and plutonium-239,240. Study design COPECs were found in 15 of the 23 reaches.

Aquatic Community Organisms

Water Pathway Receptors

The aquatic community organism that represents various aquatic functional and feeding guilds had HQs greater than 3 for 13 COPECs: aluminum, barium, cadmium, cobalt, copper, total cyanide, iron, lead, manganese, silver, zinc, americium-241, and radium-226. Most COPECs were identified in samples from station E200, which include COPECs from filtered stormwater.

Sediment Pathway Receptors

The aquatic community organism that represents various aquatic functional and feeding guilds had HQs greater than 3 for 15 COPECs, including barium, copper, iron, mercury (inorganic), silver, acenaphthene, anthracene, dibenz(a,h)anthracene, fluorene, methylnaphthalene, naphthalene, Aroclor-1260, chlordane (alpha), chlordane (gamma), and DDT [4,4'-]. Study design COPECs were found in 9 of the 23 reaches.

8.1.1.3 Conceptual Exposure Model

An ecological scoping checklist was completed for the Mortandad watershed during June and July 2003. A separate Part B checklist was completed for each of several subsets of reaches that were similar in habitat. All the completed ecological scoping checklists appear in Appendix C of the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308). In Mortandad Canyon above the confluence with Ten Site Canyon (which includes reaches M-1W, M-1C, M-1E, M-2W, M-2E, M-3W, and M-3E), the terrestrial vegetation cover consists primarily of ponderosa pine, mixed-conifer species, box elder, scrub oak, and various deciduous shrubs. Wetland vegetation (e.g., cattails, rushes, and willows) and aquatic receptors are also found in riparian areas along this part of Mortandad Canyon, particularly in reach M-1W, which contains a cattail wetland. Wildlife noted in this part of the canyon included many species of birds (including bluebirds), burrowing animals, garter snakes, lizards, harvester ants, and evidence of large mammals (deer and bear). Chironomids and stonefly larvae were noted in aquatic areas within reach M-1W. A wide selection of wildlife receptors was noted throughout the reaches within Mortandad Canyon. In Mortandad Canyon east of the Ten Site Canyon confluence (which includes reaches M-4, M-5W, M-5E, and M-6), the vegetation cover consists of piñon-juniper woodland, with scattered ponderosa pine, and numerous shrub species and many of the same wildlife species seen in the Mortandad Canyon reaches farther west. In Effluent Canyon (which includes reaches E-1FW, E-1W, and E-1E), terrestrial plant species include ponderosa pine and wetland species (willows, rushes, and cattails) that were common throughout reach E-1W. In Ten Site Canyon (including reaches TS-1W, TS-1C, TS-1E, TS-2W, TS-2C, TS-2E, and TS-3), the vegetation cover includes ponderosa pine, mixed-conifer

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species, and oak, along with deciduous shrubs and forbs and associated terrestrial wildlife species. Some areas of riparian and aquatic vegetation (willows, rushes, and cattails) occur in reaches TS-1C, TS-2W, TS-2C and TS-2E. Reach TS-2E also contained aquatic insects at the time of the site visits. The unnamed tributary canyon that heads in TA-05 (including reaches MCW-1 and MCW-2) contains ponderosa pine mixed with piñon-juniper woodland and some shrub oak with a low level of vegetative cover.

Some of the reaches also represent potential or actual habitat for T&E species (Keller 2004, 87688). All the reaches considered in this study are rated as low potential forage areas for the bald eagle except for reach M-6, which is rated as a moderate potential forage area for the eagle. The Mexican spotted owl, however, is believed to actively use several reaches within the canyon (E-1E, M-2W, M-2E, and M-3W). Additional reaches (TS-1E, all TS-2 reaches, and M-3E) are designated as very high potential foraging area, with a number of other reaches considered high or moderate as potential foraging area for the Mexican spotted owl (Keller 2004, 87688). Reaches M-1W and E-1W both contain habitat in which the southwestern willow flycatcher may be assumed to forage at a moderate frequency (Keller 2004, 87688), although this species has not yet been observed in the watershed. The biota studies therefore include explicit consideration of risk to both the Mexican spotted owl, which nests within Mortandad Canyon, and the southwestern willow flycatcher, for which potential habitat exists within the Mortandad watershed.

Surface water in the Mortandad watershed originates either as effluent releases, stormwater, or snowmelt runoff. Where present, surface water can be discontinuous within a reach, alternately stopping where the flow entirely infiltrates into alluvium and emerging downstream where the alluvium thins. Transitions from alluvial channels to bedrock channels are common locations of surface water as water discharges from the shallow alluvial groundwater. Table D-2.3-1 in the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308) presents the results of a survey of surface water occurrence in the Mortandad watershed.

Historical contaminant releases to the soils, sediments, and persistent surface water in the Mortandad watershed have occurred from multiple SWMUs and AOCs, primarily through releases of effluent, as discussed in Section 2.1. For ecological receptors, the primary impacted media in the canyons are sediment deposits in the canyon bottoms, surface water derived from effluent releases or persistent pools, and reaches of water that remain for some time after periods of runoff. Active channel sediments (c1 geomorphic unit), potentially subject to persistent water, are referred to as "sediment" in this section. Sediment in other geomorphic units (abandoned channels and floodplains) is referred to as "soil" in this section. The active channel sediments in the Mortandad watershed were also evaluated as part of the soil because all sediments within any of the reaches may be exposed and dry for at least some period of the year, and therefore terrestrial receptors could also be exposed to these sediments.

Persistent surface water exists only in limited sections of the active channel in the watershed. Even so, all active channel deposits are considered in this assessment to be potentially subject to persistent flow under different climatic conditions and therefore to potentially harbor aquatic receptors, i.e., organisms dependent on water, such as algae or chironomids (LANL 2004, 87630, p.26). Floodplains and abandoned channels generally have well-developed terrestrial plant and animal populations and do not support truly aquatic species. Thus, only active channel sediments and surface water potentially have complete exposure pathways to truly aquatic species, whereas terrestrial animals and plants are exposed to COPECs in surface water, soil, or sediment. It is important to recognize that the aquatic species in the watershed represent a fairly simple food web that does not include aquatic vertebrates because surface water is limited both spatially and temporally.

Exposure pathways to terrestrial receptors can occur through the following:

- Air—through respiration of vapors, inhalation, and deposition of particulates
- Surface soil—through root uptake and rain splash on plants, food web transport to plants and animals, incidental ingestion of soil, dermal contact with contaminated soil, and external irradiation
- Persistent surface water and sediments—through root uptake and rain splash on plants, food web transport to animals, incidental ingestion of water and sediment, dermal contact with contaminated water or sediment, and external irradiation from sediment

The major soil-related exposure pathways are plant uptake, food web transport, incidental ingestion of contaminated soil, and external gamma radiation exposure. Water and sediment pathways are of lesser importance to terrestrial receptors because of the limited temporal and/or spatial extent of persistent surface water in the watershed. Exposure to vapors is unlikely because of the infrequent detection of VOCs in the watershed, the low VOC concentrations measured in sediment and water, and the rapid volatilization of VOCs in sediments near the ground surface. Exposure to airborne particulates is a minor pathway because of the limited amount of contamination at the ground surface and the dense plant cover in some reaches.

The remaining pathways related to exposure to surface soil (dermal contact) and surface water and sediment (food web transport, incidental ingestion of contaminated sediment and water, dermal contact, and external radiation exposure) are also minor because of the limited amount of contamination at the ground surface or in surface water. In addition, soil exposure pathway analysis EPA performed to support the development of its ecological soil screening levels (Eco-SSLs) has shown that inhalation and dermal pathways contribute a small fraction of the dose obtained orally (EPA 2003, 76077). All complete exposure pathways are at least qualitatively evaluated in the assessment in this report because some of the measures proposed in this investigation are field measures of effect or exposure.

8.1.1.4 Assessment Endpoints

Assessment endpoints consist of an entity (a receptor species) and an attribute (survival, growth, or reproduction) of that entity that is being assessed. Seven assessment endpoints for the Mortandad watershed are identified based on the study design COPECs summarized in Section 8.1.1.1 (and the associated tables) and the conceptual exposure model. These endpoints were selected to represent T&E receptors (the Mexican spotted owl and the southwestern willow flycatcher) as well as receptors that are representative of the terrestrial and aquatic food web in the Mortandad watershed (food webs are shown in Figures 3.4-1 and 3.4-2 of LANL 2004, 87630). The conceptual exposure model indicates that ingestion exposure pathways and, in particular, food web transport, are important pathways for these COPECs. Assessment endpoints were developed for the five terrestrial feeding guilds (including aerial insectivores) that represented the receptors with the highest HQs, as well as for the surrogates for the T&E species. Because aquatic environments in the Mortandad watershed are generally not perennial and rely on effluent and persistent water from storm runoff, a single assessment endpoint for the aquatic study design was selected. The seven assessment endpoints (AE1 through AE7) are as follows:

- Survival and reproduction of the Mexican spotted owl (AE1)
- Population abundance or persistence and species diversity of avian ground invertevore feeding guild species (e.g., American robin, bluebird) (AE2)

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- Population abundance or persistence and diversity of mammalian invertevore and omnivore feeding guild species (e.g., shrews and deer mice) (AE3)
- Survival and growth of detritivore species (earthworms) (AE4)
- Native plant species presence and diversity (AE5)
- Survival and reproduction of the southwestern willow flycatcher (AE6)
- Abundance and survival of the aquatic community in the reaches of the Mortandad watershed that retain surface water long enough to support aquatic communities (AE7)

Assessment endpoints were used as the basis for developing the measures of exposure and the measures of effects. Those measures evaluate impacts to the attributes of survival, growth, or reproduction in the receptor species and in the feeding guilds that those receptor species represent. The measures included field, laboratory, and model data. For the biota investigation in the Mortandad watershed, the measures are based on extension of the field biota investigation done in the Los Alamos and Pueblo watershed (LANL 2004, 87390).

8.1.2 Study Design, Field Verification, and Site Investigation

This section discusses the ecological risk assessment study design, field verification, and site investigation; this encompasses ERAGS steps 4 and 5 and the first part of step 6. Biological data were collected as measures of exposure and effect (lines of evidence) to evaluate the potential for adverse ecological effects from contaminants in soil, sediment, and persistent surface water. The initial design of each study is documented in the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308). As a result of discussions with NMED during the review of the biota investigation work plan, an additional measure was added. Algal toxicity tests were added to assess potential risk to algae from radionuclides in surface water. These algal toxicity tests are described in Section 8.1.2.11. Figure 8.1-1 shows reaches and the sample locations in the Mortandad watershed and the background site (reach LA-BKG). Shrews were trapped in two of the reaches (E-1W and LA-BKG) designated for the general small mammal trapping. The plant diversity field studies were conducted in the same reaches indicated for the plant and earthworm toxicity studies. Field bird surveys are not indicated on the map because they did not correspond directly to individual locations in reaches, as explained in Section 8.1.2.5. The rapid bioassessment characterization studies were collocated with the chironomid toxicity tests indicated in Figure 8.1-1. Table 8.1-1 shows the reaches included in each type of study, as well as the study design COPECs used as the basis for including that reach for that type of study.

8.1.2.1 Small Mammal Trapping and Analysis of Pelts and Carcasses

Trapping small mammals was conducted in three reaches within the Mortandad watershed and one background reach in Los Alamos Canyon. The results of the trapping determined measures of effect on the small mammal population including relative abundance, species composition, reproductive status, and body weight. The field measures of the small mammals were lines of evidence for the effects to the small mammals themselves (see Table D-4.0-4 in LANL 2005, 89308) in support of AE3.

Small mammals were also collected for laboratory analysis to determine the concentration of COPECs in tissues. The concentrations in the tissues were lines of evidence for the exposure of the Mexican spotted owl (AE1) as well as for the mammalian carnivore (the red fox), which was not designated as an individual assessment endpoint. All the individuals of most species from each reach were separated into pelts and carcasses; the pelts and carcasses were then combined so that one pelt and one carcass sample from each species was sent for analytical analysis for each reach. The exception is for shrews, which were too

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small to allow separation into pelt and carcass, and instead whole body samples were submitted. Table B-3.0-2 shows the sample IDs associated with these tissue samples as well as the weights for the composite pelt and tissue samples from each species. Individuals of some species (particularly wood rats) have enough mass that not all animals trapped were included in the composite pelt and carcass samples. Also, animals that tested positive for Hanta virus after collection were not included in the composite samples.The total number of animals trapped of each species is discussed in Section 8.1.3.4. The number of animals collected (excluding released or hanta virus infected animals) for each pelt or carcass sample from each reach is shown in Table 8.1-2.

The analytical suites were prioritized based on study design COPECs for predators, as shown in Table D-6.0-2 (LANL 2005, 89308). Analyses conducted on these carcass and pelt samples included EPA Method SW-846 6010B metals, perchlorate, mercury, PCBs, americium-241, cesium-137, and strontium-90.

As discussed in Section 7.1.2, cyanide is designated as a study design COPEC based on sediment concentrations exceeding the BV only in reach MCW-2W. Resampling done in that location and two adjacent locations in the same area produced values below the BV (see Section 7.1.2 and Tables E-1.2-1 and Table E-1.2-4). Cyanide was therefore not considered further in sediment in this investigation report. Total cyanide was also designated as a study design COPEC for aquatic organisms in the biota work plan based on detected concentrations in water at gage station E200 (Table B-7.1-1 in LANL 2005, 89308). Water from E200 was collected as the reach M-2W sample and included in the algae toxicity studies. Neither this water sample nor any other new water samples from other reaches contained cyanide at concentrations that would make cyanide a study design COPEC (see Table E-1.2-7 and E-1.2-9) at this water station or the others sampled. Cyanide was detected in water for the algae test only in the samples from TS-1C and TS-2C, and the concentrations were less than 3 µg/L. Sediment from reach M-2W was also used for the chironomid toxicity test to assess risk to aquatic organisms. Regression analysis was conducted for each analyte detected (except sodium) in the carcass or pelt samples of each species, even if the analyte was not a study design COPEC. These regression analyses compared the concentration of a COPEC in the composite sediment samples collected at the trapping arrays, discussed in Section 8.1.2.2, against the concentration of the COPEC detected in tissues. Some analytes were detected in some tissue samples but not other samples; plots and regressions for analytes that were detected at least once in tissue include nondetects for that analyte as values at their detection limit

8.1.2.2 Soil Characterization

Samples of sediment were collected from the locations in the Mortandad watershed used for laboratory toxicity tests and also from sediment within the small mammal trapping arrays for additional characterization of exposure to small mammals. Table B-3.0-3 shows the reach, location ID, and geomorphic unit associated with each of these samples. For the earthworm and plant toxicity tests, discrete samples were collected from 0–30 cm (0–1 ft) for the toxicity assays and for the analytical analysis of the same samples. Samples for the earthworm and plant toxicity tests were collected from geomorphic units outside the active channel (generally c2, c3, or f1 units). Sediment samples for the *Chironomus tentans* toxicity tests were collected from 0–15 cm (0-0.5 ft) in the c1 geomorphic unit (the active channel) to represent the sediment to which these aquatic organisms would be exposed. At the four sites for the small mammal trapping, composite samples were collected for Laboratory analysis to estimate COPEC concentrations the mammals would be exposed to. The composite samples consisted of 10 subsamples collected from 0–15 cm (0–0.5 ft) at 10 locations within each trap array.

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8.1.2.3 Owl Pellet Analysis

Owls regurgitate pellets containing fur and bones from prey items they have consumed; the contents of these pellets were examined to determine the species of prey consumed as an ancillary line of evidence for AE1. For this study, 46 pellets collected from four owl roosting sites were sent for taxonomic identification of the bone and tooth fragments (Bennett et al. 2006, 93774). Three of the roosting sites are known to be occupied by the Mexican spotted owl. One roosting site lies within Mortandad Canyon near reach M-2W. Two additional Mexican spotted owl roosting sites are in Cañon de Valle. The analysis of species included 17 taxonomic groups of mammals as well as birds. The complete list of number and type of each species found is described in Bennett et al. (2006, 93774). The primary use of this information in this study was to determine which species of small mammals from the tissue COPEC concentration analysis were appropriate to use for modeling the COPEC concentrations ingested during prey consumption by the Mexican spotted owl, as described in Section 8.1.2.1. The results of this comparison are described in Section 8.1.3.1.

8.1.2.4 Nest Box Studies

An avian nest box monitoring network has existed in the vicinity of the Laboratory since 1997; the network includes both potentially contaminated and noncontaminated areas. As part of the baseline ecological risk assessment for the Mortandad watershed, additional nest boxes were placed in the canyon bottoms or canyon bench areas within Mortandad Canyon and its major tributary canyons. Figure 8.1-1 shows the boxes within the Mortandad watershed that were sampled for the biota studies. Both the western bluebird (*Sialia mexicana*) and the ash-throated flycatcher (*Myiarchus cinerascens*) occupy these boxes. Measures collected using the nest box network included field measures of effect on reproductive success of these avian species (including clutch size, fledgling success, growth of fledglings, etc.) and measures of exposure through analysis of COPEC concentrations in unhatched western bluebird eggs and unconsumed prey (insects) collected within the boxes. Table B-3.0-5 shows the egg and insect samples collected for analytical analysis within the Mortandad watershed; the locations of the boxes within the reaches are shown in Figure 8.1-1. Boxes in Cañada del Buey and in the Cañada del Buey watershed (near TA-51) and boxes from two areas outside the Laboratory (the Los Alamos golf course and the Guaje Pines Cemetery; LANL 2004, 87390, Figure 8.1-1) were also included in the study for reference. Eggs from individual boxes within a reach were submitted as samples. In some cases, individual boxes contained sufficient material for analysis, but in other cases insects from more than one box in a reach were combined to obtain sufficient sample size for analysis. Table 8.1-3 shows a summary of the eggs and insects collected per reach.

Because of sample size limitations, egg and insect samples were analyzed only for metals. These measures were collected to evaluate AE2, the endpoint for avian ground invertevores. The COPEC concentrations in nest box insects were used as a measure for AE6, the avian insectivore (southwestern willow flycatcher) and the mammalian insectivore (the occult little brown myotis bat); the bat is being evaluated for possible exposure through prey even though this species does not represent a specific assessment endpoint in the baseline ecological risk assessment studies. Results of the field measures of effect through reproductive success are discussed in Section 8.1.3.3. The measures of exposure through COPEC concentrations measured in insects are discussed in Section 8.1.3.2 and exposure based on COPEC concentrations in eggs is discussed in Section 8.1.3.3.

8.1.2.5 Breeding Bird Survey

An additional study done as a measure for AE2 and AE6 for the avian ground invertevore and the avian insectivore was a survey of the level of use of upper Mortandad Canyon and Ten Site Canyon by avian

species. The survey recorded species, sex, and age of birds within these canyon bottom areas and provides an estimate of the diversity of species in the survey areas. The survey areas were not restricted to the designated reach areas but included birds seen or heard in the majority of the canyon bottoms in these areas during the walkover survey. The complete survey results are presented in Keller (2005, 93690). The results relevant to this investigation are discussed in Section 8.1.3.3.

8.1.2.6 Earthworm Toxicity Tests

Sediment collected from the 0- to 30-cm (0- to 1-ft) depth interval was used for the earthworm toxicity tests (a measure for AE4). The earthworm tests used the standard American Society for Testing and Materials (ASTM) method E1676-97. The toxicity tests compared the growth and mortality of the earthworms from the seven reaches shown in Table 8.1-1 with the reference site in reach LA-BKG. As shown in the table, the reaches were selected to represent a gradient of concentrations for COPECs associated with both the soil invertebrate receptor and the mammalian and avian receptors that feed on the soil invertebrate. The biota investigation work plan (LANL 2005, 89308) originally proposed that this assay would also include a bioaccumulation test to determine concentrations of COPECs in the worm tissues after 28 days' exposure to the sediment samples. Unfortunately, the earthworms were inadvertently discarded at the conclusion of the test before being sent for laboratory analysis for COPEC concentration. Therefore, the dose to avian receptors in Section 8.1.3.3 is calculated based on concentrations detected in earthworms in the Los Alamos and Pueblo Canyon studies (LANL 2004, 87390) from sediments with the same COPEC concentrations or on extrapolated values from those studies. Section 8.1.3.5 discusses the results of the statistical analysis of the growth and mortality between sites.

8.1.2.7 Seedling Germination Tests

Sediment collected from the 0-30-cm (0-1-ft) depth interval was used for the plant toxicity tests (a measure for AE5). The plant toxicity tests used the standard ASTM method E1963-98. The plant toxicity tests compared survival rates, shoot height, root length, and shoot and root mass in plants grown in soil the same seven locations used for the earthworm toxicity tests with plants grown in the soil sample from the background site. The tests used yarrow (*Achillea millefolium* L. var *occidentalis*), which has more variable results than some other available test species of plant but is more relevant to the ecosystems found at the Laboratory. Section 8.1.3.6 discusses the results of the statistical analysis of the growth and mortality between sites.

8.1.2.8 Plant Survey

A field plant survey was conducted in reaches within the Mortandad watershed to provide ancillary information for the small mammal trapping (AE3); significant differences in the amount of plant cover may affect the number or type of small mammals caught. The field plant survey also serves as an ancillary line of evidence for ecological risk to plants (AE5), although the plant toxicity test is the major line of evidence for that assessment endpoint. The plant survey encompassed nine reaches (see Table 8.1-1) including all of the mammal trapping reaches, all reaches for the plant and earthworm toxicity tests, and the background reach.

In these surveys, vegetation was identified as tree, shrub, forb, cacti, or graminoid (with identification to species where possible) and percent canopy cover for each species was categorized (Balice and Sandoval 2006, 93689). Two measures of diversity, the Shannon diversity function and species richness, were used to compare the vegetation between sites. A brief summary of the results and their relevance to other measures is provided in Section 8.1.3.6.

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8.1.2.9 *Chironomus tentans* Toxicity Test

Sediment samples from the eight reaches shown in Table 8.1-1 were used in the EPA Method 100.2 (EPA 2000, 73776) 10-day growth and survival test with the larval insect *Chironomus tentans*. Each sediment sample was tested at 100% only; dilution series were not run on the sites. Standard control and reference toxicants were included. The endpoints for this test include both survival and growth (as ash-free dry weight). The results of the test are discussed in Section 8.1.3.7.

8.1.2.10 Rapid Bioassessment Characterization

Rapid bioassessment characterization was conducted at five reaches in the Mortandad watershed that had sufficient flow to potentially support aquatic macroinvertebrate communities (Henne and Buckley 2006, 93687), using the EPA Rapid Bioassessment Protocol (EPA 1999, 73728). Collection of aquatic macroinvertebrates was conducted in association with the bioassessment. Collection and assessment were attempted at all reaches specified in Table 8.1-1 in June and September 2005, but becaue of absence of wate,r neither TS-1C nor TS-2C underwent an assessment or invertebrate collection in June 2005. Similarly, reaches M-2W and TS-1C could not be sampled in September due to lack of water. The biota investigation work plan (LANL 2005, 89308) specified use of a Hess sampler to collect aquatic macroinvertebrates when sufficient water was present to use this sampler. However, none of the sites had sufficient water to use the Hess sampler in either June or September 2005. The Hess sampler is needed to collect data for comparison to the NMED Stream Condition Index (SCI); therefore, no comparisons to the SCI were done for the aquatic macroinvertebrate sampling in the Mortandad watershed. Semiquantitative sampling using a D-frame dip net to determine taxonomic composition of macroinvertebrates was done at the sites. The biota investigation work plan indicated that the collected macroinvertebrates would be submitted for Laboratory analysis if sufficient mass could be collected for analysis. The field team was unable to collect sufficient mass of aquatic macroinvertebrates to submit for analysis.

8.1.2.11 Algal Toxicity Test

Water samples collected from the reaches shown in Table 8.1-1 were used for the EPA Method 1003.0 short (96-hr) chronic toxicity algal growth test. This test uses the green algae *Selenastrum capricornutum*. The test methods, conditions, and results are described in Pacific Ecorisk (2005, 91270). Samples were collected from M-2W, E-1W, E-1E, M-1W, and LA-BKG in July 2005 for the test. Locations in TS-1C, TS-1E, and TS-2C were dry at that time, but water samples were collected from these locations in August 2005 for the toxicity test. Controls and reference toxicants were run with both sets of samples. The results of the test are discussed in Section 8.1.3.7.

8.1.2.12 Spatial Modeling Using ECORSK.9.

The ECORSK.9 model was used to model HQs and hazard indices (HIs) across the Mortandad watershed for the Mexican spotted owl, southwestern willow flycatcher, deer mouse, and western bluebird, as presented in Gonzales et al. (2006, 93786). ECORSK.9 includes both canyon and noncanyon sources as well as measured and interpolated concentrations of COPECs from these sources. The model estimates exposure based on an environmental exposure unit (EEU) that consists of foraging throughout the home range centered on known or potential nest sites input into the model. For the Mexican spotted owl, the model restricted the nest sites to within the buffer area for this T&E species. For the southwestern willow flycatcher, the model restricted the nest sites to within the wetland area designated as potential flycatcher habitat. For the deer mouse and western bluebird, the modeled area included the entire Mortandad watershed west of SR 4. The model produces mean total HIs that provide

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an estimate of risk to populations and are most useful for species such as the deer mouse and western bluebird. For evaluating T&E species, risk to individuals and therefore the number of individual grid cells with elevated HIs are a better indicator of locations and COPECs that may need additional investigation. The model calculates both unadjusted HQs and HIs and adjusted HQs and HIs; the adjusted values do not include the contribution of background concentrations of COPECs. For this investigation report, the model was run with two scenarios: In the first scenario all nondetects were included as values at one-half of their detection limit. For many organic chemicals, nondetects constituted 75% to 98% of the data set values, resulting in detection limits heavily influencing the HQ and HI values. To overcome this problem, a second scenario was run in the model in which nondetects for organic chemicals were treated as zeros to focus the results on the actual detected COPECs in the model.

8.1.3 Characterization of Exposure and Effects

This section discusses the baseline ecological risk assessment characterization of exposure and effects, which represents the second part of ERAGS Step 6. This section provides the results from the studies and their interpretation as well as the supporting information in tables and figures. Revised calculations of dose to predators based on concentrations of COPECs in prey are also presented in this section. Although the screening of concentrations of COPCs in sediment and water samples collected in 2005 is also a line of evidence supporting the evaluation of potential ecological risk in the Mortandad watershed, that evaluation is separate from the field studies conducted for the base line ecological risk assessment. Screening the 2005 sediment and water samples against ESLs is presented in Appendix E and summarized in Section 8.1.1.1.

8.1.3.1 Mexican Spotted Owl

ECORSK.9 Model

In the ECORSK.9 model, a number of grid cells within the Mortandad watershed with elevated HIs indicated there may be areas of potential risk to individual Mexican spotted owls (Gonzales et al. 2006, 93786). This was true for both the unadjusted and adjusted mean HI. The adjusted mean HQ and mean HI values calculated in the second scenario (all organic nondetects treated as zeros, as explained in Section 8.1.2.12) are considered the most representative of potential risk from Laboratory sources to the modeled receptors, although the adjustment for background made little difference for the HQ and HI values for the owl. The adjusted total mean HI with nondetects treated as zeros for the owl is 1.6; only bis(2-ethylhexyl)phthalate had an HQ >1.0. Lead was the second most important COPEC (HQ = 0.6). The HI was ≥1 in 49% of the focal points; almost all of these HIs were less than 10. The area with the highest adjusted HI values indicating potential risk to the Mexican spotted owl were in part of Ten Site Canyon, including TA-35 and reaches TS-2E and TS-2C, and in Mortandad Canyon reach M-2E. Although it is difficult to pinpoint the individual source of elevated HIs in the model for a receptor with a home range as large as the owl, the primary sources of high HI values in the model appear to be from samples from noncanyon sources, particularly sources of COPECs associated with TA-35.The adjusted HI for the grid cell in Mortandad Canyon in which a pair of owls has nested was only 0.2. Therefore, the adjusted HI for the grid cell in Mortandad Canyon containing a confirmed owl nest indicates little to no threat of potential adverse effects from Laboratory-related contaminants.

Concentrations of COPECs in Prey

Remains of prey found in the owl pellets from the collection site near reach M-2W in Mortandad Canyon were dominated by wood rats (*Neotoma sp.*), which made up approximately half the identified pellets (Bennett et al. 2006, 93774). Wood rats were collected and analyzed from all trapping sites except the

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LA-BKG site. Deer mice, brush mice, and pinyon mice were also found in pellets from this site. All these species were collected during the small mammal trapping done for this study. Two other pellet collection sites lie outside of the Mortandad watershed but within the home range of Mexican spotted owls at the Laboratory. These two other sites are also used for roosting by the Mexican spotted owl. Pellets from both these sites also contained wood rats; in addition, one site contained the remains of brush mice and another site contained pellets with the remains of long-tailed voles. The analysis of the pellets collected from these three sites indicate that the species collected from the small mammal trapping locations are appropriate to use in the refined calculation of the estimated doses to the Mexican spotted owl. The dose was calculated using the maximum detected concentrations in any prey species, although because wood rats may represent the dominant prey species; use of maximum concentrations from other species may overestimate the dose to the Mexican spotted owl.

COPECs for the Mexican spotted owl were identified in the initial screening of the sediment data (LANL 2005, 89308, p. D-37). While only Aroclor-1254 met the criterion for a study design COPEC (HQ >1 for a T&E species), mercury and cesium-137 had HQs just above 0.8. These three COPECs were not detected in the tissues of the small mammals sent for Laboratory analysis in this study. The detection limits for mercury and Aroclor-1254 are conservatively used to represent the tissue concentration in the refined dose calculation for the Mexican spotted owl. Cesium-137 results are not used in the dose calculations, as discussed below. Based on comments by NMED (NMED 2005, 92084), selenium is also a study design COPEC for all avian receptors although the HQ did not indicate that selenium should be included.

Small mammals are also assumed to be the prey of the receptor representing the carnivorous mammal, the red fox. Study design COPECs for the fox identified in the screening conducted for the biota investigation work plan (LANL 2005, 89308, p. D-35) include cesium-137, Aroclor-1254, and Aroclor-1260. Detected concentrations of Aroclor-1260 are used in the refined estimate of the dose to the fox, and the detection limit for Aroclor-1254 is conservatively used as tissue concentrations for this COPEC.

As described in the biota investigation work plan (LANL 2005, 89308 p. D-14), an HQ for the owl can be calculated by dividing the avian toxicity reference value (TRV) for a COPEC from the ECORISK Database, Version 2.2 (LANL 2005, 90032) by the normalized food intake of the owl of 0.102 mg fresh weight (fw) food/kg body weight (bw)/day (LANL 2005, 89308, p. D-14). Because the TRV for cesium-137 is based on a radiation dose to the organism and not on an amount ingested, this COPEC is not amenable to these calculations. Table 8.1-4 shows the calculations to combine the maximum detected concentrations in carcass and pelt into the equivalent concentration in a whole animal. This table also shows the HQ calculated by dividing the concentration in the reconstructed whole animal by the food ESL calculated as described above. The proportions of methylated mercury and inorganic mercury in the tissues were not measured, but the calculations in Table 8.1-4 demonstrate that the HQ is <0.5 for the owl regardless of whether the mercury is in the inorganic or methylated form.

8.1.3.2 Southwestern willow flycatcher

ECORSK.9 Model

In the ECORSK.9 model, a number of grid cells within the Mortandad watershed with elevated HIs indicated there may be areas of potential risk to southwestern willow flycatchers (Gonzales et al. 2006, 93786). This was true for both the unadjusted and adjusted HI. The adjusted mean HI value for the flycatcher was 6.2. The dominant COPECs were mercury (HQ = 1.7), di-n-butyl phthalate (HQ = 1.5), boron (1.4), and bis (2 ethylhexyl) phthalate (HQ = 0.48). HIs were ≥1.0 in 81% of the grids; approximately half of these HIs were less than 10. The flycatcher was modeled only for areas that contain

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flycatcher habitat; therefore, the area with elevated HIs are limited to the Effluent Canyon area. The elevated HQs for di-n-butyl phthalate resulted primarily from measured values in the noncanyons portion of the data set used in the ECORSK.9 model. There is no BV for boron, and it is unknown whether the detected boron values represent releases from Laboratory sites or instead background levels.

Concentrations of COPECs in Prey

This section estimates the potential dose to the southwestern willow flycatcher using the concentrations in the insects collected from the nest boxes. As described in the biota investigation work plan (LANL 2005, 89308, p. D-14), an HQ for the flycatcher can be calculated by dividing the avian TRV for a COPEC from the ECORISK Database Version 2.2 (LANL 2005, 90032) by the normalized food intake. For the flycatcher, normalized food intake was calculated from the body weight of 12.7 g (LANL 2005, 89308, p. D-14) and estimating the food ingestion rate using the allometric equation for passerine birds from EPA's Wildlife Exposure Factors Handbook (EPA 1993, 59384, equation 3-4). The calculated food ingestion rate is 0.0034 kg/day. This food ingestion rate is in grams of dry weight per day, and was converted to fresh weight using the dry weight to fresh weight ratio for honeybees (Fresquez and Ferenbaugh 1999, 91269). The final insect ingestion rate used in the calculations for the southwestern willow flycatcher is therefore 0.79 kg fw food/ kg bw/day. Table 8.1-5 shows the calculated HQs for the flycatcher based on ingestion of the concentration measured in nest box insects. In some reaches, more than one insect sample could be analyzed, so the arithmetic mean of the concentrations was used (nondetects treated as one-half of the detection limit) as the sample size was too small for calculation of a UCL of the mean. In reaches with only one insect sample analyzed, the maximum detected concentration was used.

The HQs for food ingestion are shown in Table 8.1-5 and predict a much lower level of potential ecological risk than the screening against ESLs did, even though HQs for five COPECs still exceed one (barium, copper, mercury [assumed to be methyl], vanadium, and zinc). Four of these COPECs also had HQs elevated above one in samples collected outside the Mortandad watershed in the Cañada del Buey, Pueblo, and Rendija watersheds. The concentration of these metals in insects is therefore unlikely to be correlated with the concentration of COPECs in soil. The TRVs for these metals probably result in an overprediction of riskbecause the TRV is likely to be based on a more toxic form of the COPEC than is found in the insects. In addition, the southwestern willow flycatcher has not been observed in this part of the Laboratory, so the risk is hypothetical at this time. However, further evaluation may be warranted if the flycatcher is observed to utilize this area in the future.

Bis(2-ethylhexyl)phthalate could not be evaluated in this study, as the mass of insect tissue collected was sufficient only to run the metals analytical suite. However, potential effects of bis(2-ethylhexyl)phthalate are considered in the nest box study evaluation described in Section 8.1.3.3.

8.1.3.3 Avian Invertevore Feeding Guild

This section provides results for trends of COPEC concentration in sediment versus field measures for the avian invertevore feeding guild in the Mortandad watershed, such as nest success and eggshell thickness. This section also evaluates trends of COPEC concentration in sediment versus concentration in eggs. Field measures are derived from Colestock and Fair (2005, 93691).

Nest Success for Bluebirds

As part of the Laboratory's nest box monitoring program, a large number of field measures are collected from the nest boxes each year (Colestock and Fair 2005, 93691). Two of these measures that relate to

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juvenile survival were selected for this study for comparison to concentrations of COPECs in sediment. The measures selected are percent fledged and percent female (the latter may relate to specifically to PCBs as COPECs). Occupied bird boxes were found in five reaches within the Mortandad watershed: M-3, M-4, M-5, TS-2C, and TS-2W. All species occupying the nest boxes (western bluebirds, violet green swallows, ash-throated flycatchers, and mountain bluebirds) are included in the analysis of the measures to provide a larger dataset as the overall number of occupied boxes in the reaches is fairly small. Appendix E provides box plots comparing these two measures between species; no significant differences are seen. Comparisons of the selected nest measures between these reaches are shown in Figure 8.1-2 for percent fledged and Figure 8.1-3 for percent female. Boxes in these figures indicate the interquartile range of the sample results, with the upper and lower ends defined by the 75th and 25th percentiles, respectively. Horizontal lines within the boxes indicate median values, and horizontal lines above and below the boxes represent the 5th and 95th percentiles of the data. Neither measure appears to differ significantly between the reaches, but there are small sample sizes for some measures (e.g., percentage of females in reaches TS-2C and TS-2W). These measures were recorded from 1997 to 2005; bivariate plots of each measure versus year were made and are shown in Appendix E. These measures do not correlate significantly with the year, so data from all years are included on the plots.

In addition to the comparison conducted between reaches, the combined data from all reaches within the Mortandad watershed are compared with other areas within the nest box monitoring network. The groups are Mortandad (Mort), Cañada del Buey (CdB), the cemetery (Cem, unimpacted area), the golf course (GC, unimpacted area), TA-35 (impacted, boxes are near SWMUs or AOCs), Los Alamos and Pueblo Canyons (LA/P, impacted by SWMUs and AOCs), and other (representing the boxes in the nest box network not included in the other groups). Figure 8.1-4 shows a comparison of the percent fledged between the groups and Figure 8.1-5 shows a comparison of the percent female nestlings between the groups. For both measures the results for the Mortandad watershed do not differ from the other areas.

Eggshell Thickness

Another set of parameters collected as part of the nest box network are related to the condition of the eggs. Numerous parameters have been collected; three of these parameters were chosen for inclusion in this study. Eggshell length (in millimeters) and total egg weight correlate well with each other and provide an estimate of egg size. Eggshell thickness was also chosen because previous studies had shown that some thinning of eggshells has occurred in Sandia Canyon (Fair and Meyers 2002, 82655). As with the other nest measures described above, all species are included to provide a larger dataset. Appendix E shows the comparison between species for egg length, egg weight, and eggshell thickness; the comparison shows no significant differences between species for these parameters. Appendix E also compares length, weight, and thickness across years in bivariate plots. None of the three measures vary significantly with year, so data from all years are included in the analysis.

The measures for the eggs are compared between the same five reaches (M-3, M-4, M-5, TS-2C, and TS-2W) as the other nest measures and are also compared among the same areas (Mortandad, cemetery, golf course, Cañada del Buey, TA-35, Los Alamos and Pueblo Canyons, and other). Figures 8.1-6 to 8.1-8 show the comparisons for the egg measures between reaches within the Mortandad watershed. Figures 8.1-9 to 8.1-11 show the comparisons for these measures between the areas. The sample sizes vary between reaches and between groups; however, the three measures do not show any significant differences between reaches or between groups.

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COPEC Concentration in Eggs

The concentrations of metals measured in eggs were plotted against the reach average sediment concentration of that COPEC in the reach from which the egg was collected. The concentration in eggs does not correlate significantly with the concentration in sediment for any of the metals. The plots and regression calculations for all metals are presented in Appendix E. For two of the metals that generated higher HQs for the robin—mercury and copper—in the screening conducted for the biota plan and that were detected in the eggs, the graphs are presented in Figures 8.1-12 and 8.1-13. In addition, NMED requested retaining selenium for all evaluations in the report (NMED 2005, 92084), even though the initial screening did not show this as a COPEC; therefore the graph for selenium is presented in this section in Figure 8.1-14.

COPEC Concentration in Worms

As discussed in Section 8.1.2.6, COPEC concentrations in earthworms were not obtained from the Mortandad watershed in this study. Therefore estimates of potential risk to birds in the avian invertevore feeding guild cannot be directly made using measured concentrations in earthworms. In this report, regressions based on data from the Los Alamos and Pueblo watershed (LANL 2004, 87390) are used to estimate potential concentrations in earthworms in the Mortandad watershed for COPECs that had a significant correlation between detected concentrations in soil and worms in the Los Alamos and Pueblo watershed. For COPECs without significant correlations, the transfer factor from the ECORISK Database Version 2.2 (LANL 2005, 90032) is used. For both types of calculations, the concentration of the COPEC in the composite sample used for the earthworm toxicity test in a reach is used to estimate the concentration in earthworms from that reach. This estimated concentration in the worms is then compared with the concentration in food items expected to have no toxic effects (the food ESL) to derive an HQ for each reach reflecting risk from consumption of earthworms exposed to soil from that reach. Table 8.1-6 shows the basis of the calculations of the estimated concentrations in the worms, the food for each COPEC, the concentration in each soil composite sample by reach, and the HQ from worm ingestion. Two of the two organic COPECs (bis(2-ethylhexyl)phthalate, di-n-butyl phthalate) are not included in Table 8.1-6 because neither COPEC was detected in any of the soil composite samples used in the earthworm toxicity tests. An HQ >3 appears in all reaches, including the reference reach, for mercury based on assuming all mercury is in the methylated form. Only reach E-1E shows an HQ >3 for mercury in the non methylated form. Risk from both types of mercury are included in the table to provide bounding estimates. Because mercury speciation was not measured, the actual ratio of methylated to non methylated mercury in soil and worms is not known. No COPECs, except mercury, produced an HQ >3 in the modeling of dose through earthworms.

Field Surveys of Bird Abundance and Diversity

Field surveys of bird species were done in two areas: Mortandad Canyon from reaches M-1 through M-2, and adjacent parts of Effluent Canyon, and Ten Site Canyon from reaches TS-1 through TS-2, and adjacent areas in Pratt Canyon (Keller 2005, 93690). Species diversity was measured by calculating a Shannon-Weaver Index for each site. The index value was 2.7 for Mortandad and Effluent Canyons and 2.5 for Ten Site Canyon, indicating similar diversity of species between the two areas. The composition of species based on diet type was also similar between the two areas: most of the species in both areas were insectivores (including both ground-feeding insectivores and aerial insectivores). This finding supports using COPEC analysis in earthworms for assessing the risk to avian receptors in the Mortandad watershed.

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The surveys yielded similar results for both areas even though there are some differences in bird COPECs between Mortandad and Effluent Canyons and Ten Site Canyon. As shown in Tables D-2.2-6 and D-2.2-8 (LANL 2005, 89308; pp. D-36 and D-38), the study design COPECs for the robin in that part of Mortandad Canyon are predominantly copper, lead, mercury, vanadium, and Aroclor-1254. In Ten Site Canyon, Aroclor-1254 and mercury are also study design COPECs, but other metals have HQs less than 3. Di-n-butyl phthalate was also a study design COPEC only in Ten Site Canyon. Study design COPECs for the violet-green swallow in Mortandad and Effluent Canyons included primarily aluminum and zinc. Other metals (cadmium, copper, mercury, and vanadium) were the dominant COPECs for the swallow in Ten Site Canyon. Both areas have a number of study design COPECs for birds, but the field surveys support that a good diversity of avian species are still found in these areas.

ECORSK.9 Model for Western Bluebird

Based on the ECORSK.9 model (Gonzales et al. 2006,93786), the percentage of the western bluebird population in the Mortandad watershed that has potential for adverse effects predicted by elevated HIs is too low to affect population viability. The adjusted mean HI for the bluebird is 1.2. The dominant COPEC for this receptor based on the adjusted HI is mercury (mean HQ = 0.38). Other metals (cyanide, zinc, and vanadium) dominated the unadjusted HI, but the entire contribution of these three COPECs was attributable to background. HIs in 24% of the focal points were greater than 1.0.

8.1.3.4 Mammalian Invertevore Feeding Guild

Field Surveys of Small Mammal Relative Abundance and Reproductive Status

A variety of field measures were collected during the trapping and collection of small mammals for this biota investigation (Bennett et al. 2006, 93701). The mean percent daily capture rate, which is an estimate of relative population density, was highest in reach E-1W at 22% and lowest in reach LA-BKG at 7%. The results are shown in Figure 8.1-15. The trend within the Mortandad watershed reaches of decreasing mean daily capture rates with distance downcanyon is probably related to habitat; the trend is consistent with the total percent vegetation canopy cover discussed in Section 8.1.3.6. Species diversity expressed as a Shannon-Weaver Index (see Figure 8.1-16) follows the same trend. The HQ and HI values for deer mouse COPECs also decrease downcanyon; so increasing COPEC concentrations cannot be responsible for the drop in capture rates.

Species composition (the frequency of capture for each species at a site) was very similar between the three Mortandad watershed reaches; species composition in all the Mortandad reaches differed from the Los Alamos Canyon reference site. Data collected during the trapping study indicated no differences in ratios of males to females, body weights, or reproductive status between reaches, using chi square analysis (Bennett et al. 2006, 93701); however, the size of the sample set in this study is somewhat small for evaluation of effects on these parameters.

Concentrations of COPECs in Small Mammals

As described in Section 8.1.3.4, several species of small mammals were trapped and collected in each reach used in the study. All the individuals of most species from a reach were separated into pelt and carcass; the pelts and carcasses were combined so that one pelt and one carcass sample from each species was sent for analysis for each reach. The exception is for shrews, where whole bodies were sent for analysis because of the small size of these mammals. Distinct differences in tissue concentration versus sediment concentration were not seen between species. Regression analysis of concentrations of study design COPECs in carcasses of all species and concentrations in sediment are presented in

Appendix E and show statistically significant correlations for only three of the detected COPECs: aluminum, iron, and perchlorate, although two of the correlations are negative. As shown in Figures 8.1-17 and 8.1-18, aluminum and iron concentrations in tissue are negatively correlated with sediment concentrations, indicating no significant uptake by small mammals from the soil. Figure 8.1-19 shows perchlorate in body tissue; perchlorate was positively correlated with sediment concentrations, indicating uptake by small mammals from the soil. At NMED's request (NMED 2005, 92084), selenium was retained as a COPEC in this evaluation. Selenium concentrations in small mammal tissue did not have a significant correlation with concentrations in soil, as shown in Figure 8.1-20. Figures presenting concentrations in carcass and concentrations in soil for all other detected analytes are in Appendix E.

Regression analysis of concentrations in pelts of all species and COPEC concentrations in sediment showed statistically significant correlations for only two of the detected analytes: americium-241 and arsenic. Concentrations of both these COPECs in pelts were positively correlated with sediment concentration. Figure 8.1-21 shows the concentration of americium-241 in pelt versus sediment. Figure 8.1-22 shows the concentration of arsenic in pelt versus sediment. Selenium concentrations in pelt versus sediment are shown in Figure 8.1-23, and indicate a positive correlation. In contrast, lead concentrations in pelts seem to be negatively correlated with sediment concentrations, although the regression was not statistically significant ($p = 0.07$ for regression). Because analyses of pelts include soil particles adhering to the pelt, these analyses are not as useful as concentrations in carcasses in indicating potential uptake, although they still provide information for possible transfer to higher levels of the food chain. Appendix E presents regression equations and figures showing concentrations in soil versus concentrations in pelts for other detected analytes. The other study design, COPECs detected in pelt and carcass samples were not correlated with sediment concentrations in the study reaches. Graphs of carcass and pelt concentration versus sediment concentration for all other detected COPECs are presented in Appendix E. For some COPECs, this result may indicate that concentrations in tissues are unrelated to environmental exposure. For COPECs that are known bioaccumulators, such as Aroclor-1260, these results indicate that the sediment in the study reaches is not a significant contributor to the total body burden of these small mammals.

Concentrations in the pelts and carcasses were multiplied by the proportional masses of the pelts and carcasses to reconstruct an estimate of the whole animal body tissue concentration. This information was used in Section 8.1.3.1.1 to refine the estimate of dose to the Mexican spotted owl. The same information is used here for comparison to the results of small mammal trapping studies conducted in other canyons; those studies all used concentrations determined from analysis of whole animals. Regression analysis of estimated concentrations in whole bodies of all species and concentrations in sediment show statistically significant correlations for only two of the detected analytes, with positive correlations for americium-241 and perchlorate. Regression equations and figures showing concentrations in soil versus concentrations in whole animals for other detected analytes are presented in Appendix E.

Concentrations of Aroclor-1260 in small mammals from the Mortandad watershed (except for the shrew, which was not included in previous studies) are similar to concentrations detected in small mammals trapped in the Los Alamos and Pueblo watershed. These two watersheds have similar concentrations of Aroclor-1260 in soil from the mammal trapping areas. This indicates a consistent relationship between this COPEC in soil and in small mammal tissue, indicating that this correlation may have some predictive value.

ECORSK.9 Model for Deer Mouse

The percentage of deer mouse population in the Mortandad watershed that has potential for adverse effects predicted by elevated HIs in the ECORSK.9 model is too low to affect population viability

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(Gonzales et al. 2006, 93786). Mean HI values exceeded 1.0 in only 8% of the focal points for the deer mouse. Based on the unadjusted HI (the adjusted HI showed no COPECs with an HQ >0.3), the dominant COPEC would be thallium. Nondetects constituted 72.5% of the thallium values used in the data set, and the mammalian TRV for thallium is very low. The model likely overpredicts the potential risk from thallium based on detection limits; thallium was detected in relatively few of the canyon bottom samples (37% detection frequency). In addition, thallium was only detected above the BV in five sediment samples in the Mortandad watershed, three in E-1E and 2 in M-2W. This indicates relatively small releases of thallium from the TA-50 RLWTF and low levels of thallium contamination in a small area, as discussed in Section 7.1.2.

Refinement of COPEC Dose to the Shrew from Earthworms

Some COPECs in the ecological screening in the biota investigation work plan had HQs exceeding three for deer mice and for shrews. All deer mouse COPECs were also shrew COPECs. Therefore, the shrew (which has a higher exposure because the diet is modeled as 100% earthworm versus 50% earthworm for the deer mouse) was evaluated through modeling of the dose through earthworms based on estimated concentrations in earthworms. Regression equations or concentrations based on transfer factors from the ECORISK Database Version 2.2 were used, as explained for the avian receptors in Section 8.1.3.3. The results of the calculations are shown in Table 8.1-7. Only thallium has an HQ >3 for the shrew; this would also be the case for the deer mouse. Thallium has a very low TRV for mammals and uses a default transfer factor of one to estimate the concentration in earthworms. Table 8.1-8 provides some additional information on the comparison of thallium HQs between reaches. Because these factors are so conservative, the thallium HQ shown in the table is likely to overestimate risk. As discussed above and in Section 7.1.2, there is also evidence of only very small releases of thallium into the canyon bottoms.

8.1.3.5 Detritivores

The earthworm toxicity tests measured growth and survival of earthworms at seven locations in the Mortandad watershed in comparison with the background location in reach LA-BKG (EP&T 2005, 91267). The results for this test, including all replicates, are summarized with box plots for survival and growth (as weight change) in Figures 8.1-24 and 8.1-25. Negative and positive control samples from the laboratory are also shown (LAEW-Neg and LAEW-Pos). The boxes on these plots indicate the interquartile range of the sample results, with the upper and lower ends defined by the 75th and 25th percentiles, respectively. Horizontal lines within the boxes indicate median values, and lines above and below the boxes represent the 5th and 95th percentiles of the data. Dunnett's t-Test results are presented in the right-hand section of each figure. The comparison circles indicate statistical differences between the tests and the reference site (LA-BKG). The background sample for the Dunnett's t-Test is displayed as a heavy red circle, and the text for the reference site is printed in bold red text on the x-axis. Thin red circles represent samples that are not statistically different ($p < 0.05$), and the reach names for these reaches are in red on the axis. Heavy gray circles represent samples that are statistically different, and these reach names are printed in black on the x-axis. No significant differences in survival were seen between any of the sites and the reference site; survival was almost 100% in all replicates, except the Laboratory positive controls (LAEW-Pos samples). In all treatments, including the negative Laboratory control (LAEW-Neg sample), worms showed weight loss, which is typical of earthworms in this assay (EP&T 2005, 91267). Only one reach, M-2W, showed a significant decrease in weight compared with the reference site in LA-BKG. The composite sediment samples from each reach were also analyzed for COPECs; the concentrations of all earthworm study design COPECs in M-2W were lower than the concentrations of these COPECs in some other reaches that did not have as high a weight loss (Table 8.1-9). The higher weight loss of worms in

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the sample from this reach is therefore unlikely to be related to the presence of earthworm COPECs in the soil.

Organic matter in soil can serve as a food source for earthworms during this type of test. The organic matter was measured in each of these samples, but the organic matter in the sample did not correlate with the percent survival or weight change in the test groups (see figures in Appendix E).

8.1.3.6 Plant (Primary Producers)

Seedling Germination and Growth

A number of measures of plant growth and survival are included in the Laboratory toxicity test on samples collected from the Mortandad watershed; these measures include mass of dry shoots, mass of dry roots, mass of wet shoots, mass of wet roots, percent survival, mean root length, and mean shoot length. The complete results are provided in EP&T (2005, 91268). The results are plotted on box plots with the results of the Dunnett's t-Test comparison printed on the right-hand side of the figure; this type of figure is explained in Section 8.1.3.5. As shown in Figure 8.1-26, the dry mass of roots, dry mass of shoots, and mean root length showed no significant differences between reaches, although the test sites did differ from the negative and positive (boric acid) laboratory control samples. In the analysis of wet root length shown in Figure 8.1-27, the plants grown in soil from reach TS-2C had significantly higher mass of wet roots and wet shoots than the other reaches, which were not significantly different from each other. The dry weight of roots and shoots in TS-2C did not differ from the other reaches.

The soil samples used in the plant toxicity test were also analyzed for study design COPECs. The results of those analyses show that reach TS-2C had lower concentrations of chromium, copper, manganese, thallium, vanadium, and zinc than some of the other reaches, although that soil sample had the maximum detected concentration of silver (Table 8.1-9).

Plant survival by reach is shown in Figure 8.1-28. The Dunnett's test results indicate the reaches can be divided into two groups. Reaches E-1W, E-1E, and M-2W represent a group with the highest survival rate. Reaches E-1FW, M-4, TS-1C, TS-2C, and the reference site (LA-BKG) form a second group with slightly lower survival. Although survival in the two groups differ statistically, it is important to note that survival in all replicates from all reaches (except a single replicate from M-4) exceeded 87%, and the background sample was also in the lower survival group. Differences in survival are therefore unlikely to have population level effects and are not related to the presence of COPECs.

Mean shoot length is shown in Figure 8.1-29. The Dunnett's test for this measure also divided the reaches into two groups; these groups did not contain the same reaches as seen in the results for survival discussed above. For the measure of shoot length, reaches E-1E and TS-2C are statistically the same as the reference site (LA-BKG). Reaches E-1FW, E-1W, M-2W, M-4, and TS-1C form a second group with a slightly decreased mean shoot length.

Nutrients in soil can strongly influence growth in soils during this test. Therefore, nutrient parameters such as phosphate, nitrate, and percent organic matter were measured on the soils used in the plant toxicity test. The laboratory negative control sample, for example, contains 10% organic matter, which is the primary reason the control growth always exceeds the growth in the soils from the Laboratory, which are much lower in organic matter. Each growth measure is compared with phosphate, nitrate, and percent organic matter in the bivariate plots in Appendix E. Based on the bivariate plots, percent organic matter may influence plant growth measures in the test regardless of the presence of COPECs in the soil sample.

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Abundance and Diversity of Plants

Data from a field survey of plant abundance and diversity in the Mortandad watershed (Balice and Sandoval 2006, 93689) provide supplemental information on plant communities between reaches and possible effects of COPECs on plants. Table 8.1-10 provides the total species richness, the Shannon diversity index for all species, and the total percent canopy cover for all species. These same reaches were surveyed in 2003 for species richness, and the average species richness of 36 from 2005 is much higher than the 2003 species richness of 25. This increase in species richness occurred for all vegetation categories except cacti and is associated with the lessening of drought conditions between surveys. The increase in plant species richness with higher precipitation from one survey year to the next supports the results of the toxicity assay, indicating that COPECs in the canyon soils are not inhibiting the germination or growth of plants in these areas. Part of the variability in species between reaches is caused by variations in climate, including the general increase in annual precipitation from east to west across the study area. Differences in local topography and hydrology, such as canyon width and depth and presence or absence of wetlands, also affect plant communities. Total species richness, Shannon diversity index, and total percent canopy cover for each reach are plotted versus distance from the Rio Grande as a measure of relative precipitation in Figure 8.1-30. The Shannon diversity index has a significant positive correlation with distance from the Rio Grande (primarily caused by diversity at reach LA-BKG representing an outlier value), suggesting that climate is a primary control on this measure. In contrast, total species richness and total percent canopy cover have much variability with distance, which suggests other factors are important. Total species richness is least in reaches M-2W, E-1W, and E-1E, and total percent canopy cover is also least in E-1E at intermediate distances from the Rio Grande. E-1E and M-2W are the narrowest reaches included in this study, bounded by Bandelier Tuff bedrock, and E-1W is the reach with the largest wetland in this study, suggesting that these factors have negatively affected species richness and canopy cover. The presence of COPECs in canyon soils may also potentially affect these parameters, although the results of the toxicity assay indicate that COPECs in the canyon soils are not inhibiting the germination or growth of plants in these areas.

8.1.3.7 Aquatic Community

Chironomus Tentans Toxicity Bioassay

The *Chironomus tentans* toxicity test measures survival and growth of larval insects in active channel sediment collected from the eight reaches specified in Table 8.1-1. A complete description of the test conditions and results is contained in Pacific Ecorisk (2005, 91271). Figure 8.1-31 shows box plots of the number of live larvae remaining per replicate per reach at the conclusion of the test. This box plot shows no significant differences in larval survival between the selected reaches or between the reaches with COPECs and the reference site in reach LA-BKG. Figure 8.1-32 shows the mean dry weight of surviving larvae in each replicate test for each reach. This box plot also shows no significant difference between reaches for this measure of larval growth. Box plots of two other measures of larval growth, total ash-free dry larvae weight and mean ash-free dry larvae weight, are presented in Appendix E. Neither of those growth measures showed any difference between reaches. These results indicate that sediment COPECs do not have an effect on the growth or survival of *C. tentans*.

Rapid Bioassessment Characterization

Data on collected macroinvertebrates, habitat scores, and dissolved oxygen levels in reaches E-1W, M-1W, and M-2W indicate that these sites are marginal for sustaining a diverse community of aquatic life (Henne and Buckley 2006, 93687). However, the assessment protocols used are based on perennial streams and may be biased toward rating ephemeral streams as degraded. Hess sampling could not be

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used because of low flow conditions, so quantitative estimates are not available for comparison to the NMED metric. Macroinvertebrates were collected from each reach by D-frame dip net. During both sampling events (June and September 2005), 25% of the taxa at reach E-1W were chironomids. In June, chironomids constituted 85% of the identified individuals from this site as well. Chironomids represented 25% of the taxa and 92% of the individuals in M-1W in June, and 16% of taxa and 71% of individuals in September. The site in reach M-2W also contained predominantly chironomids; chironomids were 33% of the taxa and 69% of individuals in June, and the site was dry in September. The predominance of chironomids at the sites also supports the use of the *Chironomus tentans* Laboratory toxicity test as the appropriate assay to determine if sediment COPECs are adversely impacting the macroinvertebrate communities in these ephemeral stream systems.

Algal Toxicity Test

Water was collected from areas of intermittent or persistent water in reaches E-1W, E-1E, M-1W, M-2W, and LA-BKG in July 2005 for tests of algal toxicity, and from reaches TS-1C, TS-1E, and TS-2C in August 2005 after summer rainstorms provided enough water in these drier reaches. These two sampling events resulted in two separate tests for toxicity of water to algae. For these short-term tests, the endpoint is growth expressed as number of cells versus the control. The results of the toxicity tests are reported in Pacific Ecorisk (2005, 91270). Different rates of growth were seen in the controls between the two tests, so the results for the two tests are shown separately. Figure 8.1-33 shows a box plot comparing the samples from each reach (this type of plot is explained in Section 8.1.3.5) with the July samples, which include the reference site (LA-BKG). Laboratory controls are labeled "control" and "0.5 ZN" (0.5 ppm zinc as a positive control) through "20 ZN" (20 ppm zinc as a positive control). Figure 8.1-34 shows a box plot for the laboratory controls and samples from Ten Site Canyon collected in August. The box plots show that for both sets of tests, growth in all reaches except TS-1C exceeded both the negative (Laboratory control water) and positive laboratory controls (the range of zinc growth-inhibiting concentrations) for the test.

Table 8.1-11 shows the concentrations of detected radionuclides in algal test samples that are study design COPECs and the value for the algal HQ based on these concentrations. Radium-226 was detected in the M-1W sample, and americium-241 was detected in the E-1E, M-2W, and TS-1C samples. A comparison between Figures 8.1-33 and 8.1-34 and Table 8.1-11 shows that the differences in growth do not correspond to the detected concentrations of radium-226 and americium-241. The only reach sample in which algal growth was inhibited was in TS-1C; this sample contained the lowest detected concentration of americium-241, and radium-226 was not detected in that sample. The growth rates for all reaches were compared with general water quality parameters, which can strongly influence the results of this type of test. For both tests, the mean algal cell density correlates extremely well with water hardness, as shown in the bivariate plots in Figure 8.1-35. These results indicate that differences in the growth rates of algal cells between reaches (including reach TS-1C) result from the differences in water hardness between samples from the reaches and not from the concentrations of radionuclides in the water samples. Bivariate plots of algal cell density against conductivity and alkalinity are presented in Appendix E. None of these parameters correlated with cell growth as well as the water hardness.

The detected concentration of radium-226 in the M-1W sample has an HQ >3 (equivalent to a study design COPEC), but this sample did not show adverse impacts to the growth of green algae when compared with positive controls in the test. The detected concentrations of americium-241 are below the ESL, and the test results do not indicate adverse impacts to populations of green algae.

Estimate of COPEC Dose through Food to the Bat

Although several COPECs in the Mortandad watershed had HQs >3 for the bat (aluminum, arsenic, and naphthalene), the bat was not identified as an appropriate measure for an assessment endpoint in the biota investigation work plan because its large home range and high food ingestion rate indicate that much of a bat's food would be obtained from outside the watershed. However, because nest box insect tissues were analyzed to evaluate avian receptors, these same analytical results were used to refine the potential COPEC dose through food to the occult little brown myotis bat, as shown in Table 8.1-12. Because of the size of the insect samples, only metals analyses could be run on the insects. Therefore, naphthalene was not included in these calculations. Aluminum was included in the analytical suite for the nest box insects, but the ESL for aluminum has been updated to follow EPA guidance that aluminum is only a potential COPEC in soils with a pH below 5.5 (EPA 2003, 85645); therefore, aluminum no longer fits the ESL model for accumulation through the food chain and is also not included in Table 8.1-12. The HQ for arsenic for bioaccumulation through insects into the bat is 0.6, indicating no potential risk to the bat through ingestion of insects even if all insects come from the canyon bottom areas within the Mortandad watershed.

8.1.3.8 Refinement of COPEC Dose to the Fox through Ingestion of Small Mammals

The red fox was not evaluated as the measure for a specific endpoint in this study, but Aroclor-1254, Aroclor-1260, and cesium-137 had HQs greater than 3 for the red fox in the ecological risk screening (LANL 2005, 89308, p. D-35). For the two PCBs, maximum detected concentrations in whole small mammals were used to refine the dose estimate. These calculations and the resulting HQs are shown in Table 8.1-13. Aroclor-1254 and cesium-137 were not detected in small mammal tissues, so this COPEC is not evaluated further. For Aroclor-1260, the maximum whole body concentration was detected in a montane shrew. The calculated HQ for Aroclor-1260 is 0.003, indicating no potential risk to the red fox from PCBs through ingestion of small mammals

8.1.4 Risk Characterization

ERAGS Step 7 is risk characterization, which includes risk estimation and the uncertainty analysis. Risk estimation includes a summary of the results for the measures used to evaluate potential for ecological effects. A qualitative weight of evidence (WOE) criterion was assigned to each measure in Appendix D of the biota investigation work plan (LANL 2005, 89308). If measures indicate different outcomes, meaning one measure indicates a potential for adverse effects and one does not, then the overall conclusion would be weighted toward the measure with the higher WOE.

8.1.4.1 Risk Estimation

Mexican Spotted Owl

The two main measures for the Mexican spotted owl are the ECORSK.9 modeling and the modeling of estimated dose through the food chain from the study design COPECs detected in small mammals. The WOE assigned to each measure is shown in Table 8.1-14. In the ECORSK.9 model, the total adjusted mean HI (using zero for nondetects) across the core and buffer areas for the owl was 1.6. This value exceeds the HI target of 1.0, indicating a small potential for effects to individual owls, primarily from bis(2-ethylhexyl)phthalate (Section 8.1.3.1 and Gonzales et al. 2006, 93786). This SVOC has a high frequency of nondetects in sediment samples from the Mortandad watershed (99.5% nondetects; Section 7.1.3.3), and the potential risk is largely from analyses of samples collected outside the canyon bottoms. One Mexican spotted owl nest currently exists in the Mortandad watershed, and the adjusted HI for this

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nest location is 0.2, which does not indicate potential risk to the Mexican spotted owl. The other measure estimated the dose to the Mexican spotted owl based on detected concentrations in mammal tissue (Section 8.1.3.1). The dose modeling was conducted for the nonradionuclide COPECs for the owl (Aroclor-1254, mercury, and selenium) as determined by the screening against ESLs in the biota investigation work plan. The dose modeling shows no HQs greater than 0.5, indicating no potential risk to the owl. Small mammals were not analyzed for SVOCs. Bis(2-ethylhexyl)phthalate was not a study design COPEC in the original screening because it had a higher ESL in the version of the ECORISK Database (Version 2.1, LANL 2004, 87386), which was current at that time. The owl pellet analysis showed that the small mammal species used in the dose modeling are among the species consumed by the Mexican spotted owl in the Mortandad watershed. Based on the dose modeling and on the ECORSK.9 model results for the portion of the canyon in which Mexican spotted owls currently nest, the WOE indicates no adverse effects of COPECs on survival and reproduction of the Mexican spotted owl (AE1).

Southwestern WillowFlycatcher

The aerial insectivores applicable measures for the southwestern willow flycatcher are the ECORSK.9 model, the results of estimated dose through prey using the concentrations of COPECs detected in nest box insects and the field nest box measures. The WOE assigned to each measure is presented in Table 8.1-15. The ECORSK.9 model had a total mean adjusted HI of 6.2, indicating some potential for risk to the flycatcher through exposure to mercury, di-n-butyl phthalate, boron, and bis (2ethylhexyl) phthalate (Section 8.1.3.2 and Gonzales et al. 2006, 93786). The food chain modeling showed HQ values >1 for six metals when the maximum detected concentration in insects was used for the calculation. When the mean detected concentration in the insects is used in the calculations, the HQs are still elevated for mercury (if all the mercury is considered to be in the methylated form), copper, vanadium, and zinc. These calculations indicate potential for risk to flycatchers from ingestion of the nest box insects. The WOE from these measures indicates some potential for adverse effects to survival and reproduction of the southwestern willow flycatcher (AE6) from COPECs in sediment. However, the field measures (nest box studies) of other avian insectivores do not show impacts to nest success, which indicates that the models used for assessing the flycatcher overestimate the potential for ecological risk to avian insectivores. In addition, the southwestern willow flycatcher has not been observed in this part of the Laboratory, so the risk to this species is hypothetical at this time.

Avian Ground Invertevore Feeding Guild

A number of measures were evaluated for the avian ground invertevore feeding guild. The WOE assigned to each measure is provided in Table 8.1-16. ECORSK.9 modeling using the western bluebird indicated a total mean adjusted HI of 1.2, too low to have effects on populations of avian invertevores (Section 8.1.3.3 and Gonzales et al. 2006,93786). Modeling the estimated dose of COPECs to the robin through earthworms was also done, although this analysis had to employ estimated concentrations of COPECs in the earthworms instead of measured concentrations as initially planned. The dose modeling indicates a potential for risk to avian ground invertevores through ingestion of COPECs in earthworms. The primary COPECs are mercury, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, and Aroclor-1254. A number of field measures of impacts on avian invertevore species were also conducted. The measures of nest success through percent fledged, percent female nestlings, and egg size and thickness show no differences between reaches with and without COPECs. Concentrations of COPECs in eggs do not correlate with sediment concentrations, indicating that uptake into the birds is less than the levels predicted by models, including the dose modeling from earthworms. Field surveys of avian species in Effluent, Mortandad, and Ten Site Canyons did not show any differences in species diversity or avian diet types represented between the canyons, even though di-n-butyl phthalate was a study design COPEC in

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Ten Site Canyon and not in Effluent and Mortandad Canyons. Overall, the WOE indicates that COPECs in the Mortandad watershed do not pose a risk to population abundance or persistence and species diversity of avian ground invertevore feeding guild species (AE2).

Mammalian Invertevore and Omnivore Feeding Guild

The mammalian invertevore and omnivore feeding guild includes both the deer mouse (an omnivore) and the shrew (an insectivore). Four lines of evidence were evaluated for these species, and the WOE for these lines is presented in Table 8.1-17. The unadjusted HI had only thallium as a COPEC; this results because thallium has a low TRV and the data set consisted mostly of nondetects that elevated the HQs. ECORSK.9 modeling for the deer mouse showed no COPECs with the adjustment to remove the contribution of thallium (Section 8.1.3.4 and Gonzales et al. 2006, 93786). The tissue and pelt concentrations of COPECs were measured in small mammals as well. This line of evidence was primarily for dose modeling to receptors that eat small mammals, but the results are also relevant to the small mammals themselves. Very few of the COPECs detected in the small mammals correlated with the concentrations in sediment: three COPECs correlated with body tissue, two with pelt, and two with whole animals. These results indicate that the ESL model overestimates the uptake of COPECs into small mammals. Thallium was one of the COPECs that did not correlate with soil concentrations in any of the tissues tested.

The third measure for the small mammals was to estimate the potential dose to them through ingestion of earthworms. As with the avian receptors, estimated COPEC concentrations in earthworms had to be substituted for the planned analytical results. Both the shrew and deer mouse are modeled for the ESL development with invertebrates in their diet, but as explained in Section 8.1.3, the dose modeling was conducted using the shrew. Only thallium had an HQ >3 for the small mammals; this results because thallium has a low TRV and a default transfer factor of 1. Thallium in earthworms did not correlate with soil concentrations of thallium in the study in the Los Alamos and Pueblo watershed; therefore, the thallium result from the modeling is likely to greatly exceed the actual risk and not be a strong line of evidence for small mammals. Overall, the WOE for small animals indicates that COPECs in soil do not have adverse effects on population abundance or persistence and diversity of mammalian invertevore and omnivore feeding guild species (AE3).

Mammalian Carnivore Feeding Guild

Although the fox did not represent a specific assessment endpoint because carnivores were evaluated through AE1, the ecological screening presented in the biota investigation work plan indicated that PCBs may impact this receptor. The mammal tissue concentrations of PCBs were used to calculate a refined estimate of dose through the food chain (Section 8.1.3.8). Only Aroclor-1260 was detected in small mammal tissue and the HQ for Aroclor-1260 was less then 0.01, indicating that there is no risk to this receptor through ingestion of small mammals in the Mortandad watershed.

Detritivores

ALaboratory toxicity test measured both survival and weight change in earthworms from samples in reaches with and without soil COPECs (Section 8.1.3.5). The WOE for this measure and measures of detritivores relevant to other receptors is given in Table 8.1-18. There was no difference in survival between any of the reaches. There were differences in weight loss between the reaches, but the differences in weight loss did not correlate with COPEC concentration. The WOE for detritivores indicates that COPECs in soil in the Mortandad watershed do not adversely impact survival and growth of detritivore species (AE4).

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Plants (Primary Producers)

Lines of evidence and their WOE for plants are provided in Table 8.1-19. The main line of evidence is the seedling germination test with supporting information from the field survey of plants in reaches with different concentrations of COPECs. Survival and most measures of growth in roots and shoots showed no difference between reaches (Section 8.1.3.6). Two measures (wet root length and mean shoot length) differed between reaches but did not correlate with COPEC concentration. The field survey of plants showed no differences between reaches that could be directly related to variations in COPEC concentrations, and all reaches that had been previously surveyed had more species diversity than previously, supporting the finding that germination and growth are not inhibited. The overall WOE indicates no adverse effects of COPECs in soil on native plant species presence and diversity (AE5).

Aquatic Community

The measures used as lines of evidence for evaluating impacts to the aquatic community in the Mortandad watershed, and the WOE assigned to each measure are provided in Table 8.1-20. The Laboratory toxicity test using *C. tentans* showed no difference in survival and no difference in growth correlated with COPEC concentration. The field bioassessment characterization indicated that chironomids dominate the aquatic community in sampled reaches and that the toxicity test using chironomids is therefore an appropriate measure of impacts to the aquatic community. The Laboratory algal toxicity test showed differences in cell growth with reaches, but these differences were attributable to water hardness and not to COPECs in water. The WOE for measures of the aquatic community indicates there are no adverse effects from COPECs in sediment and water on abundance and survival of the aquatic community in the reaches of the Mortandad watershed (AE7).

8.1.4.2 Uncertainty Analysis

Exposure Uncertainty

Uncertainties in the ecological risk assessment are potentially associated with the characterization for sediment and surface water. Maximum detected concentrations were used for some comparisons, which would overestimate the exposure concentration in a reach. For comparisons to bird boxes, arithmetic mean concentrations in soil in each reach were used for comparison; because sampling is biased towardlocations where contaminant concentrations are highest, use of straight means generally provide overestimates of actual exposure concentrations, as discussed in Section B-1.0 of Appendix B. Media concentrations for evaluating the results of Laboratory toxicity tests came from the actual water and sediment samples used in those tests and provide a good estimate of the exposure concentration for the assay organisms. These concentrations would overestimate exposure concentrations throughout the sampled reaches because sampling was biased to specific locations with higher concentrations of COPECs in these reaches. For the small mammal trapping, composite soil samples for comparison were obtained from the traps within the array.This provides a good representation of the concentration in the trapping array, but because the arrays were centered in areas with contaminated sediment deposits, the data are expected to overestimate exposure concentrations for mammals that largely forage outside these areas.

Another uncertainty is the adequacy of the toxicity and bioaccumulation data used to develop the assessment endpoints and select the associated measures and develop the study design. In fact, a number of toxicity values and transfer factors in the ECORISK database and the associated food chain and ECORSK.9 modeling were changed between the design of the studies and their evaluation in this investigation report. These changes brought new COPECs into consideration. Gaps also exist for toxicity

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for some classes of COPECs on some receptors that hamper evaluating those COPEC-receptor combinations except in the field studies. The study design included field, Laboratory, and model components to provide complementary information and reduce uncertainties related to toxicity and bioaccumulation data.

Field Measures

Empirical ecological effects data are the most relevant data for determining if there are adverse effects on ecological receptors, especially at the population level. However, these data are inherently more variable and difficult to quantify than laboratory measures. Uncertainty associated with a limited number of locations and a limited number of sampling events is mitigated by collecting information across a variety of measures of exposure and effect.Factors unrelated to COPECs, such as drought and other climatic variations, fire, and annual variation in species, can have confounding effects on analysis of field measures.

Field measures can also provide some information on adverse effects that cannot be obtained with other methods. This includes an estimate of impacts from COPECs for which there are not toxicity values. Field measures also provide valuable information on the usefulness of models and transfer factors in predicting ecological effects.

Laboratory Measures

Laboratory toxicity tests provide more standardized results than field data because they are conducted under controlled conditions, but they are still subject to uncertainties associated with sample collection and representativeness. Confounding factors are also possible, as was demonstrated in this investigation by the effect of water hardness on the results of the algal toxicity test (Section 8.1.3.7). Other confounding factors may include variability in the test species selected; for example, the yarrow used in the plant toxicity test for these studies is more variable in growth than standard assay plants, but it is also more relevant to the ecosystems under consideration. Mortandad watershed soils are generally nutrient-poor, which can influence growth in plant, earthworm, algae, and chironomid tests. Sample sites were also selected to represent a gradient of COPEC concentrations to improve the representativeness of the toxicity tests to potential COPEC impacts.

Model Measures

ECORSK.9 represents a modified exposure model with many of the limitations of the simple exposure models used of screening-level ecological risk assessments. ECORSK.9 blends more realistic information on spatial use of the watershed with simple models of contaminant bioaccumulation and toxicity (Gonzales et al. 2006, 93786). In ECORSK.9, conservatism is still present for key parameters like TRVs and bioaccumulation factors. For example, the TRVs are based on NOAELs or the geometric mean of NOAEL values, and risks are assessed assuming additivity of response or summing of exposure across COPECs. ECORSK.9 is also based on conservative estimates of COPEC concentrations in soil; it assumes that the average of the sample data for a model grid cell is representative of the true concentration, although sampling is typically biased toward areas with higher concentrations of contaminants (Section B-1.0 of Appendix B). For this study, nondetected concentrations of organic chemicals were handled as either one-half their detection limits or as zero.The different results demonstrate that assumptions regarding nondetects can obscure sources of problem contaminants and overestimate risks. The simple dose modeling from concentrations in food done for this investigation is subject to many of the same uncertainties arising from toxicity values, transfer factors, and assumptions about concentrations and nondetects as the ECORSK.9 modeling.

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8.1.5 Summary

Many COPECs were identified as study design COPECs in the ecological screening of soil, sediment, and surface water in the Mortandad watershed. The WOE demonstrated by the various lines of evidence for the seven assessment endpoints indicates there are no adverse effects of COPECs on terrestrial and aquatic receptors in the Mortandad watershed. The overall WOE from field studies, analysis of COPEC concentrations in tissues, and Laboratory toxicity tests supports this conclusion. Some of the results from modeling (both ECORSK.9 modeling and the dose through food ingestion modeling) indicate a potential for some ecological risk. However, these two models incorporate many of the same conservative factors (TRVs and transfer factors) inherent to the original screening using ESLs, which are designed to overestimate potential effects to provide a conservative screen. Therefore these models are not as strong a line of evidence as the other studies mentioned. Thus, no COPECs are retained for any further assessment or mitigation as a result of this baseline ecological risk assessment.

8.2 Human Health Risk Assessment

This human health risk assessment evaluates the potential for adverse effect on human health in the Mortandad watershed for COPCs identified in Section 6 of this report. The risk assessment approach used in this report follows guidance from EPA (1989, 08021), LANL (2004, 87800), NMED (2006, 92513), and EPA (2005, 91002) and is organized in seven major subsections. The approach utilizes media- and scenario-specific media-based screening levels to evaluate the potential for human health risks from sediment and surface water in the Mortandad watershed. Section 8.2.1 provides the basis for selecting exposure scenarios for the human health risk assessment. In Section 8.2.2, the data collection and evaluation processes described in previous sections of the report are summarized, focusing on aspects of data analysis that are pertinent to the risk assessment. Section 8.2.2 also lays out the logic for selecting COPCs for the human health risk assessment. The exposure assessment (Section 8.2.3) provides information used in quantifying human exposure to COPCs in sediments and water. The toxicity assessment (Section 8.2.4) provides information on potential human health effects from chemicals and radionuclides evaluated in the risk assessment. Section 8.2.4 provides the sources for the media- and scenario-specific screening levels. Risk characterization (Section 8.2.5) is based on the SOF method for evaluating the potential for additive effects with COPCs that are classified as noncarcinogens, carcinogens, or radionuclides. Uncertainty related to the various assumptions and inputs used in the risk assessment is evaluated in Section 8.2.6 to support interpretation of the risk characterization. A summary of the risk assessment is provided in Section 8.2.7.

8.2.1 Problem Formulation

The purpose of this risk assessment is to evaluate potential human health risks related to the COPCs identified in sediments and surface water in the Mortandad watershed. This information can be used to inform a risk management decision. This risk assessment uses information pertaining to current and reasonably foreseeable future land use to assess potential impacts under reasonable maximum exposure (RME) conditions. The canyon bottoms in the Mortandad watershed include a mixture of Laboratory property and San Ildefonso Pueblo lands, potentially supporting a variety of land use alternatives.

The assessment in this report primarily employs the trail user exposure scenario to represent the current and reasonably foreseeable future exposure activities for contaminated sediments and surface waters in the watershed. The trail user scenario describes an adult individual who contacts contaminated sediments and surface water while hiking or jogging in the canyons. This use is considered to be inclusive of realistic present-day potential exposure activities in canyon bottoms in areas of the watershed where contaminants are at levels requiring a human health risk assessment.

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One supplemental exposure scenario, residential, is evaluated in the human health risk assessment for comparison purposes only. A description of this supplemental exposure scenario is provided in Section 8.2.3.3. Unlike the trail user scenario, residential use is not currently applicable across the watershed. A residential scenario does not represent current or reasonably foreseeable future land uses in the canyon bottoms, and residential development in particular is not a feasible land use within the parts of the canyons subject to flooding.

Assessment results for the trail user scenario are provided in Section 8.2.5. The results of risk calculations for the residential scenario are provided in Section E-3 of Appendix E.

8.2.2 Data Collection and Evaluation

The approach to sampling design, data collection, and characterization is described in Sections 3 and 4 and Appendix B. Sample locations, sample results, and data quality for data employed in the human health risk assessment are presented in Appendix C. Section 6 describes how sediment data were separated into reaches and status and how sediment data within reaches were combined for the comparison of contaminant data maxima with BVs. Water data were evaluated at each surface water sampling location, as described in Section 6.

Identifying COPCs for the Human Health Risk Assessment

COPCs for the human health risk assessment are identified based on screening level risk calculations using a residential exposure scenario. This process is initially inclusive of all COPCs and evaluates the potential for human health risks under a protective residential scenario. This process includes calculating a ratio, which is the maximum concentration of an analyte in a specific media in a reach or at a water sampling station divided by the media-specific risk-based screening level. This is analogous to the HQ as used in Section 8.1 for assessing potential ecological risk. An SOF is also calculated for a risk type; i.e., carcinogens (SOF_{ca}), noncarcinogens (SOF_{nc}), and radionuclides (SOF_{rad}). These are analogous to HIs calculated in Section 8.1. Ratios for all COPCs within a reach or water location are summed to calculate the SOF for the risk class of those analytes (carcinogen, noncarcinogen, or radionuclide). For all reaches or water locations with an SOF >1.0 for a risk class, all COPCs within that risk class with ratios greater than 0.1 are retained as COPCs for the site-specific risk assessment. COPCs with a ratio ≤0.1 based on maximum sample results are excluded because they are unlikely to significantly contribute to risk.

Sediment COPCs: The human health screening levels for nonradionuclides in sediment used in this screening assessment are the NMED residential SSLs from Revision 4 of NMED guidance (NMED 2006, 92513). For analytes for which NMED does not provide a value, the residential screening value from EPA Region 6 (EPA 2005, 91002) or EPA Region 9 (epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf) was used as the SSL (carcinogens are adjusted to a 10^{-5} risk level to be consistent with the NMED target risk level). NMED-approved surrogate compounds were used for some COPCs that lack NMED or EPA screening levels (NMED 2003, 81172). SALs related to residential land use for radionuclides are based on the soil guidelines for unrestricted release of property (DOE Order 5400.5, "Radiation Protection of the Public and the Environment"); these values are derived using RESRAD version 6.21 as described in "Derivation and Use of Radionuclide Screening Action Levels Revision 1" (LANL 2005, 88493).

Tables 8.2-1 to 8.2-3 contain the set of human health residential SSLs and SALs used to calculate ratios; these tables also provides the SOFs for each reach for each risk class for all sediment COPCs. COPCs and reaches shaded gray are those retained for the risk assessment. Table 8.2-1 provides the results for noncarcinogens, Table 8.2-2 provides the results for carcinogens, and Table 8.2-3 provides the results for radionuclides.

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Surface Water COPCs: Screening levels for surface water for organic and inorganic chemicals are the EPA Region 6 risk-based screening levels for tap water (EPA 2005, 91002). The EPA Region 6 values were supplemented by screening values from EPA Region 9 , available at (epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf). Radionuclide screening levels are based on a dose of 4 mrem/yr and are from the DOE DCG (DOE Order 5400.5, "Radiation Protection of the Public and the Environment").

Tables 8.2-4 to 8.2-6 contain the set of human health water screening levels used to calculate ratios; these tables also provide the SOFs for each type of field preparation (filtered or unfiltered) for each water location, and each risk class for all surface water COPCs. COPCs and water locations shaded gray are those retained for the further assessment. Table 8.2-4 provides the results for noncarcinogens; Table 8.2-5 provides the results for carcinogens; Table 8.2-6 provides the results for radionuclides. Surface water data have been obtained from the surveillance station "Mortandad at Rio Grande" (monitoring station A-11), and there is no associated reach for this location. The primary source of surface water at station A-11 is effluent from the Los Alamos County wastewater treatment plant in White Rock. The SOF_{nc} for station A-11 was 1.01, and the primary contributors to the sum were fluoride and vanadium. Because station A-11 has no associated sediment sample results, and surface water is wastewater effluent, this location will not be retained for evaluation in the human health risk assessment.

COPC Summary: Table 8.2-7 presents a summary of endpoints and reaches considered in the human health risk assessment for the Mortandad watershed. For each reach and endpoint combination with both sediment and water COPCs retained, a multimedia assessment is also assessed for this reach. Table 8.2-7 shows that the most downstream reach in the Mortandad watershed requiring further human health risk assessment is reach M-4.

Calculating Representative Concentrations

Sediment: The investigation approach for sediments resulted in samples associated with discrete geomorphic units and sediment facies within each reach. These data are combined to estimate weighted averages and weighted 95% upper confidence limits (UCLs) on the averages for COPCs retained for the human health risk assessment in each reach. The approach to estimating weighted averages and weighted 95% UCLs is well established in the statistical methods for stratified sampling, (e.g., Gilbert 1987, 56179; Cochran 1977, 84462). A description of these methods is provided in Section E-3 of Appendix E. Many of the data sets for combinations of COPCs and reaches or COPCs and water sampling locations include nondetect values. The approach to estimating averages and 95% UCLs with data that include nondetects is also described in Section E-3 (Appendix E).

The trail user exposure scenario uses representative sediment concentrations calculated from surface-area weighted averages and surface-area weighted 95% UCLs for sediment facies that typically occur in the uppermost parts of geomorphic units because trail user exposures predominantly occurs with near-surface sediment. In addition, the uppermost sediment facies is usually finer grained and contains higher contaminant concentrations than deeper sediment, thus providing a more protective assessment. The calculation approach for the averages and 95% UCLs uses the relative areas of the different geomorphic units in a reach to derive the weights. The residential exposure scenario includes activities that penetrate the ground surface, resulting in direct exposure to buried sediments. Therefore, the residential exposure scenario uses the volumes of sediment deposits within geomorphic units to derive weights rather than the surface areas. The area weights and volume weights for each unit in each reach are presented in Table D-1.3-1 in Appendix D. Representative sediment concentrations for the trail user scenario are presented in Section 8.2.5.

Surface Water: Water COPC concentrations are evaluated for each sampling location, unlike sediments where multiple sample locations are combined to generate a representative concentration for a reach. The only exception is for locations that are basically collocated within a few meters of each other. As a result, methods to estimate weighted averages and weighted 95% UCLs are not used to calculate water representative concentration. The approach to calculating averages and 95% UCLs for the water data follows the approach described in Section E-3 (Appendix E). Representative surface water concentrations for the trail user scenario are presented in Section 8.2.5.

8.2.3 Exposure Assessment

The trail user scenario is the exposure scenario that applies to all reaches identified in Table 8.2-3. Additionally, potential risk associated with the residential scenario is provided as a point of comparison. The two exposure scenarios employed in the human health risk assessment have been described in other documents. The trail user scenario is the adult receptor in the recreational scenario document (LANL 2004, 87800) and the recreational scenario in the radionuclide SALs document (LANL 2005, 88493). An adult trail user is evaluated in this assessment because access to these reaches is limited to Laboratory workers or trespassers, and it is unlikely that young children would accompany either workers or trespassers on recreational visits to these reaches. Exposures to surface water ingestion are evaluated based on the trail user scenario described in the "Los Alamos and Pueblo Canyon Investigation Report" (LANL 2004, 87390, p. 8-37), which also provides risk-based concentrations for trail user surface water exposures (LANL 2004, 87390, p. E-317). Residential SSLs are in NMED guidance (NMED 2006, 92513), and residential SALs are in LANL guidance (LANL 2005, 88493).

8.2.3.1 Exposure Scenario Description

The human health risk assessment focuses on potential risks resulting from direct exposure to contaminants in sediments through ingestion, inhalation, external irradiation (radionuclides only), and dermal contact (chemicals only). The water pathways for the trail user consist of ingestion and dermal contact (chemicals only) using persistent surface water data. Exposure to stormwater is not assessed because stormwater is transient and does not occur frequently enough to sustain chronic exposures. Exposure to groundwater is not evaluated because no groundwater in the Mortandad watershed is available for human uses under current conditions or for the reasonably foreseeable future. A summary of potentially complete exposure pathways, by scenario, is provided in Table 8.2-8.

Exposure scenario parameters were selected to provide an RME estimate of potential exposures. As discussed in EPA (1989, 8021), the RME estimate is generally the principal basis for evaluating potential health impacts. In general, an RME estimate of risk is at the high end of a risk distribution, i.e., 90th–99.9th percentiles (EPA 2001, 85534). An RME scenario assesses risk to individuals whose behavioral characteristics may result in much higher potential exposure than seen in the average individual.

The trail user scenario addresses limited site use for outdoor activities such as hiking and jogging. The receptor for this scenario is anticipated to be a Laboratory employee using the canyon over an extended period of time. Therefore, receptors for the trail user scenario are defined as adults. A complete description of the parameter values and associated rationale is provided in Laboratory guidance (LANL 2004, 87390, p. 8-37). Exposure parameters for the trail user are provided in Appendix E-3.

8.2.3.2 Supplemental Exposure Scenario

Risk estimates are provided for a resident as a supplemental exposure scenario. A more detailed discussion of the basis and parameterization of this scenario is provided in NMED guidance (2006,

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92513) and Laboratory guidance (LANL 2005, 88493). Exposure parameters for the resident are provided in Appendix E-3.

8.2.3.3 Spatial Scales of Application for the Exposure Scenarios

Each exposure scenario is evaluated at the scale of a reach for sediments and at the scale of individual sampling locations for water. Each of the surface water sampling locations has been associated with a reach for combining results into a multimedia assessment (where appropriate). The investigations evaluated in this report have multiple investigation reaches and water sampling locations. The risk assessment does not attempt to integrate exposure across multiple reaches for sediment or across water sampling locations for surface water. By assessing each reach and associated water sampling locations separately, the impacts of local variability in COPC concentrations upon the risk assessment results are preserved.

8.2.4 Toxicity Assessment

This section of the human health risk assessment provides information related to the basis for distinguishing among the three classes of chemicals that are evaluated in this assessment: systemic toxicants (noncarcinogens), chemical carcinogens, and radionuclides. This information provides a context for interpreting the results of the risk assessment, which employs COPC-specific values of toxicity and radiation dose to evaluate potential health impacts.

Using media-specific risk-based screening levels simplifies aspects of the risk assessment in that exposure and toxicity information has been compiled in available guidance documents and reports. The sources for toxicity data used for this risk assessment include NMED and LANL guidance documents and the "Los Alamos and Pueblo Canyon Investigation Report" (LANL 2004, 87390) and its supplement (LANL 2005, 91918). The "Los Alamos and Pueblo Canyon Investigation Report" is used as a source of surface water screening values because there is no guidance document available with such values, and the exposure information provided therein is germane to trail user exposures in other Laboratory canyons. Toxicity information used to develop surface water screening values is also generally consistent with values used in NMED and LANL guidance documents (as discussed below).

Media-specific risk-based screening levels are from seven sources based on COPC type and exposure medium.

- Recreational scenario (trail user) for carcinogens and noncarcinogens
    - Sediment: used the recreational SSLs developed in Laboratory guidance (LANL 2004, 87800)
    - Surface water: used the risk-based concentrations for trail user surface water ingestion and dermal contact developed in the "Los Alamos and Pueblo Canyon Investigation Report" (LANL 2004, 87390, except lead is from LANL 2005, 91918)
- Recreational scenario (trail user) for radionuclides
    - Sediment: used the recreational SALs developed in Laboratory guidance (LANL 2005, 88493)
    - Surface water: used the risk-based concentrations for trail user surface water ingestion developed in the "Los Alamos and Pueblo Canyon Investigation Report" (LANL 2004, 87390)

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- Residential scenario for carcinogens and noncarcinogens
    - Sediment: used the SSLs from NMED guidance (NMED 2006, 92513), except for certain values from EPA Region 6 (EPA 2005, 91002) and EPA Region 9 (epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf)
- Residential scenario for radionuclides
    - Sediment: used the residential SALs developed in Laboratory guidance (LANL 2005, 88493)

Table 8.2-9 provides the compilation of the sediment and surface water media-specific risk-based screening levels and target adverse effect-levels. Comparing the screening values with COPCs for a given risk endpoint provides some information of the relative toxicity of these analytes. Because these risk-based screening values are obtained from references prepared from 2004 to 2006, there is potential for differences in the toxicity values used in the screening level calculations. The slope factors and reference doses were compared with the COPCs listed in Table 8.2-9 among the sources; differences in these toxicity values are summarized in Table 8.2-10. This information will be considered in the uncertainty analysis of this assessment.

8.2.5 Risk Characterization

In this section of the human health risk assessment, information provided in the exposure and toxicity assessments (Sections 8.2.3 and 8.2.4, respectively) is integrated to characterize potential adverse effects. The risk characterization is conducted on the basis of the general principles described in Section 8.0 of the risk assessment guidance for Superfund (EPA 1989, 8021). Potential adverse effects related to noncarcinogens, chemical carcinogens, and radionuclides are discussed in Sections 8.2.5.1, 8.2.5.2, and 8.2.5.3, respectively. The presentation of potential adverse effects focuses on the quantitative expressions of potential impacts. In the uncertainty analysis (Section 8.2.6), the confidence associated with the quantitative risk estimates is discussed through an evaluation of the uncertainties pertaining to each step of the risk assessment process.

This risk assessment employs media-specific risk-based screening levels to evaluate COPCs for potential adverse health effects. COPC intake and toxicity are combined within the screening value calculations; therefore, separate calculations of intake and health effects (cancer risk, hazard, and dose) were not generated. Human health effects were assessed using the ratios of representative concentrations to media-specific risk-based screening levels for each COPC retained in this assessment for each of the exposure scenarios. These ratios were summed for an investigation reach and (when applicable) a water sampling location within the COPC classes of chemical carcinogens, noncarcinogens, and radionuclides (SOFs). A sum of less than 1 indicates that exposure is unlikely to result in an unacceptable cancer risk, hazard, or radiation dose. The SOF values were multiplied by the target effect level (i.e., HI = 1, risk = 1×10^{-5}, or dose = 15 mrem/yr) to provide risk estimates for each COPC class.

For the trail user scenario, exposure to sediment and surface water is evaluated through a multimedia sum. For COPCs with a common target adverse effect level (e.g., all carcinogens are based on 1×10^{-5} incremental cancer risk), the multimedia sum can be converted into an approximate effect level. Carcinogen and noncarcinogen screening levels are based on a common adverse effect level across sediment and surface water, but the radionuclide adverse effect levels are not the same for sediment (15 mrem/yr) and surface water (4 mrem/yr).

The trail user scenario multimedia sums and the risk values for noncarcinogens, carcinogens, and radionuclides based on 95% UCLs are summarized in Table 8.2-11. Most of the carcinogen and

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radionuclide multimedia sums are similar to the sediment risk values, which indicate that there is greater potential for effects from the sediment concentrations and exposure pathways than from surface water. For noncarcinogens, this observation is reversed for many reaches: the multimedia sum is similar to the surface water risk values. There is one reach where the multimedia sum and the sediment risk values are greater than the target risk level for the trail user scenario: radionuclide dose in reach E-1E.

Table 8.2-12 presents the COPC and reach-specific recreational risk values for sediment; Table 8.2-13 presents the COPC and reach-specific recreational risk values for surface water. The representative concentrations for sediment are presented in Table 8.2-14; the representative concentrations for surface water are presented in Table 8.2-15. Results for the supplemental exposure scenario (residential) are provided in Tables E-3.5-2 and E-3.5-3.

8.2.5.1 Noncarcinogenic Effects

Chemical hazard for an individual chemical is commonly defined by the HQ, which is calculated as the ratio of the chemical intake to the reference dose (RfD) for that chemical. An HQ greater than 1 is indicative of the potential for adverse effects; therefore, an HQ of 1 was used in the calculation of screening values for noncarcinogenic effects. When the potentially additive effects of two or more chemicals are considered, HQs may be summed to generate an HI. However, summing of chemical HQs to create an HI assumes that the target organs and mechanisms of toxicity are similar. The SOF_{nc} values in this human health risk assessment are functionally equivalent to generating an HI. The protective approach of summing these ratios does not warrant refinement because the HI values are in all cases well below 1.0.

The four largest HI values for the trail user scenario were between 0.4 and 0.7 (Table 8.2-11) and related mostly to the potential for adverse effects from lead in surface water (reaches M-1W and TS-1C; Table 8.2-13) or aluminum and iron in sediment (reaches M-1E and E-1FW; Table 8.2-13). The HI was between 0.1 and 0.4 in four other reaches (E-1W, E-1E, M-2W, and TS-2E) with the key contributors to these noncarcinogenic sums being aluminum, arsenic, iron, and manganese in sediment and lead and perchlorate in surface water.

8.2.5.2 Carcinogenic Effects

Cancer risk for an individual chemical is defined by the incremental cancer risk (ICR), which is calculated as the product of exposure to a single chemical and the cancer slope factor (SF) for that chemical. ICRs for each exposure route and chemical are then summed to calculate the total ICR to an individual. A target risk level of 1×10^{-5} was used in this human health risk assessment to calculate risk-based concentrations for carcinogenic effects (NMED 2006, 92513). Lifetime cancer risk is considered to be additive over time; childhood and adulthood exposures are summed to calculate the ICR.

The potential risk from carcinogens was evaluated in 12 investigation reaches, and the range of sediment or multimedia ICR for the trail user scenario was from 8×10^{-7} to 6×10^{-6} (Table 8.2-7). The maximum ICR (6×10^{-6}) was calculated for reach M-1W. The primary contributors to the ICR in these reaches from sediment were arsenic and PAHs (Table 8.2-12). Carcinogenic COPCs were not significant contributors to the ICR for trail users from surface water exposure.

8.2.5.3 Radiation Dose

The radiation dose associated with the EPA dose conversion factors (DCFs) used in the human health risk assessment is the annual committed effective dose equivalent (internal) or annual effective dose

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equivalent (external), expressed in units of millirems per year. The target dose limit used for calculating media-specific risk-based screening levels related to soil pathways is 15 mrem/yr, which is consistent with guidance from DOE (DOE-AL 2000, 67153). For water-based exposure pathways, media-specific risk-based screening levels were calculated using a target dose limit of 4 mrem/yr. Use of this more protective dose limit for water pathways is based on the radiation dose limit for a public drinking water supply in DOE Order 5400.5, "Radiation Protection of the Public and the Environment." Consistent with EPA guidance (EPA 1989, 8021), dose through dermal absorption is not quantified because it is probably negligible compared with the other exposure pathways.

The potential risk from radionuclides in sediment was evaluated in 12 reaches; the potential risk from radionuclides in surface water was evaluated in four reaches, and multimedia sums were also calculated in these four reaches. The range of sediment or multimedia radionuclide dose was from 0.01 to 44 mrem/yr; the range of surface water radionuclide dose was from 0.04 to 0.3 mrem/yr (Table 8.2-11). One reach had a radionuclide dose value for the trail user scenario greater than 15 mrem/yr: reach E-1E had a multimedia dose of 44 mrem/yr. Americium-241, cesium-137, plutonium-238, and plutonium-239,240 contributed more than 99% of the dose from radionuclide sediment COPCs for all reaches except TS-1C (Table 8.2-8). In reach TS-1C, thorium-228, thorium-230, and thorium-232 contributed approximately 59% of the radionuclide dose from sediment. Approximately 80% of the dose in reach E-1E from sediment was from cesium-137.

8.2.6 Uncertainty Analysis

The uncertainty analysis uses qualitative and semiquantitative information to evaluate the uncertainty associated with the risk, hazard, and dose estimates described in Section 8.2.5. This uncertainty analysis pertains to the results of the trail user scenario. The uncertainty analysis is organized according to the major aspects of the human health risk assessment: data collection and evaluation (Section 8.2.6.1), exposure assessment (Section 8.2.6.2), and toxicity assessment (Section 8.2.6.3).

8.2.6.1 Data Collection and Evaluation

All analytes that were identified as COPCs in Section 6 were retained for evaluation in the human health risk assessment. COPCs that were retained for calculation of representative concentrations were those that had ratios greater than 0.1 for endpoints with SOF values greater than 1 for the residential screen. Thus, the analytes retained represent an inclusive list of potential human health risk drivers.

No BVs are available for surface water. The inability to distinguish COPCs in surface water based on comparisons with background concentrations is a substantial source of uncertainty in the results of the human health risk assessment for this media. For example, concentrations of arsenic and iron in surface water, which contribute to HI, could be associated with local background and not with releases from Laboratory SWMUs or AOCs.

Overestimating representative concentrations for investigation reaches is another potential source of uncertainty. Five approaches were used to minimize that possibility. First, the emphasis of the geomorphic characterization and sediment sampling was to identify and sample post-1942 sediment deposits, which focuses sampling on potentially contaminated areas. The process of characterizing reaches and focusing sampling is discussed further in Section 4.1 and Section B-1 of Appendix B. Second, the canyon bottoms include other geomorphic units that are not impacted or are only minimally impacted by Laboratory releases. Samples from these other geomorphic units were not included in the area-weighted and volume-weighted averages to provide more protective estimates of COPC concentrations for use in the human health risk assessment. Third, 95% UCLs on the area-weighted

average sediment concentrations were employed as representative concentrations to minimize the chance of underestimating representative concentrations in a reach. Fourth, it was assumed that exposure in most geomorphic units for the trail user scenario was entirely caused by fine facies sediment deposits where concentrations are generally highest, as discussed in Section 7.1, excluding data from coarse facies sediment deposits where concentrations are generally lower. Fifth, for radionuclides, no correction was made for radioactive decay since the time of sampling, although present-day concentrations are lower than at the time of sampling for some key radionuclides. For example, the maximum concentration of cesium-137 measured in the Mortandad watershed was in a sample collected from reach E-1E in 1998, and concentrations in 2006 when this report was written would be about 17% lower in that sediment layer due to radioactive decay. Accounting for radiological decay would decrease the calculated dose in reach E-1E from 44 mrem/yr to approximately 38 mrem/yr.

A similar uncertainty exists for estimating representative concentrations for water sampling locations. COPC concentrations often change with hydrologic conditions and can either increase or decrease seasonally or related to effluent discharges. The data evaluated in this assessment represent a snapshot of the current hydrological conditions and generally reflects a range of hydrologic conditions at each sampling location. As discussed in Section 7.2.1 and Appendix B, Section B-2, sampling occurred during a range of water-level conditions and field parameters, such as pH and dissolved oxygen. The representative concentrations calculated from these data represent the range of COPC concentrations at the sampling locations. Using the 95% UCL on the average minimizes the chance of underestimating the representative concentrations for a sampling location.

8.2.6.2 Exposure Assessment

Uncertainty pertaining to exposure parameters was addressed in the human health risk assessment by using RME estimates for several exposure parameters (see Appendix E-3). The use of RME assumptions, coupled with upper-bound estimates of the average concentration of COPCs in sediment, is intended to produce a protective bias in the risk calculations. The results of the risk assessment, discussed in Section 8.2.5, include a description of the key COPCs and exposure pathways associated with potential health impacts. This evaluation of uncertainty in exposure is focused on these COPCs and pathways.

Key exposure pathways for contaminated sediments across hazard, ICR, and dose for the trail user exposure scenario include dermal absorption, incidental soil ingestion, and external irradiation. A common source of protective bias in the exposure assessment for these pathways is that the entire 1-h daily exposure time defined for the trail user scenario is spent on contaminated sediment deposits within a reach. To the extent that time may be spent in other canyon areas such as uncontaminated stream terraces, colluvial slopes, or bedrock areas during recreational activities, exposure to contaminated sediment deposits is overestimated.

The assessment also includes no consideration of the current signage in the canyon, which reads "No Trespassing: Access to Mortandad Canyon is Restricted to Workers on Official Business." In addition, the area at the head of reach E-1E at the TA-50 RLWTF outfall is posted as "Caution: Soil Contamination Area." Because each reach is treated equally from an exposure perspective, no consideration is made regarding ease of access or land area available for recreation. For example, reach E-1E has the highest estimated radionuclide dose (44 mrem/yr for the trail user scenario), but it is one of the shortest, narrowest, and roughest reaches in the Mortandad watershed and has no developed trails or other features that attract trail users. Reach E-1E is also in a part of the Laboratory with access controls and access requirements and has signs that discourage the specific recreational activity being assessed. In addition, the estimated dose of 44 mrem/yr is below the 100 mrem/yr dose limit established by DOE for

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radiation workers, indicating that trained workers conducting environmental or other work in this area would not be expected to exceed dose limits for these specific and occasional activities. As a further point of comparison, dose to the trail user would be less than 15 mrem/yr if 50 h/yr was spent in reach E-1E (instead of the 200 h//yr assumed for the trail user).

For both carcinogens and radionuclides, the exposure assessment should be evaluating incremental exposures that are greater than background. Representative concentrations are calculated that include background concentrations. For the most part, background exposures are likely negligible with the exception of some metals in sediment and surface water (e.g., arsenic) and do not lead to overestimating risk or dose.

Dermal contact with sediments and incidental soil ingestion exposure pathways each have a second exposure characteristic in addition to time spent on-site that was biased in a protective manner. The soil adherence factors that were used to define soil loading on skin for children and adults are both protectively biased. The adult adherence factor is based on a high-exposure activity (gardening) that probably would result in greater exposure than would be the case during trail use. Adult soil ingestion was assumed to be 100 mg/d, which is twice the EPA-recommended value for adults (EPA 1997, 66596).

Radionuclides in reach E-1E represent the greatest potential for risk for adult trail users, and the largest fraction of dose is related to external gamma radiation from cesium-137. Because external gamma radiation is the main contributor to radionuclide dose, the assessment should also be protective of child exposures because behaviors that increase child exposure through some pathways (incidental soil ingestion and dermal contact) play basically no role in external gamma dose.

Exposure related to external irradiation from soil is primarily a function of time spent on-site. However, the external DCFs used in the calculation of external dose protectively assume an effectively infinite area and depth of contamination. The contaminated sediments in reach E-1E, where external irradiation was an important contributor to trail user dose, are approximately 200 m long and average 3 m in width and less than 1 m in depth. The calculated dose through external irradiation from cesium-137, assuming an infinite source, would likely be twice as large as would actually be the case given the described source geometry of reach E-1E. Actual external irradiation received during recreational activities would probably be lower, assuming that receptors are not consistently in the center of the contaminated area.

An important aspect of uncertainty in exposure to COPCs in surface water relates to exposure intensity. Dermal contact and surface water ingestion were assumed to occur 20 times per year for 30 years (trail user). There is no empirical basis for this assumption, which was developed to bound a high-end exposure condition. Potential contact by adults with surface water in the Mortandad watershed would be highly intermittent at some locations based on the limited availability of water. It is also unlikely that a Laboratory employee would be drinking surface water, which is in some cases nonpotable effluent.

8.2.6.3 Toxicity Assessment

The evaluation of uncertainty pertaining to the toxicity assessment focuses primarily on the toxicology of cesium-137 because this COPC was primarily responsible for the calculated radionuclide dose to be greater than 15 mrem/yr in one reach. Nearly all of the dose for cesium-137 for the trail user scenario is associated with external gamma radiation (LANL 2005, 88493, Table A-2, p. A-2). The main uncertainties associated with the external radiation DCF relate to the geometry of the source and the receptor. Uncertainties associated with the source term were discussed in Section 8.2.6.2.

Table 8.2-10 provides a summary of the COPCs where the reference dose or SF values differ between various sources used in this assessment. The toxicity values used by NMED or EPA Region 6 are

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basically the same, but these values differ from the sources used in Laboratory guidance or reports. For barium, copper, and manganese, the Laboratory toxicity values were more protective. There are three cases where the values used by NMED are more protective and the impact on the assessment for these analytes is considered.

- *Aroclor-1254*: The inhalation cancer risk slope factor used by NMED is 6 times more protective than the Laboratory value. However, the inhalation pathway is orders of magnitude less important than soil ingestion from an exposure perspective, so this difference in the inhalation cancer slope would not change the estimated risks from Aroclor-1254.
- *Thallium*: The oral reference dose used by NMED is about 20% lower (more protective) than the Laboratory value. This level of difference in thallium toxicity would not change any of the noncarcinogen assessments because the largest ratio for thallium was 0.003.
- *Vanadium*: The oral reference dose used by NMED is 7 times lower (more protective) than the Laboratory value. This level of difference in vanadium toxicity would not change any of the noncarcinogen assessments because the largest ratio for vanadium was 0.004.

8.2.7 Summary of the Human Health Risk Assessment

The health effects associated with COPCs in the Mortandad watershed were assessed relative to a radiological dose criterion of 15 mrem/yr for sediment and 4 mrem/yr for water, a chemical cancer risk criterion of 1×10^{-5}, and a chemical hazard criterion of 1.0. The risk assessment results are below these thresholds for the trail user with one exception. The calculated radionuclide dose for reach E-1E was 44 mrem/yr, and this was almost entirely related to sediment COPCs and primarily related to external gamma radiation from cesium-137.

The sediment radionuclide dose corresponds to a radiological risk of approximately 2×10^{-4} based on risk-based recreational radionuclide SALs. Radiological risks from surface water in reach E-1E will be negligible as sediment contributed about 99.4% of the dose. Radiological risks from sediments for reaches M-2W, M-2E, and M-3 were 2×10^{-5} to 3×10^{-5}, and radiological risks in other reaches ranged from 2×10^{-8} to 9×10^{-6}.

The nonsuitability of E-1E for traditional trail use and access restrictions in this part of the Laboratory, combined with conservatism included in the risk assessment, indicates that it is unlikely that actual recreational users of the Mortandad watershed would receive a dose exceeding 15 mrem/yr. Surface water risk results are below all adverse effect levels.

9.0 CONCLUSIONS AND RECOMMENDATIONS

Investigations of sediment, surface water, and groundwater in the Mortandad watershed indicate that inorganic, organic, and radionuclide COPCs are present in these media at concentrations above screening levels and federal and/or state groundwater standards. These COPCs are derived from several sources, including Laboratory SWMUs and AOCs, runoff from developed areas, and natural sources such as noncontaminated soils, sediments, and bedrock.

The spatial distribution of contaminants in the Mortandad watershed, supported by effluent discharge data, indicates that the TA-50 RLWTF outfall into Effluent Canyon, which has been active since 1963, is the most important source of contamination with respect to potential human health risk and groundwater impacts. Source areas for Laboratory-derived COPECs that are most important in the assessment of potential ecological risk include TA-48 outfalls into the head of Effluent Canyon and into Mortandad

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Canyon, the TA-50 RLWTF outfall, and additional releases from TA-50 or TA-35 into the head of Ten Site Canyon. The impacts of additional Laboratory sources (e.g., outfalls from the former TA-35 WWTP, wastewater lagoons, and filter beds) are indicated by the characterization data, although the concentrations, extent, and inventory of COPCs from these sources are generally minor compared with the sources listed above.

Contaminants in sediment that were originally released from the TA-50 RLWTF outfall are largely or entirely restricted to approximately 4 km (2.5 mi) of canyon bottom downcanyon from the outfall. The COPCs in alluvial groundwater derived from the RLWTF outfall are also restricted to this area. The infiltration of stormwater into alluvium, particularly upcanyon from the Mortandad–Ten Site Canyon confluence, results in a complete loss of surface water in most runoff events and deposition of contaminated sediment. The most important sediment deposition area is in the 0.6 km (0.4 mi) of canyon bottom west of the confluence (reach M-3E), and approximately 50% of the inventory of most radionuclides in sediments occurs there. No floods have been recorded crossing the Laboratory-San Ildefonso Pueblo boundary since RLWTF discharges began in 1963, and only one event before 1963 is recorded as having reached the Laboratory boundary in August 1952. Construction of the current sediment traps in Mortandad Canyon east of the Ten Site Canyon confluence in 1986 enhanced a process of infiltration and sediment deposition that was occurring previously.

Contaminant concentrations in sediment, surface water, and alluvial groundwater in the Mortandad watershed have generally decreased over time, indicating that the initial SWMU and AOC sources are no longer major contributors to contamination in canyons media. The canyon bottom sediment deposits contain the largest inventory of adsorbed contaminants that are susceptible to remobilization and transport in floods and are now the primary source for ongoing surface water and alluvial groundwater contamination. Therefore, any future efforts that may be required to address contaminants in canyons media should address the current distribution of contaminants in sediment and associated groundwater rather than in the original source areas.

In contrast, contaminant concentrations in deeper perched-intermediate or regional groundwater have increased over time, indicating the migration of mobile constituents through the vadose zone and into deeper zones of saturation. Vadose-zone pore-water concentration profiles indicate that these mobile contaminants have percolated in the subsurface. Currently, the majority of the mass of the nonsorbing contaminants—nitrate, perchlorate, and tritium—is located within the vadose zone, particularly beneath the area near and east of the confluence of Mortandad and Ten Site Canyons. Chromium is present in the regional aquifer in one characterization well (R-28) above groundwater standards; chromium, nitrate, perchlorate, and tritium have been measured above groundwater standards in perched intermediate-depth groundwater in one or more wells. Iron and manganese have also been measured above drinking water standards in regional groundwater in one well (R-14) and nickel in another well (R-33), although available data indicate that these results represent naturally occurring constituents and not Laboratory-derived contamination. Additional evaluations will be necessary to further understand contamination in intermediate-depth and regional groundwater and to consider potential remedial actions. A more detailed evaluation of chromium contamination in groundwater is currently in progress (LANL 2006, 91987) and will be available in an interim measures report scheduled for completion in November 2006.

Many organic, inorganic, and radionuclide COPECs have been identified in the ecological screening assessments; subsequently, a plan for a base line ecological risk assessment was developed. This process is based upon the eight-step EPA ecological risk assessment guidance for Superfund (EPA 1997, 59370). The base line ecological risk assessment evaluated evidence of ecological risks from COPECs to omnivorous mammals, insect-eating birds, plants, earthworms, aquatic invertebrates, algae, and two T&E species: the Mexican spotted owl and the southwestern willow flycatcher. The multiple lines

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of evidence did not identify adverse effects to terrestrial or aquatic receptors that currently inhabit the watershed. Therefore, no mitigation is necessary.

The site-specific human health risk assessment uses a trail user exposure scenario to represent the present-day and reasonably foreseeable future land use in canyons throughout the Mortandad watershed. The assessment results indicate that for the trail user scenario, no areas in the Mortandad watershed have contaminant concentrations greater than levels acceptable for noncarcinogens (HI of 1) or carcinogens (incremental cancer risk criterion of 1×10^{-5}) in sediment or water. However, the radionuclide dose for one area, reach E-1E in Effluent Canyon downcanyon from the TA-50 RLWTF outfall, exceeds the target dose limit of 15 mrem/yr. The calculated dose for reach E-1E, 52 mrem/yr (corresponding to a radiological risk of approximately 2×10^{-4}), is primarily related to external gamma radiation from cesium-137 in sediment. The radionuclide dose limit of 4 mrem/yr in water was not exceeded at any location.

As discussed in Section 8.2.6, reach E-1E is a short, steep, and rocky area that has no developed trail within the contaminated area, and it is unlikely that recreational users of the Mortandad watershed use this reach as much as assumed in the trail user scenario (1 h/d and 200 d/yr). Other protectively biased assumptions are incorporated into the exposure assessment, also contributing to an overestimate of potential dose. In addition, the area is currently posted as a "soil contamination area," and posting also states that "access is restricted to workers on official business," further discouraging recreational use in reach E-1E. Therefore, no remedial action is proposed to reduce the potential radiation dose to recreational users of Effluent Canyon, although it is recommended that appropriate posting be maintained.

Evaluations of the changes in COPC concentrations over time for sediment, surface water, and alluvial groundwater indicate that concentrations are either relatively stable or are decreasing for contaminants derived from Laboratory SWMUs or AOCs. These decreases are associated with processes that remobilize, transport, and dilute sediment- and waterborne constituents. Radioactive decay also contributes to decreasing concentrations for some radionuclides (e.g., cesium-137, strontium-90, and tritium). Therefore, the potential for impacts to human health or ecosystems from Laboratory-derived contaminants in these media is expected to continue to decrease in the absence of new sources.

Potential future changes in the vadose-zone contamination and concentrations of contaminants in perched-intermediate and regional groundwater are less well constrained, and a corrective measures evaluation (CME) is necessary to assess the need for remedial actions. The CME will assess the fate of the contaminant mass in the vadose zone and impacts to the regional groundwater where water-supply wells are located. A more detailed evaluation of chromium contamination in groundwater is currently in progress and will be addressed in pending reports to the NMED. Monitoring in the Mortandad watershed will continue through the proposed CME process and is described in the Interim Facility-Wide Groundwater Monitoring Plan.

In summary, the results of this investigation indicate that human health risks are acceptable for present-day and foreseeable future land uses, assuming that recreational use of Effluent Canyon below the TA-50 RLWTF outfall continues to be discouraged. In addition, no adverse ecological effects were observed within terrestrial and aquatic systems in the Mortandad watershed. Therefore, corrective actions are not needed to mitigate unacceptable risks. However, a CME is proposed to address contamination in groundwater.

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10.0 REFERENCES

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Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

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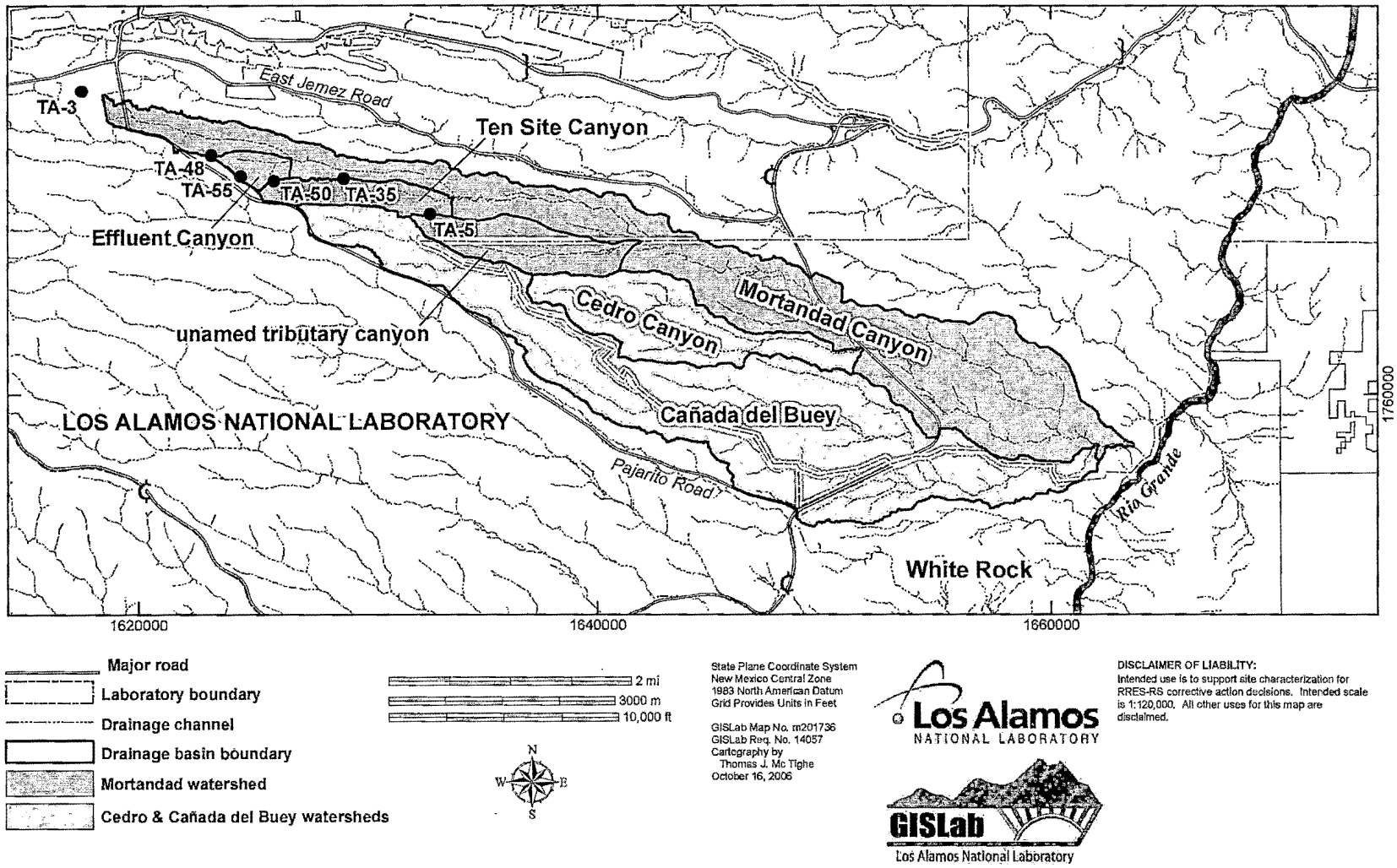


Figure 1.1-1. Map of the Mortandad Canyon watershed, showing major subbasins

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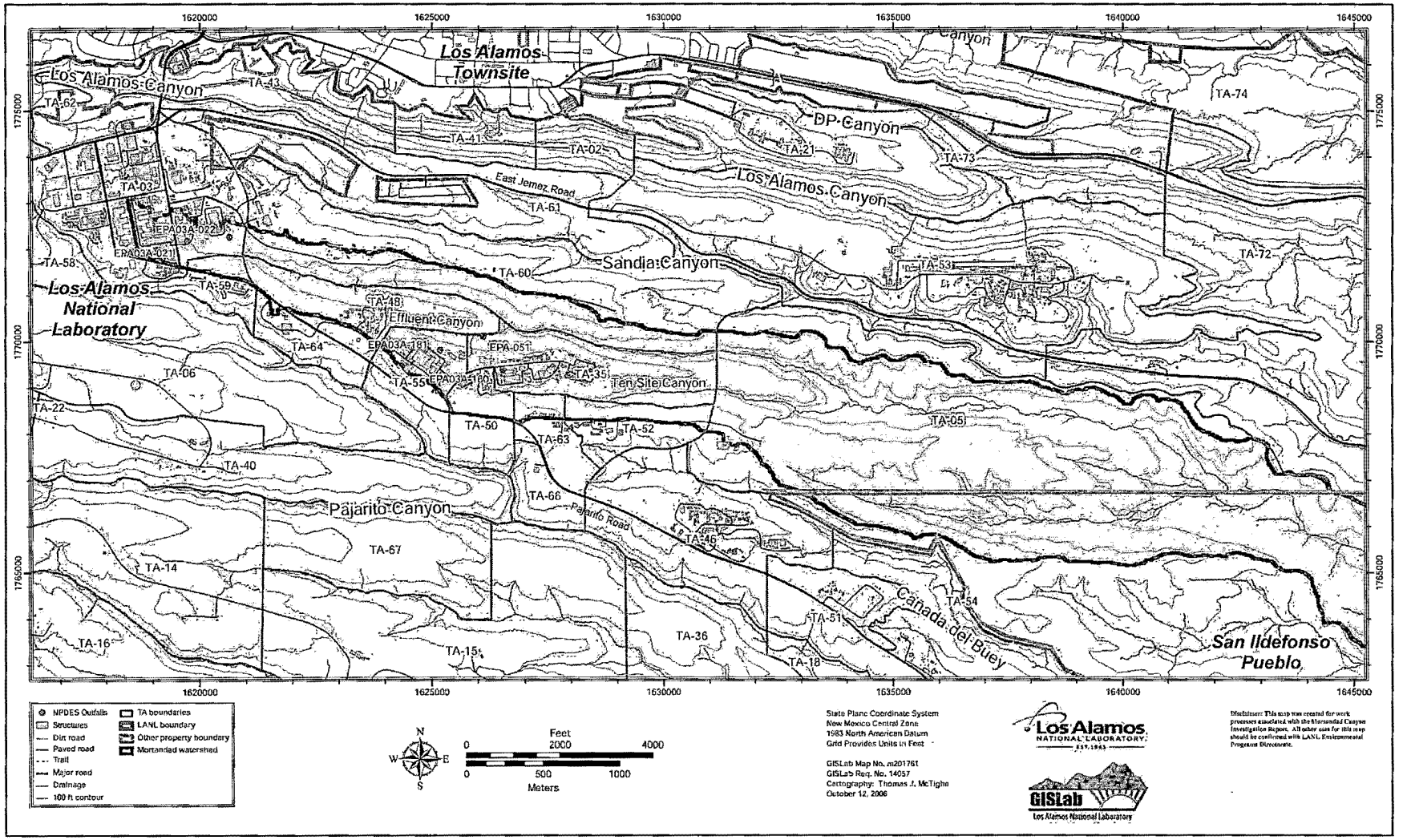


Figure 1.1-2. Mortandad watershed, showing TA boundaries and active NPDES outfalls

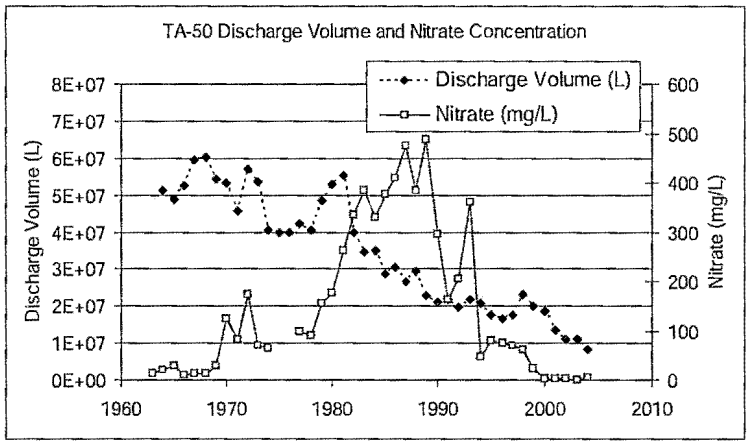


Figure 2.1-1. Historical discharge volumes (L/yr) and outfall nitrate concentrations (mg/L as N) for the TA-50 RLTWF, NPDES EPA-051

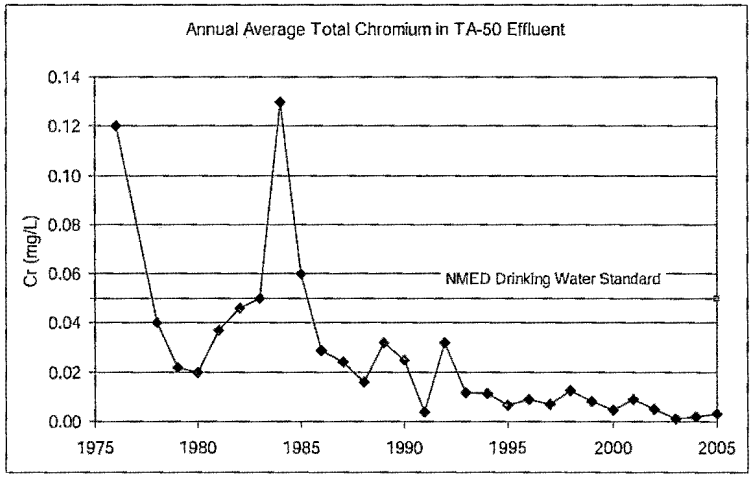


Figure 2.1-2. Historical outfall total chromium concentrations for the TA-50 RLTWF, NPDES EPA-051

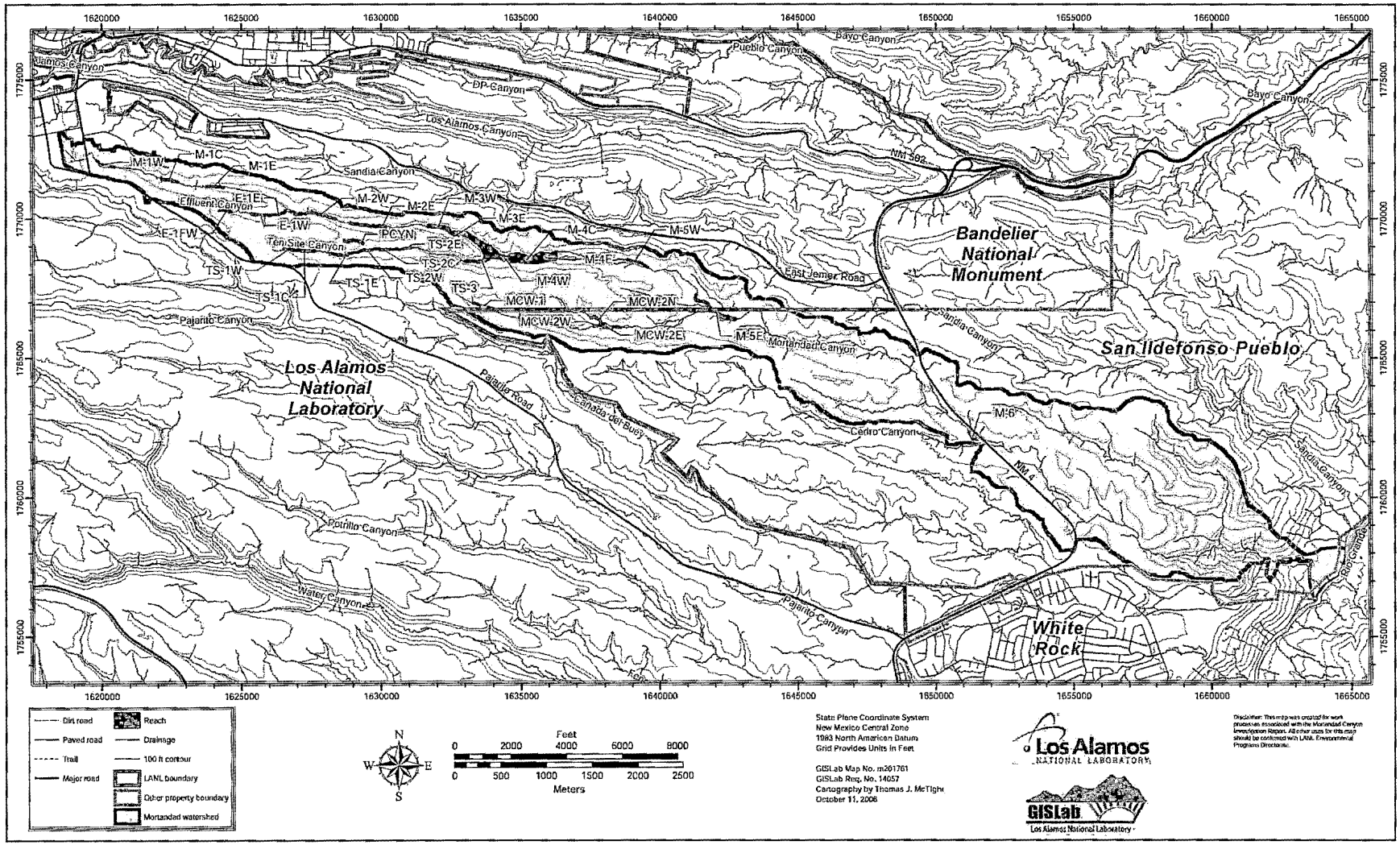


Figure 3.1-1. Reaches in the Mortandad watershed

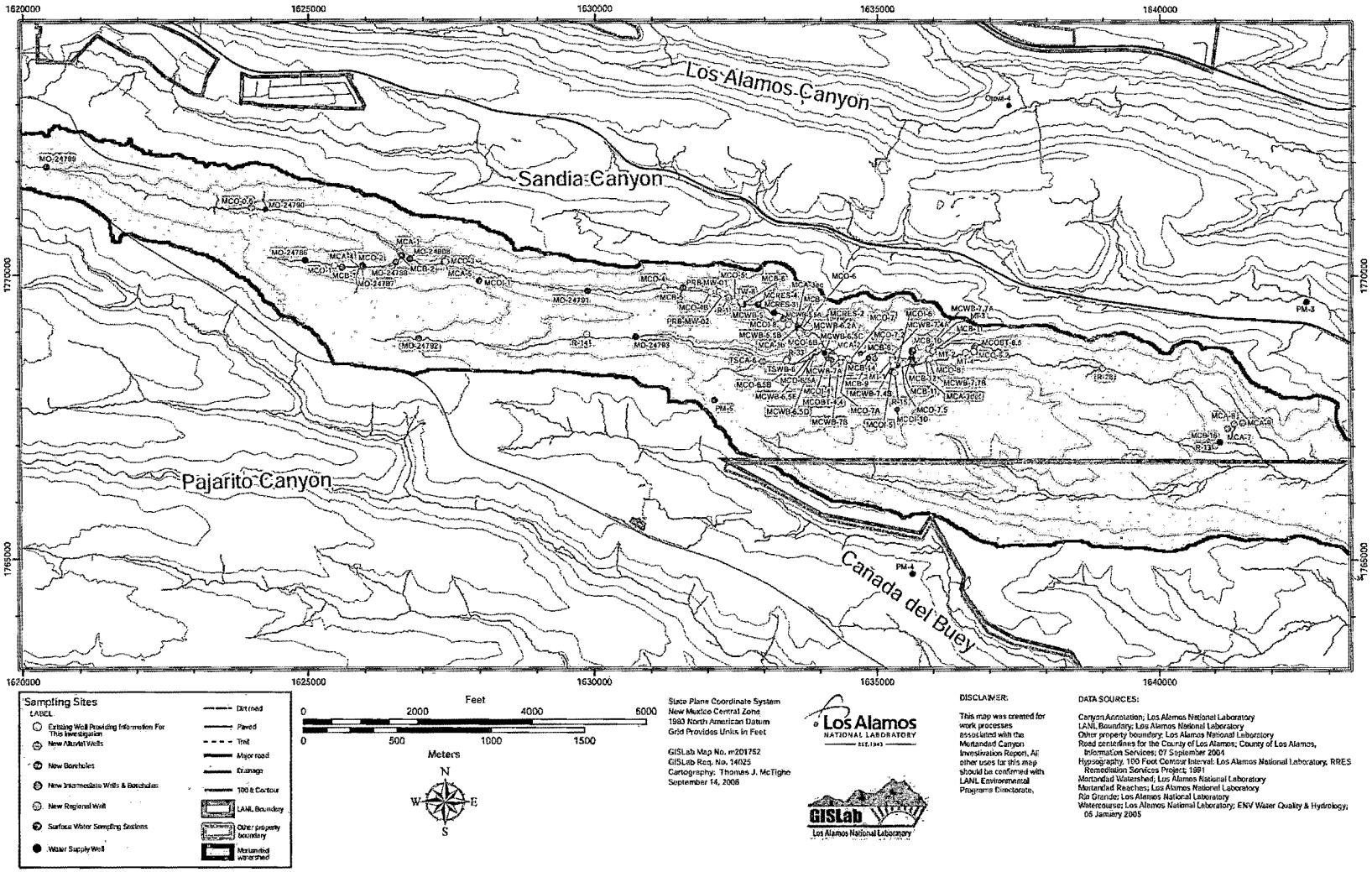


Figure 3.2-1. Water-sampling locations in the Mortandad watershed

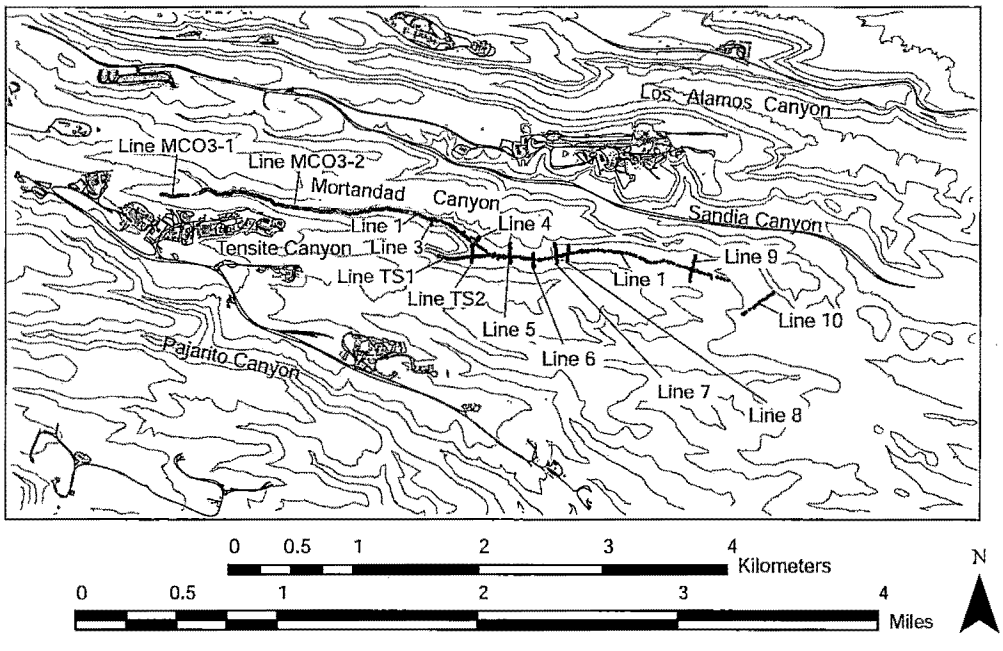


Figure 4.2-1. Locations of Surface-Based Direct-Current Resistivity Lines Collected by Geophex, Inc. in Mortandad Canyon

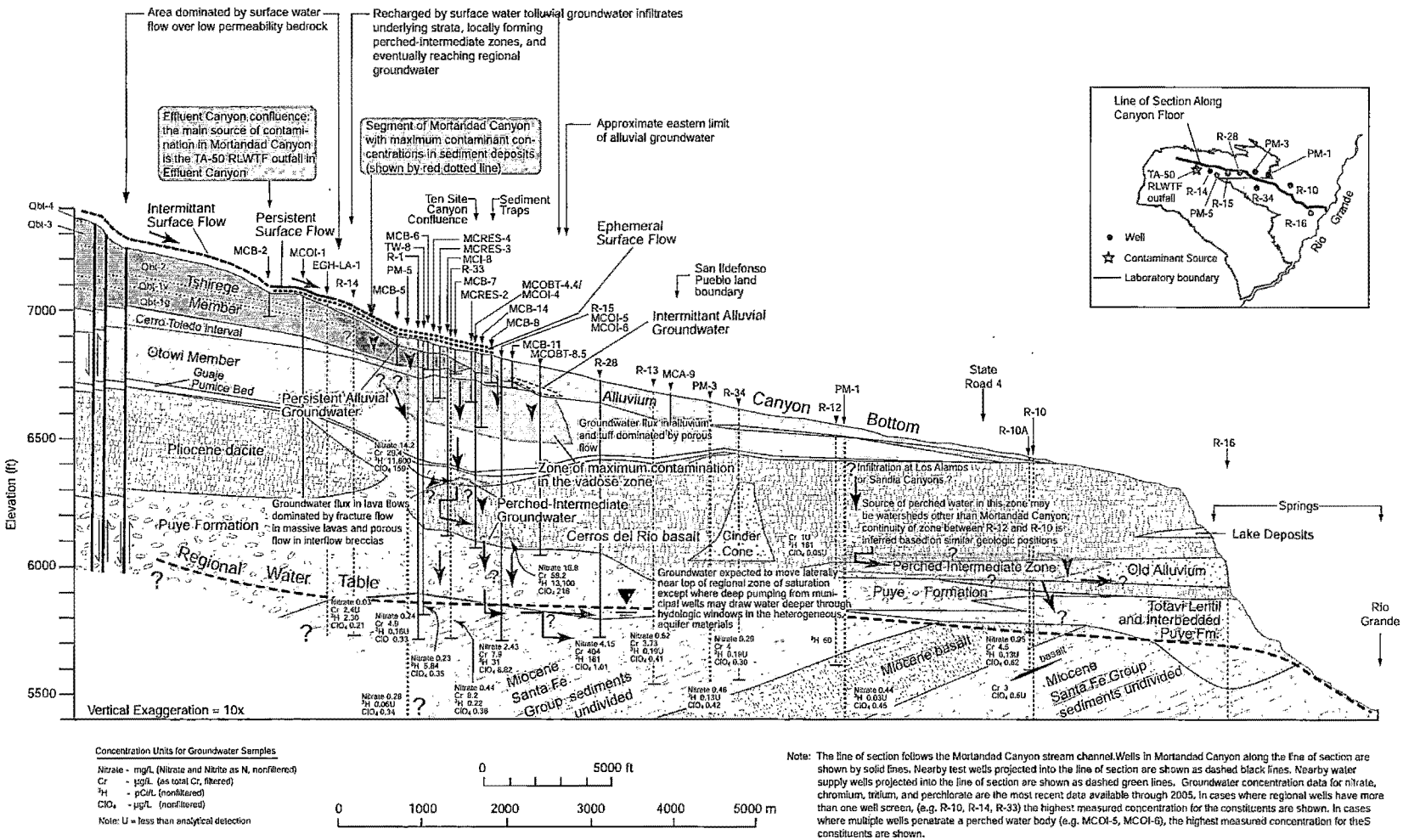


Figure 7.0-1. Conceptual hydrogeologic cross section showing potential contaminant transport pathways and the most recent concentration data through 2005 for selected contaminants in groundwater

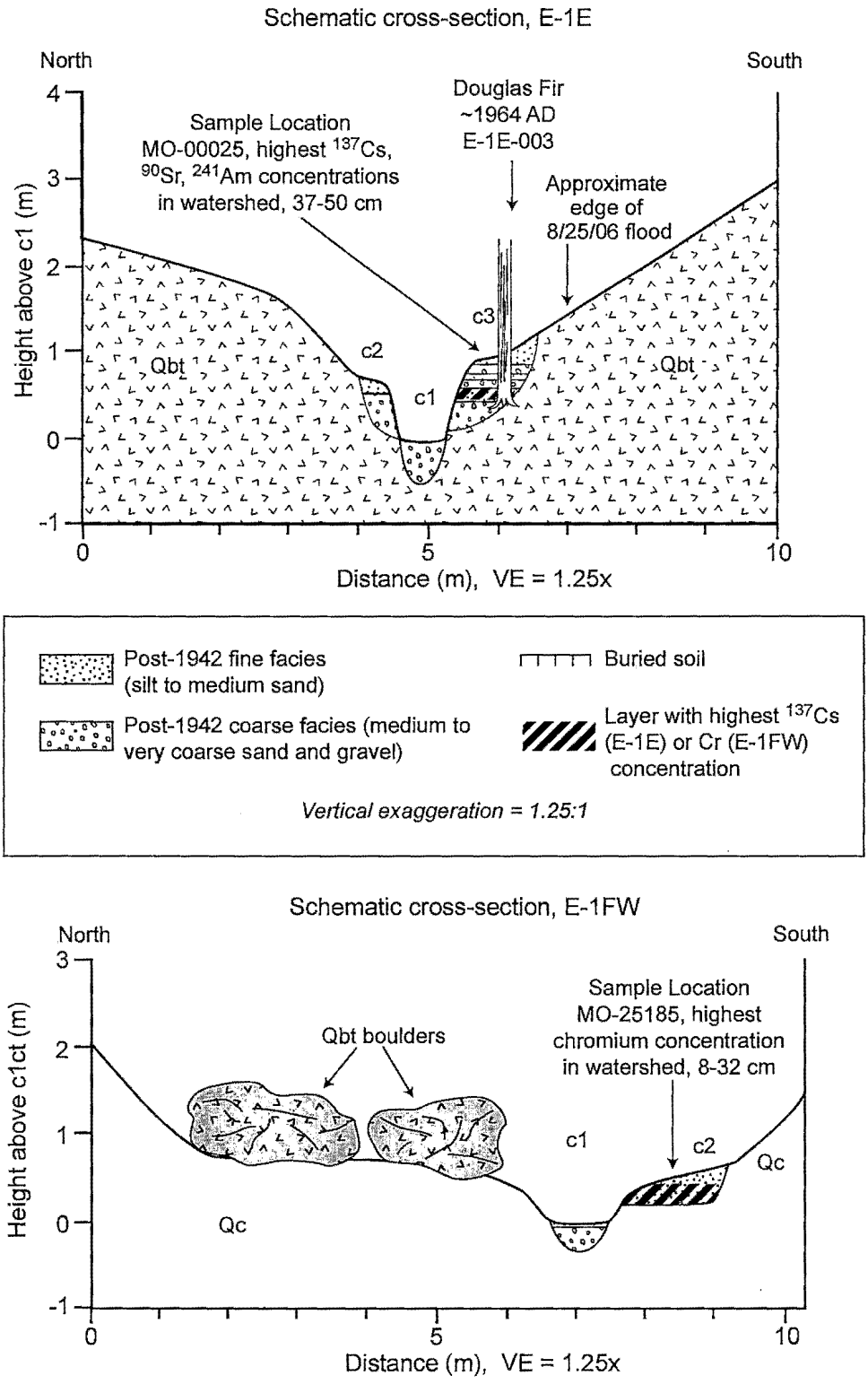


Figure 7.1-1. Schematic cross sections showing post-1942 coarse facies and fine facies sediment deposits in reaches E-1FW and E-1E

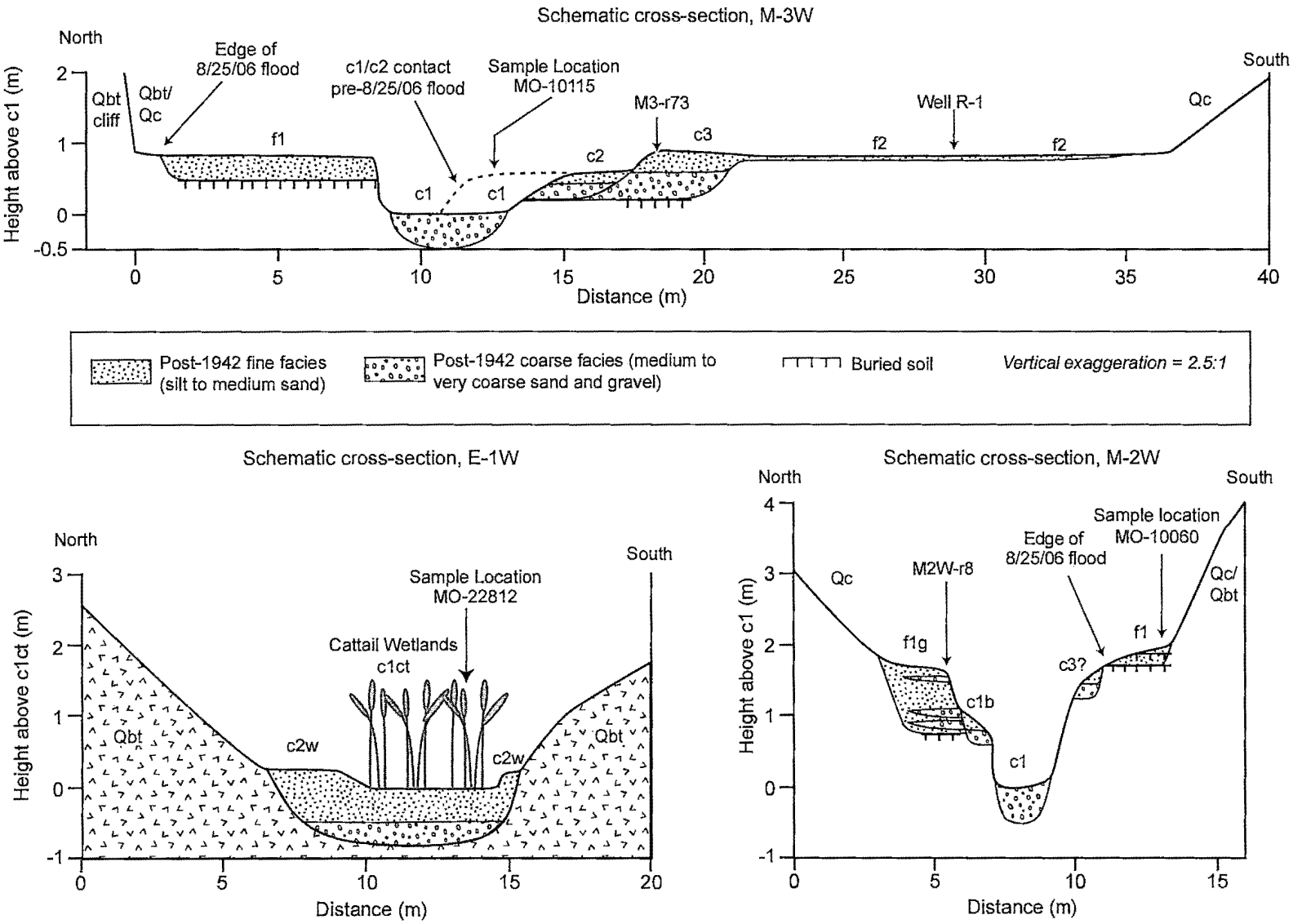


Figure 7.1-2. Schematic cross sections showing post-1942 coarse facies and fine facies sediment deposits in reaches E-1W, M-2W, and M-3W

09521

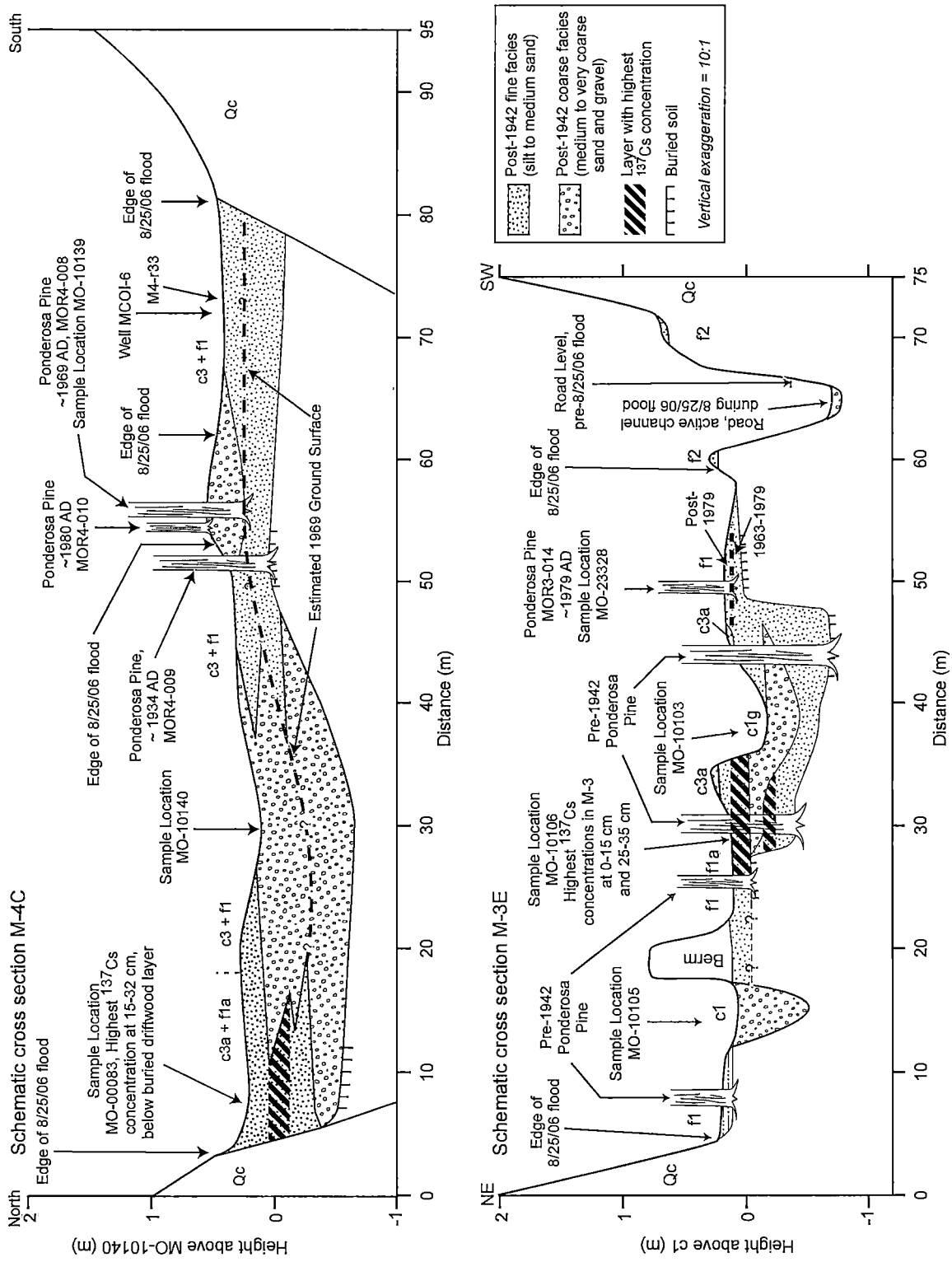


Figure 7.1-3. Schematic cross sections showing post-1942 coarse facies and fine facies sediment deposits in reaches M-3E and M-4C

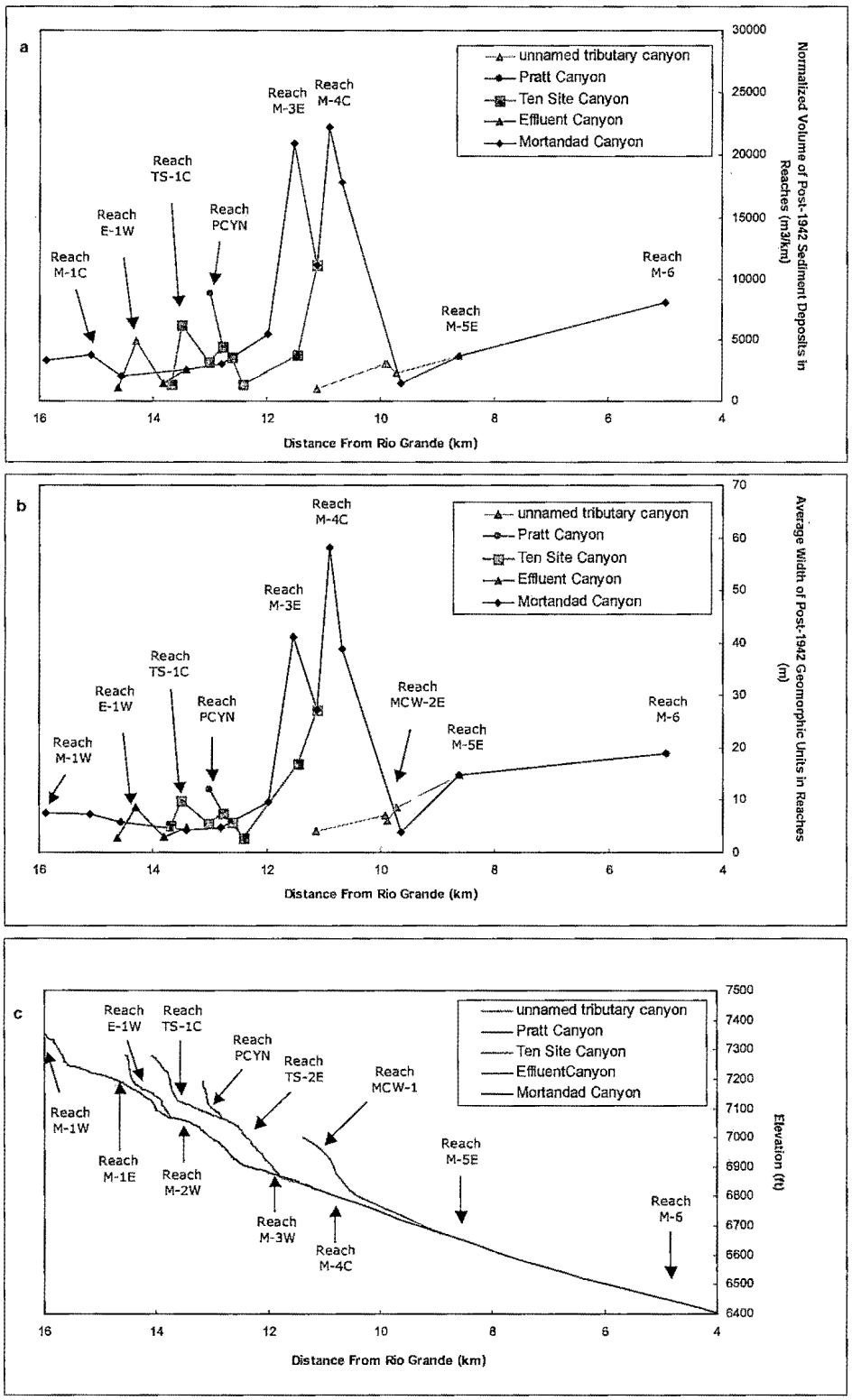


Figure 7.1-4. Longitudinal variations in normalized volume (a in units of m^3/km) and width, (b) of post-1942 sediment and geomorphic units, and stream profiles, and (c) in the Mortandad watershed

: 07623

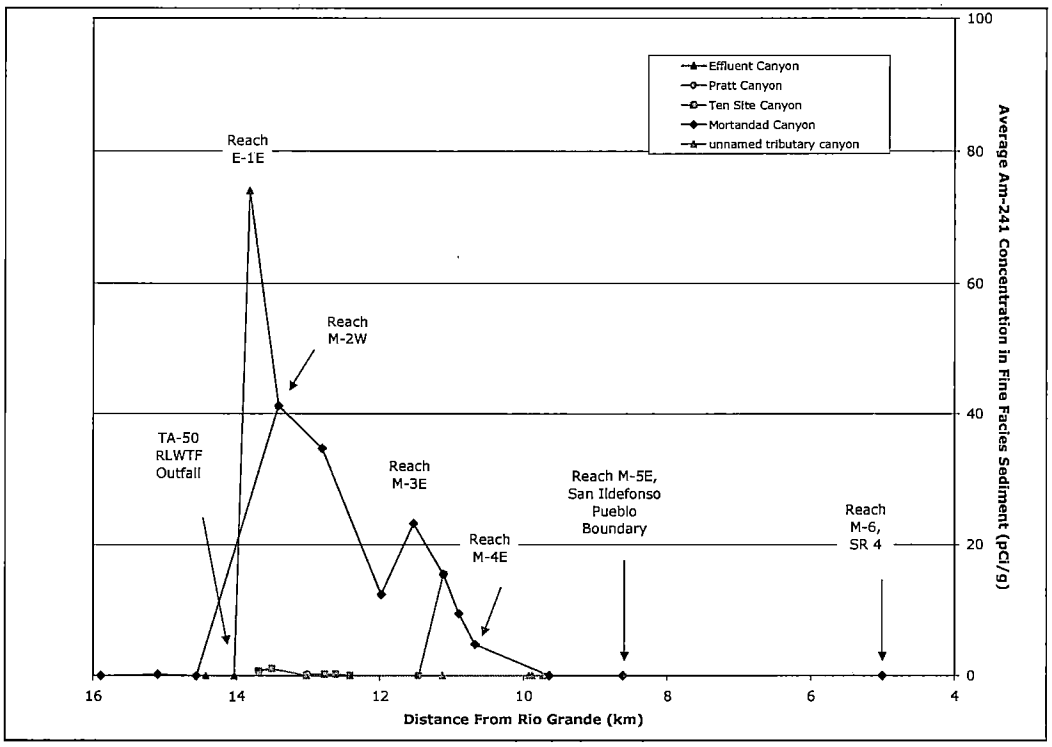


Figure 7.1-5. Estimated average concentrations of americium-241 in fine facies sediment in the Mortandad watershed

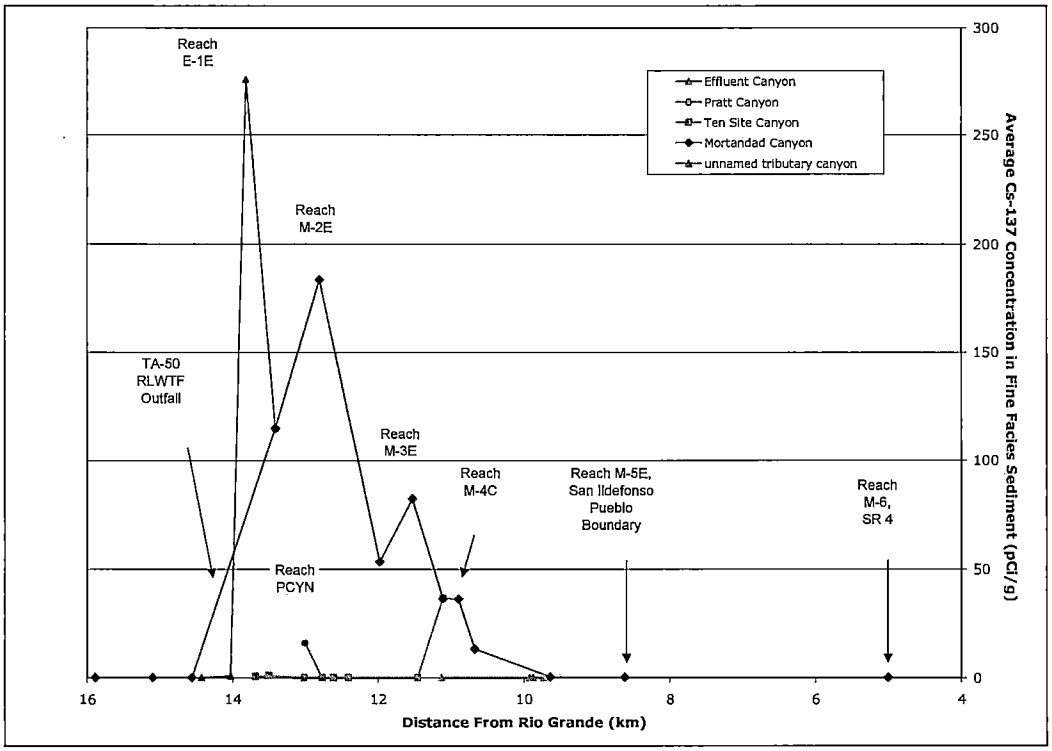


Figure 7.1-6. Estimated average concentrations of cesium-137 in fine facies sediment in the Mortandad watershed

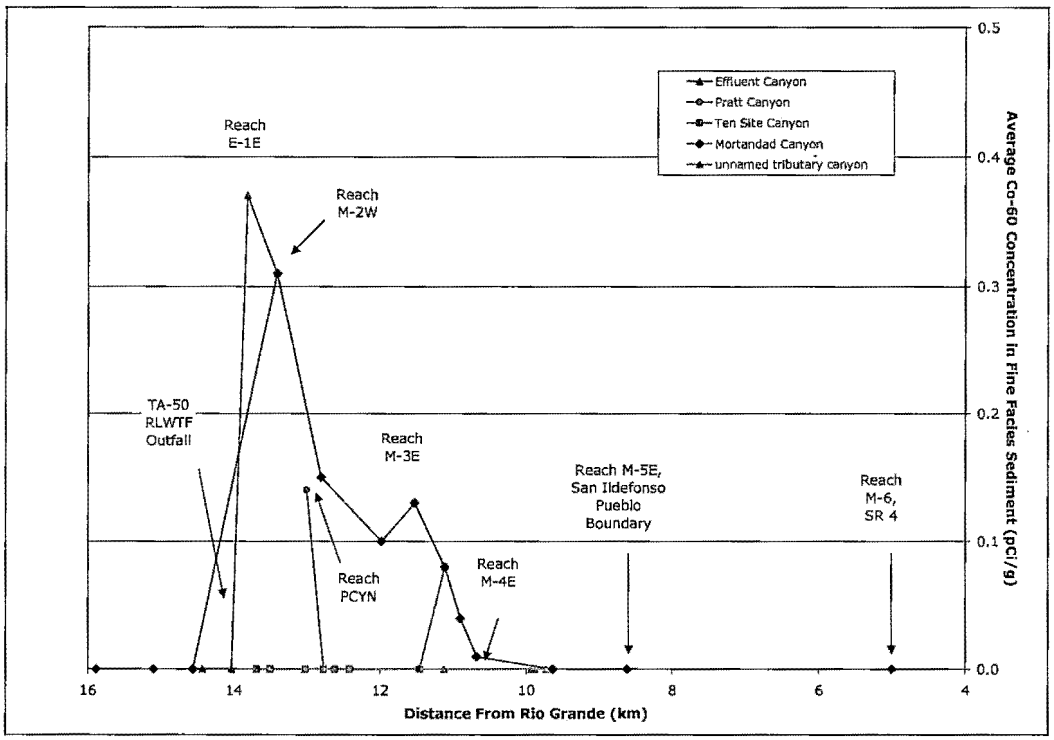


Figure 7.1-7. Estimated average concentrations of cobalt-60 in fine facies sediment in the Mortandad watershed

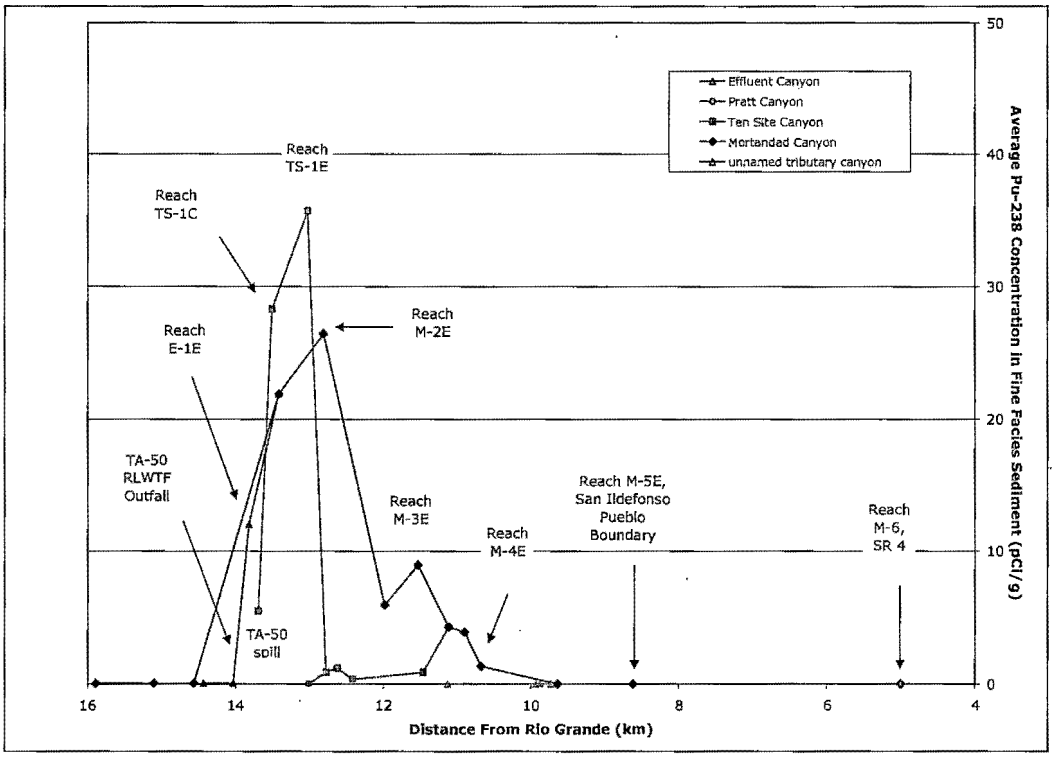


Figure 7.1-8. Estimated average concentrations of plutonium-238 in fine facies sediment in the Mortandad watershed

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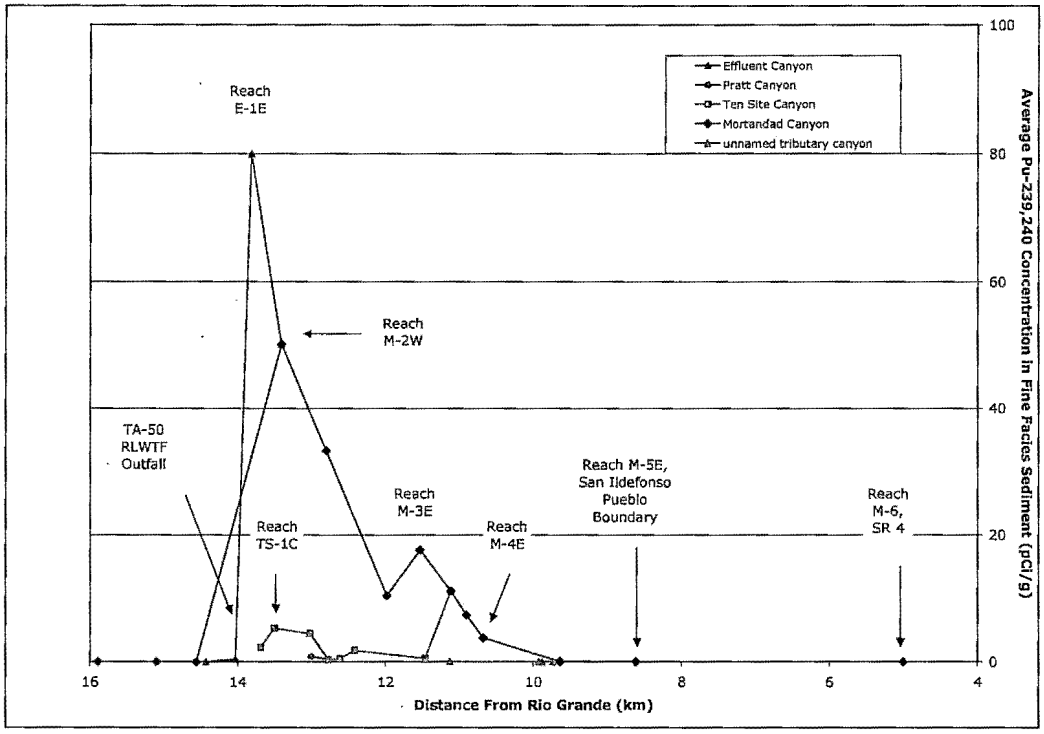


Figure 7.1-9. Estimated average concentrations of plutonium-239,240 in fine facies sediment in the Mortandad watershed

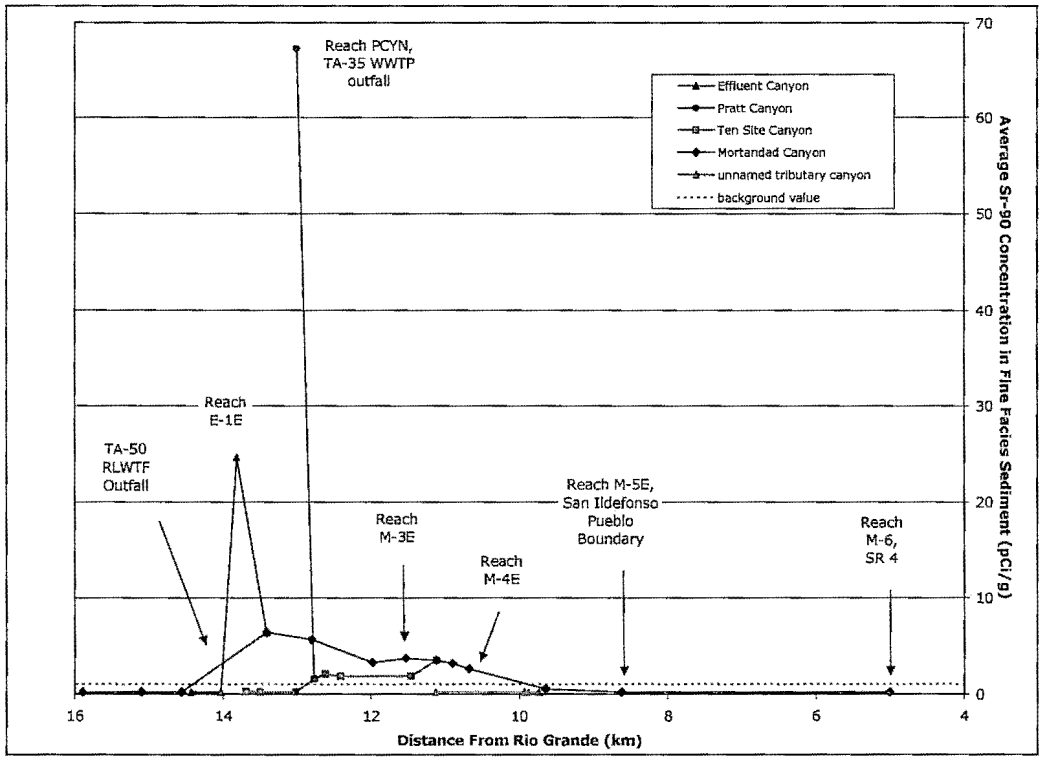


Figure 7.1-10. Estimated average concentrations of strontium-90 in fine facies sediment in the Mortandad watershed

07626

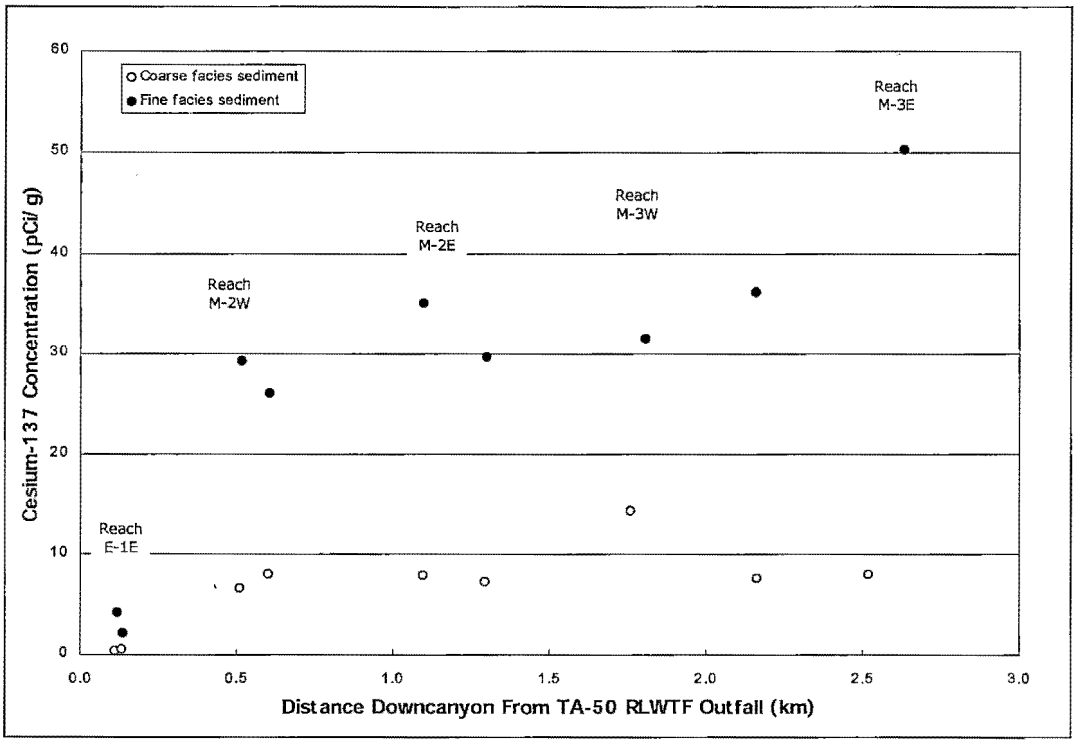
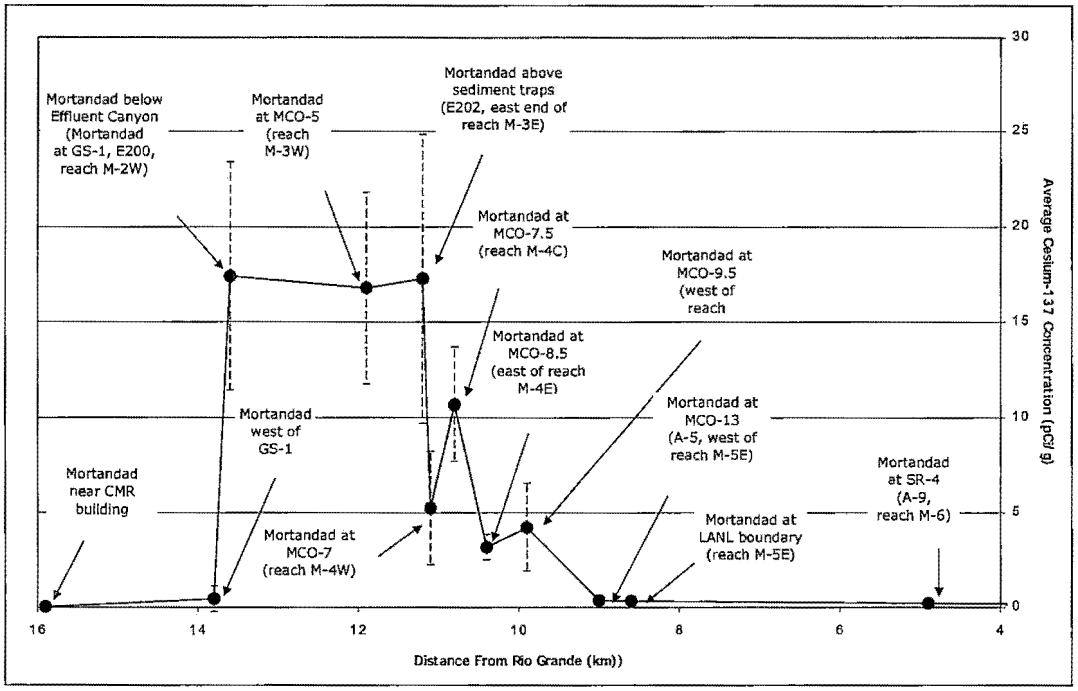


Figure 7.1-11. Cesium-137 concentrations in active channel sediment collected in Effluent and Mortandad Canyons in 2004



Notes: Error bars indicate 1 standard deviation of measurements. Previously used station names shown in parentheses, along with associated reaches.

Figure 7.1-12. Average cesium-137 concentrations at environmental surveillance stations in Mortandad Canyon, 1996–2005

: 07627

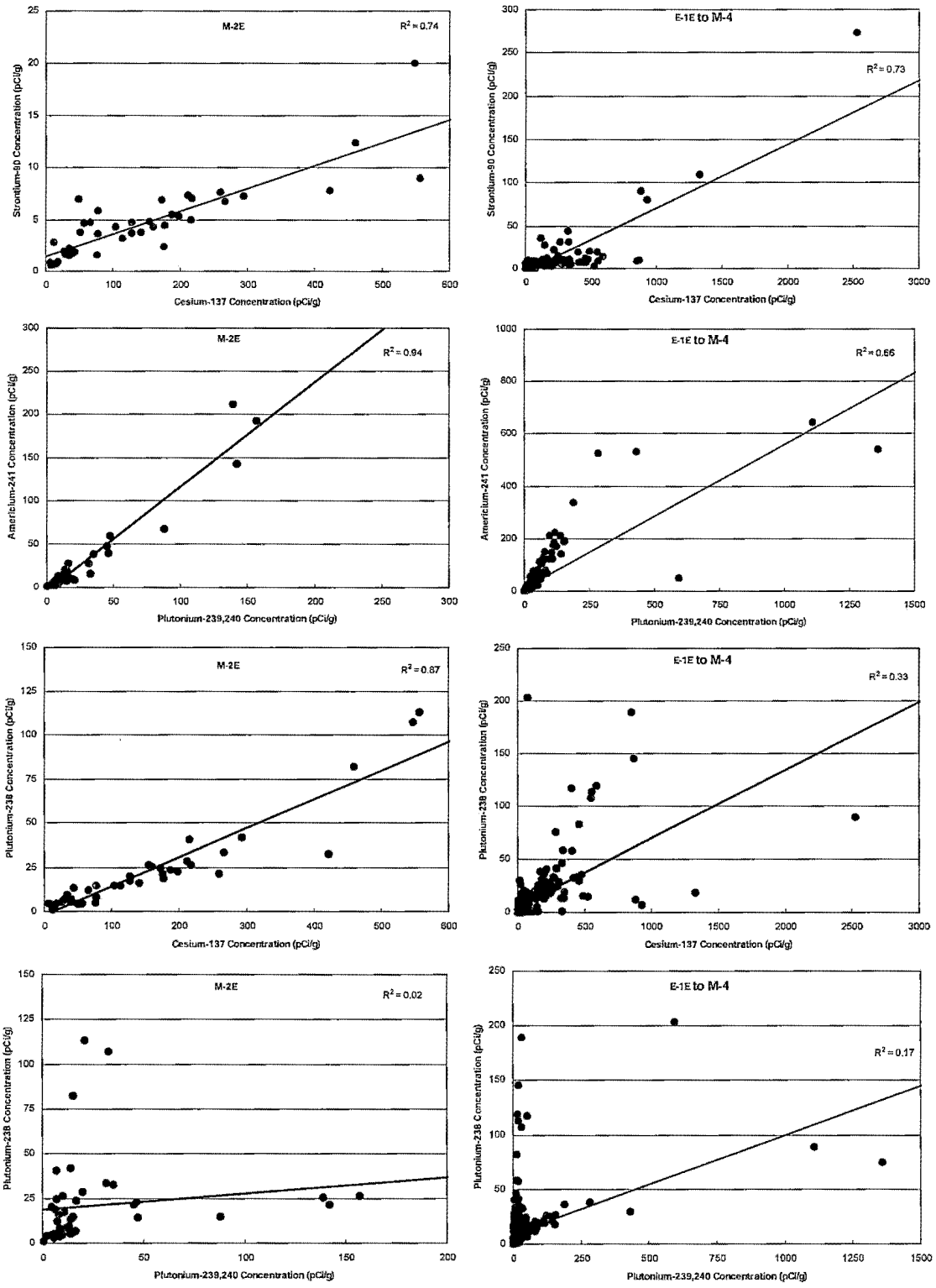


Figure 7.1-13. Scatter plots showing relations between pairs of radionuclides in sediment samples from reach M-2E and in entire data set from the TA-50 RLWTF outfall through reach M-4

07628

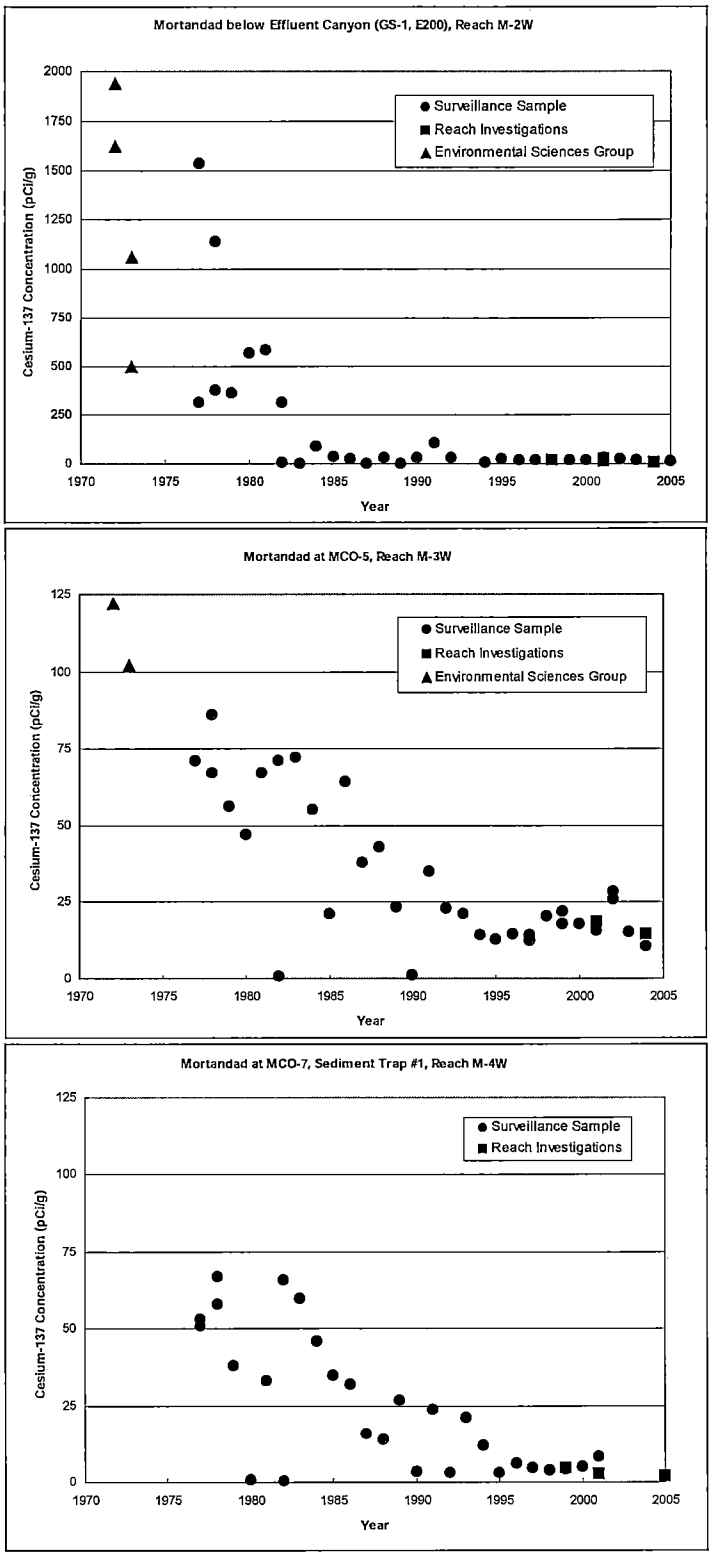


Figure 7.1-14. Time series of cesium-137 concentrations from active channel samples at environmental surveillance stations and from reach investigations

07629

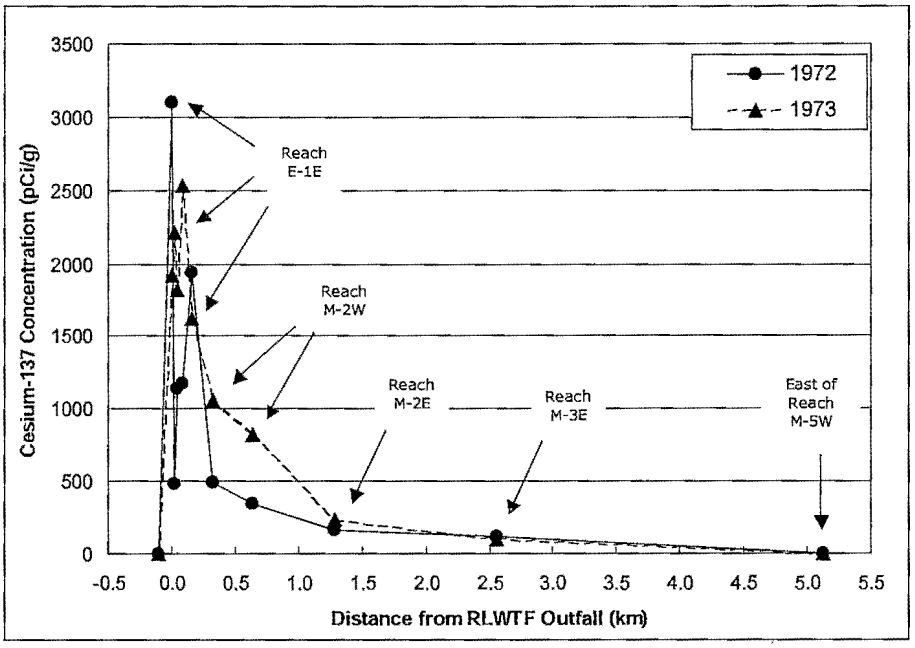


Figure 7.1-15. Cesium-137 concentrations from active channel samples collected in 1972 and 1973 plotted versus distance from TA-50 RLWTF outfall (data from Nyhan et al. 1978, 05726)

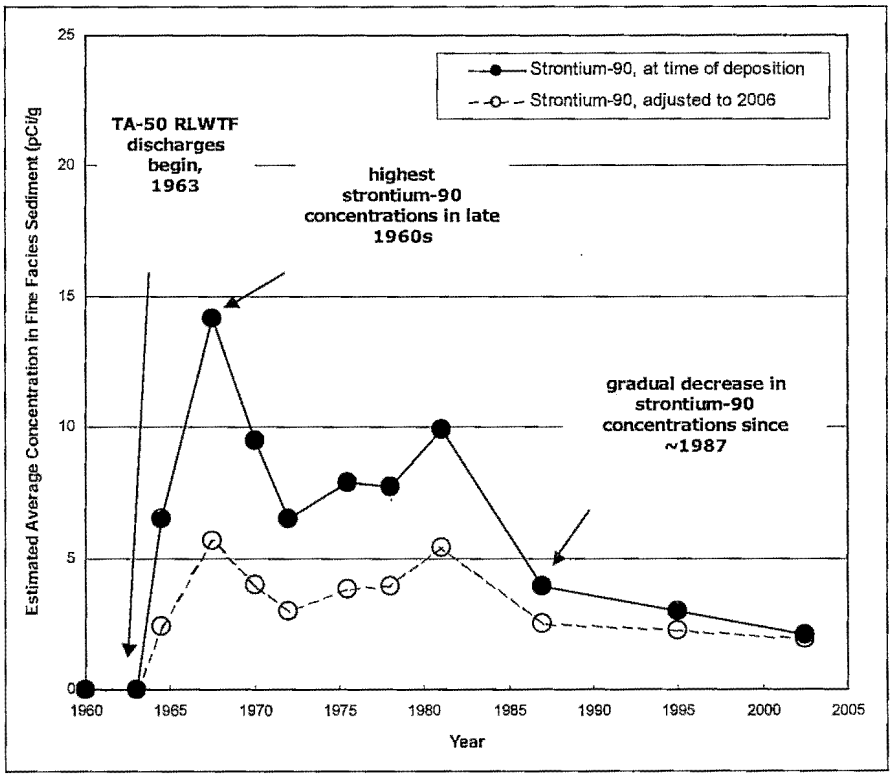


Figure 7.1-16. Reconstructed concentrations of americium-241, cesium-137, plutonium-238, plutonium-239,240, and strontium-90 in fine facies sediment in reaches M-3, M-4W, and M-4E, plotted against year

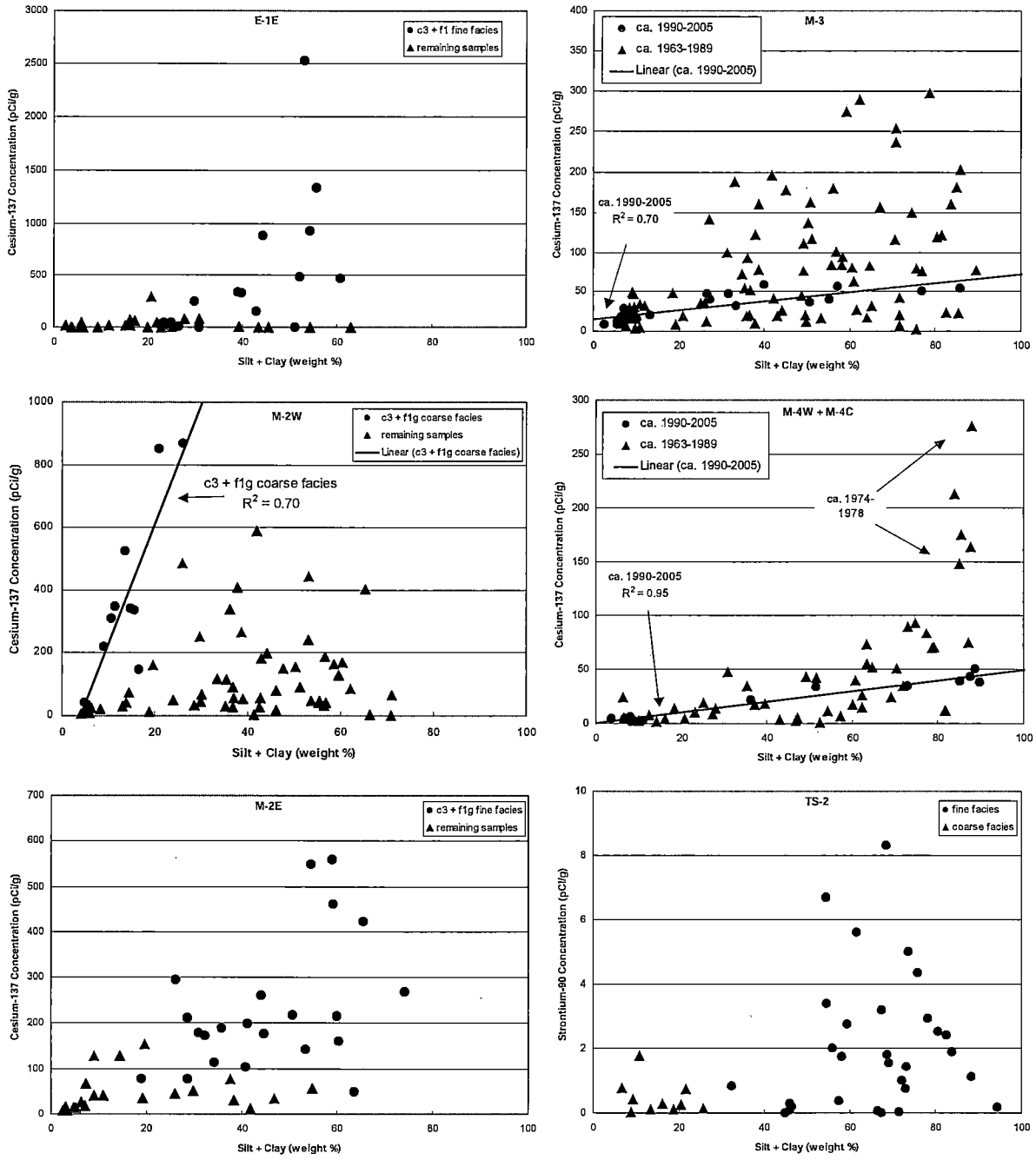


Figure 7.1-17. Scatter plots showing relations between radionuclide concentration and silt and clay content in reaches E-1E, M-2W, M-2E, M-3, M-4, and TS-2

: 07531

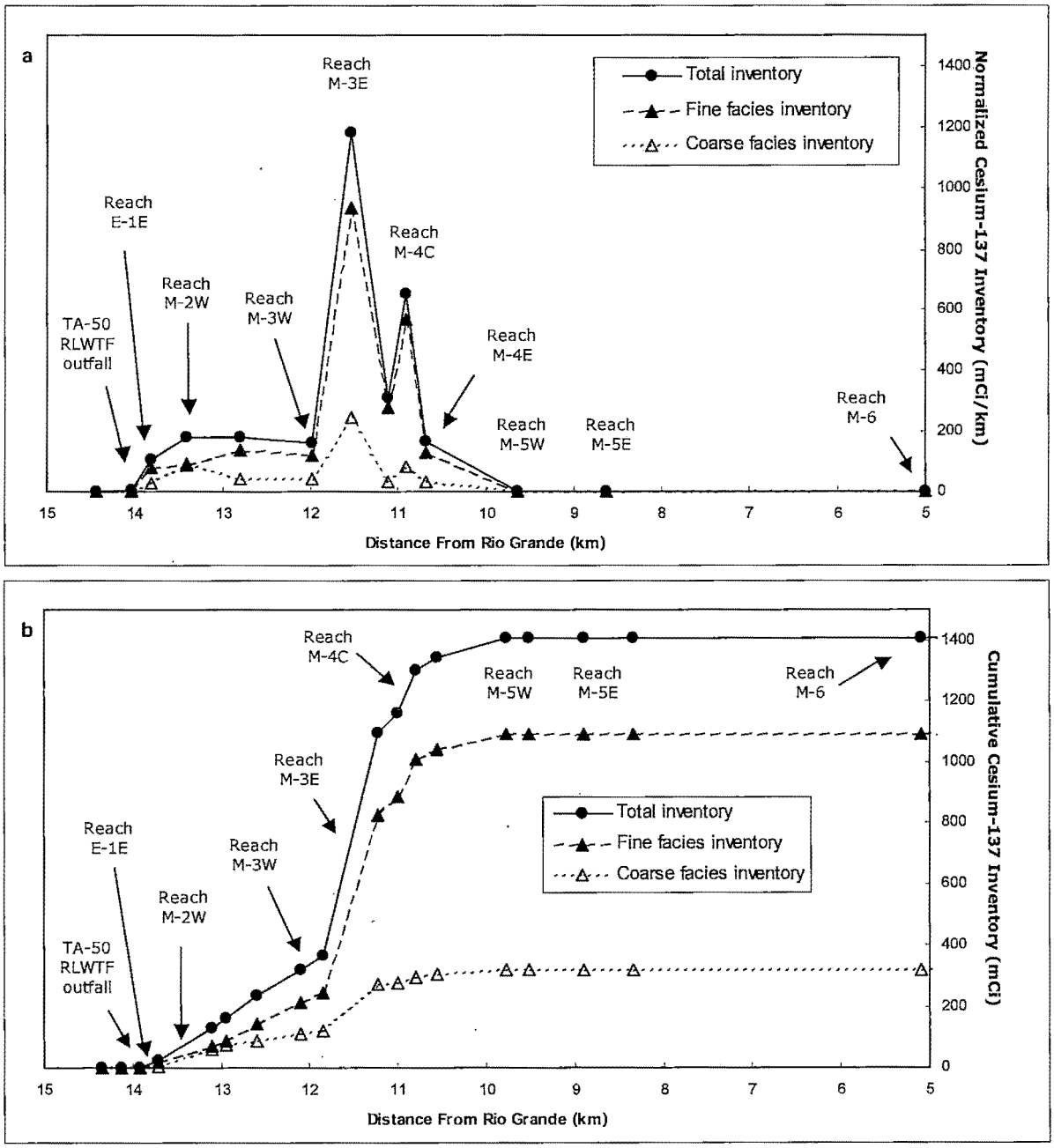


Figure 7.1-18. Estimated cesium-137 inventory in Effluent and Mortandad Canyons downstream from the TA-50 RLWTF outfall: (a) normalized inventory [mCi/km]; (b) cumulative inventory [mCi]

07532

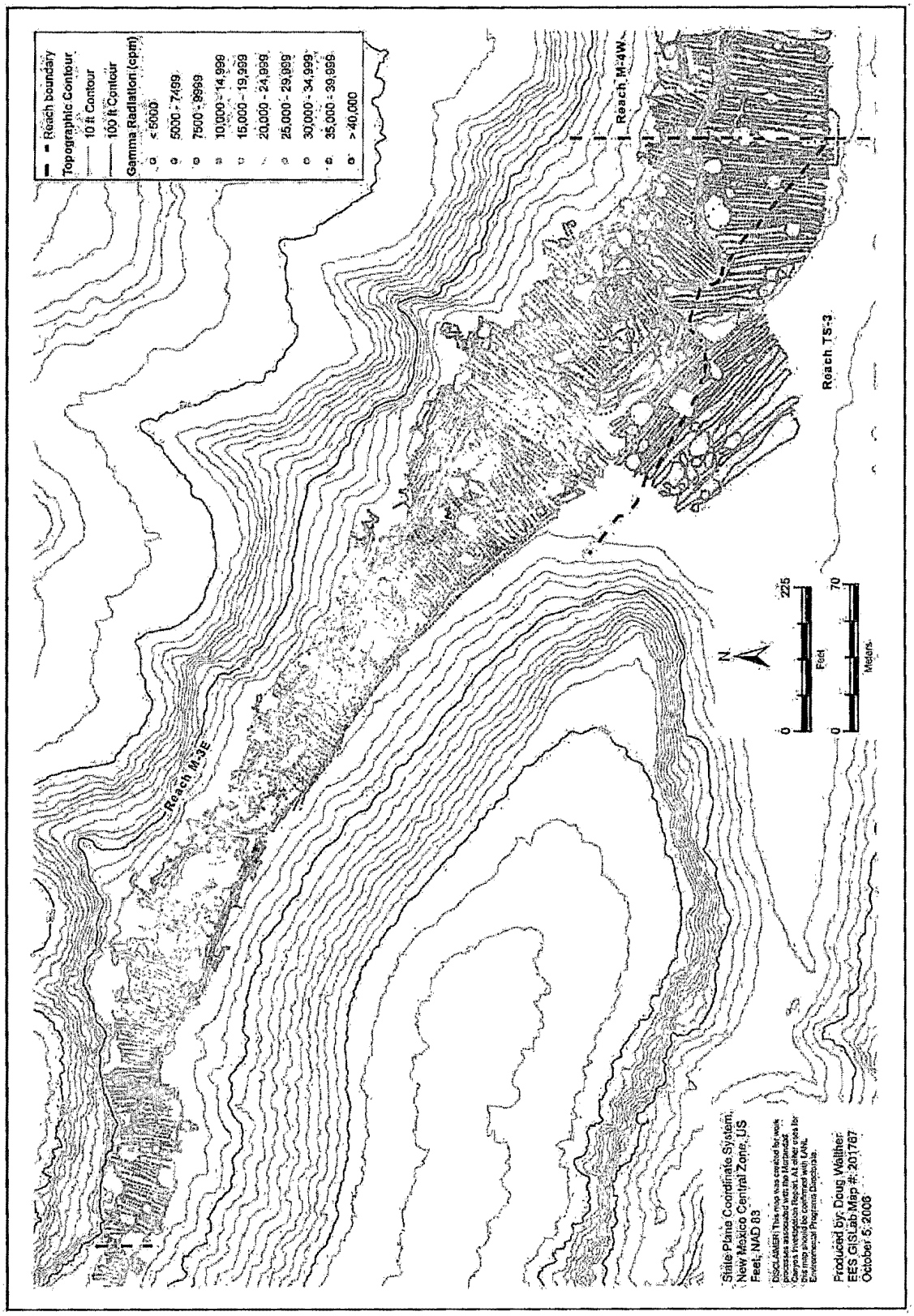
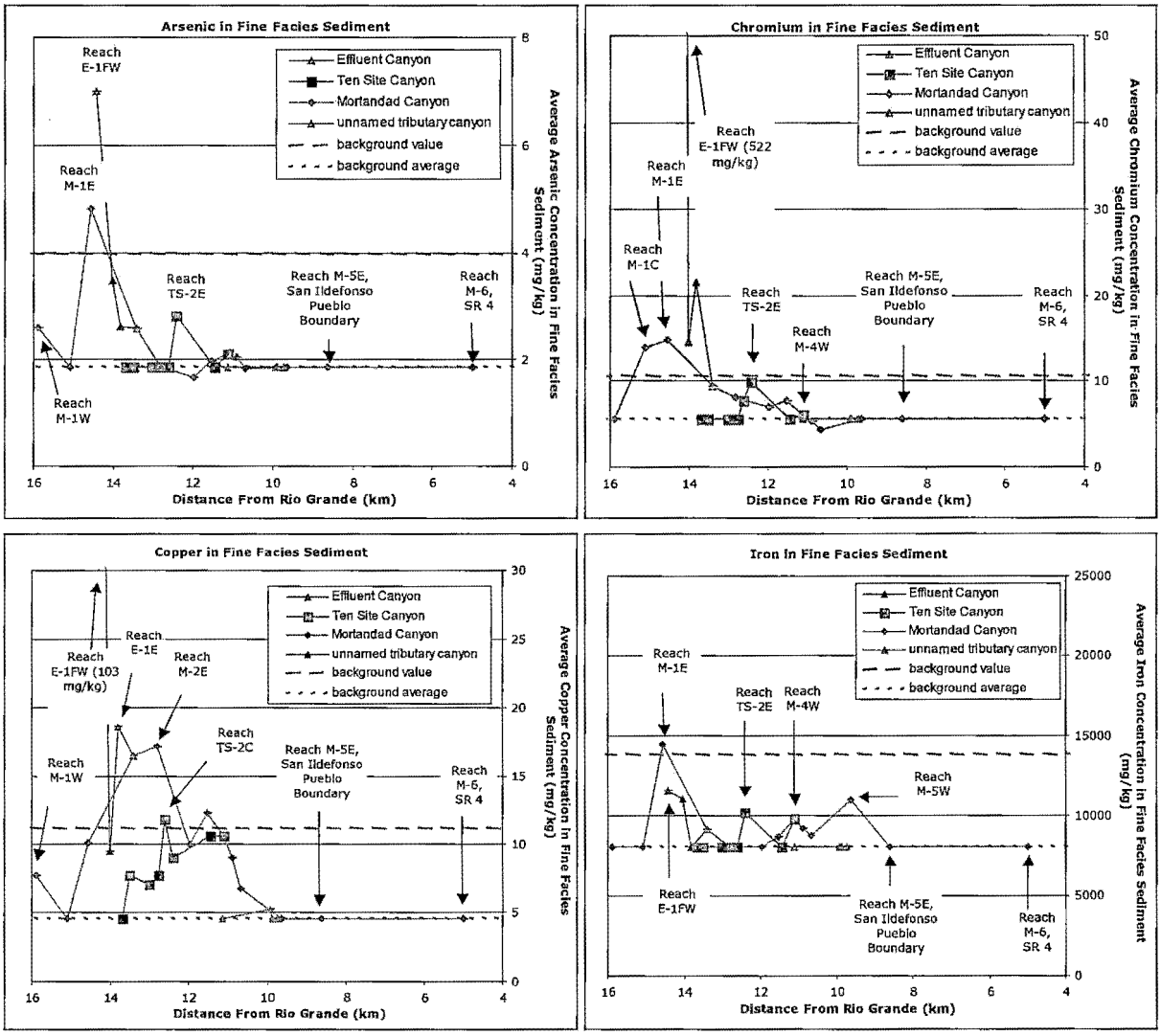


Figure 7.1-19. Results of gross-gamma radiation walkover survey in reach M-3E, in area of highest cesium-137 inventory in the Mortandad watershed, showing area of sediment deposition where floodwaters spread over canyon bottom

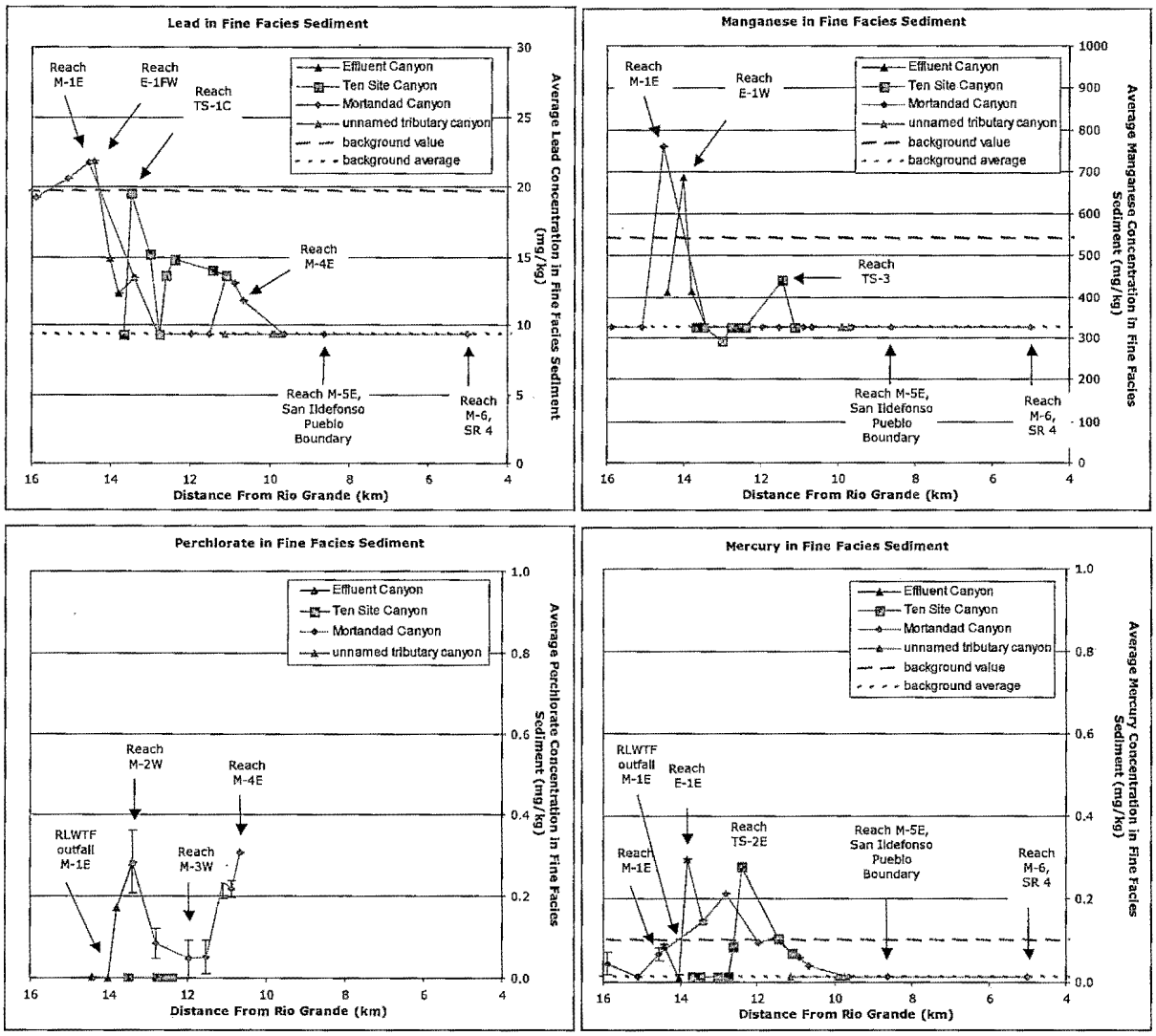
07633



Note: Error bars indicate upper and lower bounds based on replacing nondetect values with either the detection limit or zero.

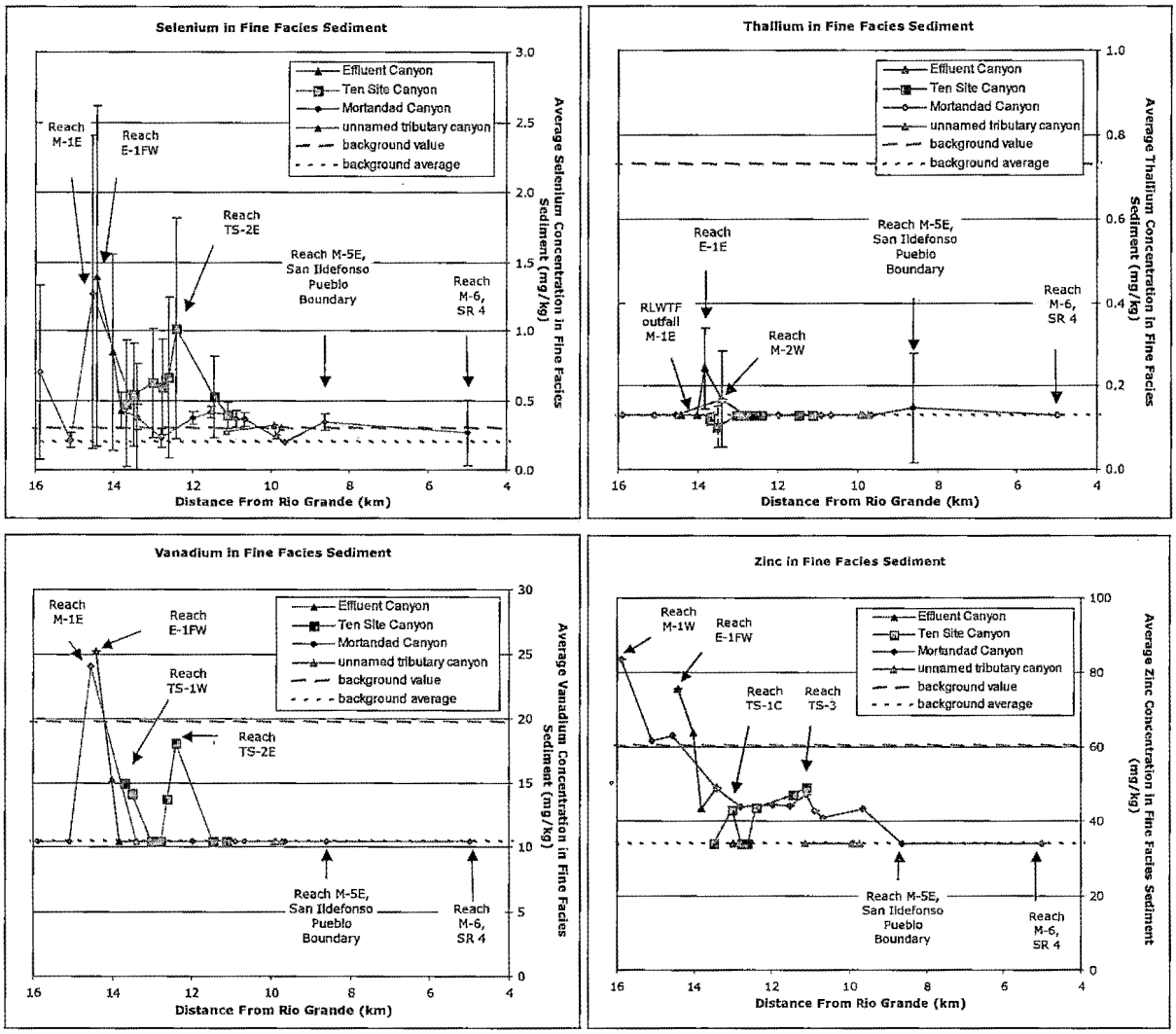
Figure 7.1-20. Estimated average concentrations of inorganic chemicals in fine facies sediment in the Mortandad watershed

: 07634



Note: Error bars indicate upper and lower bounds based on replacing nondetect values with either the detection limit or zero.

Figure 7.1-20 (continued). Estimated average concentrations of inorganic chemicals in fine facies sediment in the Mortandad watershed



Note: Error bars indicate upper and lower bounds based on replacing nondetect values with either the detection limit or zero.

Figure 7.1-20 (continued). Estimated average concentrations of inorganic chemicals in fine facies sediment in the Mortandad watershed

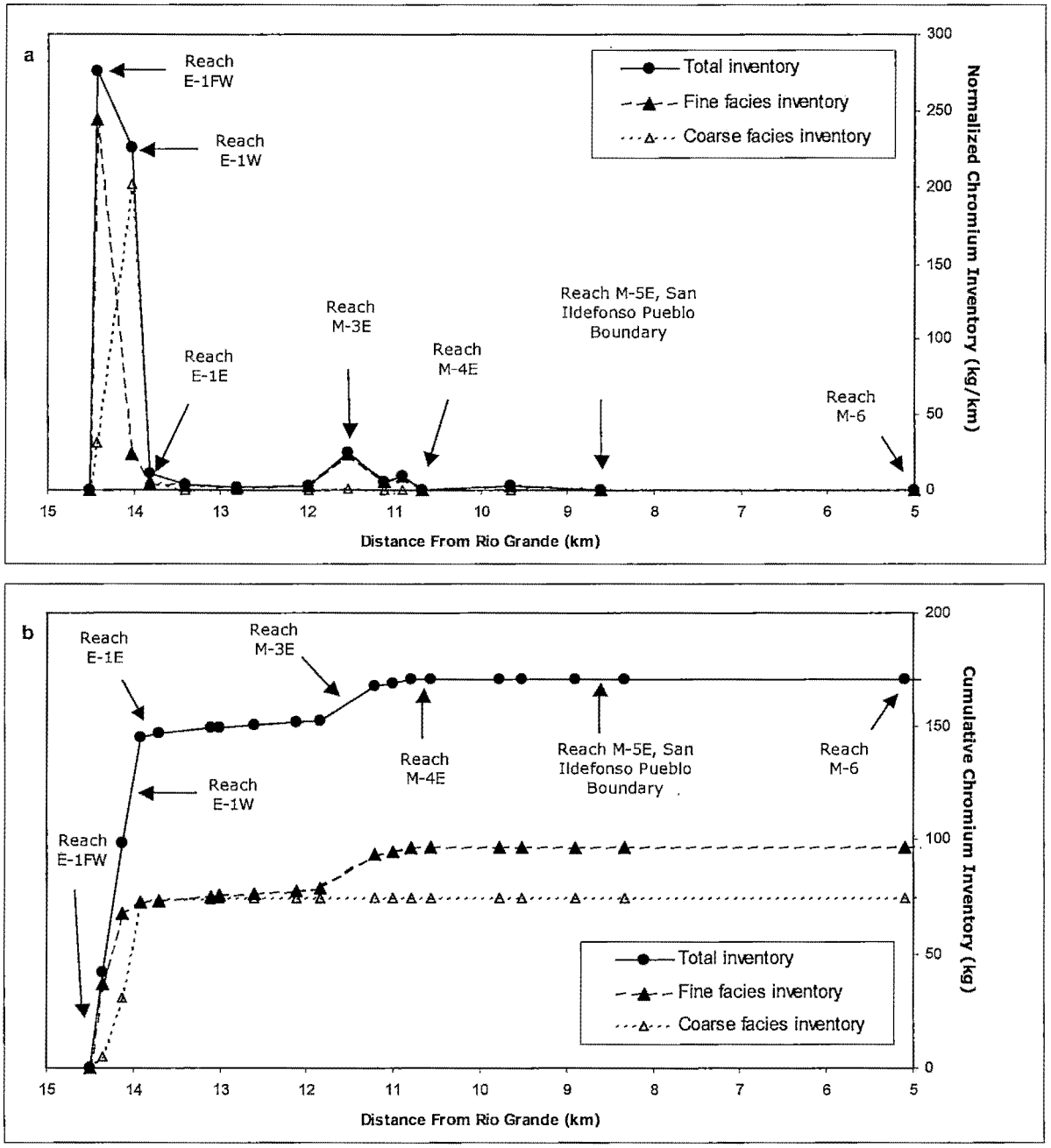


Figure 7.1-21. Estimated anthropogenic chromium inventory in Effluent and Mortandad Canyons downstream from the head of reach E-1FW: (a) normalized inventory [kg/km]; (b) cumulative inventory [kg]

07637

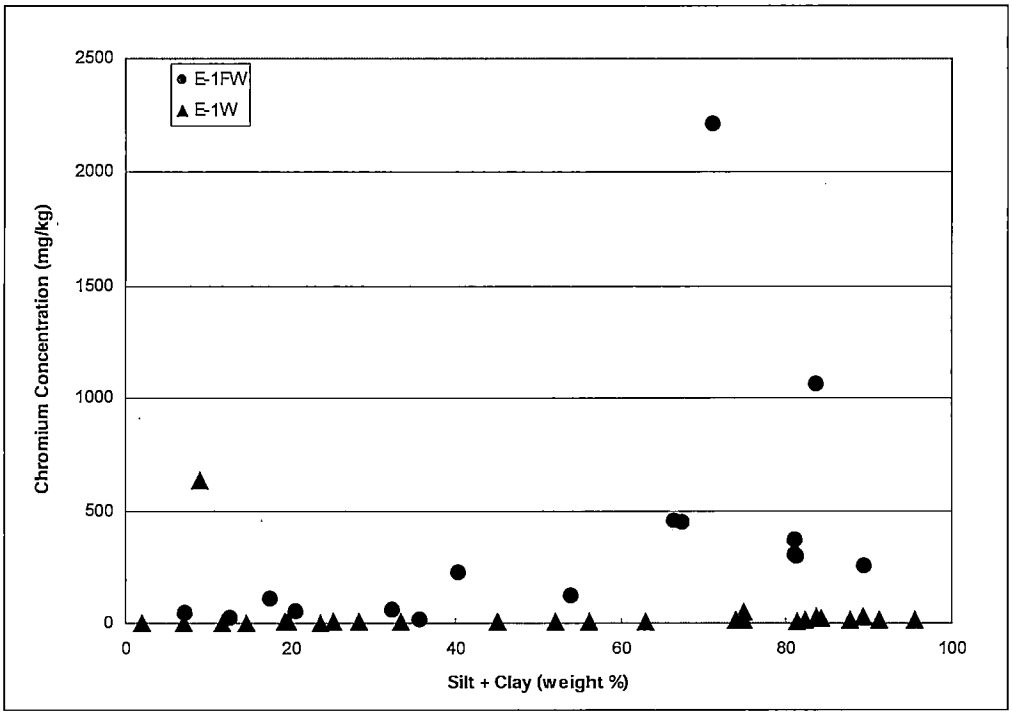


Figure 7.1-22. Scatter plot showing relations between chromium concentration and silt and clay content in reaches E-1FW and E-1W

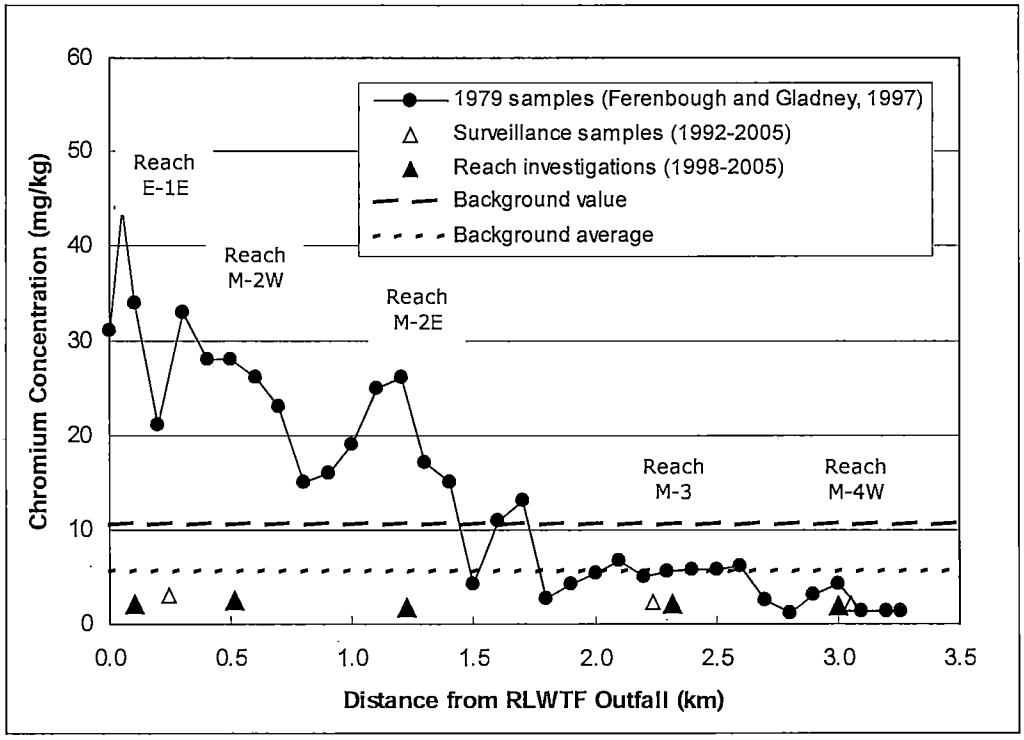
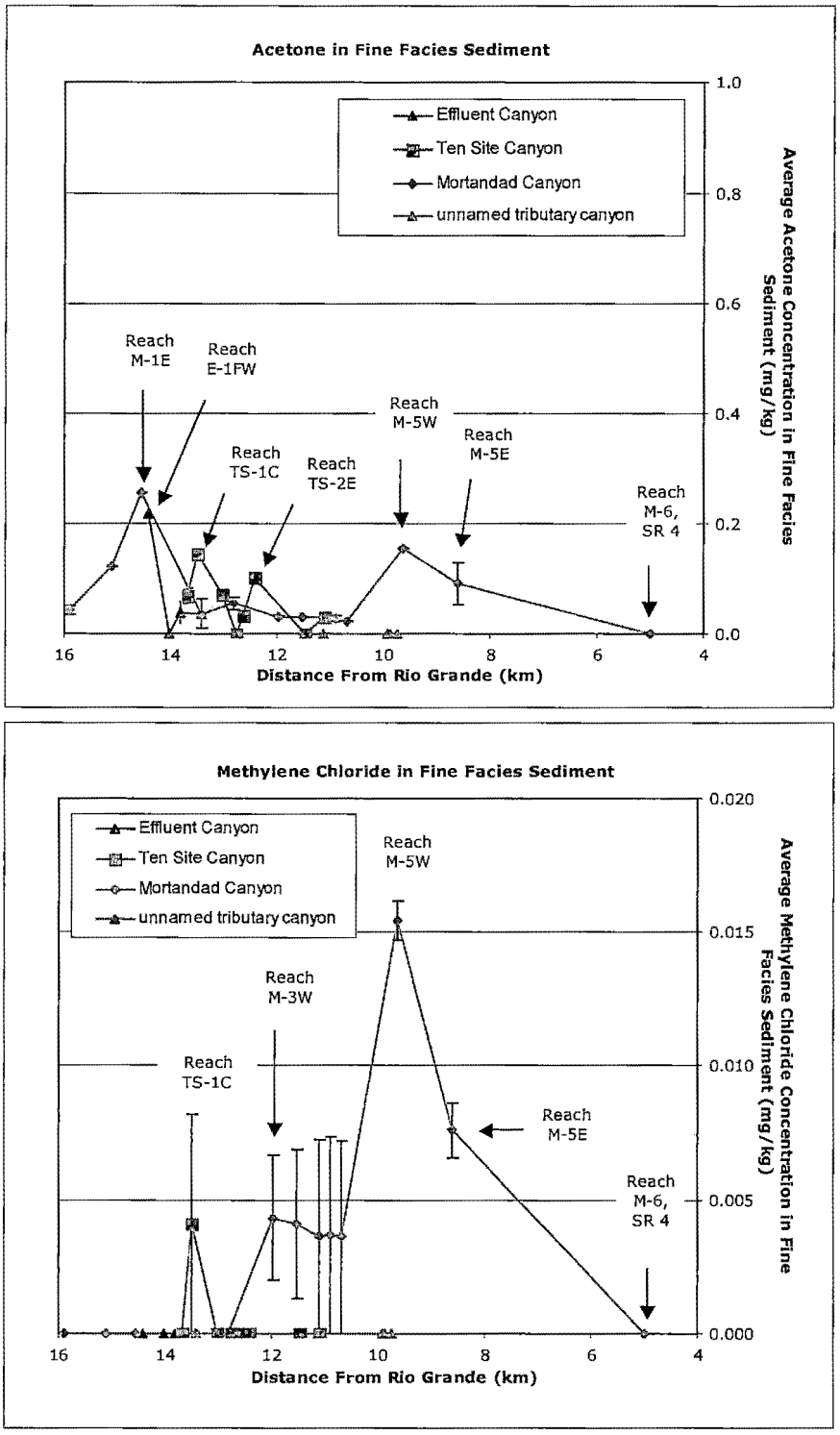


Figure 7.1-23. Chromium concentrations from active channel samples collected in 1979 (Ferenbaugh and Gladney 1997, 93715) and from later investigations plotted versus distance from TA-50 RLWTF outfall

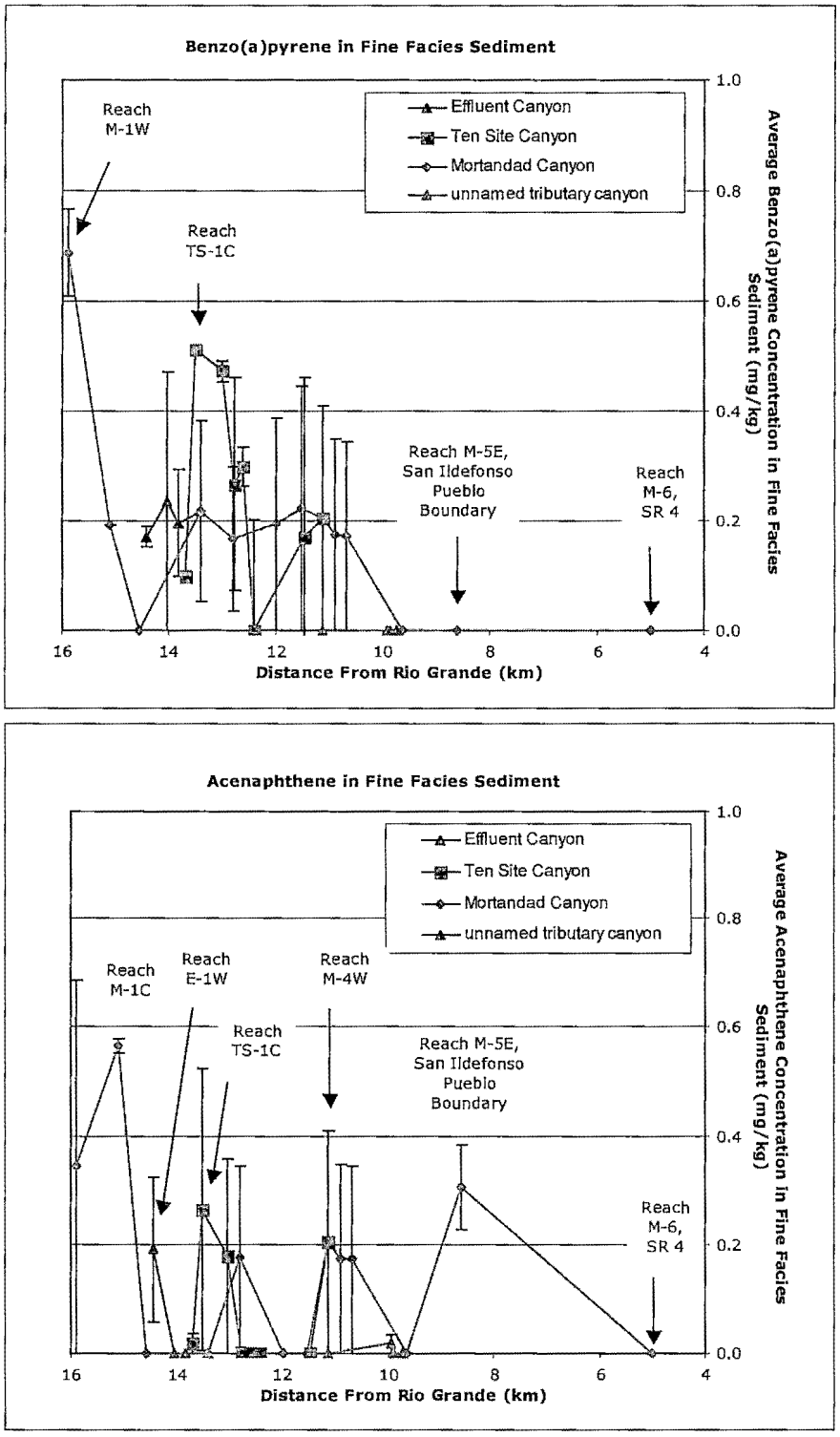
07638



Notes: Error bars indicate upper and lower bounds based on replacing nondetect values with either the detection limit or zero. A value of zero is shown where there are no detected results.

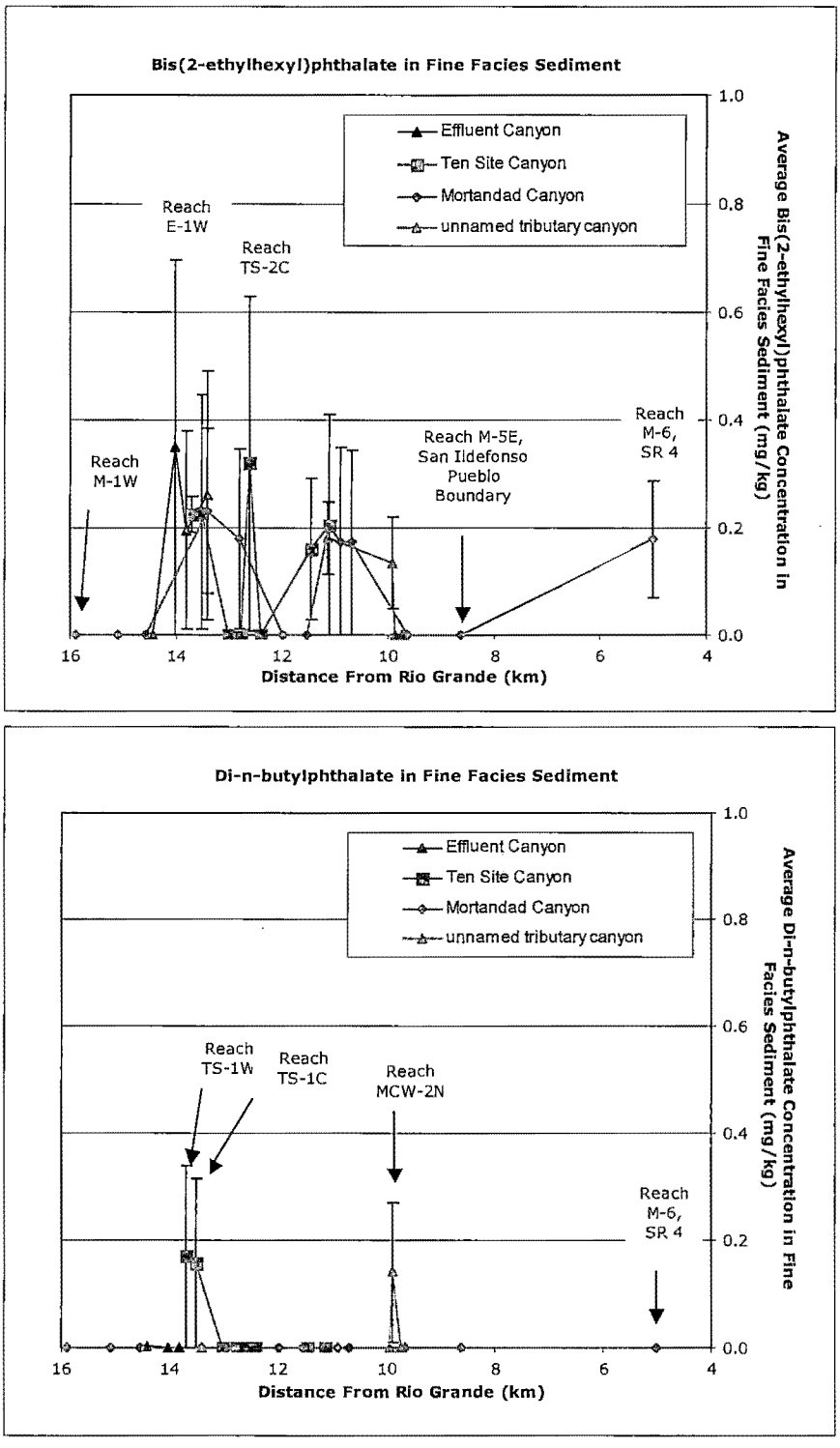
Figure 7.1-24. Estimated average concentrations of the PCBs Aroclor-1260 and Aroclor-1254 in fine facies sediment in the Mortandad watershed

07639



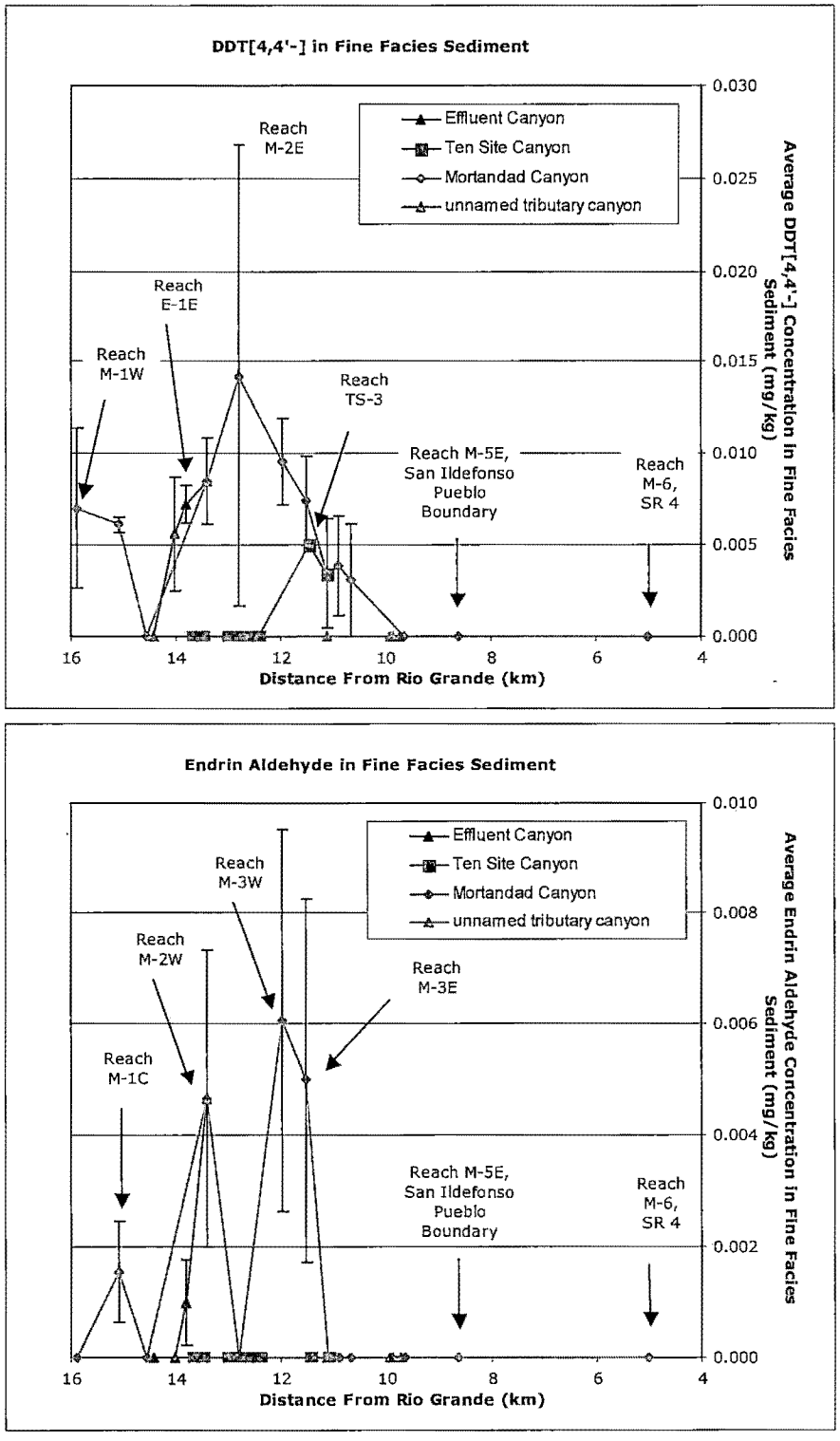
Notes: Error bars indicate upper and lower bounds based on replacing nondetect values with either the detection limit or zero. A value of zero is shown where there are no detected results.

Figure 7.1-25. Estimated average concentrations of the PAHs benzo(a)pyrene and acenaphthene in fine facies sediment in the Mortandad watershed



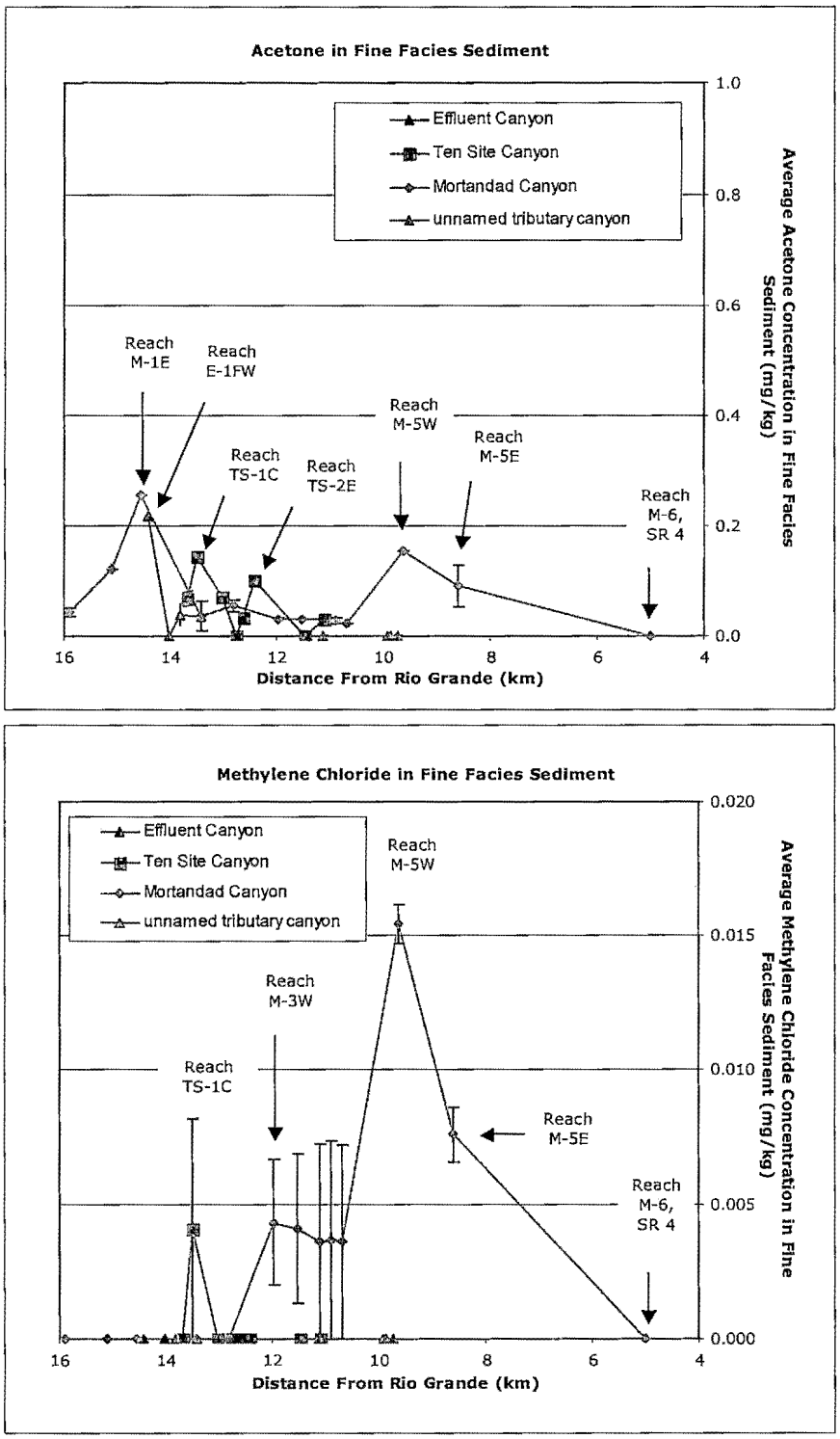
Notes: Error bars indicate upper and lower bounds based on replacing nondetect values with either the detection limit or zero. A value of zero is shown where there are no detected results.

Figure 7.1-26. Estimated average concentrations of the SVOCs bis(2-ethylhexyl)phthalate and di-n-butylphthalate in fine facies sediment in the Mortandad watershed



Notes: Error bars indicate upper and lower bounds based on replacing nondetect values with either the detection limit or zero. A value of zero is shown where there are no detected results.

Figure 7.1-27. Estimated average concentrations of the pesticides DDT and endrin aldehyde in fine facies sediment in the Mortandad watershed



Notes: Error bars indicate upper and lower bounds based on replacing nondetect values with either the detection limit or zero. A value of zero is shown where there are no detected results.

Figure 7.1-28. Estimated average concentrations of the VOCs acetone and methylene chloride in fine facies sediment in the Mortandad watershed

: 07643

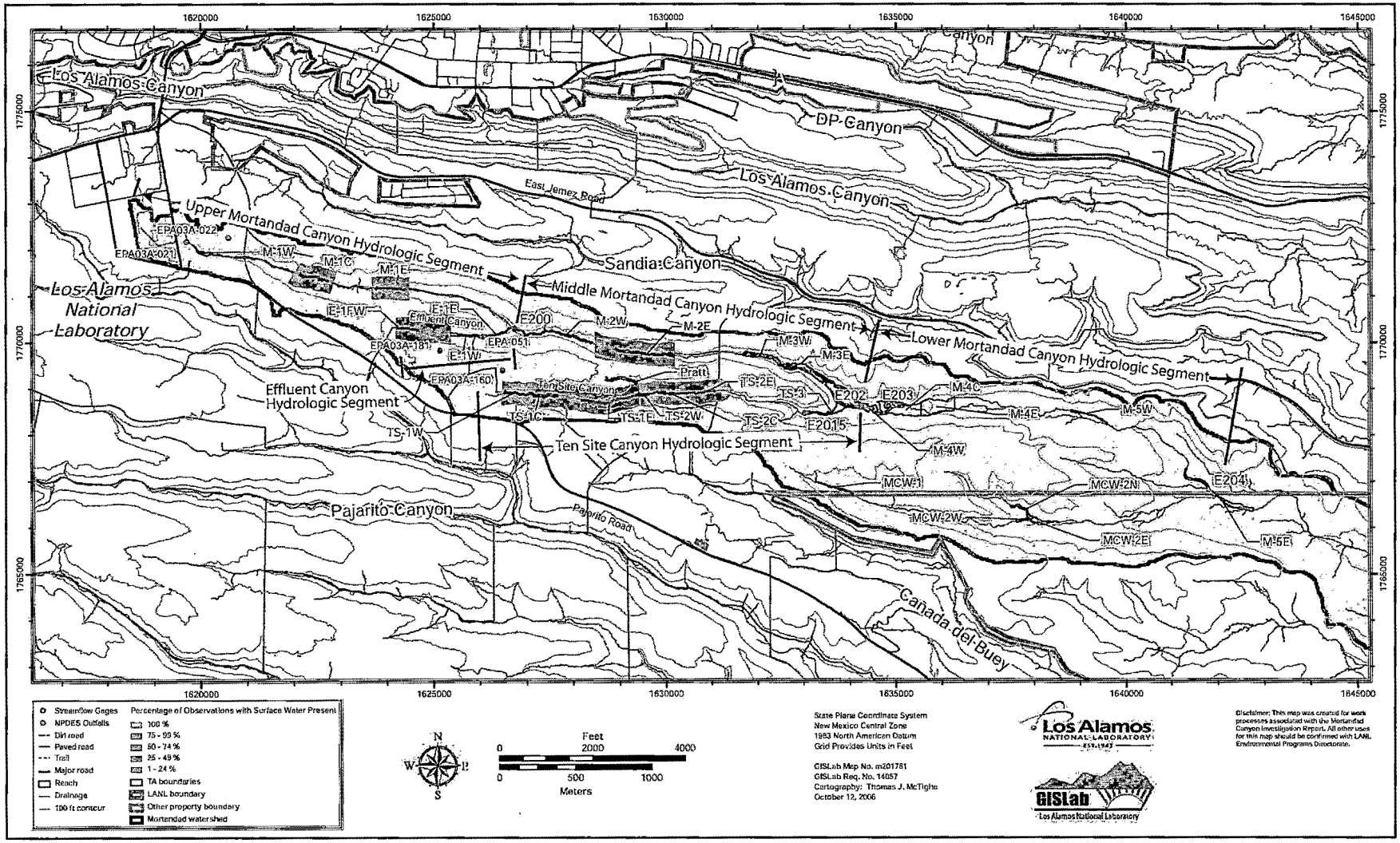


Figure 7.2-1. Mortandad watershed depicting different surface water occurrences, NPDES outfalls, and gaging stations

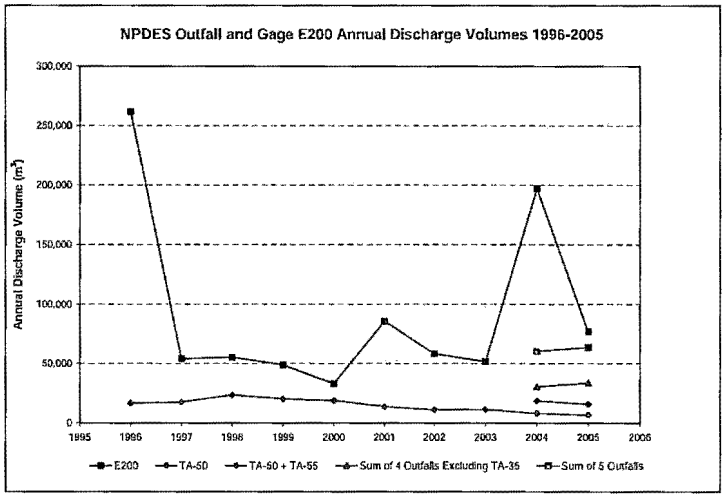


Figure 7.2-2. Comparison of NPDES outfall and gage E200 discharge volumes

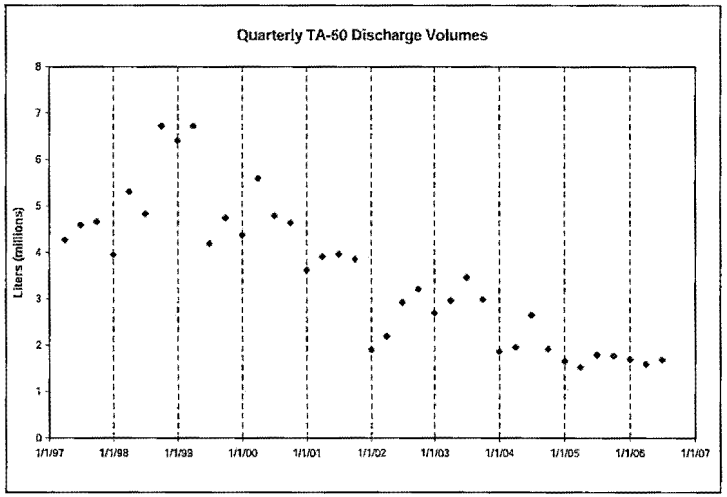


Figure 7.2-3. Seasonal variability in TA-50 RLWTF outfall discharges

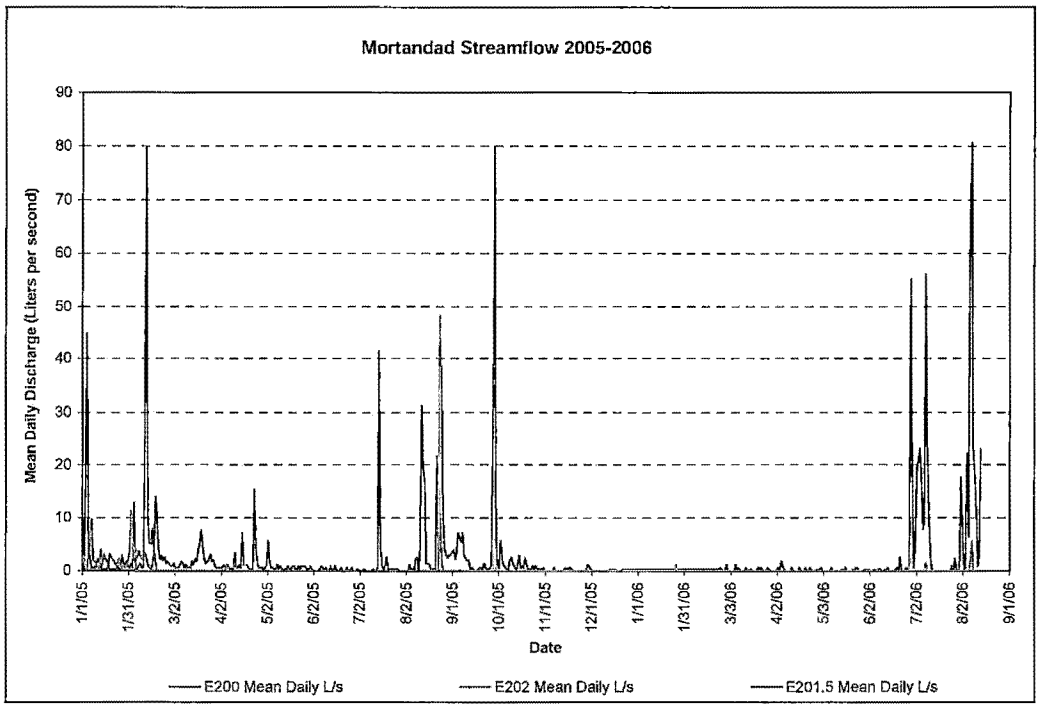


Figure 7.2-4. Mortandad Canyon streamflow during 2005–2006

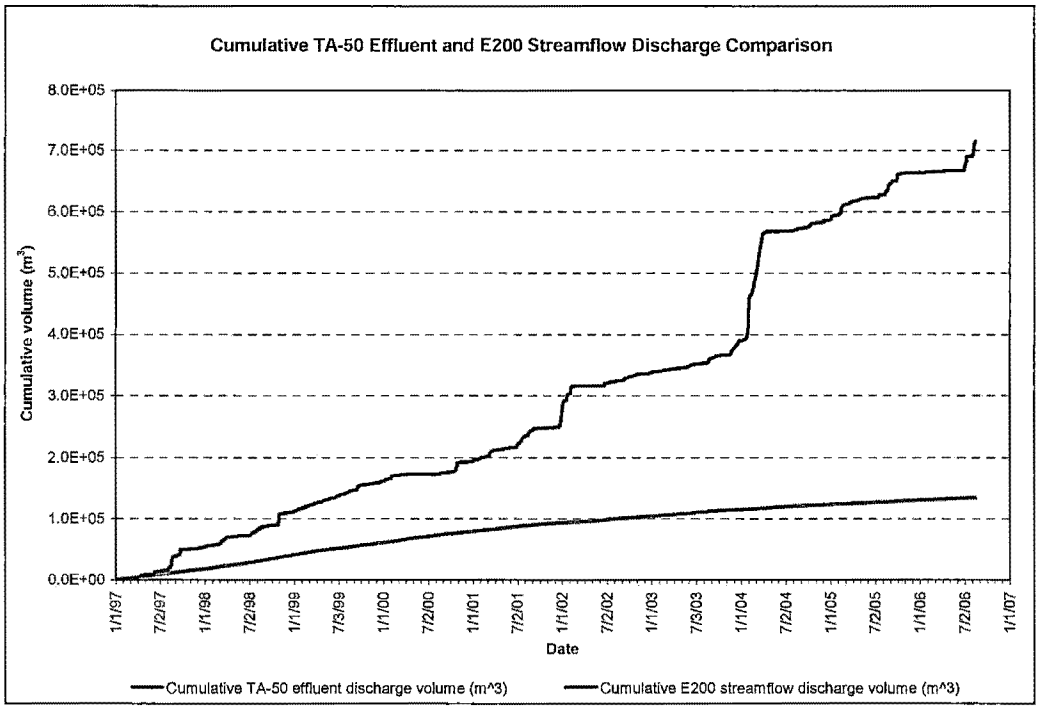
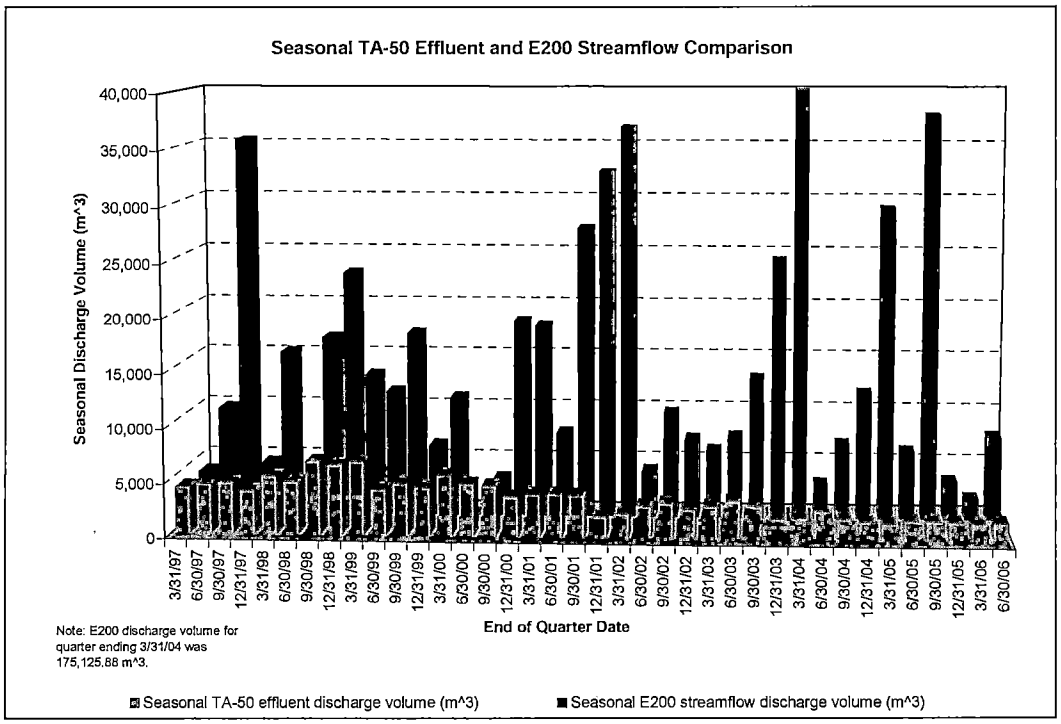


Figure 7.2-5. Comparison of cumulative TA-50 RLWTF outfall discharge and gage E200 streamflow volumes since 1997 using daily records



Note: Discharge volume for quarter ending 3/31/04 is off the chart at a volume exceeding 175,000 m^3.

Figure 7.2-6. Comparison of seasonal TA-50 RLWTF outfall discharge and gage E200 streamflow volumes since 1997

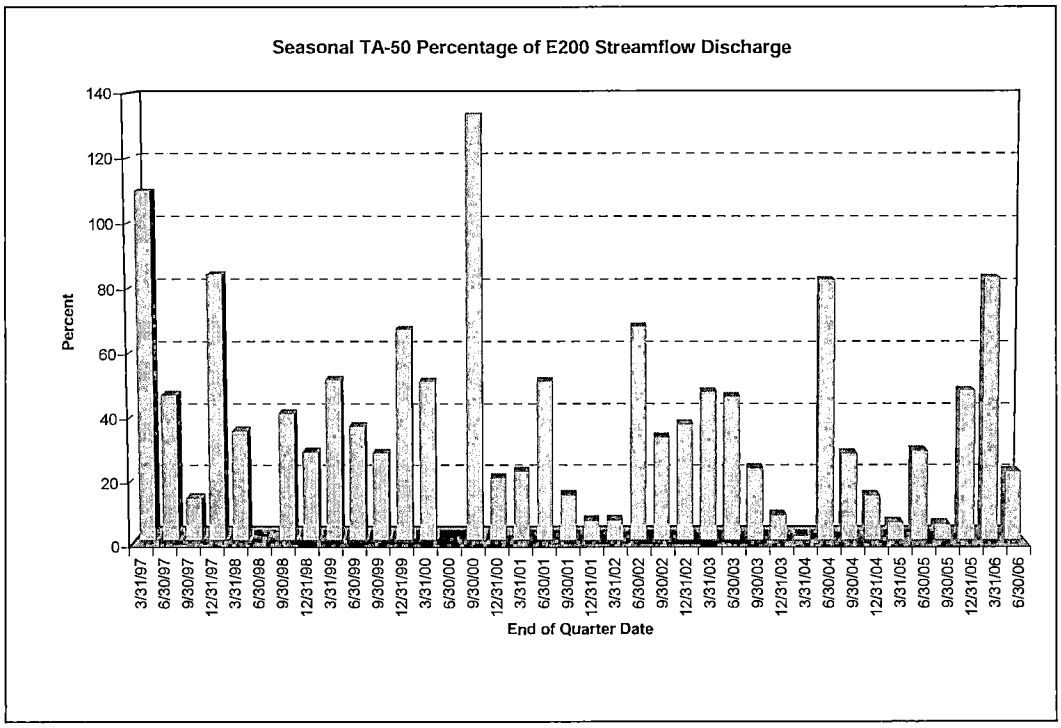


Figure 7.2-7. Seasonal TA-50 RLWTF outfall percentage of gage E200 total streamflow discharge

: 07647

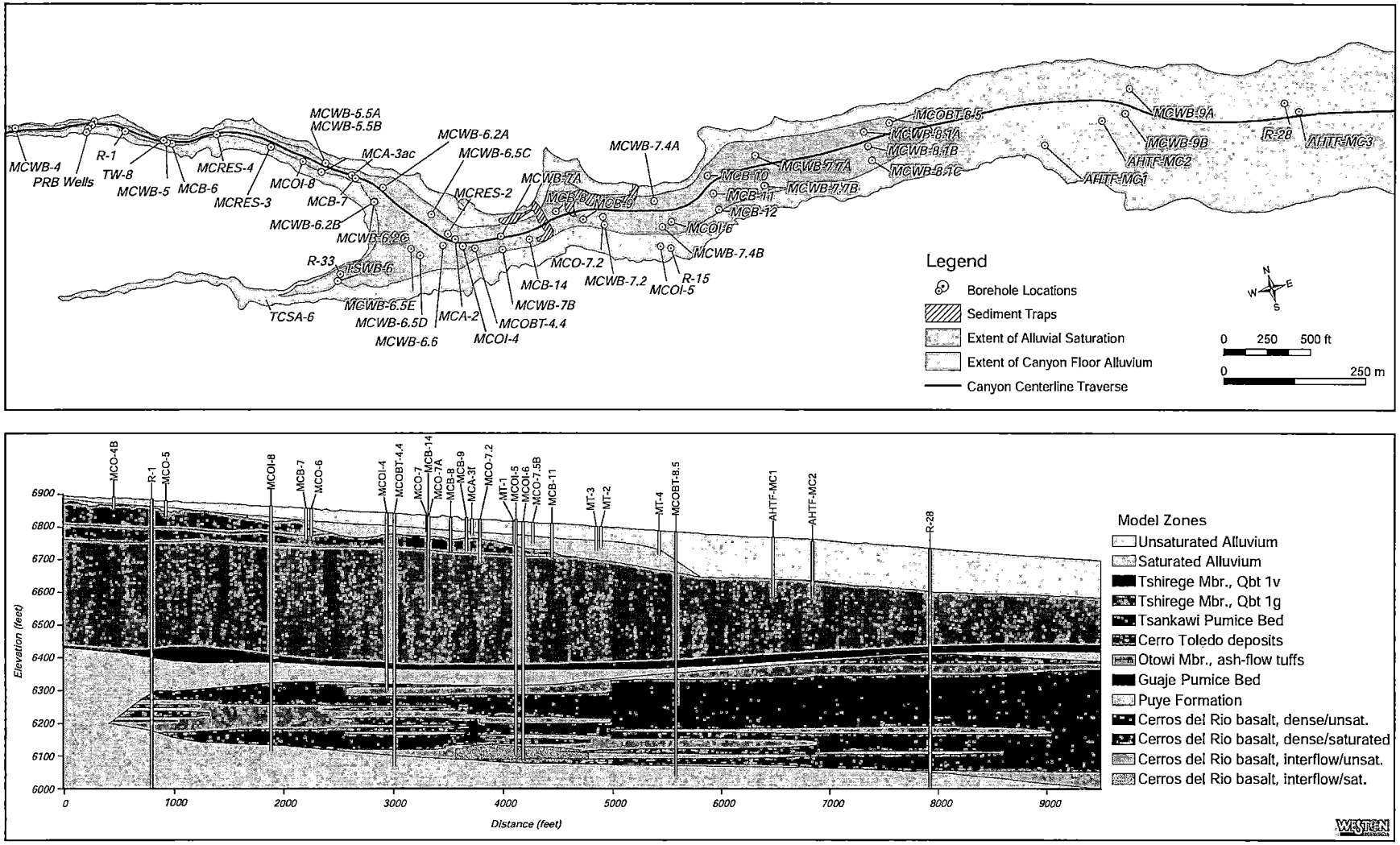


Figure 7.2-8. Map and cross section showing extent of alluvial groundwater in Mortandad Canyon

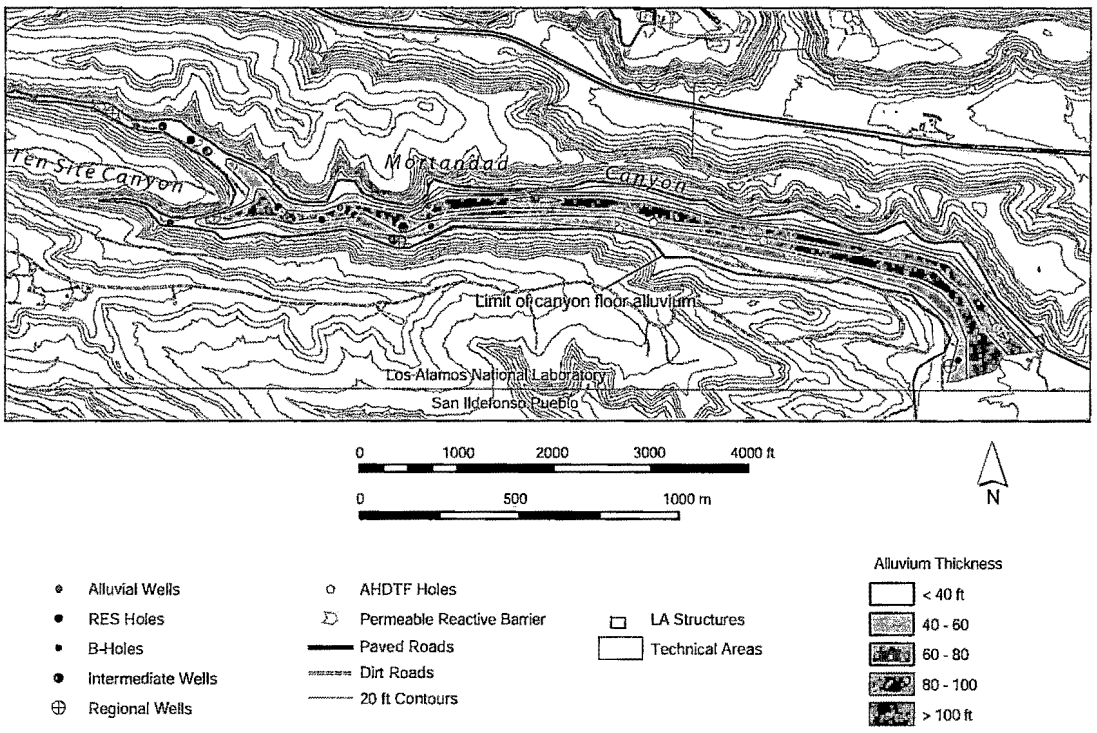


Figure 7.2-9. Map showing thickness of alluvium in Mortandad Canyon

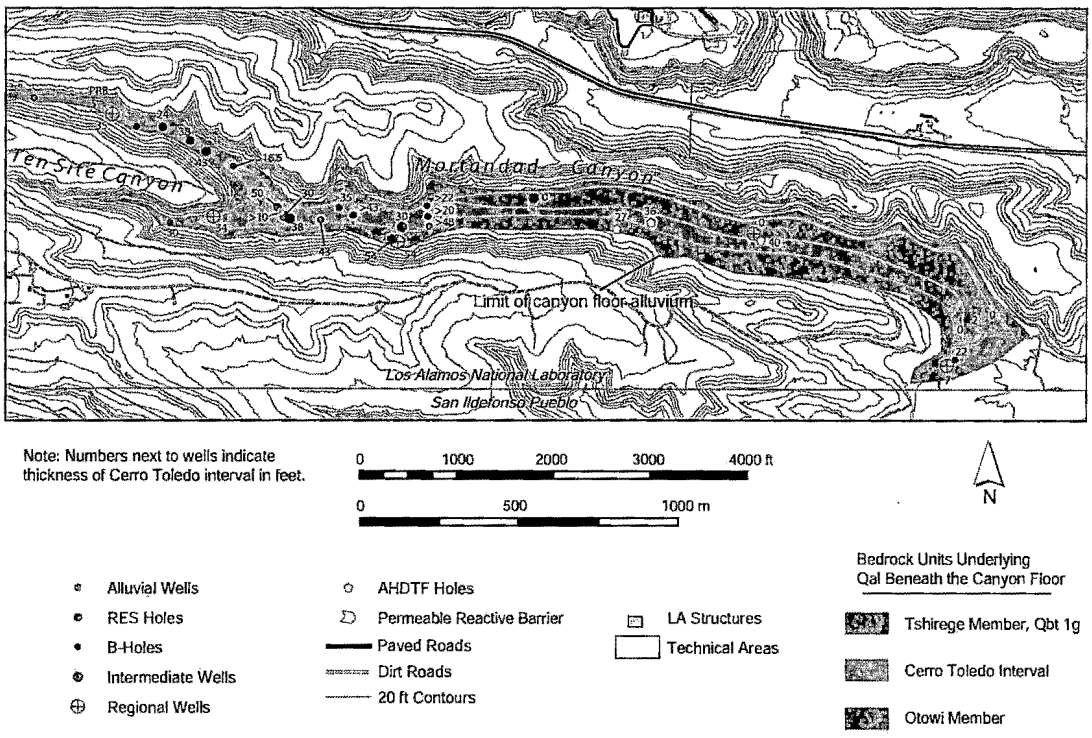


Figure 7.2-10. Distribution of geologic bedrock units beneath alluvium in Mortandad Canyon

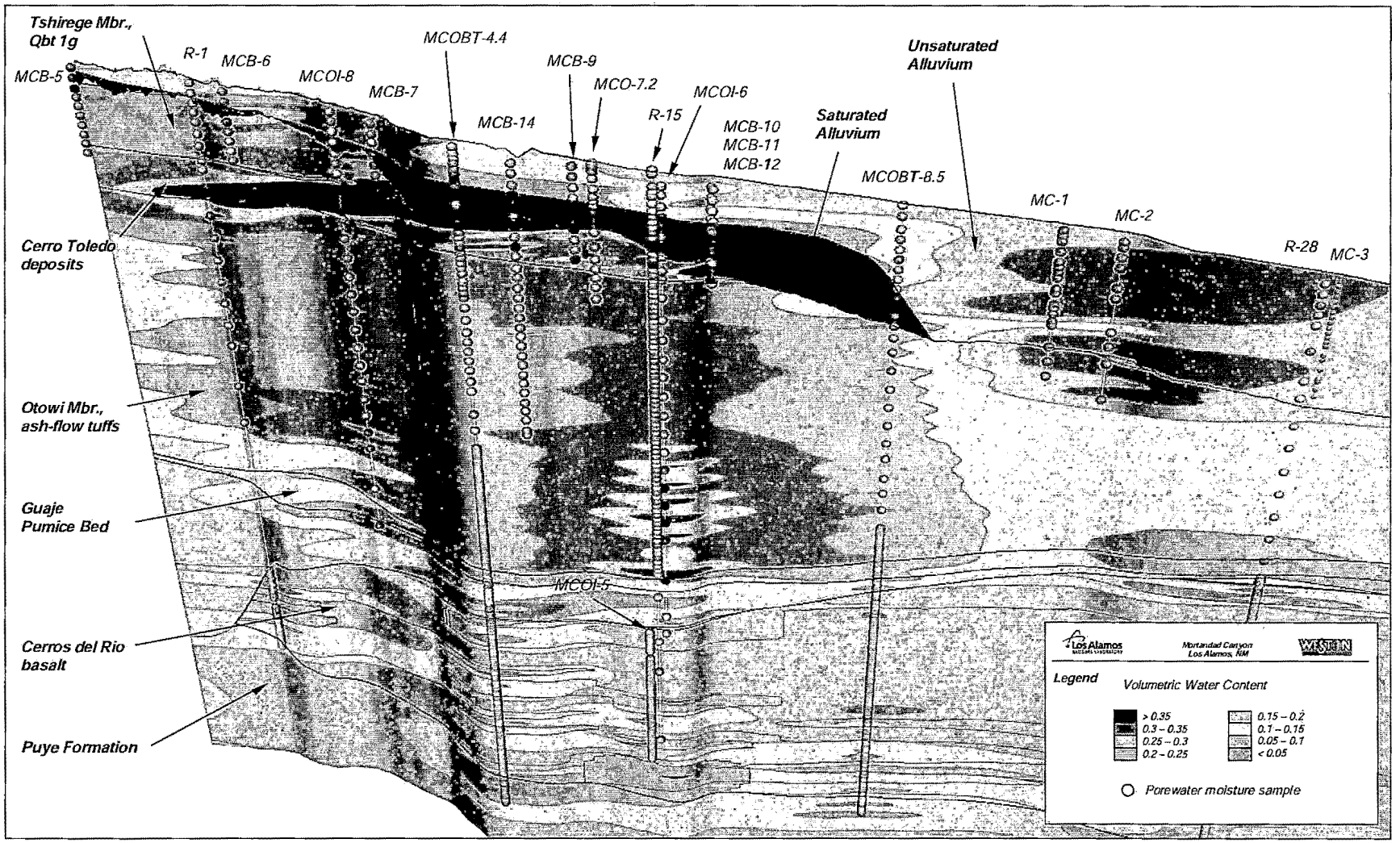


Figure 7.2-11. Cross section showing estimated volumetric moisture content based on borehole porewater measurements and saturated conditions occurring in alluvium and perched-intermediated groundwater

075651

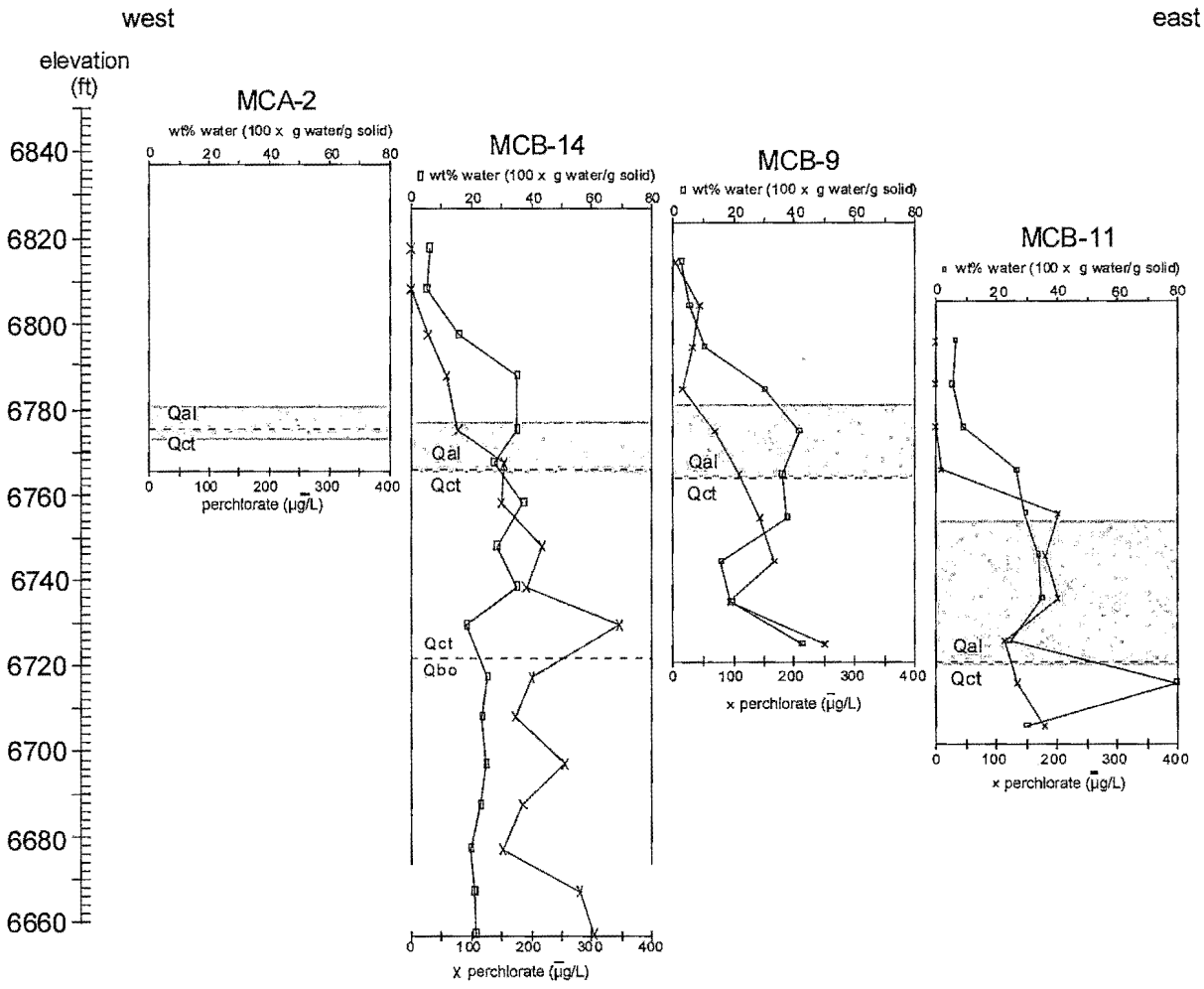
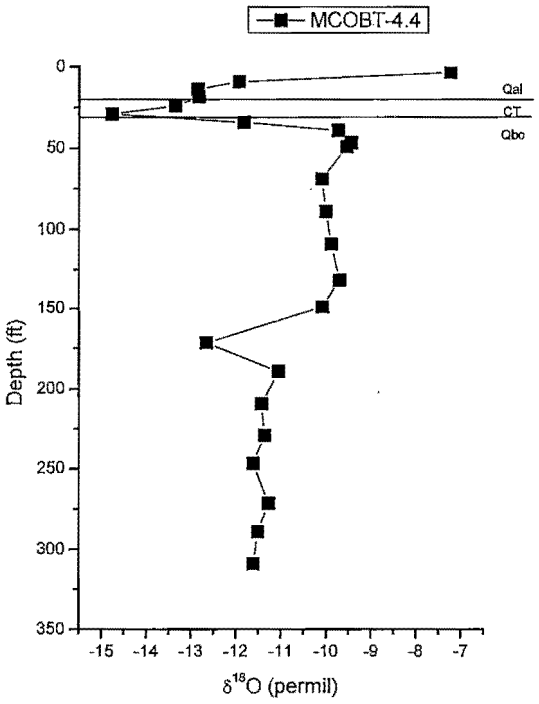


Figure 7.2-12. Comparison of alluvial groundwater occurrences (blue-shaded areas) with moisture and perchlorate profiles in wells MCA-2, MCB-9, MCB-11 and MCB-14

07652



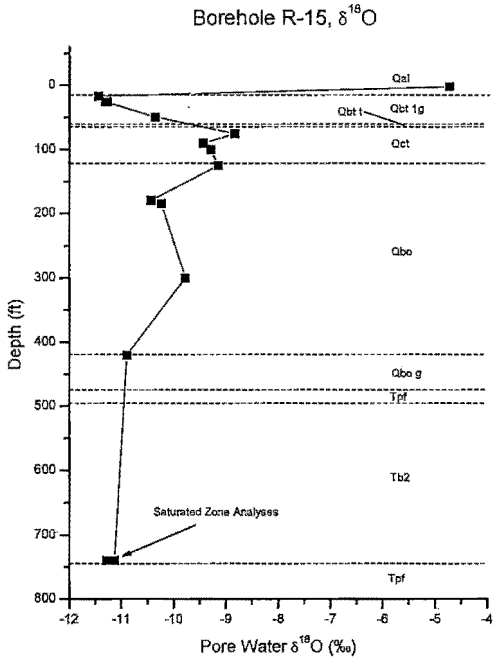


Figure 7.2-13. Oxygen isotope profiles for boreholes MCOBT-4.4, R-15 and MCOBT-8.5

07653

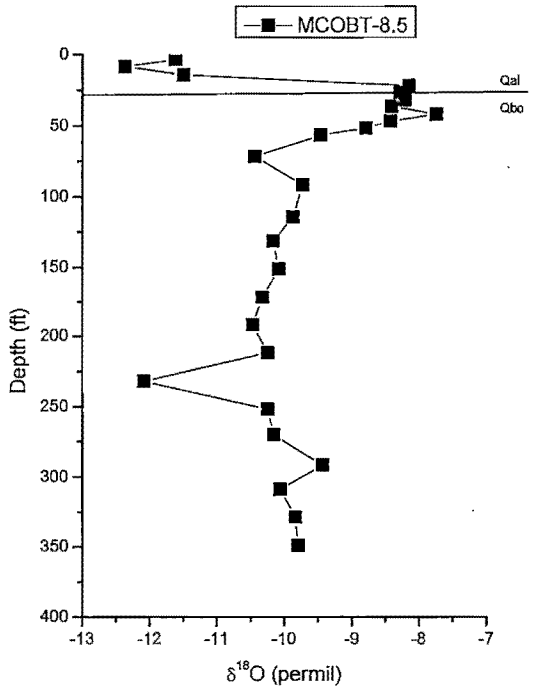


Figure 7.2-13 (continued). Oxygen isotope profiles for boreholes MCOBT-4.4, R-15 and MCOBT-8.5

07654

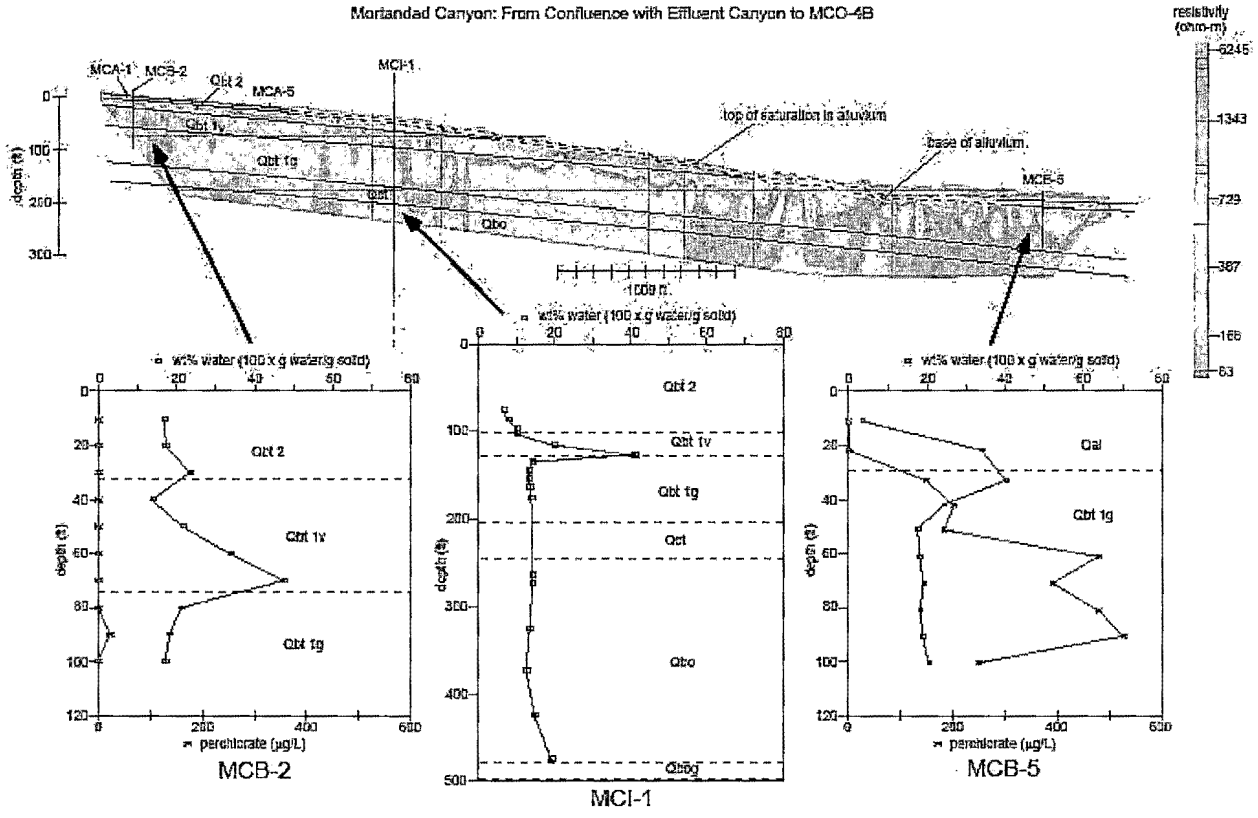


Figure 7.2-14. DC Resistivity profiles results compared to vadose-zone gravimetric moisture and porewater perchlorate concentrations for boreholes MCB-2, MCIO-I and MCB-5

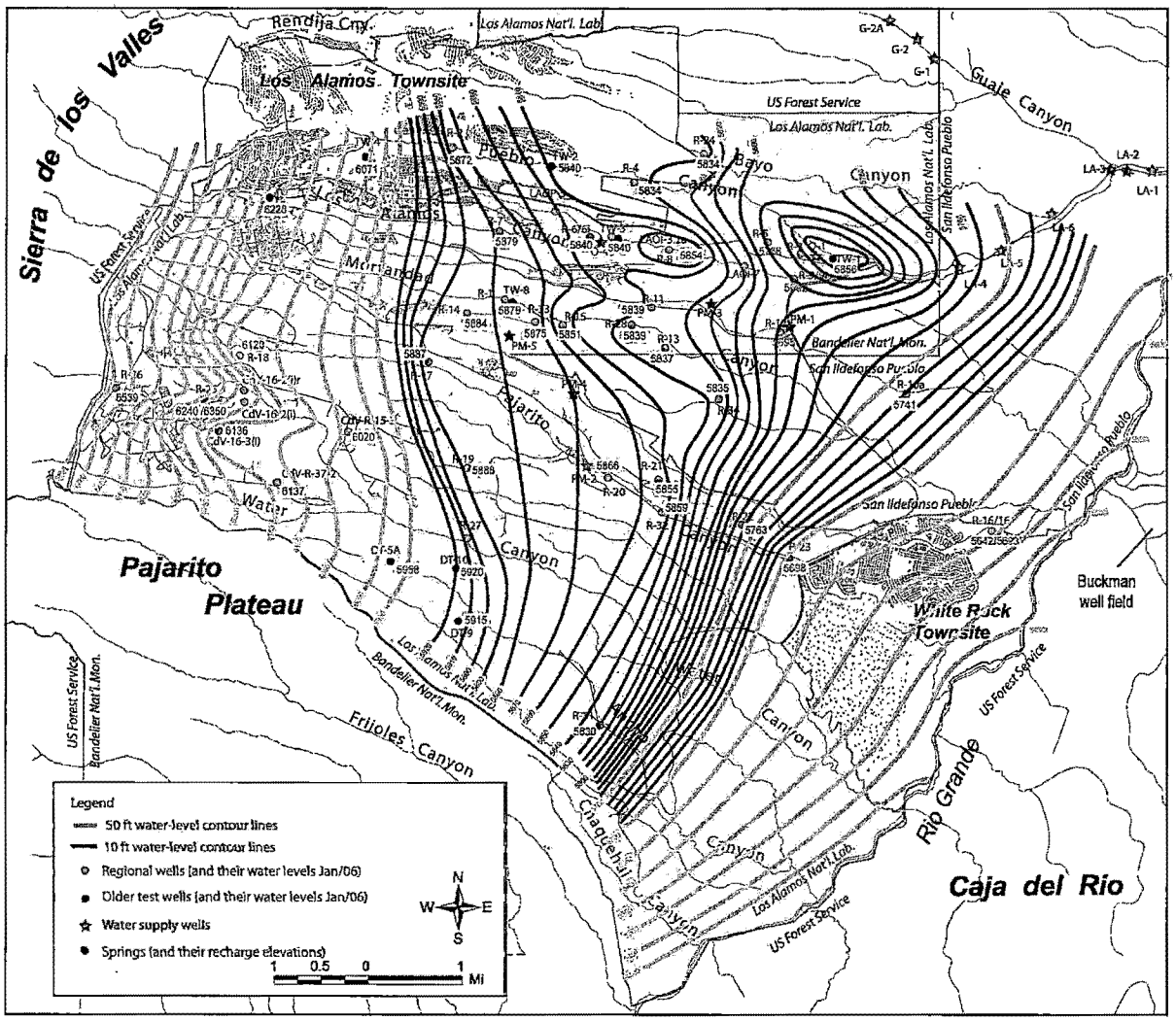
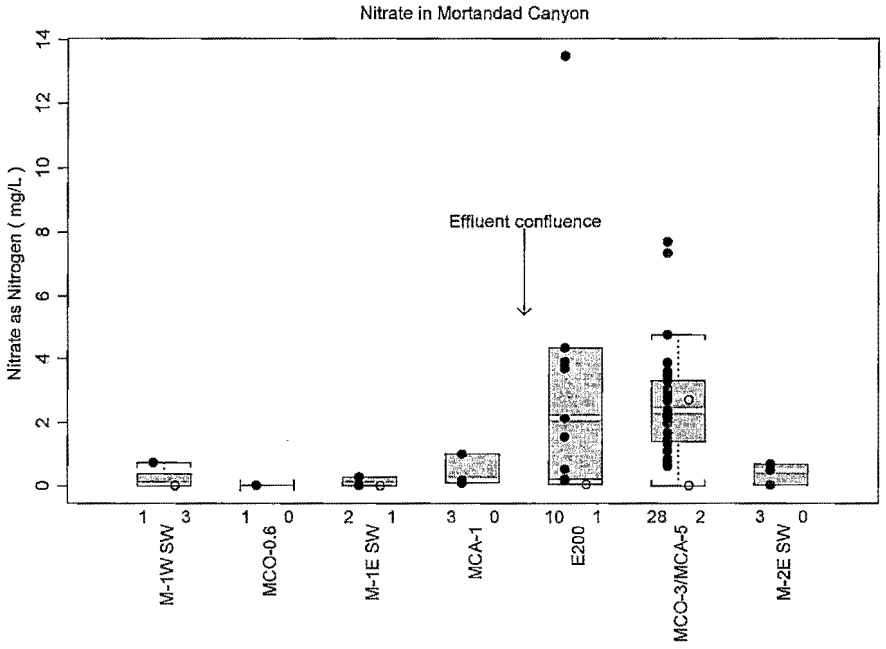
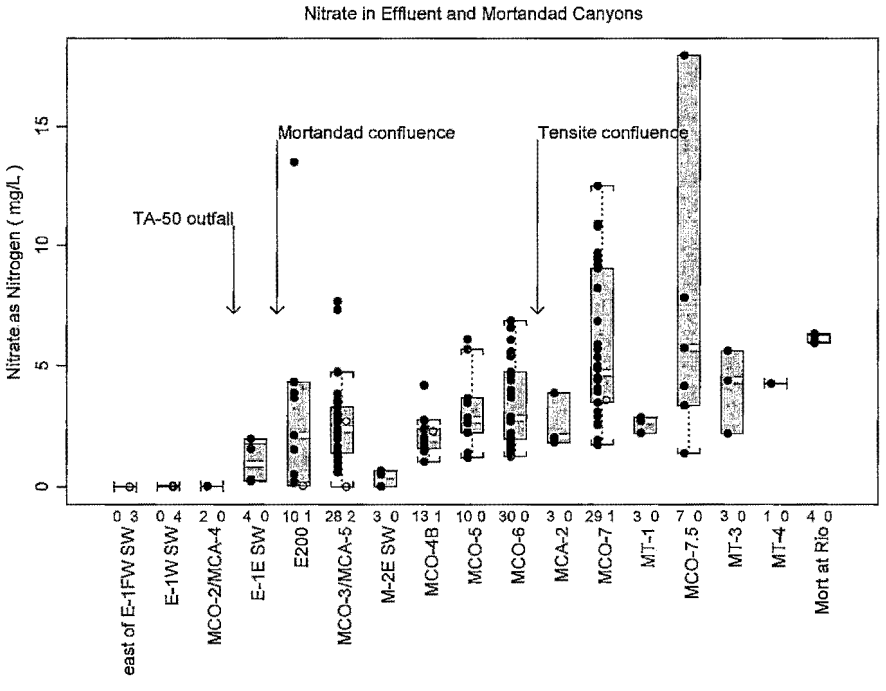


Figure 7.2-15. Water-table map based on January 2006 water-level data

07656



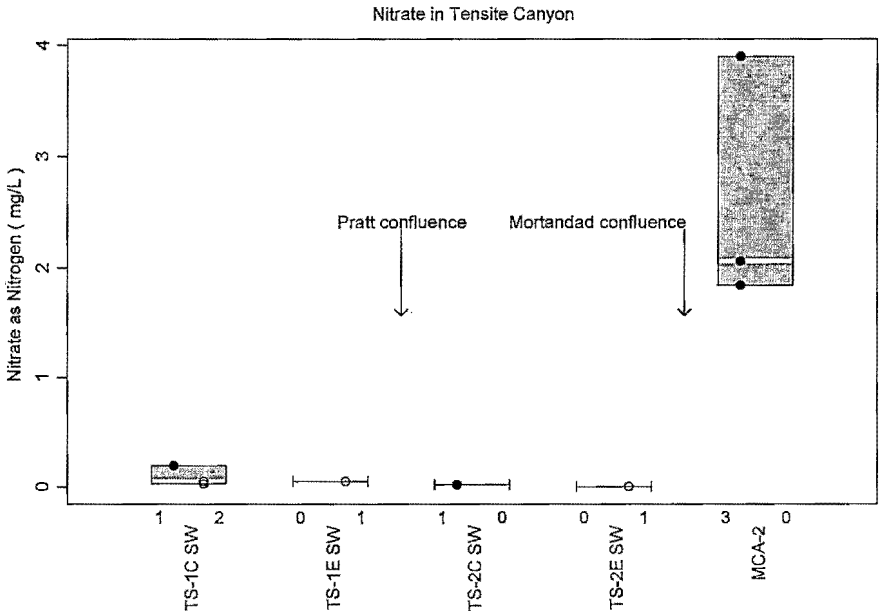
(a)



(b)

Figure 7.2-16. Box plots showing the spatial distribution of nitrate (as N) at surface water and alluvial groundwater locations in both filtered and non-filtered samples (a) the upper Mortandad Canyon hydrologic segment, (b) in Effluent Canyon and in Mortandad Canyon between the Effluent Canyon confluence and the Rio Grande, (c) in Ten Site Canyon to just past the Mortandad Canyon confluence

: 07657



(c)

Figure 7.2-16 (continued). **Box plots showing the spatial distribution of nitrate (as N) at surface water and alluvial groundwater locations in both filtered and non-filtered samples (a) the upper Mortandad Canyon hydrologic segment, (b) in Effluent Canyon and in Mortandad Canyon between the Effluent Canyon confluence and the Rio Grande, (c) in Ten Site Canyon to just past the Mortandad Canyon confluence**

07658

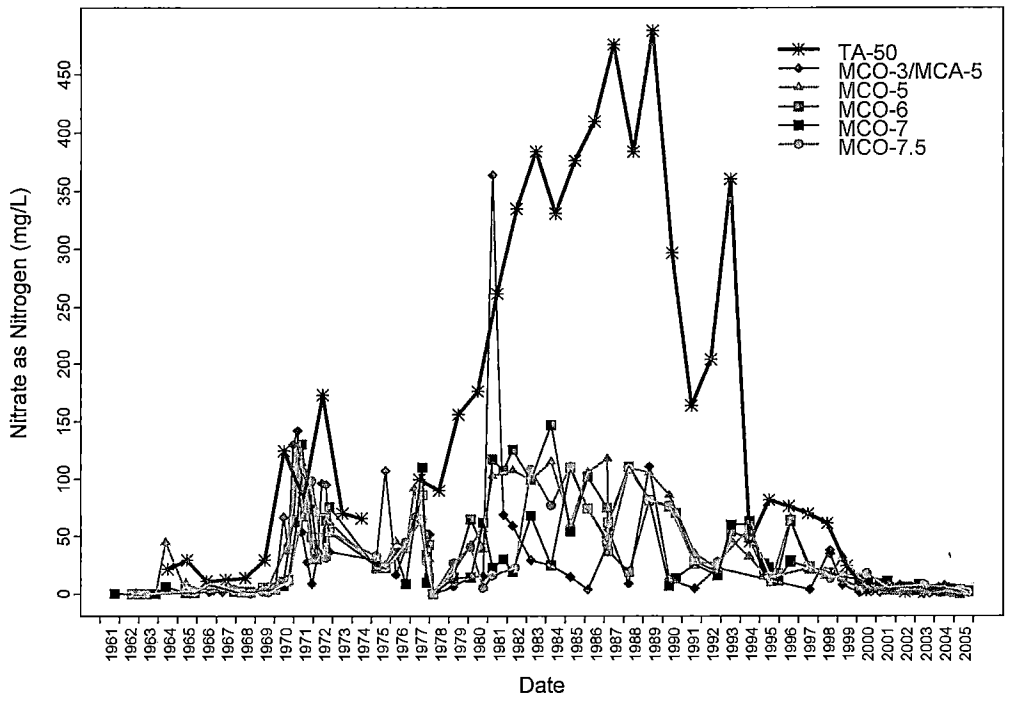


Figure 7.2-17. Comparison of nitrate concentrations (as N, mg/L) in TA-50 RLWTF effluent to those in down-gradient alluvial wells - history since 1960s

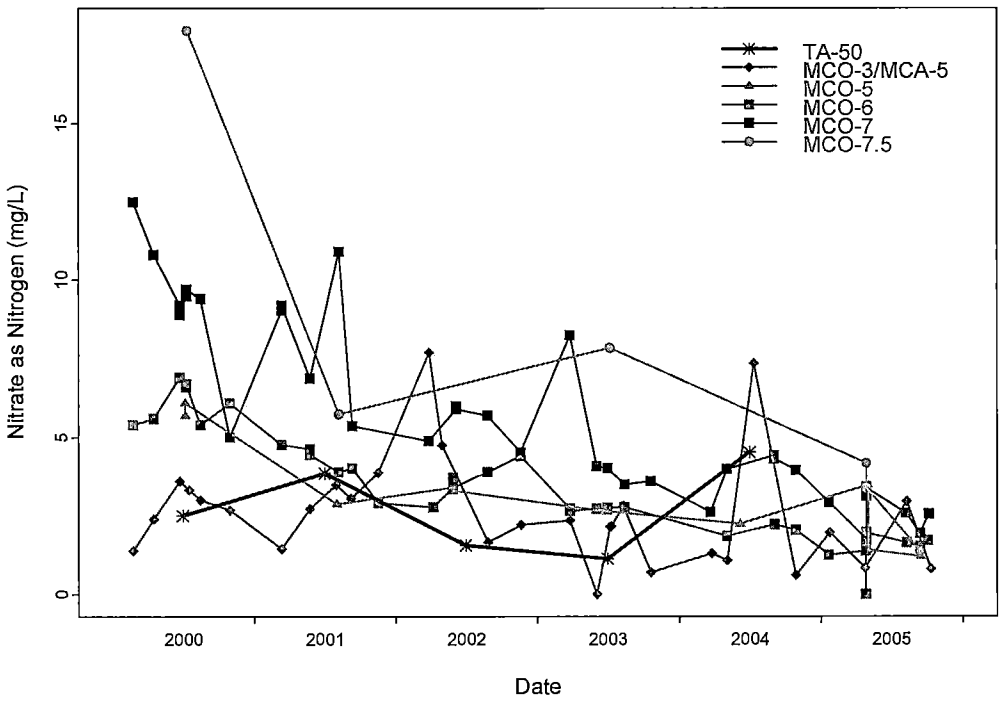


Figure 7.2-18. Comparison of nitrate concentrations (as N, mg/L) in TA-50 RLWTF effluent to those in down-gradient alluvial wells - history since 2000

: 07659

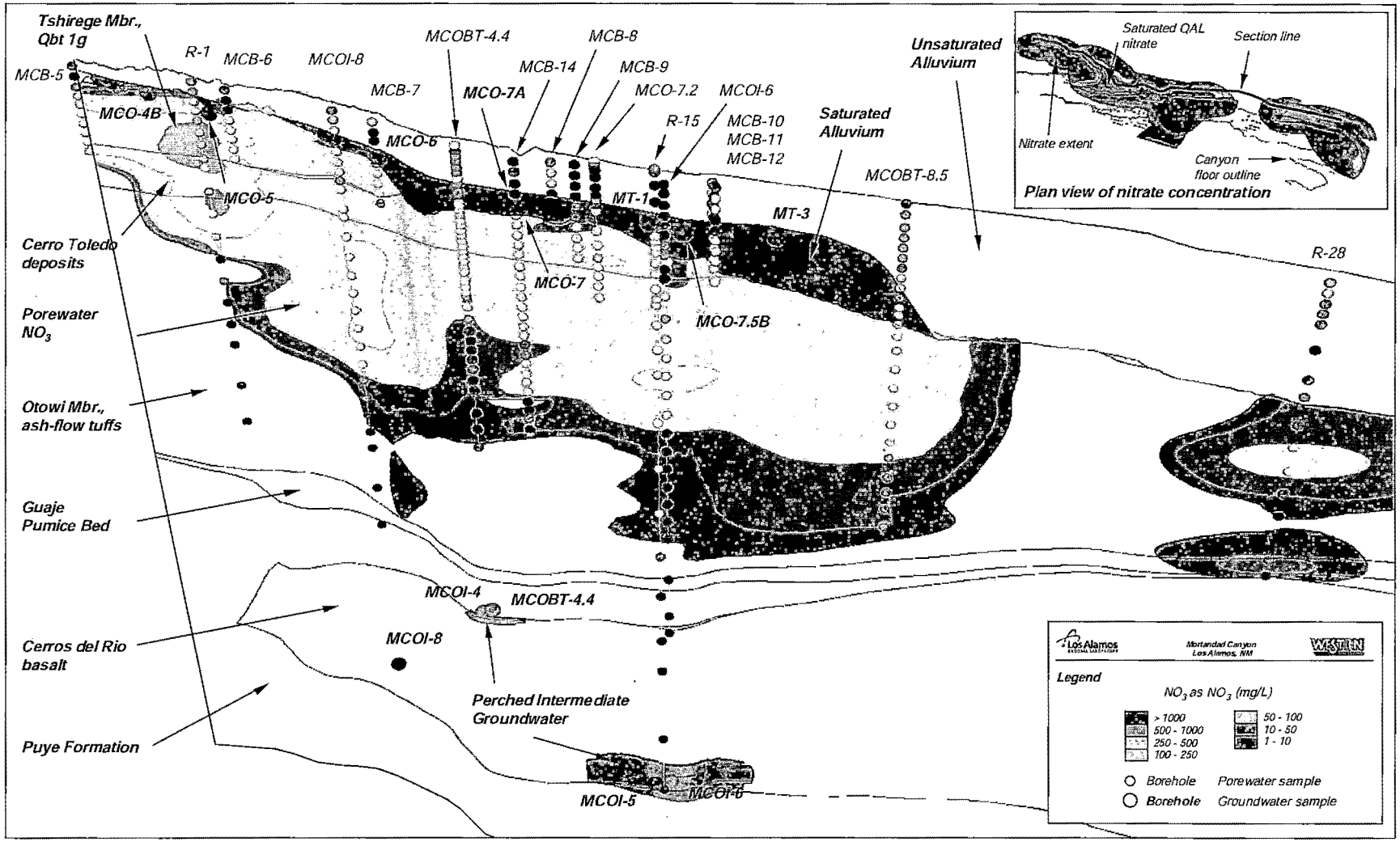


Figure 7.2-19. Cross section showing estimated nitrate concentrations (NO_3 as NO_3, mg/L) in Mortandad Canyon vadose-zone pore water and perched-intermediate groundwater

09/29/06

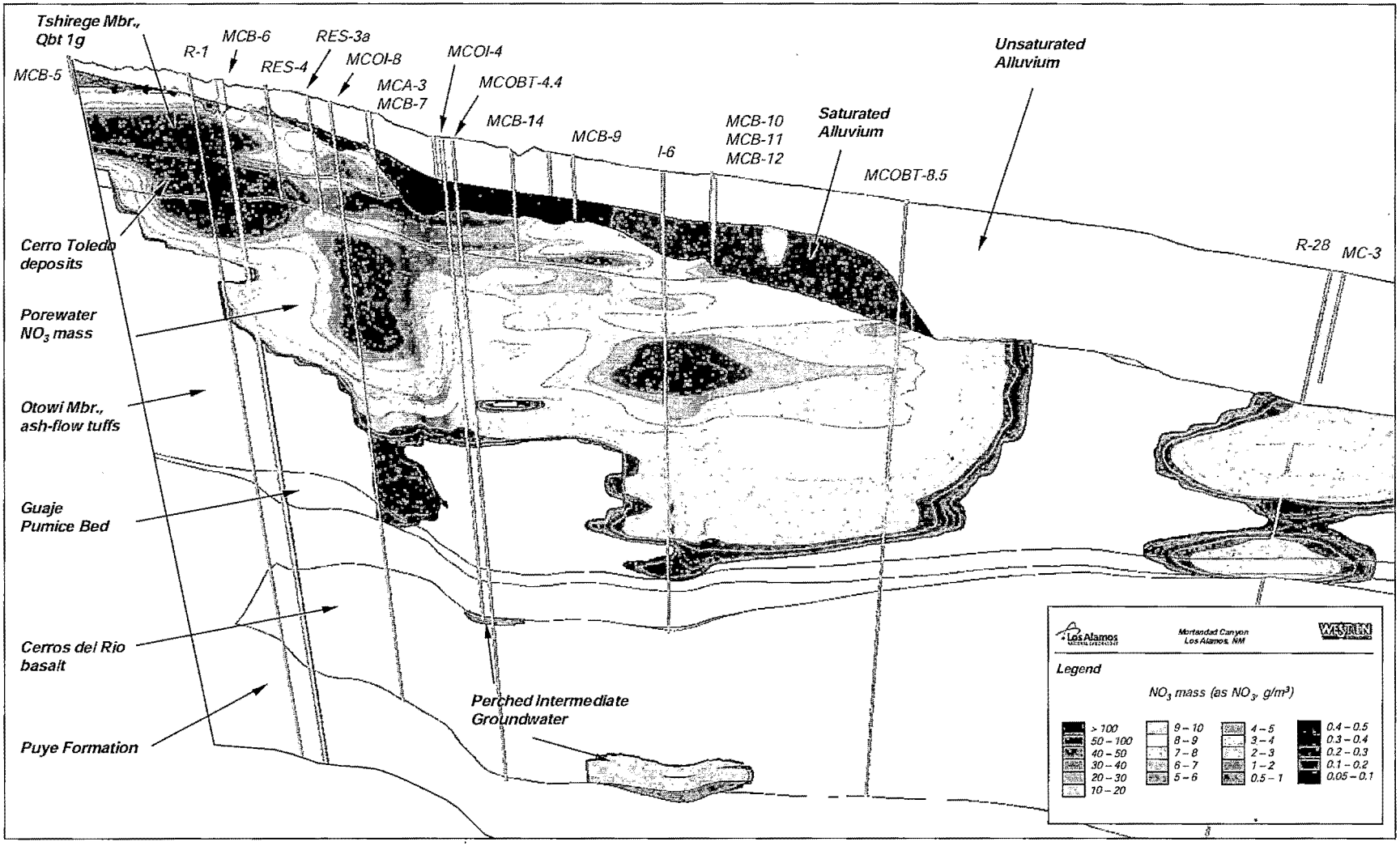


Figure 7.2-20. Cross section showing estimated nitrate mass (g NO_3 as NO_3/m^3 rock) distribution located within Mortandad Canyon vadose-zone pore water and perched-intermediate groundwater

9764

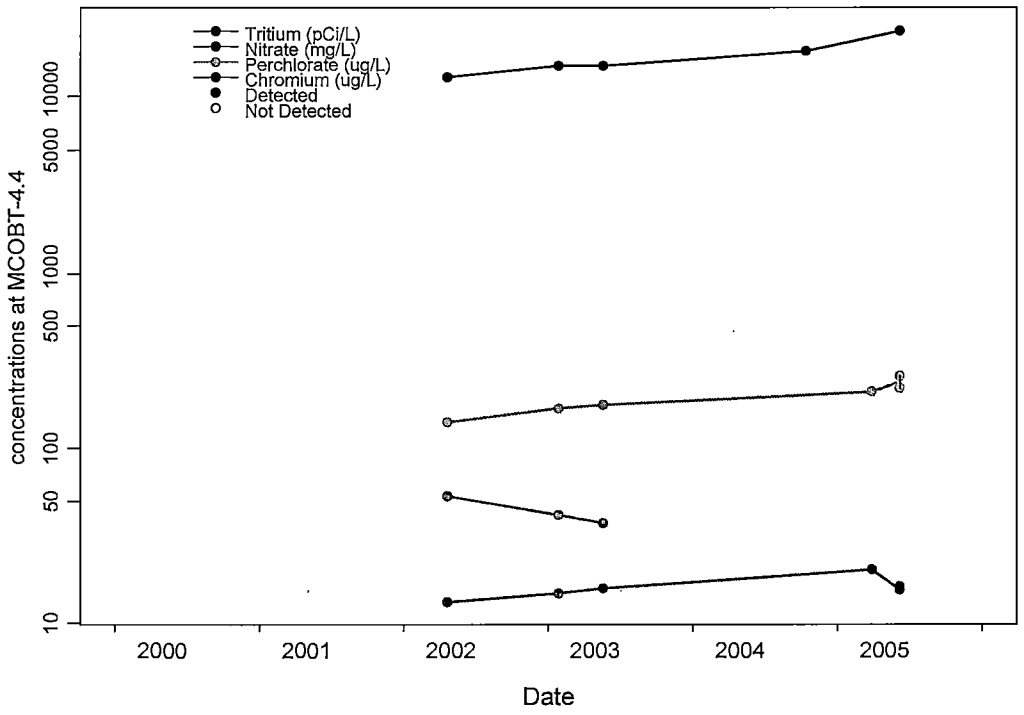


Figure 7.2-21. Concentrations of nitrate (as N), perchlorate, filtered chromium and tritium in perched-intermediate groundwater for period of record in well MCOBT-4.4

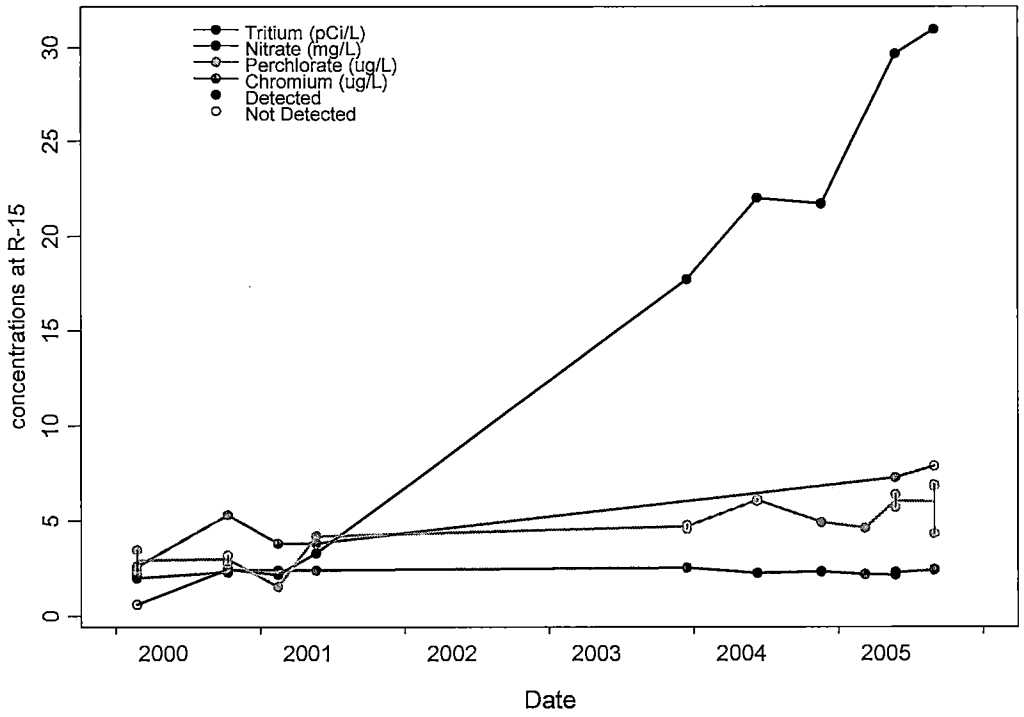


Figure 7.2-22. Concentrations of nitrate (as N), perchlorate, filtered chromium and tritium in regional groundwater for period of record in well R-15

07662

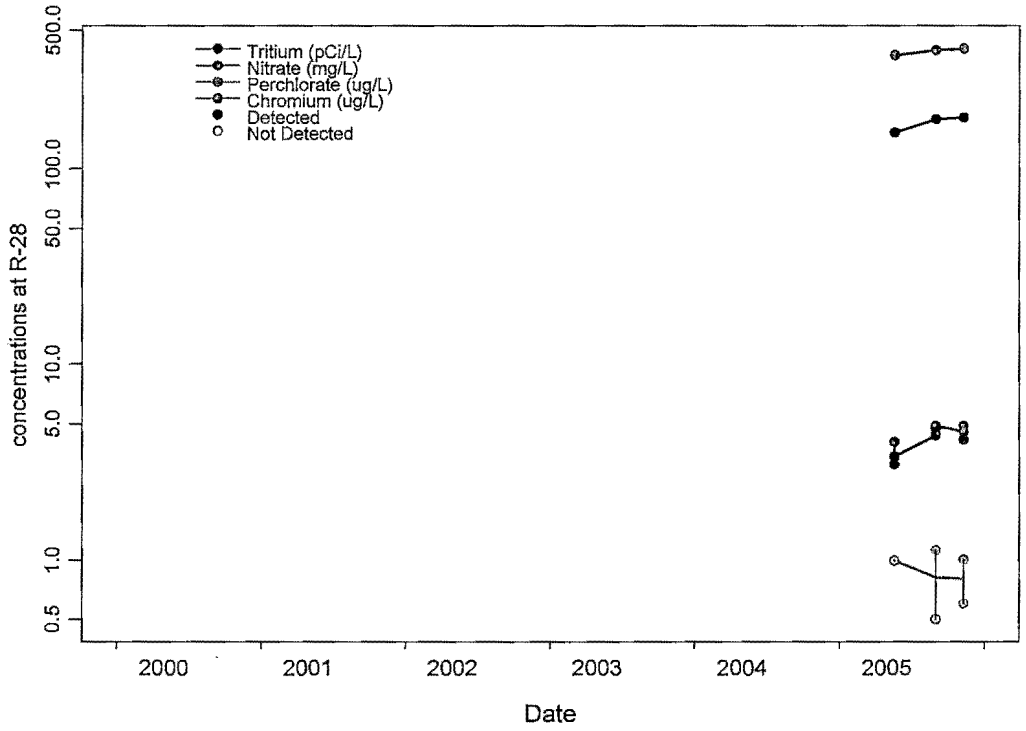
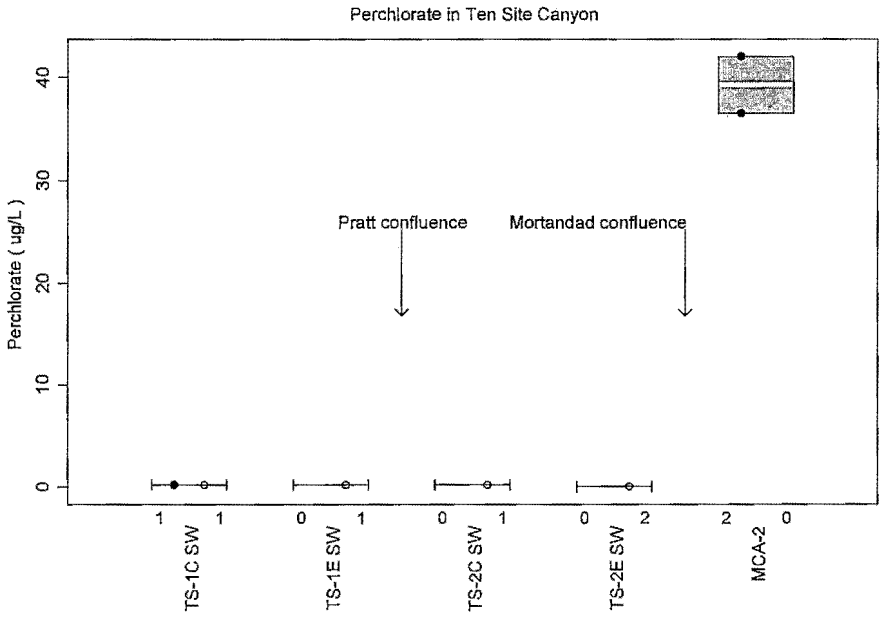
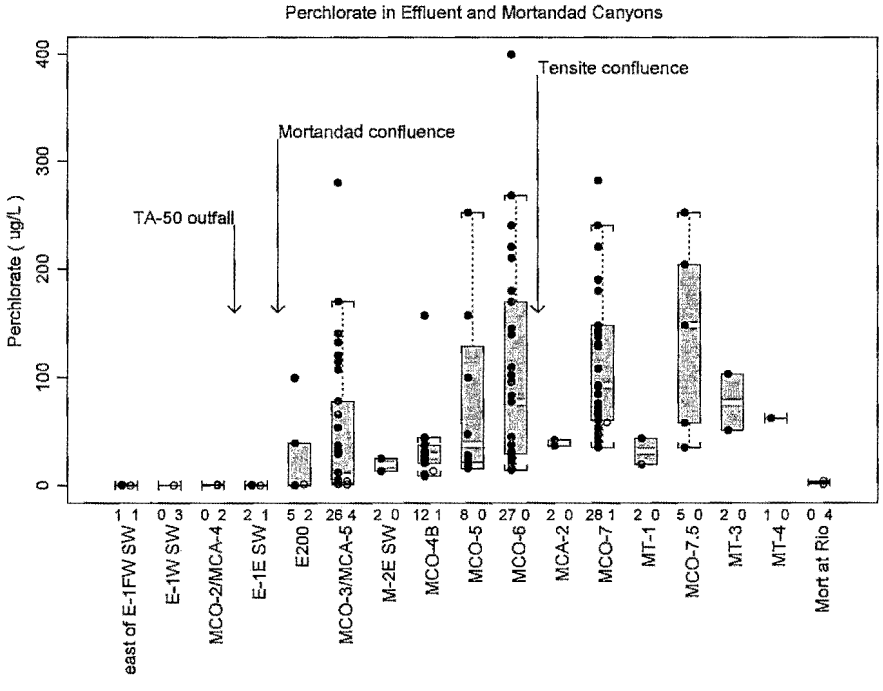


Figure 7.2-23. Concentrations of nitrate (as N), perchlorate, filtered chromium and tritium in regional groundwater for period of record in well R-28

: 07663



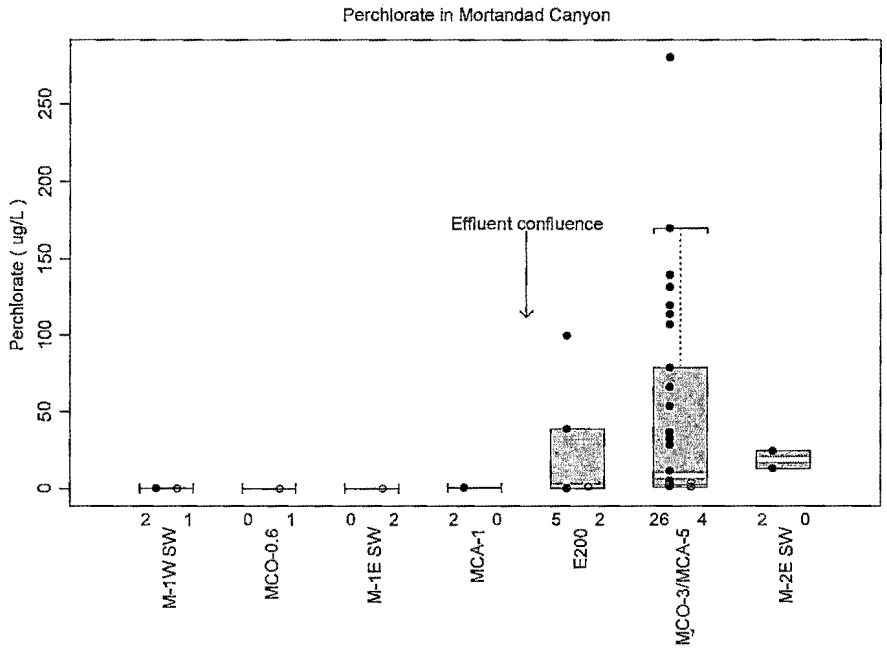
(a)



(b)

Figure 7.2-24. Box plots showing the spatial distribution of perchlorate (µg/L) at surface water and alluvial groundwater locations in both filtered and non-filtered samples (a) the upper Mortandad Canyon hydrologic segment, (b) in Effluent Canyon and in Mortandad Canyon between the Effluent Canyon confluence and the Rio Grande, (c) in Ten Site Canyon to just past the Mortandad Canyon confluence

07664



(c)

Figure 7.2-24 (continued). **Box plots showing the spatial distribution of perchlorate (µg/L) at surface water and alluvial groundwater locations in both filtered and non-filtered samples (a) the upper Mortandad Canyon hydrologic segment, (b) in Effluent Canyon and in Mortandad Canyon between the Effluent Canyon confluence and the Rio Grande, (c) in Ten Site Canyon to just past the Mortandad Canyon confluence**

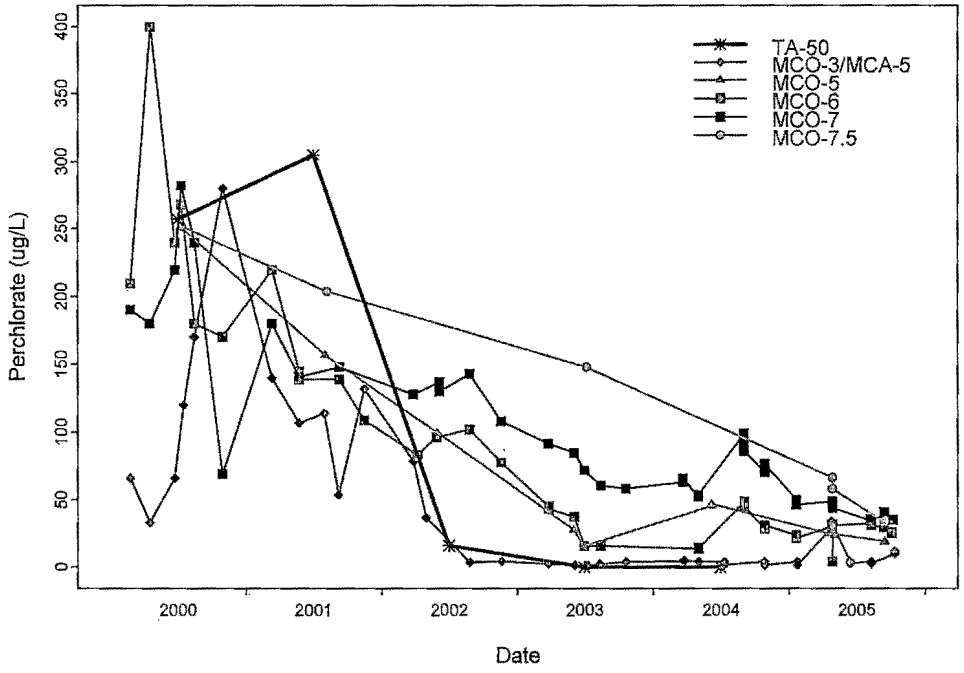


Figure 7.2-25. Comparison of perchlorate concentrations (µg/L) in TA-50 RLWTF effluent to those in down-gradient alluvial wells - history since 2000

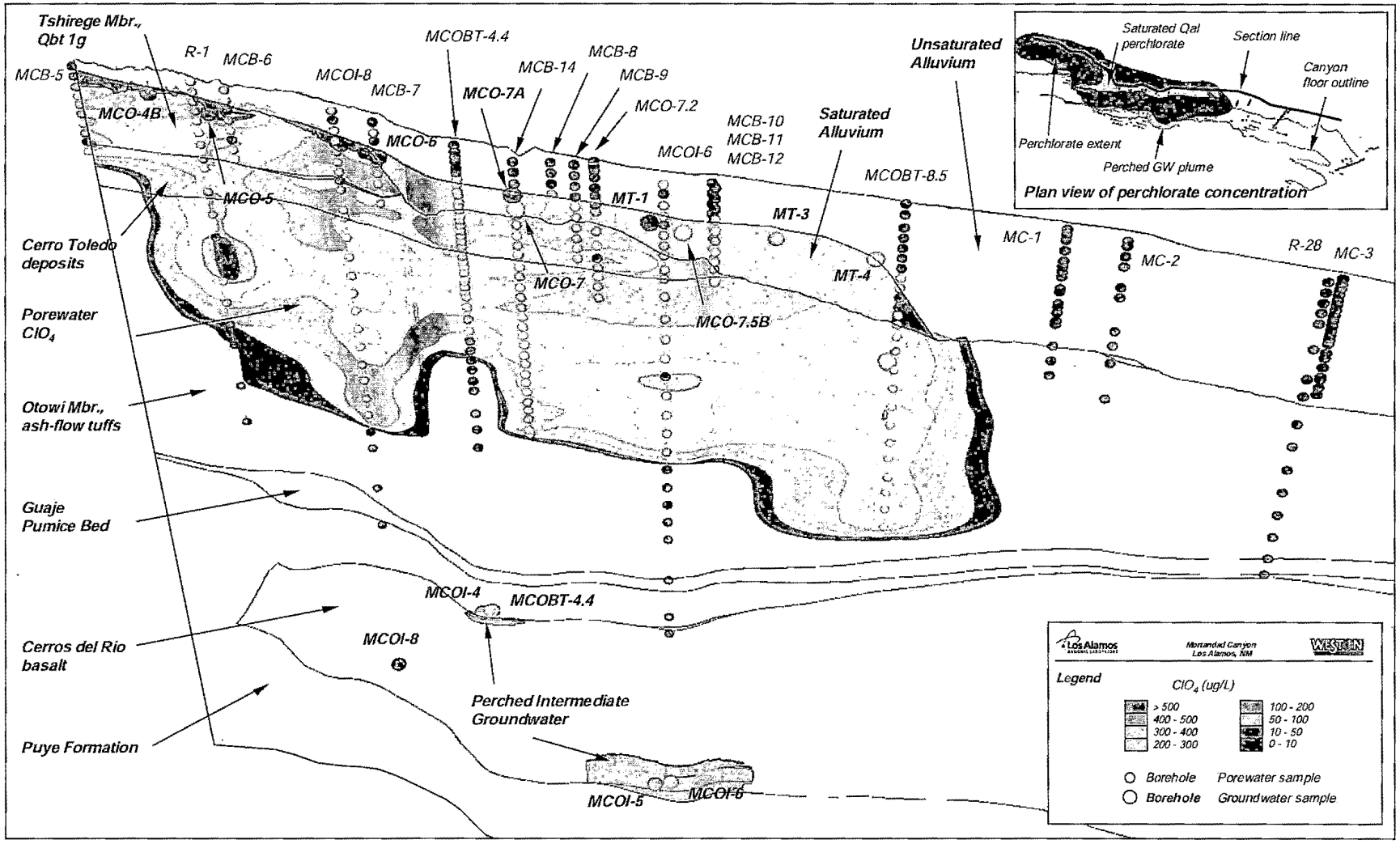


Figure 7.2-26. Cross section showing estimated perchlorate concentration (µg/L) in Mortandad Canyon vadose-zone pore water and perched-intermediate groundwater

07265

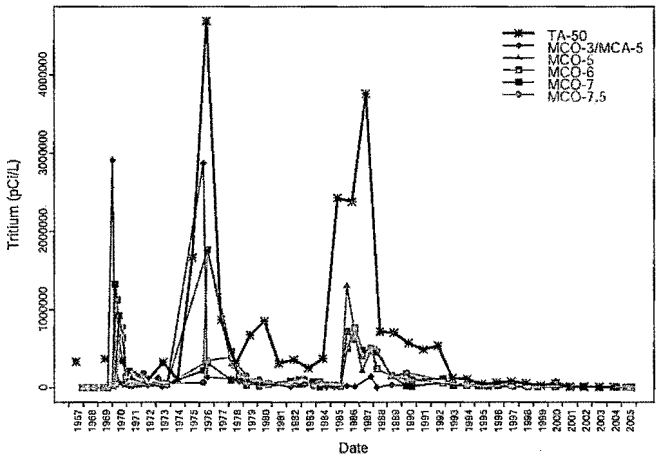


Figure 7.2-27. Comparison of tritium concentrations (pCi/L) in TA-50 RLWTF effluent to those in down-gradient alluvial wells - history since 1960s

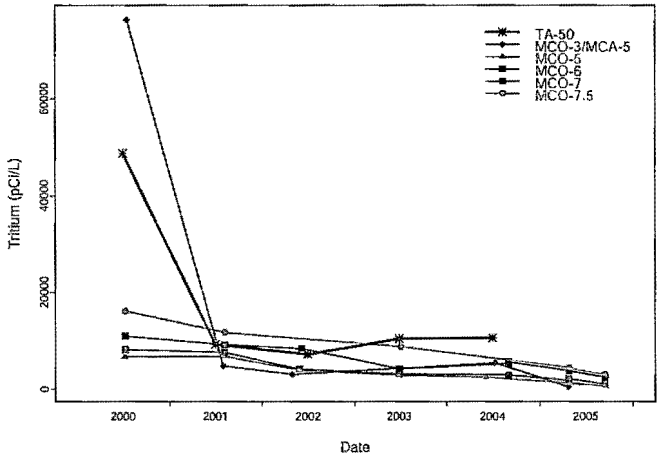


Figure 7.2-28. Comparison of tritium concentrations (pCi/L) in TA-50 RLWTF effluent to those in down-gradient alluvial wells - history since 2000

9769

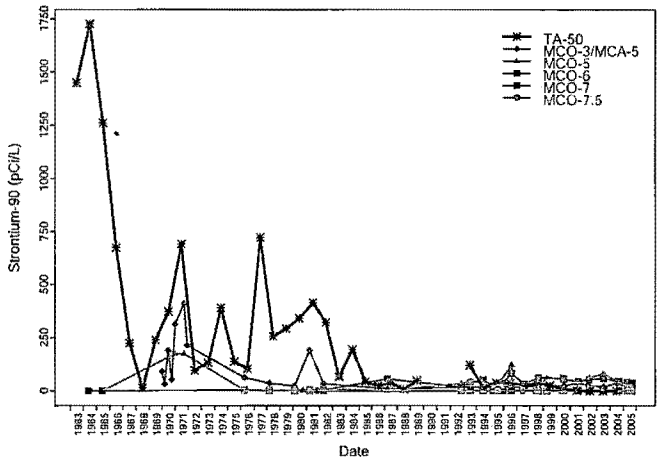


Figure 7.2-29. Comparison of strontium-90 concentrations (pCi/L) in TA-50 RLWTF effluent to those in down-gradient alluvial wells - history since 1960s

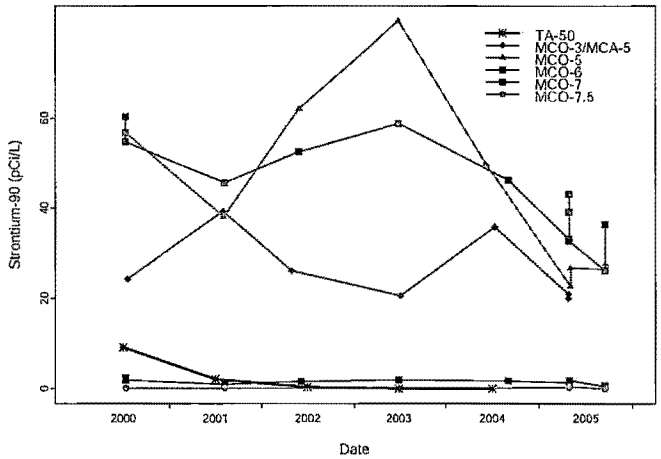


Figure 7.2-30. Comparison of strontium-90 concentrations (pCi/L) in TA-50 RLWTF effluent to those in down-gradient alluvial wells - history since 2000

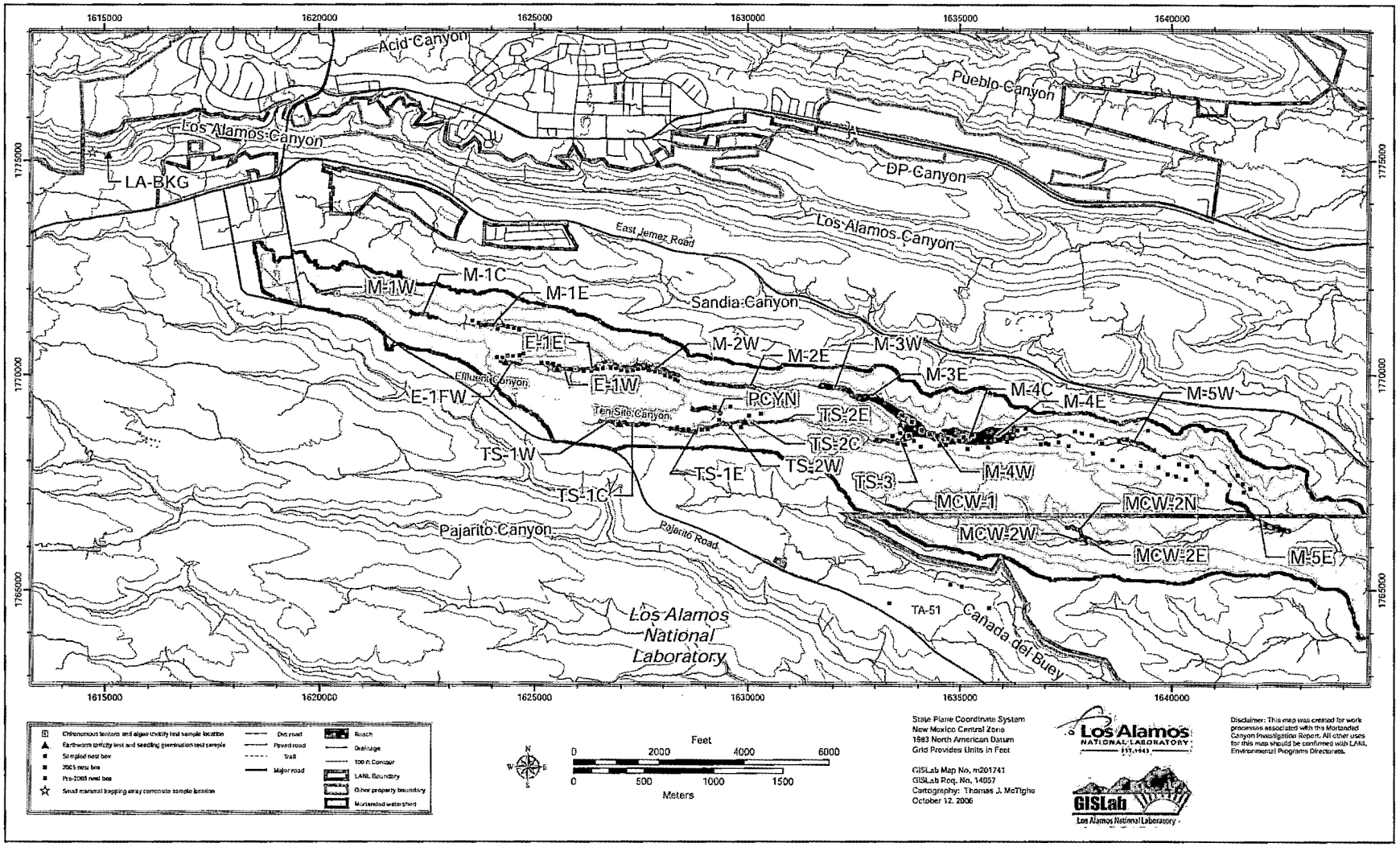


Figure 8.1-1. Map of reaches and sample locations

9159

Key to Bird Species in Figures 8.1-2 to 8.1-11: ATFL = ash-throated flycatcher, HOFI = House Finch, HOWR = House wren, JUTI = juniper titmouse, MOBL = mountain bluebird, MOCH = mountain chickadee, PYNU = pygmy nuthatch, VGSW = violet-green swallow, WBNH = white-breasted nuthatch, WEBL = western bluebird

Key to Group Codes in Figures 8.1-2 to 8.1-11: M-# = reach # in Mortandad Canyon, TS-# = reach # in Ten Site Canyon, Mort = all of Mortandad Canyon, Cem = Cemetery, GC = Golf Course, CdB = Cañada del Buey, LA/P = Los Alamos and Pueblo Canyons, TA-35 = Technical Area 35, Other = boxes within nest box network but outside of areas listed above

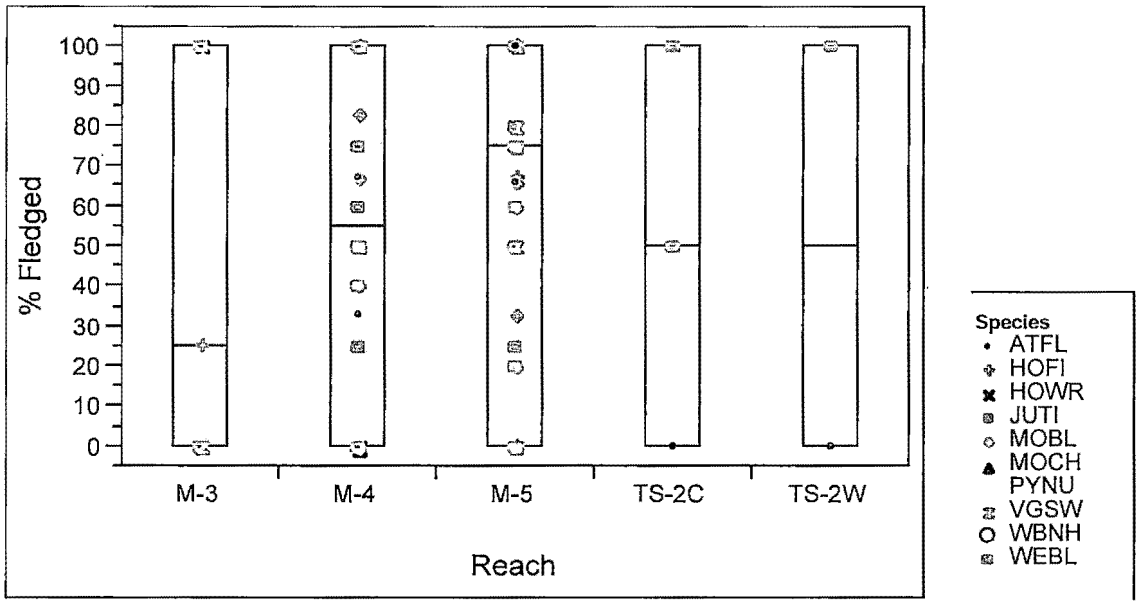


Figure 8.1-2. Box plots showing percent fledged by reach

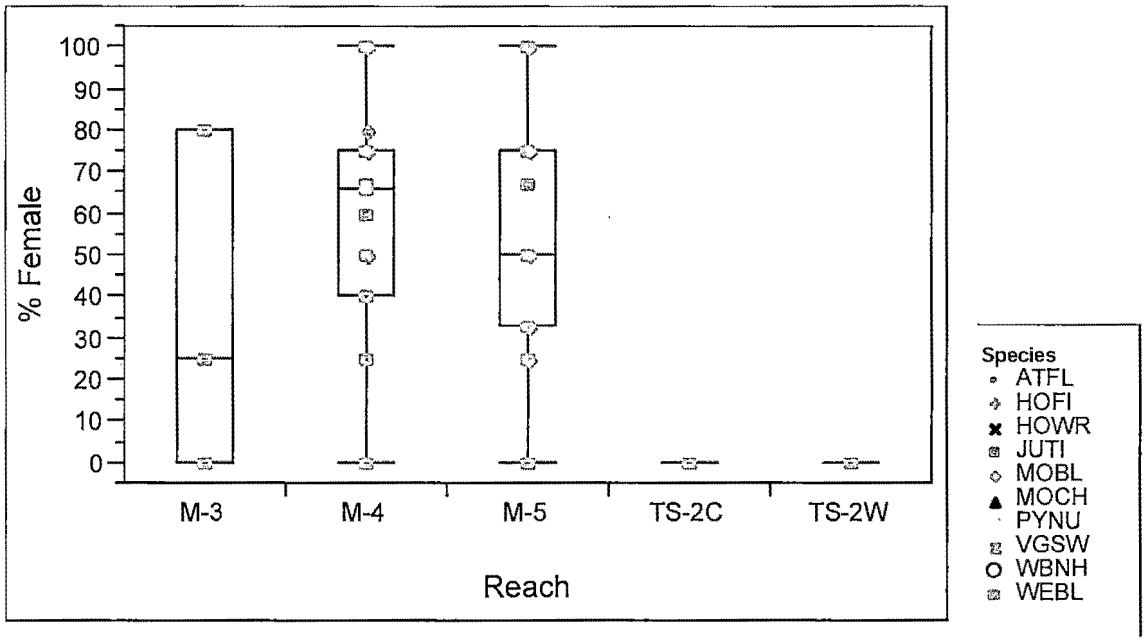


Figure 8.1-3. Box plots showing percent female by reach

07670

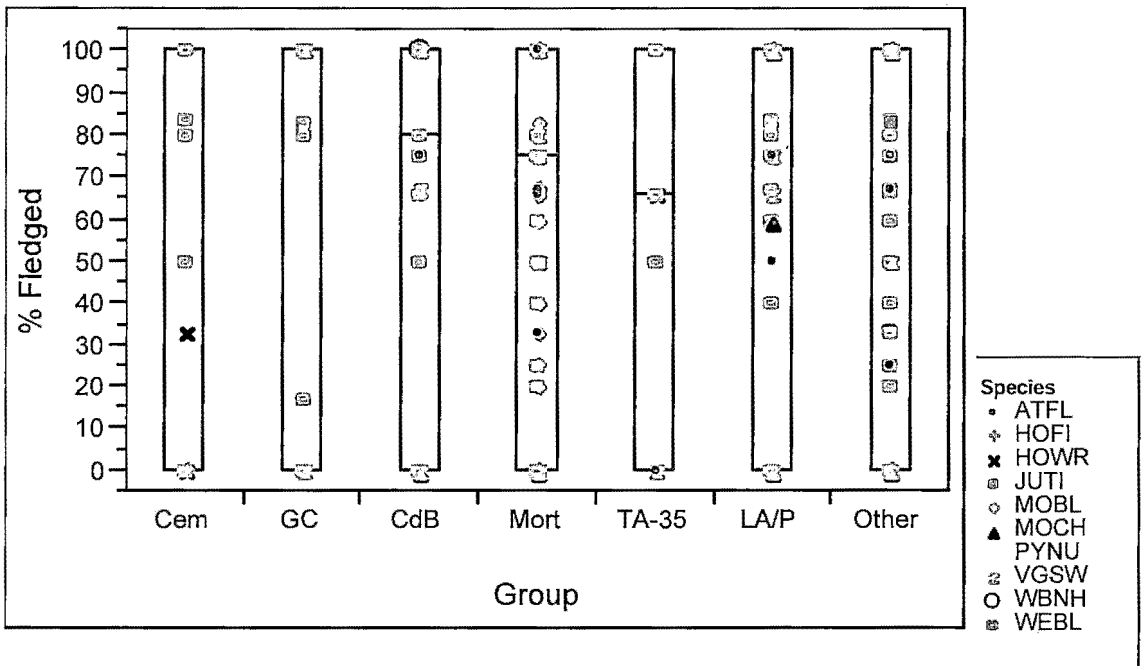


Figure 8.1-4. Box plots showing percent fledged by area (group)

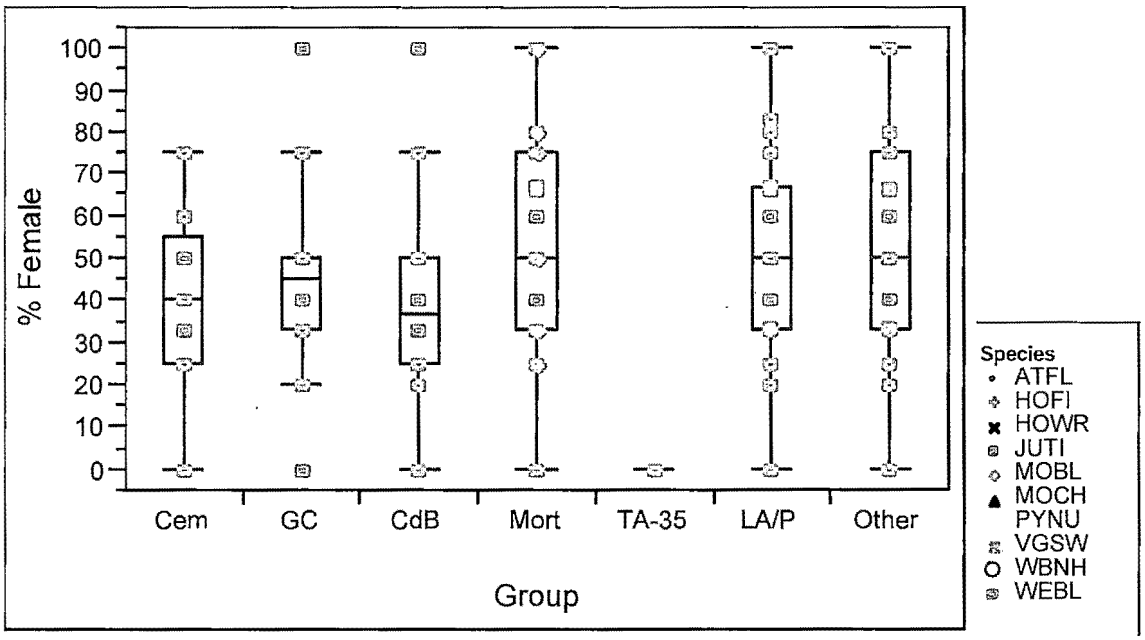


Figure 8.1-5. Box plots showing percent female by area (group)

07671

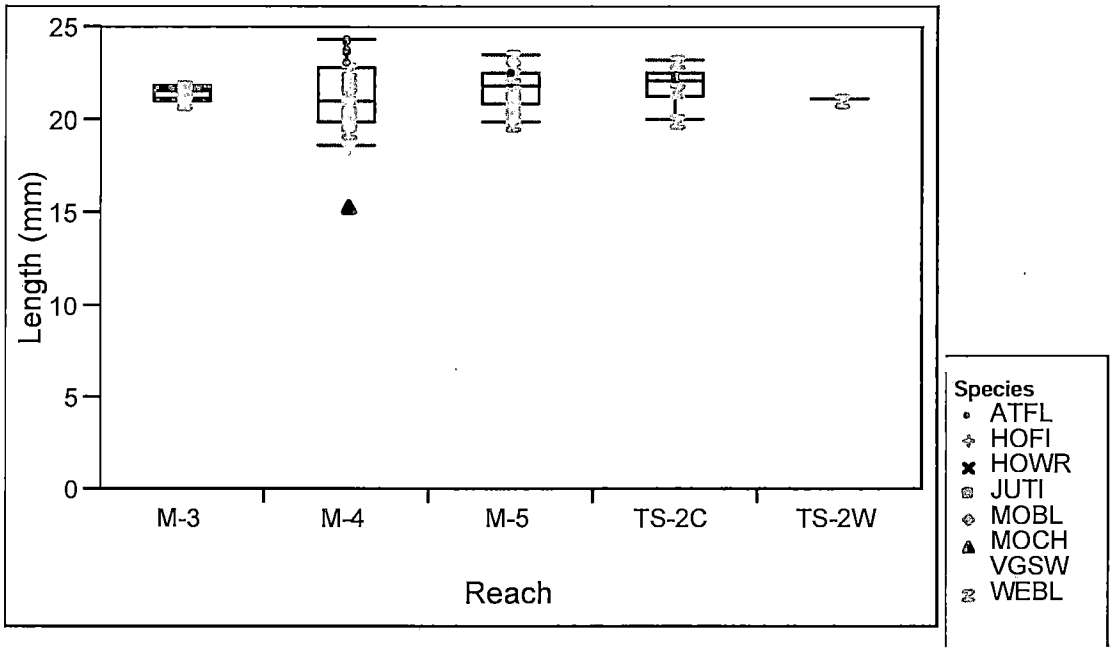


Figure 8.1-6. Box plots showing egg length by reach

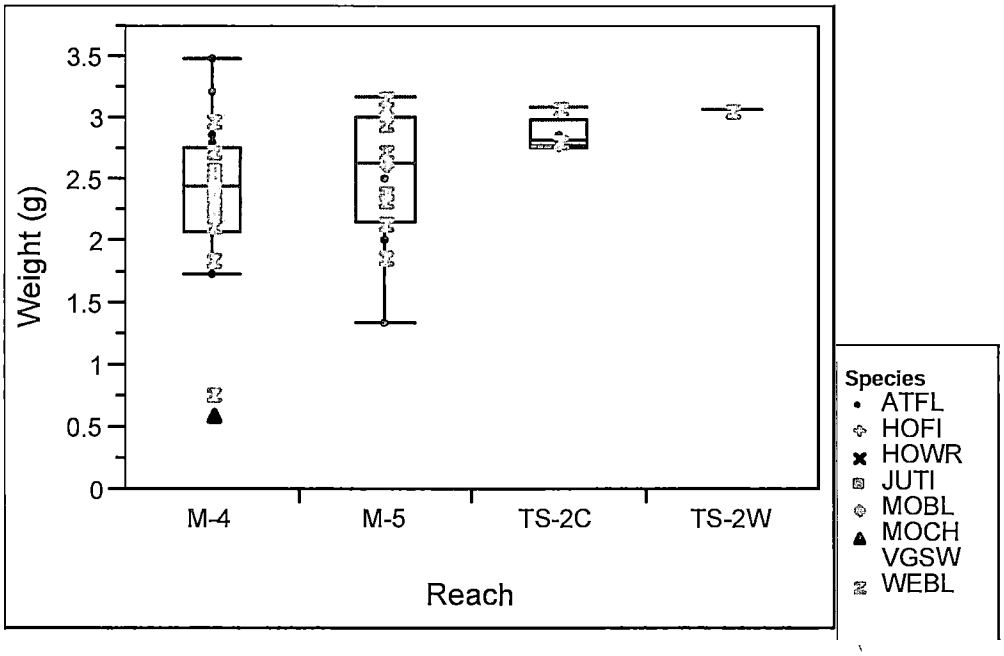


Figure 8.1-7. Box plots showing egg weight by reach

07672

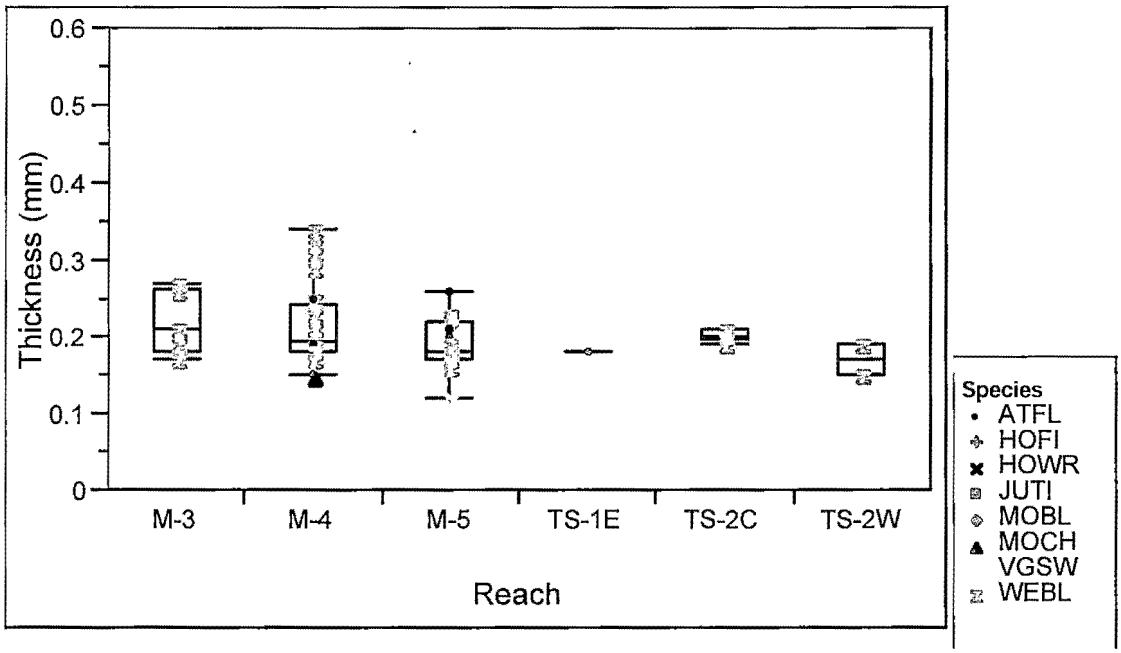


Figure 8.1-8. Box plots showing eggshell thickness by reach

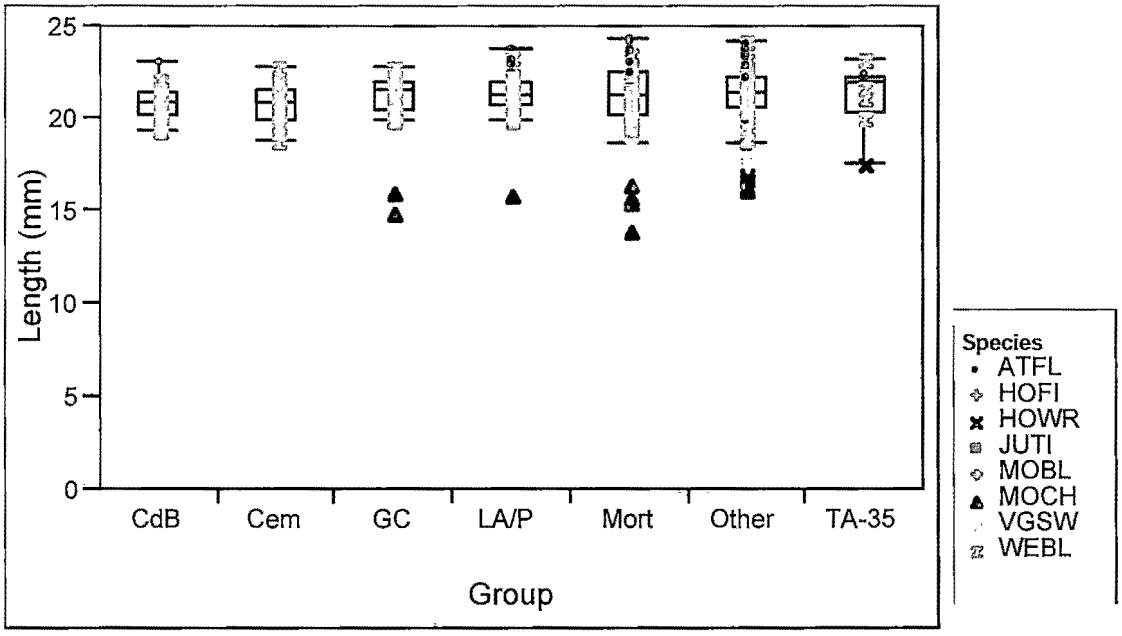


Figure 8.1-9. Box plots showing egg length by group

: 07673

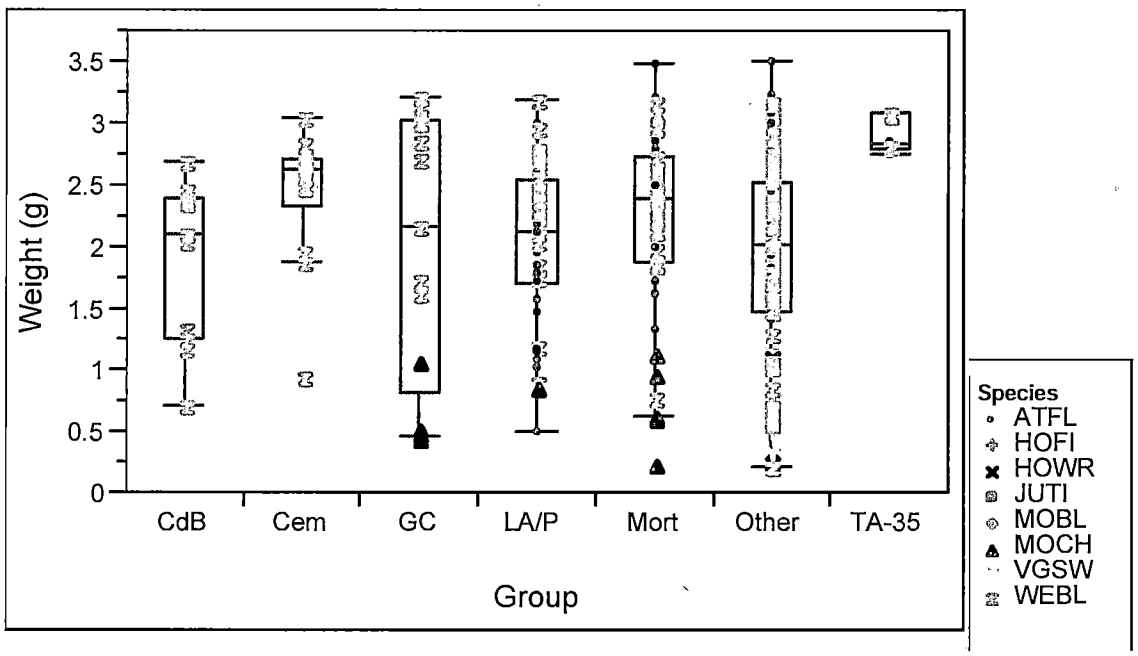


Figure 8.1-10. Box plots showing egg weight by group

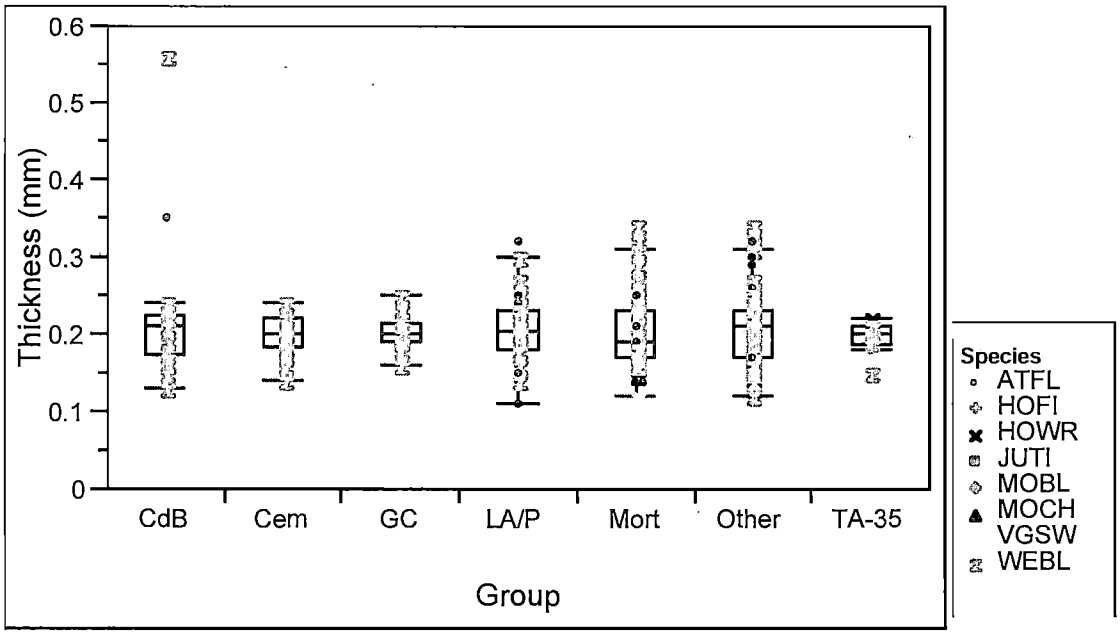


Figure 8.1-11. Box plots showing eggshell thickness by group.

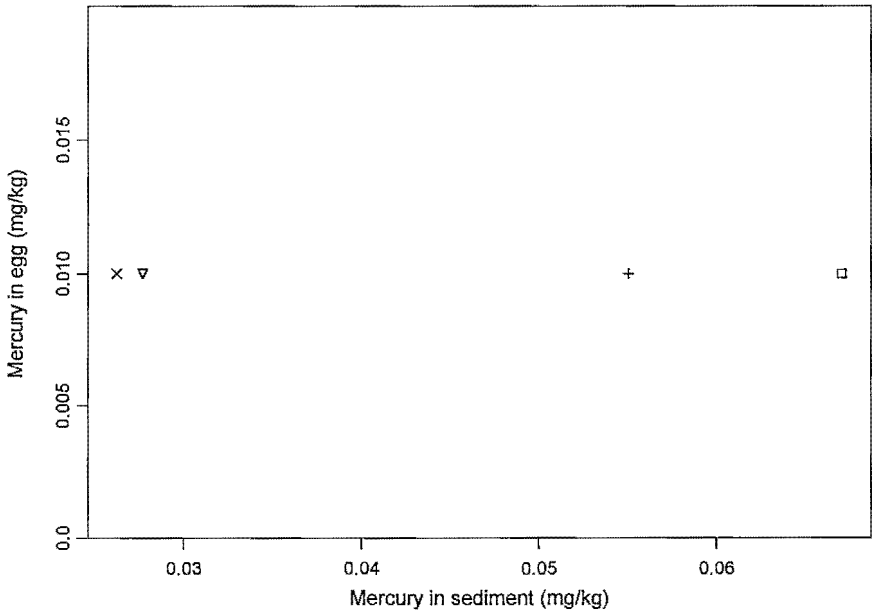


Figure 8.1-12. Concentration of mercury in egg contents

□ = E-1FW, + = M-4, × = M-5W,
△ = TS-1E, ▽ = TS-2W,

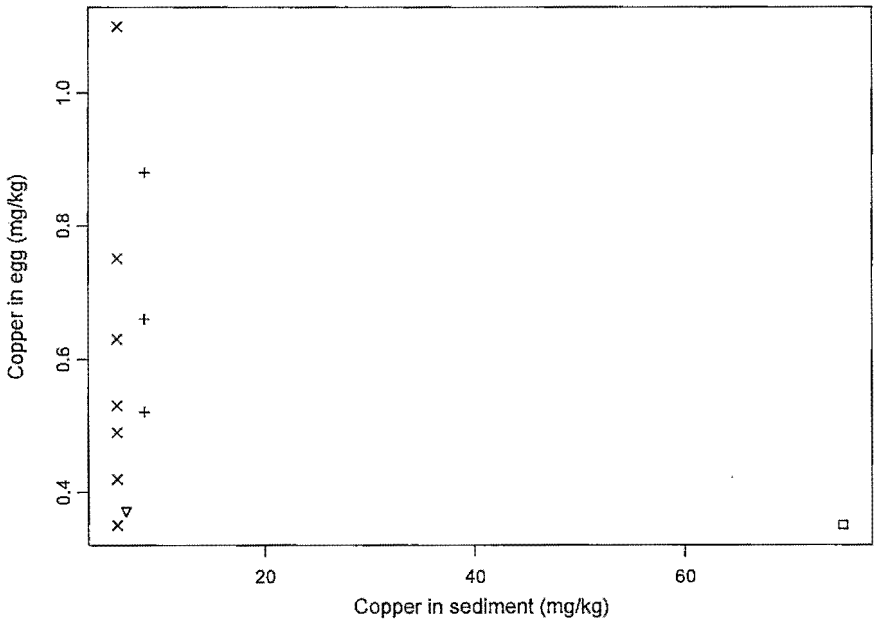


Figure 8.1-13. Concentration of copper in egg contents

: 07675

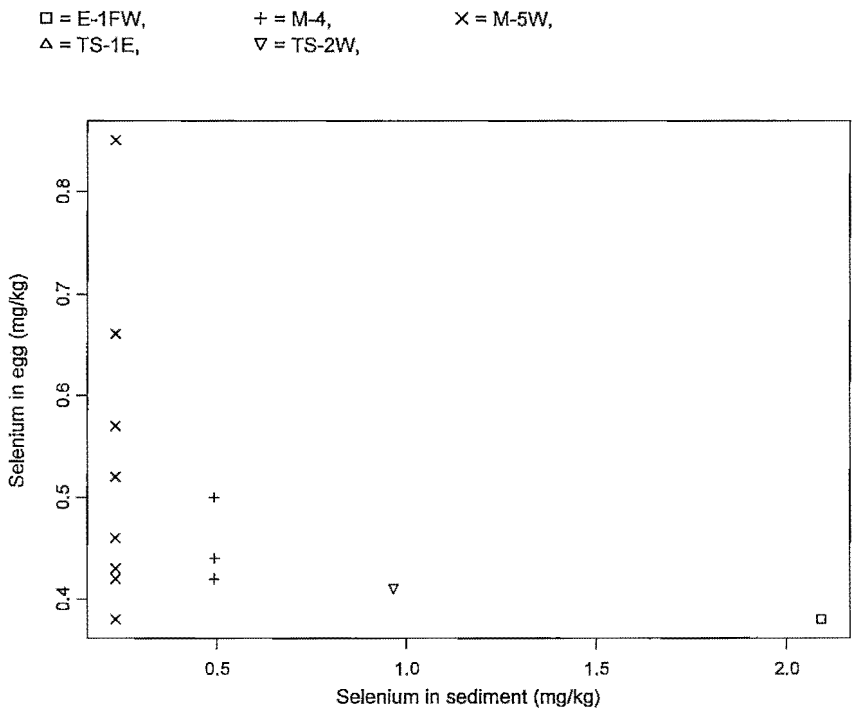


Figure 8.1-14. Concentration of selenium in egg contents

: 07676

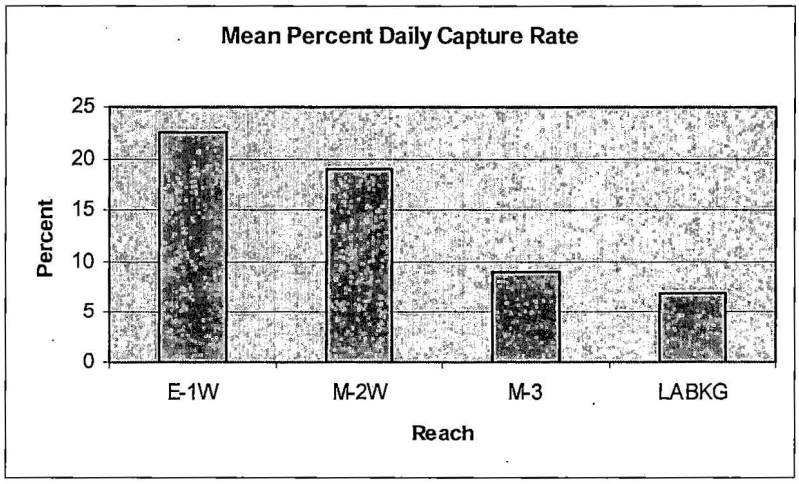


Figure 8.1-15. Mean percent daily capture rate for small mammals

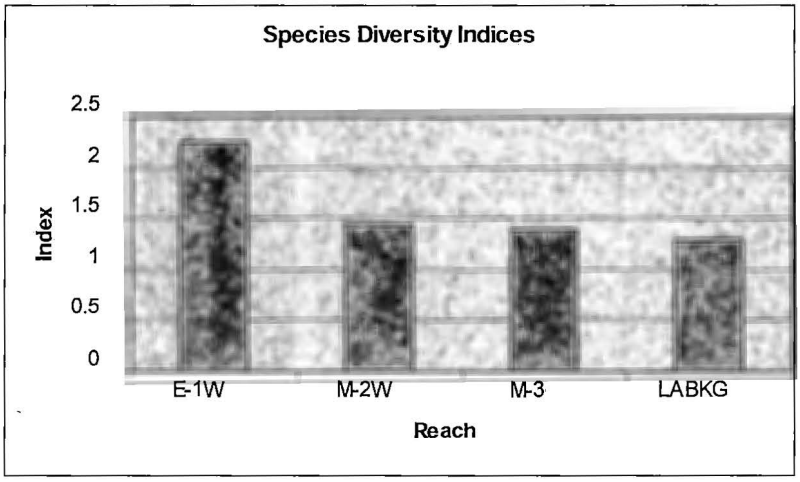


Figure 8.1-16. Small mammal species diversity

: 87677

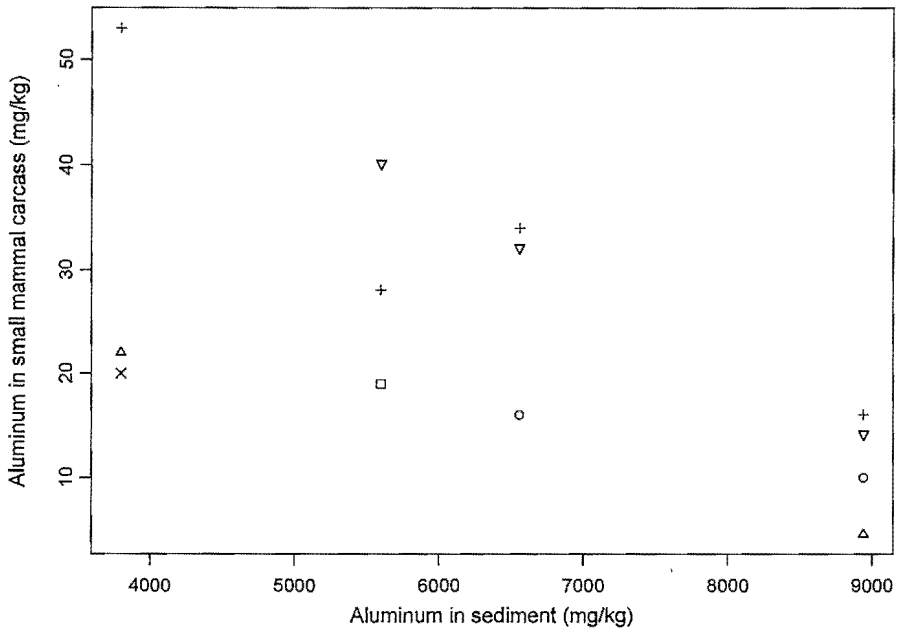


Figure 8.1-17. Aluminum in small mammal carcass versus sediment

○ = brush mouse, + = deer mouse, × = pinon mouse,
▽ = Mexican woodrat, △ = long tailed vole, □ = western harvest mouse.

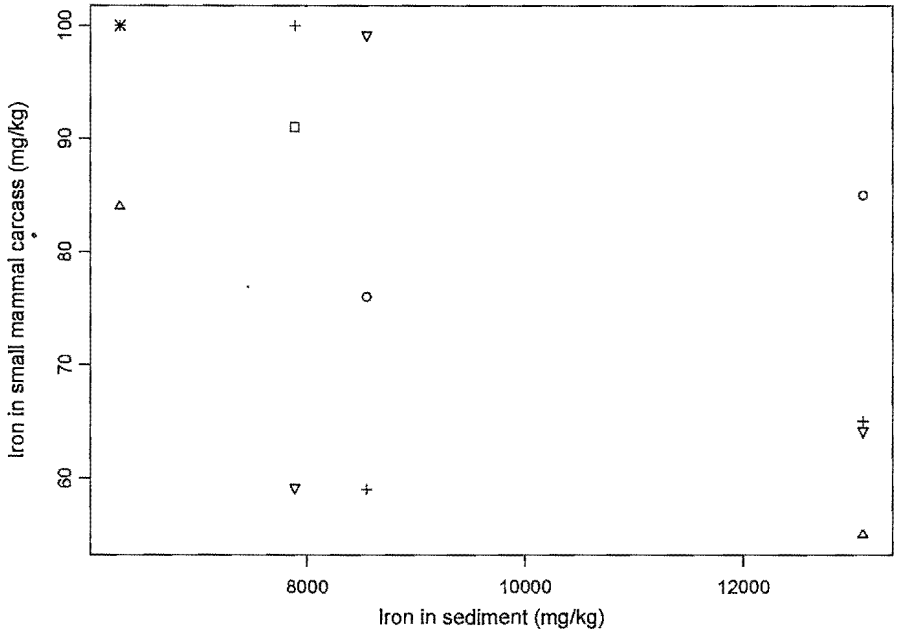


Figure 8.1-18. Iron in small mammal carcass versus sediment

07678

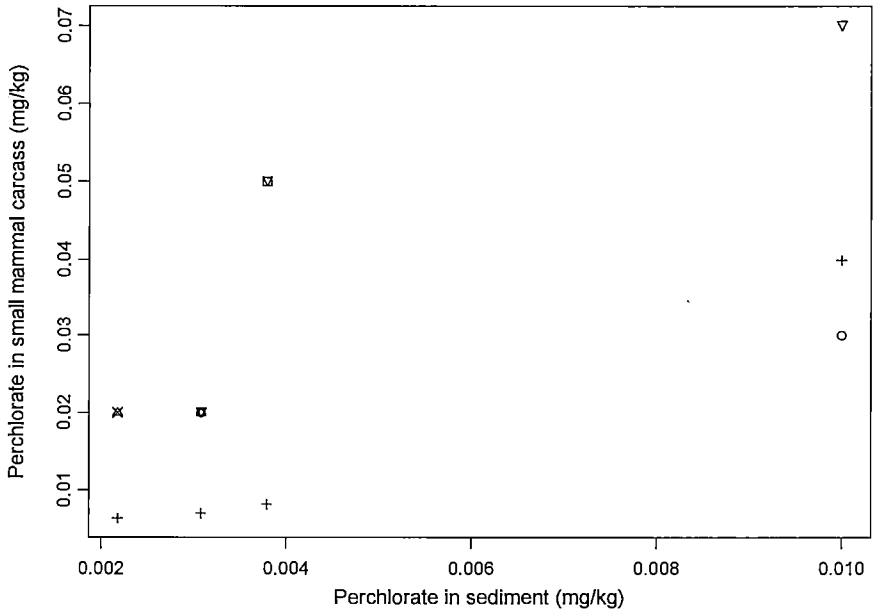
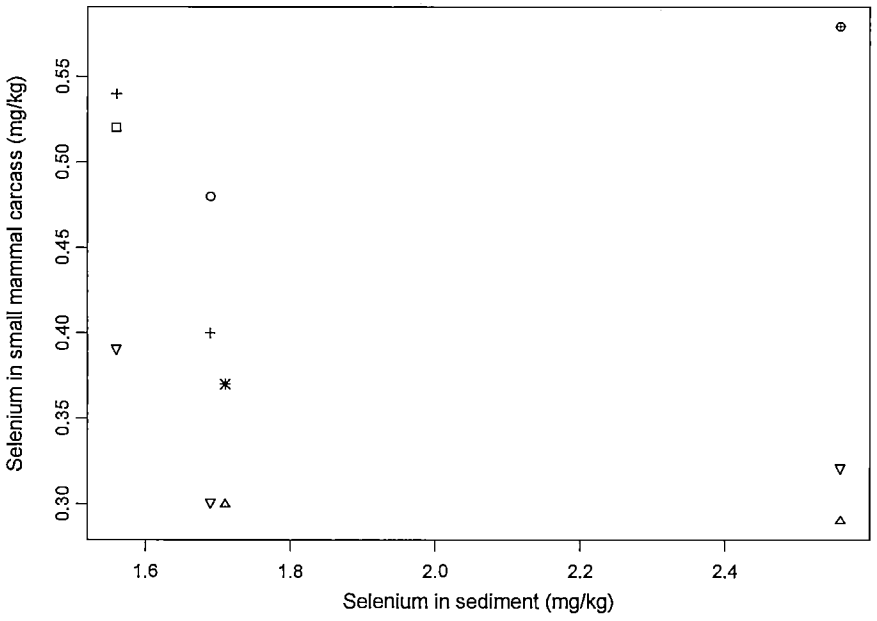


Figure 8.1-19. Perchlorate in small mammal carcass versus sediment

○ = brush mouse, + = deer mouse, × = pinon mouse,
▽ = Mexican woodrat, △ = long tailed vole, □ = western harvest mouse.



○ = brush mouse, + = deer mouse, × = pinon mouse,
▽ = Mexican woodrat, △ = long tailed vole, □ = western harvest mouse.

Figure 8.1-20. Selenium in small mammal carcass versus sediment

07679

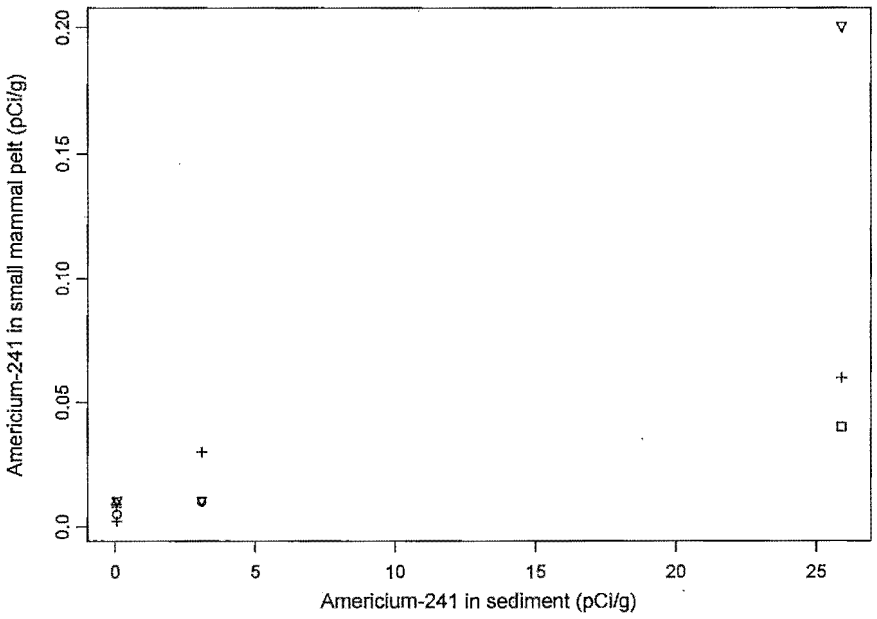


Figure 8.1-21. Concentration of americium-241 in small mammal pelt versus sediment concentration

○ = brush mouse, + = deer mouse, × = pinon mouse,
▽ = Mexican woodrat, △ = long tailed vole, □ = western harvest mouse.

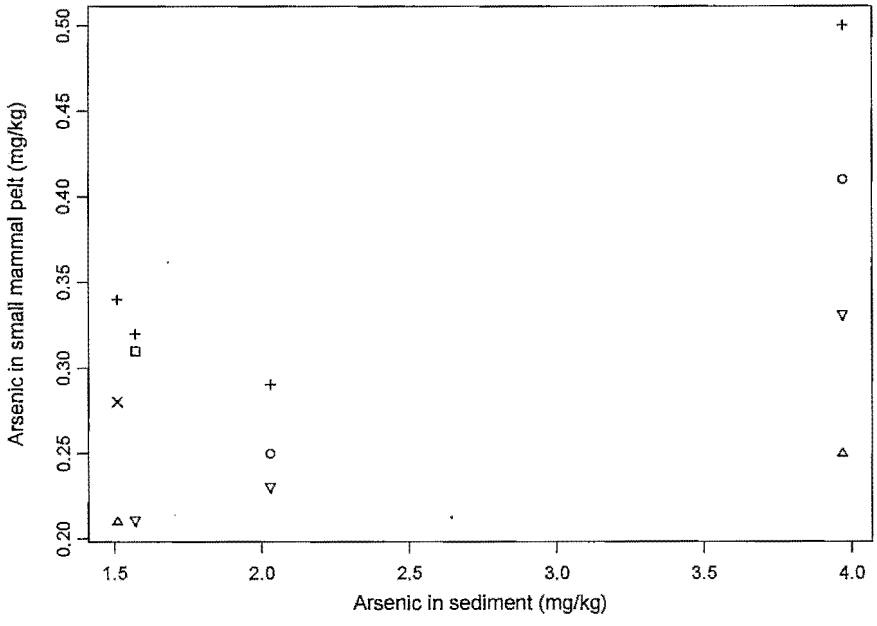


Figure 8.1-22. Concentration of arsenic in small mammal pelt versus sediment concentration

07580

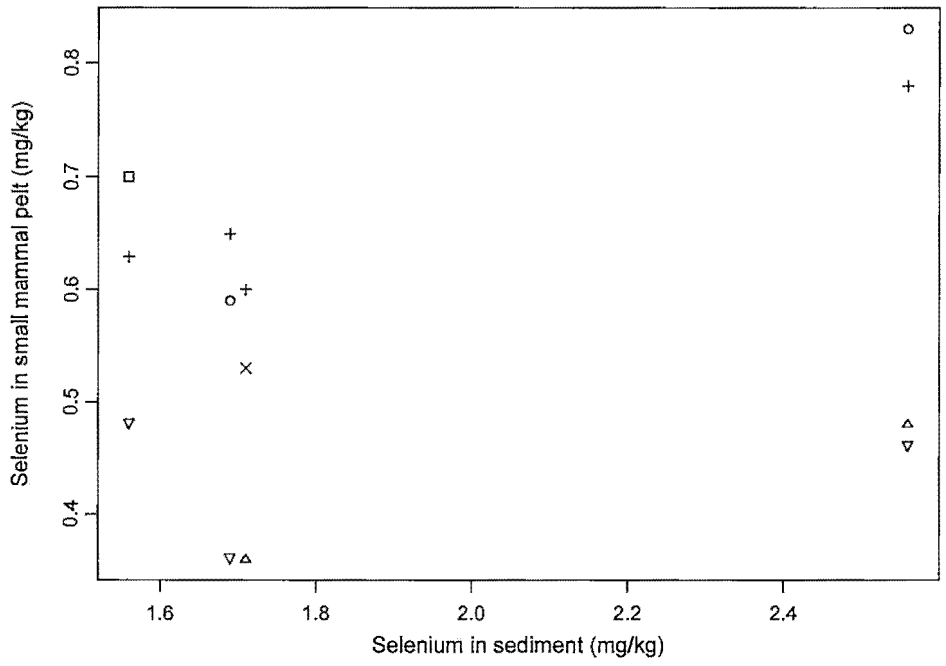


Figure 8.1-23. Concentration of selenium in small mammal pelt versus sediment concentration

: 07681

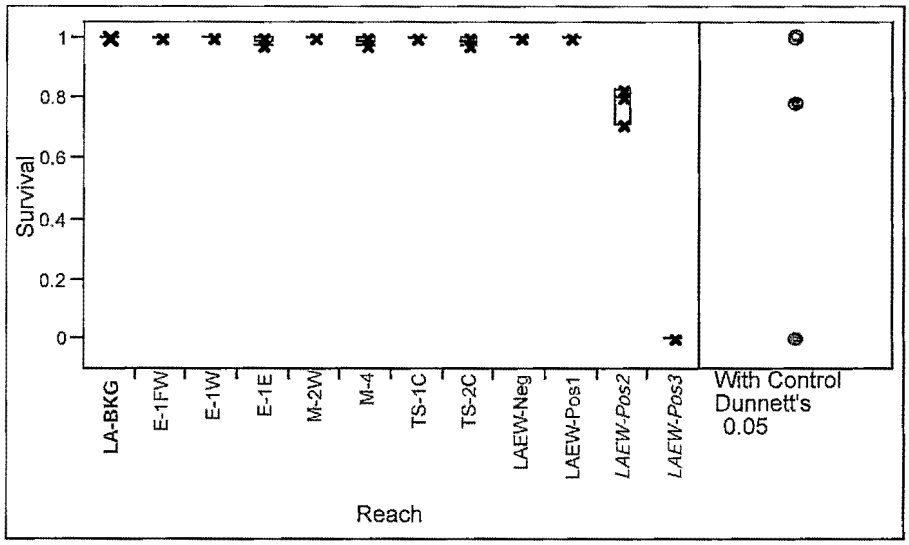


Figure 8.1-24. Survival of earthworms in toxicity test by reach

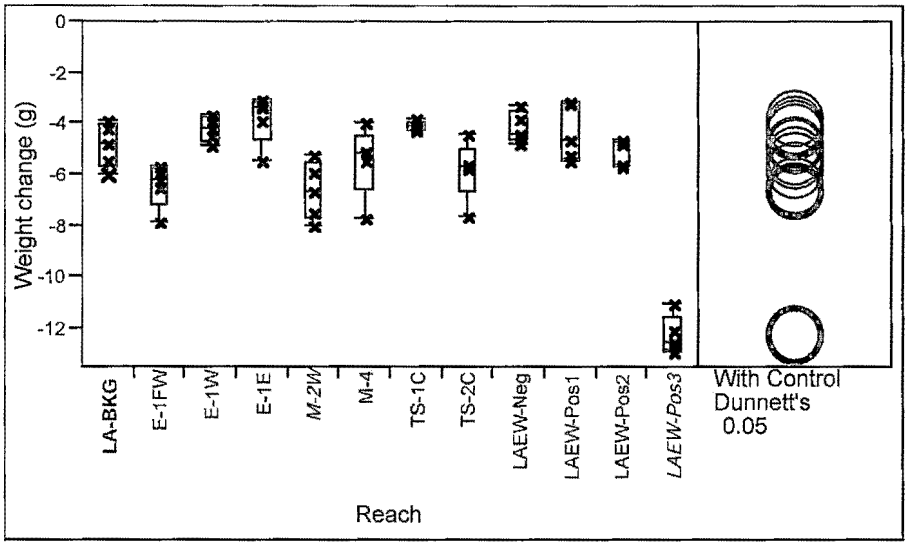
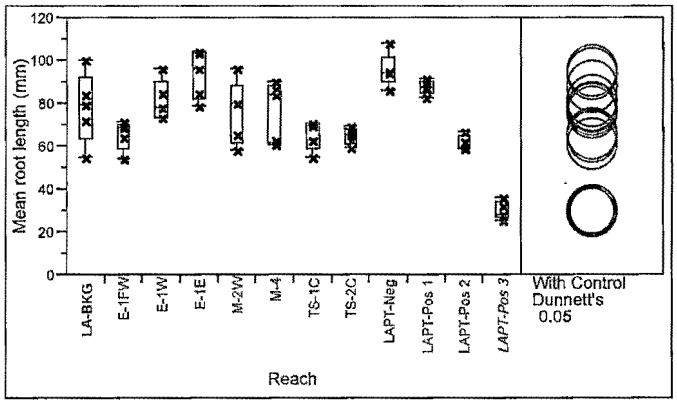
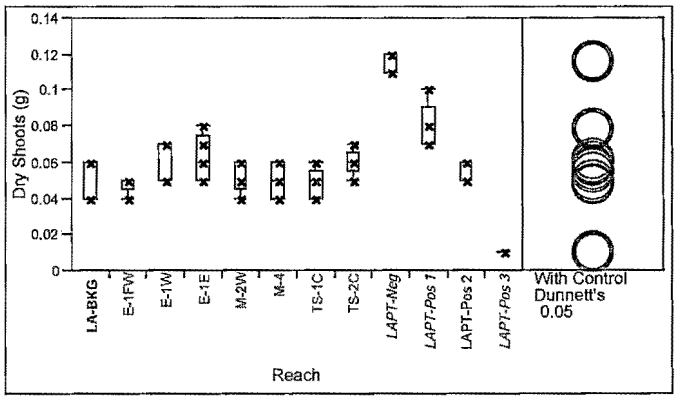


Figure 8.1-25. Weight change in earthworms during toxicity test by reach

: 07682





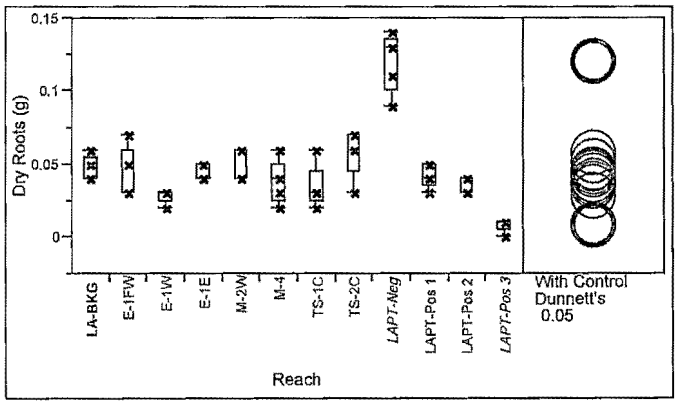


Figure 8.1-26. Plant Growth Parameters in toxicity test by reach

07683

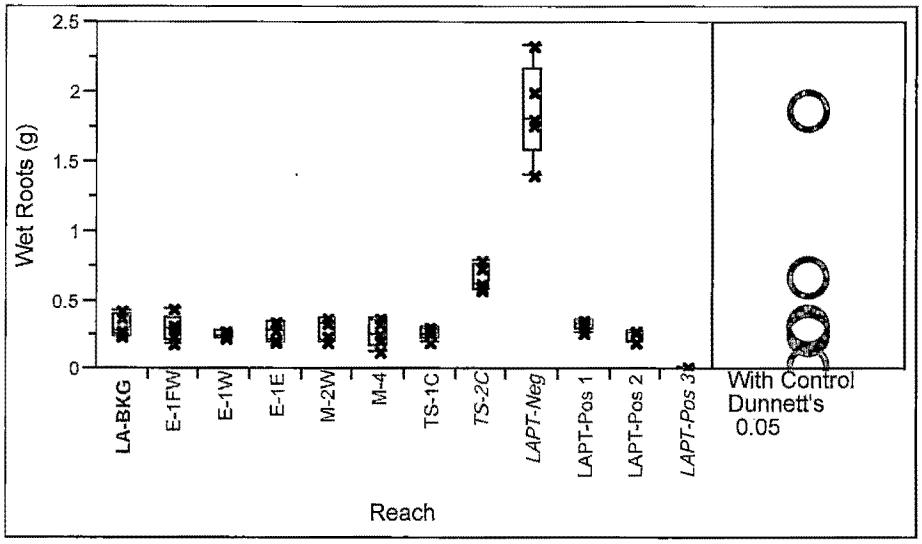


Figure 8.1-27. Wet root length by reach in plant toxicity test

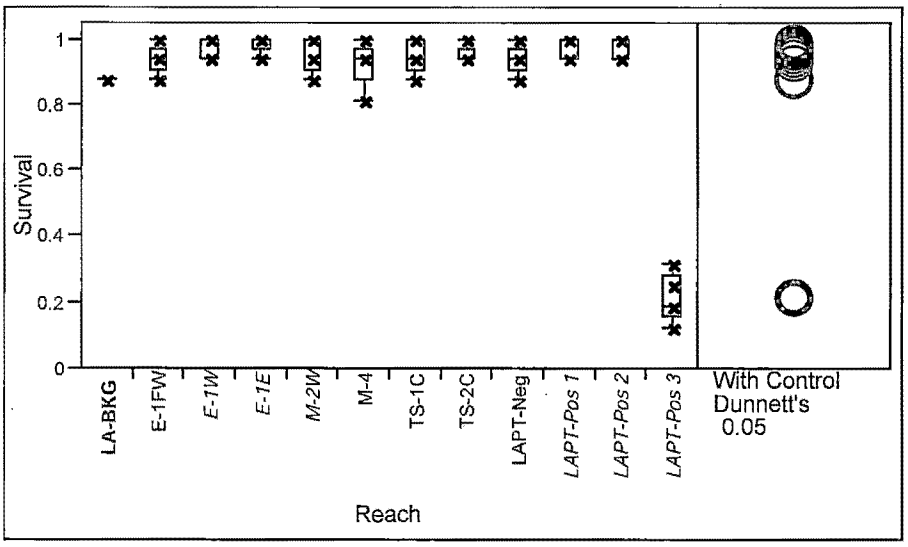


Figure 8.1-28. Fraction of Plants Surviving at end of Toxicity Test by reach

: 07684

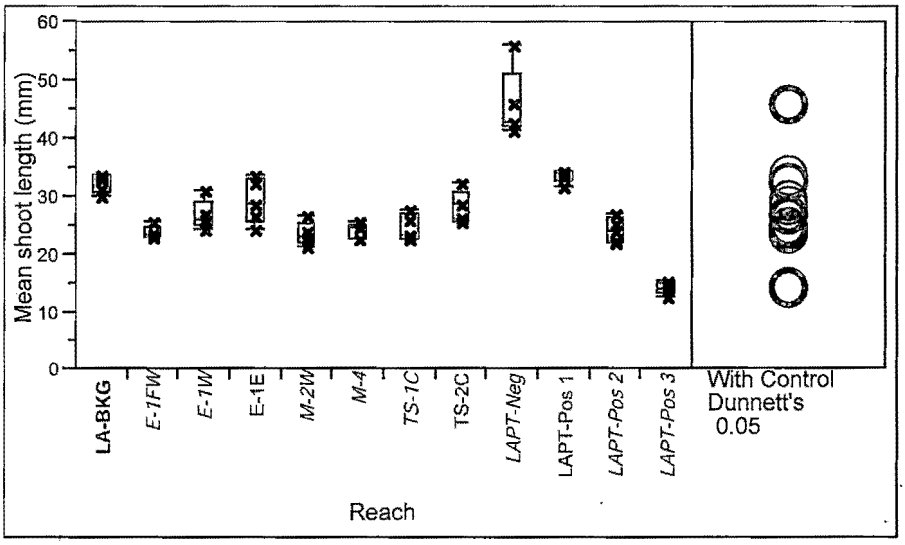


Figure 8.1-29. Mean shoot length of plants surviving at end of toxicity test by reach

07685

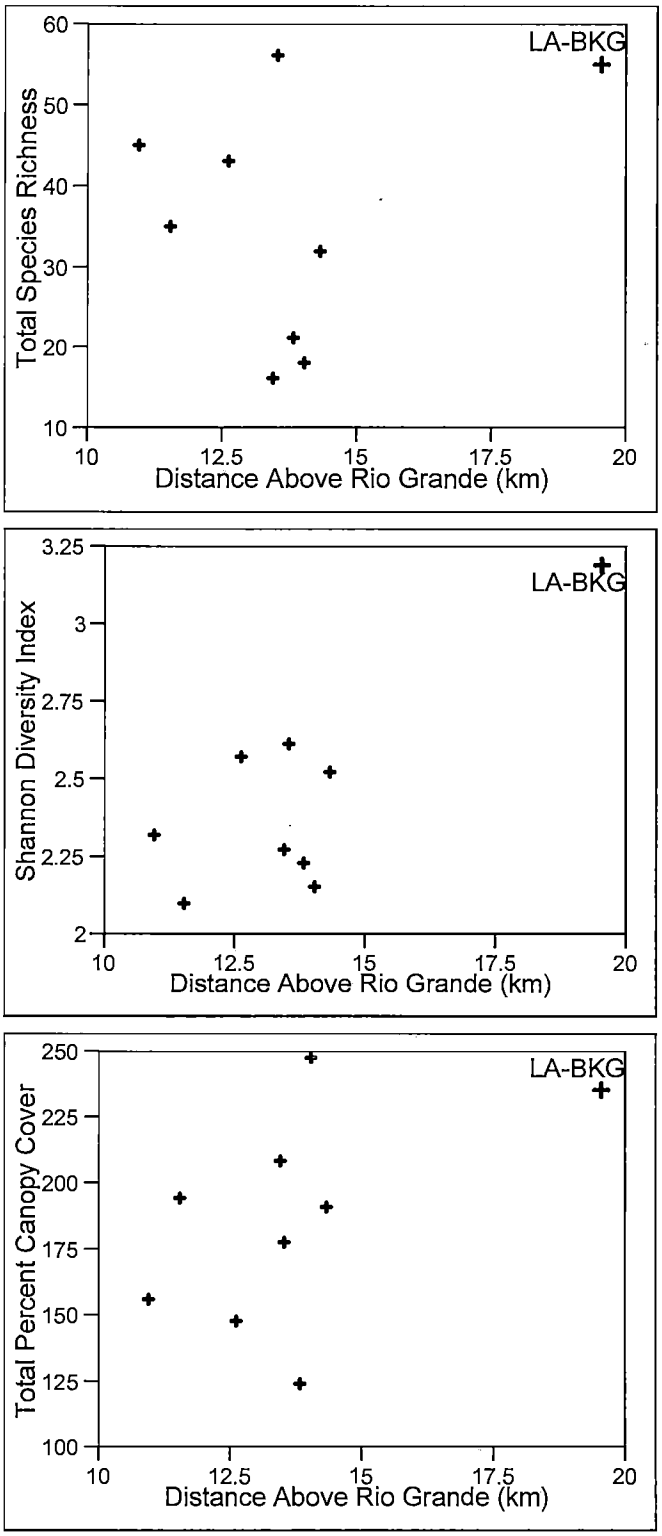


Figure 8.1-30. Scatter plots of plant field measures of diversity and cover versus distance from Rio Grande

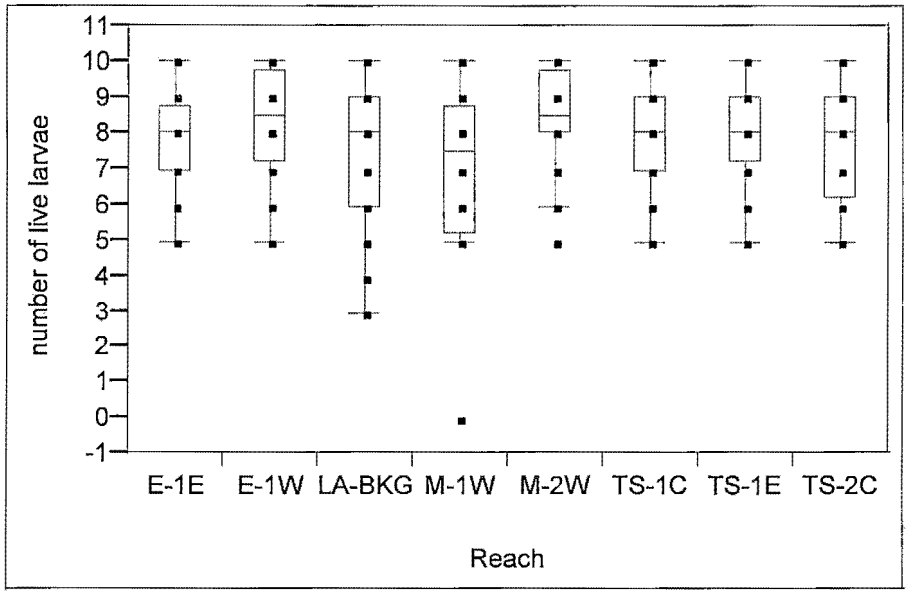


Figure 8.1-31. Number of live larvae at Conclusion of Chironomid Toxicity Test

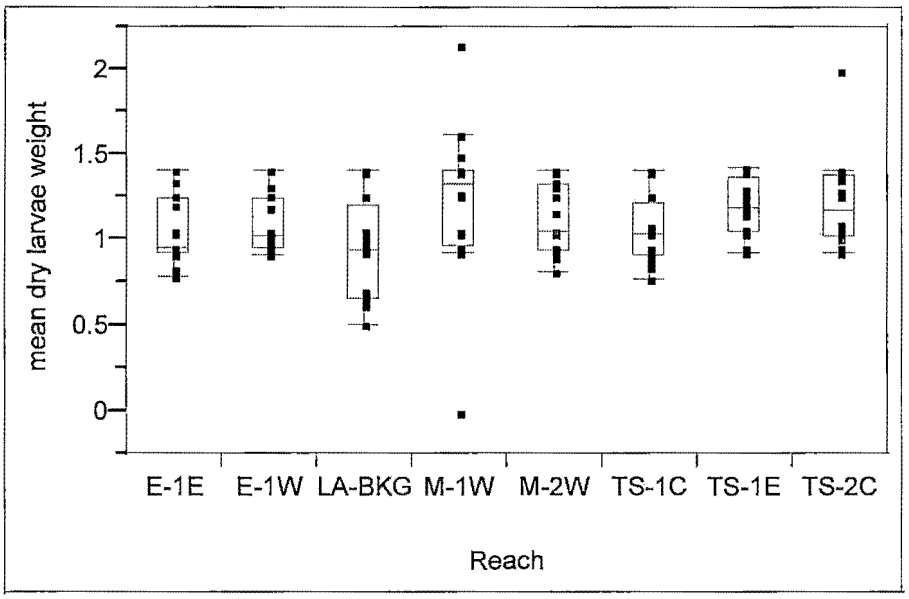


Figure 8.1-32. Box plot of mean dry larval weight (in mg) per Replicate after chironomid toxicity test

: 07687

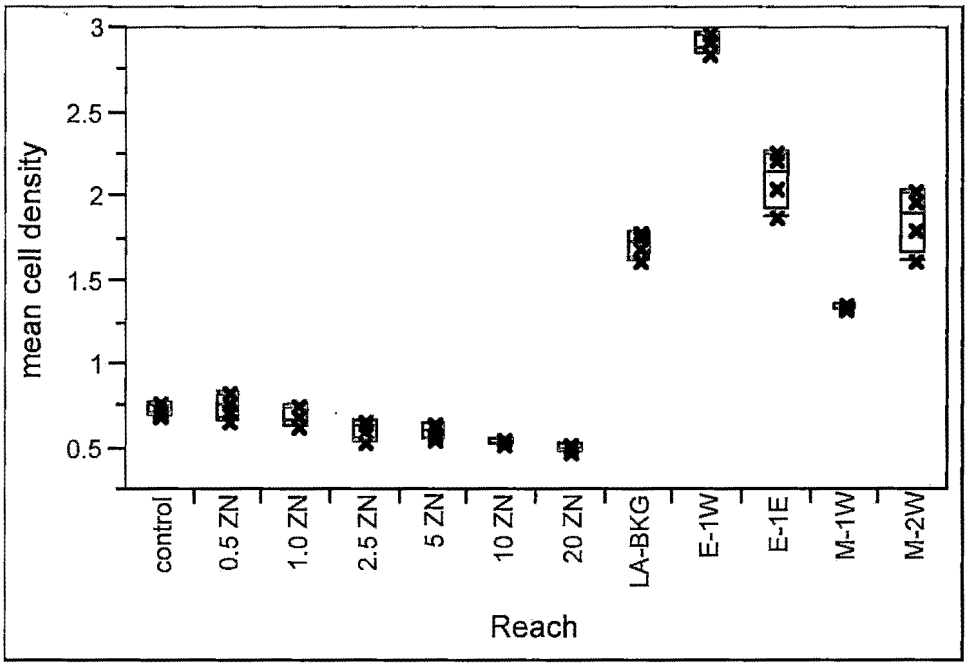


Figure 8.1-33. Box plot for mean algal cell density (in millions of cells/mL) at conclusion of July toxicity test

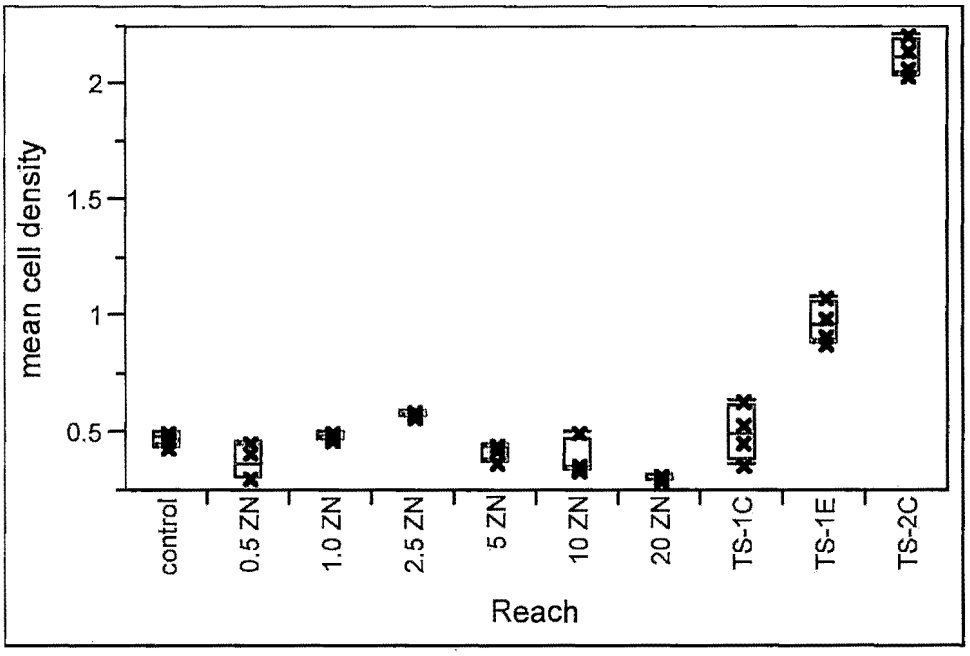


Figure 8.1-34. Box plot for mean algal cell density (in millions of cells/mL) at conclusion of August toxicity test

: 07688

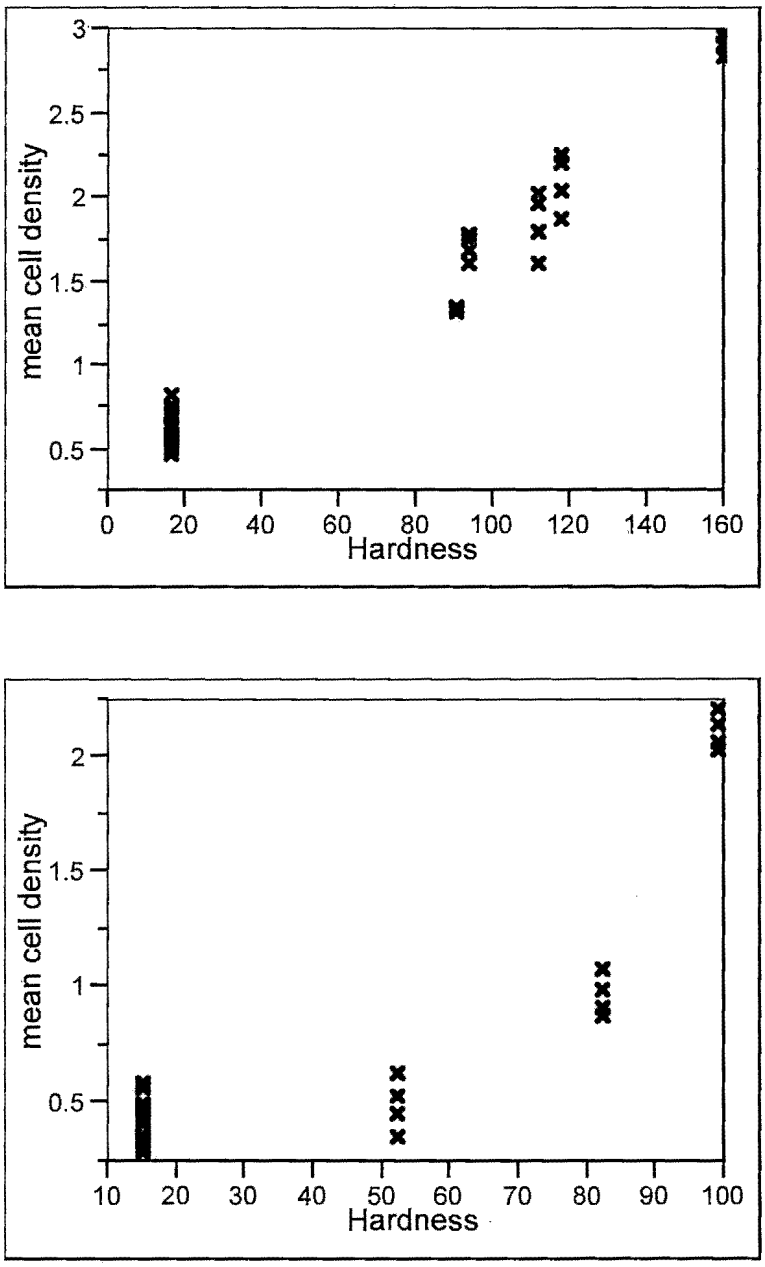


Figure 8.1-35. Bivariate fit of mean cell density (in millions of cells/mL) by hardness for July test (top panel) and August test (bottom panel)

Table 2.1-1
Annual Discharges Recorded for TA-50 RLWTF

Year	Discharge Volume (L)	^{241}Am (Ci)	^{137}Cs (Ci)	Gross Alpha (Ci)	Gross Beta/Gamma (Ci)	^{238}Pu (Ci)	^{239,240}Pu (Ci)	^{89}Sr (Ci)	^{90}Sr (Ci)	Total Tritium (Ci)	Total NO_3 as N (kg)
1963	2.74E+07	b	b	0.00371	0.1594	b	0.0016	0.1486	0.0397	b	b
1964	5.14E+07	b	b	0.0012	2.525	b	0.00194	0.06074	0.08865	b	1,126
1965	4.90E+07	b	b	0.00189	0.7084	b	0.00349	0.04229	0.06177	b	1,450
1966	5.28E+07	b	b	0.00209	0.3382	b	0.00162	0.02436	0.03558	b	596
1967	5.97E+07	b	b	0.00342	0.3091	b	0.00422	0.0535	0.0134	20	741
1968	6.03E+07	b	b	0.00257	0.2858	b	0.00259	0.0326	0.00082	b	858
1969	5.45E+07	b	b	0.0066	0.2893	b	0.00678	0.0546	0.0131	20	1,612
1970	5.32E+07	b	b	0.0033	0.1614	b	0.00498	0.0136	0.0198	b	6,618
1971	4.57E+07	b	b	0.00394	1.849	b	0.00691	0.01253	0.03159	b	3,838
1972	5.71E+07	b	b	0.00513	0.3747	0.00769	0.00102	0.00352	0.0055	5.97	9,875
1973	5.37E+07	0.00136	0.2927	0.00424	0.9586	0.00839	0.00058	0.00455	0.0071	17.47	3,762
1974	4.06E+07	0.00166	0.156	b	0.181	0.0114	0.00039	0.00287	0.0159	4.05	2,660
1975	3.97E+07	0.00113	0.174	b	0.12	0.0148	0.00067	0.0017	0.00544	66.00	b
1976	3.99E+07	0.00114	0.193	b	0.0155	0.00748	0.00105	0.00092	0.00417	187.00	b
1977	4.21E+07	0.00193	0.142	b	0.0763	0.00257	0.00147	0.00226	0.0304	36.50	4,199
1978	4.05E+07	0.00173	0.317	b	0.0963	0.00405	0.00183	0.00264	0.0104	12.30	3,649
1979	4.86E+07	0.00468	0.17	b	0.0707	0.00055	0.00171	0.00607	0.0142	32.70	7,578
1980	5.28E+07	0.0057	0.132	b	b	0.0013	0.0082	0.0409	0.018	44.90	9,298
1981	5.53E+07	0.023	0.12	b	b	0.0029	0.055	0.042	0.023	17.00	14,496
1982	3.98E+07	0.0178	0.209	b	b	0.003	0.0166	0.0118	0.0128	14.20	13,320
1983	3.45E+07	0.038	b	b	b	0.011	0.042	0.057	0.0023	8.70	13,248
1984	3.50E+07	0.0082	b	b	b	0.0061	0.0081	0.26	0.0068	13.00	11,595
1985	2.86E+07	0.00542	b	b	b	0.00393	0.00575	0.00904	0.00125	69.40	10,754
1986	3.05E+07	0.00324	0.018	b	b	0.0015	0.00355	0.0092	0.00069	72.50	12,505

Table 2.1-1 (continued)

Year	Discharge Volume (L)	^{241}Am (Ci)	^{137}Cs (Ci)	Gross Alpha (Ci)	Gross Beta/Gamma (Ci)	^{238}Pu (Ci)	^{239,240}Pu (Ci)	^{89}Sr (Ci)	^{90}Sr (Ci)	Total Tritium (Ci)	Total NO_3 as N (kg)
1987	2.66E+07	0.0036	0.0081	b	b	0.0014	0.0032	0.064	0.001	100.00	12,662
1988	2.93E+07	0.0037	0.031	b	b	0.0011	0.0032	0.081	0.0002	21.00	11,251
1989	2.28E+07	0.0041	0.039	b	b	0.00051	0.002	0.018	0.0011	16.00	11,126
1990	2.11E+07	0.0027	0.0125	b	b	0.0002	0.0006	b	b	12.00	6,267
1991	2.19E+07	0.0011	0.067	b	b	0.0003	0.001	b	b	10.60	3,592
1992	1.99E+07	0.00027	0.0005	b	b	0.00032	0.00039	b	b	10.63	4,060
1993	2.17E+07	0.0112	0.00817	0.0124	0.0231	0.00058	0.00049	0.00263	0.00263	2.66	7,821
1994	2.08E+07	0.00306	0.00851	0.00523	0.0851	0.00281	0.00046	0.00196	0.000285	2.23	948
1995	1.76E+07	0.0034	0.00662	0.00531	0.02348	0.0034	0.0006	0.00012	0.000651	0.73	1,440
1996	1.65E+07	0.00199	0.0022	0.005036	0.010988	0.00225	0.00039	0.00066	0.0006	1.02	1,260
1997	1.75E+07	0.00256	0.00248	0.005713	0.009524	0.00134	0.0008	0.00083	0.0005	1.33	1,220
1998	2.32E+07	0.002	0.001	0.006272	0.018301	0.002	0.00091	0.002	0.00082	1.23	1,420
1999	2.00E+07	0.0011	0.0015	0.004977	0.011468	0.0024	0.0014	0.00036	0.00052	0.49	486
2000	1.86E+07	0.000041	0.0031	0.000219	0.002712	0.000063	0.000035	0.000332	0.00017	0.91	47
2001	1.36E+07	0.000056	0.000213	0.000248	0.006944	0.000074	0.000024	0.000039	0.000029	0.13	53
2002	1.10E+07	0.000114	0.000582	b	b	0.000073	0.000024	0.000004	0.000003	0.07898	17.31
2003	1.12E+07	0.000055	0.000614	b	b	0.000109	0.000043	0.0	0.0	0.1171	12.8
2004	8.17E+06	0.000013	0.000085	b	b	0.000018	0.000011	0.0	0.0	0.0865	36.7
2005	6.8E+06	0.00003	0.000039	b	b	0.000003	0.000002	0.0	0.0	0.0215	25.1
MinTotal	1.43E+09	0.156	2.12	0.0835	8.71	0.1056	0.1977	1.069	0.4709	823	197,498

DTSC4

Table 3.1-1
Sediment Investigation Reaches in the Mortandad Watershed

Subwatershed	Investigation Reach	Reach Abbreviation	Approximate Distance from Rio Grande to Midpoint of Reach (km)	Reach Length (km)	Year(s) of Sample Collection (Canyons Investigations)	Notes
Effluent Canyon	E-1 Far West	E-1FW	14.43	0.15	2004, 2005	Upcanyon of TA-55
	E-1 West	E-1W	14.03	0.21	1998, 2001, 2004, 2005	Downcanyon of TA-55
	E-1 East	E-1E	13.82	0.21	1998, 2001, 2004, 2005	Downcanyon of TA-50 outfall
Mortandad Canyon	M-1 West	M-1W	15.89	0.23	1998, 2004, 2005	Downcanyon of Diamond Drive
	M-1 Central	M-1C	15.10	0.20	2004	Upcanyon of TA-48
	M-1 East	M-1E	14.56	0.20	1998, 2004, 2005	Downcanyon of TA-48
	M-2 West	M-2W	13.41	0.60	1998, 2001, 2004, 2005	Downcanyon of Effluent Canyon
	M-2 East	M-2E	12.81	0.41	2001, 2004	Downcanyon of TA-35
	M-3 West[a]	M-3W	11.98	0.29	1999, 2001, 2004	Vicinity of permeable reactive barrier
	M-3 East[a]	M-3E	11.53	0.62	1999, 2001, 2004, 2005	Upcanyon of Ten Site Canyon; canyon floor widens
	M-4 West[b]	M-4W	11.12	0.21	1999, 2001, 2004, 2005	Downcanyon of Ten Site Canyon; includes sediment traps #1 and #2
	M-4 Central[b]	M-4C	10.90	0.22	1999, 2001, 2004, 2005	Downcanyon of sediment trap #2
	M-4 East[b]	M-4E	10.68	0.23	1999, 2001, 2004	Area where radionuclide concentrations are decreasing
	M-5 West	M-5W	9.64	0.25	2004	Midway between M-4 and M-5E
	M-5 East	M-5E	8.62	0.56	2000, 2001, 2004	Spans LANL-San Ildefonso Pueblo boundary
	M-6	M-6	5.00	0.20	2003, 2004, 2005	Upcanyon of SR 4

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Table 3.1-1 (continued)

Subwatershed	Investigation Reach	Reach Abbreviation	Approximate Distance from Rio Grande to Midpoint of Reach (km)	Reach Length (km)	Year(s) of Sample Collection (Canyons Investigations)	Notes
Ten Site Canyon	TS-1 West	TS-1W	13.69	0.13	2004, 2005	Downcanyon of TA-50 and MDA C; steep and rocky
	TS-1 Central	TS-1C	13.50	0.24	1999, 2004, 2005	Canyon bottom widening and flattening
	TS-1 East	TS-1E	13.02	0.39	1999, 2004, 2005	Upcanyon of Pratt Canyon
	Pratt Canyon	PCYN	13.01	0.23	none	Sampled as part of TA-35 investigations in 1994, 1997, 1998, and 2005
	TS-2 West	TS-2W	12.77	0.11	1999, 2004, 2005	Downcanyon of Pratt Canyon
	TS-2 Central	TS-2C	12.62	0.20	1999, 2004, 2005	Downcanyon of TA-35 sewage lagoon outfall
	TS-2 East	TS-2E	12.42	0.21	1999, 2004, 2005	Downcanyon of TA-35 sand filter bed outfall
	TS-3	TS-3	11.46	0.31	2001, 2005	Upcanyon of Mortandad Canyon
Unnamed tributary canyon	MCW-1	MCW-1	11.13	0.25	2003, 2005	Upper part of unnamed tributary below TA-5
	MCW-2 North	MCW-2N	9.93	0.20	2003, 2005	Tributary below Far Point firing site (SWMU 05-001[c])
	MCW-2 West	MCW-2W	9.88	0.10	2003, 2005	Upcanyon of Far Point firing site tributary
	MCW-2 East	MCW-2E	9.73	0.20	2003, 2005	Downcanyon of Far Point firing site tributary

[a] In Section 6 and Appendix C tables, these 2 reaches are combined and reported as "M-3."

[b] In Section 6 and Appendix C tables, these 3 reaches are combined and reported as "M-4."

087699

Table 3.2-1
Mortandad Canyon Surface and Groundwater Sampling Locations and Rationale

Location Name	Location and Rationale
Alluvial Groundwater Wells (West to East)	
MCO-0.6	Mortandad Canyon north of TA-48. Westernmost alluvial groundwater monitoring point in Mortandad Canyon. Provides samples of base line alluvial water upstream of the Mortandad and Effluent Canyons confluence and downstream of all potential contaminant sources in upper Mortandad Canyon.
MCA-1	Mortandad Canyon above confluence with Effluent Canyon. New well that provides samples of alluvial groundwater from the upper part of the Mortandad Canyon watershed above the influence of the TA-50 RLWTF outfall (NPDES outfall EPA03A-051).
MCA-4	Effluent Canyon. New well located downcanyon of release sites in Effluent Canyon and upcanyon of TA-50 RLWTF outfall. Provides continuity with historical groundwater quality data. Replacement for well MCO-2.
MCO-2	Effluent Canyon. Location is downcanyon of release sites in Effluent Canyon and upcanyon of TA-50 RLWTF outfall. Sampled when insufficient water was obtained from MCA-4.
MCA-5	Mortandad Canyon below confluence with Effluent Canyon. New well that provides samples of alluvial groundwater representing contributions from both Effluent Canyon and the upper part of the Mortandad Canyon watershed. First groundwater monitoring point below the TA-50 RLWTF outfall. Provides continuity with historical groundwater quality data. Replacement for well MCO-3.
MCO-4B	Mortandad Canyon near the east end of the narrow, deeply incised portion of the canyon. Provides samples of alluvial water upcanyon of the permeable reactive barrier and the major zone of infiltration where the canyon widens to the east. Provides continuity with historical groundwater quality data.
MCO-5	Mortandad Canyon near TW-8. Provides samples of alluvial water where the canyon widens eastward and alluvium thickens. First groundwater monitoring point downcanyon of the permeable reactive barrier. Provides continuity with historical groundwater quality data.
MCO-6	Mortandad Canyon above confluence with Ten Site Canyon. Location provides samples of alluvial groundwater from the upper part of the Mortandad Canyon watershed above the influence of release sites in the Ten Site Canyon watershed. Provides continuity with historical groundwater quality data.
MCA-2	Confluence of Mortandad and Ten Site canyons. New well that provides samples of alluvial groundwater that may a source of intermediate-perched groundwater encountered at MCI-4 and MCOBT-4.4. Equivalent to well MCO-6.8 in the "Work Plan for Mortandad Canyon" (LANL 1997, 56835).
MCO-7	Mortandad Canyon below confluence with Ten Site Canyon. Location provides samples of alluvial groundwater representing contributions from both Ten Site Canyon and the upper and middle parts of the Mortandad Canyon watershed. Located west of sediment traps. Provides continuity with historical groundwater quality data.
TSCA-6	Ten Site Canyon. New well located downcanyon of historic release sites at TA-35. Formerly called MCA-6. The TSCA-6 alluvial well was installed in the MCB-15 core hole after backfilling the deep borehole to the level of alluvial saturation.
MCO-7.2	Mortandad Canyon east of sediment traps. New well installed to determine if suballuvium groundwater occurs within Cerro Toledo deposits in this part of Mortandad Canyon. This well is dry although alluvial groundwater was present in overlying alluvium during drilling.

075614

Table 3.2-1 (continued)

Location Name	Location and Rationale
MT-1	Mortandad Canyon downcanyon of sediment traps. Provides continuity with historical groundwater quality data. Alternative water sampling well for alluvial groundwater near MCO-7.2.
MCO-7.5	Mortandad Canyon downcanyon of sediment traps. Located near the eastern extent of persistent alluvial groundwater saturation. Provides continuity with historical groundwater quality data.
MT-2	Mortandad Canyon in area of intermittent alluvial saturation.
MT-3	Mortandad Canyon in area of intermittent alluvial saturation.
MT-4	Mortandad Canyon in area of intermittent alluvial saturation.
MCA-7,-8,-9	Mortandad Canyon near eastern Laboratory boundary. Transect of new wells installed to determine if saturation occurs near the Laboratory boundary. MCA-7 (dry) was plugged and abandoned. Alluvial wells (dry) were installed in MCA-8 and MCA-9. Meets the requirement to install wells MC-13A and -13B in the "Work Plan for Mortandad Canyon" (LANL 1997, 56835).
Surface Water (West to East)	
Reach M-1W Surface Water (MO-24789)	Mortandad Canyon east of Diamond Drive. Provides base line information for surface water in uppermost part of Mortandad Canyon watershed.
Reach M-1E Surface Water (MO-24790)	Mortandad Canyon north of TA-48. Provides samples of surface water upstream of the Mortandad and Effluent Canyons confluence and downstream of all potential contaminant sources in upper Mortandad Canyon.
Reach E-1FW Surface Water (MO-24786)	Uppermost Effluent Canyon. Provides samples surface water downstream of outfalls on the east end of TA-48.
Reach E-1W Surface Water (MO-24787)	Middle Effluent Canyon. Provides samples surface water upstream of TA-50 RLWTF outfall (NPDES outfall EPA03A-051).
Reach E-1E Surface Water (MO-24788)	Effluent Canyon about 130 m (425 ft) downstream of the TA-50 RLWTF outfall. Provides samples of surface water downstream of all Effluent Canyon contaminant sources.
Reach M-2W Surface Water (MO-24808)	Below confluence of Mortandad and Effluent Canyons at the E200 gaging station. Provides samples combined Mortandad and Effluent Canyons surface water.
Reach M-2E Surface Water (MO-24791)	Mortandad Canyon about 970 m (3180 ft) downcanyon of the Effluent Canyon confluence. Provides samples of surface water near the terminus of surface water flow supported by the TA-50 RLWTF outfall.

07595

Table 3.2-1 (continued)

Location Name	Location and Rationale
Reach TS-1W Surface Water (MO-24792)	Ten Site Canyon headwaters above TA-35.
Reach TS-2E Surface Water (MO-24793)	Ten Site Canyon downcanyon of TA-35 where surface water occurs in persistent bedrock pools.
Perched Intermediate Groundwater (West to East)	
MCOI-1	Bench south of Mortandad Canyon about 425 m (1400 ft) east of the confluence with Effluent Canyon. New borehole to investigate western extent of intermediate-perched groundwater. Borehole was moist but did not produce flowing water. Well installed but does not produce water.
MCOI-8	Mortandad Canyon between TW-8 and MCOBT-4.4. New well to investigate possible saturation was encountered in the lower part of Cerros del Rio basalts. Water level in well generally coincides with top of sump.
MCOI-4	Confluence of Mortandad and Ten Site canyons. New well completed in a thin zone of intermediate-perched groundwater that occurs in Puye Formation sedimentary deposits on top of Cerros del Rio basalts.
MCOBT-4.4	Confluence of Mortandad and Ten Site canyons. Well completed in 2001 within a thin zone of perched groundwater occurs in Puye Formation sedimentary deposits on top of Cerros del Rio basalt.
MCOI-5	Mortandad Canyon on the R-15 well pad on the south side of the canyon. New well completed in an intermediate perched groundwater that occurs in the lower part of Cerros del Rio basalts.
MCOI-6	Mortandad Canyon north of R-15 near the canyon axis. New well completed in an intermediate-perched groundwater occurs in the lower part of Cerros del Rio basalt.
MCOI-10	Mesa top south of Mortandad Canyon, south of well R-15. New borehole to investigate southern extent of intermediate perched groundwater in the Cerros del Rio basalt. Borehole was dry and backfilled.
MCOBT-8.5	Mortandad Canyon about 440 m (1450 ft) downcanyon of R-15, located near the stream channel. New borehole to investigate eastern extent of intermediate-perched groundwater in the Cerros del Rio basalt. Borehole was dry and backfilled.
Regional Groundwater (West to East)	
R-1	Mortandad Canyon in area transitioning from narrow slot canyon to the west and a broad open canyon to the east. Westernmost well for monitoring regional groundwater in Mortandad Canyon. Completed as a single screen well. R-1 is a replacement well for TW-8.
TW-8	Mortandad Canyon in area transitioning from narrow slot canyon to the west and a broad open canyon to the east.
R-14	Upper Ten Site Canyon. Location provides samples of regional groundwater downstream of historic release sites at TA-35. Well has two screens in the regional aquifer.
R-33	Lower Ten Site Canyon near confluence with Mortandad Canyon. Location provides samples of regional groundwater near confluence. Well has two screens in the regional aquifer.

07-7520

Table 3.2-1 (continued)

Location Name	Location and Rationale
R-15	Mortandad Canyon. Location provides samples of regional groundwater in part of canyon where infiltration of contaminated alluvial water is expected to affect deep groundwater systems. Completed as a single screen well.
R-28	Mortandad Canyon. Location provides samples of regional groundwater downgradient of where infiltration of contaminated alluvial water is expected to affect deep groundwater systems. Completed as a single screen well.
R-13	Mortandad Canyon near the eastern Laboratory boundary. Location provides samples of regional groundwater moving off-site. Completed as a single screen well.
R-34	Cedro Canyon. Well installed at the request of San Ildefonso Pueblo to monitor groundwater on San Ildefonso lands downgradient of Mortandad Canyon. Completed as a single screen well.

Note: Gray shading indicates new wells required by the "Work Plan for Mortandad Canyon" (LANL 1997, 56835) and "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613).

: 57597

Table 3.2-2a
Period of Record for Manual Water-Level Data in Mortandad Canyon Wells

Saturated Zone	Well	Period of Record
Alluvial	MCA-1	5/05–07/06
	MCA-2	5/05–07/06
	MCA-3ac[a]	11/04–07/06
	MCA-3b	11/04–07/06
	MCA-3def[b]	03/05–07/06
	MCA-4	04/05–07/06
	MCA-5	04/05–07/06
	TSCA-6	04/05–07/06
	TSWB-6	01/95–07/97; 02/00–07/06 (dry)
	MCA-8	09/04–07/06 (dry)
	MCA-9	01/04–07/06 (dry)
	MCO-0.6	03/99–09/02; 05/05–07/06
	MCO-4B	8/90; 8/97; 5/98 – 7/06
	MCO-5	10/60-12/69; 07/71-09/71; 2/74–11/74; 8/76–11/79; 10/80; 4/81; 4/82; 10/83; 2/91 9/91; 8/92–10/92; 12/93; 6/94; 8/95; 8/96–11/96; 8/97; 5/98; 3/99–11/99; 03/00–07/06
	MCO-6	08/61–09/71; 02/74–11/74; 08/76–1/79; 10/80; 04/81; 04/82; 02/91–09/91; 08/92; 12/93; 03/95– 08/95; 11/96; 08/97; 10/98–07/06
	MCO-7	10/60–12/69; 07/71–09/71; 02/74–11/74; 08/76–11/79; 10/80; 04/81; 04/82; 10/83; 02/91 –10/91; 07/92; 12/93; 06/94; 06/95–11/96; 03/99–07/06
	MCO-7.5	10/61–12/69; 07/7–09/71; 02/74–11/74; 08/76–11/79; 10/80; 04/81; 10/83; 02/91–09/91; 07/92; 06/94; 06/95–08/95; 08/96–11/96; 05/98–07/03; 04/05–07/06
	MCWB-5	01/95–09/95; 01/96; 08/98; 01/00; 12/05 –07/06
	MCWB-5.5A	01/95–09/95; 07/97; 01/00; 12/05–07/06
	MCWB-5.5B	01/95– 09/95; 07/97; 01/00; 12/05–07/06
	MCWB-6.2A	01/95–09/95; 11/96; 07/97; 01/00; 12/05–07/06
	MCWB-6.5C	01/95–09/95; 11/96; 07/97; 01/00; 12/05–07/06
	MCWB-6.5D	01/95–09-95; 11/96; 06/97; 08/98; 06/99–06/03; 12/05– 0706 (mostly dry)
	MCWB-6.5E	01/95–09/95; 11/96; 06/97–07/97; 08/98; 01/00; 12/05– 0706
	MCWB-7A	01/95–09/95; 11/96; 06/97–07/97; 01/00; 12/05-0306
	MCWB-7B	01/95–09/95; 11/96; 06/97–07/97; 07/01; 12/05
	MCWB-7.4A	01/95–09/95; 11/96; 06/97–07/97; 01/00; 12/05-0306
	MCWB-7.4B	01/95 09/95; 11/96; 06/97–07/97; 01/00; 07/01; 12/05– – 03/06
	MCWB-7.7A	01/95–09/95; 06/97; 08/98; 01/00; 12/05– 3/06
	MCWB-7.7B	01/95–9/95; 07/97; 08/98; 03/99–06-03; 10/05–03/06
	MT-1	11/88; 02/91; 05/98–08/98; 03/99–06/03; 04/05–07/06
	MT-2	11/88; 02/91; 05/98–08/98; 03/99–06/03; 04/05–07/06 (dry)
	MT-3	11/88; 02/91; 05/98–08/98; 03/99–06/03; 04/05–07/06
	MT-4	11/88; 02/91; 05/98–08/98; 03/99–06/03; 05/05–07/06

: 07598

Table 3.2-2 (continued)

Saturated Zone	Well	Period of Record
Intermediate	MCOBT-4.4	04/02–05/03; 11/04; 03/05–07/06
	MCOI-1	01/05–06/06 (dry)
	MCOI-4	11/04–07/06
	MCOI-5	10/04–03/06
	MCOI-6	01/05–02/06
	MCOI-8	01/05 –06/06
Regional	R-1	12/03; 01/05– 2/06
	R-13	02/02–12/03; 06/04; 01/05–02/06
	R-14	None, Westbay well
	R-15	09/99 02/00; 02/01–05/01; 07/02; 12/03; 06/04–02/06
	R-28	12/03 –01/04; 01/05–02/06
	Test Well 8	10/92–01/94; 01/00; 06/01; 06/04–02/06
	R-33	None; manual measurements are not possible with well completion.
	R-34	08/04– 05/06

[a] Denotes a nest of two piezometers with two transducers.

[b] Denotes a nest of three piezometers with three transducers.

07699

Table 3.2-2b
Period of Record for
Automated Water-Level Data in Mortandad Canyon Alluvial Wells

Saturated Zone	Well	Period of Record
Alluvial	MCA-1	05/05–07/06
	MCA-2	05/05 07/06
	MCA-3ac[a]	04/05–07/06
	MCA-3b	04/05–07/06
	MCA-3def[b]	MCA-3d 04/05–07/06; MCA-3e and MCA-3f 10/05-0706
	MCA-4	05/05 07/06
	MCA-5	05/05–07/06
	TSCA-6	10/05–07/06
	TSWB-6	02/00–12/05; 07/06 (dry)
	MCA-8	10/05–07/06
	MCA-9	08/05 –07/06
	MCO-0.6	05/05– 07/06
	MCO-4B	05/05–07/06
	MCO-5	10/92–12/93; 05/05– 07/06
	MCO-6	05/05–07/06
	MCO-7	05/05–07/06
	MCO-7.5	05/05–07/06
	MCWB-5	01/96–10/99; 01/00–05/01; 07/02–07/06
	MCWB-5.5A	07/97–07/06
	MCWB-5.5B	07/97–07/06
	MCWB-6.2A	07/97–07/06
	MCWB-6.5C	07/97–03/06
	MCWB-6.5D	12/05–03/06
	MCWB-6.5E	07/97–10/99; 01/00–07/06
	MCWB-7A	07/97–07/06
	MCWB-7B	07/97–12/00; 07/01–01/03
	MCWB-7.4A	07/97– 04/99; 01/00 03/06
	MCWB-7.4B	07/97–07/99; 07/01–03/06
	MCWB-7.7A	01/00– 03/06
	MCWB-7.7B	07/97–03/06
	MT-1	05/05–07/06
	MT-2	05/05–07/06 (dry)
	MT-3	05/05–07/06
	MT-4	05/05–07/06

07700

Table 3.2-2 (continued)

Saturated Zone	Well	Period of Record
Intermediate	MCOBT-4.4	07/02–07/06
	MCOI-1	None
	MCOI-4	10/05–07/06
	MCOI-5	08/05–07/06
	MCOI-6	08/05–07/06
	MCOI-8	10/05–07/06
Regional	R-1	01/05–03/06
	R-13	01/05–05/06
	R-14	12/04–09/05; 11/05–06/06
	R-15	12/04–05/06
	R-28	01/05–05/06
	Test Well 8	06/93–11/93; 01/94–03/97; 01/00–08/03; 12/04-05/06
	R-33	No valid data
	R-34	01/05–02/05; 05/05–06/06

[a] Denotes a nest of two piezometers with two transducers.
[b] Denotes a nest of three piezometers with three transducers.

07701

Table 3.2-3
Characterization and RES Boreholes Installed in Mortandad Canyon

Borehole	Depth	Purpose and Location
Characterization Boreholes		
MCB-1	32 m (105 ft)	Determine distribution of contaminants in the vadose zone above the TA-50 outfall in Effluent Canyon. Borehole plugged and abandoned.
MCB-2	31.9 (104.5 ft)	Determine distribution of contaminants and moisture flux in the vadose zone below the TA-50 outfall near the Mortandad and Effluent Canyons confluence. Borehole is instrumented with water content and matric potential sensors.
MCB-3	NA	Determine distribution of contaminants in the vadose zone beneath the narrow slot portion of Mortandad Canyon between the confluence with Effluent Canyon and TW-8. Could not be drilled because there is no access to this portion of Mortandad Canyon.
MCB-4	NA	Determine distribution of contaminants in the vadose zone beneath the narrow slot portion of Mortandad Canyon between the confluence with Effluent Canyon and TW-8. Could not be drilled because there is no access to this portion of Mortandad Canyon.
MCB-5	31.7 m (104 ft)	Determine distribution of contaminants and moisture flux in the vadose zone beneath the narrow slot portion of Mortandad Canyon between the confluence with Effluent Canyon and TW-8. Borehole is about 205 m (670 ft) west of the permeable reactive barrier and represents westernmost access to slot portion of Mortandad Canyon. Borehole is instrumented with a vector probe.
MCB-6	27 m (89 ft)	Determine distribution of contaminants and moisture flux in the vadose zone in area where Mortandad Canyon begins to widen eastward. The borehole is about 140 m (460 ft) east of the permeable reactive barrier. Borehole is instrumented with a vector probe.
MCB-7	30.8 m (101 ft)	Determine distribution of contaminants and moisture flux in the vadose zone in Mortandad Canyon about 200 m (650 ft) upcanyon of the confluence with Ten Site Canyon. Borehole is instrumented with water content and matric potential sensors.
MCB-8	31.9 m (104.5 ft)	Determine distribution of contaminants and moisture flux in the vadose zone in the Mortandad Canyon sediment traps. Borehole is instrumented with water content and matric potential sensors.
MCB-9	31.2 m (102.5 ft)	Determine distribution of contaminants and moisture flux in the vadose zone adjacent to easternmost sediment trap in Mortandad Canyon. Borehole is instrumented with a vector probe.
MCB-10	31.7 m (104 ft)	Determine distribution of contaminants in the vadose zone near eastern limit of alluvial saturation in Mortandad Canyon. Northern borehole in north-south transect across canyon that includes MCB-11 and MCB-12. Borehole plugged and abandoned.
MCB-11	31.7 m (104 ft)	Determine distribution of contaminants and moisture flux in the vadose zone near eastern limit of alluvial saturation in Mortandad Canyon. Middle borehole in north-south transect across canyon that includes MCB-10 and MCB-12. Borehole is instrumented with water content and matric potential sensors.
MCB-12	31.9 m (104.5 ft)	Determine distribution of contaminants in the vadose zone near eastern limit of alluvial saturation in Mortandad Canyon. Southern borehole in north-south transect across canyon that includes MCB-10 and MCB-11. Borehole plugged and abandoned.
MCB-13	NA	Determine distribution of contaminants in the vadose zone in Mortandad Canyon east of persistent alluvial groundwater. Could not be drilled because this portion of Mortandad Canyon is a protected archeological zone.
MCB-14	86.6 m (284 ft)	Determine distribution of contaminants and moisture flux in the vadose zone adjacent to the westernmost Mortandad Canyon sediment trap. Borehole is instrumented with a vector probe.

07702

Table 3.2-3 (continued)

Borehole	Depth	Purpose and Location
MCB-15	47.1 m (154.5 ft)	Determine distribution of contaminants in the vadose zone in lower Ten Site Canyon. Borehole was drilled to total depth and partially backfilled before installing alluvial well TSCO-6.
MCB-16	30.5 m (100 ft)	Determine distribution of contaminants and moisture flux in the vadose zone near the eastern Laboratory. The borehole was drilled about 32 m (105 ft) northeast of R-13. Borehole is instrumented with water content and matric potential sensors.
RES Boreholes		
MCRES-2	61 m (200.2 ft)	Borehole drilled to collect moisture data, soil properties, and borehole geophysics at the confluence of Mortandad Ten Site canyons where surface-based resistivity survey indicates electrically resistive bedrock at depth. Borehole is instrumented with a vector probe. Paired with data collected from MCOBT-4.4 to evaluate lateral changes in resistivity structure in bedrock units beneath Mortandad Canyon.
MCRES-3	61 m (200 ft)	Borehole drilled to collect moisture data, soil properties, and borehole geophysics in Mortandad Canyon east of TW-8 where surface-based resistivity survey indicates resistive bedrock at depth. MCRES-3 is paired with MCRES-4 to evaluate lateral changes in resistivity structure in bedrock units beneath Mortandad Canyon. Borehole plugged and abandoned.
MCRES-4	68.6 m (225 ft)	Borehole drilled to collect moisture data, soil properties, and borehole geophysics in Mortandad Canyon east of TW-8 where surface-based resistivity survey indicates conductive bedrock at depth. MCRES-4 is paired with MCRES-3 to evaluate lateral changes in resistivity structure in bedrock units beneath Mortandad Canyon. Borehole is instrumented with water content and matric potential sensors.
R-28	45.6 (150 ft)	Core collected from the upper 45.6 m (150 ft) of the corehole drilled at the R-28 regional well site were analyzed for moisture data and soil properties. The data were collected to determine if data from a surface-based resistivity survey can be used to predict changes in moisture content with depth. The corehole was plugged and abandoned.

: 07703

Table 3.4-1
Deviations from Plans for Alluvial Wells,
Characterization Boreholes, Resistivity Boreholes, and Intermediate Wells

Planned	Actual Disposition
Alluvial wells A-3a to A-3f to be drilled along the canyon axis between MCO-8 and MCW-8.1A,B,C	Archeological site restrictions required moving the drilling location . MCA-3 actually installed as two sets of three nested piezometers each. The set MCA-3a,b,c was installed in Mortandad Canyon upcanyon of the confluence with Ten Site Canyon, ~25 ft upcanyon of MCB-7. The set MCA-3d,e,f was installed south of sediment trap #3 and near MCB-9.
Alluvial well MCA-6 to be installed singly in lower Ten Site Canyon	Hole was extended to 154.5-ft depth to accomplish the goals of MCB-15 before the lower interval was plugged to 21.3-ft depth to allow construction of alluvial well MCA-6.
Transect of alluvial wells MCA-7, MCA-8, and MCA-9 proposed across Mortandad Canyon near R-13	All three alluvial explorations were dry to total depth. MCA-8 and MCA-9 were completed as alluvial wells; MCA-7 was plugged and abandoned.
Characterization borehole MCB-3 to be drilled in Mortandad Canyon between MCA-5 and MCO-4	MCB-3 was not drilled because this stretch of Mortandad Canyon is too narrow and heavily vegetated for drilling activity.
Characterization borehole MCB-4 to be drilled in Mortandad Canyon between MCA-5 and MCO-4, immediately north of R-14	MCB-4 was not drilled because this stretch of Mortandad Canyon is too narrow and heavily vegetated for drilling activity.
Characterization borehole MCB-8 to be drilled in Mortandad Canyon between sediment traps #1 and #2	MCB-8 was moved to a location south of sediment trap #1.
Characterization borehole MCB-9 to be drilled in Mortandad Canyon within sediment trap #1	MCB-9 was moved to a location south of sediment trap #3.
Characterization boreholes MCB-10, MCB-11, and MCB-12 to be drilled in Mortandad Canyon in a cluster downcanyon of the sediment traps	Characterization boreholes MCB-10, MCB-11, and MCB-12 were drilled in a north-to-south transect across Mortandad Canyon downcanyon of sediment trap #3.
Characterization borehole MCB-13 to be drilled between MCO-8 and MCW-8.1A,B,C	MCB-13 was not drilled because of archeological site restrictions.
Characterization borehole MCB-14 to be drilled in accessible portion of lower Ten Site Canyon west of MCOI-3	MCB-14 was moved to a location next to sediment trap #1.
Characterization borehole MCB-15 to be installed singly in lower Mortandad Canyon.	MCB-15 was backfilled to 21.3-ft depth and completed as alluvial well MCA-6.
Intermediate well MCOI -3 to be installed in lower Ten Site Canyon with one screen in Cerros del Rio basalt. Projected depth 770 ft. Core to be collected to refusal (~560 ft).	MCOI-3 was not drilled; the objectives set out for MCOI -3 were obtained by drilling R-33 in this locality.
Intermediate well MCOI -5 to be installed near R-15, with one screen in Cerros del Rio basalt. Projected depth 760 ft. Core to be collected to refusal (~500 ft).	Intermediate well MCOI-5 located and completed as planned. Total depth drilled 717 ft. No core was collected because of available core (0–420 ft and 740–751.5 ft) from adjacent R-15 borehole.
Intermediate well MCOI -10 to be installed on the north flank of the mesa south of R-15, on the Qbt 2 bench above the canyon bottom, with one screen in the Cerros del Rio basalt. Projected depth 1000 ft. Core to be collected from 300 to 800 ft depth.	MCOI-10 was moved farther south to the mesa top because of limited space on the Qbt 2 bench. No well was installed at MCOI-10 because the borehole was dry throughout; the hole was plugged and abandoned. Total depth drilled 1050 ft. Core was collected from 300 to 727.3-ft depth.

Table 4.2-1
Summary of Water Samples Taken, 2000–2005, Mortandad Canyon

Location Name	Sampling Performed for the Work Plan for Mortandad Canyon and the Mortandad Canyon Groundwater Work Plan, Revision 1					
	2000	2001	2002	2003	2004	2005
Alluvial Wells (West to East)						
MCO-0.6						Dry √
MCA-1	n/a*	n/a	n/a	n/a	n/a	√ √
MCA-4	n/a	n/a	n/a	n/a	n/a	Dry √
MCO-2	√					Dry Dry
MCA-5	n/a	n/a	n/a	n/a	n/a	√ Dry
MCO-4B		√		√	√ √	√ √ √ √
MCO-5	√	√	√	√	√	√ √
MCO-6	√√√√√	√√√√	√√√	√√√	√√	√ √ √ √
MCA-2	n/a	n/a	n/a	n/a	n/a	√ √
MCO-7	√√√√√	√√√	√√√	√√√√	√√√	√ √ √ √ √
TSCA-6	n/a	n/a	n/a	n/a	n/a	Dry Dry
MT-1						√ √
MCO-7.5	√	√		√		√ √
MT-2						Dry Dry
MT-3			√			√ √
MT-4						Dry √
Surface Water (West to East)						
Reach M-1W Surface Water (MO-24789)	n/a	n/a	n/a	n/a	n/a	√ √ √
Reach M-1E Surface Water (MO-24790)	n/a	n/a	n/a	n/a	n/a	√ √
Reach E-1FW Surface Water (MO-24786)	n/a	n/a	n/a	n/a	n/a	√ √
Reach E-1W Surface Water (MO-24787)	n/a	n/a	n/a	n/a	n/a	√ √ √
Reach E-1E Surface Water (MO-24788)	n/a	n/a	n/a	n/a	n/a	√ √ √
Reach M-2W Surface Water (MO-24808)	n/a	n/a	n/a	n/a	n/a	√ √
Reach M-2E Surface Water (MO-24791)	n/a	n/a	n/a	n/a	n/a	√ √
Reach TS-1W Surface Water (MO-24792)	n/a	n/a	n/a	n/a	n/a	√ √ √ √
Reach TS-2E Surface Water (MO-24793)	n/a	n/a	n/a	n/a	n/a	√ √

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Table 4.2-1 (continued)

Location Name	Sampling Performed for the Work Plan for Mortandad Canyon and the Mortandad Canyon Groundwater Work Plan, Revision 1					
	2000	2001	2002	2003	2004	2005
Perched-Intermediate Groundwater (West to East)[smr1]						
MCOI-1	n/a	n/a	n/a	n/a	n/a	Dry
MCOI-8	n/a	n/a	n/a	n/a	n/a	√ Dry
MCOI-4	n/a	n/a	n/a	n/a	n/a	√ √
MCOBT-4.4	n/a			√ √	√	√ √
MCOI-5	n/a	n/a	n/a	n/a	n/a	√ √
MCOI-6	n/a	n/a	n/a	n/a	n/a	√ √
Regional Groundwater (west to east)						
R-1	n/a	n/a	n/a	√		√ √ √
TW-8	√ √ √	√ √ √ √ √	√ √ √	√	√	√ √
R-14	n/a	n/a	n/a		√ √ √	√ √
R-33	n/a	n/a	n/a	n/a	n/a	√ √
R-15	√ √	√ √		√	√ √	√ √ √
R-28	n/a	n/a	n/a	n/a	n/a	√ √ √
R-13	n/a	n/a	√ √ √	√ √ √	√	√ √ √
R-34	n/a	n/a	n/a	n/a		√ √
PM-5	√ √ √ √ √	√ √ √ √ √ √ √ √ √	√ √ √ √ √ √ √ √ √ √	√ √ √ √ √ √ √	√ √ √ √ √	√ √ √ √ √

Notes: Gray shading highlights sample locations required under the "Mortandad Canyon Groundwater Work Plan, Revision 1" (LANL 2004, 82613).
Multiple checks (√) represent number of sampling events in a year. Underlined checks (√) represent samples collected as part of two rounds of snapshot sampling. Underlined Dry (Dry) indicates sample location was dry during the snapshot sampling. Checks without underlining (√) represent samples collected as part of routine surveillance monitoring.

*n/a = Not applicable, well not installed or surface water station not established.

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Table 6.2-1
Mortandad Sediment Inorganic COPCs

Reach	Aluminum	Ammonia	Antimony	Arsenic	Barium	Beryllium	Boron	Bromide	Cadmium	Calcium	Chloride	Chromium[a]	Chromium hexavalent ion	Cobalt	Copper	Cyanide (Total)	Fluoride	Iron	Lead
LANL sediment BV[b]	**15400**	**#N/A**	**0.83**	**3.98**	**127**	**1.31**	**#N/A**	**#N/A**	**0.4**	**4420**	**17.1**	**10.5**	**#N/A**	**4.73**	**11.2**	**0.82**	**#N/A**	**13800**	19.7
Residential SSL[c]	**77800**	**#N/A**	**31.3**	**3.9**	**15600**	**156**	**15600**	**#N/A**	**39**	**#N/A**	**#N/A**	**2100**	**234**	**1520**	**3130**	**1220**	**3670**	**23500**	400
M-1W	—[d]	4.67	11 (U)	4.4	—	—	—	—	0.93 (U)	—	—	—	—	—	13.3	0.93 (U)	—	—	25.8
M-1C	—	—	—	—	132	—	—	—	—	—	—	16.8	—	—	—	—	—	—	24
M-1E	26000	—	—	8.4	270	1.4	29	—	0.79 (U)	—	—	18.8	—	7.7	14	—	—	21000	30
E-1FW	21300 (J+)	—	—	16.6	233	—	—	—	0.85	4820	—	2210	1.99	4.78	383	—	3.73	18300	56.8 (J)
E-1W	19000	3.22	1.41 (U)	11	350	2.4	—	8.31	1.75 (U)	5800	185	636	—	12	20	1.2 (U)	7.59	25000	34.6 (J-)
E-1E	—	—	—	6.1	130	—	—	12.4	2.2 (J+)	51000	88.7	140	—	6	120	—	3.9	—	50
M-2W	—	3.05	13 (U)	4.3	130	—	—	3.83	0.8	22000	39.2	22	—	—	47	—	70.6	14000	58
M-2E	—	—	—	—	—	—	—	1.12	0.508 (U)	12000	52.7	14	—	—	35	—	13.3	—	—
M-3	—	—	—	4	—	—	—	0.944	0.53 (U)	5460	35.8	17.5	—	—	29	—	3.62	13900	—
TS-1W	—	—	11.2 (UJ)	—	131	—	—	—	1	—	—	—	—	4.84	—	—	—	—	—
TS-1C	—	3.84	11.2 (UJ)	—	153	—	—	—	1.7	—	—	—	—	5.9 (J)	14.5	—	—	28800 (J+)	39.1
TS-1E	—	4.65	—	—	—	—	—	—	0.59 (U)	—	—	—	—	6.77	119	—	—	—	24.7
TS-2W	—	—	—	—	—	—	—	—	0.67 (U)	—	—	—	—	—	18.8	—	6.2	—	—
TS-2C	—	4.45	—	—	—	—	—	—	0.59 (U)	—	—	22.3	—	—	48.1	—	2.23	—	29.2
TS-2E	16100	—	—	4.43	—	—	—	—	0.75	—	126	26.8	—	5.5 (J)	67	—	1.8	13900 (J+)	26.3
TS-3	—	—	—	—	—	—	—	—	0.51 (U)	—	—	—	—	—	19	—	—	—	20
M-4	—	—	1.9 (J-)	4.6	146	—	—	—	0.75 (U)	5180	—	14.5 (J)	—	5.1	37.2	—	1.48	15100	22.6
MCW-1	—	—	—	—	—	—	—	—	0.582 (U)	—	—	—	—	—	—	—	—	—	21.4
MCW-2N	—	—	—	—	—	—	—	—	0.532 (U)	—	—	—	—	—	—	—	—	—	—
MCW-2W	—	—	—	—	—	—	—	—	0.5 (U)	—	—	—	—	—	11.5	1.37	—	—	—
MCW-2E	—	—	—	—	—	—	—	—	0.53 (U)	—	—	—	—	—	—	—	—	—	—
M-5W	—	—	—	—	143	—	—	—	—	—	—	—	—	—	—	—	—	14100	—
M-5E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
M-6	—	—	—	—	—	—	—	—	0.51 (U)	—	—	—	—	—	—	—	—	—	—

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Table 6.2-1 (continued)

Reach	Magnesium	Manganese	Mercury	Nickel	Nitrate	Nitrate-Nitrite as N	Nitrite	Oxalate	Perchlorate[c]	Phosphorus, Orthophosphate (Expressed as PO4)	Selenium	Silver	Sodium	Sulfate	Thallium	Total Phosphorus	Uranium[e]	Vanadium	Zinc
LANL sediment BV[b]	2370	543	0.1	9.38	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.3	1	1470	58.2	0.73	#N/A	2.22	19.7	60.2
Residential SSL[a]	#N/A	3590	100000	1560	100000	#N/A	7820	#N/A	55	#N/A	391	391	#N/A	#N/A	5.16	#N/A	16	78.2	23500
M-1W	—	—	0.19 (U)	28.8	—	—	—	—	—	—	2.22 (U)	3.7 (U)	—	—	—	—	—	—	137
M-1C	—	—	—	—	—	—	—	—	—	—	0.35	—	—	—	—	—	—	—	71.8
M-1E	3400	1640	0.16 (U)	11	—	—	—	—	—	—	10.7 (U)	3.2 (U)	—	—	—	—	—	37	94
E-1FW	3310	1040	0.22	10.9	—	—	—	—	0.00323	—	11.5 (U)	—	—	—	—	101	—	53.1	169
E-1W	2700	2500 (J-)	0.24 (U)	11	—	—	—	46.5	—	—	5.25 (U)	4.8 (U)	—	232	—	293	4.32	30	110
E-1E	—	1700	2.7	46	—	0.21 (J)	—	25.8	0.0011 (J)	—	2.28 (U)	3.3	—	204	1.6	154	4.14 (J+)	—	78 (J-)
M-2W	—	—	0.69	—	—	0.7	—	19.3	0.959	—	1.6 (U)	2.8 (U)	1700	181	0.8 (J)	101	—	—	100
M-2E	—	—	1.1	—	—	—	—	15.8	0.141 (J)	—	0.59	2.7	—	99.9	—	—	—	—	60.6
M-3	—	—	0.43	—	—	—	—	12.8	0.162 (J+)	—	1.6 (U)	—	—	96.2	—	—	—	—	88.8
TS-1W	—	—	—	—	—	—	—	—	—	—	1.63 (U)	1.4 (U)	—	—	1 (U)	—	—	23	—
TS-1C	—	—	—	58.9	—	—	—	—	—	—	3 (U)	1.4 (U)	—	—	1 (U)	93.3	—	25.9	94
TS-1E	—	661	—	—	—	—	—	—	—	—	1.8 (U)	—	—	—	—	—	—	—	—
TS-2W	—	—	—	—	1.9	—	0.26	—	—	3.8 (J)	2.02 (U)	—	—	—	—	—	—	—	—
TS-2C	—	—	0.86	—	1.5	—	0.32	—	—	2.4 (J)	1.8 (U)	42.8	—	—	—	99.4	—	22	61
TS-2E	—	—	1.36	—	0.7	—	0.11 (J)	—	—	3.4 (J)	9.94 (U)	33.9	—	827	—	—	—	27.1	90.4
TS-3	—	570	0.19	—	—	—	—	—	—	—	1.76 (U)	4.4	—	—	—	—	—	—	63
M-4	—	—	0.32	—	—	0.3 (J)	—	—	0.627 (J-)	—	2.26 (U)	7	—	—	—	127	—	—	73.6
MCW-1	—	—	—	—	—	—	—	—	—	—	0.582 (U)	—	—	—	—	—	—	—	—
MCW-2N	—	—	—	—	—	—	—	—	—	—	0.55 (U)	—	—	—	—	—	—	—	—
MCW-2W	—	—	—	—	—	—	—	—	—	—	0.55 (U)	—	—	—	—	—	—	—	—
MCW-2E	—	—	—	—	—	—	—	—	—	—	0.52 (U)	—	—	—	—	—	—	—	—
M-5W	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	72.9
M-5E	—	—	—	—	—	—	—	—	—	—	0.56 (J-)	—	—	—	1 (U)	—	—	—	—
M-6	—	—	—	—	—	—	—	—	—	—	0.603 (U)	—	—	—	—	—	—	—	—

Notes: Values are in mg/kg. Values are maximum values > BV; if no BV, value is maximum detected value. Values in bold exceed the residential SSL. Grey shading indicates a screening value was exceeded for that chemical.

[a] EPA region 6 residential HHMSSL (Human Health Medium-Specific Screening Levels), EPA 2005, 91002.

[b] LANL (1998, 59730).

[c] Residential SSLs are NMED values (NMED 2006, 92513) unless otherwise noted.

[d] — = Not detected, not detected > BV, or not analyzed.

[e] EPA region 9 residential PRG (Preliminary Remediation Goals), EPA 2004, 93663.

Table 6.2-2
Mortandad Sediment Organic COPCs

Reach	Acenaphthene	Acetone	Anthracene	Aroclor-1254	Aroclor-1260	Aroclors (Mixed)[a]	Benzene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene[b]	Benzo(k)fluoranthene	Benzoic Acid[a]	BHC[alpha-]	BHC[beta-]	BHC[delta-]	BHC[gamma-]	Bis(2-ethylhexyl)phthalate	Bromodichloromethane	Bromomethane	Butanone[2-]	Butylbenzylphthalate[a,c]	Carbazole[a]	Carbon Tetrachloride
Residential SSL[d]	**3730**	**28100**	**22000**	**1.12**	**1.12**	**2.22**	**10.3**	**6.21**	**0.621**	**6.21**	**2290**	**62.1**	**100000**	**0.902**	**3.16**	**#N/A**	**4.37**	**347**	**14.4**	**8.51**	**31800**	**240**	**240**	**3.47**
M-1W	0.42	0.087 (J)	0.74	—[e]	0.063	—	—	2.71	2.11	2.51	1.18	0.2	—	0.018	0.003	—	0.0075	—	—	—	—	—	—	—
M-1C	1.7	0.19 (J)	0.32	—	0.14	—	—	0.38	0.45	0.3	0.18	0.19	—	0.021 (J+)	0.0048 (J-)	—	0.0091 (J+)	—	—	—	0.021 (J)	—	—	—
M-1E	—	0.44 (J)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.036 (J)	—	—	—
E-1FW	0.33	0.47 (J)	0.3 (J+)	0.16	0.03	—	—	0.44 (J+)	0.5 (J+)	0.49 (J+)	0.29 (J+)	0.27 (J+)	—	—	—	—	—	—	—	0.002 (J)	0.025 (J)	—	—	—
E-1W	—	—	—	—	0.02	—	—	0.23	0.26	0.48	0.25	—	—	—	—	—	—	0.04 (J)	—	—	—	—	—	—
E-1E	—	0.1	0.04 (J)	0.13 (J-)	0.11	0.053	—	0.1	0.25	0.42 (J)	0.12	0.13	5.7 (J)	0.0073 (J)	—	—	—	0.16 (J-)	—	—	0.027	—	—	—
M-2W	—	0.034 (J)	0.01 (J)	0.15 (J)	0.21 (J)	—	—	0.37 (J-)	0.37 (J-)	0.37 (J-)	0.07	0.37 (J-)	0.13 (J)	—	—	—	—	0.4 (J)	—	—	0.02 (J+)	—	—	—
M-2E	0.088 (J-)	0.085 (J)	0.15 (J-)	0.053	0.054	—	—	0.22 (J-)	0.16 (J-)	0.11 (J)	—	0.069 (J)	—	—	0.0023 (J)	—	—	0.091 (J)	—	—	—	—	—	—
M-3	—	0.046	—	—	0.39	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TS-1W	0.041 (J)	0.13 (J)	0.04 (J)	0.57	1.37	1.52	—	0.44 (J)	0.67 (J)	0.87 (J)	0.25 (J)	0.27 (J)	0.13 (J)	—	—	—	—	0.55	—	—	—	—	—	0.002 (J)
TS-1C	0.51 (J)	0.21 (J)	0.9 (J)	0.01 (J)	1.3	—	0.00069 (J)	1.86 (J)	2.04	2.53 (J)	1.35 (J)	1.13 (J)	0.14 (J)	—	—	—	—	0.16 (J)	—	—	0.038 (J)	0.51 (J)	—	—
TS-1E	0.06	0.13 (J)	0.11 (J)	0.03 (J)	0.19 (J)	—	—	0.72 (J-)	0.85 (J)	1.6 (J)	0.58	0.25 (J-)	—	—	—	—	—	—	—	—	0.02 (J)	—	—	—
TS-2W	—	—	0.045	—	0.1	—	—	0.33	0.38	0.36	0.26	0.16	—	—	—	—	—	—	—	—	0.019 (J)	—	—	—
TS-2C	—	0.16 (J)	0.01 (J)	0.069 (J)	0.16	—	—	0.11 (J+)	0.17 (J-)	0.37 (J)	0.12 (J-)	—	—	—	—	—	—	0.15 (J)	—	—	0.026 (J)	—	—	—
TS-2E	—	0.14	—	—	0.31	—	0.0008 (J)	—	—	—	0.082	—	—	—	—	—	—	—	—	—	0.014 (J)	—	—	—
TS-3	—	—	—	—	0.076	—	—	0.059 (J)	0.084 (J)	0.09 (J)	—	0.079 (J)	0.14 (J)	0.007	—	—	—	0.094 (J)	—	—	—	—	—	—
M-4	0.29 (J)	0.087 (J+)	0.38 (J)	0.01	0.12	—	—	0.58 (J-)	0.59 (J)	0.6 (J)	0.73 (J-)	0.2 (J)	0.18 (J)	—	—	—	—	0.41 (J)	0.004 (J)	—	0.014 (J)	—	0.23 (J)	—
MCW-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.191 (J)	—	—	—	—	—	—
MCW-2N	0.0108 (J)	—	—	—	—	—	—	—	—	—	—	—	0.402 (J)	—	—	—	—	0.17 (J)	—	—	—	—	—	—
MCW-2E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
M-5W	—	0.23 (J)	—	—	—	—	—	—	—	—	—	—	—	0.049	0.0076	0.0034	0.017	—	—	—	0.03 (J)	—	—	—
M-5E	1.8 (J+)	0.16 (J)	—	—	—	—	0.00057 (J)	—	—	—	—	—	—	—	—	—	—	—	—	—	0.024 (J)	—	—	—
M-6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.207 (J)	—	—	—	—	—	—

Table 6.2-2 (continued)

Reach	Chlordane[alpha-][f]	Chlordane[gamma-][f]	Chloroform	Chloromethane	Chlorophenol[2-]	Chlorophenyl-phenyl[4-] Ether	Chrysene	DDD[4,4'-]	DDE[4,4'-]	DDT[4,4'-]	Dibenz(a,h)anthracene	Dibenzofuran	Dichlorobenzene[1,2-][b]	Dichlorobenzidine[3,3'-]	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dieldrin	Diethylphthalate	Di-n-butylphthalate	Endosulfan Sulfate	Endrin Aldehyde	Fluoranthene	Fluorene	Heptachlor Epoxide[a]	Hexachlorobutadiene
Residential SSL[d]	**16.2**	**16.2**	**4**	**21.8**	**166**	**#N/A**	**615**	**24.4**	**17.2**	**17.2**	**0.621**	**142**	**37.4**	**10.8**	**206**	**76.5**	**0.304**	**48900**	**6110**	**18.3**	**18.3**	**2290**	**2660**	**0.53**	**12.2**
M-1W	0.002 (J)	0.0024	—	—	—	—	2.22	0.0038	—	0.013 (J)	—	—	—	—	—	—	0.0033 (J)	—	—	—	—	7.78	0.031	—	—
M-1C	—	—	—	—	—	—	0.56	0.0031 (J+)	0.0036 (J+)	0.016 (J+)	—	—	—	—	—	—	—	—	—	—	0.0032 (J+)	1.5	0.23	—	—
M-1E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E-1FW	—	—	—	—	—	—	0.59 (J+)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.5 (J+)	0.22 (J+)	—	—
E-1W	—	—	—	—	—	—	0.23	—	—	0.0096 (J-)	—	—	—	—	—	—	—	—	—	—	—	0.7 (J)	—	—	—
E-1E	0.0095	0.014	0.0013 (J-)	—	—	—	0.25	—	0.0062 (J)	0.078 (J)	—	—	—	—	—	—	—	—	—	—	0.0035 (J)	0.63	—	0.0027 (J)	—
M-2W	—	—	—	—	—	—	0.37 (J-)	—	—	0.035 (J)	—	—	—	—	—	—	—	—	—	—	0.014 (J)	0.37 (J-)	—	—	—
M-2E	—	—	—	—	—	—	0.21 (J-)	—	—	0.01 (J)	—	—	—	—	—	—	0.0045 (J)	—	—	0.0034 (J)	—	0.59 (J-)	0.089 (J-)	—	—
M-3	—	—	—	—	—	—	—	—	—	0.028	—	—	—	—	—	—	—	—	—	—	0.011 (J+)	0.15 (J)	—	—	—
TS-1W	—	—	—	—	—	—	0.72 (J)	—	—	—	—	—	—	—	—	—	—	—	2.6 (J)	—	—	1 (J)	—	—	—
TS-1C	—	—	—	—	—	—	1.64 (J)	—	—	—	0.18 (J)	0.26 (J)	—	—	—	—	—	0.1 (J)	3 (J)	—	—	3.18 (J)	0.47 (J)	—	—
TS-1E	—	—	—	—	—	—	0.91 (J)	—	—	—	—	0.14 (J)	—	—	—	—	—	—	—	—	—	1.7 (J+)	—	—	—
TS-2W	—	—	—	—	—	—	0.53	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.88 (J)	—	—	—
TS-2C	—	—	—	—	—	—	0.18 (J+)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.36 (J-)	—	—	—
TS-2E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TS-3	—	—	—	—	—	—	0.087 (J)	—	—	0.0095 (J)	—	—	—	—	—	—	—	—	—	—	—	0.35 (J)	—	—	—
M-4	—	—	—	0.002 (J)	—	—	0.59 (J)	—	—	0.015 (J-)	—	—	—	0.7	—	0.001 (J)	—	—	—	—	—	1.5	0.24 (J)	—	—
MCW-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MCW-2N	—	—	—	—	0.024 (J)	0.0904 (J)	—	—	—	—	—	0.0251 (J)	—	—	—	—	—	—	0.0406 (J)	—	—	—	0.0195 (J)	—	0.02 (J)
MCW-2E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
M-5W	—	—	—	—	—	—	—	0.0067	0.0022	0.019 (J)	—	—	—	—	0.0012 (J)	—	—	—	—	—	—	—	—	—	—
M-5E	—	—	—	—	—	—	—	—	—	—	—	—	0.0013 (J)	—	0.0016 (J)	—	—	—	—	—	—	—	—	—	—
M-6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 6.2-2 (continued)

Reach	Hexanone[2-]	Indeno(1,2,3-cd)pyrene	Isopropylbenzene	Isopropyltoluene[4-][g]	Methoxychlor[4,4'-][a]	Methyl-2-pentanone[4-]	Methylene Chloride	Methylnaphthalene[2-][h]	Naphthalene	Nitroaniline[2-][a]	Nitroaniline[4-][a]	Nitrophenol[2-]	Nitrosodiphenylamine[N-]	Phenanthrene	Pyrene	Tetrachloroethene	Toluene[b]	Trichloroethane[1,1,1-][b]	Trichloroethene	Trichlorofluoromethane	Trichlorophenol[2,4,5-]	Trimethylbenzene[1,2,4-]	Xylene (Total)[b]	Xylene[1,2-][b]	Xylene[1,3-][b]
Residential SSL[d]	**31800**	**6.21**	**271**	**271**	**305.515**	**5510**	**182**	**79.5**	**79.5**	**180**	**180**	**166**	**993**	**1830**	**2290**	**12.5**	**252**	**563**	**0.638**	**588**	**6.11**	**58**	**82**	**99.5**	**82**
M-1W	—	1.23	—	—	0.1	—	—	—	—	—	—	—	—	3.38 (J)	5.2	0.00067 (J)	—	—	—	—	—	—	—	—	—
M-1C	—	0.22	—	0.0065 (J)	0.14	—	—	—	1	—	—	—	—	1.1	0.86	0.00086 (J)	—	—	—	—	—	—	—	—	—
M-1E	—	—	—	0.039 (J)	—	—	—	—	—	—	—	—	—	—	—	0.0011 (J-)	0.028	—	0.00023 (J)	—	—	—	—	—	—
E-1FW	—	0.34 (J+)	0.024	0.57 (J-)	—	0.014 (J)	—	0.0082 (J)	1.2 (J+)	—	—	—	—	0.94 (J-)	1 (J+)	0.0011 (J-)	0.075 (J-)	—	—	—	—	—	0.0014 (J)	—	—
E-1W	—	—	—	—	—	—	—	—	—	—	—	—	—	0.4 (J)	0.57	—	—	—	—	—	—	—	—	—	—
E-1E	—	0.13	—	0.016 (J)	—	—	—	—	—	—	—	—	—	0.34	0.65	—	—	—	—	0.002 (J)	—	—	—	—	—
M-2W	—	0.06	—	0.032	—	—	—	—	—	—	—	—	—	0.37 (J-)	0.37 (J-)	—	—	—	—	0.0034 (J)	—	—	—	—	—
M-2E	—	—	—	—	0.034 (J)	—	—	—	0.08 (J-)	—	—	—	—	0.56 (J-)	0.55 (J-)	—	—	0.03 (J+)	—	0.0027 (J)	—	—	—	—	—
M-3	—	—	—	0.026 (J)	—	—	0.0083	—	—	—	—	—	—	0.11 (J)	—	—	0.023 (J)	—	—	—	—	—	—	—	—
TS-1W	0.014	0.23 (J)	—	0.014	—	—	0.002 (J)	—	—	0.25 (J)	0.24 (J)	—	—	0.35 (J)	1.2 (J)	—	0.022 (J)	—	—	—	—	—	—	—	—
TS-1C	0.0033 (J)	1.45 (J)	0.00074 (J)	0.026 (J)	—	0.008 (J)	—	0.081 (J)	0.18 (J)	—	—	—	—	3.1 (J)	3.52 (J)	—	0.016 (J-)	—	0.00035 (J)	—	—	—	—	—	—
TS-1E	—	0.52 (J+)	—	0.0082 (J)	—	—	—	0.13 (J)	—	—	—	—	—	0.81 (J)	2.2 (J-)	0.02 (J)	0.018 (J)	0.01	0.0003 (J)	—	—	0.00078 (J)	—	—	—
TS-2W	—	0.28	—	—	—	—	—	—	—	—	—	—	—	0.29	0.63 (J)	0.02	—	0.01	0.0011 (J)	—	—	0.00086 (J)	—	—	—
TS-2C	—	0.12 (J-)	—	0.0038 (J)	—	—	—	—	—	—	—	—	—	0.097 (J+)	0.66 (J)	0.01	0.0073 (J)	0.0055 (J-)	0.00028 (J)	—	—	0.001 (J)	—	—	—
TS-2E	—	—	—	—	—	0.0043 (J+)	—	—	—	—	—	—	—	—	—	—	0.00096 (J)	—	—	0.00037 (J)	—	—	—	—	—
TS-3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.38 (J)	—	—	—	—	—	—	—	—	—	—
M-4	—	0.29 (J)	—	—	—	—	0.0067	—	0.002 (J)	—	—	—	—	1.5	1.4	0.006 (J)	0.014	—	—	0.0088 (J)	—	0.003 (J)	—	0.002 (J)	0.005 (J)
MCW-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MCW-2N	—	—	—	0.0025 (J)	—	—	—	0.0274 (J)	—	—	—	0.0818 (J)	0.0801 (J)	—	—	—	—	—	—	—	0.052 (J)	—	—	—	—
MCW-2E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0028 (J)	—	—	—	—	—	—	—	—
M-5W	—	—	—	—	0.23	—	0.034 (J)	—	—	—	—	—	—	—	—	0.0017 (J)	—	0.00072 (J)	0.0048 (J)	—	—	—	—	—	—
M-5E	—	—	—	0.0019 (J)	—	—	0.01 (J)	—	—	—	—	—	—	—	—	0.024 (J)	—	0.0014 (J)	0.013 (J)	—	—	0.00074 (J)	—	—	—
M-6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Notes: All values are in mg/kg. All values are maximum detected values. Values in bold exceed the residential SSL. Grey shading indicates a screening value was exceeded for that chemical.

[a] EPA region 6 residential HHMSSL (EPA 2005, 91002).

[b] Pyrene residential SSL is used as a surrogate

[c] SSL based on the soil saturation concentration; not a risk-based value.

[d] Residential SSLs are NMED values (NMED 2006, 92513) unless otherwise noted.

[e] — = Not detected or not analyzed.

[f] Chlordane residential SSL is used as a surrogate.

[g] Isopropylbenzene residential SSL is used as a surrogate.

[h] Naphthalene residential SSL is used as a surrogate.

Table 6.2-3
Mortandad Sediment Radionuclide COPCs

Reach	Americium-241	Cesium-134	Cesium-137	Cobalt-60	Europium-152	Plutonium-238	Plutonium-239	Ruthenium-106	Sodium-22	Strontium-90	Thorium-228	Thorium-230	Thorium-232	Tritium	Uranium-234	Uranium-235	Uranium-238
LANL sediment BV[a]	**0.04**	**#N/A**	**0.9**	**#N/A**	**#N/A**	**0.006**	**0.068**	**#N/A**	**#N/A**	**1.04**	**2.28**	**2.29**	**2.33**	**0.093**	**2.59**	**0.2**	**2.29**
Residential SAL[b]	**30**	**2.4**	**5.6**	**1.3**	**2.9**	**37**	**33**	**20**	**1.6**	**5.7**	**2.3**	**5**	**5**	**750**	**170**	**17**	**86**
M-1W	—[c]	—	—	—	—	0.04	—	—	—	—	—	—	—	0.13	—	—	—
M-1C	1	0.07	—	—	—	0.1	—	—	—	—	—	—	3.48	—	—	—	—
M-1E	—	—	—	—	—	0.048	—	—	—	—	—	—	—	—	—	—	—
E-1FW	—	0.083	—	—	—	0.102	—	—	—	—	—	—	—	—	—	—	—
E-1W	0.28	—	2.14	—	—	0.417	30.1	—	—	—	—	—	—	—	—	—	2.65
E-1E	642	0.196	2530	5.22	—	88.7 (J-)	1360 (J-)	—	0.49	273 (J-)	—	—	—	105.0239	16.04	0.683	7.125
M-2W	524	0.24	870	2.45	—	203	596	—	0.151	35.9 (J-)	—	—	—	7.153747	14.7	0.8	10.7
M-2E	211	0.114	557	0.5	—	113	157	—	—	20	—	—	—	0.518	—	—	—
M-3	223	0.177	298	1.47	—	40.9 (J+)	123 (J+)	0.8	—	8.6 (J-)	—	—	—	0.3211111	—	0.45	—
TS-1W	4.172 (J-)	0.072	3.585	1.2991	—	67.817 (J-)	19.51	—	—	3.11 (J-)	—	—	—	1.264033 (J)	2.735	—	3.049
TS-1C	2.3	—	3.1869	—	—	314.079	35.198 (J-)	—	—	—	15.2	28.511	13.557	0.3034217 (J)	—	0.255	3.006
TS-1E	—	—	—	—	—	338.335 (J-)	37.916	—	—	—	—	—	—	—	—	—	—
TS-2W	0.493	0.086	—	—	—	2.087	0.665	—	—	6.7	—	—	—	0.143	—	—	—
TS-2C	0.302	0.099	—	—	—	1.98	0.896	—	—	5.61	—	—	—	0.134	—	0.22	—
TS-2E	—	0.062	—	—	—	1.351	5.237	—	—	8.3	—	—	—	—	—	—	2.37
TS-3	—	—	1.22	—	—	1.55	0.77	—	—	3.1	—	—	—	0.297	—	—	—
M-4	112	0.194	276	0.445	0.338	32.2 (J+)	64.5 (J+)	—	—	9.64	—	—	—	0.2781174	—	0.285	—
MCW-1	—	—	—	—	—	—	0.0741	—	—	—	—	2.44	—	—	—	—	—
MCW-2N	—	—	—	—	—	0.0229	—	—	—	—	—	—	—	—	—	—	—
M-5W	—	—	0.92	—	—	—	0.11	—	—	1.68	—	—	—	—	—	0.24	—
M-5E	—	0.1	0.93	—	—	0.09	0.13	—	—	—	—	—	—	—	—	0.27	—

Notes: Values are in pCi/g. Values are maximum detected values > BV; if no BV, value is maximum detected value. Values in bold exceed the residential SSL. Grey shading indicates a screening value was exceeded for that chemical.

[a] LANL 1998, 59730

[b] LANL 2005, 88493.

[c] — = Not detected, not detected > BV, or not analyzed.

Table 6.3-1
Mortandad Filtered Water Inorganic COPCs

Location ID	Media Code[a]	Aluminum	Ammonia	Ammonia as Nitrogen	Antimony	Arsenic	Barium	Beryllium	Boron	Bromide	Cadmium	Calcium	Cerium	Chloride	Chromium	Chromium hexavalent ion	Cobalt	Copper	Cyanide (Total)	Dysprosium	Erbium
Acute Aquatic Life[b]		750	—[c]	—	—	340	—	—	—	—	2	—	—	—	570	—	—	13.4	—	—	—
Human Health Persistent[b]		—	—	—	640	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Livestock Watering[b]		5000	—	—	—	200	—	—	5000	—	50	—	—	—	1000	—	1000	500	—	—	—
MO-24786	WS	263	—	—	—	7.8	210 (J)	—	25.5	—	0.1	29300 (J)	10.3	130000	36.4	—	14.2 (J)	29.2	2.86	0.4	0.3
MO-24787	WS	1400	—	—	—	—	114	—	44.4	—	—	24000	4.2	39100	7.4	—	1.6	—	—	0.3	—
MO-24788	WS	924 (J)	—	—	0.82	—	32.1	—	107	—	—	18000	2.6	39000	2.5	—	2	12.2	—	0.2	—
MO-24789	WS	12500	—	—	1.2	—	98.8	—	32.8	—	0.26	12900	19.6	224000 (J)	7.8	—	4.1	12.4	8.64	1.2	0.6
MO-24790	WS	4230 (J)	—	—	—	—	132	—	26.7	—	—	21300	10.7	47400	4	—	7.4	3.5	—	0.6	0.3
MO-24791	WS	230	—	—	0.61	—	44.8	—	59	—	—	33400	—	109000	2.3	—	—	3.9	—	—	—
MO-24792	WS	1620	—	—	—	—	95.3	—	46	—	—	25100 (J)	0.8	48800	1.3	—	1.9	3.1	10	—	—
MO-24793	WS	389	—	—	—	—	146	—	30	—	—	40400	3.8	14200	1.7	—	2.4	8.3	—	0.2	—
Mortandad at GS-1	WS	1021	—	—	1	2.4	38.5	0.11	65.99	—	1.02	46800	—	20600	7.19	—	0.87	30.3	—	—	—
Mortandad at Rio Grande (A-11)	WS	142 (J-)	—	—	—	—	61.1	—	572	—	0.07	31200	—	63400	—	—	12.8	22.1 (J+)	—	—	—
Mortandad below Effluent Canyon	WS	2790 (J)	—	—	0.56	—	39	—	104	—	0.11	32600	—	34600	2.39 (J-)	—	—	12.9	—	—	—
NM Groundwater Standards[d]		—	—	—	—	100	1000	—	—	—	10	—	—	250000	50	—	—	1000	200	—	—
EPA MCLs[e]		—	—	—	6	10	2000	4	—	—	5	—	—	—	100	100	—	1300	200[f]	—	—
EPA region 6 tap water screening levels[g]		36500	208.6	208.6	—	—	—	—	7300	—	—	—	—	—	—	—	730	—	—	—	—
MCA-1	WGA	5770	—	—	—	—	84.6	0.37	33.7	—	0.1	19500	10.4	38000	4.6	—	—	3.1	—	0.6	0.3
MCA-2	WGA	895 (J+)	—	—	—	—	185	—	82.7	40	—	25400 (J)	1.4	58700	1.1	—	—	—	—	0.2	0.4
MCA-4	WGA	1410 (J+)	—	—	—	16.6	121	—	32.1	—	0.28	21100 (J)	—	—	43	—	10.6	5.4	—	—	—
MCA-5	WGA	1400	—	—	0.64	—	25.5	0.13	38.8	—	—	25900	3.1	46900	3.7	—	1.4	5.9	—	0.3	—
MCO-0.6	WGA	1040 (J+)	—	—	—	—	214	—	20.9	200	—	22800 (J)	30.3	303000	6	—	14.3	4.1	—	1.4	0.8
MCO-2	WGA	111	—	—	—	17	155	2	37.99	—	—	28660	—	4590	13	—	—	—	—	—	—
MCO-3	WGA	951	—	100 (J+)	0.69	—	35.9	—	90	—	0.24	45200	—	22600	3.98	—	2.2	33	—	—	—
MCO-4B	WGA	1490 (J-)	—	310	—	—	113	—	79.8	—	—	53800	1.6	64400	2.1	—	—	2.21	—	0.2	0.2
MCO-5	WGA	323	—	—	—	2.43	135	—	110	—	0.28	56100	0.4	59400	1.8	—	—	2.13	—	—	0.2
MCO-6	WGA	113	—	—	0.75 (J)	2.6 (JN-)	117	0.04 (J)	137	—	0.15	47500	—	53100	1.79 (J)	—	4.9	2.8	—	—	0.2
MCO-7	WGA	385	—	—	—	1.29	224	0.03 (J)	96.3	100	0.2	33800	0.3	51300	1.89 (J)	—	0.34 (J)	3.2	2.85 (J)	0.2	0.5
MCO-7.5	WGA	2270	—	—	—	0.75	174	0.02	87.9	120	0.16	30400	2.9	31000	4	—	2.3	0.92	3.79	0.4	0.9
MT-1	WGA	1920	—	—	—	—	198	—	49.5	40	—	23300	2.5	40000 (J)	2.4	—	—	—	—	0.4	0.8
MT-3	WGA	156	—	—	—	—	150	1.3	83.1	100	—	20600	—	39600	5.2	—	1.2	9.8	—	0.4	1.2
MT-4	WGA	110	—	—	—	—	97.1	—	52.7	120	—	16000	—	34000	1.6	—	—	—	—	0.2	0.6
MCOBT-4.4	WGI	—	—	—	—	—	13.6	—	47.4	—	0.18	32400	—	17300	53.5	—	0.92	2.28	—	—	—
MCOI-4	WGI	—	—	—	—	—	19.4	—	31.7	400	0.14	36500	—	20700	29.4	—	—	30.5	4.04	—	—
MCOI-5	WGI	—	—	—	2.7	—	26.9	—	23.7	150	—	20100 (J)	—	6700	3.5	—	4	4.3	—	—	—
MCOI-6	WGI	—	—	—	—	—	33.1	—	32.5	290	—	48100	—	24000	57.2	—	—	7.6	3.89	—	—
PM-5	WGR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5.3	—	—	—	—	—
R-1	WGR	—	—	—	—	—	17.9	—	13.9	170	0.11	12200	—	1970	5.6	—	1.6	—	—	—	—
R-13	WGR	40.5	40 (J)	—	—	—	29.3	—	21.5	—	—	14700	—	5950	3.76	—	1.6	—	—	—	—
R-14	WGR	29.3 (J-)	—	80 (J-)	—	8.24 (JN-)	48.6	—	21.1	40	—	12300	—	2050	3.02	—	—	2.79	—	—	—
R-15	WGR	—	160	—	0.16 (J)	7.2	30.2	0.02 (J)	19 (J)	110	—	14200	—	4900	7.3	—	—	—	—	—	—
R-28	WGR	—	—	—	—	—	56.2	—	25.5	180	—	35700	—	24400	404	—	—	—	—	—	—
R-33	WGR	—	—	—	—	—	34.8	—	13.5	—	0.1	12000	—	2190	8.2	—	1.7	—	—	—	—
Test Well 8	WGR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.3	—	—	—	—	—

Table 6.3-1 (continued)

Location ID	Media Code[a]	Europium	Fluoride	Gadolinium	Holmium	Iron	Lanthanum	Lead	Lutetium	Magnesium	Manganese	Molybdenum	Neodymium	Nickel	Nitrate as Nitrogen	Nitrate-Nitrite as N	Nitrite	Perchlorate	Phosphorus, Orthophosphate (Expressed as PO4)	Potassium
Acute Aquatic Life[b]		—	—	—	—	—	—	64.6	—	—	—	—	—	467	—	—	—	—	—	—
Human Health Persistent[b]		—	—	—	—	—	—	—	—	—	—	—	—	4600	—	—	—	—	—	—
Livestock Watering[b]		—	—	—	—	—	—	100	—	—	—	—	—	—	132000	132000	132000	—	—	—
MO-24786	WS	—	90	0.7	—	5730 (J)	3.1	1.1	—	5140 (J)	816	87	3.2	13 (J)	—	—	—	0.15 (J-)	—	3590 (J)
MO-24787	WS	—	750	0.4	—	4510	2.1	0.78	—	5920	958	45.1	1.8	1.7	—	—	—	—	—	13200
MO-24788	WS	—	530	0.3	—	560 (J)	1.7	0.63	—	3660	13.4	34.3	1.4	14	—	1570	—	0.38 (J)	—	12300
MO-24789	WS	—	270 (J+)	1.8	0.2	7280	8.2	8.1	—	2310	42.3	117	8.3	5.6	—	—	—	0.42	—	7040
MO-24790	WS	—	180 (J+)	0.9	—	2280 (J)	4.5	1.6	—	4490	1850	4.8	4.3	7.6	—	10 (J-, JN-)	—	—	—	6400
MO-24791	WS	—	590	—	—	103	0.3	—	—	2040	—	32.1	0.4	2.8	—	670	—	24.7	—	7310
MO-24792	WS	—	60	—	—	852	0.4	—	—	3150	449	12.6	0.4	1.7	—	—	—	0.22 (J)	—	7310
MO-24793	WS	—	300 (J+)	0.3	—	548	1	0.58	—	5610	875	36.7	1.1	8.4	—	—	—	—	—	4800
Mortandad at GS-1	WS	—	890	—	—	584	—	1.47	—	3660	7	97	—	13	—	4340	—	—	—	8610
Mortandad at Rio Grande (A-11)	WS	—	1120	—	—	75.9	—	0.54	—	7370	33.7	2.09	—	3.31	—	6350	—	—	—	15900
Mortandad below Effluent Canyon	WS	—	540	—	—	1540 (J)	—	1.5	—	4620 (J-)	16.9	37.5	—	6.45	—	13500 (J-)	—	0.48 (J)	—	8100
NM Groundwater Standards[c]		—	1600	—	—	1000	—	50	—	—	200	—	—	—	—	—	—	—	—	—
EPA MCLs[d]		—	4000	—	—	—	—	15	—	—	—	—	—	100	10000	10000	1000	—	—	—
EPA region 6 tap water screening levels[g]		—	—	—	—	—	—	—	—	—	—	183	—	—	—	—	—	25.55[h]	—	—
MCA-1	WGA	—	160	0.9	—	3270	5.1	1.1	—	4970	62.4	1.2	4.7	2.8	—	170	—	0.75 (J)	—	4430
MCA-2	WGA	—	1450	0.2	—	409	0.7	—	—	4520	3.8 (J)	93.3	0.7	3.9 (JN-)	—	3900	—	44.3	—	20700
MCA-4	WGA	—	—	—	—	9060	—	3.4	—	4530	1510 (J)	611	—	10.7	—	—	—	—	—	8340
MCA-5	WGA	—	440	0.3	—	726	1.8	—	—	2320	6.2	27.8	1.7	—	—	595000	—	34	—	6520
MCO-0.6	WGA	0.2	210	2.2	0.3	8820	8.4	1.9	—	4990	2040 (J)	—	9.2	16.7	—	20	—	—	—	12100
MCO-2	WGA	—	870	—	—	15328	—	—	—	6800	2266	400.99	—	—	—	20	—	—	—	3870
MCO-3	WGA	—	900	—	—	499 (J)	—	0.15 (JN-)	—	2960	1.07 (JN-)	77	—	7.04	—	530000	—	170	—	8170
MCO-4B	WGA	—	1070	0.2	—	611	1.1	0.08	—	4020	3.8	72.9	1	7.17	—	73100	—	44.3 (J+)	—	13600
MCO-5	WGA	—	1180	—	—	136	0.5	0.13	—	4680	0.3	81.3	0.5	9.19 (J)	—	6100	—	24.4 (J)	—	16000
MCO-6	WGA	—	1440	—	—	32.8	0.2	0.2 (J)	—	4410	7.3	89.7	0.2	12.5	—	6900	—	400	—	17700
MCO-7	WGA	—	2130	—	—	173	—	0.82	—	7410	1.6	92.1	—	10.6	—	12500	—	240	—	19300
MCO-7.5	WGA	—	1770	0.3	—	1020	1.3	1.1	0.3	7210	7.6	108	1.2	8.08	—	18000	—	66.3	—	16600
MT-1	WGA	—	1960	0.3	—	1000	1.1	0.76	0.3	5680	7.5	99.8	1	2.8	—	2730	—	49.2	—	17700
MT-3	WGA	—	1560	—	0.2	92.5	—	—	0.5	5190	—	81.4	—	3.9	—	4400 (J)	—	106	—	9570
MT-4	WGA	—	1330	—	—	—	—	—	0.3	4040	—	56.6	—	4.6	—	4280	—	62.9	—	5740
MCOBT-4.4	WGI	—	420	—	—	—	—	—	—	5590	—	0.96	—	2.25	—	15800	—	256	—	690
MCOI-4	WGI	—	230	—	—	28.5	—	—	—	5720	15.9	1.4	—	5.1	—	14200	—	159	—	840
MCOI-5	WGI	—	370	—	—	69.8	—	—	—	3780	157 (J)	8.1	—	62.2 (J)	2930	4220	360	104	—	740
MCOI-6	WGI	—	560	—	—	—	—	—	—	9650	25.1	2.5	—	5.9 (J+)	—	16400	—	245 (J)	—	740
PM-5	WGR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-1	WGR	—	260 (J+)	—	—	78.8	—	—	—	4220	4.2	2.4	—	1.1	—	250	—	0.33	40 (J)	1790
R-13	WGR	—	480	—	—	147	—	—	—	3710	7.55	1.12	—	—	—	810	—	0.41 (J)	—	1440
R-14	WGR	—	390	—	—	4500	—	0.08	—	3520	588 (J)	5.53	—	2 (JN-)	50 (J)	90 (J-)	—	0.18	370 (J)	2290
R-15	WGR	—	220	—	—	210	—	0.22 (J)	—	3880	18	—	—	1.89 (J)	—	2430	—	6.92	—	1900
R-28	WGR	—	350	—	—	—	—	—	—	9010	3.5	0.87	—	7.4	—	4760	—	1.13 (J)	—	1660
R-33	WGR	—	240	—	—	263	—	—	—	4080	6	10.9	—	168	—	430	—	0.38 (J+)	—	2280
Test Well 8	WGR	—	160	0.9	—	3270	5.1	1.1	—	4970	62.4	1.2	4.7	2.8	—	170	—	0.75 (J)	—	4430

Table 6.3-1 (continued)

Location ID	Media Code[a]	Praseodymium	Samarium	Selenium	Silver	Sodium	Strontium	Sulfate	Terbium	Thallium	Thulium	Tin	Titanium	Total Phosphate as Phosphorus	Total Phosphorus	Uranium	Vanadium	Ytterbium	Zinc
Acute Aquatic Life[b]		—	—	—	3.2	—	—	—	—	—	—	—	—	—	—	—	—	—	117.2
Human Health Persistent[b]		—	—	4200	—	—	—	—	—	6.3	—	—	—	—	—	—	—	—	26000
Livestock Watering[b]		—	—	50	—	—	—	—	—	—	—	—	—	—	—	—	100	—	25000
MO-24786	WS	0.8	0.7	—	—	64100 (J)	158 (J)	11100 (J+)	—	0.6	—	3.7 (J)	—	—	—	0.37	4.1	0.2	12.4
MO-24787	WS	0.5	0.4	9.7 (JN-)	—	47700	121	14000	—	—	—	—	—	730	450	0.27	3.5	—	11.7
MO-24788	WS	0.4	0.3	—	—	82700	67.6	13700	—	0.42	—	—	—	220	—	0.53	2.3	—	9
MO-24789	WS	2.1	1.6	—	—	178000	58.9	6870	0.2	—	—	—	—	—	—	0.44	20.4	0.5	76.1
MO-24790	WS	1.1	0.8	—	—	37100	125	3590	—	—	—	—	—	—	—	0.28	3.6	0.3	13.8
MO-24791	WS	—	—	—	—	60000	80.8	15000	—	—	—	—	—	—	—	0.66	1.2	—	2.6
MO-24792	WS	—	—	—	—	41800	125	6360	—	0.88	—	—	—	—	—	0.24	—	—	15.4
MO-24793	WS	0.3	0.3	—	0.26	12000	183	6540	—	—	—	—	—	—	—	0.77	3.9	—	4.6
Mortandad at GS-1	WS	—	—	1.6	0.05 (J)	77310	74.3	40700	—	0.26	—	39.99	0.17	210	—	3.78	4.5 (J+)	—	265
Mortandad at Rio Grande (A-11)	WS	—	—	—	—	92700	123	34900	—	—	—	—	6.36 (J)	4080	4850	0.5	7.89	—	39.7
Mortandad below Effluent Canyon	WS	—	—	—	—	96400	95	70800	—	0.19	—	—	—	—	150	—	4.73	—	14.8
NM Groundwater Standards[d]		—	—	50	50	—	—	600000	—	—	—	—	—	—	—	—	—	—	10000
EPA MCLs[e]		—	—	50	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
EPA region 6 tap water screening levels[g]		—	—	—	—	—	21900	—	—	—	—	21900	—	—	—	7.3[f]	36.5	—	—
MCA-1	WGA	1.3	0.9	—	—	33600	116	27900	—	—	—	—	—	60	—	0.21	—	0.3	11.3
MCA-2	WGA	0.2	0.2	—	—	70000 (J)	143	23200	—	—	—	—	—	280	—	1.7	2.8	0.7	—
MCA-4	WGA	—	—	—	—	102000 (J)	128	—	—	0.97	—	—	—	—	—	1.2	14.8	—	—
MCA-5	WGA	0.4	0.3	—	—	58300	57.8	24000	—	0.46	—	—	—	—	120	—	—	—	5.5
MCO-0.6	WGA	2.3	1.9	—	—	273000 (J)	163	12700	0.3	—	—	—	—	80	—	4.1	12.5	0.7	25.1
MCO-2	WGA	—	—	—	8.99	36050	152.99	—	—	—	—	—	—	430	—	—	—	—	—
MCO-3	WGA	—	—	—	—	92090	97.6	89100	—	0.39	—	—	0.25	200	100	0.69	1.41	—	7.96 (J+)
MCO-4B	WGA	0.3	0.2	—	—	80700	173	45600	—	0.3	—	—	—	120	60	0.66	2.3	0.3	7.66 (J-)
MCO-5	WGA	—	—	5.24	—	77400	202	76000	—	0.24	—	—	—	180	90	1.21	1.6	0.3	9.92 (J+)
MCO-6	WGA	—	—	6.1	0.02 (J)	71300	189	83000	—	1.01	—	—	—	150	100 (J+)	1.62	1.1	0.4	14.7 (J+)
MCO-7	WGA	—	—	7.3	0.01	79300	161	77000	—	0.44	—	—	—	410	280	28.5	3.3	0.8	8.8
MCO-7.5	WGA	0.3	0.3	1.2	—	84900	140	36000	—	—	—	—	—	140	290 (J-)	1.6	4	1.7	19.6
MT-1	WGA	0.3	0.2	—	—	67900	154	30600	—	—	—	—	—	210	—	0.56	3.6	1.3	10.6
MT-3	WGA	—	—	—	—	90900	136	36600	—	—	0.3	4.5	—	160	110	1.2	3.1	2.4	34.8
MT-4	WGA	—	—	—	—	86700	105	27200	—	0.8	—	—	—	200	—	1.5	2.5	1.3	—
MCOBT-4.4	WGI	—	—	—	—	21700	157	27500	—	0.08	—	—	—	—	60	0.28	0.98	—	2.01
MCOI-4	WGI	—	—	—	—	24300	177	31800	—	—	—	—	—	100	—	0.23	1.5	—	141
MCOI-5	WGI	—	—	—	—	13900	92.4	14100	—	0.48	—	—	—	—	—	0.15	1.4	—	145
MCOI-6	WGI	—	—	—	—	21600	218	39500	—	0.6	—	—	—	180 (J+)	—	0.5	1.4	—	74.2
PM-5	WGR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-1	WGR	—	—	—	—	12900	55.4	3650	—	0.64	—	—	—	—	—	0.84	8.4	—	7.6
R-13	WGR	—	—	—	—	11100	55.1	3140	—	0.03	—	—	—	90 (J+)	40 (J+)	0.5	4.81	—	5.78
R-14	WGR	—	—	—	—	15000	98.4	1920	—	0.45	—	—	—	—	790	0.83	6.75	—	6.4
R-15	WGR	—	—	0.95 (J)	—	11300	63.7	6640	—	0.86	—	—	—	140	60	0.45	6.4 (J)	—	7.09 (J)
R-28	WGR	—	—	6.8	—	14200	140	39400	—	0.52	—	—	—	60	—	1.1	5.4	—	11

Table 6.3-1 (continued)

Location ID	Media Code[a]	Praseodymium	Samarium	Selenium	Silver	Sodium	Strontium	Sulfate	Terbium	Thallium	Thulium	Tin	Titanium	Total Phosphate as Phosphorus	Total Phosphorus	Uranium	Vanadium	Ytterbium	Zinc
R-33	WGR	—	—	—	1.8 (NJ)	12000	52.6	2790	—	0.78	—	—	—	—	—	0.98	6.1	—	38.6
Test Well 8	WGR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Notes: All values in ug/L. All surface waters associated with these locations are ephemeral. Bolded concentrations exceed a standard and/or screening level. Grey shading indicates a standard and/or screening value was exceeded for that chemical.

[a] Media code definitions are provided in Table C-2-4.

[b] 20.6.4 NMAC.

[c] — = Not detected or not analyzed.

[d] 20.6.2 NMAC.

[e] EPA 2005, 91002.

[f] EPA MCL for free cyanide.

[g] EPA 2005, 91002 only listed for chemicals without a standard or MCL.

[h] Perchlorate-revised value.

[i] EPA region 9 PRG (EPA 2004, 93663).

Table 6.3-2
Mortandad Unfiltered Water Inorganic COPCs

Location ID	Media Code[a]	Aluminum	Ammonia	Ammonia as Nitrogen	Antimony	Arsenic	Barium	Beryllium	Boron	Bromide	Cadmium	Calcium	Cerium	Chloride	Chromium	Chromium hexavalent ion	Cobalt	Copper	Cyanide (Total)	Dysprosium	Erbium	Europium
Acute Aquatic Life[b]		—[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Livestock Watering[b]		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Wildlife Habitat[b]		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MO-24786	WS	1090	—	—	—	7.6	201	—	26.3	190	0.16	28600	13.9	135000	46.3	—	11.1	45.3	—	0.6	0.3	—
MO-24787	WS	3350	131	—	—	6.6 (J)	148	0.41 (J)	26.6	120	0.13	27300	9.8	53300	7.5	—	1	3.5 (J)	—	0.6	0.3	—
MO-24788	WS	3310	66	—	0.67	—	46.4	0.19 (J)	94.4	130	0.12 (J)	23700	4.4	66100	4.6 (J)	—	—	23.5	—	0.3	—	—
MO-24789	WS	43700	99	—	1 (J)	6.5 (J)	198	2.1	37.3	40	0.49 (J)	13500	33.6	226000 (J)	27.5	—	2.7	55.4	—	2	1	0.3
MO-24790	WS	7400	—	—	—	—	138	—	27.2	120	0.12	21500	11.5	47700 (J)	6.8	—	5.6	4.4	—	0.6	0.3	—
MO-24791	WS	941	—	—	0.56	—	42.9	—	58.1	20	—	32600	2.1	58900	2.4	—	—	4.2	—	0.2	—	—
MO-24792	WS	37700	—	—	—	7.5	349	3.5	57.7	—	1.2	34400 (J)	8.4	48400	20.8	—	11.4	25	2.72 (J)	0.5	0.2	—
MO-24793	WS	2360	—	—	—	—	149	—	30.5	100	0.15	40700	4.6	242000	2.1	—	2.1	10.2	—	0.3	—	—
MO-24794	WS	1170	—	—	—	—	114	0.12 (J)	—	—	—	26000	—	11500	—	—	—	4.7 (J)	—	—	—	—
MO-24795	WS	590	—	—	—	—	172	0.18 (J)	—	—	0.56 (J)	27600	—	9920	1.4 (J)	—	1.4 (J)	32.5	2.79 (J)	—	—	—
MO-24808	WS	809	80	—	—	—	48.8	0.14 (J)	—	—	0.11 (J)	25200	—	23900	1.4 (J)	—	—	9.2 (J)	—	—	—	—
Mortandad at GS-1	WS	1010	—	160	—	2.59	42.29	0.13	—	—	0.25	47400	—	—	8.69	—	1.39	18.79	10.00	—	—	—
Mortandad below Effluent Canyon	WS	4410	—	—	—	—	44.9	—	30.4	—	—	15000	—	34000	—	—	—	4.7	—	—	—	—
NM Groundwater Standards[d]		—	—	—	—	**100**	**1000**	—	—	—	**10**	—	—	**250000**	**50**	—	—	**1000**	**200**	—	—	—
EPA MCLs[f]		—	—	—	**6**	**10**	**2000**	**4**	—	—	**5**	—	—	—	**100**	**100**	—	**1300**	**200[e]**	—	—	—
EPA region 6 tap water screening levels[g]		**36500**	**208.6**	**208.6**	—	—	—	—	**7300**	—	—	—	—	—	—	—	**730**	—	—	—	—	—
MCA-1	WGA	8740	—	—	—	—	89.3	0.56	34.2	60	0.11	19600	13.6	37700	6.5	—	—	—	—	0.8	0.4	—
MCA-2	WGA	3120 (J+)	—	—	—	—	196	0.1	75.5	50	—	25600 (J)	5	53700	2.2	—	—	—	—	0.4	0.4	—
MCA-4	WGA	24700 (J+)	—	—	0.84	**19.4**	216	2.2	37	—	0.75	22800 (J)	—	—	**101**	—	10.5	26.1	—	—	—	—
MCA-5	WGA	4370	—	—	0.53	—	31	0.18	41.2	40	—	26200	4.4	53600	5.6	—	—	7.1	—	0.4	0.2	—
MCO-0.6	WGA	3880 (J+)	—	—	—	—	234	—	21.1	200	0.13	23600 (J)	36.2	**299000**	12.9	—	**14.5**	10.9	—	1.6	0.9	0.3
MCO-2	WGA	128.99	—	—	—	**15**	155	—	35.99	—	—	—	—	—	17	—	—	—	10	—	—	—
MCO-3	WGA	1570	—	—	0.6	2.73 (JN-)	36.2	—	90.99	—	0.59	46400	—	—	4.77	—	—	32.8	2	—	—	—
MCO-4B	WGA	1810	—	—	—	4.31	117	—	82	30	—	36200	1.9	66800	2.5	—	—	2.12	—	0.3	0.2	—
MCO-5	WGA	521	—	—	—	2.31	**135**	0.03 .	110	80	0.31	44300	1.6	50700	1.6	—	2.46	2.93	—	0.2	0.2	—
MCO-6	WGA	103 (J+)	—	—	—	1.5	115	0.04 (J)	103	30	0.39	42600	—	60700	3.9 (J)	—	3.15	4.9	—	—	0.2	—
MCO-7	WGA	2300	—	—	—	2.94	208	0.04 (J)	152	110	0.28 (J+)	24200	0.5	52000	1.89 (J)	—	0.4 (J)	4.3	—	0.2	0.5	—
MCO-7.5	WGA	3230	—	—	—	0.92	172	0.15 (J)	81.7	100	—	29200	3.6	38300	2.9	—	0.51	2.4	—	0.5	0.9	—
MT-1	WGA	2100	—	—	—	—	223	0.24	49.5	70	0.13	24200	12.4	44800	2.8	—	—	—	—	1	0.8	—
MT-3	WGA	602	—	—	—	—	148	—	78.5	100	—	20400	0.8	39800	2.1	—	—	**5**	—	0.5	1.3	—
MT-4	WGA	173	—	—	—	—	98	—	52.2	130	—	16100	0.2	34400	1.9	—	—	—	—	0.2	0.6	—

Table 6.3-2 (continued)

Location ID	Media Code[a]	Aluminum	Ammonia	Ammonia as Nitrogen	Antimony	Arsenic	Barium	Beryllium	Boron	Bromide	Cadmium	Calcium	Cerium	Chloride	Chromium	Chromium hexavalent ion	Cobalt	Copper	Cyanide (Total)	Dysprosium	Erbium	Europium
MCOBT-4.4	WGI	23.6	—	—	—	0.4	15	—	50.9	130	—	38000	—	17300	53.6	—	4.82	2.8	2.27 (J)	—	—	—
MCOI-4	WGI	499 (J)	—	—	—	0.9	21.7	—	30	380	—	35600	0.7	20300	135 (J)	—	1.3	97.1	—	—	—	—
MCOI-5	WGI	3410	—	—	7.1	—	51.2	0.15	23.5	130	—	20800 (J)	5.9	6690	770	—	9	211	—	0.3	—	—
MCOI-6	WGI	7	—	—	—	1.2	33.2	—	31.5	290	—	47600	—	24100	59	—	—	14.5	—	—	—	—
MCOI-8	WGI	9.3	—	—	—	0.6	63	—	66	200	—	25300	—	13200	—	—	—	1.7	—	—	—	—
PM-5	WGR	44.7	—	—	—	1	32.5	—	67 (J)	—	—	12300	—	2850	5.9	5.5	—	—	50	—	—	—
R-1	WGR	23	—	—	—	1	17.3	—	14	170	0.14	11700	—	2250	5.9	—	—	4.8	—	—	—	—
R-13	WGR	7	—	—	—	3.56 (JN-)	310	—	63	20	—	14200	—	2520	5.9	—	—	2.34	2.36	—	—	—
R-14	WGR	37	—	80	—	7.3	75	—	27	100	—	13800	0.3	1970	7.7	—	5.2	7.56 (J)	—	—	—	—
R-15	WGR	56.5 (JN-)	110	—	—	4.91 (JN-)	34	0.05 (J)	20 (J)	21000	—	14700	0.2	5220	9.2	—	—	1.91	6.56	—	—	—
R-28	WGR	10	—	—	—	1	370	—	77	160	—	36500	—	29200	416	—	8.6	4.3	3.95	—	—	—
R-33	WGR	14	—	—	—	0.9	35.6	—	14.3	30	—	12000	0.3	2240	12.3	—	—	3.5	—	—	—	—
Test Well 8	WGR	88.3	—	—	0.45	0.4	8.51	—	28.4	20	—	11800	—	2060	7.92	2.3	—	1.7	6	—	—	—

Table 6.3-2 (continued)

Location ID	Media Code[a]	Fluoride	Gadolinium	Holmium	Iron	Iron (ferrous)	Lanthanum	Lead	Lithium	Lutetium	Magnesium	Manganese	Mercury	Molybdenum	Neodymium	Nickel	Nitrate	Nitrate as Nitrogen	Nitrate-Nitrite as N	Nitrite	Perchlorate
Acute Aquatic Life[b]		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Livestock Watering[b]		—	—	—	—	—	—	—	—	—	—	—	10	—	—	—	132000	132000	132000	132000	—
Wildlife Habitat[b]		—	—	—	—	—	—	—	—	—	—	—	0.77	—	—	—	—	—	—	—	—
MO-24786	WS	340	0.9	—	4200	—	4.2	3.1	—	—	5060	873	—	93.5	4.3	11.2	—	—	—	—	—
MO-24787	WS	760 (J)	0.8	—	6250	—	4	1.8	—	—	6860	1080	—	63.9	3.6	2.5	—	—	—	—	—
MO-24788	WS	620	0.5	—	2080	—	2.8	2.3	—	—	4070	74	—	34.8	2.4	13	—	720	1990	—	0.68
MO-24789	WS	720	3.1	0.4	25700	—	14.6	27	—	—	6060	115	0.07 (J)	121	14.8	13.6	—	—	730	—	—
MO-24790	WS	500	0.9	—	4230	—	4.9	3.1	—	—	4670	2010	—	4.8	4.8	7.7	—	270	—	—	—
MO-24791	WS	620	0.3	—	467	—	1.4	—	—	—	2050	5.9	—	30.9	1.3	3	—	30	—	—	—
MO-24792	WS	220	0.7	—	37800	—	3.7	33.6	—	—	8200	1690	—	15.5	3.4	17.1	—	190	—	—	—
MO-24793	WS	310	0.4	—	1120	—	1.9	1.7	—	—	5670	887	—	36.6	1.8	8.3	—	—	—	—	—
MO-24794	WS	322	—	—	679	—	—	1.2 (J)	—	—	4490	88.4	—	—	—	3 (J)	—	—	—	—	—
MO-24795	WS	430	—	—	493	—	—	1.6 (J)	—	—	4380	426	—	—	—	8.8	—	—	19.6 (J)	—	—
MO-24808	WS	—	—	—	472	—	—	0.55 (J)	—	—	3870	108	—	—	—	5.8	—	—	—	—	0.14 (J)
Mortandad at GS-1	WS	—	—	—	644	—	—	0.52	—	—	2660	16	0.07	—	—	14.39	—	4340	3900	—	99.5
Mortandad below Effluent Canyon	WS	310 (J+)	—	—	2460	—	—	2.7	—	—	3290	29.1	—	—	—	—	—	—	160 (J-)	—	0.5
NM Groundwater Standards[d]		1600	—	—	1000	—	—	50	—	—	—	200	2	—	—	—	—	—	—	—	—
EPA MCLs[f]		4000	—	—	—	—	—	15	—	—	—	—	2	—	—	100	10000	10000	10000	1000	—
EPA region 6 tap water screening levels[g]		—	—	—	—	—	—	—	730	—	—	—	—	183	—	—	—	—	—	—	25.55[h]
MCA-1	WGA	170	1.2	—	5070	—	6.5	2.9	—	—	5170	50.1	—	1.3	6.1	3.1	—	1000	—	3960	—
MCA-2	WGA	1430	0.5	—	1490	—	2.2	1.6	—	—	4750	21.7 (J)	—	94.2	2.1	3.4	—	1840	—	—	—
MCA-4	WGA	—	—	—	26500	—	—	20.8	—	—	7210	1670 (J)	—	600	—	20.4	—	—	—	—	—
MCA-5	WGA	410	0.5	—	2370	—	2.6	—	—	—	2650	10.7 (J)	0.05	27	2.3	—	—	840	—	—	—
MCO-0.6	WGA	220	2.6	0.3	11900	—	10.4	4.3	—	—	5520	2140 (J)	—	—	11.1	19.1	—	—	—	—	—
MCO-2	WGA	—	—	—	16041	—	—	—	—	—	—	2375	—	354.99	—	—	—	30	—	—	—
MCO-3	WGA	—	—	—	815 (J)	—	—	0.58	—	—	2750	6.19	0.03	74.5	—	7.03	—	3320	—	—	280
MCO-4B	WGA	980	0.3	—	735	—	1.2	0.13	—	—	2850	4.8	—	76.9	1.2	7.31	—	1710	—	—	157
MCO-5	WGA	1680	0.3	—	242	—	1.3	0.51	—	—	3830	8.1	—	83.1	1.1	8.9	—	3470	5700	—	252
MCO-6	WGA	1310	—	—	38.7	—	0.2	0.29 (J)	—	—	3910	2.32	—	89.9 (J)	0.3	22.79	—	1380	6600	—	268
MCO-7	WGA	1400	—	—	1140	—	0.3	1.32	—	—	5660	17.6	0.24	83.3	0.2	10	—	1750	9500	—	282
MCO-7.5	WGA	1780	0.4	0.2	1460	—	1.5	1.01	—	0.3	7180	26.4	—	93.9	1.4	8.6	—	4170	18000	20	252
MT-1	WGA	1960	1.2	0.2	1180	—	5	1.7	—	0.3	6060	45.6	—	100	4.8	5.3	—	2890	—	—	—
MT-3	WGA	1960	—	0.2	351	—	0.3	—	—	0.5	5120	6.5	—	79.7	0.3	3.9	—	5620	—	—	—
MT-4	WGA	1350	—	—	—	—	—	—	—	0.3	4030	—	—	57.3	—	4.9	—	—	—	—	—

Table 6.3-2 (continued)

Location ID	Media Code[a]	Fluoride	Gadolinium	Holmium	Iron	Iron (ferrous)	Lanthanum	Lead	Lithium	Lutetium	Magnesium	Manganese	Mercury	Molybdenum	Neodymium	Nickel	Nitrate	Nitrate as Nitrogen	Nitrate-Nitrite as N	Nitrite	Perchlorate
MCOBT-4.4	WGI	350	—	—	—	—	—	—	39	—	6030	1.6	—	0.98	—	3.73	89500	20200	16200	—	210
MCOI-4	WGI	220	—	—	1150 (J)	—	0.3	4.8	27	—	5620	23.3	—	4.3	0.3	35.8 (J)	—	11220	13200	—	140
MCOI-5	WGI	310	0.3	—	6980	—	2.6	13.8	—	—	4560	231 (J)	—	20.8	2.4	414	—	—	3070	—	—
MCOI-6	WGI	580	—	—	107	—	—	1.3	34	—	9560	29	—	2	—	7.3	—	16710	15000	580	160
MCOI-8	WGI	1730	—	—	30	—	—	—	49	—	5950	940	—	150	—	27	—	—	—	—	—
PM-5	WGR	330	—	—	—	—	—	0.35	—	—	4870	1.81	—	2.31	—	0.23	—	350	340	—	1.29
R-1	WGR	180	—	—	74.5	—	—	0.3	37	—	4060	—	—	2.8	—	1	1460	330	240	—	0.34
R-13	WGR	450	—	—	140	—	—	0.1	24	—	3520	7.66	—	1.11	—	—	3320	750	790	—	0.4
R-14	WGR	340	—	—	6850	910	—	0.4	27	—	3480	586	0.08	5.6	—	2.2 (JN-)	760	170	70 (J-)	190	0.19
R-15	WGR	270	—	—	520	—	—	0.65 (J)	25	—	4250	24	—	—	—	2.79 (J)	10700	2410	2530	—	6.15
R-28	WGR	330	—	—	24.8	—	—	—	48	—	9220	17	—	0.9	—	8.1	20200	4570	4890	—	1.13 (J)
R-33	WGR	250	—	—	402	—	—	—	21	—	4090	4.9	—	1.5	—	32	—	350	310	—	—
Test Well 8	WGR	870	—	—	1210	—	—	7	21	—	4310	9.52	—	2.01	—	1.8 (JN-)	670	350	340	—	3.26

Table 6.3-2 (continued)

Location ID	Media Code[a]	Phosphorus, Orthophosphate (Expressed as PO4)	Potassium	Praseodymium	Samarium	Selenium	Silver	Sodium	Strontium	Sulfate	Sulfide, Total	Terbium	Thallium	Thulium	Tin	Titanium	Total Phosphate as Phosphorus	Total Phosphorus	Uranium	Vanadium	Ytterbium	Zinc
Acute Aquatic Life[b]		—	—	—	—	20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Livestock Watering[b]		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Wildlife Habitat[b]		—	—	—	—	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MO-24786	WS	—	3710	1.1	0.8	—	—	61100	152	10900	—	—	—	—	—	—	—	—	0.46	8.3	0.3	16.8
MO-24787	WS	20	14100	1	0.7	—	—	48300	117	14000	—	—	—	—	—	—	—	941	0.51	6.2	0.3	18.3
MO-24788	WS	160	13500	0.7	0.5	—	—	76200	72.2	23300	—	—	—	—	—	—	—	270	0.67	3.2	—	29.1
MO-24789	WS	400	10100	3.8	2.9	—	—	173000	64.3	32200	—	0.4	—	—	—	—	—	401	0.72	48.3	0.8	271
MO-24790	WS	560	6630	1.2	0.9	—	—	38800	126	14600	—	—	—	—	—	—	—	—	0.34	7.6	0.3	21.3
MO-24791	WS	200	7020	0.3	0.3	—	—	61100	79	17700	—	—	—	—	—	—	—	—	0.73	1.4	—	4.1
MO-24792	WS	10	14500	0.9	0.7	—	0.39	43800 (J)	185	11300	—	—	0.73	—	4.5	—	—	174	2.9	36.4	0.2	213
MO-24793	WS	50	4840	0.5	0.4	—	0.32	12000	184	6940	—	—	—	—	—	—	—	—	0.77	4.4	—	8.6
MO-24794	WS	—	4760	—	—	—	—	20100	—	8400	—	—	—	—	—	—	—	—	—	3.3 (J)	—	10.4
MO-24795	WS	—	2760	—	—	—	5.4	16700	—	5320	—	—	—	—	—	—	—	—	—	2.5 (J)	—	22.1
MO-24808	WS	—	9590	—	—	—	—	39900	—	10000	—	—	—	—	—	—	—	149	—	2.1 (J)	—	17.1
Mortandad at GS-1	WS	220	9160	—	—	2	0.11	79100	—	—	—	—	0.21	—	—	—	220	—	3.8	5.8	—	—
Mortandad below Effluent Canyon	WS	—	7630	—	—	2.55	—	38000	63.1	10600	—	—	—	—	—	—	—	170	—	—	—	14.9
NM Groundwater Standards[d]		—	—	—	—	50	50	—	—	600000	—	—	—	—	—	—	—	—	—	—	—	10000
EPA MCLs[f]		—	—	—	—	50	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
EPA region 6 tap water screening levels[g]		—	—	—	—	—	—	—	21900	—	—	—	—	—	—	—	—	—	7.3[f]	36.5	—	—
MCA-1	WGA	—	4640	1.6	1.2	—	—	33600	117	28700	—	—	—	—	—	—	—	—	0.26	8.7	0.4	18.2
MCA-2	WGA	310	21000	0.6	0.5	7.7	—	69600 (J)	145	23200	—	—	—	—	—	—	—	—	1.8	4	0.7	—
MCA-4	WGA	—	11100	—	—	—	0.31	97400 (J)	143	—	—	—	—	—	—	—	—	—	3	34.7	—	64.9
MCA-5	WGA	250	6910	0.6	0.5	—	—	58500	58.7	25800	—	—	—	—	—	—	—	—	—	—	0.2	10.6
MCO-0.6	WGA	—	12700	2.8	2.3	—	—	277000 (J)	169	12800	—	0.3	—	—	—	—	—	—	4.3	15.5	0.8	32.4
MCO-2	WGA	430	—	—	—	2	8	—	153.99	1300	—	—	—	—	—	—	—	—	—	—	—	—
MCO-3	WGA	210	6980	—	—	—	—	68100	97.7	18700	—	—	0.24	—	—	—	—	—	0.71	2.01	—	15.1
MCO-4B	WGA	150	12700	0.3	0.3	—	—	67800	179	19800	—	—	—	—	—	—	—	—	0.66	2.2	0.3	5.8
MCO-5	WGA	220	16000	0.3	0.3	—	—	65400	203	33800	—	—	0.14	—	—	—	90	—	1.82 (J)	1.4	0.3	9.13 (J+)
MCO-6	WGA	200	16700	—	—	2.79	0.01 (J)	75000	184	19800	—	—	0.73	—	—	—	—	—	1.7 (J)	1.89 (J)	0.4	3.9
MCO-7	WGA	280	19100	—	—	0.95 (J)	0.1	75500	158	25900	—	—	—	—	—	—	270	—	2.18	3.1	0.9	12
MCO-7.5	WGA	600	13300	0.4	0.3	1.29	0.02	83900	138	33400	—	—	—	—	—	—	—	—	1.69	4.2	1.7	12.7
MT-1	WGA	340	18800	1.5	1.1	—	—	70200	165	32200	—	0.2	—	—	—	—	—	—	0.52	3.9	1.3	13.8
MT-3	WGA	240	9560	—	—	—	—	89300	134	37400	—	—	—	0.3	—	—	—	—	1.2	1.5	2.5	6
MT-4	WGA	—	5780	—	—	—	—	86700	105	27100	—	—	—	—	—	—	—	—	1.5	2.8	1.3	—

Table 6.3-2 (continued)

Location ID	Media Code[a]	Phosphorus, Orthophosphate (Expressed as PO4)	Potassium	Praseodymium	Samarium	Selenium	Silver	Sodium	Strontium	Sulfate	Sulfide, Total	Terbium	Thallium	Thulium	Tin	Titanium	Total Phosphate as Phosphorus	Total Phosphorus	Uranium	Vanadium	Ytterbium	Zinc
MCOBT-4.4	WGI	100	710	—	—	—	—	23200	170	27300	—	—	—	—	—	1	—	—	0.28	1	—	9
MCOI-4	WGI	90	830	—	—	—	—	22600	173	31700	—	—	—	—	—	—	—	—	0.12	1.9	—	137
MCOI-5	WGI	—	1240	0.6	0.5	—	—	14100	108	14200	—	—	—	—	—	—	210	—	0.26	8.6	—	382
MCOI-6	WGI	200	740	—	—	—	—	21600	215	39500	—	—	—	—	—	2	—	—	0.47	1.3	—	90.8
MCOI-8	WGI	140	4790	—	—	—	—	45400	170	23500	—	—	—	—	—	—	—	—	1.6	—	—	50
PM-5	WGR	—	2310	—	—	—	—	13500	59.3	2760	—	—	—	—	—	—	30	40	0.55	11	—	12.2
R-1	WGR	120	1840	—	—	—	—	12800	53	3700	2	—	—	—	—	—	—	—	0.83	8.7	—	11
R-13	WGR	50	1400	—	—	2.98	—	11700	53.8	3360	—	—	0.27	—	—	—	—	—	0.49	6	—	38
R-14	WGR	580	2300 (J)	—	—	10.1 (J+)	—	15700	102	1890	30	—	0.03 (JN-)	—	1	—	—	1020	0.63	6.45 (J)	—	13
R-15	WGR	70	2000	—	—	2.9	—	12100	65	7590	—	—	1.51	—	—	—	—	70	0.46	7.34	—	3.59 (J)
R-28	WGR	20	1740 (J)	—	—	6.3 (J)	0.61	15600	143	43200	5	—	—	—	—	2	90	—	1.1 (J)	7	—	52
R-33	WGR	70	2170	—	—	6.2	—	12100	53.2	2800	—	—	—	—	—	—	—	—	1	6.1	—	63.2
Test Well 8	WGR	90	2060	—	—	—	—	10800	54.3	2150	—	—	0.45	—	—	—	—	60	0.84	5.3	—	460

All values in ug/L. Bolded concentrations exceed a standard and/or screening level. Grey shading indicates a standard and/or screening value was exceeded for that chemical. All surface waters associated with these locations are ephemeral.

[a] Media code definitions are provided in Table C-2-4.

[b] 20.6.4 NMAC.

[c] — = Not detected or not analyzed.

[d] 20.6.2 NMAC.

[e] EPA MCL for free cyanide.

[f] EPA 2005, 91002.

[g] EPA 2005, 91002 only listed for chemicals without a standard or MCL.

[h] Perchlorate-revised value.

[i] EPA region 9 PRG (EPA 2004, 93663).

Table 6.3-3
Mortandad Unfiltered Water Organic COPCs

Location ID	Media Code[a]	Acenaphthene	Acenaphthylene	Acetone	Anthracene	Aroclor-1260	Benzene	Benzo(a)anthracene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzoic Acid	Bis(2-ethylhexyl)phthalate	Butanone[2-]	Carbazole	Carbon Disulfide	Chloromethane	Chloronaphthalene [2-]	Chrysene	DDD[4,4'-]	DDE[4,4'-]	DDT[4,4'-]	Dichlorobenzene [1,2-]
Acute Aquatic Life[b]		—[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.1	1.1	1.1	—
Human Health Persistent[b]		—	—	—	—	0.00064	—	—	—	—	—	—	—	—	—	—	—	—	0.0022	0.0022	0.0022	—
Wildlife Habitat[b]		—	—	—	—	0.014	—	—	—	—	—	—	—	—	—	—	—	—	0.001	0.001	0.001	—
MO-24786	WS	—	—	2.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MO-24787	WS	—	—	2.9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MO-24788	WS	—	—	2	—	—	—	—	—	—	14.2	—	—	—	—	—	—	—	—	—	—	—
MO-24790	WS	—	—	3.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MO-24792	WS	—	—	2.4	—	1.1 (J-)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MO-24793	WS	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MO-24808	WS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mortandad below Effluent Canyon	WS	—	—	75.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NM Groundwater Standards[d]		—	—	—	—	1	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
EPA MCLs[e]		—	—	—	—	—	5	—	—	—	—	6	—	—	—	—	—	—	—	—	—	600
EPA region 6 tap water screening levels[f]		365	—	5475	1825	—	—	0.92	0.92	9.2	146000	—	7065	33.62	1043	21.3	487	92	2.77	1.95	1.95	—
MCA-1	WGA	—	—	—	—	—	—	—	—	—	—	—	1.4	—	—	—	—	—	—	—	—	—
MCA-2	WGA	—	—	—	—	—	—	—	—	—	—	3.2	—	—	—	—	—	—	—	—	—	—
MCA-5	WGA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MCO-0.6	WGA	—	—	5.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.26
MCO-3	WGA	—	—	—	—	—	—	—	—	—	—	0.25	—	—	—	—	—	—	—	—	—	—
MCO-4B	WGA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.3	—	—	—	—	—	—
MCO-5	WGA	—	—	—	—	—	0.45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MCO-6	WGA	—	—	—	—	—	—	—	—	—	—	3.1	—	—	—	—	—	—	—	—	—	—
MCO-7	WGA	—	—	—	—	—	—	—	—	—	—	3.2	—	—	—	—	—	—	—	—	—	—
MT-1	WGA	—	—	2.4	—	—	—	—	—	—	—	7	—	—	—	—	—	—	—	—	—	—
MT-3	WGA	0.71	0.6	3.4	0.64	—	—	—	0.44	0.66	—	0.59	—	0.68	—	—	0.68	0.8	—	—	—	—
MCOBT-4.4	WGI	—	—	5.3	—	—	—	—	—	—	—	1.6 (J)	—	—	—	—	—	—	—	—	0.03 (J)	—
MCOI-4	WGI	—	—	3.5	—	—	—	—	—	—	—	—	—	—	4.2 (J)	3.4 (J)	—	—	—	—	—	—
MCOI-5	WGI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MCOI-6	WGI	—	—	—	—	—	—	—	—	—	—	4.6	3.7	—	—	—	—	—	—	—	—	—
PM-5	WGR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00792	—	—	—
R-1	WGR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-13	WGR	—	—	71.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.01	—	—
R-14	WGR	—	0.25 (J)	4.2	0.3 (J)	—	—	0.42 (J)	—	—	—	—	—	—	—	—	—	0.38 (J)	—	—	—	—
R-15	WGR	—	—	19 (J)	—	—	—	—	—	—	—	9.3 (J)	—	—	—	—	—	—	—	—	—	—
R-28	WGR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.1	—	—	—	—	—	—
R-33	WGR	—	—	—	—	—	—	—	—	—	—	8.2	—	—	—	—	—	—	—	—	—	—
Test Well 8	WGR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 6.3-3 (continued)

Location ID	Media Code[a]	Dichlorobenzene[1,3-]	Dichlorobenzene[1,4-]	Dichlorobenzidine[3,3'-]	Diethylphthalate	Dioxane[1,4-]	Endrin	Fluoranthene	Fluorene	Isopropylbenzene	Methyl-2-pentanone[4-]	Methylene Chloride	Methylnaphthalene[2-]	Naphthalene	Nitroaniline[4-]	Octachlorodibenzofuran [1,2,3,4,6,7,8,9-]	Phenanthrene	Pyrene	Toluene	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
Acute Aquatic Life[b]		—	—	—	—	—	0.086	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Human Health Persistent[b]		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Wildlife Habitat[b]		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MO-24786	WS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MO-24787	WS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MO-24788	WS	—	—	—	—	—	—	—	—	—	1.9	—	—	—	—	—	—	—	—	—	—	—
MO-24790	WS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MO-24792	WS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MO-24793	WS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MO-24808	WS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mortandad below Effluent Canyon	WS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.85	—	—	—	—
NM Groundwater Standards[d]		—	—	—	—	—	—	—	—	—	—	100	30	30	—	—	—	—	750	620	—	—
EPA MCLs[e]		—	75	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	1000	—	—	—
EPA region 6 tap water screening levels[f]		14.5	—	1.49	29200	61.12	—	1460	243	658	—	—	—	—	—	—	—	183	—	—	1431	—
MCA-1	WGA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MCA-2	WGA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MCA-5	WGA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.38	—	—	—
MCO-0.6	WGA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MCO-3	WGA	0.65	0.39	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MCO-4B	WGA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MCO-5	WGA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.84E-05	—	—	0.83	0.64	0.19	0.45
MCO-6	WGA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MCO-7	WGA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MT-1	WGA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MT-3	WGA	—	—	14.1 (J+)	—	—	—	0.73	0.74	—	—	—	0.6	0.64	—	—	0.75	0.66	0.34	—	—	—
MCOBT-4.4	WGI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MCOI-4	WGI	—	—	—	—	53.3 (J)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MCOI-5	WGI	—	—	—	—	—	—	—	—	—	—	—	—	—	17.6 (J+)	—	—	—	8.5	—	—	—
MCOI-6	WGI	—	—	—	—	52.2 (J)	—	—	—	—	5.8 (J)	—	—	—	—	—	—	—	31.2	—	—	—
PM-5	WGR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-1	WGR	—	—	—	7.44 (J+)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-13	WGR	—	0.32 (J)	—	—	—	0.0084	—	—	—	—	—	—	—	—	—	—	—	2.8	—	—	—
R-14	WGR	—	—	—	—	—	—	0.33 (J)	0.3 (J)	0.3	—	—	—	—	—	—	0.43 (J)	0.36 (J+)	—	—	—	—
R-15	WGR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.69 (J)	—	—	—
R-28	WGR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	29.1	—	—	—

Table 6.3-3 (continued)

Location ID	Media Code[a]	Dichlorobenzene[1,3-]	Dichlorobenzene[1,4-]	Dichlorobenzidine[3,3'-]	Diethylphthalate	Dioxane[1,4-]	Endrin	Fluoranthene	Fluorene	Isopropylbenzene	Methyl-2-pentanone[4-]	Methylene Chloride	Methylnaphthalene[2-]	Naphthalene	Nitroaniline[4-]	Octachlorodibenzofuran [1,2,3,4,6,7,8,9-]	Phenanthrene	Pyrene	Toluene	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
R-33	WGR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Test Well 8	WGR	—	—	—	—	—	—	—	—	—	—	1.1	—	0.37	—	—	—	—	0.3	—	—	—

Notes: All values in ug/L. Bolded concentrations exceed a standard and/or screening level. Grey shading indicates a standard and/or screening value was exceeded for that chemical. All surface waters associated with these locations are ephemeral.

[a] Media code definitions are provided in Table C-2-4.

[b] 20.6.4 NMAC

[c] — = Not detected or not analyzed.

[d] 20.6.2 NMAC

[e] EPA 2005, 91002.

[f] EPA 2005, 91002 only listed for chemicals without a standard or MCL.

Table 6.3-4
Mortandad Filtered Water Radionuclide COPCs

Location ID	Media Code[a]	Americium-241	Cesium-137	Gross Alpha	Gross Beta	Gross Gamma	Plutonium-238	Plutonium-239/240[b]	Potassium-40	Radium-226	Sodium-22	Strontium-90	Uranium-234	Uranium-235/236[c]	Uranium-238
Derived Concentration Guide (DCG) 100 mrem/yr[d]		**30**	**3000**	**—[e]**	**—**	**—**	**40**	**30**	**7000**	**100**	**10000**	**1000**	**500**	**600**	**600**
MO-24786	WS	—	—	—	5.5 (J)	—	—	—	—	—	—	—	0.14 (J)	—	0.12 (J)
MO-24787	WS	—	—	—	16 (J)	—	—	—	—	—	—	—	0.44	0.09 (J)	—	0.07 (J)
MO-24788	WS	4.07	22.8	7.98	48.1	—	1.5	2.56	—	0.41 (J)	—	4.37	0.42	—	0.36
MO-24789	WS	—	—	—	6.22 (J)	—	—	—	—	1.45 (J)	—	—	0.16 (J)	—	0.14 (J)
MO-24790	WS	—	—	1.94 (J)	8.42	—	—	—	—	0.37 (J)	—	0.6 (J)	0.13 (J)	—	0.08 (J)
MO-24791	WS	0.64	—	4.24 (J)	109	—	0.2	0.39	—	—	—	41.4	0.58	—	0.19
MO-24792	WS	0.04 (J)	—	—	25.7	—	0.23	0.07 (J)	—	—	—	9.1	0.13 (J)	—	0.1 (J)
MO-24793	WS	—	—	—	44.9	—	—	—	—	—	—	19.1	0.24 (J)	—	0.26
Mortandad at GS-1	WS	0.6	—	—	—	—	1.51	0.82	—	—	—	45.29	3.51	0.07	1.08
Mortandad below Effluent Canyon	WS	1.62	9.67 (J)	4.68 (J)	28.8	—	0.44	0.75	—	0.61 (J)	—	3.2	0.17 (J)	—	0.07 (J)
EPA MCLs[f]		—	—	**15**	—	—	—	—	—	—	—	—	—	—	—
Derived Concentration Guide (DCG) 4 mrem/yr		**1.2**	**120**	—	—	—	**1.6**	**1.2**	**280**	**4**	**400**	**40**	**20**	**24**	24
MCA-1	WGA	—	—	2.35	6.03 (J)	—	—	—	—	1.94	—	0.42 (J)	0.11 (J)	—	0.09 (J)
MCA-2	WGA	0.1 (J)	—	3.67 (J)	47.4	—	—	—	70.8 (J)	1.66	—	10.4	0.99	0.06 (J)	0.66
MCA-5	WGA	1.19	—	3.11 (J)	59.6	—	0.78	0.76	—	1.41	—	21	0.47	0.03 (J)	0.17
MCO-0.6	WGA	—	—	5.16 (J, J-)	14.5 (J)	—	—	—	—	—	—	0.45 (J)	1.2	—	1.38
MCO-4B	WGA	0.17	—	3.73 (J)	112	—	0.11 (J)	0.2	—	—	—	39.6 (J)	0.54	—	0.17 (J)
MCO-5	WGA	0.11	—	1.89 (J)	95.9	—	0.06	—	—	—	—	57	0.42 (J)	0.04	0.41
MCO-6	WGA	0.08 (J)	—	3.06 (J)	112	—	0.02	—	—	1.42	5.84	56.79	1.4	0.06 (J)	0.5
MCO-7	WGA	0.12	—	—	31.5	—	0.03	—	—	2.19 (J)	—	1.92	0.77	0.08 (J)	0.65
MCO-7.5	WGA	0.21	—	2.53 (J)	25	—	—	0.07 (J)	—	0.72 (J)	—	—	0.5	0.06 (J)	0.45
MT-1	WGA	0.12	—	1.25 (J)	30.4	—	—	0.04 (J)	—	1.37 (J)	—	0.41 (J)	0.65	—	0.48
MT-3	WGA	0.23	—	2.89 (J)	28.8	—	—	—	—	—	—	—	0.57	0.08 (J)	0.47
MT-4	WGA	0.08 (J)	—	2.46 (J)	15.5	—	—	—	—	—	—	—	0.69	0.06 (J)	0.62
MCOBT-4.4	WGI	—	—	—	—	—	—	—	44.4	—	—	—	0.25	—	0.15
MCOI-4	WGI	—	—	—	3.35 (J)	—	—	—	—	—	—	—	0.11 (J)	—	—
MCOI-5	WGI	—	—	—	—	—	—	—	—	—	—	—	0.11 (J)	—	0.06 (J)
MCOI-6	WGI	—	—	2.11 (J)	14.7 (J)	—	—	—	—	3.04	—	—	0.4	0.06 (J)	0.19
R-1	WGR	—	—	—	3.63 (J)	—	—	—	—	—	—	—	0.63	—	0.23
R-13	WGR	—	—	—	—	—	—	—	—	—	—	—	0.33	—	0.14
R-15	WGR	—	—	—	3.42 (J)	137	—	—	—	—	—	1.51	0.34	0.04	0.18 (J)
R-28	WGR	—	—	—	9.29 (J)	—	—	—	—	—	—	—	0.89	0.07 (J)	0.39
R-33	WGR	—	—	—	4.96 (J)	—	—	—	—	—	—	—	0.65	—	0.32

Note: All values in pCi/L. Bolded concentrations exceed a standard and/or screening level. Grey shading indicates a standard and/or screening value was exceeded for that chemical.

[a] Media code definitions are provided in Table C-2-4.

[b] Plutonium-239 DCG.

[c] Uranium-235 DCG.

[d] No applicable NM standards; all surface waters are ephemeral.

[e] — = Not detected or not analyzed.

[f] EPA 2005, 91002.

Table 6.3-5
Mortandad Unfiltered Water Radionuclide COPCs

Location ID	Media Code[a]	Americium-241	Cesium-137	Gross Alpha	Gross Alpha/Beta	Gross Beta	Gross Gamma	Plutonium-238	Plutonium-239/240	Potassium-40	Radium-226	Sodium-22	Strontium-90	Technetium-99	Thorium-228	Thorium-230	Thorium-232	Tritium	Uranium-234	Uranium-235/236	Uranium-238
Livestock Watering[d]		—[e]	—	15	—	—	—	—	—	—	30	—	—	—	—	—	—	20000	—	—	—
Derived Concentration Guide (DCG) 100 mrem/yr[f]		30	3000	—	—	—	—	40	30	7000	—	10000	1000	100000	400	300	50	—	500	600	600
MO-24786	WS	—	—	—	—	5 (J)	—	—	—	—	—	—	0.36 (J)	—	—	—	—	117.18	0.19 (J)	—	0.16 (J)
MO-24787	WS	—	—	—	—	16.1	—	—	—	—	0.76	—	0.58 (J)	—	—	—	—	365 (J)	0.19 (J)	—	0.16 (J)
MO-24788	WS	8.64 (J)	35.6	18.4 (J)	12.3	52.7 (J)	—	3.15 (J)	4.85 (J)	63.6 (J)	—	—	3.97 (J)	—	—	—	—	1090	0.56 (J+)	—	0.24 (J+)
MO-24789	WS	—	—	4.87 (J)	7.44	13.1	—	0.13 (J)	0.08	—	0.43	—	0.44 (J)	—	—	—	—	87.8	0.42	—	0.4
MO-24790	WS	—	—	2.2 (J)	—	9.26	—	—	—	—	—	—	0.5 (J)	—	—	—	—	86.84	0.12 (J)	—	0.12 (J)
MO-24791	WS	0.98 (J)	6.15 (J)	7.22	—	119	—	0.28 (J)	0.5	—	—	—	43.9 (J)	9.87	—	—	—	590.7	0.52	—	0.18
MO-24792	WS	0.2	—	7.41 (J,J-)	7.73	43.9	—	1.79	0.79	—	—	—	6.63	—	—	—	—	72.8	0.24	—	0.22
MO-24793	WS	—	—	81.2	—	59.2	—	0.07 (J)	—	—	—	—	21.3	—	—	—	—	167.31	0.22 (J)	—	0.26
MO-24794	WS	—	—	—	3.1	—	—	0.12	—	—	—	—	—	—	—	—	—	—	0.26	—	0.29
MO-24795	WS	—	—	—	6.15	—	—	0.06	—	—	—	—	—	—	—	—	—	—	0.15	—	0.13
MO-24808	WS	1.88	—	—	4.59	—	—	0.75	0.81	—	—	—	—	—	—	—	—	—	0.36	—	0.19
Mortandad at GS-1	WS	6.54 (J+)	31.39	39.9	—	92.9 (J)	262	5	6.75	—	—	8.96	47.7	—	—	—	—	52633.41	3.43	0.07	1.12
Mortandad at Rio Grande (A-11)	WS	0.03	—	—	—	15.3	—	—	—	—	1.36	—	0.3 (J)	—	—	—	—	5.97	0.35	—	0.17
Mortandad below Effluent Canyon	WS	15	42.6	49.3	—	80.3	—	6.75	4.73	—	0.7 (J)	12.8	11.5	—	0.12 (J)	0.07	0.1 (J)	12900	2.93	0.17	0.25
EPA MCLs[g]		—	—	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Derived Concentration Guide (DCG) 4 mrem/yr[g]		1.2	120	—	—	—	—	1.6	1.2	280	4	400	40	4000	16	12	2	80000	20	24	24
MCA-1	WGA	—	—	3.66 (J)	—	10.5	—	—	—	—	—	—	—	—	—	—	—	109.83	0.17 (J)	—	0.2 (J)
MCA-2	WGA	0.07 (J)	—	3.63 (J)	—	51.4	—	—	—	—	1.63	—	9.53	12.6 (J)	—	—	—	3649.59	0.94	0.06 (J)	0.66
MCA-5	WGA	2.44 (J)	7.53 (J)	8.91 (J)	—	80.2 (J)	—	1.75 (J)	1.96 (J)	—	1.35 (J)	—	20 (J)	15.6 (J)	—	—	—	491 (J)	0.49 (J)	—	0.26 (J)
MCO-0.6	WGA	—	—	7.86 (J,J-)	—	19.7 (J)	—	—	—	—	—	—	0.38 (J)	—	—	—	—	222 (J)	1.43	0.09 (J)	1.53
MCO-2	WGA	—	—	—	—	—	—	—	—	—	—	—	0.67	—	—	—	—	—	0.14	—	0.15
MCO-3	WGA	3.98	8.08	12.4	—	161 (J)	—	2.19	1.78	649	0.52 (JN+)	24.6	39.3	—	—	—	0.05 (J)	76300	4.27	0.17 (J)	1.17
MCO-4B	WGA	0.7	—	7.11 (J-)	—	262 (J)	—	0.14	0.27	—	1.28 (J)	—	79.1	6.25 (J)	—	—	—	2790	3.24	0.21	0.91
MCO-5	WGA	1.06	—	11.9 (J-)	—	251 (J)	—	0.17	0.29	63.1 (J)	0.99 (J)	26.2	81.6	7.43 (J)	—	0.05 (J)	—	6820	2.66	0.14 (J)	0.8
MCO-6	WGA	0.97	—	6.28 (J-)	—	152 (J)	—	0.01	0.03 (J)	—	1.55 (J)	18.5	60.29	10.7 (J)	—	0.03 (J)	—	8260.29	2.48	0.16	0.88
MCO-7	WGA	0.98	16.5	3.39 (J-)	—	54.2	—	—	0.02	—	1.59 (J)	12.4	2.32	18 (J)	—	0.04 (J)	—	10971.14	0.85	0.04 (J)	0.69
MCO-7.5	WGA	0.32	—	2.8 (J)	—	43.3 (J)	—	0.23	0.32	—	2.27	8.34 (J)	0.42 (J)	23.1	0.12 (J)	0.16 (JN+)	0.05 (J)	16137.42	0.51	0.05 (J)	0.55
Mort PRB Apatite Cell 10	WGA	0.12 (J)	—	—	—	—	—	—	—	—	—	—	1.48	—	—	—	—	—	—	—	—
Mort PRB Apatite Cell 4	WGA	—	—	—	—	—	—	0.05 (J)	—	—	—	—	14.4	—	—	—	—	—	—	—	—
Mort PRB Apatite Cell 8	WGA	0.4	—	—	—	—	—	0.21	0.22	—	—	—	36.9	—	—	—	—	—	—	—	—
Mort PRB Bio Cell 3	WGA	0.66	—	—	—	—	—	0.08 (J)	0.06 (J)	—	—	—	45.9	—	—	—	—	—	—	—	—
Mort PRB Bio Cell 7	WGA	0.21	—	—	—	—	—	0.1 (J)	0.05 (J)	—	—	—	34.6	—	—	—	—	—	—	—	—

Table 6.3-5 (continued)

Location ID	Media Code[a]	Americium-241	Cesium-137	Gross Alpha	Gross Alpha/Beta	Gross Beta	Gross Gamma	Plutonium-238	Plutonium-239/240[b]	Potassium-40	Radium-226	Sodium-22	Strontium-90	Technetium-99	Thorium-228	Thorium-230	Thorium-232	Tritium	Uranium-234	Uranium-235/236[c]	Uranium-238
Mort PRB Bio Cell 9	WGA	0.34	—	—	—	—	—	0.23	0.13	—	—	—	**48.5**	—	—	—	—	—	—	—	—
Mort PRB Gravel Cell 11	WGA	0.34	—	—	—	—	—	0.27	0.23	—	—	—	**60.9**	—	—	—	—	—	—	—	—
Mort PRB Gravel Cell 12	WGA	0.12 (J)	—	—	—	—	—	0.1	0.05 (J)	—	—	—	**67.7**	—	—	—	—	—	—	—	—
Mort PRB Gravel Cell 6	WGA	0.24	—	—	—	—	—	0.13	0.08 (J)	—	—	—	62	—	—	—	—	—	—	—	—
Mort PRB Limestone Cell 13	WGA	0.35	—	—	—	—	—	0.1	0.24	—	—	—	**53.4**	—	—	—	—	—	—	—	—
Mort PRB Limestone Cell 14	WGA	0.19	—	—	—	—	—	0.07 (J)	—	—	—	—	**49.3**	—	—	—	—	—	—	—	—
Mort PRB Limestone Cell 5	WGA	**0.67**	—	—	—	—	—	0.19	0.43	—	—	—	47	—	—	—	—	—	—	—	—
MT-1	WGA	0.11 (J)	—	6.38	—	33.1 (J)	—	0.07 (J)	0.1 (J)	—	1.54 (J)	—	0.58 (J)	16	—	—	—	3610	0.94 (J)	0.05 (J)	0.81 (J)
MT-3	WGA	0.2 (J)	—	2.06 (J)	—	29.8 (J)	—	—	—	—	—	—	—	17.4	—	—	—	6287.01	0.45	—	0.39
MT-4	WGA	0.08 (J)	—	—	—	17	—	—	—	—	—	—	—	20.2	—	—	—	4720	0.7	0.04 (J)	0.62
PRB-MW-01	WGA	**3.09**	—	—	—	—	—	1.41	**1.57**	—	—	—	**90.5**	—	—	—	—	—	—	—	—
PRB-MW-02	WGA	0.74	—	—	—	—	—	0.33	0.88	—	—	—	**78.9**	—	—	—	—	—	—	—	—
MCOBT-4.4	WGI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	23500	0.4	0.06	0.36
MCOI-4	WGI	—	—	—	—	2.03 (J)	—	—	—	—	3.28	—	—	5.76 (J)	—	—	—	12900	0.13 (J)	—	—
MCOI-5	WGI	—	—	—	—	—	—	—	—	—	—	—	—	4.72 (J)	—	—	—	4480	0.19 (J)	—	0.13 (J)
MCOI-6	WGI	—	—	—	—	10.2 (J)	—	—	—	—	0.73 (J)	—	—	7.86 (J)	—	—	—	13100	0.41	—	0.21
MCOI-8	WGI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	136.37	—	—	—
PM-5	WGR	0.15	—	—	—	4.01 (J)	—	—	—	—	0.56 (J)	—	—	—	—	0.2 (J)	—	2.36	0.39	0.04 (J)	0.21
R-1	WGR	—	—	14.5	—	3.75 (J)	—	—	—	—	—	—	—	—	—	—	—	—	0.67	0.06 (J)	0.28
R-13	WGR	—	—	0.64 (J)	—	2.58	—	—	—	—	0.44 (J)	—	—	—	—	—	—	—	0.31	0.06 (J)	0.15
R-14	WGR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.55	0.33	0.08 (J)	0.2
R-15	WGR	—	—	—	—	3.1	240	—	—	195	0.92 (J)	—	—	—	—	—	—	30.97	0.31	0.07	0.18
R-28	WGR	—	—	—	—	12.4 (J)	—	—	—	—	—	—	—	—	—	—	—	181.36	0.85	0.08 (J)	0.39
R-33	WGR	—	—	—	—	4.51 (J)	—	—	—	—	0.7 (J)	—	—	—	—	—	—	137.29	0.62	0.05 (J)	0.33
Test Well 8	WGR	—	—	—	—	3.01	—	—	—	—	3.99	—	—	—	—	—	—	6.06	0.41	—	0.22

Notes: All values in pCi/L. Bolded concentrations exceed a standard and/or screening level. Grey shading indicates a standard and/or screening value was exceeded for that chemical.

[a] Media code definitions are provided in Table C-2-4.

[b] Plutonium-239 DCG.

[c] Uranium-235 DCG.

[d] 20.6.4 NMAC.

[e] — = Not detected or not analyzed.

[f] Only listed for chemicals without a NM standard.

[g] EPA 2005, 91002.

Table 6.4-1
Mortandad Core Inorganic COPCs

Borehole	Media Code[a]	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium[b]	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
QAL (ALLH) LANL BV[c]		29200	0.83	8.17	295	1.83	0.4	6120	19.3	8.64	14.7	21500	22.3	4610	671	0.1	#N/A	15.4	1.52	1	0.73	39.6	48.8
QBT2 LANL BV		7340	0.5	2.79	46	1.21	1.63	2200	7.14	3.14	4.66	14500	11.2	1690	482	0.1	#N/A	6.58	0.3	1	1.1	17	63.5
QBT1V LANL BV		8170	0.5	1.81	26.5	1.7	0.4	3700	2.24	1.78	3.26	9900	18.4	780	408	0.1	#N/A	2	0.3	1	1.24	4.48	84.6
QBT 1G, QCT, QBO, QBOF LANL BV		3560	0.5	0.56	25.7	1.44	0.4	1900	2.6	8.89	3.96	3700	13.5	739	189	0.1	#N/A	2	0.3	1	1.22	4.59	40
Residential SSL		77800	31.3	3.9	15600	156	39	#N/A	2100	1520	3130	23500	400	#N/A	3590	100000	391	1560	391	391	5.16	78.2	23500
B-1	QBT1V	—[d]	—	—	—	—	0.53 (U)	—	—	—	—	—	—	—	—	—	—	—	0.67	—	—	—	—
B-1	QBT2	—	—	—	—	1.76	—	—	—	—	—	—	—	—	—	—	—	—	1.08	—	—	—	64.4
B-2	QBT1G	9440	—	0.88	—	1.71	—	—	14	—	—	5040	—	—	264 (J)	—	—	—	—	—	—	—	—
B-2	QBT1V	25500	—	3.82	338	5.51	—	—	—	—	4.36 (J+)	11000	60	—	670 (J)	—	—	—	0.69 (U)	—	1.63	—	98.2
B-2	QBT2	—	—	—	—	—	—	—	—	—	—	—	11.4	—	497 (J)	—	—	—	—	—	—	—	65.5
B-5	QAL	—	—	—	—	—	0.61 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B-5	QBT1G	—	—	0.57 (U)	—	—	0.58 (U)	—	—	—	—	4090 (J)	—	—	—	—	—	—	0.58 (U)	—	—	—	—
B-6	QAL	—	—	—	—	—	0.6 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	70.6
B-6	QBT1G	—	—	0.8 (U)	—	—	0.62 (U)	—	—	—	—	—	—	—	—	—	—	—	0.62 (U)	—	—	—	—
B-7	QAL	—	—	—	—	—	0.58 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B-7	QBT1G	42000	0.53 (U)	2.7 (U)	634	3.89	0.66 (U)	—	6.6	—	9.41	13200	29.6	1310	—	—	—	13.5	0.66 (U)	—	—	8.65	101
B-7	QCT	14600	—	1.39	70	4.41	0.63 (U)	—	5.23	—	4.41	6880	17.8	1630	—	—	—	3.91	0.56 (J)	—	—	7.3	120
B-8	QAL	—	—	—	—	—	0.56 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B-8	QCT	37200	—	1.9	166	3.59	0.77 (U)	—	7.15	—	7.67	10700	26.3	1710 (J+)	364	—	—	18.2	1.03	—	—	9.66	65.4
B-9	QAL	36000	—	—	—	3.18	0.61 (U)	—	—	—	—	—	37.9	—	—	—	—	—	—	—	0.82	—	86.2
B-9	QCT	14900	—	0.95	56.6	1.76	0.62 (U)	—	3.47	—	—	12500	—	905 (J)	216 (J)	—	—	3.43	1.13	—	—	9.81	44
B-10	QAL	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	57.9
B-10	QCT	17300	—	2.42 (J)	73	2.49	—	—	5.74	—	5.19	12500	14.2	1540 (J+)	474	—	—	4.43	1.2	—	—	9.12	62.5
B-11	QAL	—	—	—	—	—	0.63 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	65.6
B-11	QCT	23300	0.52 (UJ)	1.23	81.8	1.5	0.65 (U)	—	4.27	—	—	10600	—	1000	246	—	—	4.21	0.65 (U)	—	—	7.19	—
B-12	QCT	28000 (J+)	—	3.52	178	6.66	—	2420	11.2 (J)	—	5.9	14100 (J+)	114	4270	918 (J-)	—	—	6 (J)	0.74	—	—	21.7	245 (J)
B-14	QAL	62600	—	—	365	4.18	0.72 (U)	—	—	—	17	—	31.9	—	—	—	—	25.4	—	—	—	—	94.8
B-14	QBOF	7850 (J)	—	1.35 (J)	85.1 (J-)	—	0.58 (U)	—	71.7 (J-)	—	8.19 (J)	10900	—	1390 (J-)	217 (J-)	—	—	3.56	1.19	—	—	6.83	—
B-14	QCT	11400	—	0.84 (U)	43.4	—	0.62 (U)	—	4.09 (J)	—	4.33	5860	—	1230 (J)	—	—	—	2.8	0.62	—	—	9.63 (J)	—
B-15	QAL	—	—	—	—	—	0.53 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B-15	QBO	—	—	—	30.5	—	0.55 (U)	—	3.07	—	—	6690 (J+)	—	—	198	—	—	—	0.55 (U)	—	—	5.25	49.7
B-15	QBT1G	—	—	0.6 (U)	—	—	0.6 (U)	—	—	—	—	—	—	—	—	—	—	—	0.57 (U)	—	—	—	—
B-15	QCT	17300 (J+)	—	1.36 (U)	66.9	5.71	0.58 (U)	—	9.98	—	5.95	10100 (J+)	—	2470 (J+)	237	—	—	5.4	0.84 (U)	—	—	13	63.8
B-16	QBO	—	—	—	49	—	—	—	6.48	—	—	4000	—	—	230	—	—	—	0.66	—	—	—	—

Table 6.4-1 (continued)

Borehole	Media Code[a]	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium[b]	Cobalt	Copper	Iron[c]	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
R-14	QBO	—	—	—	—	—	0.528 (U)	—	—	—	—	3830	—	—	—	—	—	—	0.528 (U)	—	—	—	—
R-14	QBT1G	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.531 (U)	—	—	—	—
R-14	QBT1V	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.499 (U)	—	—	—	—
R-14	QBT2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.523 (U)	—	—	—	—
R-14	QCT	3660	—	—	—	—	0.489 (U)	—	2.76	—	—	—	—	—	—	—	—	—	0.489 (U)	—	—	—	—
R-15	QBO	8820	1.3 (J-)	1.4 (J)	156	—	0.6 (U)	10200	9.6	21.2	35.1	28000	—	16700	545 (J+)	0.12 (U)	0.83 (J)	75.6	1.3	2.4 (U)	—	28.1	46.2
R-15	QBT1G	27500	0.68 (UJ)	2.8	192	4.8	—	2040	6.4	—	15.4	9390	31.2	1300	479 (J-)	—	—	9.1 (J)	0.79 (U)	—	—	11.8	80.2
R-15	QCT	23800	0.72 (UJ)	2.1 (J)	72.5	2.9	—	2190	442	—	46.1	8110	16.6	1840	348 (J-)	—	—	218	0.83 (U)	—	—	10 (J)	46.4

Notes: All values in mg/kg. Values are maximum values > BV. Values in bold exceed the residential SSL. Grey shading indicates a screening value was exceeded for that chemical.

[a] Media code definitions are provided in Table C-2-4.

[b] EPA region 6 residential HHMSSL (EPA 2005, 91002).

[c] LANL (1998, 59730).

[d] — = Not detected > BV or not analyzed.

Table 6.4-2
Mortandad Core Radionuclide COPCs

Borehole	Media Code[a]	Americium-241	Cesium-134	Plutonium-238	Plutonium-239	Tritium	Uranium-234	Uranium-235	Uranium-238
QAL (ALLH) LANL BV[b]		**0.013**	**#N/A**	**0.023**	**0.054**	**#N/A**	**2.59**	**0.2**	**2.29**
QBT2 LANL BV		**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**1.98**	**0.09**	**1.93**
QBT1V LANL BV		**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**3.12**	**0.14**	**3.05**
QBT 1G, QCT, QBO, QBOF LANL BV		**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**4**	**0.18**	**3.9**
Residential SSL[c]		**30**	**2.4**	**37**	**33**	**750**	**170**	**17**	**86**
B-1	QBT2	-[d]	-	-	-	-	2.24	0.1	2.26
B-2	QBT1V	-	-	-	-	-	-	0.19	3.22
B-2	QBT2	-	-	-	-	-	-	0.13	1.94
B-5	QAL	0.79	-	0.19	0.78	-	3.08	-	3.16
B-5	QBT1G	-	-	-	0.07	13.39	-	-	-
B-6	QAL	0.06	-	-	-	-	-	-	-
B-6	QBT1G	-	-	-	-	9.28	-	-	-
B-7	QAL	1.07	-	0.18	1.11	0.84	-	-	-
B-7	QBT1G	-	-	-	-	8.72	-	0.2	-
B-7	QCT	-	-	-	-	3.31	-	-	-
B-8	QCT	-	-	-	-	1.06	-	-	-
B-9	QAL	-	-	0.07	-	1.02	-	-	-
B-9	QCT	-	-	-	-	7.5	-	-	-
B-10	QAL	-	-	-	-	29.44	-	-	2.65
B-10	QCT	-	-	-	-	4.16	-	-	-
B-11	QAL	-	-	-	-	5.9	-	-	-
B-11	QCT	-	-	-	-	3.64	-	-	-
B-12	QAL	-	-	-	-	1.75	-	-	-
B-12	QCT	-	-	-	-	6.81	-	-	-
B-14	QAL	0.03	-	-	0.06	7.92	-	-	-
B-14	QBOF	-	-	-	-	5.66	-	-	-
B-14	QCT	-	0.13	0.12	-	5.71	-	-	-
B-15	QBT1G	-	-	-	-	-	-	-	3.94
B-16	QAL	-	-	-	-	-	-	-	2.42
I-6	QAL	-	-	-	-	1.85	-	-	-
I-6	QBO	-	-	-	-	8.33	-	-	-
I-6	QCT	-	-	-	-	0.97	-	-	-
I-8	QAL	-	-	-	-	1.23	-	-	-
I-8	QBO	-	-	-	-	9.18	-	-	-

077732

Table 6.4-2 (continued)

Borehole	Media Code[a]	Americium-241	Cesium-134	Plutonium-238	Plutonium-239	Tritium	Uranium-234	Uranium-235	Uranium-238
QAL (ALLH) LANL BV[b]		**0.013**	**#N/A**	**0.023**	**0.054**	**#N/A**	**2.59**	**0.2**	**2.29**
QBT2 LANL BV		**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**1.98**	**0.09**	**1.93**
QBT1V LANL BV		**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**3.12**	**0.14**	**3.05**
QBT 1G, QCT, QBO, QBOF LANL BV		**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**4**	**0.18**	**3.9**
Residential SSL[c]		**30**	**2.4**	**37**	**33**	**750**	**170**	**17**	**86**
I-8	QBT1G	-	-	-	-	3.33	-	-	-
I-8	QCT	-	-	-	-	5.65	-	-	-
R-1	QAL	0.486	-	0.0812	0.503	0.604	-	-	-
R-1	QBO	-	-	-	-	10.3	-	0.233	-
R-1	QBT1G	-	-	-	-	29.6	-	0.242	-
R-1	QCT	-	-	-	-	10.8	-	-	-
R-14	QBT1V	-	-	-	-	-	-	0.157	-
R-15	QAL	-	-	-	-	0.12	-	-	-
R-15	QBO	-	-	-	-	26.5	-	-	-
R-15	QBT1G	-	-	-	-	14.6	-	-	-
R-15	QCT	-	-	-	-	12.5	-	-	-
R-28	QAL	-	-	-	-	0.0591	-	-	-
R-28	QBO	-	-	-	-	-	-	0.424	-
R-28	QBOG[e]	-	-	-	-	-	3.58	0.184	3.77
R-28	QCT	-	-	-	-	-	-	0.268	-

Notes: All values in pCi/g. Values are maximum detected values > BV; if no BV, value is maximum detected value. No values exceed the residential SSL.

[a] Media code definitions are provided in Table C-2-4.

[b] LANL 1998, 59730.

[c] LANL 2005, 88493.

[d] — = Not detected (if no BV), not detected > BV, or not analyzed.

[e] No background values have been developed for QBOG.

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Table 6.5-1
Mortandad COPC Summary

Analyte	Sediment	Water	Core
Aluminum	x[a]	x[b]	x
Ammonia	x	x	—[c]
Ammonia as Nitrogen	—	x	—
Antimony	x	x	x
Arsenic	x	x	x
Barium	x	x	x
Beryllium	x	x	x
Boron	x	x	—
Bromide	x	x	—
Cadmium	x	x	x
Calcium	x	x	x
Cerium	—	x	—
Chloride	x	x	—
Chromium	x	x	x
Chromium hexavalent ion	x	x	—
Cobalt	x	x	x
Copper	x	x	x
Cyanide (Total)	x	x	—
Dysprosium	—	x	—
Erbium	—	x	—
Europium	—	x	—
Fluoride	x	x	—
Gadolinium	—	x	—
Holmium	—	x	—
Iron	x	x	x
Iron (ferrous)	—	x	—
Lanthanum	—	x	—
Lead	x	x	x
Lithium	—	x	—
Lutetium	—	x	—
Magnesium	x	x	x
Manganese	x	x	x
Mercury	x	x	x
Molybdenum	—	x	x
Neodymium	—	x	—
Nickel	x	x	x
Nitrate	x	x	—
Nitrate as Nitrogen	—	x	—
Nitrate-Nitrite as N	x	x	—

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Table 6.5-1 (continued)

Analyte	Sediment	Water	Core
Nitrite	x	x	—
Oxalate	x	—	—
Perchlorate	x	x	—
Phosphorus, Orthophosphate (Expressed as PO_4)	x	x	—
Potassium	—	x	—
Praseodymium	—	x	—
Samarium	—	x	—
Selenium	x	x	x
Silver	x	x	x
Sodium	x	x	—
Strontium	—	x	—
Sulfate	x	x	—
Sulfide, Total	—	x	—
Terbium	—	x	—
Thallium	x	x	x
Thulium	—	x	—
Tin	—	x	—
Titanium	—	x	—
Total Phosphate as Phosphorus	—	x	—
Total Phosphorus	x	x	—
Uranium	x	x	—
Vanadium	x	x	x
Ytterbium	—	x	—
Zinc	x	x	x
Acenaphthene	x	x	—
Acenaphthylene	—	x	—
Acetone	x	x	—
Anthracene	x	x	—
Aroclor-1254	x	—	—
Aroclor-1260	x	x	—
Aroclors (Mixed)	x	—	—
Benzene	x	x	—
Benzo(a)anthracene	x	x	—
Benzo(a)pyrene	x	—	—
Benzo(b)fluoranthene	x	x	—
Benzo(g,h,i)perylene	x	—	—
Benzo(k)fluoranthene	x	x	—
Benzoic Acid	x	x	—
BHC[alpha-]	x	—	—
BHC[beta-]	x	—	—

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Table 6.5-1 (continued)

Analyte	Sediment	Water	Core
BHC[delta-]	x	—	—
BHC[gamma-]	x	—	—
Bis(2-ethylhexyl)phthalate	x	x	—
Bromodichloromethane	x	—	—
Bromomethane	x	—	—
Butanone[2-]	x	x	—
Butylbenzylphthalate	x	—	—
Carbazole	x	x	—
Carbon Disulfide	—	x	—
Carbon Tetrachloride	x	—	—
Chlordane[alpha-]	x	—	—
Chlordane[gamma-]	x	—	—
Chloroform	x	—	—
Chloromethane	x	x	—
Chloronaphthalene[2-]	—	x	—
Chlorophenol[2-]	x	—	—
Chlorophenyl-phenyl[4-] Ether	x	—	—
Chrysene	x	x	—
DDD[4,4'-]	x	x	—
DDE[4,4'-]	x	x	—
DDT[4,4'-]	x	x	—
Dibenz(a,h)anthracene	x	—	—
Dibenzofuran	x	—	—
Dichlorobenzene[1,2-]	x	x	—
Dichlorobenzene[1,3-]	—	x	—
Dichlorobenzene[1,4-]	—	x	—
Dichlorobenzidine[3,3'-]	x	x	—
Dichloroethene[1,1-]	x	—	—
Dichloroethene[cis-1,2-]	x	—	—
Dieldrin	x	—	—
Diethylphthalate	x	x	—
Dioxane[1,4-]	—	x	—
Di-n-butylphthalate	x	—	—
Endosulfan Sulfate	x	—	—
Endrin	—	x	—
Endrin Aldehyde	x	—	—
Fluoranthene	x	x	—
Fluorene	x	x	—
Heptachlor Epoxide	x	—	—
Hexachlorobutadiene	x	—	—

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Table 6.5-1 (continued)

Analyte	Sediment	Water	Core
Hexanone[2-]	x	—	—
Indeno(1,2,3-cd)pyrene	x	—	—
Isopropylbenzene	x	x	—
Isopropyltoluene[4-]	x	—	—
Methoxychlor[4,4'-]	x	—	—
Methyl-2-pentanone[4-]	x	x	—
Methylene Chloride	x	x	—
Methylnaphthalene[2-]	x	x	—
Naphthalene	x	x	—
Nitroaniline[2-]	x	—	—
Nitroaniline[4-]	x	x	—
Nitrophenol[2-]	x	—	—
Nitrosodiphenylamine[N-]	x	—	—
Octachlorodibenzofuran[1,2,3,4,6,7,8,9-]	—	x	—
Phenanthrene	x	x	—
Pyrene	x	x	—
Tetrachloroethene	x	—	—
Toluene	x	x	—
Trichloroethane[1,1,1-]	x	—	—
Trichloroethene	x	—	—
Trichlorofluoromethane	x	—	—
Trichlorophenol[2,4,6-]	x	—	—
Trimethylbenzene[1,2,4-]	x	—	—
Xylene (Total)	x	x	—
Xylene[1,2-]	x	x	—
Xylene[1,3-]	x	—	—
Xylene[1,3-]+Xylene[1,4-]	—	x	—
Americium-241	x	x	x
Cesium-134	x	—	x
Cesium-137	x	x	—
Cobalt-60	x	—	—
Europium-152	x	—	—
Plutonium-238	x	x	x
Plutonium-239/240	x	x	x
Potassium-40	—	x	—
Radium-226	—	x	—
Ruthenium-106	x	—	—
Sodium-22	x	x	—
Strontium-90	x	x	—
Technetium-99	—	x	—

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Table 6.5-1 (continued)

Analyte	Sediment	Water	Core
Thorium-228	**x**	x	—
Thorium-230	**x**	x	—
Thorium-232	**x**	x	—
Tritium	x	**x**	x
Uranium-234	x	x	x
Uranium-235/236	x	x	x
Uranium-238	x	x	x

[a] x = Analyte is a COPC for given medium.

[b] Bold x = Analyte exceeded residential SSL, SAL, or standard.

[c] — = Analyte is not a COPC for given medium.

Table 7.1.1
Summary of Estimated Inventory of Radionuclides in Post-1942 Sediments in the Mortandad Watershed

Area	Distance From Rio Grande (km)	Americium-241		Cesium-137		Cobalt-60		Plutonium-238		Plutonium-239,240		Strontium-90	
		Inventory (mCi)	Percent of Total Inventory	Inventory (mCi)	Percent of Total Inventory	Inventory (mCi)	Percent of Total Inventory	Inventory (mCi)	Percent of Total Inventory	Inventory (mCi)	Percent of Total Inventory	Inventory (mCi)	Percent of Total Inventory
Effluent Canyon	13.71–14.70	11	3%	23	2%	0.1	3%	3	1%	17	4%	1.7	1%
Mortandad Canyon between Effluent Canyon and Reach M-3E	11.84–13.71	81	19%	340	24%	0.8	29%	55	21%	87	22%	16	10%
Mortandad Canyon Reach M-3E	11.22–11.84	230	55%	732	52%	1.5	52%	85	32%	192	50%	36	23%
Pratt Canyon	12.83–13.12	0.2	0%	10	1%	0	3%	0.0	0%	0.5	0%	62	39%
Ten Site Canyon	11.22–13.75	2.3	1%	2.0	0%	0.0	0%	87	33%	16	4%	5	3%
Mortandad Canyon Reach M-4	10.56–11.22	75	18%	246	17%	0.4	12%	27	10%	57	15%	24	15%
Mortandad Canyon between Reach M-4 and East End of Reach M-5E	8.90–10.56	21	5%	66	5%	0.1	2%	7	3%	18	5%	13	8%
Total	n/a*	420	100%	1420	100%	3	100%	263	100%	387	100%	157	100%

Note: Inventory does not include estimates in reaches where these analytes are not COPCs or for parts of Mortandad Canyon upcanyon of Effluent Canyon or downcanyon of M-5E, or for the unnamed tributary canyon that heads in TA-5

*n/a = Not applicable.

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Table 7.2-1
Recent Annual Discharge Volumes for NPDES Outfalls in the Mortandad Watershed

Outfall	Key Facility	Annual Total Discharge (m^3)	
		2004	2005
051	WMO: RLWTF (TA-50, 21)	8170	6796
03A-021	CMR Building (TA-03)	4490	3483
03A-022	Sigma Complex (TA-03)	7461	14,403
03A-160	Nonkey (TA-35)	29,844	29,844
03A-181	Plutonium Facility Complex (TA-55)	10,306	9087
	Sum of Mortandad Outfall Discharges	60,271	63,613

Sources: LANL 2004, 94068; LANL 2005, 94073.

Table 7.2-2
Days with Recorded Flow for Streamflow Gaging Stations in the Mortandad Watershed

Gage	E200	E202	E2015	E203	E204
Period of Record[a]	10/1/1995 8/14/2005	10/1/1996 8/19/2006	11/17/1999 9/30/2005	10/1/1996 9/30/2005	10/1/1993 9/30/2005
Days with Recorded Flow	2798	436	212	0	0
Total Days of Record[b]	3710	3069	1919	3288	4383
% of Days with Recorded Flow	75.4%	14.2%	11.1%	0.0%	0.0%

Source: WQH database.

[a] Water year data are provisional.

[b] Excludes days when equipment malfunction resulted in no record.

Table 7.2-3
Seasonal TA-50 RLWTF Outfall Percentage of E200 Flow

Year	Jan–Mar	Apr–Jun	Jul–Sep	Oct–Dec	Annual Average
1997	109.7%	45.9%	13.2%	83.7%	63.1%
1998	34.5%	Not available[a]	40.0%	27.8%	34.1%
1999	50.6%	35.8%	27.5%	66.4%	45.1%
2000	50.0%	Not available[b]	na[b]	19.6%	34.8%
2001	21.6%	50.2%	14.1%	5.9%	22.9%
2002	6.0%	67.4%	32.5%	36.6%	35.6%
2003	46.9%	45.3%	22.6%	7.6%	30.6%
2004	1.1%	81.9%	27.4%	13.9%	31.1%
2005	5.2%	28.2%	4.7%	47.2%	21.3%
2006	82.6%	21.5%			
Mean	40.8%	47.0%	22.7%	34.3%	35.4%
Median	40.7%	45.6%	25.0%	27.8%	34.1%

[a] E200 gage malfunctioned from 5/23/1998 to 6/3/2000; summary data not valid.

[b] E200 gage malfunctioned from 4/5/2000 to 7/24/2000; summary data not valid.

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Table 7.2-4
Average Volumetric Water Content for Mortandad Boreholes by Unit

Borehole	Average 0–6 m (0–20 ft)	Alluvium >6m (>20 ft)	Qbt 2 >6 m (>20 ft)	Qbt 1	Qct	Qbo
MCB-1	16		10	10		
MCB-2	17		24	25		
MCB-5	4	37		19		
R-1	12			21	48	22
MCB-6	10	30		23		
MCI-8	6	12		22	32	24
MCB-7	1	31				
MCOBT-4.4	14	30			36	19
MCB-14	6	28			30	20
MCB-8	14	12			19	
MCB-9	3	29			28	
MCI-6	7	28			16	29
R-15	8			16	36	19
MCB-10	15	24			39	
MCB-11	6	26			55	
MCB-12	10	22			31	
MCOBT-8.5	10	15				21
R-28	6	8				16
MCB-16	7	21				12
MCB-15	5	30		20	17	16
MCI-1			8	17		15
MCI-10				9		9

Notes: Blank cells indicate unit is not present; 0–20 ft average is independent of stratigraphic unit. Qbt 2 is Tshirege Member unit Qbt 2. Qbt 1 is Tshirege Member unit Qbt 1 (includes subunits 1v and 1g). Qct is the Cerro Toledo interval, and Qbo is the Otowi Member of the Bandelier Tuff.

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Table 7.2-5
Estimated Nitrate and Perchlorate Masses by Strata Based on earthVision Models

Model Zone	NO_3 (as N, kg)	% NO_3	CLO_4 (kg)	% CLO_4
Unsaturated Alluvium	6379	2.9	10	0.8
Saturated Alluvium	230	0.1	35	2.8
QBT3	0	0.0	0	0.0
QBT2	12	0.0	0	0.0
QBT1V	7986	3.6	8	0.7
QBT1G	41609	18.8	150	12.1
QBTT	1087	0.5	4	0.3
QCT	39667	17.9	171	13.8
QBOF	123370	55.8	839	67.7
QBOG	131	0.1	0	0.0
TPF	41	0.0	0	0.0
TPF2	2	0.0	0	0.0
TPF3	0	0.0	0	0.0
TT	0	0.0	0	0.0
Saturated TB4 (Dense)	57	0.0	1	0.1
Saturated TB4 (Interflow)	325	0.1	20	1.6
Unsaturated TB4 (Dense)	91	0.0	0	0.0
Unsaturated TB4 (Interflow)	2	0.0	0	0.0
Total Porewater	220377	99.7	1,183	95.5
Perched Intermediate	382	0.2	22	1.8
Alluvial Saturation	230	0.1	35	2.8
Grand Total	**220,989**	**100.0**	**1,239**	**100.0**

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Table 8.1-1
Field Studies in Mortandad Canyon Watershed As Implemented

Assay Type	Reach	Rationale for Reach Selection Based on HQ
Soil COPECs		
Earthworm toxicity, plant toxicity, sediment characterization	E-1FW	Plant: high chromium, vanadium (+ other inorganic chemicals) Worm: high chromium, high copper
	E-1W	Plant: high chromium, vanadium Worm: high chromium
	E-1E	Plant: high chromium, high silver Worm: high chromium, high mercury, high Am-241, high Pu-239
	TS-1C	Plant: high selenium, vanadium Worm: di-n-butyl phthalate
	TS-2C	Plant: high silver, high vanadium Worm: moderate chromium, moderate mercury
	M-2W	Plant: lower inorganic chemicals Worm: moderate chromium, moderate mercury, high Am-241, Pu-238, and Pu-239 High perchlorate
	M-4	Plant: high silver, lower other inorganic chemicals Worm: lower chromium, lower mercury Moderate perchlorate
	LA-BKG	Background location
General small mammal trapping, sediment characterization	E-1W	Moderate arsenic and manganese
	M-2W	High thallium, Aroclor-1260 for potential risk to Mexican spotted owl High perchlorate
	M-3	Low arsenic, no other small mammal COPECs Low perchlorate
	LA-BKG	Background location
Shrew trapping, sediment characterization	E-1W	100% wet, high arsenic, high thallium
	LA-BKG	Background location
Plant diversity	E-1FW	Correlate to plant toxicity
	E-1W	Correlate to mammal trapping and plant toxicity
	E-1E	Correlate to plant toxicity
	TS-1C	Correlate to plant toxicity
	TS-2C	Correlate to plant toxicity
	M-2W	Correlate to mammal trapping and plant toxicity High perchlorate
	M-3	Correlate to mammal trapping and plant toxicity
	M-4	Correlate to plant toxicity
	LA-BKG	Background location
Additional nest boxes	E-1FW	Robin: moderate copper, vanadium, PCBs Swallow: no COPECs
	E-1W	Robin: high vanadium, lower zinc Swallow: High aluminum, moderate vanadium, lower copper and zinc Kestrel: no COPECs

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Table 8.1-1 (continued)

Assay Type	Reach	Rationale for Reach Selection Based on HQ
	E-1E (bench above reach)	Robin: high mercury, moderate copper, lead Swallow: low zinc Kestrel: no COPECs but total hazard index (HI)=2 and Cs-137 HQ=0.8
	TS-1C	Swallow: high vanadium, zinc Kestrel: no COPECs but total HI=1.2 Robin: highest organic HQ (di-n-butyl phthalate)
	M-1E	Robin: high vanadium Swallow: high aluminum and vanadium, lower zinc Kestrel: no COPECs
	M-2W (bench above reach)	Robin: lower lead, mercury, zinc, PCBs Swallow: low zinc Kestrel: no COPECs but total HI=1.2 High perchlorate
	M-2E (bench above reach)	Robin: moderate mercury Swallow: low zinc Kestrel: no COPECs Moderate perchlorate
	TS-1E	Add to existing network in area of higher contamination
Sediment/Water COPECs		
Aquatic Toxicity and rapid bioassessment protocol	E-1W	High barium, PCBs, DDT for aquatic community
	E-1E	No aquatic community COPECs
	M-1W	Chlordane and DDT COPECs for aquatic community
	M-2W	No aquatic community COPECs Low perchlorate
	TS-1C	High PCBs and anthracene for aquatic community
	TS-1E	High PCBs, anthracene, and copper for aquatic community
	TS-2C	High silver for aquatic community Moderate PCBs and dibenz(a,h)anthracene for aquatic community
	LA-BKG	Background location. Collect sediment and water for toxicity testing, not used for rapid bioassessment protocol
Algal toxicity tests	M-1W	Included to collocate with aquatic toxicity tests
	M-2W	sampled at gaging station E200; location with high HQs for algae for radium-226 and americium-241
	E-1W	Just downcanyon from gaging station E196, location with high HQs for algae for radium-226
	E-1E	Upcanyon of high HQ at gaging station E200 for algae for radium-226 and americium-241
	TS-1C	Included to collocate with aquatic toxicity tests
	TS-1E	Included to collocate with aquatic toxicity tests
	TS-2C	Included to collocate with aquatic toxicity tests
	LA-BKG	Background location

Table 8.1-2
Number of Each Species Collected for Analysis in Each Reach in the Mortandad Watershed

Reach	M-3E	M-2W	E-1W	LA-BKG
Deer Mouse (*Peromyscus maniculatus*)	23	10	8	18
Mexican Wood rat (*Neotoma mexicana*)	4	4	2	0
Brush Mouse (*Peromyscus boylii*)	0	17	7	0
Long-tailed Vole (*Microtus longicaudus*)	0	0	1	5
Pinyon Mouse (*Peromyscus truei*)	0	0	0	2
Western Harvest Mouse (*Reithrodontomys megalotis*)	10	0	0	0
Montane Shrew (*Sorex spp*)	0	0	4	6

Table 8.1-3
Samples Collected from Nest Boxes

Reach/Location	Number of Egg Samples	Number of Insect Samples
E-1FW	1	1
TS-1E	0	1
TS-2W	1	1
M-4	2	2
M-4E	1	1
M-4W	1	1
M-5W	9	3
TA-51	1	0
Cañada del Buey	3	1
Guaje Pines Cemetery	7	2
Los Alamos golf course	6	1

Table 8.1-4
Estimate of Risk to Mexican Spotted Owl Through Ingestion of Small Mammals

COPEC	Maximum Detected Concentration in Carcass (mg/kg)	Carcass wt (kg)	Max Concentration in Pelt (mg/kg)	Pelt wt (kg)	Calculated Whole Animal Concentration (mg/kg)	Avian Soil TRV (mg/kg/d)	Owl Food Ingestion Rate (kg/d)	ESL for Food (in mg/kg)	HQ
Mercury (inorganic)	0.02	0.1025	0.07	0.0193	0.03	0.019	0.102	0.186	0.15
Mercury (methyl)*	0.02	0.1025	0.07	0.0193	0.03	0.0064	0.102	0.063	0.45
Selenium	0.58	0.1025	0.83	0.0193	0.62	0.44	0.102	4.31	0.14

*Not analyzed; bounding case of 100% methyl mercury

Table 8.1-5
Estimate of Risk to Southwestern Willow Flycatcher Through Ingestion of Nest Box Insects by Reach

COPEC	Avian sediment TRV (mg COPEC/kg bird/day)	SWF food ingestion rate (kgfresh food/kg bird/d)	Food ESL (in mg/kg or pCi/g)	Detected Concentration in Insect Tissue in E-1FW Nest Boxes (mg/kg fresh insect)	HQ for E-1FW	Detected Concentration in Insect Tissue in TS-1E Nest Boxes (mg/kg fresh insect)	HQ for TS-1E	Mean Detected Concentration in Insect Tissue in M-4 Nest Boxes (mg/kg fresh insect)	HQ for M-4	Mean Detected Concentration in Insect Tissue in M-5W nest boxes (mg/kg fresh insect)	HQ for M-5W	Detected Concentration in Insect Tissue in Cañada del Buey Nest Boxes (mg/kg fresh insect)	HQ for Canada del Buey	Detected Concentration in Insect Tissue in Pueblo Nest Boxes (mg/kg fresh insect)	HQ for Pueblo	Mean Detected Concentration in Insect Tissue in Rendija Nest Boxes (mg/kg fresh insect)	HQ for Rendija
Aluminum	pH dependent	0.79	n/a	51	n/a	250	n/a	118	n/a	141	n/a	130	n/a	70	n/a	145	n/a
Barium	73.5	0.79	93	5.3	0.057	120	1.29	6.4	0.07	6.3	0.07	5.6	0.060	4.3	0.046	17.5	0.188
Cadmium	1.47	0.79	1.9	0.33	0.1774	0.63	0.34	0.11	0.06	0.13	0.07	0.72	0.3871	0.13	0.0699	0.205	0.1102
Copper	2.98	0.79	3.8	41	10.87	70	18.56	35	9.28	12.6	3.34	28	7.42	28	7.42	48	12.73
Mercury (inorganic)	0.019	0.79	0.024	ND*	0.000	ND	0.00	ND	0.00	0.02	0.83	0.02	0.83	0.02	0.83	ND	0.000
Mercury (methyl)	0.0064	0.79	0.01	ND	0.000	ND	0.00	ND	0.00	0.02	2.47	0.02	2.47	0.02	2.47	ND	0.000
Selenium	0.44	0.79	0.6	0.19	0.341	0.31	0.56	0.425	0.76	0.29	0.52	0.13	0.23	0.13	0.233	0.165	0.296
Silver	5.44	0.79	6.9	0.02	0.00291	0.17	0.02	0.071	0.01	0.014	0.0020	0.19	0.02760	0.02	0.00291	0.055	0.00799
Vanadium	0.344	0.79	0.44	ND	0.000	ND	0.00	ND	0.00	0.36	0.83	0.31	0.712	ND	0.000	0.615	1.413
Zinc	37.7	0.79	48	100	2.096	210	4.40	99.65	2.09	73.7	1.54	100	2.096	120	2.515	125	2.620

*ND = Analyte not detected.

Table 8.1-6
Estimate of Risk to the Insectivorous Robin Using Estimated Concentrations of COPECs in Earthworms

COPEC	Basis of Estimated Worm Tissue Concentration	Avian Soil TRV (mg COPEC/ kg bw/day)	Robin Food Ingestion Rate for Regression (kgfresh food/kg bird/d)	Robin Food Ingestion Rate for ESL TF (kg dry food/kg bw/d)	Food ESL (in mg/kg)	Concentration in Soil LA-BKG	HQ for LA-BKG	Concentration in Earthworm Toxicity Test Soil - Reach E-1FW	HQ for E-1FW	Concentration in Earthworm Toxicity Test Soil - Reach E-1W	HQ for E-1W	Concentration in Toxicity Test Soil - Reach E-1E	HQ for E-1E	Concentration in Earthworm Toxicity Test Soil - Reach M-2W	HQ for M-2W	Concentration in Earthworm Toxicity Test Soil - Reach M-4	HQ for M-4	Concentration in Earthworm Toxicity Test Soil - Reach TS-1C	HQ for TS-1C	Concentration in Earthworm Toxicity Test Soil - Reach TS-2C	HQ for TS-2C
Copper	regression	2.98	0.897	na[a]	3.322185	4.2	0.65	90.9	2.80	12.2	0.85	4.2	0.27	12.4	0.86	20	1.05	3.69	0.64	6.94	0.72
Lead	regression	1.63	0.897	na	1.817168	9.6	0.15	27.3	0.97	17.8	0.531	9.56	0.49	11.1	0.22	19	0.59	5.76	-0.028	10.7	0.20
Mercury (inorganic)	regression	0.019	0.897	na	0.021182	0.01	1.200	0.09	2.9	0.04	1.826	0.01	42	0.04	1.8	0.21	5.4	0.008	1.2	0.02	1.4
Mercury (methyl)	regression	0.0064	0.897	na	0.007135	0.01	3.5	0.09	8.5	0.04	5.4	0.01	126	0.04	5.4	0.21	16	0.008	3.4	0.02	4.2
Selenium	ESL TF	0.44	na	0.35	1.257143	ND[b]	0	ND	0	ND	0	0.75	0.28	ND	0	ND	0	ND	0	ND	0
Silver	regression	5.44	0.897	na	6.06466	ND	0	0.15	0.014	0.11	0.013	0.1	0.15	0.11	0.013	0.3	0.019	0.04	0.01	0.78	0.036
Vanadium	ESL TF	0.344	na	0.35	0.982857	11	0.48	30	1.3	20.5	0.88	11.3	0.36	11.9	0.51	19.1	0.82	11.9	0.51	13.3	0.57
Zinc	ESL TF	37.7	na	0.35	107.7143	30	1.1	75	2.6	75	2.6	30	0.003	79.5	2.8	55.9	2.0	45.9	1.6	46.5	1.6
Aroclor-1254	ESL TF	0.1	na	0.35	0.285714	ND	0	0.04	0.95	ND	0	0.0017	1.23	0.0059	0.140	0.01	0.24	0.01	0.24	0.01	0.24

[a] na = Not applicable to model used for this COPEC.

[b] ND = Analyte not detected.

Table 8.1-7
Estimate of Risk to Small Mammals (shrew) from Estimated COPEC Concentrations in Earthworms

COPEC	Basis of Concentration	Maximum Detected Concentration Detected in Earthworm Toxicity Test Soil	Estimated Concentration in Earthworm Tissue (mg/kg fresh wt)	Mammalian Soil TRV (mg COPEC/kg bird/day)	Shrew Food Ingestion Rate (kg fresh food/kg bw/d) or if ESL TF Used (kg dry food/kg bw/d)	Food ESL (in mg/kg or pCi/g)	HQ
Arsenic	ESL TF	5.6	1.32	1.04	0.198	5.3	0.25
Cadmium	Regression	0.66	2.25	0.77	0.508	1.5	1.48
Manganese	Regression	614	30.95	44	0.508	86.6	0.36
Thallium	ESL TF	0.87	0.87	0.0071	0.198	0.036	24
Vanadium	ESL TF	29.7	1.25	4.16	0.198	21.0	0.06
Chrysene	ESL TF	0.62	0.15	0.17	0.198	0.86	0.17

Table 8.1-8
Estimate of Risk to Shrews from Estimated Thallium Concentrations in Earthworms by Reach

Reach	Concentration in Earthworm Tox Test Composite Soil	Estimated Concentration in Earthworm Tissue (mg/kg fresh wt)	Mammalian Soil TRV (mg COPEC/kg bird/day)	Shrew Food Ingestion Rate (kgfresh food/kg bw/d) or if ESL TF Used (kg dry food/kg bw/d)	Food ESL (in mg/kg or pCi/g)	HQ
TS-1C	0.16	0.16	0.0071	0.198	0.036	4
E-1E	0.87	0.87	0.0071	0.198	0.036	24
M-4	0.52	0.52	0.0071	0.198	0.036	15
E-1FW	0.15	0.15	0.0071	0.198	0.036	4
E-1W	0.2	0.20	0.0071	0.198	0.036	6
M-2W	0.14	0.14	0.0071	0.198	0.036	4
TS-2C	0.13	0.13	0.0071	0.198	0.036	4
LA-BKG	0.1	0.10	0.0071	0.198	0.036	3

07716

Table 8.1-9
Plant and Earthworm HQs for Study Design COPECs in Soil from Laboratory Toxicity Tests

		HQ of Soil Sample from Toxicity Test for Receptor at Left							
Plant COPEC	**Plant ESL**	**LA-BKG**	**E-1FW**	**E-1W**	**E-1E**	**M-2W**	**M-4**	**TS-1C**	**TS-2C**
Barium	110	0.39	0.93	1.1	0.81	0.52	1.1	0.26	0.70
Chromium	2.4	2.2	218	84	20	324	57	1.7	2.8
Copper	10	0.42	91	1.2	0.03	1.2	2.0	0.37	0.69
Manganese	50	3.1	5.9	11	12	7.5	9.4	5	5.5
Selenium	0.1	ND[a]	ND	ND	750	ND	ND	ND	ND
Silver	0.05	ND	3.0	2.2	2.0	2.2	60	0.80	1560
Thallium	0.1	1.0	1.5	2.0	87	1.4	52	1.6	1.3
Vanadium	0.025	440	1200	820	452	476	764	476	532
Zinc	10	3.0	75	75	3.0	80	56	46	47
Acenapthene	0.25	ND	ND	ND	ND	ND	ND	ND	ND
Endrin aldehyde	0.0034	ND	ND	ND	ND	ND	ND	ND	ND
Plant HI		450	1446	853	507	500	799	490	563
Worm COPEC	**Worm ESL**	**LA-BKG**	**E-1FW**	**E-1W**	**E-1E**	**M-2W**	**M-4**	**TS-1C**	**TS-2C**
Chromium	2.3	2.3	226	878	21	34	60	1.8	2.9
Copper	13	0.32	70	0.94	0.021	0.95	1.5	0.28	0.53
Mercury	0.05	0.20	1.8	0.80	0.20	0.80	42	0.16	0.40
Amercium-241	44	NA[b]	ND	0.01	0.73	NA	0.23	0.00	0.01
Plutonium-238	44	ND	ND	ND	0.48	0.14	0.43	0.13	0.03
Plutonium-239	47	ND	0.0011	0.01	1.8	0.20	0.29	0.02	0.01
Worm HI		2.8	237	11	25	5.5	13	2.4	3.9

[a] ND = Not detected.

[b] NA = Not analyzed.

077419

Table 8.1-10
Summary of Field Plant Survey Results

Reach	Approximate Distance Above Rio Grande (km)	Total Species Richness	Shannon Diversity Index (All Species)	Total Percent Canopy Cover
LA-BKG	19.5	55	3.19	235.25
E-1E	13.8	21	2.23	124.25
E-1FW	14.3	32	2.52	190.75
E-1W	14.0	18	2.15	247.25
M-2W	13.4	16	2.27	208.25
M-3	11.5	35	2.10	194.25
M-4	10.9	45	2.32	155.50
TS-1C	13.5	56	2.61	177.75
TS-2C	12.6	43	2.57	147.75

Table 8.1-11
Detected Radionuclide Concentrations in Algal Toxicity Test Samples

Reach	Sample ID	Radionuclide	Result (pCi/L)	HQ Based on Algae ESL
TS-1C	CAMO-05-61178	Americium-241	0.2	0.03
M-2W	CAMO-05-61170	Americium-241	1.88	0.32
E-1E	CAMO-05-61174	Americium-241	5.29	0.91
M-1W	CAMO-05-61176	Radium-226	0.43	4.3

07750

Table 8.1-12
Estimate Risk to the Occult Myotis Little Brown Bat from Ingestion of COPECs in the Tissues of Insects Collected from Nest Boxes

COPEC	Maximum Detected Concentration in Insect Tissue in Nest Box (mg/kg fresh insect)	Mammalian Sediment TRV (mg COPEC/kg bw/day)	Bat Food Ingestion Rate (kgfresh food/kg bird/d)	Food ESL (in mg/kg or pCi/g)	HQ
Aluminum	250	pH dependent	0.410	n/a*	n/a
Arsenic	1.4	1.04	0.410	3	0.55

*n/a = Not applicable.

Table 8.1-13
Estimate of Risk to the Red Fox from Ingestion of COPECs in the Tissues of Small Mammals

COPEC	Measured Whole Animal Concentration	Mammalian TRV (mg/kg/d)	Fox Food Ingestion Rate (kg food fresh weight/kg bird/d)	ESL (in mg/kg)	HQ
Aroclor-1260	0.32	13.8	0.14	98	0.003

Table 8.1-14
Lines of Evidence and Rationale for the Mexican Spotted Owl (AE1)

Line of Evidence	Weight of Evidence Criteria	Result
(1) Modeled exposure and literature toxicity information to calculate spatially weighted HQ values using ECORSK.9 (includes consideration of nesting and foraging habitat based on vegetation class coverage)	Medium	Total mean adjusted HI across watershed for owl equals 1.6, indicating a slight potential fro risk (mostly associated with non-canyons contaminants). Mean adjusted HI for reach with known owl nest is 0.2, indicating no potential for risk to owl.
(2) Modeled and measured concentrations in prey species (small mammals)—compare prey COPEC concentrations across gradient and determine division of contaminants between carcass and pelt	Medium	Dose of COPEC ingested had HQ<1.0 for all COPECs when compared to TRV, indicating that the risk through food ingestion was much lower than that predicted by the ESL screening.
(3) Analysis of owl pellets	Low	Results of pellet analysis confirmed that the small mammal prey species captured and used for tissue analysis are the species consumed by the owl, supporting the use of these species in the food chain modeling
(4) Comparison of concentrations in 2005 sediment samples to ESLs	Low	Screening of 2005 sediment data against ESLs resulted in addtion of bis (2ethylhexyl) phthalate as a new COPEC for this receptor

07751

Table 8.1-15
Lines of Evidence and Rationale for Avian and Mammalian Aerial Insectivores (AE6)

Line of Evidence	Weight of Evidence Criteria	Result	Aerial Insectivore Receptors
(1) Nest box study—determine nest success rate by bluebirds along a gradient of COPEC concentrations in the Mortandad Canyon watershed; need to account for other factors known to influence nest success (food, predators, etc.)	Medium (new boxes) High (established boxes)	Percent fledged and percent female nestlings were not different between Mortandad watershed reaches or between Mortandad watershed and other canyons, indicating no effect on population (measured as nest success)	Southwestern willow flycatcher/Violet-green swallow
(2) Nest box study—determine eggshell thickness for bluebirds along a gradient of COPEC concentrations in Mortandad, Effluent, and Ten Site Canyons; need to account for other factors known to influence eggshell thickness (amount of calcium in diet, etc.)	Medium	Egg size (length and weight), and eggshell thickness were not different between Mortandad reaches or between Mortandad and other canyons, indicating no effect on nest success	Southwestern willow flycatcher/Violet-green swallow
(3) Nest box study—compare COPEC concentrations in eggs within Mortandad Canyon watershed and also compare concentrations with "reference" locations	Medium-low	Concentrations of metals in eggs did not correlate with concentrations of metals in soil, indicating soil is not a source of bioaccumulation into eggs	Southwestern willow flycatcher/Violet-green swallow
(4) Compare the measured concentrations of COPECs in insects with the TRV	Medium	Potential dose through food to Southwestern willow flycatcher and little myotis bat modeled based on measured COPEC concentrations in nest box insects. Copper, mercury, vanadium, and zinc had 1.0<HQ<10 for flycatcher using mean concentrations. Bat had no COPECs with HQ>1.0 using maximum detected concentrations.	Southwestern willow flycatcher/Violet-green swallow Occult little myotis bat
(5) Comparison of concentrations in 2005 sediment and water samples to ESLs	Low	Only new COPEC to swallow or flycatcher from screening of 2005 sediment samples is bis (2 ethylhexyl) phthalate. No new COPECs for bat. Some existing study design COPECs are now COPECs in additional reaches	Southwestern willow flycatcher/Violet-green swallow Occult little myotis bat
(6) Modeled exposure and literature toxicity information to calculate spatially weighted HQ values using ECORSK.9 (includes consideration of nesting and foraging habitat based on vegetation class coverage)—could be based on a frequency of HQ values greater than 1 for the watershed	Medium	The mean adjusted total HI for the SWF was 6.2, based on mercury, di-n-butyl phthalate, boron, and bis (2ethylhexyl) phthtalate. These values indicate a potential for risk to the flycatcher.	Southwestern willow flycatcher

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Table 8.1-16
Lines of Evidence and Rationale for Avian Ground Invertevores (AE2)

Line of Evidence	Weight of Evidence Criteria	Result
(1) Nest box Study-Compare the measured concentrations of COPECs in insects with the TRV for the robin with the invertevore diet	Medium	Substituted calculations with earthworms for this measure
(2) Nest box study—determine nest success rate by bluebirds along a gradient of COPEC concentrations in the Mortandad Canyon watershed; need to account for other factors known to influence nest success (food, predators, etc.)	Medium (new boxes) High (established boxes)	Percent fledged and percent female nestlings were not different between Mortandad watershed reaches or between Mortandad watershed and other canyons, indicating no effect on population (measured as nest success)
(3) Nest box study—determine eggshell thickness for bluebirds along a gradient of COPEC concentrations in Mortandad, Effluent, and Ten Site Canyons; need to account for other factors known to influence eggshell thickness (amount of calcium in diet, etc.)	Medium	Egg size (length and weight), and eggshell thickness were not different between Mortandad watershed reaches or between Mortandad watershed and other canyons, indicating no effect on nest success
(4) Nest box study—compare COPEC concentrations in eggs within Mortandad Canyon watershed and also compare concentrations with "reference" locations	Medium-low	Concentrations of metals in eggs did not correlate with concentrations of metals in soil, indicating soil is not a source of bioaccumulation into eggs
(5) Modeled and measured concentrations in food (earthworm bioaccumulation test)—determine if exposure concentrations differ within the watershed in relation to sediment concentrations; design used a gradient in COPEC concentrations with the Mortandad Canyon watershed and also compared concentrations with "reference" locations	Medium	HQs based on modeled doses from estimated concentrations in earthworms indicated that some COPECs (mercury, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, and Aroclor-1254) may have potential for ecological risk to avian ground invertevores
(6) Modeled exposure and literature toxicity information to calculate spatially weighted HQ values using ECORSK.9 (includes consideration of nesting and foraging habitat based on vegetation class coverage) for bluebird populations in the watershed; will be based on a frequency of HQ values greater than 1 for the watershed (or assessment population area)	Medium	Western bluebird served as a surrogate for the robin representing avian invertevores in the model. The mean adjusted total HI for the bluebird is 1.2, too low for population level effects.
(7) Field surveys of avian ground invertevore abundance and diversity in the Mortandad Canyon watershed; and also compare abundance/diversity with "reference" locations	Low	Field surveys of Upper Mortandad and Ten Site Canyon had similar diversity indices and most species in both areas were invertevores, no population level effects seen
(8) Comparison of concentrations in 2005 sediment samples to ESLs	Low	Only new COPEC from screening of 2005 sediment samples is bis(2-ethylhexyl)phthalate. Some existing study design COPECs are now COPECs in additional reaches.

Table 8.1-17
Lines of Evidence and Rationale for Mammalian Invertevores and Omnivores (AE3)

Line of Evidence	Weight of Evidence Criteria	Result
(1) Field surveys to determine small mammal reproduction status along gradient of COPEC concentrations in the Mortandad Canyon watershed and also compare reproduction rates with "reference" locations	Medium high	No differences seen in relative population abundance, gender, or body weight between reaches
(2) Modeled and measured concentrations in food (earthworms)—could determine if exposure concentrations differ within the watershed in relation to sediment concentrations; design could use a gradient in COPEC concentrations with the Mortandad Canyon watershed and also compare concentrations with "reference" location	Medium	Modeling of potential risk through food to the shrew or mouse using estimated concentrations in earthworms showed only thallium with an HQ elevated enough to indicate potential for population-level effects. Thallium has a very low TRV and high default TF in model
(3) Modeled exposure and literature toxicity information to calculate spatially weighted HQ values using ECORSK.9 (includes consideration of nesting and foraging habitat based on vegetation class coverage) for deer mouse and shrew populations in the watershed—could be based on a frequency of HQ values greater than 1 for the watershed	Medium	Mean HI exceeded 1 in only 8% of sites across watershed. Dominant COPEC in this model is also thallium
(4) Comparison of concentrations in 2005 sediment samples to ESLs	Low	Screening of 2005 sediment sample data did not show any new COPECs for these receptors

Table 8.1-18
Lines of Evidence and Rationale for Detritivores (AE4)

Line of Evidence	Weight of Evidence Criteria	Result
(1) Toxicity test (earthworm mortality) along gradient of COPEC concentrations in the Los Alamos and Pueblo watershed—compare mortality rates with "reference" locations	High	No differences in earthworm mortality seen between reaches, indicating no effect along COPEC gradient. Weight loss differed between reaches, but did not correlate with COPEC concentration.
(2) The concentration of COPECs in earthworms	Contributor to other AEs	Not measured due to laboratory error
(3) Comparison of concentrations in 2005 sediment samples to ESLs	Low	Screening of 2005 sediment data indicates that hexavalent chromium would be a study design COPEC for this receptor. Existing studies included reaches with this COPEC.

: 07754

Table 8.1-19
Lines of Evidence and Rationale for Plants (AE5)

Line of Evidence	Weight of Evidence Criteria	Result
1) Toxicity test (seedling germination) along gradient of COPEC concentrations in the Los Alamos and Pueblo watershed and also compare germination rates with "reference" locations	High	No differences in mortality, dry root mass, dry shoot mass, or mean root length. Some differences in wet root length and mean shoot length between reaches, but effect did not match with COPEC concentration
2) Abundance and diversity of plants along gradient of COPEC concentrations in the Mortandad watershed and also compare plant abundance/diversity with "reference" locations	Medium	Plant survey showed differences between reaches, but not attributable to COPEC gradient. Differences attributable to climate factors, and species in all reaches increased since previous survey during dry year.
(3) Comparison of concentrations in 2005 sediment samples to ESLs	Low	Screening of 2005 sediment data indicates that hexavalent chromium would be a study design COPEC for this receptor. Existing studies included reaches with this COPEC.

Table 8.1-20
Lines of Evidence and Rationale for the Aquatic Community (AE7)

Line of Evidence	Weight of Evidence Criteria	Result
(1) Estimates of growth and mortality of aquatic invertebrates based on toxicity tests using *Chironomus tentans* compared with the reference location	High	No significant differences in larval survival or mean dry weight of larvae between reaches, indicating no effect of COPECs on larval survival and growth.
(2) A rapid bioassessment characterization to evaluate habitat ratings at selected locations based on watershed features, riparian vegetation, in-stream features, aquatic vegetation, and benthic substrate; assessment will also include measures of abundance and diversity of aquatic invertebrates through Hess sampling and dip net capture	Medium	Physical aspects of habitat similar between reaches; all rated as marginal using index scores. Chironomids made up majority of biomass in all reaches, supporting their use as toxicity indicator organism.
(3) Comparison of concentrations in 2005 sediment and water samples to ESLs	Low	Screening of 2005 sediment data indicated iron should be a new COPEC for this receptor. Screening of water data also indicated iron should be a new COPEC, and cobalt would be a COPEC at one water location
(4) Algae toxicity test	High	Differences seen between water samples from different reaches attributable to differences in water hardness. Algal cell growth in all samples except TS-1C exceeded negative and positive laboratory control sample growth. Results indicate no impairment of algal cell growth due to COPECs in water.

Table 8.2-1
Identifying Sediment COPCs, Non-carcinogens

Reach	Aluminum	Antimony	Barium	Beryllium	Boron	Cadmium	Chromium hexavalent ion	Cobalt	Copper	Cyanide (Total)	Fluoride	Iron	Lead	Manganese	Mercury[a]	Nickel	Nitrate	Nitrite	Perchlorate[a]	Selenium	Silver	Thallium	Uranium[a]	Vanadium	Zinc	Acenaphthene	Acetone	Anthracene	Aroclor-1254	Aroclor-1260	Benzo(g,h,i)perylene[c]	Benzoic Acid[a]	Bromomethane	Butanone[2-]
Residential SSL	**77800**	**31.3**	**15600**	**156**	**15600**	**39**	**234**	**1520**	**3130**	**1220**	**3670**	**23500**	**400**	**3590**	**23**	**1560**	**100000**	**7820**	**55**	**391**	**391**	**5.16**	**16**	**78.2**	**23500**	**3730**	**28100**	**22000**	**1.12**	**1.12**	**2290**	**100000**	**8.51**	**31800**
M-1W	-	0.35	-	-	-	0.02	-	-	<0.01	<0.01	-	-	0.06	-	<0.01	0.02	-	-	-	<0.01	<0.01	-	-	-	<0.01	<0.01	<0.01	<0.01	-	0.05	<0.01	-	-	-
M-1C	-	-	<0.01	-	-	-	-	-	-	-	-	-	0.06	-	-	-	-	-	-	<0.01	-	-	-	-	<0.01	<0.01	<0.01	<0.01	-	0.13	<0.01	-	-	<0.01
M-1E	0.33	-	0.02	<0.01	<0.01	0.02	-	<0.01	<0.01	-	-	0.89	0.08	0.46	<0.01	<0.01	-	-	-	0.03	<0.01	-	-	0.47	<0.01	-	<0.01	-	-	-	-	-	-	<0.01
E-1EW	0.27	-	0.01	-	-	0.02	<0.01	<0.01	0.12	-	<0.01	0.78	0.14	0.29	<0.01	<0.01	-	-	<0.01	0.03	-	-	-	0.68	<0.01	<0.01	<0.01	<0.01	0.14	0.03	<0.01	-	<0.01	<0.01
E-1W	0.24	0.05	0.02	0.02	-	0.04	-	<0.01	<0.01	<0.01	<0.01	1.06	0.09	0.70	0.01	<0.01	-	-	-	0.01	0.01	-	0.27	0.38	<0.01	-	-	-	-	0.02	<0.01	-	-	-
E-1E	-	-	<0.01	-	-	0.06	-	<0.01	0.04	-	<0.01	-	0.13	0.47	0.12	0.03	-	-	<0.01	<0.01	<0.01	0.31	0.26	-	<0.01	-	<0.01	<0.01	0.12	0.10	<0.01	<0.01	-	<0.01
M-2W	-	0.42	<0.01	-	-	0.02	-	-	0.02	-	0.02	0.60	0.15	-	0.03	-	-	-	0.02	<0.01	<0.01	0.16	-	-	<0.01	-	<0.01	<0.01	0.13	0.19	<0.01	<0.01	-	<0.01
M-2E	-	-	-	-	-	0.01	-	-	0.01	-	<0.01	-	-	-	0.05	-	-	-	<0.01	<0.01	<0.01	-	-	-	<0.01	<0.01	<0.01	<0.01	0.04	0.04	-	-	-	-
M-3	-	-	-	-	-	0.01	-	-	<0.01	-	<0.01	0.59	-	-	0.02	-	-	-	<0.01	<0.01	-	-	-	-	<0.01	-	<0.01	-	-	0.35	-	-	-	-
TS-1W	-	0.36	<0.01	-	-	0.03	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01	0.19	-	0.29	-	<0.01	<0.01	<0.01	0.51	1.22	<0.01	<0.01	-	-
TS-1C	-	0.36	<0.01	-	-	0.04	-	<0.01	<0.01	-	-	1.23	0.10	-	-	0.04	-	-	-	<0.01	<0.01	0.19	-	0.33	<0.01	<0.01	<0.01	<0.01	<0.01	1.16	<0.01	<0.01	-	<0.01
TS-1E	-	-	-	-	-	0.02	-	<0.01	0.04	-	-	-	0.06	0.18	-	-	-	-	-	<0.01	-	-	-	-	-	<0.01	<0.01	<0.01	0.03	0.17	<0.01	-	-	<0.01
TS-2W	-	-	-	-	-	0.02	-	-	<0.01	-	<0.01	-	-	-	-	-	<0.01	<0.01	-	<0.01	-	-	-	-	-	-	-	<0.01	-	0.09	<0.01	-	-	<0.01
TS-2C	-	-	-	-	-	0.02	-	-	0.02	-	<0.01	-	0.07	-	0.04	-	<0.01	<0.01	-	<0.01	0.11	-	-	0.28	<0.01	-	<0.01	<0.01	0.05	0.14	<0.01	-	-	<0.01
TS-2E	0.21	-	-	-	-	0.02	-	<0.01	0.02	-	<0.01	0.59	0.07	-	0.06	-	<0.01	<0.01	-	0.03	0.09	-	-	0.35	<0.01	-	<0.01	-	-	0.28	<0.01	-	-	<0.01
TS-3	-	-	-	-	-	0.01	-	-	<0.01	-	-	-	0.05	0.16	<0.01	-	-	-	-	<0.01	0.01	-	-	-	<0.01	-	-	-	-	0.06	-	<0.01	-	-
M-4	-	0.06	<0.01	-	-	0.02	-	<0.01	0.01	-	<0.01	0.64	0.05	-	0.01	-	-	-	0.01	<0.01	0.02	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	0.11	<0.01	<0.01	-	<0.01
MCW-1	-	-	-	-	-	0.01	-	-	-	-	-	-	0.05	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MCW-2N	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	<0.01	-	-	-	-	-	<0.01	-	-
MCW-2W	-	-	-	-	-	0.01	-	-	<0.01	<0.01	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
MCW-2E	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M-5W	-	-	<0.01	-	-	-	-	-	-	-	-	0.60	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	<0.01	-	-	-	-	-	-	<0.01
M-5E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	0.19	-	-	-	<0.01	<0.01	-	-	-	-	-	-	<0.01
M-6	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 8.2-1 (continued)

Reach	Butylbenzylphthalate[a,d]	Chlorophenol[2-]	Dibenzofuran	Dichlorobenzene[1,2-][d]	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Diethylphthalate	Di-n-butylphthalate	Endosulfan Sulfate	Endrin Aldehyde	Fluoranthene	Fluorene	Hexachlorobutadiene	Hexanone[2-]	Isopropylbenzene	Isopropyltoluene[4-][c]	Methoxychlor[4,4'-][a]	Methyl-2-pentanone[4-]	Methylnaphthalene[2-][c]	Naphthalene[a]	Nitroaniline[2-][a]	Nitroaniline[4-][a]	Nitrophenol[2-]	Phenanthrene	Pyrene	Toluene[d]	Trichloroethane[1,1,1-][d]	Trichlorofluoromethane	Trichlorophenol[2,4,6-]	Trimethylbenzene[1,2,4-]	Xylene (Total)[d]	Xylene[1,2-][d]	Xylene[1,3-][d]	SOFnc
Residential SSL	240	166	142	37.4	206	76.5	48900	6110	18.3	18.3	2290	2660	12.2	31800	271	271	306	5510	79.5	79.5	180	180	166	1830	2290	252	563	569	6.11	58	82	99.5	82	
M-1W	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01	-	-	-	-	<0.01	-	-	-	-	-	-	<0.01	<0.01	-	-	-	-	-	-	-	-	0.55
M-1C	-	-	-	-	-	-	-	-	-	<0.01	<0.01	<0.01	-	-	-	<0.01	<0.01	-	-	0.01	-	-	-	<0.01	<0.01	-	-	-	-	-	-	-	-	0.21
M-1E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	2.34
E-1FW	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01	-	-	<0.01	<0.01	-	<0.01	<0.01	0.02	-	-	-	<0.01	<0.01	<0.01	-	-	-	-	<0.01	-	-	2.58
E-1W	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01	-	-	-	-	-	-	-	-	2.96
E-1E	-	-	-	-	-	-	-	-	-	<0.01	<0.01	-	-	-	-	<0.01	-	-	-	-	-	-	-	<0.01	<0.01	-	-	<0.01	-	-	-	-	-	1.66
M-2W	-	-	-	-	-	-	-	-	-	<0.01	<0.01	-	-	-	-	<0.01	-	-	-	-	-	-	-	<0.01	<0.01	-	-	<0.01	-	-	-	-	-	1.76
M-2E	-	-	-	-	-	-	-	-	<0.01	-	<0.01	<0.01	-	-	-	-	<0.01	-	-	<0.01	-	-	-	<0.01	<0.01	-	<0.01	<0.01	-	-	-	-	-	0.18
M-3	-	-	-	-	-	-	-	-	-	<0.01	<0.01	-	-	-	-	<0.01	-	-	-	-	-	-	-	<0.01	-	<0.01	-	-	-	-	-	-	-	0.99
TS-1W	-	-	-	-	-	-	-	<0.01	-	-	<0.01	-	-	<0.01	-	<0.01	-	-	-	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	2.63
TS-1C	<0.01	-	<0.01	-	-	-	<0.01	<0.01	-	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	-	-	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	3.50
TS-1E	-	-	<0.01	-	-	-	-	-	-	-	<0.01	-	-	-	-	<0.01	-	-	<0.01	-	-	-	-	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	-	-	-	0.51
TS-2W	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01	-	<0.01	-	-	<0.01	-	-	-	0.12
TS-2C	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	-	-	-	0.74
TS-2E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	<0.01	-	<0.01	-	-	-	-	-	1.71
TS-3	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	0.32
M-4	-	-	-	-	-	<0.01	-	-	-	-	<0.01	<0.01	-	-	-	-	-	-	-	<0.01	-	-	-	<0.01	<0.01	<0.01	-	<0.01	-	<0.01	-	<0.01	<0.01	0.97
MCW-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07
MCW-2N	-	<0.01	<0.01	-	-	-	-	<0.01	-	-	-	<0.01	<0.01	-	-	<0.01	-	-	<0.01	-	-	-	<0.01	-	-	-	-	-	<0.01	-	-	-	-	0.03
MCW-2W	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
MCW-2E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	0.01
M-5W	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	0.61
M-5E	-	-	-	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	<0.01	-	-	-	0.20
M-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01

Notes: Residential SSL values are in mg/kg. Ratios in bold and gray shading show where the SOFnc>1 and the ratio is >0.1.

[a] EPA Region 6 residential SSL (EPA 2005, 91002).

[b] EPA Region 9 residential SSL (epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf).

[c] Pyrene used as surrogate for benzo(g,h,i)perylene. Isopropyltoluene uses isopropylbenzene SSL as surrogate and 2-methylnaphthalene uses naphthalene as surrogate.

[d] Screening value is based on saturation, not risk based.

Table 8.2-2
Identifying Sediment COPCs, Carcinogens

Reach	Arsenic	Chromium	Aroclor-1254	Aroclor-1260	Aroclors (Mixed)	Benzene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	BHC[alpha-]	BHC[beta-]	BHC[gamma-]	Bis(2-ethylhexyl)phthalate	Bromodichloromethane	Carbazole*	Carbon Tetrachloride	Chloroform	Chloromethane	Chrysene	DDD[4,4'-]	DDE[4,4'-]	DDT[4,4'-]	Dibenz[a,h]anthracene	Dichlorobenzene[1,4-]	Dichlorobenzidine[3,3'-]	Dieldrin	Heptachlor Epoxide*	Hexachlorobenzene	Indeno[1,2,3-cd]pyrene	Methylene Chloride	Nitrosodiphenylamine[N-]	Tetrachloroethene	Trichloroethene	SOFca
Residential SSL	**3.9**	**2100**	**2.22**	**2.22**	**2.22**	**10.3**	**6.21**	**0.62**	**6.21**	**62.1**	**0.9**	**3.16**	**4.37**	**347**	**14.4**	**240**	**0.97**	**4**	**21.8**	**615**	**24.4**	**17.2**	**17.2**	**0.62**	**39.5**	**10.8**	**0.3**	**0.53**	**3.04**	**6.21**	**182**	**993**	**12.5**	**0.64**	
M-1W	1.13	-	-	0.03	-	-	0.44	3.40	0.40	<0.01	0.01	<0.01	<0.01	-	-	-	-	-	-	<0.01	<0.01	-	<0.01	-	-	-	0.01	-	-	0.20	-	-	<0.01	-	5.62
M-1C	-	<0.01	-	0.06	-	-	0.06	0.72	0.05	<0.01	0.02	<0.01	<0.01	-	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	0.04	-	-	<0.01	-	0.97
M-1E	2.15	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01	2.16
E-1FW	4.26	1.05	0.07	0.01	-	-	0.07	0.81	0.08	<0.01	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	0.05	-	-	<0.01	-	6.41
E-1W	2.82	0.30	-	<0.01	-	-	0.04	0.42	0.08	-	-	-	-	<0.01	-	-	-	-	-	<0.01	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	3.67
E-1E	1.55	0.07	0.06	0.05	0.02	-	0.02	0.40	0.07	<0.01	<0.01	-	-	<0.01	-	-	-	<0.01	-	<0.01	-	<0.01	<0.01	-	-	-	-	<0.01	-	0.02	-	-	-	-	2.29
M-2W	1.10	0.01	0.07	0.09	-	-	0.06	0.60	0.06	<0.01	-	-	-	<0.01	-	-	-	-	-	<0.01	-	-	<0.01	-	-	-	-	-	-	<0.01	-	-	-	-	2.01
M-2E	-	<0.01	0.02	0.02	-	-	0.04	0.26	0.02	<0.01	-	<0.01	-	<0.01	-	-	-	-	-	<0.01	-	-	<0.01	-	-	-	0.01	-	-	-	-	-	-	-	0.38
M-3	1.03	<0.01	-	0.18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	<0.01	-	-	-	1.21
TS-1W	-	-	0.26	0.62	0.68	-	0.07	1.08	0.14	<0.01	-	-	-	<0.01	-	-	<0.01	-	-	<0.01	-	-	-	-	-	-	-	-	-	0.04	<0.01	-	-	-	2.89
TS-1C	-	-	<0.01	0.59	-	<0.01	0.30	3.29	0.41	0.02	-	-	-	<0.01	-	-	-	-	-	<0.01	-	-	-	0.29	-	-	-	-	-	0.23	-	-	-	<0.01	5.13
TS-1E	-	-	0.01	0.09	-	-	0.12	1.37	0.26	<0.01	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	0.08	-	-	<0.01	<0.01	1.93
TS-2W	-	-	-	0.05	-	-	0.05	0.61	0.06	<0.01	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	0.05	-	-	<0.01	<0.01	0.82
TS-2C	-	0.01	0.03	0.07	-	-	0.02	0.27	0.06	-	-	-	-	<0.01	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	0.02	-	-	<0.01	<0.01	0.48
TS-2E	1.14	0.01	-	0.14	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.29
TS-3	-	-	-	0.03	-	-	<0.01	0.13	0.01	<0.01	<0.01	-	-	<0.01	-	-	-	-	-	<0.01	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	0.19
M-4	1.18	<0.01	<0.01	0.05	-	-	0.09	0.95	0.10	<0.01	-	-	-	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	-	-	<0.01	-	-	0.06	-	-	-	0.05	<0.01	-	<0.01	-	2.50
MCW-1	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00
MCW-2N	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	0.00
MCW-2W	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00
MCW-2E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00
M-5W	-	-	-	-	-	-	-	-	-	-	0.04	<0.01	<0.01	-	-	-	-	-	-	-	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	<0.01	-	<0.01	<0.01	0.06
M-5E	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	<0.01	0.02	0.02
M-6	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00

Notes: Residential SSL values are in mg/kg. Ratios in bold and gray shading show where the SOFnc>1 and the ratio is >0.1.
*EPA Region 6 residential SSL (EPA 2005, 91002), multiplied by 10 to account for target risk level of 1E-5.

Table 8.2-3
Identifying Sediment COPCs, Radionuclides

Reach	Americium-241	Cesium-134	Cesium-137	Cobalt-60	Europium-152	Plutonium-238	Plutonium-239	Ruthenium-106	Sodium-22	Strontium-90	Thorium-228	Thorium-230	Thorium-232	Tritium	Uranium-234	Uranium-235	Uranium-238	SOFrad
Residential SAL*	**30**	**2.4**	**5.6**	**1.3**	**2.9**	**37**	**33**	**20**	**1.6**	**5.7**	**2.3**	**5**	**5**	**750**	**170**	**17**	**86**	
M-1W	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	<0.01	-	-	-	<0.01
M-1C	0.03	0.03	-	-	-	<0.01	-	-	-	-	-	-	0.7	-	-	-	-	0.76
M-1E	<0.01	-	-	-	-	<0.01	0.16	-	-	-	-	-	-	-	-	-	-	0.17
E-1FW	-	0.03	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	0.04
E-1W	0.01	-	**0.38**	-	-	0.01	**0.91**	-	-	-	-	-	-	-	-	-	0.03	**1.35**
E-1E	**21.4**	0.08	**452**	**4.02**	-	**2.4**	**41.2**	-	**0.31**	**47.9**	-	-	-	**0.14**	0.09	0.04	0.08	**569**
M-2W	**17.5**	0.1	**155**	**1.88**	-	**5.49**	**18.1**	-	0.09	**6.3**	-	-	-	0.01	0.09	0.05	**0.12**	**205**
M-2E	**7.03**	0.05	**99.5**	**0.38**	-	**3.05**	**4.76**	-	-	**3.51**	-	-	-	<0.01	-	-	-	**118**
M-3	**7.43**	0.07	**53.2**	**1.13**	-	**1.11**	**3.73**	0.04	-	**1.51**	-	-	-	<0.01	-	0.03	-	**68.3**
TS-1W	**0.14**	0.03	**0.64**	**0.99**	-	**1.83**	**0.59**	-	-	**0.55**	-	-	-	<0.01	0.02	-	0.04	**4.82**
TS-1C	0.08	-	**0.57**	-	-	**8.49**	**1.07**	-	-	-	**6.61**	**5.7**	**2.71**	<0.01	-	0.01	0.03	**25.3**
TS-1E	-	-	-	-	-	**9.14**	**1.15**	-	-	-	-	-	-	-	-	-	-	**10.3**
TS-2W	0.02	0.03	-	-	-	0.06	0.02	-	-	**1.18**	-	-	-	<0.01	-	-	-	**1.30**
TS-2C	0.01	0.04	-	-	-	0.05	0.03	-	-	**0.98**	-	-	-	<0.01	-	0.01	-	**1.13**
TS-2E	-	0.03	-	-	-	0.04	**0.16**	-	-	**1.46**	-	-	-	-	-	-	0.03	**1.71**
TS-3	-	-	0.22	-	-	0.04	0.02	-	-	0.54	-	-	-	<0.01	-	-	-	0.83
M-4	**3.73**	0.08	**49.3**	**0.34**	**0.12**	**0.87**	**1.95**	-	-	**1.69**	-	-	-	<0.01	-	0.02	-	**58.1**
MCW-1	-	-	-	-	-	-	<0.01	-	-	-	-	0.49	-	-	-	-	-	<0.01
MCW-2N	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	-	<0.01
M-5W	-	-	0.16	-	-	-	<0.01	-	-	0.29	-	-	-	-	-	0.01	-	0.48
M-5E	-	0.04	0.17	-	-	<0.01	<0.01	-	-	-	-	-	-	-	-	0.02	-	0.23

Note: Ratios in bold and gray shading show where the SOFrad>1 and the ratio is >0.1.
*LANL (2005, 88493).

5321.10

Table 8.2-4
Identifying Surface Water COPCs, Non-carcinogens

Location ID	Reach	Media Code	Field Preparation	Aluminum	Antimony	Barium	Beryllium	Boron	Cadmium	Cobalt	Copper	Cyanide (Total)	Fluoride	Iron	Lead[a]	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Strontium	Thallium	Vanadium	Zinc	Perchlorate	Uranium[b]	Acetone	Butanone[2-]	Methyl-2-pentanone[4-]	Pyrene	Benzoic Acid	SOFnc
Tap Water Screening Level				36500	14.6	7300	73	7300	18.3	730	1460	730	2190	11000	15	5110	11	183	730	183	183	21900	2.41	36.5	11000	25.6	7.3	5480	7050	1990	183	146000	
MO-24786	east of E-1FW	WS	Filtered	<0.01	-	0.03	-	<0.01	<0.01	0.02	0.02	<0.01	0.04	0.52	0.07	0.16	<0.01	0.48	0.02	<0.01	-	-	<0.01	0.25	0.05	0.11	<0.01	-	-	-	-	-	1.80
MO-24786	east of E-1FW	WS	Unfiltered	0.03	-	0.03	-	<0.01	<0.01	0.02	0.03	-	0.16	0.38	0.21	0.17	-	0.51	0.02	-	-	-	<0.01	-	0.06	0.23	<0.01	<0.01	-	-	-	-	1.86
MO-24787	E-1W	WS	Filtered	0.04	-	0.02	-	<0.01	-	<0.01	-	-	0.34	0.41	0.05	0.19	<0.01	0.25	<0.01	-	0.05	-	<0.01	-	0.04	0.10	<0.01	-	-	-	-	-	1.50
MO-24787	E-1W	WS	Unfiltered	0.09	-	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	-	0.35	0.57	0.12	0.21	-	0.35	<0.01	-	-	-	<0.01	-	0.07	0.17	<0.01	<0.01	-	-	-	-	1.98
MO-24788	E-1E	WS	Filtered	0.03	0.06	<0.01	-	0.01	-	<0.01	<0.01	-	0.24	0.05	0.04	<0.01	<0.01	0.19	0.02	0.01	-	-	<0.01	0.17	0.07	0.06	<0.01	-	-	-	-	-	0.98
MO-24788	E-1E	WS	Unfiltered	0.09	0.05	<0.01	<0.01	0.01	<0.01	-	0.02	-	0.28	0.19	0.15	0.01	-	0.19	0.02	0.03	-	-	<0.01	-	0.09	0.09	<0.01	<0.01	<0.01	-	<0.01	-	1.24
MO-24789	M-1W	WS	Filtered	0.34	0.08	0.01	-	<0.01	0.01	<0.01	<0.01	0.01	0.12	0.66	0.54	<0.01	<0.01	0.64	<0.01	0.02	-	-	<0.01	-	0.06	0.56	<0.01	-	-	-	-	-	3.11
MO-24789	M-1W	WS	Unfiltered	1.20	0.07	0.03	0.03	<0.01	0.03	<0.01	0.04	-	0.33	2.34	1.80	0.02	<0.01	0.66	0.02	-	-	-	<0.01	-	0.10	1.32	0.02	-	-	-	-	-	8.02
MO-24790	M-1E	WS	Filtered	0.12	-	0.02	-	<0.01	-	0.01	<0.01	-	0.08	0.21	0.11	0.36	<0.01	0.03	0.01	-	-	-	<0.01	-	0.04	0.10	<0.01	-	-	-	-	-	1.09
MO-24790	M-1E	WS	Unfiltered	0.20	-	0.02	-	<0.01	<0.01	<0.01	<0.01	-	0.23	0.38	0.21	0.39	-	0.03	0.01	-	-	-	<0.01	-	0.05	0.21	<0.01	<0.01	-	-	-	-	1.76
MO-24808	M-2W	WS	Unfiltered	0.02	-	<0.01	<0.01	-	<0.01	-	<0.01	-	-	0.04	0.04	0.02	-	-	<0.01	<0.01	-	-	-	-	-	0.06	<0.01	-	-	-	-	-	0.22
Mortandad at GS-1	M-2W	WS	Filtered	0.03	0.07	<0.01	<0.01	<0.01	0.06	<0.01	0.02	-	0.41	0.05	0.10	<0.01	<0.01	0.53	0.02	-	<0.01	<0.01	<0.01	0.11	0.52	0.12	0.02	-	-	-	-	-	2.08
Mortandad at GS-1	M-2W	WS	Unfiltered	0.03	-	<0.01	<0.01	-	0.01	<0.01	0.01	0.01	-	0.06	0.03	<0.01	<0.01	-	0.02	3.89	0.01	<0.01	-	0.09	0.52	0.16	-	-	-	-	-	-	4.87
Mortandad below Effluent Canyon	M-2W	WS	Filtered	0.08	0.04	<0.01	-	0.01	<0.01	-	<0.01	-	0.25	0.14	0.10	<0.01	<0.01	0.20	<0.01	0.02	-	-	<0.01	0.08	-	0.13	<0.01	-	-	-	-	-	1.09
Mortandad below Effluent Canyon	M-2W	WS	Unfiltered	0.12	-	<0.01	-	<0.01	-	-	<0.01	-	0.14	0.22	0.18	<0.01	-	-	-	0.02	0.01	-	<0.01	-	-	-	<0.01	0.01	-	-	-	<0.01	0.74
MO-24791	M-2E	WS	Filtered	<0.01	0.04	<0.01	-	<0.01	-	-	<0.01	-	0.27	<0.01	-	-	<0.01	0.18	<0.01	0.97	-	-	<0.01	-	0.09	0.03	<0.01	-	-	-	-	-	1.62
MO-24791	M-2E	WS	Unfiltered	0.03	0.04	<0.01	-	<0.01	-	-	<0.01	-	0.28	0.04	-	<0.01	-	0.17	<0.01	-	-	-	<0.01	-	0.10	0.04	<0.01	-	-	-	-	-	0.72
MO-24792	TS-1C	WS	Filtered	0.04	-	0.01	-	<0.01	-	<0.01	<0.01	0.01	0.03	0.08	-	0.09	<0.01	0.07	<0.01	<0.01	-	-	<0.01	0.37	0.03	-	<0.01	-	-	-	-	-	0.75
MO-24792	TS-1C	WS	Unfiltered	1.03	-	0.05	0.05	<0.01	0.07	0.02	0.02	<0.01	0.10	3.44	2.24	0.33	-	0.08	0.02	-	-	<0.01	<0.01	0.30	0.40	1.00	0.02	<0.01	-	-	-	-	9.18
MO-24793	TS-2E	WS	Filtered	0.01	-	0.02	-	<0.01	-	<0.01	<0.01	-	0.14	0.05	0.04	0.17	<0.01	0.20	0.01	-	-	<0.01	<0.01	-	0.11	0.11	<0.01	-	-	-	-	-	0.88
MO-24793	TS-2E	WS	Unfiltered	0.05	-	0.02	-	<0.01	<0.01	<0.01	<0.01	-	0.14	0.10	0.11	0.17	-	0.20	0.01	-	-	<0.01	<0.01	-	0.11	0.12	<0.01	<0.01	-	-	-	-	1.09
MO-24794	TS-1E	WS	Unfiltered	0.03	-	0.02	<0.01	-	-	-	<0.01	-	0.15	0.06	0.08	0.02	-	-	<0.01	-	-	-	-	-	-	0.09	<0.01	-	-	-	-	-	0.45
MO-24795	TS-2C	WS	Unfiltered	0.02	-	0.02	<0.01	-	0.03	<0.01	0.02	<0.01	0.20	0.04	0.11	0.08	-	-	0.01	-	-	0.03	-	-	-	0.07	<0.01	-	-	-	-	-	0.64
Mortandad at Rio Grande (A-11)	none	WS	Filtered	<0.01	-	<0.01	-	0.08	<0.01	0.02	0.02	-	0.51	<0.01	0.04	<0.01	<0.01	0.01	<0.01	-	-	-	<0.01	-	0.07	0.22	<0.01	-	-	-	-	-	1.00

Notes: All values in ug/L. Ratios in bold and gray shading show where the SOFnc>1 and the ratio is >0.1.

[a] EPA Region 6 screening value (EPA 2005, 91002).

[b] EPA Region 9 screening value (epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf).

Table 8.2-5
Identifying Surface Water COPCs, Carcinogens

Location ID	Reach	Media Code	Field Preparation	Arsenic	Chromium[a]	Aroclor-1260	SOFca
Tap Water Screening Level[b]				**0.44**	**1100**	**0.33**	
MO-24786	east of E-1FW	WS	Filtered	**17.6**	0.03	-	**17.7**
MO-24786	east of E-1FW	WS	Unfiltered	**17.2**	0.04	-	**17.2**
MO-24787	E-1W	WS	Filtered	-	<0.01	-	-
MO-24787	E-1W	WS	Unfiltered	**14.9**	<0.01	-	**14.9**
MO-24788	E-1E	WS	Filtered	-	<0.01	-	-
MO-24788	E-1E	WS	Unfiltered	-	<0.01	-	-
MO-24789	M-1W	WS	Filtered	-	<0.01	-	-
MO-24789	M-1W	WS	Unfiltered	**14.7**	0.03	-	**14.7**
MO-24790	M-1E	WS	Filtered	-	<0.01	-	-
MO-24790	M-1E	WS	Unfiltered	-	<0.01	-	-
Mortandad at GS-1	M-2W	WS	Filtered	**5.43**	<0.01	-	**5.4**
Mortandad at GS-1	M-2W	WS	Unfiltered	**5.86**	<0.01	-	**5.9**
Mortandad below Effluent Canyon	M-2W	WS	Filtered	-	<0.01	-	-
Mortandad below Effluent Canyon	M-2W	WS	Unfiltered	-	<0.01	-	-
MO-24791	M-2E	WS	Filtered	-	-	-	-
MO-24791	M-2E	WS	Unfiltered	-	<0.01	-	-
MO-24792	TS-1C	WS	Filtered	-	<0.01	-	-
MO-24792	TS-1C	WS	Unfiltered	**17.0**	<0.01	**3.31**	**20.3**
MO-24793	TS-2E	WS	Filtered	-	0.02	-	0.0
MO-24793	TS-2E	WS	Unfiltered	-	<0.01	-	-
MO-24794	TS-1E	WS	Unfiltered	-	<0.01	-	-
MO-24795	TS-2C	WS	Unfiltered	-	-	-	-
MO-24808	M-2W	WS	Unfiltered	-	<0.01	-	-
Mortandad at Rio Grande (A-11)	none	WS	Filtered	-	-	-	-

Notes: All values in ug/L. Ratios in bold and gray shading show where the SOFca>1 and the ratio is >0.1.

[a] Used hexavalent chromium screening value.

[b] EPA Region 6 screening value (EPA 2005, 91002).

Table 8.2-6
Identifying Surface Water COPCs, Radionuclides

Location ID	Reach	Media code	Field Preparation	Americium-241	Cesium-137	Plutonium-238	Plutonium-239	Plutonium-239/240[a]	Potassium-40	Radium-226	Sodium-22	Strontium-90	Technetium-99	Thorium-228	Thorium-230	Thorium-232	Tritium	Uranium-234	Uranium-235	Uranium-235/236[b]	Uranium-238	SOFrad
Tap Water Screening Level[c]				1.2	120	1.6	1.2	1.2	280	4	400	40	4000	16	12	2	80000	20	24	24	24	
MO-24786	east of E-1FW	WS	Unfiltered	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	<0.01	<0.01	-	-	<0.01	0.03
MO-24786	east of E-1FW	WS	Filtered	-	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	<0.01	0.01
MO-24787	E-1W	WS	Unfiltered	-	-	-	-	-	-	0.19	-	0.01	-	-	-	-	<0.01	<0.01	-	-	<0.01	0.23
MO-24787	E-1W	WS	Filtered	-	-	-	<0.01	-	-	-	-	0.01	-	-	-	-	-	<0.01	-	-	<0.01	0.02
MO-24788	E-1E	WS	Unfiltered	**7.2**	**0.30**	**1.97**	**1.78**	**4.04**	**0.23**	-	-	0.10	-	-	-	-	0.014	0.03	-	-	<0.01	**15.7**
MO-24788	E-1E	WS	Filtered	**3.39**	**0.19**	**0.94**	<0.01	**2.13**	-	**0.10**	-	**0.11**	-	-	-	-	-	0.02	-	-	0.02	**6.90**
MO-24789	M-1W	WS	Unfiltered	-	-	0.08	0.07	-	-	0.11	-	0.01	-	-	-	-	<0.01	0.02	-	-	0.02	0.31
MO-24789	M-1W	WS	Filtered	-	-	-	<0.01	-	-	0.36	-	-	-	-	-	-	-	<0.01	-	-	<0.01	0.38
MO-24790	M-1E	WS	Unfiltered	-	-	-	-	-	-	-	-	0.01	-	-	-	-	<0.01	<0.01	-	-	<0.01	0.02
MO-24790	M-1E	WS	Filtered	-	-	-	<0.01	-	-	0.09	-	0.02	-	-	-	-	-	<0.01	-	-	<0.01	0.12
MO-24808	M-2W	WS	Unfiltered	**1.57**	-	**0.47**	**0.68**	-	-	-	-	-	-	-	-	-	-	0.02	-	-	<0.01	**2.74**
Mortandad at GS-1	M-2W	WS	Unfiltered	**5.45**	**0.26**	**3.13**	-	**5.63**	-	-	0.02	**1.19**	-	-	-	-	**0.658**	**0.17**	-	<0.01	0.05	**16.6**
Mortandad at GS-1	M-2W	WS	Filtered	**0.5**	-	**0.94**	-	**0.68**	-	-	-	**1.13**	-	-	-	-	-	**0.18**	-	<0.01	0.05	**3.48**
Mortandad below Effluent Canyon	M-2W	WS	Unfiltered	**12.5**	**0.36**	**4.22**	-	**3.94**	-	**0.18**	0.03	**0.29**	-	<0.01	<0.01	0.05	**0.161**	**0.15**	-	<0.01	0.01	**21.9**
Mortandad below Effluent Canyon	M-2W	WS	Filtered	**1.35**	0.08	**0.28**	-	**0.63**	-	**0.15**	-	0.08	-	-	-	-	-	<0.01	-	-	<0.01	**2.57**
MO-24791	M-2E	WS	Unfiltered	**0.82**	0.05	**0.18**	-	**0.42**	-	-	-	**1.10**	<0.01	-	-	-	<0.01	0.03	-	-	<0.01	**2.60**
MO-24791	M-2E	WS	Filtered	**0.53**	-	**0.13**	<0.01	**0.33**	-	-	-	**1.04**	-	-	-	-	-	0.03	-	-	<0.01	**2.05**
MO-24792	TS-1C	WS	Unfiltered	**0.17**	-	**1.12**	**0.66**	**0.32**	-	-	-	**0.17**	-	-	-	-	<0.01	0.01	-	-	<0.01	**2.45**
MO-24792	TS-1C	WS	Filtered	0.03	-	0.14	-	0.06	-	-	-	0.23	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	-	<0.01	0.47
MO-24793	TS-2E	WS	Unfiltered	-	-	0.04	-	-	-	-	-	0.53	-	-	-	-	<0.01	0.01	-	-	0.01	0.60
MO-24793	TS-2E	WS	Filtered	-	-	-	<0.01	-	-	-	-	0.48	-	-	-	-	-	0.01	-	-	0.01	0.50
MO-24794	TS-1E	WS	Unfiltered	-	-	0.08	-	-	-	-	-	-	-	-	-	-	-	0.01	-	-	0.01	0.10
MO-24795	TS-2C	WS	Unfiltered	-	-	0.04	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	<0.01	0.05
Mortandad at Rio Grande (A-11)	none	WS	Unfiltered	0.03	-	-	-	-	-	0.34	-	<0.01	-	-	-	-	<0.01	0.02	-	-	<0.01	0.40
Rio Grande at Mortandad	none	WS	Unfiltered	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	-	-	-	-	<0.01
Rio Grande at Mortandad	none	WS	Filtered	-	-	-	-	-	-	-	-	<0.01	-	-	<0.01	-	-	0.03	-	-	0.01	0.06

Note: Ratios in bold and gray shading show where the SOFrad>1 and the ratio is >0.1.

[a] Plutonium-239 DCG.

[b] Uranium-235 DCG.

[c] DCG (Derived Concentration Guide) based on committed effective dose equivalent of 4 mrem/yr, all values in pCi/L.

Table 8.2-7
Reaches Evaluated for Water, Sediment, and Multimedia Exposure

Endpoint	Reach	Water	Sediment	Multimedia
Carcinogen	M-1W	x	x	yes
	M-1E		x	
	E-1FW	x	x	yes
	E-1W	x	x	yes
	E-1E		x	
	M-2W	x	x	
	M-3		x	
	TS-1W		x	
	TS-1C	x	x	yes
	TS-1E		x	
	TS-2E		x	
	M-4		x	
Non-carcinogen	M-1W	x		
	M-1E	x	x	yes
	E-1FW	x	x	yes
	E-1W	x	x	yes
	E-1E	x	x	yes
	M-2W	x	x	yes
	M-2E	x		
	TS-1W		x	
	TS-1C	x	x	yes
	TS-2E	x	x	yes
Radionuclide	E-1W		x	
	E-1E	x	x	yes
	M-2W	x	x	yes
	M-2E	x	x	yes
	M-3		x	
	TS-1W		x	
	TS-1C	x	x	yes
	TS-1E		x	
	TS-2W		x	
	TS-2C		x	
	TS-2E		x	
	M-4		x	

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Table 8.2-8
Site-Specific Exposure Scenarios and Complete Exposure Pathways

	Exposure Scenarios	
Exposure Pathways	**Trail User**	**Residential**
Incidental ingestion of soil	X	X
Inhalation of dust	X	X
Dermal contact with soil	X	X
Ingestion of fruits and vegetables	—*	X
Ingestion of meat	—	—
Ingestion of groundwater	—	—
Dermal contact with groundwater	—	—
Ingestion of surface water	X	—
Dermal contact with surface water	X	—
External irradiation	X	X

* — = Incomplete pathway.

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Table 8.2-9
Media-Specific Risk-Based Screening Levels (MSSL) for the Trail User Scenario

Medium	COPC	CAS ID	Units	Endpoint	Target Adverse-Effect Level	Recreational MSSL	Reference
Sediment	Aluminum	7429-90-5	mg/kg	nc	HQ=1	100000	LANL (2004, 87800)
Sediment	Antimony	7440-36-0	mg/kg	nc	HQ=1	317	LANL (2004, 87800)
Sediment	Aroclor-1254	11097-69-1	mg/kg	ca	1E-5 risk	10.5	LANL (2004, 87800)
Sediment	Aroclor-1254-nc	11097-69-1	mg/kg	nc	HQ=1	6.65	LANL (2004, 87800)
Sediment	Aroclor-1260	11096-82-5	mg/kg	ca	1E-5 risk	10.5	LANL (2004, 87800)
Sediment	Aroclors (Mixed)	1336-36-3	mg/kg	ca	1E-5 risk	10.5	LANL (2004, 87800)
Sediment	Arsenic	7440-38-2	mg/kg	ca	1E-5 risk	27.7	LANL (2004, 87800)
Sediment	Arsenic-nc	7440-38-2	mg/kg	nc	HQ=1	183	LANL (2004, 87800)
Sediment	Benzo(a)anthracene	56-55-3	mg/kg	ca	1E-5 risk	30.1	LANL (2004, 87800)
Sediment	Benzo(a)pyrene	50-32-8	mg/kg	ca	1E-5 risk	3.01	LANL (2004, 87800)
Sediment	Benzo(b)fluoranthene	205-99-2	mg/kg	ca	1E-5 risk	30.1	LANL (2004, 87800)
Sediment	Chromium	7440-47-3	mg/kg	ca	1E-5 risk	100000	LANL (2004, 87800)
Sediment	Chromium-nc	7440-47-3	mg/kg	nc	HQ=1	14300	LANL (2004, 87800)
Sediment	Copper	7440-50-8	mg/kg	nc	HQ=1	31700	LANL (2004, 87800)
Sediment	Indeno(1,2,3-cd)pyrene	193-39-5	mg/kg	ca	1E-5 risk	30.1	LANL (2004, 87800)
Sediment	Iron	7439-89-6	mg/kg	nc	HQ=1	100000	LANL (2004, 87800)
Sediment	Lead	7439-92-1	mg/kg	nc	HQ=1	560	LANL (2004, 87800)
Sediment	Manganese	7439-96-5	mg/kg	nc	HQ=1	15800	LANL (2004, 87800)
Sediment	Mercury	7487-94-7	mg/kg	nc	HQ=1	238	LANL (2004, 87800)
Sediment	Thallium	7440-28-0	mg/kg	nc	HQ=1	52.3	LANL (2004, 87800)
Sediment	Uranium	7440-61-1	mg/kg	nc	HQ=1	2380	LANL (2004, 87800)
Sediment	Vanadium	7440-62-2	mg/kg	nc	HQ=1	5550	LANL (2004, 87800)
Sediment	Americium-241	86954-36-1	pCi/g	rad	15 mrem/yr	280	LANL (2005, 88493)
Sediment	Cesium-137	10045-97-3	pCi/g	rad	15 mrem/yr	210	LANL (2005, 88493)
Sediment	Cobalt-60	10198-40-0	pCi/g	rad	15 mrem/yr	46	LANL (2005, 88493)
Sediment	Europium-152	14683-23-9	pCi/g	rad	15 mrem/yr	100	LANL (2005, 88493)
Sediment	Plutonium-238	13981-16-3	pCi/g	rad	15 mrem/yr	330	LANL (2005, 88493)
Sediment	Plutonium-239	15117-48-3	pCi/g	rad	15 mrem/yr	300	LANL (2005, 88493)
Sediment	Sodium-22	13966-32-0	pCi/g	rad	15 mrem/yr	58	LANL (2005, 88493)
Sediment	Strontium-90	10098-97-2	pCi/g	rad	15 mrem/yr	5600	LANL (2005, 88493)
Sediment	Thorium-228	14274-82-9	pCi/g	rad	15 mrem/yr	77	LANL (2005, 88493)
Sediment	Thorium-230	14269-63-7	pCi/g	rad	15 mrem/yr	150	LANL (2005, 88493)
Sediment	Thorium-232	7440-29-1	pCi/g	rad	15 mrem/yr	40	LANL (2005, 88493)
Sediment	Tritium	10028-17-8	pCi/g	rad	15 mrem/yr	5100000	LANL (2005, 88493)
Sediment	Uranium-238	7440-61-1	pCi/g	rad	15 mrem/yr	2100	LANL (2005, 88493)

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Table 8.2-9 (continued)

Medium	COPC	CAS ID	Units	Endpoint	Target Adverse-Effect Level	Recreational MSSL	Reference
Surface water	Arsenic	7440-38-2	ug/L	ca	1E-5 risk	98.3	LANL (2004, 87390)
Surface water	Arsenic-nc	7440-38-2	ug/L	nc	HQ=1	1900	LANL (2004, 87390)
Surface water	Aroclor-1260	11096-82-5	ug/L	ca	1E-5 risk	74.5	LANL (2004, 87390)*
Surface water	Lead	7439-92-1	ug/L	nc	HQ=1	65	LANL (2005, 88493)
Surface water	Mercury	7439-97-6	ug/L	nc	HQ=1	1660	LANL (2004, 87390)*
Surface water	Aluminum	7429-90-5	ug/L	nc	HQ=1	6320000	LANL (2004, 87390)*
Surface water	Barium	7440-39-3	ug/L	nc	HQ=1	388000	LANL (2004, 87390)
Surface water	Fluoride	7782-41-4	ug/L	nc	HQ=1	379000	LANL (2004, 87390)
Surface water	Iron	7439-89-6	ug/L	nc	HQ=1	1900000	LANL (2004, 87390)
Surface water	Manganese	7439-96-5	ug/L	nc	HQ=1	706000	LANL (2004, 87390)
Surface water	Molybdenum	7439-98-7	ug/L	nc	HQ=1	31600	LANL (2004, 87390)
Surface water	Thallium	7440-28-0	ug/L	nc	HQ=1	506	LANL (2004, 87390)
Surface water	Vanadium	7440-62-2	ug/L	nc	HQ=1	32000	LANL (2005, 88493)
Surface water	Perchlorate	14797-73-0	ug/L	nc	HQ=1	632	LANL (2004, 87390)
Surface water	Uranium	7440-61-1	ug/L	nc	HQ=1	19000	LANL (2004, 87390)
Surface water	Americium-241	86954-36-1	pCi/L	rad	4 mrem/yr	275	LANL (2004, 87390)
Surface water	Cesium-137	10045-97-3	pCi/L	rad	4 mrem/yr	20000	LANL (2004, 87390)*
Surface water	Plutonium-238	13981-16-3	pCi/L	rad	4 mrem/yr	313	LANL (2004, 87390)*
Surface water	Plutonium-239	15117-48-3	pCi/L	rad	4 mrem/yr	282	LANL (2004, 87390)
Surface water	Plutonium-239/240	15117-48-3	pCi/L	rad	4 mrem/yr	282	LANL (2004, 87390)
Surface water	Potassium-40	13966-00-2	pCi/L	rad	4 mrem/yr	53800	LANL (2004, 87390)*
Surface water	Radium-226	13982-63-3	pCi/L	rad	4 mrem/yr	758	LANL (2004, 87390)*
Surface water	Strontium-90	10098-97-2	pCi/L	rad	4 mrem/yr	6540	LANL (2004, 87390)
Surface water	Tritium	10028-17-8	pCi/L	rad	4 mrem/yr	15600000	LANL (2004, 87390)*
Surface water	Uranium-234	13966-29-5	pCi/L	rad	4 mrem/yr	3530	LANL (2004, 87390)

*Additional documentation of this MSSL is provided in Appendix E.

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Table 8.2-10
Toxicity Values that Differed Between Sources

Chemical	Chemical Abstract System ID	Parameter	Value	Source
Aroclor-1254	11097-69-1	SFi	3.50E-01	LANL (2004, 87800)
			No value	LANL (2004, 87390)
			2.00E+00	NMED (2006, 92513)
			2.00E+00	EPA (2005, 91002)
Barium	7440-39-3	RfDo	**7.00E-02**	LANL (2004, 87800)
			7.00E-02	LANL (2004, 87390)
			2.00E-01	NMED (2006, 92513)
			2.00E-01	EPA (2005, 91002)
		RfDi	**1.43E-04**	LANL (2004, 87800)
			7.00E-02	LANL (2004, 87390)
			2.00E-01	NMED (2006, 92513)
			2.00E-01	EPA (2005, 91002)
Copper	7440-50-8	RfDo	4.00E-02	LANL (2004, 87800)
			3.70E-02	LANL (2004, 87390)
			4.00E-02	NMED (2006, 92513)
			3.70E-02	EPA (2005, 91002)
Manganese	7439-96-5	RfDo	**2.00E-02**	LANL (2004, 87800)
			1.40E-01	LANL (2004, 87390)
			4.70E-02	NMED (2006, 92513)
			4.70E-02	EPA (2005, 91002)
Thallium	7440-28-0	RfDo	**6.60E-05**	LANL (2004, 87800)
			8.00E-05	LANL (2004, 87390)
			6.60E-05	NMED (2006, 92513)
			7.00E-05	EPA (2005, 91002)
Vanadium	7440-62-2	RfDo	7.00E-03	LANL (2004, 87800)
			7.00E-03	LANL (2004, 87390)
			1.00E-03	NMED (2006, 92513)
			1.00E-03	EPA (2005, 91002)

Notes: More protective values are in bold type. CSFi = inhalation cancer slope factor, RFDo = oral reference dose, RFDi = inhalation reference dose.

Table 8.2-11
Summary of Trail User Risk Assessment Results

Endpoint	Reach	Sediment	Surface Water	Multimedia Sum
Non-carcinogen HI	M-1W	0.016	0.446	0.46
	M-1E	0.397	0.055	0.45
	E-1FW	0.429	0.060	0.49
	E-1W	0.304	0.042	0.35
	E-1E	0.063	0.040	0.10
	M-2W	0.116	0.206	0.32
	M-2E		0.003	
	M-3	0.011		
	TS-1W	0.091		
	TS-1C	0.113	0.549	0.66
	TS-2E	0.184	0.030	0.21
	M-4	0.012		
Carcinogen risk	M-1W	5.5E-06	6.6E-07	6.2E-06
	M-1E	1.9E-06		
	E-1FW	3.5E-06	7.7E-07	4.3E-06
	E-1W	2.4E-06	6.7E-07	3.0E-06
	E-1E	1.6E-06		
	M-2W	2.0E-06	7.6E-07	2.8E-06
	M-3	8.6E-07		
	TS-1W	1.4E-06		
	TS-1C	2.7E-06	9.1E-07	3.6E-06
	TS-1E	2.3E-06		
	TS-2E	1.2E-06		
	M-4	7.8E-07		
Radionuclide dose (mrem/yr)	E-1W	1.60		
	E-1E	**43.7**	0.25	**44.0**
	M-2W	10.4	0.33	10.7
	M-2E	10.2	0.05	10.3
	M-3	9.08		
	TS-1W	0.43		
	TS-1C	3.39	0.04	3.43
	TS-1E	3.98		
	TS-2W	0.05		
	TS-2C	0.01		
	TS-2E	0.30		
	M-4	2.75		

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Table 8.2-12
Risk Ratios based on Representative Concentrations for Sediment, Trail User Scenario

Non-carcinogen COPCs - Ratios															
Reach	Aluminum	Antimony	Aroclor-1254	Arsenic	Chromium	Copper	Iron	Lead	Manganese	Mercury	Thallium	Uranium	Vanadium	SOFnc	HI
MSSL	1E+05	317	6.65	183	14300	31700	1E+05	560	15800	238	52.3	2380	5550		
M-1W	-	-	-	0.014	-	-	-	-	-	-	-	-	-	0.01	0.01
M-1E	0.12	-	-	0.022	-	-	0.12	-	0.045	-	-	-	0.004	0.31	0.31
E-1FW	0.091	-	0.021	0.035	0.048	0.003	0.1	0.045	0.029	-	-	-	0.004	0.38	0.38
E-1W	0.059	-	-	0.018	0.003	-	0.087	-	0.041	-	-	0.001	0.002	0.21	0.21
E-1E	-	-	-	0.011	-	-	-	0.017	0.021	0.001	0.003	0.002	-	0.06	0.06
M-2W	-	9E-04	-	0.011	-	-	0.08	0.015	-	-	0.002	-	-	0.11	0.11
M-2E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M-3	-	-	-	0.011	-	-	-	-	-	-	-	-	-	0.01	0.01
TS-1W	-	-	-	-	-	-	-	-	-	-	0.002	-	0.002	0.00	0.005
TS-1C	-	0.002	-	-	-	-	0.11	-	-	-	0.002	-	0.003	0.12	0.12
TS-1E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TS-2W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TS-2C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TS-2E	0.066	-	-	0.012	-	-	0.087	-	-	-	-	-	0.003	0.17	0.17
M-4	-	-	-	0.011	-	-	-	-	-	-	-	-	-	0.01	0.01

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Table 8.2-12 (continued)

Carcinogen COPCs - Ratios										
Reach	Aroclor-1254	Aroclor-1260	Arsenic	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Chromium	Indeno(1,2,3-cd)pyrene	SOFca	Carcinogenic risk
MSSL	10.5	10.5	27.7	30.1	3.01	30.1	1E+05	30.1		
M-1W	-	-	0.092	0.033	0.286	0.035	-	0.012	0.46	4.6E-06
M-1E	-	-	0.147	-	-	-	-	-	0.15	1.5E-06
E-1FW	0.013	-	0.23	-	0.05	-	0.007	-	0.30	3.0E-06
E-1W	-	-	0.117	-	0.086	-	4E-04	-	0.20	2.0E-06
E-1E	0.007	-	0.074	-	0.083	-	-	-	0.16	1.6E-06
M-2W	0.014	0.004	0.073	-	0.123	-	-	-	0.21	2.1E-06
M-2E	-	-	-	-	-	-	-	-	-	-
M-3	-	0.014	0.072	-	-	-	-	-	0.09	8.6E-07
TS-1W	0.054	-	-	-	0.034	-	-	-	0.09	8.8E-07
TS-1C	-	0.034	-	0.017	0.136	0.019	-	0.011	0.22	2.2E-06
TS-1E	-	-	-	0.016	0.137	0.023	-	-	0.18	1.8E-06
TS-2W	-	-	-	-	-	-	-	-	-	-
TS-2C	-	-	-	-	-	-	-	-	-	-
TS-2E	-	0.03	0.081	-	-	-	-	-	0.11	1.1E-06
M-4	-	-	0.073	-	-	-	-	-	0.07	7.3E-07

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Table 8.2-12 (continued)

Radionuclide COPCs - Ratios														
Reach	Americium-241	Cesium-137	Cobalt-60	Plutonium-238	Plutonium-239	Sodium-22	Strontium-90	Thorium-228	Thorium-230	Thorium-232	Tritium	Uranium-238	SOFrad	Radionuclide dose (mrem/yr)
MSSL	280	210	46	330	300	58	5600	77	150	40	5E+06	2100		
M-1W	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M-1E	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E-1FW	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E-1W	-	0.005	-	-	0.1	-	-	-	-	-	-	-	0.11	1.58
E-1E	**0.38**	**2.58**	0.022	0.057	**0.37**	0.001	0.002	-	-	-	2E-07	-	**3.42**	**51.2**
M-2W	0.169	0.305	0.007	0.107	0.151	-	1E-03	-	-	-	-	7E-04	0.74	11.1
M-2E	0.086	0.467	0.004	0.049	0.076	-	6E-04	-	-	-	-	-	0.68	10.2
M-3	0.099	0.388	0.004	0.028	0.091	-	7E-04	-	-	-	-	-	0.61	9.16
TS-1W	0.003	0.003	-	0.014	0.006	-	1E-04	-	-	-	-	-	0.03	0.39
TS-1C	-	0.009	-	0.058	0.029	-	-	0.033	0.025	0.079	-	-	0.23	3.50
TS-1E	-	-	-	0.235	0.031	-	-	-	-	-	-	-	0.27	3.98
TS-2W	-	-	-	-	-	-	4E-04	-	-	-	-	-	0.00	0.007
TS-2C	-	-	-	-	-	-	4E-04	-	-	-	-	-	0.00	0.006
TS-2E	-	-	-	-	0.017	-	0.001	-	-	-	-	-	0.02	0.28
M-4	0.034	0.138	0.001	0.01	-	-	6E-04	-	-	-	-	-	0.18	2.76

Table 8.2-13
Risk Ratios based on Representative Concentrations for Surface Water, Trail User Scenario

Non-carcinogen COPCs – Ratios															
Reach	Aluminum	Arsenic-nc	Barium	Fluoride	Iron	Lead	Manganese	Mercury	Molybdenum	Perchlorate	Thallium	Uranium	Vanadium	SOFnc	HI
MSSL	6E+06	1900	4E+05	4E+05	2E+06	65	7E+05	1660	31600	632	506	19000	31700		
M-1W	0.007	0.003		0.002	0.014	0.415		4E-05	0.004				0.002	0.45	0.45
M-1E	0.001			0.001	0.002	0.048	0.003						2E-04	0.06	0.06
east of E-1FW		0.004		9E-04	0.002	0.048	0.001		0.003		4E-04		3E-04	0.06	0.06
E-1W		0.003		0.002	0.003	0.029	0.001		0.002				2E-04	0.04	0.04
E-1E				0.002	0.001	0.035			0.001		1E-03			0.04	0.04
M-2W	7E-04	0.004			0.001	0.042		5E-05	2E-04	0.157	1E-03		7E-05	0.21	0.21
M-2E				0.002					1E-03					0.00	0.00
TS-2E				8E-04	6E-04	0.026	0.001		0.001			4E-05	1E-04	0.03	0.03
TS-1C	0.006		9E-04	6E-04	0.02	0.517	0.002				0.001	2E-04	0.001	0.55	0.55

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Table 8.2-13 (continued)

Reach	Carcinogen COPCs - Ratios				Radionuclide COPCs - Ratios										
	Aroclor-1260	Arsenic	SOFca	Carcinogenic risk	Americium-241	Cesium-137	Plutonium-238	Plutonium-239/240	Potassium-40	Radium-226	Strontium-90	Tritium	Uranium-234	SOFrad	Radionuclide dose (mrem/yr)
MSSL	74.5	98.3			275	20000	313	282	53800	758	6540	15600000	3530		
M-1W		0.066	0.07	6.6E-07											
M-1E															
east of E-1FW		0.077	0.08	7.7E-07											
E-1W		0.067	0.07	6.7E-07											
E-1E					0.0314	0.0018	0.0101	0.0172	0.0012	0.0003	0.0006			0.063	0.25
M-2W		0.076	0.08	7.6E-07	0.0463	0.0016	0.016	0.0147		0.0007	0.0017	0.002272	0.0004	0.084	0.33
M-2E					0.0036		0.0009	0.0018			0.0067			0.013	0.05
TS-2E															
TS-1C	0.015	0.076	0.09	9.1E-07			0.0057	0.0028			0.001			0.01	0.04

Table 8.2-14
Representative Concentrations for Sediment COPCs, Trail User Scenario (Surface Area Weighted)

Reach	COPC	UCL	Mean	Number of Samples	Number of Detects	Maximum Detect
E-1E	Americium-241	107.45	36.05	31	30	642
E-1E	Arsenic	2.0481	1.6772	32	31	6.1
E-1E	Cesium-137	542.15	186.79	31	31	2530
E-1E	Cobalt-60	0.9935	0.43307	31	16	4.35
E-1E	Lead	9.6317	8.3673	32	32	50
E-1E	Manganese	331.94	271.84	32	32	1700
E-1E	Mercury	0.259	0.1205	32	29	0.39
E-1E	Plutonium-238	18.892	9.4569	31	30	88.7
E-1E	Plutonium-239	110.5	34.177	31	30	1110
E-1E	Sodium-22	0.08	0.05088	31	3	0.49
E-1E	Strontium-90	13.809	8.2762	31	19	273
E-1E	Thallium	0.1497	0.09421	32	6	1.6
E-1E	Tritium	1.0007	0.5814	15	8	2.4
E-1E	Uranium	4.14	2.632	5	5	4.14
E-1FW	Aluminum	9126.9	8004	16	16	21300
E-1FW	Aroclor-1254	0.1398	0.11108	8	5	0.16
E-1FW	Arsenic	6.3618	5.6298	16	16	16.6
E-1FW	Benzo(a)pyrene	0.1519	0.12288	16	11	0.5
E-1FW	Chromium	690.81	452.91	16	16	2210
E-1FW	Copper	108.83	79.415	16	16	383
E-1FW	Iron	9955.6	9876.6	16	16	18300
E-1FW	Lead	24.925	24.078	16	16	56.8
E-1FW	Manganese	462.3	379.86	16	16	1040
E-1FW	Vanadium	21.66	19.888	16	16	53.1
E-1W	Aluminum	5897.9	7891.9	22	22	19000
E-1W	Arsenic	3.2493	3.3112	22	21	11
E-1W	Cesium-137	1.0536	0.81755	11	7	2.14
E-1W	Chromium	40.773	13.894	22	22	50
E-1W	Iron	8727.6	10751	22	22	25000
E-1W	Manganese	642.34	642.5	22	22	2500
E-1W	Plutonium-239	30.1	2.19368	8	7	30.1
E-1W	Uranium	3.3943	2.084	5	5	4.32
E-1W	Vanadium	12.018	14.894	22	22	30
M-1E	Aluminum	11961	12972	21	21	26000
M-1E	Arsenic	4.065	4.509	21	21	8.4
M-1E	Iron	11962	13660	21	21	21000
M-1E	Manganese	704.27	714.48	21	21	1640

Table 8.2-14 (continued)

Reach	COPC	UCL	Mean	Number of Samples	Number of Detects	Maximum Detect
M-1E	Vanadium	20.13	22.561	21	21	37
M-1W	Arsenic	2.5527	2.3785	16	14	4.4
M-1W	Benzo(a)anthracene	0.9801	0.62494	16	10	2.71
M-1W	Benzo(a)pyrene	0.8623	0.54029	16	8	2.11
M-1W	Benzo(b)fluoranthene	1.0678	0.56874	16	7	2.51
M-1W	Indeno(1,2,3-cd)pyrene	0.3636	0.19041	16	5	1.23
M-2E	Americium-241	23.982	17.323	36	34	211
M-2E	Cesium-137	98.113	81.947	36	36	557
M-2E	Cobalt-60	0.194	0.16677	36	20	0.47
M-2E	Plutonium-238	16.073	12.864	36	36	113
M-2E	Plutonium-239	22.737	17.567	36	36	157
M-2E	Strontium-90	3.1602	2.7663	36	35	20
M-2W	Americium-241	47.189	24.688	53	47	524
M-2W	Antimony	0.2853	0.25509	48	25	0.65
M-2W	Aroclor-1260	0.0432	0.02508	21	9	0.21
M-2W	Arsenic	2.0119	1.5455	54	51	4.3
M-2W	Cesium-137	64.061	54.577	53	53	850
M-2W	Cobalt-60	0.3364	0.26596	53	33	2.45
M-2W	Iron	7967.3	6170.9	54	54	14000
M-2W	Lead	8.5311	8.0198	54	54	18
M-2W	Plutonium-238	35.185	15.216	53	51	203
M-2W	Plutonium-239	45.28	24.119	53	53	596
M-2W	Strontium-90	5.38	3.0123	53	51	35.9
M-2W	Thallium	0.1009	0.08676	54	12	0.8
M-2W	Uranium-238	2.4555	1.3226	16	16	10.7
M-3	Americium-241	27.795	20.917	76	70	223
M-3	Aroclor-1260	0.148	0.0698	15	13	0.39
M-3	Arsenic	1.9829	1.8303	65	65	4
M-3	Cesium-137	81.557	72.188	76	76	298
M-3	Cobalt-60	0.1684	0.1276	74	43	1.47
M-3	Plutonium-238	9.3315	7.9833	76	74	40.9
M-3	Plutonium-239	27.153	18.154	76	76	123
M-3	Strontium-90	3.9094	3.5116	76	71	8.6
M-4	Americium-241	9.5695	7.723	65	59	112
M-4	Arsenic	2.0265	1.9372	63	62	4.6
M-4	Cesium-137	28.951	23.989	65	65	276
M-4	Cobalt-60	0.0586	0.0457	64	14	0.44
M-4	Plutonium-238	3.2719	2.6901	65	64	32.2
M-4	Strontium-90	3.443	2.8102	65	60	9.64

Table 8.2-14 (continued)

Reach	COPC	UCL	Mean	Number of Samples	Number of Detects	Maximum Detect
TS-1C	Antimony	0.4931	0.46543	19	3	0.63
TS-1C	Aroclor-1260	0.359	0.28663	19	18	1.3
TS-1C	Benzo(a)anthracene	0.5231	0.28428	19	11	1.86
TS-1C	Benzo(a)pyrene	0.4095	0.2689	19	13	2.04
TS-1C	Benzo(b)fluoranthene	0.5792	0.33632	19	8	2.53
TS-1C	Cesium-137	1.9247	0.83	4	3	2.19
TS-1C	Indeno(1,2,3-cd)pyrene	0.3339	0.16673	19	10	1.45
TS-1C	Iron	11007	9093.1	19	19	28800
TS-1C	Plutonium-238	19.058	12.1	18	18	314.07
TS-1C	Plutonium-239	8.6642	4.679	18	18	35.19
TS-1C	Thallium	0.1104	0.10289	19	8	0.18
TS-1C	Thorium-228	2.5368	1.6239	14	14	15.2
TS-1C	Thorium-230	3.7975	1.9887	14	14	28.51
TS-1C	Thorium-232	3.1583	1.5906	14	14	13.55
TS-1C	Vanadium	14.873	13.752	19	19	25.9
TS-1E	Benzo(a)anthracene	0.4958	0.32692	17	11	0.72
TS-1E	Benzo(a)pyrene	0.4122	0.38296	17	14	0.85
TS-1E	Benzo(b)fluoranthene	0.7002	0.46484	17	8	1.6
TS-1E	Plutonium-238	77.436	29.308	16	16	338.33
TS-1E	Plutonium-239	9.1811	3.8059	16	16	37.91
TS-1W	Americium-241	0.7702	0.495	8	5	1.53
TS-1W	Aroclor-1260	0.4671	0.29443	8	5	1.37
TS-1W	Benzo(a)pyrene	0.1028	0.07544	14	12	0.32
TS-1W	Benzo(b)fluoranthene	0.1073	0.0737	14	12	0.87
TS-1W	Cesium-137	0.6484	0.4896	8	8	1.15
TS-1W	Plutonium-238	4.6989	3.7253	14	14	14.3
TS-1W	Plutonium-239	1.6674	1.5374	14	14	4.06
TS-1W	Thallium	0.1206	0.10237	14	7	0.24
TS-1W	Vanadium	12.456	12.086	14	14	23
TS-2C	Strontium-90	2.2671	1.9972	28	24	5.61
TS-2E	Aluminum	6584.2	6043.1	14	14	16100
TS-2E	Aroclor-1260	0.31	0.06962	8	5	0.31
TS-2E	Arsenic	2.2453	2.1303	14	14	4.43
TS-2E	Iron	8703.9	8130.9	14	14	13900
TS-2E	Plutonium-239	5.23	2.59261	8	7	5.23
TS-2E	Strontium-90	14.533	5.0773	14	9	8.3 *
TS-2E	Vanadium	15.038	14.187	14	14	27.1
TS-2W	Strontium-90	2.4796	1.5442	26	10	6.7

*Used maximum detect as representative concentration; calculated UCL > maximum.

Table 8.2-15
Representative Concentrations for Surface Water COPCs, Trail User Scenario

Reach	COPC	UCL	Mean	Number of Samples	Number of Detects	Maximum Detect
E-1E	Americium-241	8.64	6.71333	3	3	8.64
E-1E	Cesium-137	35.6	27.7	2	2	35.6 *
E-1E	Fluoride	607.091	444	4	4	620
E-1E	Iron	2080	1246.33	3	3	2080
E-1E	Lead	2.3	1.49333	3	3	2.3
E-1E	Molybdenum	34.8	28.75	2	2	34.8 *
E-1E	Plutonium-238	3.15	2.53333	3	3	3.15
E-1E	Plutonium-239/240	4.85	3.89333	3	3	4.85
E-1E	Potassium-40	63.6	35.255	2	1	63.6 *
E-1E	Strontium-90	3.97	3.13	2	2	3.97 *
E-1W	Arsenic	6.6	3.9	4	1	6.6
E-1W	Fluoride	760	610.8	5	5	760
E-1W	Iron	6250	4262.5	4	4	6250
E-1W	Lead	1.9	1.69636	4	3	1.9
E-1W	Manganese	1035.14	589.5	4	4	1080
E-1W	Molybdenum	64.5	52.6667	3	3	64.5
E-1W	Vanadium	6.2	4.92673	4	3	6.2
east of E-1FW	Arsenic	7.6	5.3	2	1	7.6 *
east of E-1FW	Fluoride	349	211.667	3	3	349
east of E-1FW	Iron	4200	3965	2	2	4200 *
east of E-1FW	Lead	3.1	1.675	2	1	3.1 *
east of E-1FW	Manganese	873	634.5	2	2	873 *
east of E-1FW	Molybdenum	93.5	55.95	2	2	93.5 *
east of E-1FW	Vanadium	8.3	4.4	2	1	8.3 *
M-1E	Aluminum	7400	4655	2	2	7400 *
M-1E	Fluoride	500	291.667	3	3	500
M-1E	Iron	4230	3095	2	2	4230 *
M-1E	Lead	3.1	1.945	2	2	3.1 *
M-1E	Manganese	2010	1080.5	2	2	2010 *
M-1E	Vanadium	7.6	6.1	2	2	7.6 *
M-1W	Aluminum	43700	31033.3	3	3	43700
M-1W	Arsenic	6.5	4.16667	3	1	6.5
M-1W	Fluoride	672.121	399.5	4	4	720
M-1W	Iron	25700	17336.7	3	3	25700
M-1W	Lead	27	19.0333	3	3	27
M-1W	Mercury	0.07	0.04833	3	2	0.07
M-1W	Molybdenum	121	83.55	2	2	121 *

Table 8.2-15 (continued)

Reach	COPC	UCL	Mean	Number of Samples	Number of Detects	Maximum Detect
M-1W	Vanadium	48.3	35.0667	3	3	48.3
M-2E	Americium-241	0.985	0.89	2	2	0.985 *
M-2E	Fluoride	628	502	3	3	628
M-2E	Molybdenum	30.9	29.7	2	2	30.9 *
M-2E	Plutonium-238	0.287	0.2765	2	2	0.287 *
M-2E	Plutonium-239/240	0.508	0.482	2	2	0.508 *
M-2E	Strontium-90	43.9	41.65	2	2	43.9 *
M-2W	Aluminum	4410	1970.67	3	3	4410
M-2W	Americium-241	12.7148	6.35501	10	10	15.1
M-2W	Cesium-137	32.925	25.775	8	8	42.6
M-2W	Iron	2460	1118	3	3	2460
M-2W	Lead	2.7	1.26333	3	3	2.7
M-2W	Mercury	0.08	0.04513	10	1	0.08
M-2W	Perchlorate	99.5	14.1489	10	5	99.5
M-2W	Plutonium-238	5.00321	3.55384	10	10	7.57
M-2W	Plutonium-239/240	4.14226	2.98443	10	10	6.7543
M-2W	Radium-226	0.51154	0.373	8	2	0.709
M-2W	Strontium-90	11.2143	7.60309	8	7	14.5
M-2W	Tritium	35500	9888.1	8	8	35500
M-2W	Uranium-234	1.36323	0.73914	10	10	2.93
M-2W	Vanadium	2.1	2.28333	3	2	2.1
TS-1C	Aluminum	37700	20920	3	3	37700
TS-1C	Aroclor-1260	1.1	0.5725	2	1	1.1 *
TS-1C	Arsenic	7.5	6	3	1	7.5
TS-1C	Barium	349	191.967	3	3	349
TS-1C	Fluoride	226.522	151.5	4	4	228
TS-1C	Iron	37800	16486.7	3	3	37800
TS-1C	Lead	33.6	13.9333	3	3	33.6
TS-1C	Manganese	1690	598.167	3	3	1690
TS-1C	Plutonium-238	1.79	1.106	3	3	1.79
TS-1C	Plutonium-239/240	0.79	0.45333	3	3	0.79
TS-1C	Strontium-90	6.63	5.57	2	2	6.63 *
TS-1C	Thallium	0.73	0.47667	3	1	0.73
TS-1C	Vanadium	36.4	17.7667	3	2	36.4
TS-1C	Uranium	2.9	2.9	1	1	2.9 *
TS-1E	Fluoride	322	322	1	1	322 *
TS-2C	Fluoride	430	430	1	1	430 *
TS-2C	Lead	1.6	1.6	1	1	1.6 *

Table 8.2-15 (continued)

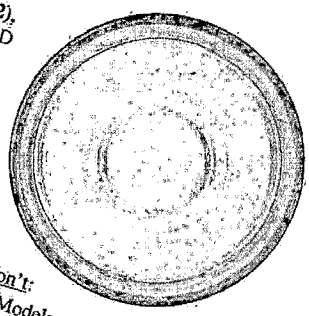
Reach	COPC	UCL	Mean	Number of Samples	Number of Detects	Maximum Detect
TS-2E	Fluoride	316	269.333	3	3	316
TS-2E	Iron	1120	908.5	2	2	1120 *
TS-2E	Lead	1.7	1.21	2	2	1.7 *
TS-2E	Manganese	887	462.75	2	2	887 *
TS-2E	Molybdenum	36.6	21.2	2	2	36.6 *
TS-2E	Uranium	0.77	0.77	1	1	0.77 *
TS-2E	Vanadium	4.4	4.05	2	2	4.4 *

*Maximum detect used as the representative concentration.

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Hydrogeologic Studies LA-14263-MS.
Hydrogeologic Site Atlas. LAUR-09-3763.
Groundwater Level Status Rpt. LA-14437-PR.

Discharge Permit Application (DP-1132),
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LAUR-12-00672
UNCLASSIFIED



Los Alamos
NATIONAL LABORATORY
Los Alamos NM 87545

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Conceptual Models of Vadose Zone Vadose Zone Journal, Vol. 4, August 2005.
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2011 Interim Facility-Wide Groundwater Monitoring Plan, Revision 1



07781

Prepared by the Environmental Programs Directorate

Los Alamos National Laboratory, operated by Los Alamos National Security, LLC, for the U.S. Department of Energy under Contract No. DE-AC52-06NA25396, has prepared this document pursuant to the Compliance Order on Consent, signed March 1, 2005. The Compliance Order on Consent contains requirements for the investigation and cleanup, including corrective action, of contamination at Los Alamos National Laboratory. The U.S. government has rights to use, reproduce, and distribute this document. The public may copy and use this document without charge, provided that this notice and any statement of authorship are reproduced on all copies.

EP2011-0375

2011 Interim Facility-Wide Groundwater Monitoring Plan, Revision 1

December 2011

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EXECUTIVE SUMMARY

This Interim Facility-Wide Groundwater Monitoring Plan (hereafter, the Interim Plan) fulfills a requirement of the Compliance Order on Consent (hereafter, the Consent Order). Los Alamos National Laboratory (the Laboratory) will collect and analyze groundwater and surface water samples at specific locations and for specific constituents to fulfill the requirements of the Consent Order. Groundwater-level data will also be collected because they are critical to understanding groundwater occurrence and movement. Four types of water are monitored: base flow (persistent surface water), alluvial groundwater, intermediate-perched groundwater, and regional aquifer groundwater. This Interim Plan is updated annually and submitted to the New Mexico Environment Department (NMED) for its approval. The 2011 Interim Plan applies to the monitoring year (MY) from October 1, 2011, to September 30, 2012. This revision of the Interim Plan will supplement the first quarter implemented under the initial 2011 Interim Plan and be in effect starting January 1, 2012.

The monitoring conducted under this plan is designed to enhance the general understanding of the groundwater within and beneath the Laboratory. These data are used for characterization purposes to support corrective measures work conducted at numerous sites around the Laboratory and to support ongoing operations. The monitoring is conducted both inside and outside of current Laboratory boundaries. Monitoring within current Laboratory boundaries takes place in seven major watershed groupings: Los Alamos Canyon/Pueblo Canyon, Sandia Canyon, Mortandad Canyon, Pajarito Canyon, Water Canyon/Cañon de Valle, Ancho/Chaquehui/Frijoles Canyons, and White Rock Canyon/Rio Grande.

Most of the monitoring wells discussed in the Interim Plan are assigned to area-specific monitoring groups related to project areas that may be located in more than one watershed. Area-specific monitoring groups are defined for Technical Area 54 (TA-54) in Pajarito and Mortandad Canyons; TA-21, primarily in Los Alamos Canyon; Material Disposal Area (MDA) AB, primarily in Ancho Canyon; MDA C, primarily in Mortandad Canyon; the chromium investigation area in Sandia and Mortandad Canyons; and the TA-16 260 Outfall in Water Canyon/Cañon de Valle. Locations that are not included within one of these six area-specific monitoring groups are assigned to the general surveillance monitoring group.

Monitoring outside the Laboratory boundaries is conducted in areas (1) where Laboratory operations have been conducted in the past (e.g., Guaje and Rendija Canyons) or (2) that historically have not been affected by Laboratory operations. To ensure water leaving the Laboratory does not pose an unacceptable risk to human and ecological receptors, this plan also includes monitoring in areas downgradient of the Laboratory and outside Laboratory boundaries (e.g., the Rio Grande and springs in White Rock Canyon).

Monitoring locations were initially derived from Table XII-5 of the Consent Order, but the current list of monitoring locations represents the most recent results of subsequent annual updates to the 2005 Interim Plan. The locations, analytical suites, and frequency of monitoring reflect the technical and regulatory status of each area-specific monitoring group.

The monitoring data collected under this plan are published in periodic monitoring reports submitted to NMED and analytical results are made available to the public in the Risk Analysis, Communication, Evaluation, and Reduction database (http://racernm.com). In addition, groundwater data collected by the Laboratory are reviewed monthly, and constituents exceeding any of the seven screening criteria laid out in the Consent Order, modified May 13, 2008, are reported monthly to the NMED Hazardous Waste Bureau.

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Appendix A Acronyms and Abbreviations, Metric Conversion Table, and Data Qualifier Definitions

Appendix B Screening Information

Appendix C Procedures, Methods, and Investigation-Derived Waste Management

Appendix D Supplemental Information for Assigned Sampling Suites and Frequencies

Appendix E Field Quality Assurance/Quality Control Samples

Appendix F Protocols for Assessing the Performance of Deep Groundwater Monitoring Wells

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Plate

Plate 1 Monitoring Group Overview

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1.0 INTRODUCTION

The 2011 Interim Facility-Wide Groundwater Monitoring Plan (hereafter, the Interim Plan) for Los Alamos National Laboratory (LANL or the Laboratory) fulfills the groundwater monitoring requirement in Section IV.A.3.b of the March 1, 2005, Compliance Order on Consent (Consent Order). Section IV.A.3.b requires the Interim Plan to be updated annually and anticipates that monitoring plans for specific areas will change as the groundwater investigation objectives in Section IV.A.3.a are met. The monitoring year (MY) for the Interim Plan is from October 1, 2011, to September 30, 2012. This revision of the Interim Plan will supplement the first quarter implemented under the initial 2011 Interim Plan and be in effect starting January 1, 2012.

Groundwater monitoring has been conducted at the Laboratory for over 60 yr, starting with U.S. Geological Survey (USGS) water-supply studies in 1945 and Laboratory groundwater quality monitoring in 1949. The first groundwater-monitoring network consisted of water-supply wells, several observation wells, and springs. The monitoring network continued to evolve through the years as various environmental investigations installed additional wells, primarily in the shallow alluvial systems, as potential monitoring points.

Between 1997 and 2005, the Laboratory implemented a sitewide hydrogeologic characterization program, described in the Laboratory's "Hydrogeologic Workplan" (LANL 1998, 059599). The primary objective of this characterization program was to refine the Laboratory's understanding of the area's hydrogeologic systems and to improve its ability to design and implement an integrated sitewide groundwater monitoring plan. Building upon information obtained from this and other programs, the Laboratory has subsequently refined the monitoring-network design and implementation through a series of monitoring-well network evaluation reports and the delineation of area-specific monitoring groups in this plan.

This plan consists of nine sections, including this introduction, with supporting appendixes. Sections 2 through 7 describe the monitoring and site activities conducted in six area-specific monitoring groups: Technical Area 21 (TA-21); chromium investigation; MDA C; MDAs G, H, and L at TA-54; TA-16 260 Outfall; and MDA AB. Section 8 describes general surveillance monitoring in seven major watersheds or watershed groupings: Los Alamos Canyon/Pueblo Canyon, Sandia Canyon, Mortandad Canyon, Pajarito Canyon, Water Canyon/Cañon de Valle, the combined watersheds of Ancho/Chaquehui/Frijoles Canyons, and White Rock Canyon/Rio Grande. Section 9 includes a list of references cited in this report and the map data sources.

Appendix A is the list of acronyms and abbreviations used in the report, a metric conversion table, and the definitions of data qualifiers. Appendix B presents screening results for data collected in the six area-specific monitoring groups and seven watershed groupings. Appendix C summarizes the methods and procedures used to conduct monitoring and the management of investigation-derived waste (IDW). Appendix D summarizes the objectives of the monitoring performed and the sampling frequencies and analytical suites for each monitoring group. Appendix E summarizes how field quality assurance (QA)/quality control (QC) results are used and the types of corrective actions that may be taken to address exceedances of target measures for each QA/QC sample type. Appendix F assesses the reliability of water-quality data collected from specific monitoring-network wells. Appendix G presents geologic cross-sections of the watersheds.

Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to the New Mexico Environment Department (NMED) in accordance with U.S. Department of Energy (DOE) policy.

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1.1 Purpose

The Interim Plan will address monitoring to

- determine the fate and transport of known legacy-waste contaminants,
- detect the arrival of potential contaminants to groundwater from previous releases,
- evaluate efficacies of corrective-action remedies,
- support proposed corrective measures,
- meet groundwater discharge permit requirements, and
- meet the monitoring requirements of DOE Orders 436.1 and 458.1.

These objectives collectively assist the Laboratory in determining any potential adverse impacts to surface water and groundwater resulting from Laboratory operations.

In addition, monitoring produces data required to evaluate risk and to assess regulatory compliance. Although the Interim Plan does not specifically address how the data collected will be used in those evaluations, the design of the monitoring network is based on conceptual models of potential sources, hydrogeologic pathways, and receptors. The data collected are intended to be useful in meeting reporting requirements under the Consent Order.

This revised Interim Plan presents an increased focus of monitoring activities on area-specific monitoring groups and key analytes for TA-54, TA-21, MDA AB, MDA C, TA-16 260 Outfall, and the chromium investigation. Monitoring of alluvial wells and springs that show a history of nondetects, that are located near other springs being monitored, or that are located in outlying areas away from Laboratory operations will be discontinued under the new focused approach.

The scope of this focused monitoring approach includes the following key elements to ensure groundwater protection.

- *The spatial coverage of the current monitoring program will be maintained.* The monitoring footprint in perched-intermediate and regional wells at all monitoring groups is retained.
- *The selection of monitoring frequency and appropriate analytes will be tailored to each specific area.* The monitoring frequency for each monitoring group was selected based on the contamination status at each site, the rate of change in contaminant concentrations, the historical monitoring data, and the hydrogeological conditions governing contaminant fate and transport for the area.
- *The groundwater monitoring program will continue to be fully protective of the regional aquifer beneath the Pajarito Plateau and of water-supply wells.* Monitoring of key sentinel wells is maintained.
- *Monitoring of key alluvial monitoring wells and springs will continue.* The alluvial wells were selected at locations downgradient of ongoing Laboratory operations. Continued monitoring of these alluvial wells will enable detection of contaminant releases, should any occur.

Section 1.6 summarizes basic sets of analytical suites and frequencies for locations assigned to area-specific monitoring groups or to general surveillance monitoring in each watershed.

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Updates to monitoring within each watershed or monitoring group, including changes in monitoring frequency, analytical suites, and monitoring locations, are based on the following:

- Summaries of contaminant frequency of detections (FDs) (Attachment B-1 in Appendix B on CD)
- Conceptual models in watershed investigation reports (IRs)
- Completed canyons investigations whose results show contributions to risk from surface water are low
- Reviews of existing analytical data and trends for individual watersheds
- Reviews of water-level data to identify wells that are consistently dry and are candidates for removal from the sampling plan (section 1.10)
- Changes to the monitoring-well networks over time, including the addition of newly installed monitoring wells, the rehabilitation and conversion of multiscreen wells, and the removal of wells recently plugged and abandoned or planned for plugging and abandonment in the near-term
- Monitoring objectives for the area-specific monitoring groups

1.2 Scope

The Interim Plan describes the objectives for monitoring, the locations of sampling stations, the frequency of sampling, the field measurements taken at each location, and the analytical suites included in the monitoring plan for each watershed or monitoring group.

Four occurrences of water are monitored in this plan:

- Base flow—persistent surface water that is maintained by precipitation, snowmelt, effluent, and other sources
- Alluvial groundwater—water within the alluvium in the bottom of the canyons
- Intermediate-perched groundwater—localized saturated zones within the unsaturated zone
- Regional groundwater—deep, laterally continuous groundwater beneath the Pajarito Plateau

Groundwater will be routinely monitored by collecting samples at wells and springs and by analyzing them for specific constituents. Groundwater monitoring refers to gathering data not only for water-quality analysis but also for water-level measurements. Water-level data are critical to understanding groundwater occurrence and movement and the responses of groundwater levels to recharge and to pumping of water-supply wells.

Surface water at the Laboratory is divided into the following three flow types:

- Base flow—persistent, but not necessarily perennial, stream flow. This stream flow is present for periods of weeks or longer. The water source may be effluent, springs, or shallow groundwater in canyons.
- Snowmelt—flowing water that is present because of melting snow. This type of water often may be present for several weeks or more (persistent) but in some years may not be present at all.
- Storm runoff—flowing water that is present in response to rainfall. These flow events are generally short-lived, with flows lasting from less than an hour to several days.

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In some cases, depending on weather conditions, each flow type may be collected at a single location within a time span of a few days. At other times, the flow may represent a combination of these types.

Storm runoff and snowmelt monitoring is not addressed in this plan but rather through the National Pollutant Discharge Elimination System (NPDES) Individual Permit and under DOE Orders 436.1 and 458.1 for surveillance. Base flow (persistent water) and, in some cases, persistent flow derived from snowmelt are monitored under the Interim Plan.

Monitoring under the Interim Plan will take place in area-specific monitoring groups within seven major watershed groupings: Los Alamos Canyon/Pueblo Canyon, Sandia Canyon, Mortandad Canyon, Pajarito Canyon, Water Canyon/Cañon de Valle, the combined watersheds of Ancho/Chaquehui/Frijoles Canyons, and White Rock Canyon. Monitoring outside the Laboratory boundary is conducted to collect baseline data in areas that have been affected by past Laboratory operations (e.g., Guaje and Rendija Canyons) or that have not been affected by Laboratory operations. To ensure water leaving the Laboratory boundaries does not pose an unacceptable risk, this plan also includes monitoring in areas off-site that have the potential to be impacted by the Laboratory (e.g., the Rio Grande and springs in White Rock Canyon). Figure 1.2-1 shows the areas included in this Interim Plan.

The Interim Plan is updated annually to incorporate new information collected during the previous year. Locations, analytes, and sampling frequencies will be evaluated and updated as appropriate to ensure adequate monitoring and to ensure monitoring objectives for the individual monitoring groups continue to be met. Information gained through characterization efforts, aquifer test results, water-level monitoring, network assessments, and water-quality data will be used to refine the monitoring plan for each monitoring group. In addition, the need for sampling of analytes previously eliminated from sampling in various monitoring groups will be reevaluated during the development of the annual updates to the Interim Plan.

1.3 Reporting

The data collected under this Interim Plan are submitted to NMED in periodic monitoring reports (PMRs) in accordance with Section IV.A.6 of the Consent Order and per subsequent agreements with NMED on the frequency of reporting. The data in reports submitted to NMED are independently maintained and are made available to the public in the Risk Analysis, Communication, Evaluation, and Reduction (RACER) database as the data are received from the analytical laboratory (available at http://racernm.com/). Subject to the protocol stipulated in the memorandum of understanding (MOU) regarding the release of monitoring data collected from locations on Pueblo of San Ildefonso lands.

The PMRs present groundwater and base-flow data and are submitted to NMED in accordance with Consent Order requirements. Each PMR includes all available watershed monitoring data, along with the previous three rounds of data. In addition, groundwater data collected by the Laboratory are reviewed monthly, and constituents exceeding any of the seven screening criteria described in the Consent Order, modified May 13, 2008, are reported monthly to the NMED Hazardous Waste Bureau.

1.4 Regulatory Context

This Interim Plan fulfills groundwater monitoring requirements of the Consent Order as described in section 1.0. In addition to the Consent Order, the Laboratory is required to perform groundwater monitoring to satisfy other regulatory requirements, as summarized below. The Laboratory has an integrated approach to monitoring groundwater, and many of the other regulatory requirements discussed below are fulfilled through the implementation of the monitoring performed under the Interim Plan.

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1.4.1 New Mexico Water Quality Control Commission Regulations

Currently, the TA-46 Sanitary Wastewater Systems (SWWS) Plant operates under a groundwater discharge permit (discharge plan number DP-857) issued by NMED pursuant to 20.6.2 New Mexico Administrative Code (NMAC). Sampling locations, monitoring frequencies, and reporting requirements are specified in the NMED-approved DP-857, under which the Laboratory conducts quarterly sampling at two NPDES outfalls, the SWWS Plant reuse wet well, and CdBO-6, an alluvial monitoring well located in Cañada del Buey. Monitoring under DP-857 began when the SWWS Plant opened in 1993 and is expected to continue indefinitely, with appropriate modifications made as discharge conditions change over time. The plan was renewed in 1998, and a second request for plan renewal was submitted to the NMED in 2002.

1.4.2 DOE Environmental Protection Programs

Groundwater monitoring has been conducted in compliance with DOE orders related to environmental protection. DOE Orders 436.1 and 458.1 require an environmental management system at DOE facilities that includes surveillance groundwater monitoring and reporting. Surveillance monitoring has been conducted at the Laboratory since the 1970s under previous DOE orders, and the results are documented in annual reports. Currently, the Laboratory conducts groundwater-surveillance monitoring from wells located within the Laboratory boundary and at off-site locations. These wells include alluvial, perched-intermediate, and regional aquifer wells. Some of the off-site monitoring is performed under cooperative agreements with Los Alamos County, which owns and operates water-supply wells within and near the Laboratory, and with the City of Santa Fe. Additional monitoring is performed under an MOU among DOE, the Bureau of Indian Affairs, and the Pueblo of San Ildefonso. The results of surveillance monitoring are reported in annual environmental reports and the RACER database. The environmental reports contain descriptions of the surveillance monitoring network, key results and trends, and the QA/QC program.

1.4.3 Hazardous Waste Facility Permit

Section III.W of the Consent Order describes the integration of the current and any future Hazardous Waste Facility Permits (hereafter, the Permits) with the Consent Order. All corrective action for releases of hazardous waste or hazardous constituents required by Sections 3004(u), 3004 (v), and 3008(h) of the federal Resource Conservation and Recovery Act (RCRA); Sections 74-4-4(A)(5)(h) and (i), 74-4-4.2(B) and 7-7-10(E) of the Hazardous Waste Act (HWA); and the federal and state implementing regulations at 40 Code of Federal Regulations (CFR) Part 264, Subpart F and 20.6.2.3103 NMAC shall be conducted solely under the Consent Order, with the following four exceptions:

1. New releases of hazardous wastes or hazardous constituents from operating units at the Laboratory;
2. Closure and postclosure care requirements as they apply to operating units at the Laboratory;
3. Implementation of controls, including long-term monitoring, for any solid waste management units (SWMUs) and areas of concern (AOCs) on the Permit's Corrective Action Complete with Controls list; and
4. Any releases of hazardous wastes or hazardous constituents that occur after the termination of the Consent Order.

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Groundwater-monitoring requirements for SWMUs, AOCs, and regulated units that satisfy the alternative requirements provisions in 40 CFR 264.90(a)(2) are addressed under the groundwater-monitoring provisions of the Consent Order, including implementation of the Interim Plan.

1.5 Integration of Groundwater Monitoring at the Laboratory

All groundwater monitoring under the Interim Plan is conducted as an integrated activity that uses the same operating procedures, field sampling and analytical contracts, and data-management systems. For chemical analysis of water samples, the Laboratory uses commonly accepted analytical methods called for under federal regulations (such as the Clean Water Act) and approved by the U.S. Environmental Protection Agency (EPA). The Laboratory is responsible for obtaining analytical services that support monitoring activities. Samples for laboratory analysis are submitted to accredited contract laboratories. The analytical laboratory statement of work provides contract laboratories the general QA guidelines and includes specific requirements and guidelines for analyzing water samples. The contract laboratories are required to establish method detection limits (MDLs) and practical quantitation limits (PQLs) for target analytes.

Appendix C includes summaries of the procedures followed to measure water levels and collect water samples (sections C-1.0 and C-2.0) and to measure field parameters (section C-3.0). Field procedures follow guidelines from USGS water sample collection methods and industrial standards common to environmental sample collection and field measurements. The analytical methods, PQLs, and applicable background or screening levels used for each analyte are listed in section C-4.0. The management of IDW is discussed in section C-5.0.

1.6 Approach to Monitoring Network Design

The interim nature of this monitoring plan reflects an evolving monitoring network at the Laboratory. The groundwater data collected under this plan are used for subsurface characterization, groundwater monitoring network evaluation, and support of corrective measures.

For the 2010 Interim Plan, monitoring groups were established to address monitoring requirements for locations within specific project areas (LANL 2010, 109830). These monitoring groups are shown in Plate 1 and include the following (the watersheds in which the monitoring area is located are given in parentheses):

- TA-21 (Los Alamos Canyon)
- TA-54 (Pajarito and Mortandad Canyons)
- MDA C (Pajarito and Mortandad Canyons)
- Chromium investigation (Sandia and Mortandad Canyons)
- TA-16 260 Outfall (Pajarito and Water Canyons and Cañon de Valle)
- MDA AB (Ancho and Water Canyons)

Monitoring locations outside of the seven area-specific monitoring groups delineated above are included in a general surveillance monitoring group, which includes locations in all seven major watershed groupings (Los Alamos Canyon/Pueblo Canyon, Sandia Canyon, Mortandad Canyon, Pajarito Canyon, Water Canyon/Cañon de Valle, the combined watersheds of Ancho/Chaquehui/Frijoles Canyons, and White Rock Canyon).

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The locations, analytical suites, and frequency of monitoring for each monitoring group reflect the state of knowledge for a given project area, including what contaminants have been released and the nature and extent of the contaminants released. Much of the information underlying the design of the monitoring plan is presented in IRs and is supported by the FD tables in Appendix B of this Interim Plan. Recommendations for the analytical suites for each watershed and locations within the watershed were determined by evaluating past Laboratory operations, investigation-derived information, and monitoring results. For this Interim Plan, updates to monitoring are made for all monitoring groups based on the adequacy of data to support the modifications to suite and the frequency. Data from 2005 to 2010 were screened to compare with one-half the lowest applicable standard (see Table 1.6-1). This period of record was selected for this version of the plan to provide a sufficiently robust data set to evaluate FD and time-series trends, if applicable. The analytical data screening results are summarized in tables in Attachment B-1 of Appendix B (on CD).

Table 1.6-2 summarizes analytical suites, and sampling frequencies for each type of sampling location (e.g., base flow, alluvial, intermediate, regional, or springs) within each area-specific monitoring group. Table 1.6-3 summarizes the analytical suites and sampling frequencies for general surveillance monitoring locations (locations not assigned to area-specific monitoring groups). In this sampling table, the northern locations (including Los Alamos/Pueblo, Sandia, and Mortandad Canyons) and the southern locations (including Pajarito, Water/Cañon de Valle, Frijoles, Ancho, and Chaquehui Canyons) are distinguished because the analytical suites differ, based primarily on the presence of high explosives (HE) in the southern canyons and their absence in the northern canyons. The analytical suites and frequencies are tailored to each watershed and sampling location based on the adequacy of the data record, the status of investigations and maturity of the conceptual model, the nature of watershed contaminant sources, and the history of detections, as documented in more detail in sections 2 to 8. Analytical suites assigned to existing (pre-2010) wells within watersheds and investigation areas are based on the results of applicable IRs and a review of ongoing monitoring data, as presented in the statistical summaries of detections in Attachment B-1 of Appendix B (on CD). The assignment of specific analytical suites to a well also reflects data needs for pending corrective measures evaluations (CMEs). Tables 1.6-2 and 1.6-3 also list characterization suites and sampling frequencies for newly installed wells (wells installed on or after October 1, 2010). New wells will be sampled for at least four rounds for the monitoring-group specific characterization suites for new wells presented in Tables 1.6-2 and 1.6-3.

Exceptions to the analytical suites and sampling frequencies presented in Tables 1.6-2 and 1.6-3 occur in some cases. These exceptions may be the result of a number of factors such as additional regulatory or permit requirements and sampling commitments outlined in the MOU with the Pueblo of San Ildefonso.

Exceptions to the default analytical suites and sampling frequencies may also be made for wells affected by residual drilling or construction products, recently rehabilitated wells, and other wells known to produce nonrepresentative water-quality data or for which the reliability of the data has not yet been established or may be questioned (Appendix F). Additionally, some wells may be monitored for a limited set of constituents tailored to address monitoring objectives or performance issues with the well.

Appendix D summarizes the sampling frequencies and analytical suites for each monitoring group and explains how the monitoring objectives are protective of groundwater.

1.7 Data-Screening Process

This section describes the process for screening the monitoring data. The purpose of the screening is to identify analytical parameters that guide the assignment of analytical suites and monitoring frequencies in each monitoring group.

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The results of the screening for all locations in each monitoring group are used to update the monitoring for that group. The results of the data-screening process and statistical summaries are presented in Appendix B. The data-screening process consists of compiling the water-quality data set, determining detection status, screening the data against applicable standards, and producing summary statistics to identify constituents of potential concern in each watershed. Table B1-1 (groundwater) and Table B1-2 (surface water) in Attachment B-1 of Appendix B (on CD) present summary statistics for each water type and analytical suites based on data compiled for individual locations in Table B1-3 (groundwater) and Table B1-4 (surface water).

Table 1.6-1 presents the regulatory standards for the various water sample types by screening category. The data results were screened against the lowest applicable regulatory standard or risk-based value in the tables in Attachment B-1 of Appendix B. The standards that apply depend on the type of field preparation conducted during collection (filtered or unfiltered) and the type of the water (i.e., groundwater or persistent surface water). Each combination of water type/field preparation is referred to as a screening category. The standards for filtered samples are those applicable to the dissolved fraction, and standards for unfiltered samples are those applicable to the total concentration in nonfiltered samples. The terms "nonfiltered" and "unfiltered" are used interchangeably in this document.

For screening purposes, laboratory and field QC samples were removed from the statistical analysis. The detection status for an analytical result was established using the combined set of laboratory-assigned validation qualifiers and reason codes assigned during data validation (Appendix E).

The screening tables presented in Attachment B-1 of Appendix B (on CD) were used to identify constituents of potential concern and to optimize the monitoring strategy for each watershed. Groundwater and base-flow data from 2005 to 2010 are screened against one-half the lowest applicable regulatory standards or other risk-based screening levels (presented in Table 1.6-1) and against appropriate groundwater background values, if available. The screening tables are organized by contaminant type in each water type (e.g., spring, perennial base flow, regional aquifer) within each monitoring group.

The screening tables in Attachment B-1 include summary information such as the total number of samples collected for each analyte; the numbers of detections and nondetects; the minimum, mean, and maximum values for detections of each analyte; and comparisons with background values (if available) and with regulatory standards. The tables also list sampling locations where the lowest applicable regulatory standards are exceeded. Additional details regarding the screening tables are presented in the introduction to Appendix B.

1.8 Sampling Frequency and Schedule

The Interim Plan proposes monitoring frequencies for each monitoring group as described in the sampling tables in sections 2 through 8. For newly installed wells (i.e., those installed on or after October 1, 2010), the monitoring frequency and characterization suite are quarterly or semiannually for target analyte (TAL) metals, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), tritium, general inorganics, and perchlorate. Less mobile constituents for which there is no reasonable migration scenario to the regional aquifer (including pesticides, polychlorinated biphenyls [PCBs], and dioxins/furans) are no longer sampled in new deep wells completed in perched-intermediate groundwater or in the regional aquifer. HE compounds may be sampled quarterly or semiannually if known or suspected to be present.

Monitoring locations that are being used or are candidates for the determination of background water quality for the regional and perched-intermediate aquifers are indicated as such in the sampling table for each monitoring group.

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The MY for the Interim Plan is from October 2011 to September 2012. This revision of the Interim Plan will supplement the first quarter implemented under the initial 2011 Interim Plan and will be in effect starting January 1, 2012. Table 1.8-1 presents a proposed sampling schedule. Following submittal of this Interim Plan to NMED, a finalized sampling schedule for each monitoring group or watershed will be established to ensure the monitoring frequency is met during the implementation year of the plan. A PMR for the periodic monitoring event conducted during first quarter of MY2012 (sampling conducted from October to December 2011) will be submitted on May 31, 2012. A PMR for second quarter of MY2012 (sampling conducted from January to March 2012) will be submitted on August 31, 2012. A PMR for the third quarter MY2012 (sampling conducted from April to June 2012) will be submitted on November 30, 2012. A PMR for the fourth quarter MY2012 (sampling conducted from July to September 2012) will be submitted on February 28, 2013.

The Consent Order requires all monitoring wells within a watershed be sampled within 21 d of the start of the groundwater sampling event. For the 2011 Interim Plan, monitoring groups for project areas have effectively replaced the watersheds, and monitoring for the individual monitoring groups, with the exception of the general surveillance monitoring group, will be completed within 21 d. Monitoring of the White Rock Canyon general surveillance group will be completed within 21 d. The other general surveillance locations will be monitored in conjunction with other monitoring activities at nearby locations or watersheds.

1.9 Water-Level Monitoring

The majority of monitoring wells sampled are equipped with pressure transducers to measure and record water levels to aid in understanding the hydrologic system. Pressure transducers are typically set to record on an hourly basis. Manual water-level measurements are also collected on a regular basis to verify the pressure transducer data.

The water-level data collected using the automated pressure transducers address the requirement of Section IX.B.2.h.i of the Consent Order to measure groundwater levels in all wells in a given watershed within 24 h. These data are available for any 24-h period and, therefore, meet the requirement for these measurements to be completed across all watersheds within 14 d of the commencement of the specified water-level measuring event as required by the Consent Order. Water levels are monitored in a number of wells and/or well screens that are not sampled under the Interim Plan to collect data to develop and validate the conceptual models (Table 1.9-1). Groundwater levels are also monitored in Los Alamos County water-supply wells in cooperation with Los Alamos County utilities personnel and in the Buckman Well Field in cooperation with the City of Santa Fe.

1.10 Wells That Are Historically Dry

Wells that are historically dry are generally no longer monitored for water levels, except for a few wells in key locations (Table 1.9-1). Wells that intermittently show water (in response to large snowmelt years or precipitation events) may continue to be monitored for water levels using transducers and will be sampled if sufficient water is present during their respective watershed's sampling campaign. New wells that are dry may be retained in the monitoring plan to evaluate potential wetting responses and temporal changes in water levels.

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2.0 TA-21 MONITORING GROUP

2.1 Introduction

The TA-21 monitoring group is located in and around TA-21 and is primarily located in upper Los Alamos Canyon (Figure 2.1-1). The group includes monitoring wells completed in the perched-intermediate groundwater and in the regional aquifer.

TA-21 is located on the mesa north of Los Alamos Canyon, which is joined by DP Canyon, east of TA-21. TA-21 consists of two historically operational areas, DP West and DP East, both of which produced liquid and solid radioactive wastes. The operations at DP West included plutonium processing, while the operations at DP East included the production of weapons initiators and tritium research.

2.2 Background

The occurrence of surface water and alluvial, perched-intermediate, and regional groundwater in Los Alamos Canyon is discussed in detail in section 7.2 of the Los Alamos and Pueblo Canyons IR (LANL 2004, 087390).

In upper Los Alamos Canyon, perennial flow originates from springs and interflow through hillslope soils. The downgradient extent of perennial flow varies but generally terminates in the upper portions of Los Alamos Canyon west of TA-41. The remainder of upper Los Alamos Canyon down to the confluence with Pueblo Canyon is characterized by intermittent surface water flow that is seasonally dependent. Within the vicinity of TA-21, surface water occurs predominantly as ephemeral flow in Los Alamos and DP Canyons. Ephemeral surface water flows generally occur during runoff associated with thunderstorms and snowmelt.

In the vicinity of TA-21, alluvial groundwater occurs in Los Alamos Canyon and in stretches of DP Canyon. DP Canyon is typical of other dry canyons (Birdsell et al. 2005, 092048) based on its small drainage area and low-elevation headwaters. However, it previously received effluent discharges operations at TA-21 [SWMU 21-011(k)]. It currently receives surface runoff from paved parking lots and roadways from within the Los Alamos townsite. These townsite runoff sources contribute to locally persistent alluvial groundwater beneath parts of the canyon floor, specifically the portion adjacent to TA-21. There, alluvial deposits are thin (approximately 2 m [6 ft]) and are periodically recharged by surface water flows that reach this part of the canyon. Surface water infiltrates the canyon bottom alluvial sediments until its downward movement is impeded by strata of lower permeability, typically welded tuff at the top of unit Qbt 2 of the Tshirege Member. Despite the episodic nature of surface water flow and thin nature of the alluvial deposits, transducer readings at alluvial well LAUZ-1 indicate the alluvium in this part of the canyon was continuously saturated from January 2008 to January 2010 (Koch and Schmeer 2010, 108926), suggesting the underlying welded tuffs are an effective perching horizon that inhibits deeper infiltration.

Appendix D of the Technical Area 21 Groundwater and Vadose-Zone Monitoring Well Network Evaluation and Recommendations report (LANL 2010, 109947) describes known occurrences of intermediate-perched water beneath Los Alamos and Pueblo Canyons. Perched-intermediate zones nearest TA-21 are shown on the geologic cross-sections presented in Appendix G.

Perched-intermediate groundwater beneath Los Alamos and Pueblo Canyons results from infiltration of surface water and alluvial groundwater derived from snowmelt and seasonal rainfall. Surface water in Pueblo Canyon was previously augmented by effluent released from the Pueblo Canyon wastewater treatment plant (WWTP) from 1951 to 1991 and the Central WWTP from 1947 to 1961. Perched-

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intermediate groundwater beneath lower Pueblo Canyon includes contributions of canyon-floor effluent infiltration from the Bayo WWTP that operated from 1963 to 2007 and the Los Alamos WWTP that began operations in 2007.

The most significant perched-intermediate groundwater in the vicinity of TA-21 occurs within the Guaje Pumice Bed and the underlying Puye Formation beneath Los Alamos Canyon. Near TA-21, saturated thicknesses for these occurrences range from about 9 ft at LADP-3 to more than 31 ft at LAOI-3.2a. The depth to perched-intermediate groundwater ranges from 124 ft to 746 ft. These perched groundwater occurrences are probably part of a larger integrated system that extends over 3.5 mi along the axis of Los Alamos Canyon from H-19 to LAOI-3.2 and LAOI-3.2a and may extend locally to the south (Appendix G).

Based on these observations, it appears an important control of intermediate-zone groundwater flow in the vicinity of TA-21 is the contact between the Guaje Pumice Bed and the underlying Puye Formation. Structure contours indicate the downdip direction for the base of the Guaje Pumice Bed is towards the south, southeast, and southwest in the vicinity of TA-21. The control exerted on groundwater flow by the Guaje Pumice Bed suggests that perched water beneath Los Alamos Canyon should move generally southward away from TA-21.

The occurrence of thicker perched-intermediate zones in the eastern part of Los Alamos Canyon may be the result of enhanced infiltration where the canyon floor is underlain by Cerros del Rio basalts rather than by the Bandelier Tuff. Because the Cerros del Rio basalt does not extend as far west as the developed portion of TA-21, it is unlikely the eastern perched zones of Los Alamos Canyon extend beneath the TA-21 area. No perched-intermediate groundwater has been encountered to date during drilling on DP Mesa.

The regional aquifer includes confined and unconfined zones. The shallow portion of the regional aquifer is predominantly unconfined, and the deeper portion of the aquifer is predominantly confined. Groundwater flow in the shallow portion of the regional aquifer generally follows the gradient of the water table. The deep portion of the regional aquifer is predominantly under confined conditions that are affected by Pajarito Plateau water-supply pumping.

In the vicinity of TA-21, the upper surface of the regional aquifer is located in the Puye Formation and in the Santa Fe Group. The depths to water range from 707 ft to 1159 ft below ground surface (bgs) (Koch and Schmeer 2011, 201566). The regional aquifer beneath the east end of DP Mesa occurs at a depth of 1159 ft bgs, based on water levels measured in well R-6. Shallow regional groundwater in the vicinity of TA-21 generally flows to the east-northeast.

Contaminant Sources and Distributions

Primary sources of contaminants in the vicinity of the TA-21 monitoring group include SWMU 21-011(k), the adsorption beds and disposal shafts at MDA T, DP West, and waste lines and sumps. Other potential sources include DP East and a diesel spill.

Mobile contaminants, such as tritium, nitrate, and perchlorate, released at the SWMU 21-011(k) outfall have dispersed down DP and Los Alamos Canyons by surface water and alluvial groundwater. They are present in perched-intermediate groundwater near the confluence of DP and Los Alamos Canyons (at wells R-6i, LAOI-3.2, and LAOI-3.2a), farther down Los Alamos Canyon (at LAOI-7 and R-9i), and beneath Mesita de Los Alamos (at R-53i).

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The lower reach of DP Canyon is the likely infiltration location for mobile contaminants such as tritium, nitrate, and perchlorate that are detected in perched groundwater at R-6i, LAOI-3.2, and LAOI-3.2a. Infiltration at the confluence with DP Canyon (near wells LAOI-3.2/LAOI-3.2a) may be further enhanced by surface water runoff and alluvial groundwater in Los Alamos Canyon, contributing to the deeper, perched-intermediate zones observed beneath the confluence of the two canyons. The zones of perched-intermediate groundwater occur within the Guaje Pumice Bed and the underlying Puye Formation near the confluence of the two canyons.

Contaminant concentrations are at background levels in regional groundwater monitoring wells in the near vicinity of TA-21 (e.g., R-6, R-8, and R-64), suggesting deep infiltration through the vadose zone, including migration from perched groundwater, does not reach the regional aquifer near TA-21. This observation is also supported by the absence of tritium in the regional screen in R-7, although the absence of nitrate and perchlorate at this location is not conclusive because of reducing conditions in the screened interval that may be attributed to residual organic drilling products. The regional aquifer at Test Well (TW) 3 shows levels of contamination above background, but this may be related to leakage around the well casing from the absence of annular seal in this older well. The well is scheduled to be plugged and abandoned. Tritium and perchlorate are slightly elevated in the regional aquifer at R-9, which is located farther down Los Alamos Canyon. These far-field contaminants may have originated at SWMU 21-011(k).

2.3 Monitoring Objectives

The monitoring objectives for the TA-21 monitoring group presented in this Interim Plan are based in part on the results and conclusions presented in the Los Alamos and Pueblo Canyons IR (LANL 2004, 087390) as well as on the NMED-approved Los Alamos and Pueblo Canyons Groundwater Monitoring Well Network Evaluation and Recommendations, Revision 1 (LANL 2008, 101330).

Sampling over the last few years has generated a substantial data set from perched-intermediate and regional groundwater wells located in and next to Los Alamos Canyon. Data from these wells indicate the importance of lateral migration of perched-intermediate groundwater and regional groundwater flow directions. This information can lead to a groundwater monitoring domain that may extend beyond the footprint of a watershed where the initial release occurred.

Monitoring for TA-21 is focused on intermediate-perched and regional wells surrounding the TA-21 area that monitor for potential releases from mesa-top sites and the fate of mobile constituents historically released into DP Canyon from SWMU 21-011(k). The key constituents detected in nearby perched-intermediate and regional groundwater wells include nitrate, perchlorate, and tritium. Base-flow and alluvial-groundwater wells near and downgradient of TA-21 are not part of the TA-21 monitoring group because the source(s) of constituents detected in these wells is terminated or controlled and residual concentrations are stable, declining, or no longer present.

2.4 Scope of Activities

Active monitoring locations in the TA-21 monitoring group include intermediate-perched groundwater wells and regional groundwater wells, which are shown in Figure 2.1-1. All the monitoring locations are in the Los Alamos Canyon/Pueblo Canyon watershed.

Table 2.4-1 presents sampling locations, the rationale for these locations, analytical suites, and frequencies for the TA-21 monitoring group. Analytical suites and frequencies assigned to individual locations listed in Table 2.4-1 generally follow the high-level monitoring design presented in Table 1.6-2 for the TA-21 monitoring group. These analytical suites and frequencies are based on the results of

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applicable IRs and a review of ongoing monitoring data, such as the statistical summaries for locations in the TA-21 monitoring group provided in the FD screening tables in Attachment B-1 of Appendix B (on CD).

Exceptions to the analytical suites and sampling frequencies presented in Table 1.6-2 may occur for some locations listed in Table 2.4-1. The majority of the wells in the TA-21 monitoring group are sampled annually. New wells R-64 (completed July 11, 2011) and R-66 (following installation of its sampling system) will be sampled quarterly. The objectives for the sampling frequency and analytical suites are presented in Table D-1.

3.0 CHROMIUM INVESTIGATION MONITORING GROUP

3.1 Introduction

The chromium investigation monitoring group is located in Sandia and Mortandad Canyons (Figure 3.1-1). Monitoring focuses on the characterization and fate and transport of chromium contamination in perched-intermediate groundwater and within the regional aquifer. The distribution of wells in the monitoring group also addresses historical releases from Outfall 051, which discharges from the Radioactive Liquid Waste Treatment Facility (RLWTF) in the Mortandad Canyon watershed. Effluent volumes were considerably reduced in 2010 and 2011 because process changes at the RLWTF have significantly reduced discharges to the outfall.

Sandia Canyon heads on Laboratory property within TA-03 at an elevation of approximately 7300 ft and trends east-southeast across the Laboratory, Bandelier National Monument, and San Ildefonso Pueblo. Sandia Canyon empties into the Rio Grande in White Rock Canyon at an elevation of 5450 ft. The area of Sandia Canyon watershed is approximately 5.5 mi^2. The head of the canyon is located on the Pajarito Plateau at TA-03. Perennial stream flow and saturated alluvial aquifer conditions occur in the upper and middle portions of the canyon system because sanitary wastewater and cooling tower effluent discharge to the canyon from operating facilities. A wetland of approximately 7 acres has developed as a result of the wastewater and cooling tower effluent discharge. The only known perennial spring in the watershed (Sandia Spring) is located in lower Sandia Canyon near the Rio Grande. TAs located in the Sandia Canyon watershed include TA-03, TA-53, TA-60, TA-61, TA-72, and former TA-20. A total of 264 SWMUs and AOCs are located within these TAs.

Mortandad Canyon is an east-to-southeast trending canyon that heads on the Pajarito Plateau near the main Laboratory complex at TA-03 at an elevation of 7380 ft (Figure 1.2-1). The drainage extends about 9.6 mi from its headwaters to its confluence with the Rio Grande at an elevation of 5440 ft. The canyon crosses Pueblo of San Ildefonso land for several miles before joining the Rio Grande (LANL 1997, 056835). The Mortandad Canyon watershed is located in the central portion of the Laboratory and covers approximately 10 mi^2. Pueblo of San Ildefonso lies immediately next to a portion of the Laboratory's eastern boundary and includes the eastern end of Mortandad Canyon. The Mortandad Canyon watershed contains several tributary canyons that have received contaminants released during Laboratory operations. The most prominent tributary canyons include Ten Site Canyon, Pratt Canyon, Effluent Canyon, and Cañada del Buey.

3.2 Background

Sources of surface water in the Sandia watershed are currently dominated by effluent releases. Effluent water releases to Sandia Canyon have occurred since the early 1950s and continue today, with the primary source being treated sanitary wastewater and steam plant discharges at Outfall 001 and lesser

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sources being cooling tower blowdown. Data from 2007 and 2008 indicate the NPDES outfalls contribute approximately 75% of the total surface water flow in Sandia Canyon, with stormwater runoff and snowmelt contributing the remainder (LANL 2008, 102996, Appendix C).

The long-term discharges and runoff support a wetland near the head of Sandia Canyon. Persistent surface flow occurs through the wetland and into the narrow, bedrock portion of the upper canyon. Surface water flows past gage E124 typically only during times of high alluvial groundwater levels, increased effluent volume, or during stormwater runoff events.

Surface water in Mortandad Canyon is ephemeral and occurs infrequently in lower Mortandad Canyon. Effluent releases from the RLWTF have historically supported surface water in middle Mortandad Canyon, but those contributions are currently minimal. The lower canyon is characterized by a broad flat canyon floor with an indistinct drainage channel. It contains thick alluvial deposits (up to 30 m [100 ft]) that rapidly accommodate the rare surface water flows that reach this part of the canyon. Surface water is rarely observed below the confluence with Ten Site Canyon.

Alluvial groundwater in Sandia Canyon is recharged daily by surface-water flow, largely supplied by effluent from Outfall 001 and periodically by stormwater. This groundwater generally accumulates in the lower part of the alluvial deposits that fill the canyon bottom, most often perching on or within shallow bedrock units. The alluvial groundwater body extends farther downcanyon (roughly more than 1 km [0.6 mi] farther east) than do the daily stream-flow events. Alluvial saturation occurs approximately between alluvial wells SCA-2 and well SCA-5, with the most persistent perched alluvial groundwater occurring between alluvial wells SCA-2 and SCA-4.

In Mortandad Canyon (LANL 2006, 094161), alluvial groundwater storage is limited in the upper reaches but increases downcanyon in wider, thicker alluvial deposits (LANL 2006, 094161). Small outfall and runoff sources in upper Effluent Canyon create localized areas of surface water and possibly minor alluvial groundwater. The extent of alluvial saturation in Mortandad Canyon is historically variable and depends primarily on variations in runoff and effluent volume; the extent has decreased recently with the decrease of effluent from RLWTF.

A zone of perched-intermediate groundwater occurs within the Puye Formation on top of the Cerros del Rio basalt between well SCI-1 and borehole SCC-4, where it ranged from approximately 1 ft to 25 ft thick, and generally thinned to the west. This perched zone is probably recharged by percolation of alluvial groundwater through the underlying bedrock units before perching on top of the basalt. The perching layer for this perched-intermediate groundwater is the top of the Cerros del Rio basalt. A local depression occurs in the upper basalt surface in the vicinity of nearby well SCI-2, which may control the accumulation of perched water in this area. The top of the Cerros del Rio basalt also acts as a perching horizon at perched-intermediate wells MCOI-4 and MCOBT-4.4 in Mortandad Canyon, indicating this contact has favorable characteristics for perching groundwater over a wide area.

A second perched-intermediate zone is penetrated by well SCI-2 within fractured lavas and interflow breccias in the lower part of the Cerros del Rio basalt. The thickness of the perched zone is uncertain but ranges between 45 ft and 100 ft. The lava flows hosting the perched groundwater at well SCI-2 were deposited over a south to south-southeast dipping surface that developed on top of the Puye Formation. The nature of the perching horizon at the base of these basalts is poorly understood but may include relatively impermeable sedimentary rock of the Puye Formation and clay altered flow-base volcanic sediment at the base of the Cerros del Rio basalt that occurs at a depth of 629 ft (LANL 2009, 105296).

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Lack of perched water in the Cerros del Rio basalt at wells R-28 and R-42 in Mortandad Canyon may indicate that the perched groundwater drained from the basalts and infiltrated the underlying Puye Formation, eventually reaching the regional aquifer in the area between wells SCI-2 and R-28/R-42.

During drilling of well R-10a, intermediate-perched groundwater was encountered between 330 ft and 370 ft depth in silts and arkosic sands sandwiched between thick massive lavas of the Cerros del Rio basalt. The water level in this zone was 304 ft, indicating the groundwater was confined. Well R-10a and its companion well R-10 were completed in the regional aquifer. However, perched-intermediate groundwater was not encountered at regional wells R-11, R-35a, R-35b, R-36, R-28, R-44, or R-45, indicating that the perched zones at wells SCI-1 and SCI-2 are not connected with those observed in R-12 and R-10/10a. The inferred connection between the perched-intermediate systems at wells R-10/10a and R-12 is based on their similar settings within the Cerros del Rio basalt, their similar groundwater elevations, and their relatively close proximity.

The regional aquifer beneath Sandia Canyon (and canyons to the north and south) includes confined and unconfined zones. The shallow portion of the regional aquifer is predominantly unconfined, and the deeper portion of the aquifer is predominantly confined. Groundwater flow in the shallow portion of the regional aquifer generally follows the gradient of the water table. Groundwater flow and water levels within the deeper portion of the regional aquifer are impacted by water-supply pumping, with the largest fluctuations in water levels observed at well R-35a, located close to water supply well PM-3.

In the vicinity of the chromium investigation monitoring group, the water table is located in the Puye Formation and in the Santa Fe Group.

Contaminant Sources and Distributions

Chromium concentrations exceed NMED groundwater standards and EPA maximum contaminant levels (MCLs) in the regional aquifer at wells R-28, R-42, and R-50 located in Mortandad Canyon. Other constituents observed above background in wells in the monitoring group include nitrate, perchlorate, and tritium. A conceptual model for the sources and distribution of these contaminants is presented in the Investigation Report for Sandia Canyon (hereafter, the Sandia Canyon IR) (LANL 2009, 107453). The Sandia Canyon IR presents the results of all the chromium and related studies conducted to date to address the nature and extent and the fate and transport of chromium and other contaminants originating in the Sandia Canyon watershed.

The conceptual model hypothesizes that chromium and other contaminants originate from releases into Sandia Canyon with lateral migration pathways that move contamination to locations beneath Mortandad Canyon. For this reason, perched-intermediate and regional wells beneath Mortandad Canyon are included in the chromium investigation monitoring group. Other sources of contamination beneath Sandia and Mortandad Canyons are from Mortandad Canyon sources, particularly historical releases from the RLWTF outfall. Lateral migration from Los Alamos Canyon sources appears to also be detected in the chromium monitoring group. These sources and the migration pathways are described in the Sandia Canyon IR (LANL 2009, 107453).

3.3 Monitoring Objectives

The objective of the chromium investigation monitoring group is to further refine the nature and extent of contamination originating from various sources principally within Sandia and Mortandad Canyons, and to monitor the fate and transport of observed contaminants. For the past 6 yr, the monitoring in and beneath Sandia Canyon and adjacent canyons has focused on acquiring a fundamental understanding of the

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nature and extent of contaminants originating in the Sandia Canyon watershed, with an emphasis on chromium contamination because its concentration exceeds groundwater standards in the regional aquifer. This work has been coupled with sediment and biota investigations to refine the conceptual model for the fate and transport of contaminants. Several new wells have also been installed and have been undergoing initial characterization monitoring on a quarterly basis.

Base-flow locations and alluvial wells in Sandia Canyon are excluded from the chromium monitoring group because the primary contaminants of concern are at low and very stable concentrations in these media (LANL 2009, 107453). In Mortandad Canyon, contaminants in the surface water and alluvial groundwater have shown a marked decrease in concentration as a result of improvements in the treatment processes at the TA-50 RLWTF (see Figures 7.2-17, 7.2-18, and 7.2-25 in the Mortandad Canyon IR [LANL 2006, 094161]). The steadily decreasing trend of the contaminant concentrations in the surface water and alluvial groundwater supports inclusion of the locations within the general surveillance monitoring group (section 8.0). These data should provide sufficient information to continue verifying the decreasing trends in contaminant concentrations in alluvial groundwater.

Perched-intermediate and regional wells in Mortandad Canyon are included in the chromium investigation monitoring group because they are located along the contaminant-transport pathway that includes the southerly diversion of groundwater within the vadose zone beneath Sandia and Mortandad Canyons. The predominant contaminants monitored in this group of wells include chromium, other metals, nitrate, perchlorate, 1,4-dioxane, and tritium. The monitoring recommendations for perched-intermediate and regional groundwater beneath Mortandad Canyon reflect the updated conceptual model for these zones as presented in the Sandia Canyon IR (LANL 2009, 107453).

3.4 Scope of Activities

Active monitoring locations in the chromium investigation monitoring group include perched-intermediate and regional aquifer wells, which are shown in Figure 3.1-1. The monitoring group includes locations in Sandia Canyon as well as in Mortandad Canyon.

Table 3.4-1 presents sampling locations, the rationale for these locations, analytical suites, and monitoring frequencies. Analytical suites and frequencies assigned to individual locations in Table 3.4-1 generally follow the high-level monitoring design presented in Table 1.6-2 for the chromium investigation monitoring group. These analytical suites and frequencies are based on the results of applicable IRs and a review of ongoing monitoring data, such as the statistical summaries for locations in the Sandia and Mortandad Canyon watersheds provided in the FD screening tables in Attachment B-1 of Appendix B (on CD).

Following submittal of the Sandia Canyon IR (LANL 2009, 107453), more intensive monitoring is now focused on the perched-intermediate and regional groundwater, with an emphasis on chromium and general inorganic chemicals (particularly nitrate), as presented in Table 1.6-2. The sampling frequency for the wells in the chromium monitoring group is based primarily on the chromium concentrations compared with groundwater standards. Wells with concentrations exceeding standards are sampled quarterly, well with concentrations above background levels but below standards are sampled semiannually, and wells with concentrations at background levels are sampled annually. New well R-62 will be sampled quarterly after the sampling system is installed. Exceptions to the analytical suites and sampling frequencies presented in Table 1.6-2 may occur for some locations listed in Table 3.4-1. The objectives for the sampling frequency and analytical suites are presented in Table D-1.

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4.0 MDA C MONITORING GROUP

4.1 Introduction

The MDA C monitoring group includes nearby regional monitoring wells on the mesa top and in Mortandad Canyon (Figure 4.1-1). MDA C is located on Mesita del Buey in TA-50, at the head of Ten Site Canyon. TA-50 is bounded on the north by Effluent and Mortandad Canyons, on the east by the upper reaches of Ten Site Canyon, on the south by Twomile Canyon, and on the west by TA-55.

MDA C is an inactive 11.8-acre landfill consisting of 7 disposal pits and 108 shafts. Solid low-level radioactive wastes and chemical wastes were disposed of in the landfill between 1948 and 1974. The depths of the seven pits at MDA C range from 12 ft to 25 ft below the original ground surface. The depths of the 108 shafts range from 10 ft to 25 ft below the original ground surface. The original ground surface is defined as beneath the cover that was placed over the site in 1984. The pits and shafts are constructed in the Tshirege Member of the Bandelier Tuff. The regional aquifer is estimated to be approximately 1330 ft deep based on the water level in well R-46 (LANL 2009, 105592). The topography of MDA C is relatively flat, although the slope steepens to the north where the northeast corner of MDA C abuts the south wall of Ten Site Canyon.

4.2 Background

MDA C is located on a mesa top, so no shallow alluvial groundwater is present in the immediate vicinity. The nearest surface water is found in Effluent Canyon to the north and in Pajarito Canyon and Twomile Canyon to the south.

No perched groundwater or intermediate-depth saturated horizons were encountered during previous investigations at MDA C (LANL 1998, 059599; LANL 2005, 091493, p. 6) or in any of the boreholes drilled during the Phase III investigation at MDA C (LANL 2011, 204370). No perched groundwater was encountered during the drilling of regional wells R-46 or R-60.

Regional monitoring wells R-46 and R-60 are located downgradient of MDA C (Figure 4.1-1) (LANL 2009, 105592; LANL 2011, 111798). The upper surface of the regional aquifer is located within the lower Puye Formation or the upper pumiceous deposits of the Santa Fe Group, and the depths to water range from approximately 1320 ft to 1330 ft bgs (Koch and Schmeer 2011, 201566). Near MDA C, the direction of shallow groundwater flow in the regional aquifer is to the east-southeast.

Contaminant Sources and Distributions

Vapor-phase VOCs and tritium are present in the upper 500 ft of the unsaturated zone beneath MDA C (LANL 2011, 204370). The primary vapor-phase contaminants beneath MDA C are trichloroethene (TCE), tetrachloroethene, and tritium. There is no evidence of groundwater contamination in the regional aquifer (Attachment B-1 of Appendix B of this report). MDA C is located on a mesa top above thick, unsaturated units of the Bandelier Tuff, and therefore present-day aqueous-phase transport is generally believed to be minimal.

4.3 Monitoring Objectives

Monitoring objectives for the MDA C monitoring group are to supplement existing vadose zone pore-gas monitoring to refine and nature and extent of contamination and assess the fate and transport of the current vadose zone contaminant distribution. The monitoring will also support upcoming CME activities.

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4.4 Scope of Activities

The MDA C Area monitoring group consists of three regional groundwater monitoring wells, R-14, R-46, and R-60, as shown in Figure 4.1-1. Table 4.4-1 presents sampling locations, the rationale for these locations, analytical suites, and frequencies for the MDA C monitoring group. Analytical suites and frequencies assigned to individual locations listed in Table 4.4-1 generally follow the high-level monitoring design presented in Table 1.6-2 for the MDA C monitoring group. These analytical suites and frequencies are based on the results of applicable IRs and a review of ongoing monitoring data, such as the statistical summaries for locations in the MDA C monitoring group provided in the FD screening tables in Attachment B-1 of Appendix B (on CD).

Exceptions to the analytical suites and sampling frequencies presented in Table 1.6-2 may occur for some locations listed in Table 4.4-1. The wells in the MDA C monitoring group are sampled semiannually. The objectives for the sampling frequency and analytical suites are presented in Table D-1.

5.0 TA-54 MONITORING GROUP

5.1 Introduction

At TA-54, groundwater monitoring is being conducted to support both the corrective measures process for SWMUs and AOCs (particularly the MDAs G, H, and L) under the Consent Order and in support of the RCRA permit. The TA-54 monitoring group was established to address the monitoring requirements for all portions and aspects of TA-54 (Figure 5.1-1). The TA-54 monitoring group includes both perched-intermediate and regional wells in the near vicinity. Other downgradient wells have general relevance to TA-54 and other upgradient sources but are not considered part of the TA-54 monitoring network and are not discussed in this section.

TA-54 is situated in the east-central portion of the Laboratory on Mesita del Buey. TA-54 includes four MDAs designated as G, H, J, and L; a waste characterization, container storage, and transfer facility (TA-54 West); active radioactive waste storage and disposal operations at Area G; hazardous and mixed-waste storage operations at Area L; and administrative and support areas. The transfer facility is located at the western end of TA-54. MDAs H and J are located approximately 500 ft and 1000 ft (150 m and 305 m) southeast of the transfer facility, respectively. MDA L is located approximately 1 mi (1.6 km) southeast of the transfer facility. MDA G subsurface units are located within Area G approximately 0.5 mi (0.8 km) southeast of MDA L.

Mesita del Buey is a 100-ft to 140-ft-high finger-shaped mesa that trends southeast. The elevation of Mesita del Buey ranges from 6750 ft to 6670 ft at Area G. The mesa is approximately 500 ft wide and is bounded by the basin of Cañada del Buey (450 ft to the north) and the basin of Pajarito Canyon (360 ft to the south) (Figure 5.1-1).

5.2 Background

The TA-54 monitoring group is located predominantly in the Pajarito Canyon watershed, and the occurrence of surface water, alluvial groundwater, and perched-intermediate and regional groundwater is discussed in detail in section 7.2 of the Pajarito Canyon IR (LANL 2009, 106939).

Sources of surface water in the Pajarito watershed currently include snowmelt, stormwater runoff, and discharges at several springs. Perennial surface water flow within the TA-54 monitoring group area occurs in within Pajarito Canyon.

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The primary alluvial groundwater body in Pajarito Canyon extends east from below the confluence with Twomile Canyon to approximately regional well R-23, a distance of 4.4 mi (7 km). Spatially restricted bodies of alluvial groundwater are also present west of the Twomile Canyon confluence and extend upcanyon to springs in the south fork of Pajarito Canyon (Upper Starmer Spring) and Pajarito Canyon above the south fork confluence (Homestead Spring). The alluvial groundwater is recharged by stream flow and some local precipitation. It accumulates in the alluvial deposits that fill the canyon bottom, often perching on shallow bedrock units. The alluvial groundwater extends farther down canyon than does stream flow because some downcanyon, lateral flow occurs within the alluvium. Alluvial groundwater acts as a source of infiltrating water into the deeper tuff units and transiently into the Cerros del Rio basalt, which is very near the surface at well R-23. The extent of this groundwater helps define deeper infiltration zones within the canyon. Overall, lateral flow within the alluvium and deeper infiltration of alluvial groundwater into underlying bedrock may provide a driving force for subsurface transport of soluble contaminants along the length of the canyon and into the deeper subsurface.

Perched-intermediate groundwater occurs in a variety of settings beneath the Pajarito watershed. Occurrences are known from deep groundwater investigations and from more localized SWMU investigations. Intermediate-perched horizons are present in the Bandelier Tuff in the upper portion of the watershed and in the Cerro Toledo interval, Puye Formation, dacitic lavas, and Cerros del Rio lavas in the middle and lower portions of Pajarito Canyon. The location and nature of most of these occurrences are consistent with, and indicative of, known or suspected canyon reaches with higher infiltration, such as nearby wells R-17 and R-23. At well R-37, relic regional groundwater may have become disconnected or stranded from the current regional groundwater as drawdown associated with water-supply production has occurred. There is no indication that the perched-intermediate zones are laterally continuous over large areas.

In the vicinity of TA-54, perched-intermediate groundwater occurs in wells R-55, R-55i and R-23/R-23i (LANL 2003, 079601; Kleinfelder 2006, 092495; LANL 2011, 111611) at depths ranging from 406 ft to 498 ft bgs. Perched-intermediate groundwater also occurs in wells R-40/40i and R-37 (LANL 2009, 106432; LANL 2009, 107116) at depths ranging from 639 ft to 909 ft. This water is thought to be localized beneath the canyon floor, and to result from localized canyon floor infiltration.

The regional aquifer in the vicinity of TA-54 includes confined and unconfined zones. The shallow portion of the regional aquifer is predominantly unconfined, and the deeper portion of the aquifer is predominantly confined. Groundwater flow in the shallow portion of the regional aquifer is generally eastward beneath the western section of Pajarito watershed and southeastward beneath the eastern section of Pajarito watershed. In the vicinity of TA-54, the upper surface of the regional aquifer is located within the Cerros del Rio basalts and the underlying sediments of the Puye Formation, and the depths to water range from 785 to 1020 ft bgs (Koch and Schmeer 2011, 201566).

Groundwater flow in the upper part of the regional aquifer beneath TA-54 appears to be substantially impacted by the Cerros del Rio lavas (LANL 2010, 111362). These lavas are more than 150 ft thick beneath the regional water table. Groundwater flow in the regional aquifer beneath TA-54 is impacted by (1) water-supply pumping, (2) the local-scale infiltration recharge along Pajarito Canyon, (3) the lateral propagation of large-scale mountain-front aquifer recharge occurring to the west of TA-54, and (4) the discharge of the regional aquifer to the southwest towards the White Rock Canyon springs and the Rio Grande.

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Contaminant Sources and Distributions

Pore-gas monitoring data show that vapor-phase transport of contaminants occurs in the upper portion of the unsaturated zone, and that vapor-phase VOCs are present beneath MDAs G and L. The primary contaminants that have transported in the vapor phase at TA-54 are 1,1,1-trichloroethane (1,1,1,-TCA); TCE; Freon-113; and tritium (LANL 2005, 090513; LANL 2006, 091888; LANL 2007, 096409).

Data from the groundwater monitoring network around TA-54 show sporadic detections of a variety of contaminants including, most notably, several VOCs. The temporal and spatial nature of the occurrences do not, however, clearly indicate the presence of a source related to potential sources at TA-54 (LANL 2009, 106939). Further evaluations of existing groundwater data near TA-54, and detailed descriptions of organic and inorganic contaminants detected in perched-intermediate and regional groundwater at TA-54 are presented in the CMEs for MDAs G, H, and L (LANL 2011, 205756; LANL 2011, 206319; LANL 2011, 206324).

5.3 Monitoring Objectives

Monitoring at TA-54 focuses on perched-intermediate and regional groundwater zones beneath TA-54 (Figure 5.1-1). The monitoring suite for perched-intermediate and regional groundwater addresses RCRA monitoring requirements and also reflects the data collected to date from wells in the TA-54 network.

Characterization of groundwater under MDAs G, H, and L is underway as data are collected from the completed network of new and existing wells. Groundwater monitoring for TA-54 is conducted with perched-intermediate well screens at R-40i, R-40 screen 1, R-23i, and R-37 screen 1, R-55i and regional wells: R-20, R-21, R-22, R-23, R-32, R-37, R-38, R-39, R-40, R-41, R-49, R-51, R-52, R-53, R-54, R-55, R-56, and R-57 (Figure 5.1-1). R-22 is not currently being sampled. The actively sampled wells have one or two screens, all of which are equipped with purgeable sampling systems.

The monitoring at TA-54 provides the basis for accurately describing the groundwater conditions beneath TA-54. The sampling plan for each of the wells within the TA-54 monitoring group is presented in Table 5.4-1. Base-flow and alluvial groundwater wells near and downgradient of TA-54 are not included in the TA-54 monitoring group because no evidence was found of a hydrologic connection between the subsurface contamination beneath TA-54 and adjacent canyons, as discussed in the Pajarito Canyon and Cañada del Buey IRs (LANL 2009, 106939; LANL 2009, 107497).

The regional monitoring-well network downgradient of the MDAs in TA-54 is a system that includes redundancy and is designed to provide reliable detection of potential contaminants reaching the regional aquifer. The wells are located both near the facility boundary and at more distal locations along the dominant regional flow direction as well as along potential local flow directions to the northeast. The locations of wells also address potential complex pathways for contaminants in the vadose zone. Because of the difficulties associated with monitoring groundwater that occurs in lavas beneath TA-54, the network is made up of two-screen wells with an upper well screen placed as close to the water table as possible to monitor the first arrival of contaminants in the aquifer and a lower screen placed in permeable aquifer sediments to monitor the primary groundwater pathways downgradient of the facility.

5.4 Scope of Activities

Active monitoring locations of the TA-54 monitoring group are focused on intermediate-perched and regional groundwater wells. These locations are shown in Figure 5.1-1.

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Sampling locations, frequencies, analytical suites, and the rationale for these locations are presented in Table 5.4-1. The FD screening tables for the TA-54 monitoring group are presented in Attachment B-1 of Appendix B (on CD).

Exceptions to the analytical suites and sampling frequencies presented in Tables 1.6-2 may occur for some locations listed in Table 5.4-1. The wells in the TA-54 monitoring group are sampled semiannually. The objectives for the sampling frequency and analytical suites are presented in Table D-1.

6.0 TA-16 260 MONITORING GROUP

6.1 Introduction

The TA-16 260 monitoring group (Figure 6.1-1) was established for the upper Water Canyon/ Cañon de Valle watershed to detect and monitor contaminants released from Consolidated Unit 16-021(c)-99, the TA-16 260 Outfall (hereafter, the 260 Outfall), and other sites at TA-16. The 260 Outfall is a former HE machining outfall that discharged HE-bearing water to Cañon de Valle for almost 50 yr and is the predominant source of contaminants detected in groundwater in the Water Canyon/ Cañon de Valle area. These discharges contaminated soils, sediments, surface waters, spring waters, and deep-perched and regional groundwater at TA-16.

The TA-16 260 monitoring group includes springs, alluvial wells, and wells completed in several deep perched-intermediate groundwater zones and in the regional aquifer. Shallow monitoring locations such as the springs and alluvial wells are included in this monitoring group because they contain HE, barium, and VOC contamination related to past activities at the 260 Outfall and other sites in the area.

TA-16 is located in the southwest corner of the Laboratory and was established to develop explosive formulations, cast and machine explosive charges, and assemble and test explosive components for the nuclear weapons program. TA-16 is bordered by Bandelier National Monument along NM 4 to the south and by the Santa Fe National Forest along NM 501 to the west. To the north and east, it is bordered by TA-08, TA-09, TA-11, TA-14, TA-15, TA-37, and TA-49. Water Canyon, a 200-ft-deep ravine with steep walls, separates NM 4 from active sites at TA-16. Cañon de Valle forms the northern border of TA-16.

6.2 Background

Surface water in the area consists of stormwater and snowmelt runoff that flows in canyon drainages, including Cañon de Valle, Fishladder Canyon, and Martin Spring (S-Site) Canyon. Fishladder Canyon also receives snowmelt and stormwater runoff. Alluvial groundwater occasionally discharges at Fishladder Spring. The surface flow in Fishladder Canyon decreased significantly once the TA-16 340 Outfall was deactivated.

The TA-16 260 monitoring group includes alluvial monitoring wells in Cañon de Valle (CdV-16-02659), in Fish Ladder Canyon (FLC-16-25280), and in Martin Spring Canyon (MSC-16-06295). Groundwater in these alluvial systems is shallow, and water levels generally show responses to snowmelt runoff.

The vadose zone at TA-16 is approximately 1000 ft to 1300 ft thick and is recharged by mountain-front precipitation and subsequent infiltration along the Pajarito fault zone east of TA-16 and along canyons (e.g., infiltration along upper Cañon de Valle). The vadose zone contains one shallow suite of perched water zones (less than 200 ft depth from the mesa top) and two significant deep- perched-intermediate groundwater zones between approximately 750 ft and 1200 ft bgs. The shallow perched zones are heterogeneous and controlled by fractures and surge beds near the Tshirege unit 3/4 contact. They

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manifest as three springs (SWSC, Burning Ground, and Martin), as intermittently saturated zones in several boreholes in the northern portions of TA-16, and in a continuously-saturated borehole near the 90s Line Pond. The deep perched-intermediate groundwater zones are believed to extend from west to east for more than 6500 ft and from north to south for approximately 3280 ft. Perched-intermediate groundwater was encountered at R-26 screen 1; R-25b, R-25 screens 1, 2, 4; CdV-16-1i; CdV-16-2ir; and R-47i. No perched groundwater was observed at R-18 and R-48, limiting its north-south extent. The low permeability Tschicoma dacite observed in R-48 (approximately 2000 ft south of Cañon de Valle) may impede the southward flow of water in the deep-perched system. The perched zones are present both within the Otowi Member of the Bandelier Tuff (R-25, R-25b, and CdV-16-1[i]) and within the Puye Formation (CdV-16-4ip and CdV-16-2[i]r). In the vicinity of CdV-16-4ip, the two perched zones are separated by a 100 ft to 150 ft of Puye sediments under variable saturation (LANL 2011, 203711). The degree of hydraulic connection between the perched horizons and the regional aquifer has not been fully analyzed to date, but will be assessed in future reports.

Water-level data indicate groundwater within the perched horizons generally flows from west to east. There is some evidence of a southerly component of flow within the Otowi Member of the Bandelier Tuff in the vicinity of R-25, possibly from recharge along Cañon de Valle. Water-level data from multiple screens in R-25 and from the two screens of CdV-16-4ip indicate water levels within the deep-perched system are lower with depth, suggesting significant vertical anisotropy, with vertical hydraulic conductivities perhaps orders of magnitude lower than horizontal hydraulic conductivities in some strata (LANL 2011, 203711).

The regional aquifer in the vicinity of northern TA-16 is predominantly unconfined, with the water table located within the Puye Formation at a depth of approximately 1108 ft to1353 ft bgs. Groundwater flow in the shallow portion of the regional aquifer is generally eastward, with some perturbation near R-25, perhaps reflecting local recharge. Downgradient (east) of R-25, the regional groundwater flow direction incorporates a northerly component of flow near R-18 and R-17. Water levels in regional wells near TA-16 show little influence from transient effects of deeper water-supply pumping (LANL 2006, 091450).

Contaminant Sources and Distributions

Discharges from the former 260 Outfall during the past 50 yr at Consolidated Unit 16-021(c)-99 served as a primary source of source of HE and inorganic contamination found throughout the site (LANL 1998, 059891; LANL 2003, 085531). Results of the 260 Outfall CME (LANL 2007, 098734) show the drainage channel below the outfall and the canyon bottom as well as surface water, alluvial groundwater, and deep-perched groundwater, are contaminated with explosive compounds, including RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine); HMX (octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine); TNT (2,4,6 trinitrotoluene); and barium. In addition, the VOCs tetrachloroethane and TCE have been detected in springs, alluvial groundwater, and perched-intermediate groundwater. Low concentrations of PCE have also been detected in the regional aquifer in R-25 (screen 5).

The primary migration pathway for these contaminants is believed to consist of (1) discharge as effluent from the 260 Outfall, (2) surface flow to Cañon de Valle via a small tributary drainage, (3) downcanyon transport by surface water flow and alluvial groundwater, (4) and infiltration through the vadose zone as recharge to the deep-perched groundwater zones and potentially into the regional aquifer.

Groundwater in the perched horizons contains the largest inventory of HE in the environment on a mass basis; estimates range from as low as approximately 700 kg of RDX to as high as approximately 8000 kg of RDX. Investigations of vadose zone and regional groundwater at TA-16 have been conducted during the past several years, and the results of these investigations are discussed in several reports

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(e.g., Longmire 2005, 088510; LANL 2006, 093798; LANL 2007, 096003; LANL 2007, 095787; LANL 2011, 203711).

6.3 Monitoring Objectives

The objective for the TA-16 260 monitoring group is to further refine nature and extent for contamination originating from the area and to monitor fate and transport for observed contaminants. These data will support the pending CME for perched-intermediate and regional groundwater (Plate 1) (LANL 2007, 098734; LANL 2008, 103165). This group's monitoring focuses on HE, barium, and VOC contamination in the upper Cañon de Valle watershed (Table 1.6-2).

Characterization sampling for a wide range of potential contaminants in groundwater from TA-16 (e.g., fission-product radionuclides, SVOCs, pesticides, PCBs, dioxins/furans) has been completed for the majority of wells in the group. These constituents have not been detected beyond sporadic, low-level detections that can be attributed to infrequent but normal analytical issues, as summarized in the FD tables in Attachment B-1 of Appendix B (on CD).

6.4 Scope of Activities

Active monitoring locations in the TA-16 260 monitoring group include alluvial groundwater wells, perched-intermediate groundwater wells, regional groundwater wells, and springs. These locations are shown in Figure 6.1-1.

Sampling locations, frequencies, analytical suites, and the rationale for these locations are presented in Table 6.4-1. The FD screening tables for Water Canyon/Cañon de Valle are presented in Attachment B-1 of Appendix B (on CD).

Additional base-flow, spring, and alluvial groundwater monitoring is conducted as general surveillance in the watershed (section 8.6). Monitoring of deep groundwater from the perched-intermediate and regional aquifers reflects a long-term data set that indicates what constituents are present and their trends and variability. Additional rounds are maintained for some constituents in the perched-intermediate groundwater as an early-detection location for potential migration of those constituents from secondary sources in the vadose zone.

Exceptions to the analytical suites and sampling frequencies presented in Table 1.6-2 may occur for some locations listed in Table 6.4-1. The sampling frequency for the wells in the TA-16 260 monitoring group is based on the presence of RDX contamination; those locations consistently showing RDX are sampled semiannually, while those locations that do not show significant contamination are sampled annually. Sampling at new well R-63 will transition from quarterly to semiannually during MY2011. The objectives for the sampling frequency and analytical suites are presented in Table D-1.

7.0 MDA AB MONITORING GROUP

7.1 Introduction

The MDA AB monitoring group is located in TA-49 and includes one monitoring well completed in perched-intermediate groundwater and three wells completed in the regional aquifer. TA-49, also known as the Frijoles Mesa Site, is located on a mesa in the upper part of the Ancho Canyon drainage and part of the area drains into Water Canyon. The MDA AB monitoring group is shown in Figure 7.1-1.

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TA-49 was used for underground hydronuclear testing in the early 1960s. The testing consisted of criticality, equation-of-state, and calibration experiments involving special nuclear materials. The testing produced large inventories of radioactive and hazardous materials: isotopes of uranium and plutonium, lead, and beryllium; explosives such as TNT, RDX, HMX; and barium nitrate. Much of this material remains in shafts on the mesa top. Further information about activities and SWMUs and AOCs at TA-49 can be found in recent Laboratory reports (LANL 2010, 109318; LANL 2010, 109319). The RCRA facility investigation work plan also describes the planned investigations that focus on identifying and quantifying migration of contaminants from the shafts.

7.2 Background

Both main Ancho Canyon and the north fork of Ancho Canyon head on the Pajarito Plateau in the south-central part of the Laboratory. Approximately 2.2 mi^2 (5.6 km^2 is drained by the north fork of Ancho Canyon and, above the confluence with the north fork, approximately 2.3 mi^2 (5.8 km^2) is drained by main Ancho Canyon. Surface-water flow is ephemeral and occurs as runoff, primarily following infrequent, intense thunderstorms or during snowmelt. Its source is direct precipitation and runoff from surrounding mesa tops. No perennial sources of surface water exist at TA-49.

In 1960, the USGS drilled three deep wells (test wells DT-5A, DT-9, and DT-10) to monitor regional aquifer water quality. No contaminants were found in these wells at concentrations near or above standards. As with other wells installed around the Laboratory using mild carbon steel during that period, samples from these three test wells have shown elevated metals concentrations related to corrosion or flaking of well components. In 2010, the total lead concentration in a sample from test well DT-9 of 20.1 µg/L was above the EPA drinking water system action level of 15 µg/L. Another sample during the year had a total lead result of less than 2 µg/L. Some results during the 1990s were above 50 µg/L.

Several deep mesa-top boreholes and wells have been drilled to intermediate depths of 300 ft to 700 ft bgs (49-CH-1 through 49-CH-4, 49-2-700) and to the regional aquifer (DT-5A, DT-9, DT-10, R-29, and R-30). No perched-intermediate groundwater zones were encountered when these wells were drilled (LANL 2006, 093714; LANL 2010, 110478; LANL 2010, 110518). A moisture profile for the 700-ft deep mesa-top borehole 49-2-700-1 (Figure B-2.0-1) shows low moisture content (<17% by weight) throughout the profile; the profile is similar to those beneath other dry mesas and indicates that infiltration along neighboring canyons does not impact moisture beneath the mesa at TA-49. In addition, 49-Gamma was drilled to 54 ft bgs in upper Ancho Canyon, and wells 49-9M-2 through 49-9M-4 were drilled in the drainage of the upper north fork of Ancho Canyon; these boreholes were dry when drilled. These observations show a lack of shallow perched groundwater in the upper portions of the Ancho watershed.

Perched-intermediate groundwater was encountered in Water Canyon, approximately 3500 ft northeast of MDA AB during the drilling of R-27 in 2005. The perched zone was detected at 628 ft bgs in the Puye Formation immediately above the Cerros del Rio basalt. Monitoring well R-27i was subsequently installed in September 2009 with a single screen to evaluate water quality and measure water levels in the perched zone.

Springs and seeps are known to occur in the lower reaches of Water and Ancho Canyons, far downgradient of TA-49 (near the Rio Grande), but none have been identified within the boundaries of TA-49 (LANL 2007, 098492).

The top of the regional aquifer occurs approximately 1126 ft to 1153 ft bgs, based on water levels in monitoring wells R-29 and R-30. The potentiometric surface of the regional aquifer beneath TA-49 lies completely within the Puye Formation and the Cerros del Rio basalt. Groundwater flow in the upper portion of the regional aquifer at TA-49 is generally eastward.

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Contaminant Sources and Distributions

The primary contaminants at MDA AB and other disposal areas in TA-49 include tritium, radionuclides (plutonium-238, plutonium-239/240, americium-241, and cesium-137), arsenic, chromium, copper, lead, and perchlorate. Radionuclides have been detected in canyon sediments, but no elevated levels of contaminants have been detected in groundwater in the wells that comprise the MDA AB monitoring group. Three decades of water-quality records from regional wells in this area (test wells DT-5A, DT-9, and DT-10) show no substantial changes in water chemistry or the presence of Laboratory contaminants in the regional aquifer. Perchlorate has been detected slightly above background in R-27i.

7.3 Monitoring Objectives

The monitoring objectives for the MDA AB monitoring group are to characterize the groundwater beneath MDA AB and ultimately to support the MDA AB CME process. New regional aquifer wells R-29 and R-30 have been drilled immediately downgradient of MDA AB at TA-49. The older test wells, DT-5A, DT-9, and DT-10, will no longer be monitored because of their potential for nonrepresentative data associated with well casing and screen materials, the long well screened intervals (617 ft, 681 ft, and 329.6 ft, respectively) and because they have been effectively replaced by R-29 and R-30.

7.4 Scope of Activities

Frequency, analytical suites, and the rationale for monitoring at each location are presented in Table 7.4-1. Groundwater monitoring for MDA AB has historically been conducted primarily at the DT-series regional aquifer wells. Recently installed wells R-29 and R-30 have been incorporated into the monitoring network for MDA AB and will be monitored annually to support the corrective action process for MDA AB.

Exceptions to the analytical suites and sampling frequencies presented in Table 1.6-2 may occur for some locations listed in Table 7.4-1. The objectives for the sampling frequency and analytical suites are presented in Table D-1.

8.0 GENERAL SURVEILLANCE MONITORING GROUP

8.1 Overview

Monitoring locations not associated with project-specific monitoring groups are included in the general surveillance monitoring group. This group includes base-flow locations, alluvial monitoring wells, and springs, except for those assigned to the TA-16 260 monitoring group. The general surveillance group also includes some wells completed in perched-intermediate zones or in the regional aquifer that are not associated with area-specific monitoring groups.

General surveillance monitoring locations are sited across the Pajarito Plateau in all the major watersheds. Some are upgradient of project specific areas or are in areas where contamination was historically present, but where concentrations have since fallen and are stable and below standards. General surveillance monitoring locations for Los Alamos/Pueblo Canyons, Sandia Canyon, Mortandad Canyon, Pajarito Canyon, Water Canyon/Cañon de Valle, and Frijoles, Ancho and Chaquehui Canyons are shown in Figure 8.1-1. General surveillance monitoring locations for White Rock Canyon are shown in Figure 8.1-2.

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Most general surveillance locations are well-characterized and have a long history of sampling data. Some locations show little or no contamination, while others show residual contamination from past operations or effluent releases. The residual contamination may be present in surface water, alluvial groundwater, and occasionally in perched-intermediate groundwater. In many cases, contaminant concentrations at these locations are fairly steady over time or decreasing as a result of reductions in sources over the years.

8.2 Monitoring Objectives

The primary monitoring objectives for the general surveillance locations are

- to continue monitoring long-term water quality trends;
- to continue verifying decreasing contaminant trends at general surveillance locations in some watersheds (Los Alamos, Sandia, and Mortandad);
- to monitor for potential impacts from ongoing operations under DOE requirements for environmental surveillance; and
- to continue surveillance for potential Laboratory impacts to the groundwater, as expressed at the springs in White Rock Canyon.

8.3 Scope of Activities

These objectives can be met at all general surveillance locations through annual monitoring at the majority of all general surveillance locations, with a few exceptions. Semiannual monitoring is proposed at two locations, monitoring well 03-B-13 (because of elevated and highly variable VOC and SVOC concentrations) and at Basalt Spring (to meet monitoring requirements under the MOU). Quarterly monitoring is proposed at R-34 to meet monitoring requirements under the MOU.

Base-flow locations will be monitored using dedicated probes to measure field parameters. Specific conductance and pH will be logged hourly. Base-flow locations monitored under general surveillance (Figure 8.1-1) will include the following:

- Water Canyon between E252 and Water at Beta (existing location)
- Pajarito below TA-14 (new location)
- Two Mile Canyon below TA-64 (new location)
- Sandia above Wetlands (new location)
- Sandia below Wetlands (existing location)

New locations will be sited based on the presence of persistent surface water. The probes will be installed by April 1, 2012. Water, Twomile, and Pajarito Canyons may be prone to flooding during the summer months because of the changed hydrology in these watersheds following the 2011 Las Conchas fire. The monitoring probes may be removed from these watersheds during the summer months (June 15 through September 30) to avoid damage or loss.

Tables 8.3-1 and 8.3-2 list the sampling locations, the rationale for these locations, the analytical suites, and frequencies for the general surveillance group. The locations in the general surveillance monitoring group are sampled annually, with the exceptions noted above. The objectives for the sampling frequency and analytical suites are presented in Table D-1.

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9.0 REFERENCES AND MAP DATA SOURCES

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Water sampling locations: ER Project Locations; Los Alamos National Laboratory, ESH&Q Waste and Environmental Services Division, 2010-2E; 1:2,500 Scale Data; 04 October 2010.

Primary drainage: Watercourse; Los Alamos National Laboratory, ENV Water Quality & Hydrology Group; 05 April 2005.

Paved road: Road Centerlines for the County of Los Alamos; County of Los Alamos, Information Services; as published 04 March 2009.

MDA: Materials Disposal Areas; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; ER2004-0221; 1:2,500 Scale Data; 23 April 2004.

LANL boundary: LANL Areas Used and Occupied; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; 19 September 2007; as published 13 August 2010.

Land ownership: LANL Areas Used and Occupied; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; 19 September 2007; as published 13 August 2010.

TA boundary: Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; September 2007; as published 13 August 2010.

07821

LANL structure: Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 29 November 2010.

Watershed: Watersheds; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; EP2006-0942; 1:2,500 Scale Data; 27 October 2006.

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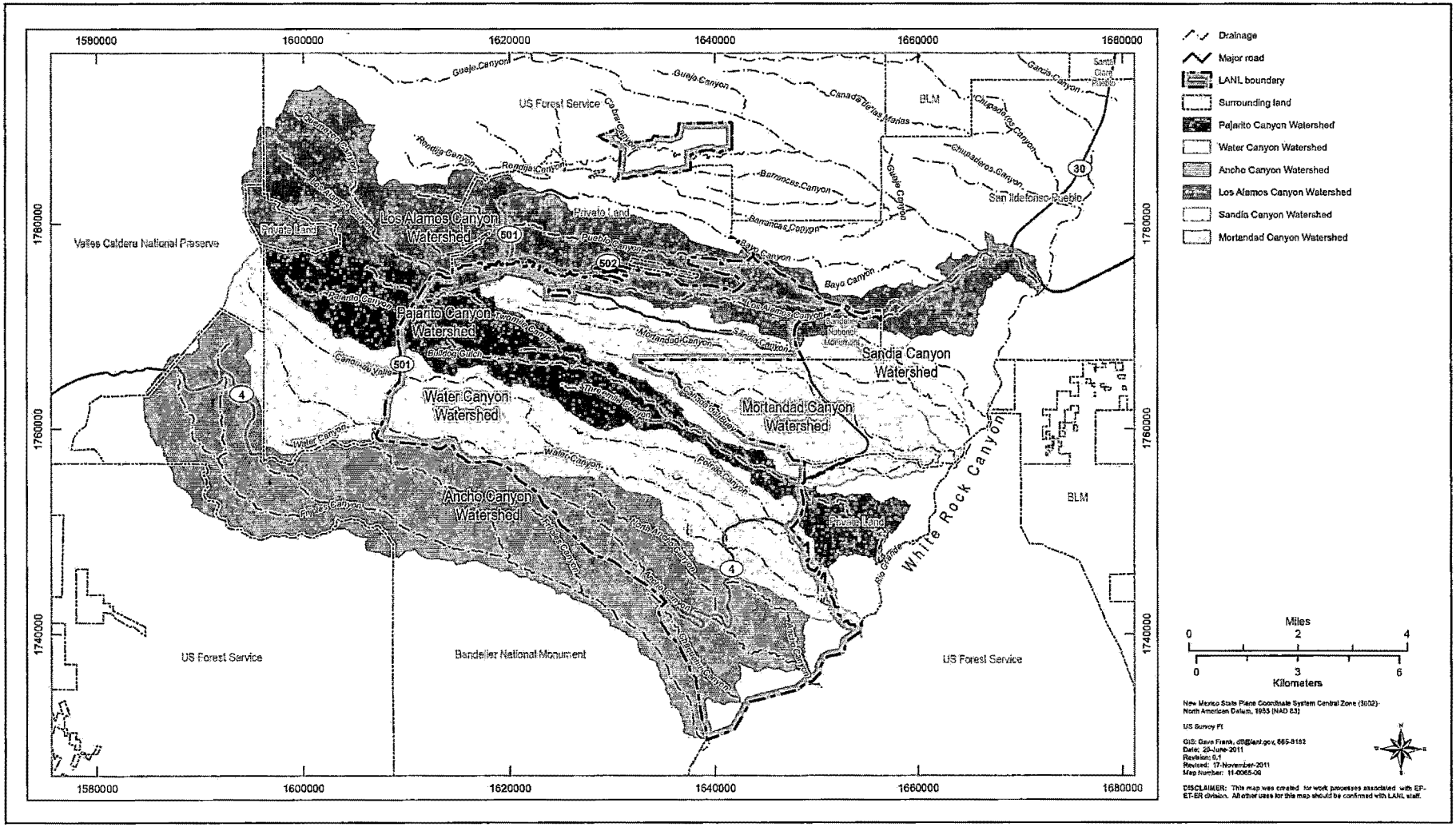


Figure 1.2-1 Watersheds at Los Alamos National Laboratory

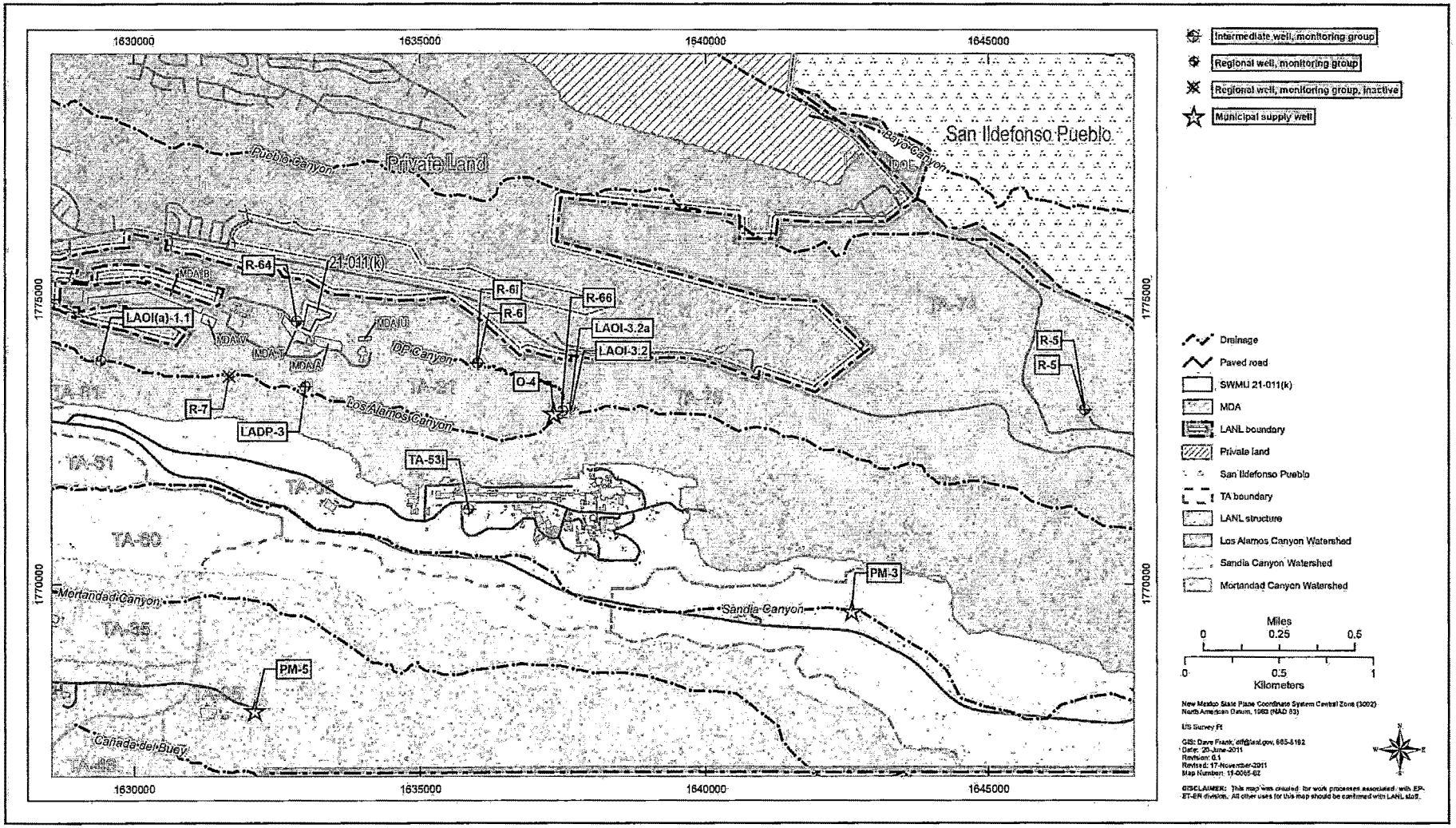


Figure 2.1-1 TA-21 monitoring group

9/8/21

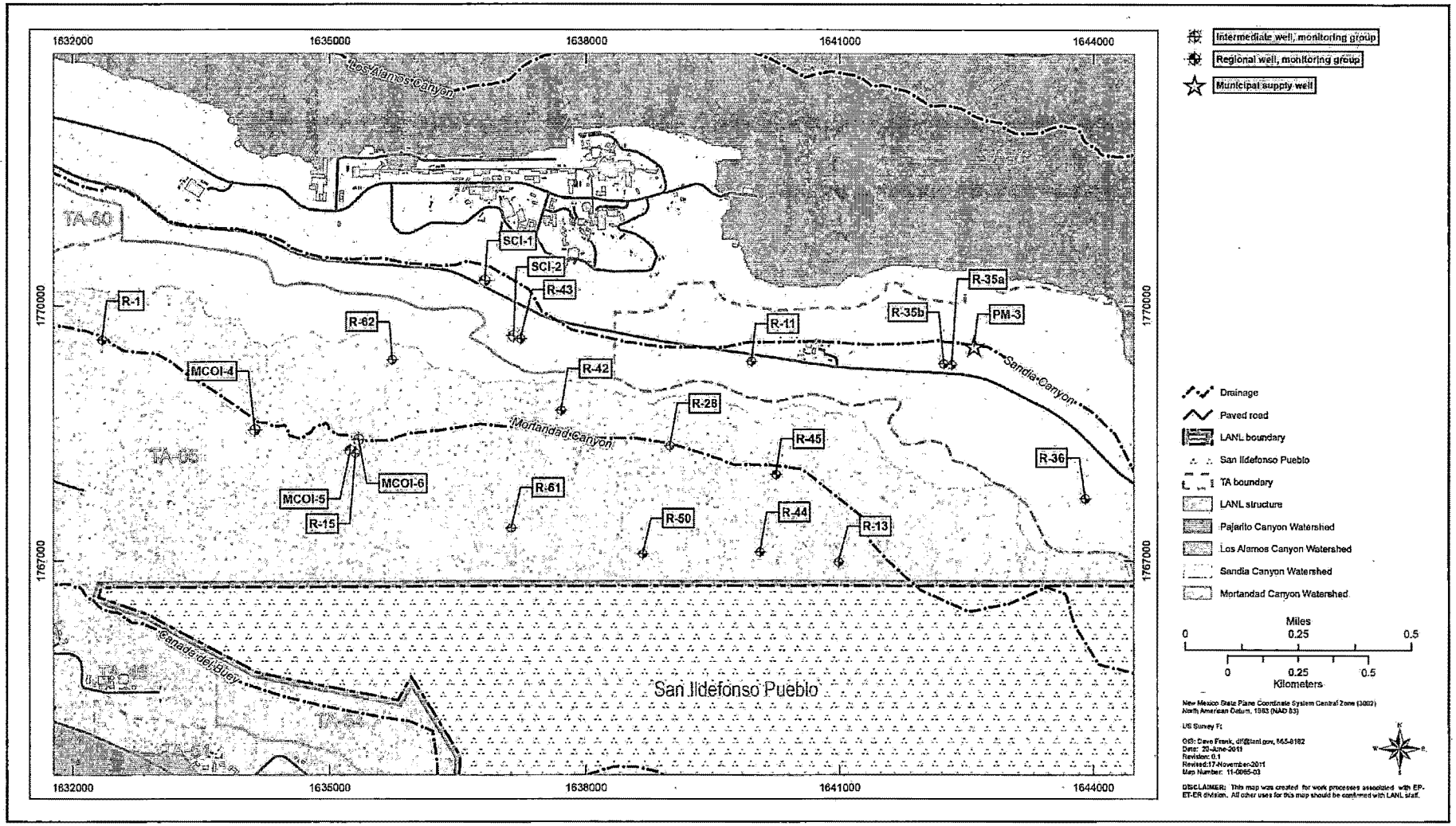


Figure 3.1-1 Chromium investigation monitoring group

LA-UR-11-05515

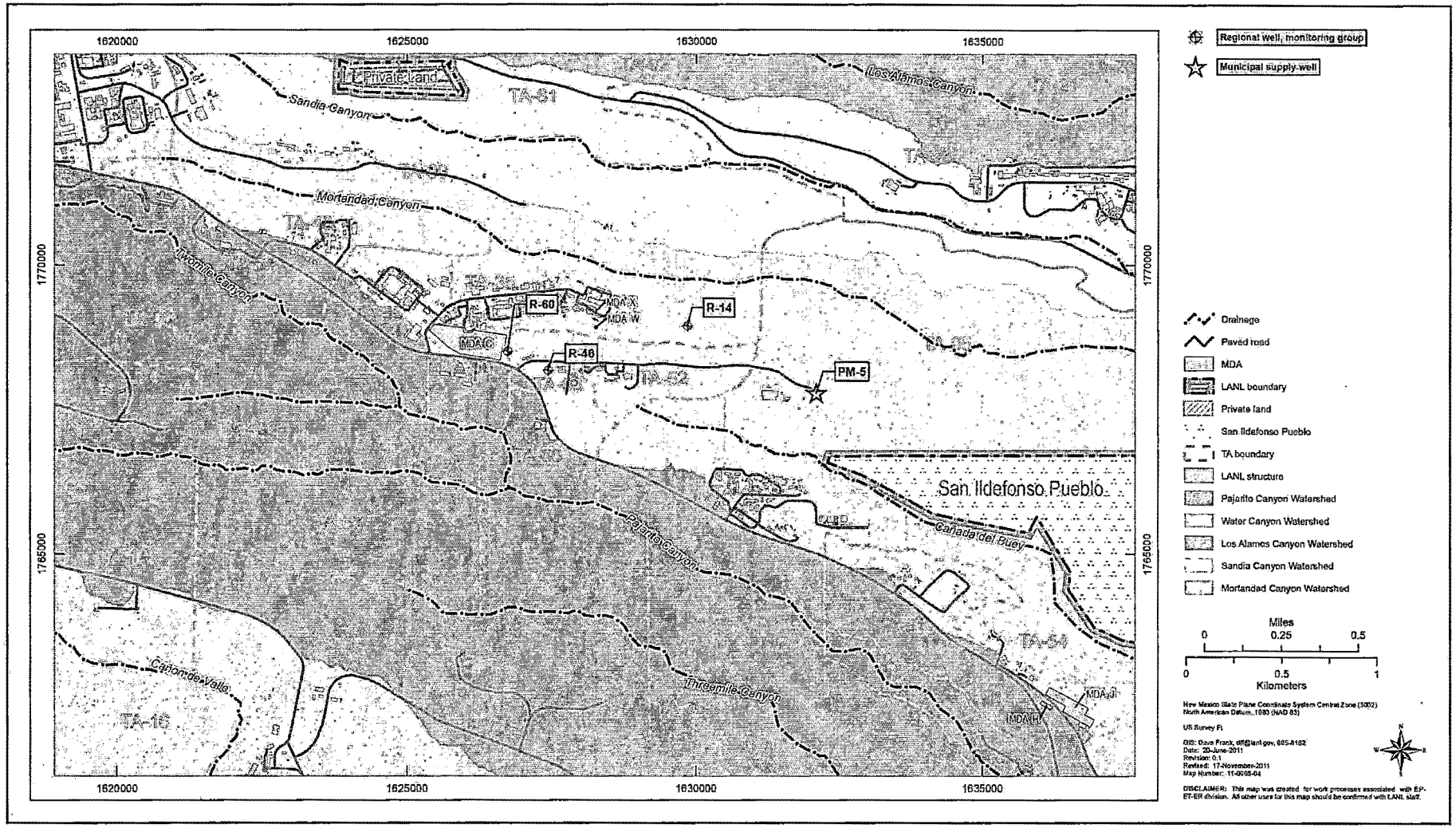


Figure 4.1-1 MDA C monitoring group

07826

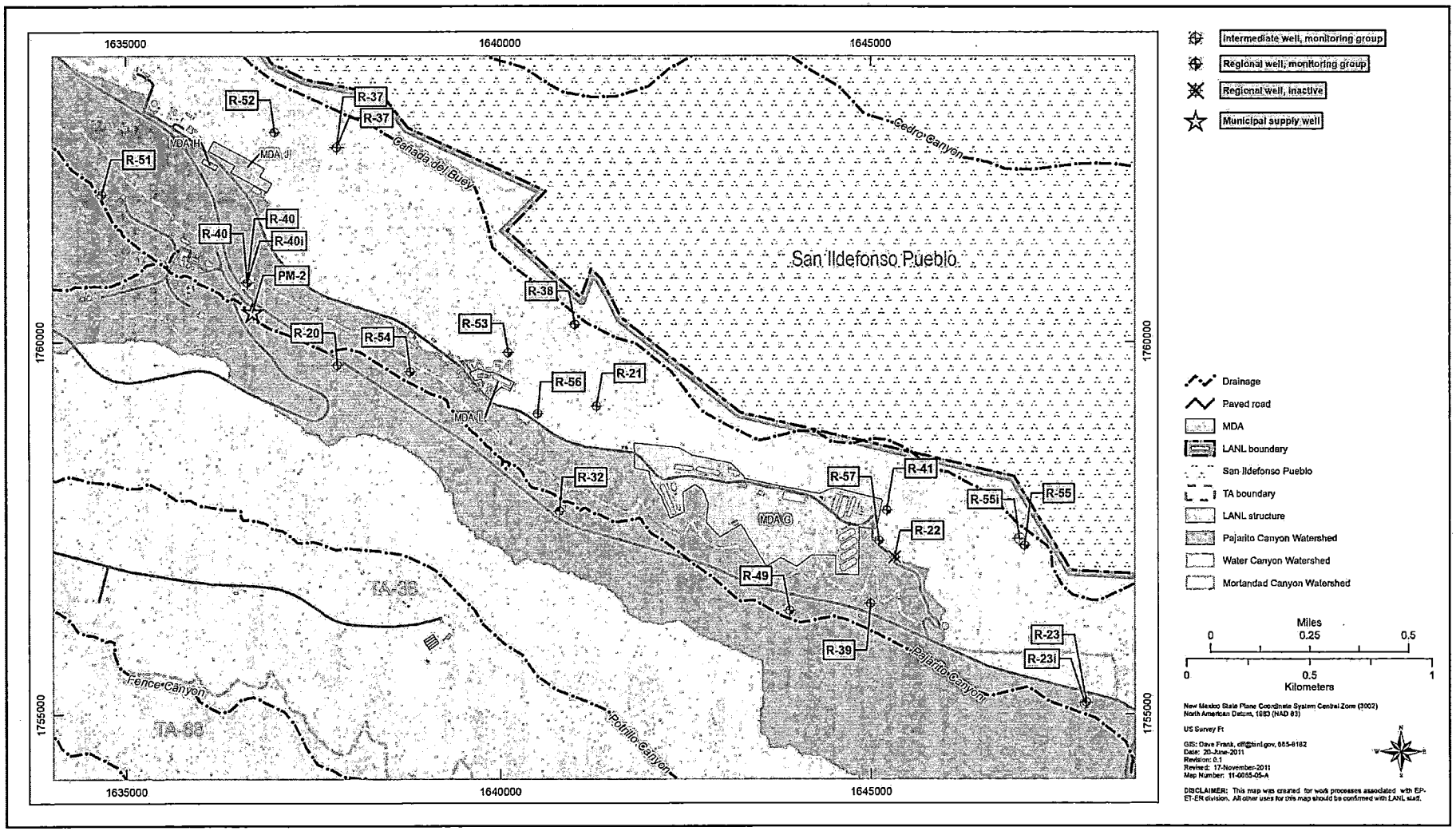


Figure 5.1-1 Monitoring well network for TA-54 MDAs H, L, and G

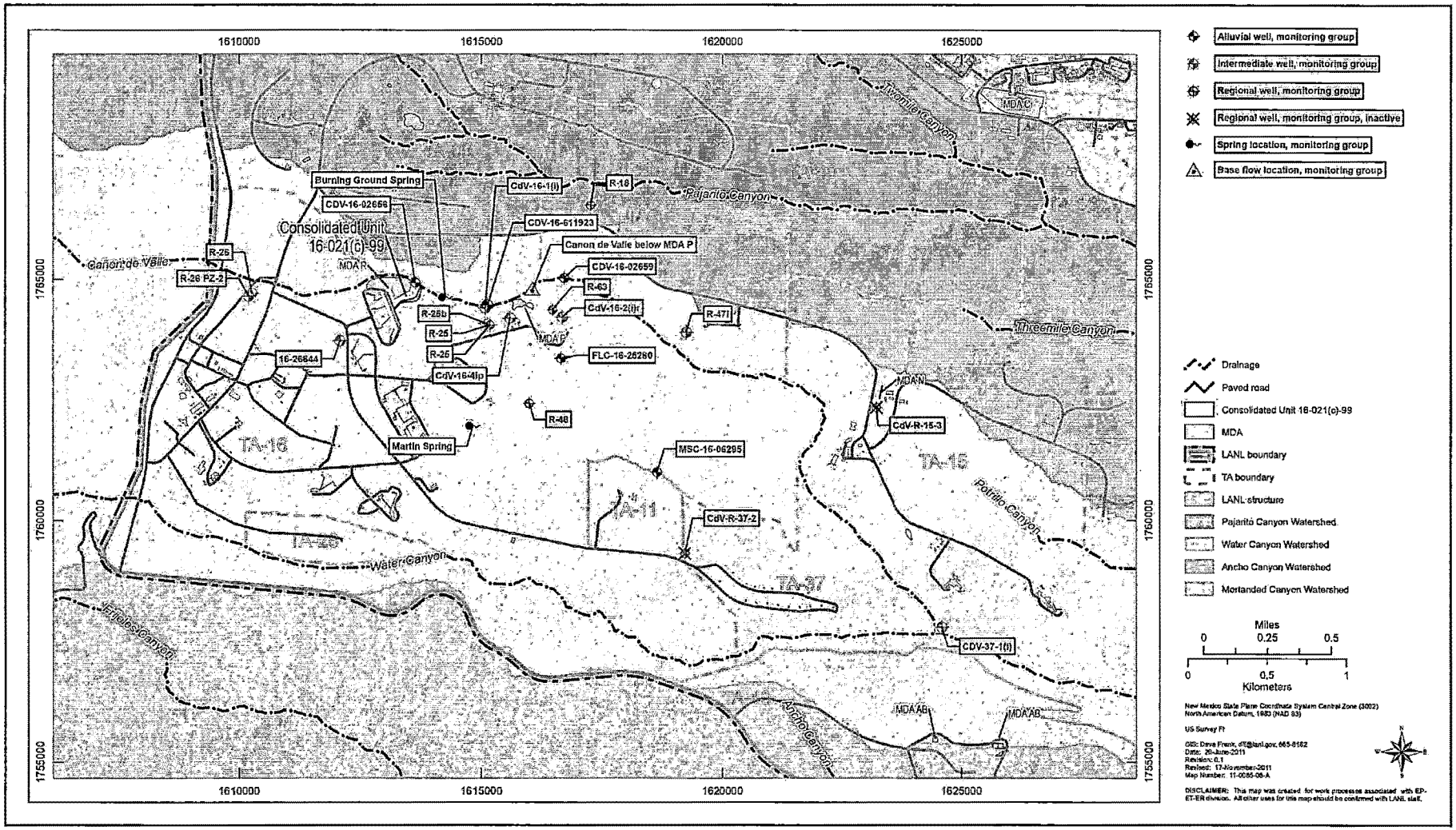


Figure 6.1-1 TA-16 260 Outfall monitoring group

09-1929

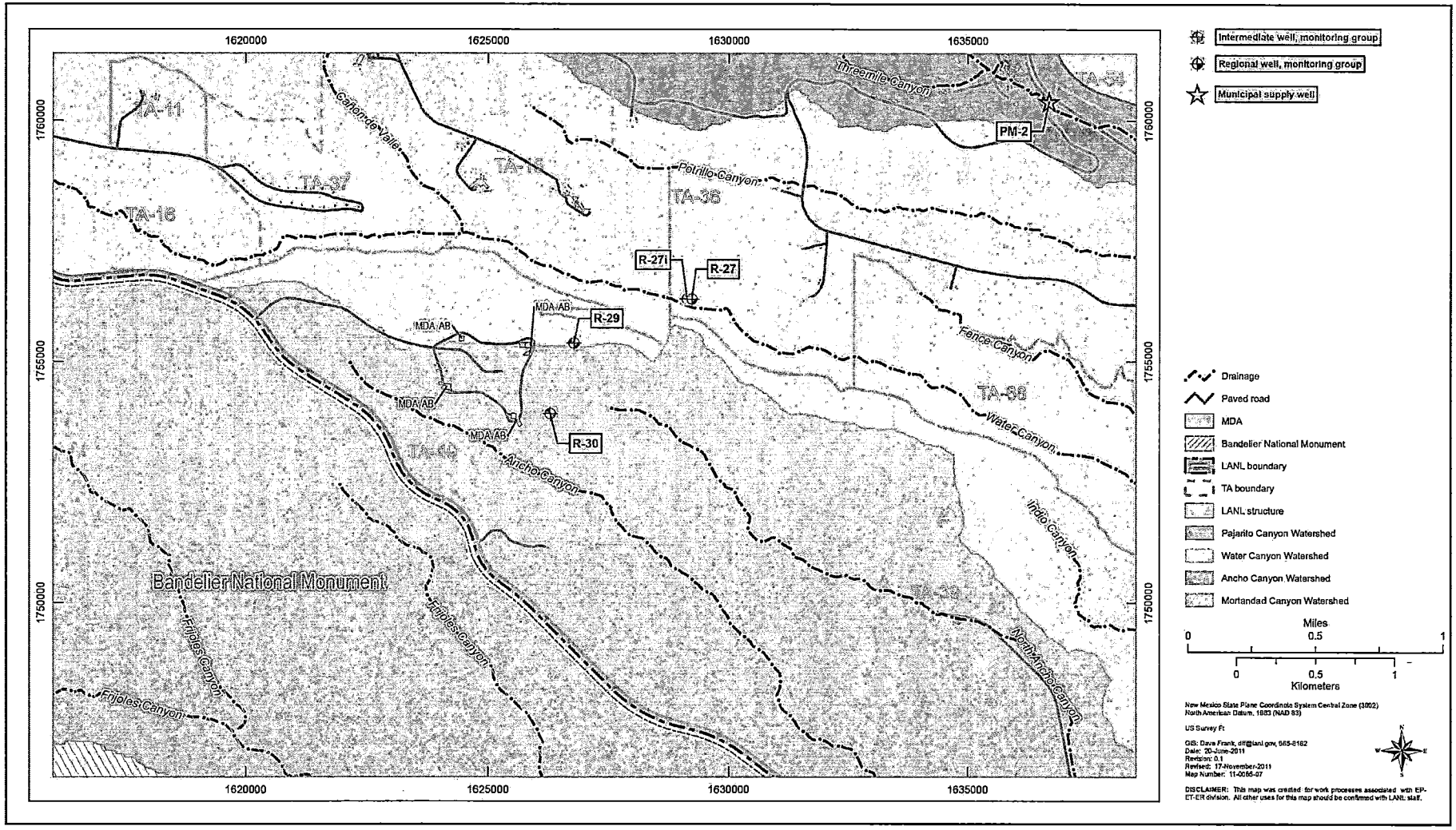


Figure 7.1-1 MDA AB monitoring group

627629

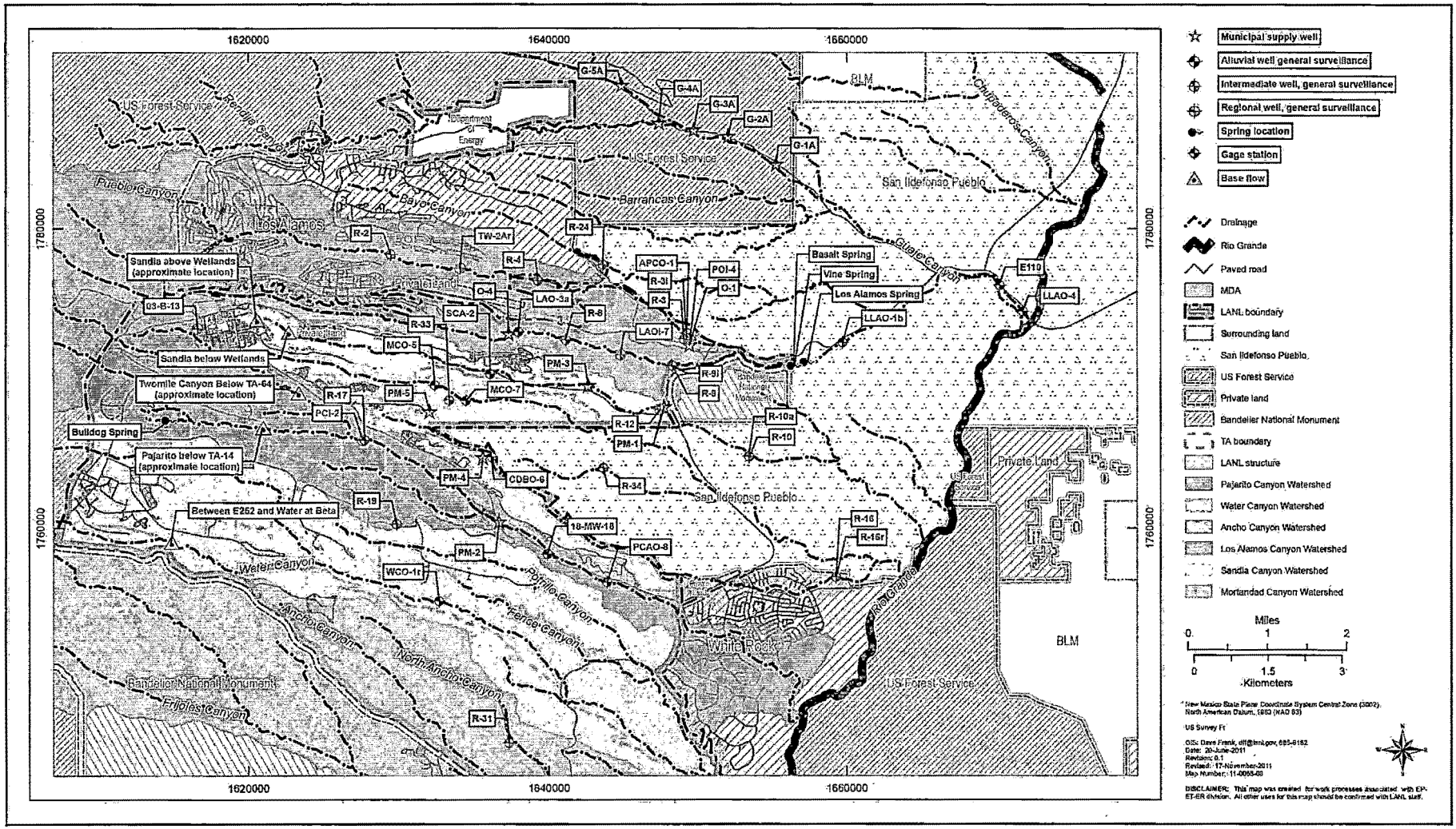


Figure 8.1-1 General surveillance

01838

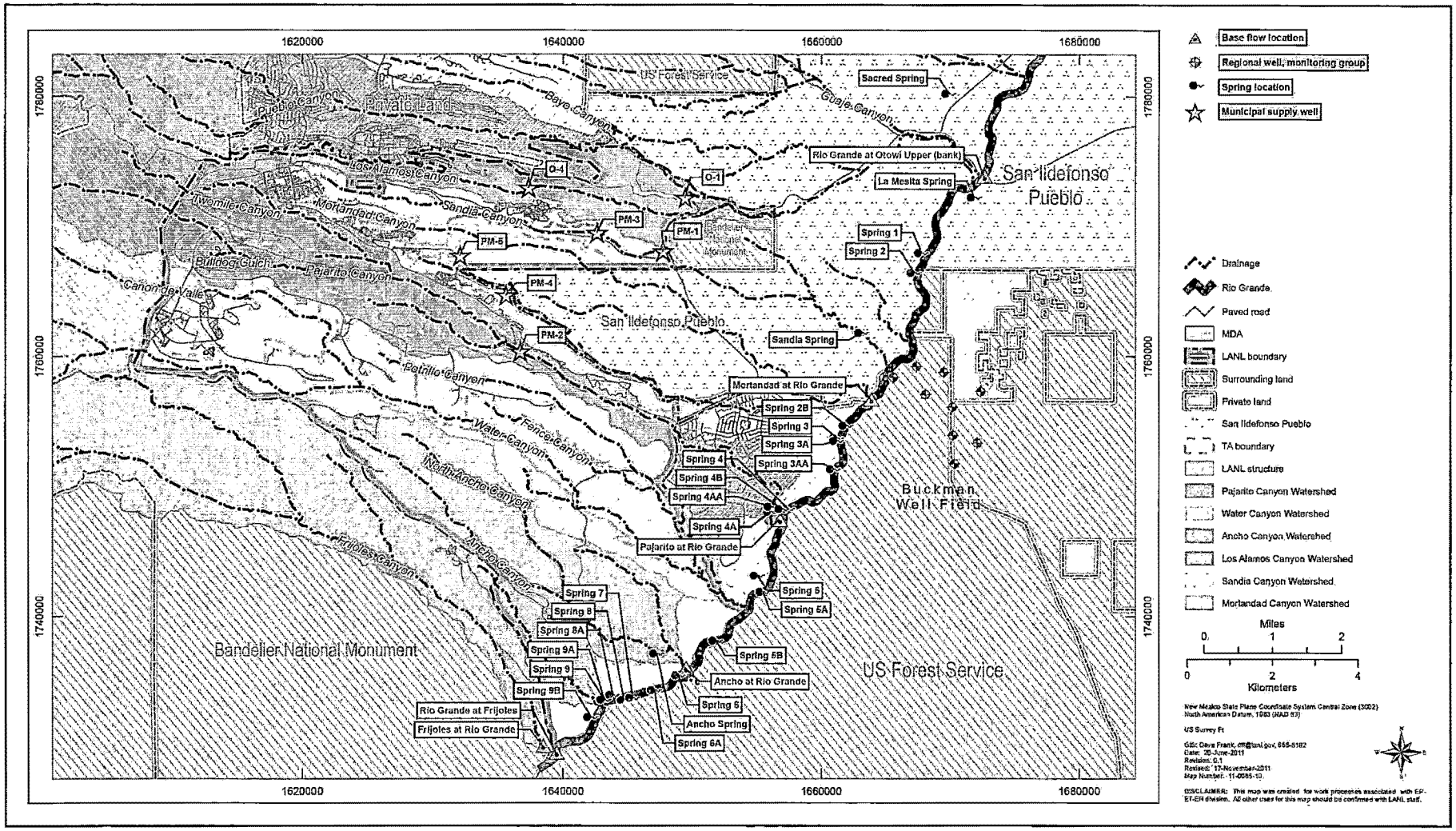


Figure 8.1-2 General surveillance, White Rock Canyon

2689892

Table 1.6-1
Potentially Applicable Standards Used to Select Base-Flow and Groundwater Screening Levels

Type	Source	Description	Abbreviation[a]	Potential Applicability[b]					
				Perennial Surface Water		Ephemeral Surface Water		Groundwater (Includes Springs)	
				F[c]	UF[d]	F	UF	F	UF
State of New Mexico Water Quality Control Commission (NMWQCC)									
Standard	NMAC 20.6.4	Livestock Watering	NM LVSTK WTR STD	X	X	X	X		
Standard	NMAC 20.6.4	Wildlife Habitat	NM WQCC WLDLF HAB		X		X		
Standard	NMAC 20.6.4	Aquatic Life Acute	NM Aqu Acute *x* mg[e]			X	X		
Standard	NMAC 20.6.4	Aquatic Life Chronic	NM Aqu Chronic *x* mg[e]	X	X				
Standard	NMAC 20.6.4	Human Health Standard	NM HH OO	X	X	X	X		
Standard	NMAC 20.6.2	Groundwater Human Health Standards, Other Standards for Domestic Water Supply and Standards for Irrigation Use	NM GW STD					X	X
Consent Order									
Screening level	Consent Order	Screening Level for Perchlorate in Groundwater	NM GW CONS					X	X
EPA									
Standard	40 CFR 141	EPA maximum contaminant levels	EPA MCL					X	X
Risk—human	EPA Regional Screening Levels[f]	EPA Regional Screening Levels for Tap Water	EPA TAP SCRN LVL					X	X
DOE									
Risk—ecological	DOE Order 458.1	DOE Biota Concentration Guides	DOE BCG WATER	X	X	X	X		
Risk—human	DOE Order 458.1	DOE 4-mrem Drinking Water Derived Concentration Guidelines	DOE DW DCG					X	X

[a] Abbreviations used in the screening tables in Attachment B-1 of Appendix B.

[b] The protocol for selecting the lowest applicable screening levels for groundwater and surface water is described in Appendix B. The description includes assumptions and rationale for hardness-dependent metals. Blank cells indicate the screening level is not applicable to the water type.

[c] F = Filtered.

[d] UF = Unfiltered.

[e] *x* indicates the hardness concentration (as mg/L) used to calculate screening levels for hardness-dependent trace metals.

[f] EPA Regional Screening Levels (EPA 2011, 204336).

07833

Table 1.6-2
Analytical Suites and Frequencies for Locations Assigned to Area-Specific Monitoring Groups

Surface-Water Body or Source Aquifer	Metals[a] (filtered)	Organics			Radionuclides			General Inorganics		Field Data[g]
	TAL Metals	VOCs[b]	SVOCs[b]	HEXP[c]	Radionuclides[d]	Tritium[e]	Low-Level Tritium[e]	General Inorganics[f]	Perchlorate	
TA-21 Monitoring Group (Upper Los Alamos and Sandia Canyons)										
Intermediate	—[h]	—	—	—	A	A	A	A	A	A
Regional	—	—	—	—	A	—	A	A	A	A
Characterization of new deep groundwater wells[i]	Q	Q	Q	S	Q	—	Q	Q	Q	Q
Chromium Investigation Monitoring Group (Sandia and Mortandad Canyons)										
Intermediate (Sandia)	S	—	—	—	A	A	—	S	S	S
Intermediate (Mortandad)	A	A	A	—	A	A	—	A	A	A
Regional	A	—	—	—	B	—	A	A	A	A
Characterization of new deep groundwater wells	Q	S	S	S	S	—	S	Q	Q	Q
MDA C Monitoring Group (Mortandad and Pajarito Canyons)										
Regional	—	S	S	—	A	—	S	A	—	S
TA-54 Monitoring Group (Mortandad Canyon/Cañada del Buey and Pajarito Canyons)										
Intermediate	A	S	A	—	A	—	S	A	—	S
Regional	A	S	A	—	A	—	S	A	—	S
TA-16 260 Monitoring Group (Water Canyon/Cañon de Valle and Pajarito Canyon)										
Base flow	S	S	—	S	B	—	—	S	—	S
Springs	S	S	—	S	B	—	—	S	—	S
Alluvial	S	S	—	S	B	—	—	A	—	S
Intermediate	S	S	—	S	B	—	—	A	—	S
Regional	A	A	—	A	B	—	—	A	—	A
Characterization of new deep groundwater wells	S	S	S	S	A	—	S	S	S	S

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Table 1.6-2 (continued)

Surface-Water Body or Source Aquifer	Metals[a] (filtered)	Organics			Radionuclides			General Inorganics		Field Data[g]
	TAL Metals	VOCs[b]	SVOCs[b]	HEXP[c]	Radionuclides[d]	Tritium[e]	Low-Level Tritium[e]	General Inorganics[f]	Perchlorate	
MDA AB Monitoring Group (Ancho and Water Canyons)										
Intermediate	A	A	A	A	A	—	A	A	—	A
Regional	A	A	A	A	A	—	A	A	—	A

Notes: Sampling suites and frequencies: Q = quarterly (4 times/yr); S = semiannual (2 times/yr); A = annual (1 time/yr); B = biennial (1 time every 2 yr). Some locations assigned to an area-specific monitoring group may be assigned analytical suites or frequencies that differ from those shown in this table for site-specific reasons documented in Appendixes D and F.

[a] Metals analysis includes the 23 TAL metals (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, Zn), plus boron, molybdenum, silicon dioxide, strontium, tin, and uranium.

[b] VOCs = Volatile organic compounds; SVOCs = semivolatile organic compounds.

[c] The analytical suite of explosive compounds (HEXP) includes the Consent Order list of the normal SW-846:8330 analytes plus pentaerythritol tetranitrate (PETN); triaminotrinitrobenzene (TATB); 3,5-dinitroaniline, tri(o-cresyl)phosphate (TOCP); 2,4-diamino-6-nitrotoluene; and 2,6-diamino-4-nitrotoluene.

[d] The radionuclide suite includes gross alpha, gross beta, strontium-90, and radionuclides analyzed by alpha and gamma spectroscopy.

[e] Tritium samples may be submitted for analysis by liquid scintillation if the average activities are anticipated to exceed 200 pCi/L. Low-level tritium is analyzed using electrolytic enrichment or direct counting.

[f] General inorganic analysis includes major anions (bromide, chloride, fluoride, sulfate); major cations (calcium, magnesium, sodium, potassium); nitrate plus nitrite (as N); total Kjeldahl nitrogen (TKN); ammonia; total phosphorus; total organic carbon (TOC); total dissolved solids (TDS); alkalinity; specific conductivity; pH; and hardness. TKN, TOC and total cyanide are analyzed only in unfiltered samples.

[g] Field parameters include pH, turbidity, specific conductance, dissolved oxygen, and temperature at all locations. Oxidation-reduction potential (ORP) will be measured if a flow-through cell is used and will not be measured in surface water, spring water, or water collected from Westbay sampling systems unless specified. Alkalinity will be measured for all samples either in the field or at the on-site Earth Systems Observations (EES-14) laboratory.

[h] --- = This analytical suite is not scheduled to be collected for this type of water at locations assigned to this monitoring group.

[i] Characterization suites and frequencies apply to new intermediate perched or regional groundwater wells assigned to this monitoring group. "New" wells are defined as those completed or converted on or after October 1, 2010.

07835

Table 1.6-3
Analytical Suites and Frequencies for Locations Assigned to General Surveillance Monitoring

Surface-Water Body or Source Aquifer	Metals[a] (filtered)	Organics			Radionuclides			General Inorganics		Suspended Sediments	Field Data[g]
	Metals (filtered)	VOCs[b]	SVOCs[b]	HEXP[c]	Radionuclides[d]	Tritium[e]	Low-Level Tritium[e]	General Inorganics[f]	Perchlorate		
Characterization of New Deep Groundwater Wells[h]											
Characterization	Q	Q	Q	S	Q	—[i]	Q	Q	Q	—	Q
Northern locations (Los Alamos/Pueblo, Sandia, and Mortandad Canyons)											
Springs	A	—	—	—	A	—	—	A	A	A	A
Alluvial	A	—	—	—	A	—	—	A	A	—	A
Intermediate	A	—	—	—	A	—	—	A	A	—	A
Regional	A	—	—	—	A	—	—	A	A	—	A
Southern locations (Pajarito, Water Canyon/Cañon de Valle, Frijoles, Ancho, and Chaquehui Canyons)											
Springs	A	—	—	A	A	—	—	A	A	A	A
Alluvial	A	—	—	A	A	—	—	A	A	—	A
Intermediate	A	—	—	A	A	—	—	A	A	—	A
Regional	A	—	—	A	A	—	—	A	A	—	A
White Rock Canyon and Rio Grande Watershed											
Base flow north of confluence with Mortandad Canyon	A	—	—	—	A	—	—	A	A	A	A
Base flow south of confluence with Mortandad Canyon	A	A	T	—	A	—	—	A	A	A	A

: 07836

Table 1.6-3 (continued)

Surface-Water Body or Source Aquifer	Metals[a] (filtered)	Organics			Radionuclides			General Inorganics		Suspended Sediments	Field Data[g]
	Metals (filtered)	VOCs[b]	SVOCs[b]	HEXP[c]	Radionuclides[d]	Tritium[e]	Low-Level Tritium[e]	General Inorganics[f]	Perchlorate		
Springs north of confluence with Mortandad Canyon	A	A	T	T	A	—	A	A	A	A	A
Springs south of confluence with Mortandad Canyon	A	A	A	A	A	—	A	A	A	A	A

Notes: Sampling suites and frequencies: Q = quarterly (4 times/yr); S = semiannual (2 times/yr); A = annual (1 time/yr); B = biennial (1 time every 2 yr). Some locations assigned to an area-specific monitoring group may be assigned analytical suites or frequencies that differ from those shown in this table for site-specific reasons documented in Appendixes D and F.

[a] Metals analysis includes the 23 TAL metals (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, Zn), plus boron, molybdenum, silicon dioxide, strontium, tin, and uranium.

[b] VOCs = Volatile organic compounds; SVOCs = semivolatile organic compounds.

[c] The analytical suite of explosive compounds (HEXP) includes the Consent Order list of the normal SW-846:8330 analytes plus pentaerythritol tetranitrate (PETN); triaminotrinitrobenzene (TATB); 3,5-dinitroaniline, tri(o-cresyl)phosphate (TOCP); 2,4-diamino-6-nitrotoluene; and 2,6-diamino-4-nitrotoluene.

[d] The radionuclide suite includes gross alpha, gross beta, strontium-90, and radionuclides analyzed by alpha and gamma spectroscopy.

[e] Tritium samples may be submitted for analysis by liquid scintillation if the average activities are anticipated to exceed 200 pCi/L. Low-level tritium is analyzed using electrolytic enrichment or direct counting.

[f] General inorganic analysis includes major anions (bromide, chloride, fluoride, sulfate); major cations (calcium, magnesium, sodium, potassium); nitrate plus nitrite (as N); total Kjeldahl nitrogen (TKN); ammonia; total phosphorus; total organic carbon (TOC); total dissolved solids (TDS); alkalinity; specific conductivity; pH; and hardness. TKN, TOC and total cyanide are analyzed only in unfiltered samples.

[g] Field parameters include pH, turbidity, specific conductance, dissolved oxygen, and temperature at all locations. Oxidation-reduction potential (ORP) will be measured if a flow-through cell is used and will not be measured in surface water, spring water, or water collected from Westbay sampling systems unless specified. Alkalinity will be measured for all samples either in the field or at the on-site Earth Systems Observations (EES-14) laboratory.

[h] Characterization suites and frequencies apply to new intermediate perched or regional groundwater wells assigned to this monitoring group. "New" wells are defined as those completed or converted on or after October 1, 2010.

[i] — = This analytical suite is not scheduled to be collected for this type of water at locations assigned to this monitoring group.

: 07837

Table 1.8-1
Sampling Schedule for MY2011: October 1, 2011–September 30, 2012

Monitoring Group or Watershed	Location Type	First Quarter Oct–Dec 2011	Second Quarter Jan–Mar 2012	Third Quarter Apr–Jun 2012	Fourth Quarter Jul–Sep 2012
Monitoring Groups					
TA-54	Routine	T, A, S, Q	—	S	—
Chromium Investigation	Routine	T, A, S, Q	Q	S, Q	Q
MDA C	Routine	A, S	—	S	—
TA-21	Routine	Q[a]	S, Q[b]	Q[b]	A, S, Q[b]
MDA AB	Routine	—	A	—	—
TA-16 260	Routine	Q[c]	A, B, S, Q[c]	—	S
General Surveillance					
Los Alamos and Pueblo Canyons	Routine	S[d]	—	A, S[d]	—
Mortandad and Sandia Canyons	Routine	Q	Q, S[e]	Q	Q, T, A, S[e]
Pajarito Canyon	Routine	S[f]	—	A, S[f]	—
Frijoles, Ancho, and Chaquehui Canyons	Routine	—	A	—	
Water Canyon	Routine	—	—	—	A
White Rock Canyon	Routine	A	—	—	—
Characterization					
All Watersheds	Characterization	Q	Q	Q	Q

Notes: Sampling frequencies: Q = quarterly (4 times/yr); S = semiannual (2 times/yr); A = annual (1 time/yr); B = biennial (1 time every 2 yr); T= triennial (1 time every 3 yr); — = no samples are scheduled to be collected from this monitoring group during this period.

[a] R-64.

[b] R-64 and R-66.

[c] R-26 screen 1 and R-63.

[d] Basalt or Vine Tree Spring.

[e] R-34.

[f] 03-B-13.

: 07838

Table 1.9-1
Frequencies for Locations Assigned to Water-Level Monitoring Only

Assigned Monitoring Group	Location	Rationale for Selection of Location	Source Aquifer	Water Level*
Los Alamos/Pueblo Canyons Watershed				
TA-21 Monitoring Group	R-5 screen 1	Well located downgradient of upper Pueblo and Acid Canyons. Screen has been dry since well installation (2001) although water was observed in the sump below the screen (Koch and Schmeer 2011, 201566). Automated monitoring of water levels maintained to determine if the zone wets up.	Intermediate	C^{HD}
	R-7 screen 1	Well located in middle Los Alamos Canyon. Screen 1 went dry during sampling in December 2003 (Koch and Schmeer 2011, 201566). The zone produced water during drilling, and the screen produced small amounts of water for a short period following installation. Water was detected in the sump below the screen since 2005. Automated monitoring of water levels maintained to determine if either zone recovers.	Intermediate	C^{HD}
	R-7 screen 2	Well located in middle Los Alamos Canyon. Screen 2 has been dry since well installation in 2001 although water has been observed in the sump since mid-2008 (Koch and Schmeer 2011, 201566). Automated monitoring of water levels maintained to determine if either zone recovers.	Intermediate	C^{HD}
	R-7 screen 3	Well located in middle Los Alamos Canyon. The collection of water-quality samples from this screen is suspended because it remains impacted by drilling products. Automated monitoring of water levels should be maintained to monitor the top of the regional aquifer	Regional	C
General Surveillance	LAO-4.5c	Monitors location down canyon below Los Alamos/DP Canyon confluence.	Alluvial	C
	LAUZ-1	Well is located downgradient of Reach DP 2. Continue monitoring water levels and specific conductance using Aqua Troll transducer to collect data on salinity impacts from snowmelt runoff.	Alluvial	C
	PAO-2	Well is located approximately mid-way between SCA-3 and the easternmost drainage from the TA-53 complex. Continue monitoring water levels and specific conductance using Aqua Troll transducer to collect data on salinity impacts from snowmelt runoff.	Alluvial	C
Sandia Canyon Watershed				
General Surveillance	SCA-1	Well located in wetland in upper Sandia Canyon. Sampling events were moved to nearby drive point well SCA-1-DP because of silting in of the screen in SCA-1. Continuous water levels are monitored in SCA-1, and manual measurements are taken at SCA-1-DP during sampling events (Koch and Schmeer 2011, 201566).	Alluvial	C
	SCA-4	Well located in lower Sandia Canyon approximately mid-way between SCA-3 and the easternmost drainage from the TA-53 complex. Water-level monitoring will provide data regarding impacts from Sandia wetlands mitigation activities.	Alluvial	C

: 07839

Table 1.9-1 (continued)

Assigned Monitoring Group	Location	Rationale for Selection of Location	Source Aquifer	Water Level*
Mortandad Canyon Watershed				
General Surveillance	MCO-2	Well monitors Effluent Canyon above the TA-50 outfall. Continue monitoring water levels and specific conductance using Aqua Troll transducer to collect data on salinity impacts from snowmelt runoff.	Alluvial	C
	MCO-3	Well monitors upper part of Mortandad Canyon. Water-level data from MCO-3 will be used to document hydrologic characteristics of the alluvial groundwater following reduction of discharges from the TA-50 RLWTF outfall since 2010. Aqua Troll transducer will be used to assess salinity impacts from snowmelt runoff.	Alluvial	C
TA-54 Monitoring Group	R-41 screen 1	Well located east of MDA G at TA-54. Screen 1 has been dry since well installation (March 2009) (Koch and Schmeer 2011, 201566). Water level should be checked annually during sampling of R-41.	Intermediate	A^{HD}
Pajarito Canyon Watershed				
General Surveillance	PCAO-7b2	Well characterizes potential impacts from TA-18. Continue monitoring water levels and specific conductance using Aqua Troll transducer to collect data on salinity impacts from snowmelt runoff.	Alluvial	C
	R-19 screen 1	Well located on a mesa south of Threemile Canyon and downgradient of TA-16. Screen 1 has been dry since installation of the Westbay sampling system in September 2000 (Koch and Schmeer 2011, 201566). Water-level data will continue to be monitored in this screen.	Intermediate	C^{HD}
	R-19 screen 5 R-19 screen 6 R-19 screen 7	Well located on a mesa south of Threemile Canyon and downgradient of TA-16. The collection of water-quality samples from these screens is suspended because they remain impacted by drilling products. Water-level data will continue to be collected from these screens until well R-19 is reconfigured or replaced.	Regional	C
Water Canyon/Cañon de Valle Watershed				
TA-16 260 Monitoring Group	R-25 screen 3	Located at TA-16 within the Cañon de Valle watershed. Screen 3 has always been dry but the screen was damaged during installation and is not reliable for water-level monitoring (Koch and Schmeer 2011, 201566). Pump water at screen 3 responded to drilling and installation of adjacent well R-25c (replacement for R-25 screen 3) in August 2008.	Intermediate	C
Ancho Canyon Watershed				
General Surveillance	R-31 screen 1	Located in the north Ancho Canyon tributary. Zone initially showed water during drilling but has been dry since installation of the Westbay system in April 2000 (Koch and Schmeer 2011, 201566). Water-level data will continue to be monitored in this screen.	Intermediate	C^{HD}

: 07840

Table 1.9-1 (continued)

Assigned Monitoring Group	Location	Rationale for Selection of Location	Source Aquifer	Water Level*
	R-31 screen 2 R-31 screen 3	The collection of water-quality samples from these screens is suspended because they remain impacted by drilling products. Water-level data will continue to be monitored in these screens.	Regional	C
Water-Level Data from Water-Supply Wells (Koch and Schmeer 2011, 201566)				
Cooperative Agreement	G-1A, G-2A, G-3A, G-5A	Water-supply wells located in Guaje Canyon	Regional	C
	G-4A	Water-supply well located in lower Rendija Canyon near its confluence with Guaje Canyon	Regional	C
	O-1	Water-supply well located in lower Pueblo Canyon	Regional	C
	O-4	Water-supply well located in Los Alamos Canyon above confluence with DP Canyon	Regional	C
	PM-1 and PM-3	Water-supply wells located in Sandia Canyon	Regional	C
	PM-2	Water-supply well located in Pajarito Canyon	Regional	C
	PM-4	Water-supply well located on Mesita del Buey south of Mortandad Canyon	Regional	C
	PM-5	Water-supply well located on a mesa south of Ten Site and Mortandad Canyons	Regional	C

*Sampling frequency: C = continuous; Q = quarterly (4 times/yr at set time periods); S = semiannual (2 times/yr); A = annual (1 time/yr). The superscript HD indicates this sampling location is historically dry. Continuous monitoring for groundwater refers to the measurement of groundwater-level measurements by a transducer placed in a well and programmed to collect groundwater-level measurements at highly frequent intervals (e.g., every 60 min daily throughout the year).

: 07841

Table 2.4-1
Interim Monitoring Plan for TA-21 Monitoring Group

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides			Inorganics		Field[i]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	DO, ORP, pH, SC, T, Turb
LADP-3	LADP-3	Los Alamos	Monitors downgradient location for potential contaminants from upper Los Alamos Canyon, DP Canyon, and TA-21.	Intermediate	C	—	—	—	—	A	—	A	A	A	A
LAOI(a)-1.1	LAOI(a)-1.1	Los Alamos	Monitors for potential contaminants from upper Los Alamos Canyon, DP Canyon, and TA-21. Background location in Groundwater Background Investigation Report, Revision 3 (GBIR R3) (LANL 2007, 095817) and Groundwater Background Investigation Report, Revision 4 (GBIR R4) (LANL 2010, 110535).	Intermediate	C	—	—	—	—	A	—	A	A	A	A
LAOI-3.2	LAOI-3.2	Los Alamos	Monitors for potential contaminants from upper Los Alamos Canyon, DP Canyon, and TA-21.	Intermediate	C	—	—	—	—	A	A	—	A	A	A
LAOI-3.2a	LAOI-3.2a	Los Alamos	Monitors for potential contaminants from upper Los Alamos Canyon, DP Canyon, and TA-21.	Intermediate	C	—	—	—	—	A	A	—	A	A	A

07812

Table 2.4-1 (continued)

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides			Inorganics		Field[i]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	DO, ORP, pH, SC, T, Turb
R-5 screen 2	R-5 S2	Los Alamos	Monitors for potential contaminants from upper Pueblo and Acid Canyons.	Intermediate	C	—	—	—	—	A	—	A	A	A	A
R-6i	R-6i	Los Alamos	Monitors for potential contaminants from upper Los Alamos Canyon, DP Canyon, and TA-21.	Intermediate	C	—	A	A	—	A	A	—	A	A	A
TA-53i	TA-53i	Los Alamos	Monitors for potential southward migration of contaminants from sources in Los Alamos Canyon. Located within TA-53 on the mesa separating Los Alamos and Sandia Canyons.	Intermediate	C	—	—	—	—	A	A	—	A	A	A
R-5 screen 3	R-5 S3	Los Alamos	Monitors for potential contaminants from upper Pueblo and Acid Canyons.	Regional	C	—	—	—	—	A	—	A	A	A	A
R-5 screen 4	R-5 S4	Los Alamos	Monitors for potential contaminants from upper Pueblo and Acid Canyons.	Regional	C	—	—	—	—	A	—	A	A	A	A

EP2012-0213

Table 2.4-1 (continued)

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides			Inorganics		Field[i]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	DO, ORP, pH, SC, T, Turb
R-6	R-6	Los Alamos	Monitors for potential contaminants from upper Los Alamos Canyon, DP Canyon, and TA-21. Background location in GBIR R4.	Regional	C	—	—	—	—	A	A	—	A	A	A
R-64	R-64	Los Alamos	New single-screen regional well. Monitors downgradient location for potential contaminants from upper Los Alamos and DP Canyons and at TA-21. Completed July 15, 2011.[k]	Regional	C	Q	Q	Q	S	Q	—	Q	Q	Q	Q
R-66	R-66	Los Alamos	New regional well to replace TW-3, located near Otowi-4. Monitors for potential contaminants from upper Los Alamos and DP Canyons and TA-21. Completed 11/16/11.	Regional	C	Q	Q	Q	S	Q	—	Q	Q	Q	Q

Table 2.4-1 (continued)

Notes: Sampling suites and frequencies: C = continuous; Q = quarterly (4 times/yr); S = semiannual (2 times/yr); A = annual (1 time/yr); T= triennial (1 time every 3 yr). Nonfiltered and filtered samples will be collected for general inorganics (excluding anions). Metals, anions, and perchlorate samples will be filtered. Samples collected for radionuclide analysis will be nonfiltered only for all water media. Organic and HEXP constituents are nonfiltered for all water media.

[a] Continuous monitoring for groundwater refers to the measurement of groundwater levels by a transducer placed in a well and programmed to collect groundwater-level measurements at highly frequent intervals (e.g., every 60 min daily throughout the year). Continuous stream-flow monitoring refers to the measurement of stream flow by a base-flow stream gage that is programmed to collect stream-flow measurements at highly frequent intervals.

[b] Metals analysis includes the 23 TAL metals (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, Zn), plus boron, molybdenum, silicon dioxide, strontium, tin, and uranium.

[c] VOC = Volatile organic compounds; SVOC = semivolatile organic compounds.

[d] HEXP = High explosive (compounds). The HEXP analytical suite includes the Consent Order list of the normal SW-846:8330 analytes plus pentaerythritol tetranitrate (PETN); triaminotrinitrobenzene (TATB); 3,5-dinitroaniline, tri(o-cresyl)phosphate (TOCP); 2,4-diamino-6-nitrotoluene; and 2,6-diamino-4-nitrotoluene. These additional analytes are analyzed by SW-846:8321A.

[e] The radionuclide suite includes gross alpha, gross beta, alpha spectroscopy, gamma spectroscopy, and strontium-90.

[f] Tritium samples may be submitted for analysis by liquid scintillation if average activities are anticipated to exceed 200 pCi/L. Low-level tritium is analyzed using electrolytic enrichment or direct counting.

[g] General inorganic analysis includes major anions (bromide, chloride, fluoride, sulfate); major cations (calcium, magnesium, sodium, potassium); nitrate plus nitrite (as N); total Kjeldahl nitrogen (TKN); ammonia; total phosphorus, total organic carbon (TOC); total dissolved solids (TDS); alkalinity; specific conductivity; pH; and hardness.

[h] Analysis for perchlorate using high-performance liquid chromatography coupled with electrospray ionization mass spectrometry or tandem mass spectrometry (EPA Method 6850).

[i] Field parameters include pH, turbidity, specific conductance, dissolved oxygen, and temperature at all locations. Oxidation-reduction potential (ORP) will be measured if a flow-through cell is used and will not be measured in surface water, spring water, or water collected from Westbay sampling systems unless specified otherwise..

[j] — = This analytical suite is not scheduled to be collected for this type of water at locations assigned to this monitoring group.

[k] Characterization suites and frequencies apply to new perched-intermediate or regional groundwater wells. "New" wells are defined as those completed, rehabilitated, or converted on or after October 1, 2010.

DOE/LM-6274

Table 3.4-1
Interim Monitoring Plan for Chromium Investigation Monitoring Group

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides			Inorganics		Field[i]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	DO, ORP, pH, SC, T, Turb
SCI-1	SCI-1	Sandia	Monitors the first perched-intermediate groundwater encountered along the key infiltration pathway in Sandia Canyon.	Intermediate	C	S	—	—	—	A	A	—	S	S	S
SCI-2	SCI-2	Sandia	Monitors key infiltration pathway in Sandia Canyon.	Intermediate	C	Q	—	—	—	A	A	—	Q	Q	Q
R-11	R-11	Sandia	Monitors for potential contaminants from Sandia Canyon and possibly Los Alamos Canyon.	Regional	C	Q	—	—	—	B	—	A	Q	Q	Q
R-35a	R-35a	Sandia	Sentinel monitoring location for chromium contamination in regional groundwater. Located within the same stratigraphic zone as the upper louvered section of water-supply well PM-3.	Regional	C	A	—	—	—	B	—	A	A	A	A
R-35b	R-35b	Sandia	Sentinel monitoring location for chromium contamination in the regional groundwater. Located near the water table above the louvered section of water-supply well PM-3.	Regional	C	A	—	—	—	B	—	A	A	A	A

EP2011-0215

Table 3.4-1 (continued)

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides			Inorganics		Field[i]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	DO, ORP, pH, SC, T, Turb
R-36	R-36	Sandia	Monitors for potential contaminants from the Sandia Canyon source and other potential sources from canyons to the north. Also serves as a sentinel well for water-supply well PM-1.	Regional	C	A	—	—	—	B	—	A	A	A	A
R-43 screen 1	R-43 S1	Sandia	Monitors downgradient extent of contamination originating in Sandia Canyon and possibly canyons to the north.	Regional	C	Q	—	—	—	B	—	A	Q	Q	Q
R-43 screen 2	R-43 S2	Sandia	Monitors downgradient extent of contamination originating in Sandia Canyon and possibly canyons to the north.	Regional	C	Q	—	—	—	B	—	A	Q	Q	Q
MCOI-4	MCOI-4	Mortandad	Monitors for potential contaminants from upper Mortandad and Ten Site Canyons or possibly Sandia Canyon.	Intermediate	C	S	A	A	—	A	A	—	S	S	S
MCOI-5	MCOI-5	Mortandad	Monitors for potential contaminants from upper Mortandad and Ten Site Canyons or possibly Sandia Canyon.	Intermediate	C	A	A	A	—	A	A	—	A	A	A
MCOI-6	MCOI-6	Mortandad	Monitors for potential contaminants from upper Mortandad and Ten Site Canyons or possibly Sandia Canyon.	Intermediate	C	Q	A	A	—	A	A	—	Q	Q	Q
R-1	R-1	Mortandad	Monitors for potential contaminants from upper Mortandad Canyon or possibly Sandia Canyon. Background location in GBIR R3.	Regional	C	A	—	—	—	B	—	A	A	A	A

EP2011-0717

Table 3.4-1 (continued)

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides			Inorganics		Field[i]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	DO, ORP, pH, SC, T, Turb
R-13	R-13	Mortandad	Monitors for nature and extent of contaminants originating in Mortandad and Sandia Canyons. Key lower boundary well. Background location in GBIR R3.	Regional	C	A	—	—	—	B	—	A	A	A	A
R-15	R-15	Mortandad	Monitors for potential contaminants from upper Ten Site or Mortandad Canyons.	Regional	C	S	—	—	—	B	—	A	S	S	S
R-28	R-28	Mortandad	Monitors for potential contaminants from upper Sandia, Mortandad, or Ten Site Canyons or possibly sources in canyons to the north.	Regional	C	Q	—	—	—	B	A	—	Q	Q	Q
R-42	R-42	Mortandad	Key characterization and monitoring point located upgradient of R-28.	Regional	C	Q	—	—	—	B	A	—	Q	Q	Q
R-44 screen 1	R-44 S1	Mortandad	Monitors near the water table for nature and extent of contaminants from sources in Sandia Canyon and possibly sources in canyons to the north.	Regional	C	S	—	—	—	B	—	A	S	A	S
R-44 screen 2	R-44 S2	Mortandad	Monitors for nature and extent of contaminants from sources in Sandia Canyon and possibly sources in canyons to the north.	Regional	C	S	—	—	—	B	—	A	S	A	S

EP2012-0145

Table 3.4-1 (continued)

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides			Inorganics		Field[i]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	DO, ORP, pH, SC, T, Turb
R-45 screen 1	R-45 S1	Mortandad	Monitors near the water table for nature and extent of contaminants from sources in Sandia Canyon and possibly sources in canyons to the north.	Regional	C	S	—	—	—	B	—	A	S	A	S
R-45 screen 2	R-45 S2	Mortandad	Monitors for nature and extent of contaminants from sources in Sandia Canyon and possibly sources in canyons to the north.	Regional	C	S	—	—	—	B	—	A	S	A	S
R-50 screen 1	R-50 S1	Mortandad	Monitoring well located on the mesa south of Mortandad Canyon to define the southern extent of chromium contamination in the regional aquifer.	Regional	C	Q	—	—	—	B	—	S	Q	Q	Q
R-50 screen 2	R-50 S2	Mortandad	Monitoring well located on the mesa south of Mortandad Canyon to define the southern extent of chromium contamination in the regional aquifer.	Regional	C	Q	—	—	—	B	—	S	Q	Q	Q
R-61 screen 1	R-61 S1	Mortandad	New well located on the mesa south of Mortandad Canyon to define the western extent of the flow path for chromium migration. Completed May 3, 2011.[k]	Regional	C	Q	S	S	S	S	—	S	Q	Q	Q
R-61 screen 2	R-61 S2	Mortandad	New well located on the mesa south of Mortandad Canyon to define the western extent of the flow path for chromium migration. Completed May 3, 2011.[k]	Regional	C	Q	S	S	S	S	—	S	Q	Q	Q

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Table 3.4-1 (continued)

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides			Inorganics		Field[i]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	DO, ORP, pH, SC, T, Turb
R-62 screen 1	R-62 S1	Mortandad	New well located on a ridge between Sandia and Mortandad Canyon at the east end of Sigma Mesa. Completed October 3, 2011.[k]	Regional	C	Q	S	S	S	S	—	S	Q	Q	Q
R-62 screen 2	R-62 S2	Mortandad	New well located on a ridge between Sandia and Mortandad Canyon at the east end of Sigma Mesa. Completed October 3, 2011.[k]	Regional	C	Q	S	S	S	S	—	S	Q	Q	Q

09-7259

Table 3.4-1 (continued)

Notes: Sampling suites and frequencies: C = continuous; Q = quarterly (4 times/yr); S = semiannual (2 times/yr); A = annual (1 time/yr); T= triennial (1 time every 3 yr). Nonfiltered and filtered samples will be collected for general inorganics (excluding anions). Metals, anions, and perchlorate samples will be filtered. Samples collected for radionuclide analysis will be nonfiltered only for all water media. Organic and HEXP constituents are nonfiltered for all water media.

[a] Continuous monitoring for groundwater refers to the measurement of groundwater levels by a transducer placed in a well and programmed to collect groundwater-level measurements at highly frequent intervals (e.g., every 60 min daily throughout the year). Continuous stream-flow monitoring refers to the measurement of stream flow by a base-flow stream gage that is programmed to collect stream-flow measurements at highly frequent intervals.

[b] Metals analysis includes the 23 TAL metals (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, Zn), plus boron, molybdenum, silicon dioxide, strontium, tin, and uranium.

[c] VOC = Volatile organic compounds; SVOC = semivolatile organic compounds.

[d] HEXP = High explosive (compounds). The HEXP analytical suite includes the Consent Order list of the normal SW-846:8330 analytes plus pentaerythritol tetranitrate (PETN); triaminotrinitrobenzene (TATB); 3,5-dinitroaniline, tri(o-cresyl)phosphate (TOCP); 2,4-diamino-6-nitrotoluene; and 2,6-diamino-4-nitrotoluene. These additional analytes are analyzed by SW-846:8321A.

[e] The radionuclide suite includes gross alpha, gross beta, alpha spectroscopy, gamma spectroscopy, and strontium-90.

[f] Tritium samples may be submitted for analysis by liquid scintillation if average activities are anticipated to exceed 200 pCi/L. Low-level tritium is analyzed using electrolytic enrichment or direct counting.

[g] General inorganic analysis includes major anions (bromide, chloride, fluoride, sulfate); major cations (calcium, magnesium, sodium, potassium); nitrate plus nitrite (as N); total Kjeldahl nitrogen (TKN); ammonia; total phosphorus, total organic carbon (TOC); total dissolved solids (TDS); alkalinity; specific conductivity; pH; and hardness.

[h] Analysis for perchlorate using high-performance liquid chromatography coupled with electrospray ionization mass spectrometry or tandem mass spectrometry (EPA Method 6850).

[i] Field parameters include pH, turbidity, specific conductance, dissolved oxygen, and temperature at all locations. Oxidation-reduction potential (ORP) will be measured if a flow-through cell is used and will not be measured in surface water, spring water, or water collected from Westbay sampling systems unless specified otherwise.

[j] — = This analytical suite is not scheduled to be collected for this type of water at locations assigned to this monitoring group.

[k] Characterization suites and frequencies apply to new perched-intermediate or regional groundwater wells. "New" wells are defined as those completed, rehabilitated, or converted on or after October 1, 2010.

07851

Table 4.4-1
Interim Monitoring Plan for MDA C Monitoring Group

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites							
						Metals	Organics			Radionuclides		Inorganics	Field[h]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Low-Level Tritium[f]	Gen Inorganics[g]	DO, ORP, pH, SC, T, Turb
R-14	R-14	Mortandad	Monitors for potential contaminants from Ten Site Canyon or upper Mortandad Canyon, including MDA C. Background location in GBIR R4.	Regional	C	—[i]	S	S	—	A	S	A	S
R-46	R-46	Mortandad	Monitors groundwater quality downgradient of MDA C.	Regional	C	—	S	S	—	A	S	A	S
R-60	R-60	Mortandad	New monitoring well installed east of MDA C. Monitors for potential contaminant releases from MDA C. Completed October 18, 2010.[j]	Regional	C	S	S	S	—	A	S	S	S

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Table 4.4-1 (continued)

Notes: Sampling suites and frequencies: C = continuous; Q = quarterly (4 times/yr); S = semiannual (2 times/yr); A = annual (1 time/yr); T= triennial (1 time every 3 yr). Nonfiltered and filtered samples will be collected for general inorganics (excluding anions). Metals, anions, and perchlorate samples will be filtered. Samples collected for radionuclide analysis will be nonfiltered only for all water media. Organic and HEXP constituents are nonfiltered for all water media.

[a] Continuous monitoring for groundwater refers to the measurement of groundwater levels by a transducer placed in a well and programmed to collect groundwater-level measurements at highly frequent intervals (e.g., every 60 min daily throughout the year). Continuous stream-flow monitoring refers to the measurement of stream flow by a base-flow stream gage that is programmed to collect stream-flow measurements at highly frequent intervals.

[b] Metals analysis includes the 23 TAL metals (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, Zn), plus boron, molybdenum, silicon dioxide, strontium, tin, and uranium.

[c] VOC = Volatile organic compounds; SVOC = semivolatile organic compounds.

[d] HEXP = High explosive (compounds). The HEXP analytical suite includes the Consent Order list of the normal SW-846:8330 analytes plus pentaerythritol tetranitrate (PETN); triaminotrinitrobenzene (TATB); 3,5-dinitroaniline, tri(o-cresyl)phosphate (TOCP); 2,4-diamino-6-nitrotoluene; and 2,6-diamino-4-nitrotoluene. These additional analytes are analyzed by SW-846:8321A.

[e] The radionuclide suite includes gross alpha, gross beta, alpha spectroscopy, gamma spectroscopy, and strontium-90.

[f] Tritium samples may be submitted for analysis by liquid scintillation if average activities are anticipated to exceed 200 pCi/L. Low-level tritium is analyzed using electrolytic enrichment or direct counting.

[g] General inorganic analysis includes major anions (bromide, chloride, fluoride, sulfate); major cations (calcium, magnesium, sodium, potassium); nitrate plus nitrite (as N); total Kjeldahl nitrogen (TKN); ammonia; total phosphorus, total organic carbon (TOC); total dissolved solids (TDS); alkalinity; specific conductivity; pH; and hardness.

[h] Field parameters include pH, turbidity, specific conductance, dissolved oxygen, and temperature at all locations. Oxidation-reduction potential (ORP) will be measured if a flow-through cell is used and will not be measured in surface water, spring water, or water collected from Westbay sampling systems unless specified otherwise.

[i] — = This analytical suite is not scheduled to be collected for this type of water at locations assigned to this monitoring group.

[j] Characterization suites and frequencies apply to new perched-intermediate or regional groundwater wells. "New" wells are defined as those completed, rehabilitated, or converted on or after October 1, 2010.

0253

Table 5.4-1
Interim Monitoring Plan for TA-54 Monitoring Group

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides			Inorganics		Field[i]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	DO, ORP, pH, SC, T, Turb
R-23i piezometer (port 1)	R-23i PIEZ	Pajarito	Downgradient monitoring location for TA-54. Monitors potential sources in Pajarito watershed and potential sources in canyons to the north.	Intermediate	A	A	S	A	—	A	A	—	A	—	S
R-23i screen 1 (port 2)	R-23i S2	Pajarito	Downgradient monitoring location for TA-54. Also monitors potential sources in Pajarito watershed and potential sources in canyons to the north.	Intermediate	C	A	S	A	—	A	—	S	A	—	S
R-23i screen 2 (port 3)	R-23i S3	Pajarito	Downgradient monitoring location for TA-54. Monitors potential sources in Pajarito watershed and potential sources in canyons to the north.	Intermediate	C	A	S	A	—	A	—	S	A	—	S
R-40i	R-40 Si	Pajarito	Monitors TA-54 and potential sources in Pajarito watershed. Screen impacted by drilling fluids.	Intermediate	C	A	S	A	—	A	—	S	A	—	S
R-20 screen 1	R-20 S1	Pajarito	Monitors TA-54 and potential sources in Pajarito watershed.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-20 screen 2	R-20 S2	Pajarito	Monitors TA-54 and potential sources in Pajarito watershed.	Regional	C	A	S	A	—	A	—	S	A	—	S

Table 5.4-1 (continued)

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides			Inorganics		Field[i]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	DO, ORP, pH, SC, T, Turb
R-23	R-23	Pajarito	Downgradient monitoring location for TA-54. Also monitors potential sources in Pajarito watershed and possible sources from canyons to the north.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-32	R-32	Pajarito	Monitors TA-54 and potential sources in Pajarito watershed.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-39	R-39	Pajarito	Monitors TA-54 and potential sources in Pajarito watershed.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-40 screen 1	R-40 S1	Pajarito	Monitors TA-54 and potential sources in Pajarito watershed.	Intermediate	C	—	S	—	—	—	—	S	—	—	S
R-40 screen 2	R-40 S2	Pajarito	Monitors TA-54 and potential sources in Pajarito watershed.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-49 screen 1	R-49 S1	Pajarito	Monitors groundwater south of Area G in Pajarito Canyon.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-49 screen 2	R-49 S2	Pajarito	Monitors groundwater south of Area G in Pajarito Canyon. Background location in GBIR R4.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-51 screen 1	R-51 S1	Pajarito	Monitoring well installed west of MDAs H and J and northwest of TA-18. Monitors TA-54 and other potential contaminant sources in Pajarito Canyon. Completed February 8, 2010.	Regional	C	A	S	A	—	A	—	S	A	—	S

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Table 5.4-1 (continued)

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides			Inorganics		Field[i]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	DO, ORP, pH, SC, T, Turb
R-51 screen 2	R-51 S2	Pajarito	Monitoring well installed west of MDAs H and J and northwest of TA-18. Monitors TA-54 and other potential contaminant sources in Pajarito Canyon. Completed February 8, 2010.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-54 screen 1	R-54 S1	Pajarito	Monitoring well installed immediately west of MDA L in Pajarito Canyon; monitors for potential releases from MDA L. Completed January 29, 2010.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-54 screen 2	R-54 S2	Pajarito	Monitoring well installed immediately west of MDA L in Pajarito Canyon; monitors for potential releases from MDA L. Completed January 29, 2010.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-37 screen 1	R-37 S1	Mortandad	Monitors perched-intermediate groundwater downgradient of MDA H.	Intermediate	C	A	S	S	—	A	—	S	A	—	S
R-55i	R-55i	Mortandad	Intermediate well located downgradient of MDA G. Monitors for potential contaminant releases from MDA G and other sources in Pajarito Canyon. Completed January 18, 2011.[k]	Intermediate	C	S	S	S	S	A	—	S	S	S	S

07856

Table 5.4-1 (continued)

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides			Inorganics		Field[i]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	DO, ORP, pH, SC, T, Turb
R-21	R-21	Mortandad	Monitors regional groundwater in Mortandad Canyon. Background location in GBIR R3 and GBIR R4.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-37 screen 2	R-37 S2	Mortandad	Monitors regional groundwater downgradient of MDA H.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-38	R-38	Mortandad	Monitors groundwater downgradient of MDA L in the north fork of Cañada del Buey in the Mortandad watershed.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-41 screen 2	R-41 S2	Pajarito	Monitors groundwater near northeast corner of MDA G.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-52 screen 1	R-51 S1	Pajarito	Located north-northeast of MDAs H and J on mesa south of Cañada del Buey. Monitors for potential releases of contaminants from MDA H. Completed March 31, 2010.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-52 screen 2	R-51 S2	Pajarito	Located north-northeast of MDAs H and J on mesa south of Cañada del Buey. Monitors for potential releases of contaminants from MDA H. Completed March 31, 2010.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-53 screen 1	R-53 S1	Pajarito	Located north of MDA L in Cañada del Buey; monitors for potential releases from MDA L. Completed March 29, 2010.	Regional	C	A	S	A	—	A	—	S	A	—	S

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Table 5.4-1 (continued)

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides			Inorganics		Field[i]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	DO, ORP, pH, SC, T, Turb
R-53 screen 2	R-53 S2	Pajarito	Located north of MDA L in Cañada del Buey; monitors for potential releases from MDA L. Completed March 29, 2010.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-55 screen 1	R-55 S1	Mortandad	Located downgradient of MDA G. Monitors for potential contaminant releases from MDA G and other sources in Pajarito Canyon. Completed August 25, 2010.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-55 screen 2	R-55 S2	Mortandad	Located downgradient of MDA G. Monitors for potential contaminant releases from MDA G and other sources in Pajarito Canyon. Completed August 25, 2010.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-56 screen 1	R-56 S1	Pajarito	Located on Mesita del Buey between MDAs G and L. Monitors for potential contaminant releases from MDAs G and L and other sources in Pajarito Canyon. Completed July 19, 2010.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-56 screen 2	R-56 S2	Pajarito	Located on Mesita del Buey between MDAs G and L. Monitors for potential contaminant releases from MDAs G and L and other sources in Pajarito Canyon. Completed July 19, 2010.	Regional	C	A	S	A	—	A	—	S	A	—	S

087858

Table 5.4-1 (continued)

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides			Inorganics		Field[i]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	DO, ORP, pH, SC, T, Turb
R-57 screen 1	R-57 S1	Pajarito	Located downgradient of MDA G at the eastern end of TA-54; monitors for potential releases from MDA G. Completed June 8, 2010.	Regional	C	A	S	A	—	A	—	S	A	—	S
R-57 screen 2	R-57 S2	Pajarito	Located downgradient of MDA G at the eastern end of TA-54; monitors for potential releases from MDA G. Completed June 8, 2010.	Regional	C	A	S	A	—	A	—	S	A	—	S

07852

Table 5.4-1 (continued)

Notes: Sampling suites and frequencies: C = continuous; Q = quarterly (4 times/yr); S = semiannual (2 times/yr); A = annual (1 time/yr); T= triennial (1 time every 3 yr). Nonfiltered and filtered samples will be collected for general inorganics (excluding anions). Metals, anions, and perchlorate samples will be filtered. Samples collected for radionuclide analysis will be nonfiltered only for all water media. Organic and HEXP constituents are nonfiltered for all water media.

[a] Continuous monitoring for groundwater refers to the measurement of groundwater levels by a transducer placed in a well and programmed to collect groundwater-level measurements at highly frequent intervals (e.g., every 60 min daily throughout the year). Continuous stream-flow monitoring refers to the measurement of stream flow by a base-flow stream gage that is programmed to collect stream-flow measurements at highly frequent intervals.

[b] Metals analysis includes the 23 TAL metals (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, Zn), plus boron, molybdenum, silicon dioxide, strontium, tin, and uranium.

[c] VOC = Volatile organic compounds; SVOC = semivolatile organic compounds.

[d] HEXP = High explosive (compounds). The HEXP analytical suite includes the Consent Order list of the normal SW-846:8330 analytes plus pentaerythritol tetranitrate (PETN); triaminotrinitrobenzene (TATB); 3,5-dinitroaniline, tri(o-cresyl)phosphate (TOCP); 2,4-diamino-6-nitrotoluene; and 2,6-diamino-4-nitrotoluene. These additional analytes are analyzed by SW-846:8321A.

[e] The radionuclide suite includes gross alpha, gross beta, alpha spectroscopy, gamma spectroscopy, and strontium-90.

[f] Tritium samples may be submitted for analysis by liquid scintillation if average activities are anticipated to exceed 200 pCi/L. Low-level tritium is analyzed using electrolytic enrichment or direct counting.

[g] General inorganic analysis includes major anions (bromide, chloride, fluoride, sulfate); major cations (calcium, magnesium, sodium, potassium); nitrate plus nitrite (as N); total Kjeldahl nitrogen (TKN); ammonia; total phosphorus, total organic carbon (TOC); total dissolved solids (TDS); alkalinity; specific conductivity; pH; and hardness.

[h] Analysis for perchlorate using high-performance liquid chromatography coupled with electrospray ionization mass spectrometry or tandem mass spectrometry (EPA Method 6850).

[i] Field parameters include pH, turbidity, specific conductance, dissolved oxygen, and temperature at all locations. Oxidation-reduction potential (ORP) will be measured if a flow-through cell is used and will not be measured in surface water, spring water, or water collected from Westbay sampling systems unless specified otherwise.

[j] — = This analytical suite is not scheduled to be collected for this type of water at locations assigned to this monitoring group.

[k] Characterization suites and frequencies apply to new perched-intermediate or regional groundwater wells. "New" wells are defined as those completed, rehabilitated, or converted on or after October 1, 2010.

DRAFT

Table 6.4-1
Interim Monitoring Plan for TA-16 260 Monitoring Group

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides		Inorganics			Field[j]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	Suspended Sed[i]	DO, ORP, pH, SC, T, Turb
Cañon de Valle below MDA P (E256)	Cañon de Valle below MDA P	Water	Downgradient surface water location for 260 Outfall. Monitors HE and other contaminants in support of surface CME.	Base flow	C	S	S	—[k]	S	B	—	A	—	S	S
Martin Spring	Martin Spring	Water	Spring located in upper Martin/S-Site Canyon.	Spring	C	S	S	—	S	B	—	A	—	S	S
Burning Ground Spring	Burning Ground Spring	Water	Spring downgradient of TA-16 260 Outfall [Consolidated Unit 16-021(c)-99].	Spring	C	S	S	—	S	B	—	A	—	S	S
CdV-16-02656	CdV-16-02656	Water	Alluvial well location nearest to 260 Outfall drainage/Cañon de Valle confluence. Downgradient of MDA R. Monitors HE and other contaminants in support of surface CME.	Alluvial	C	S	S	—	S	B	—	A	—	S	S
CdV-16-02659	CDV-16-02659	Water	Downgradient alluvial well from 260 Outfall drainage confluence. Monitors HE and other contaminants in support of surface CME.	Alluvial	C	S	S	—	S	B	—	A	—	—	S
CdV-16-611923	CdV-16-611923	Water	Key location downgradient of 260 Outfall.	Alluvial	C	S	S	—	S	B	—	A	—	—	S

Table 6.4-1 (continued)

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides		Inorganics			Field[j]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	Suspended Sed[i]	DO, ORP, pH, SC, T, Turb
FLC-16-25280	16-25280	Water	Alluvial well downgradient of Fishladder and Burning Ground.	Alluvial	C	S	S	—	S	B	—	A	—	—	S
MSC-16-06295	MSC-16-06295	Water	Alluvial well in S-Site/Martin Canyon downgradient of Martin Spring and several TA-16 SWMU sites.	Alluvial	C	A	A	—	A	B	—	A	—	—	A
16-26644	16-26644	Water	Intermediate well located at TA-16 southeast and downgradient of the 90s Line Pond.	Intermediate	C	S	S	—	S	B	—	A	—	—	S
CdV-16-1(i)	CdV-16-1(i)	Water	Located downgradient of the 260 Outfall.	Intermediate	C	S	S	—	S	B	—	A	—	—	S
CdV-16-2(i)r	CdV-16-2(i)r	Water	Located downgradient of the 260 Outfall.	Intermediate	C	S	S	—	S	B	—	A	—	—	S
CdV-16-4ip screen 1	CDV-16-4ip S1	Water	Hydrologic test well installed downgradient of the 260 Outfall to evaluate the hydrologic properties of the deep perched-intermediate aquifer in TA-16. Completed August 23, 2010.	Intermediate	C	S	S	S	S	A	S	S	S	—	S

EES-16-09-2525

Table 6.4-1 (continued)

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides		Inorganics			Field[j]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	Suspended Sed[i]	DO, ORP, pH, SC, T, Turb
Cdv-37-1(i)	CDV-37-1(i)	Water	Located near the confluence of Water Canyon and Cañon de Valle. Monitors groundwater contamination in the perched-intermediate zone downgradient of TA-16.	Intermediate	C	A	A	—	A	B	—	A	—	—	A
R-25 screen 1	R-25 S1	Water	Downgradient monitoring location for the 260 Outfall.	Intermediate	C	—	S	—	S	B	—	A	—	—	S
R-25 screen 2	R-25 S2	Water	Downgradient monitoring location for the 260 Outfall.	Intermediate	C	S	S	—	S	B	—	A	—	—	S
R-25 screen 4	R-25 S4	Water	Downgradient monitoring location for the 260 Outfall.	Intermediate	C	S	S	—	S	B	—	A	—	—	S
R-25b	R-25b	Water	Located immediately west of R-25 on the mesa top in TA-16. Monitors perched-intermediate groundwater for potential contamination associated with effluent from the 260 Outfall. Installed as a replacement for screen 1 in R-25.	Intermediate	C	A	A	—	A	B	—	A	—	—	A
R-26 PZ-2	R-26 PZ-2	Water	Piezometer installed near R-26. Provides data for perched-intermediate groundwater upgradient of TA-16.	Intermediate	C	S	S	—	S	B	—	A	—	—	S

097952

Table 6.4-1 (continued)

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides		Inorganics			Field[j]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	Suspended Sed[i]	DO, ORP, pH, SC, T, Turb
R-26 screen 1	R-26 S1	Water	Provides site-specific background data for perched-intermediate groundwater upgradient of TA-16. Background location in GBIR R3. Converted to single-screen well.	Intermediate	C	S	S	S	S	A	S	S	S	—	S
R-47i	R-47i	Water	Located northeast of the 260 Outfall. Provides data in support of the 260 Outfall CME.	Intermediate	C	A	A	—	A	B	—	A	—	—	A
R-25 screen 5	R-25 S5	Water	Downgradient monitoring location for the 260 Outfall.	Regional	C	A	A	—	A	B	—	A	—	—	A
R-25 screen 6	R-25 S6	Water	Downgradient monitoring location for the 260 Outfall.	Regional	C	A	A	—	A	B	—	A	—	—	A
R-25 screen 7	R-25 S7	Water	Downgradient monitoring location for the 260 Outfall.	Regional	C	A	A	—	A	B	—	A	—	—	A
R-48	R-48	Water	Completed by deepening open borehole CdV-16-3(i). Monitors historical TA-16 sources.	Regional	C	A	A	—	A	B	—	A	—	—	A
R-63	R-63	Water	New single-screen regional well installed as a replacement for R-25 screen 5. Completed February 9, 2011.	Regional	C	S+Q	S+Q	S+Q	S+Q	A	S+Q	S+Q	S+Q	—	S+Q

09-7251

Table 6.4-1 (continued)

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites										
						Metals	Organics			Radionuclides		Inorganics			Field[j]	
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Low-Level Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	Suspended Sed[i]	DO, ORP, pH, SC, T, Turb	
R-18	R-18	Pajarito	Monitors for potential contaminants from sources in TA-16.	Regional	C	S	S	—	S	B	—	A	—	—	S	

Notes: Sampling suites and frequencies: C = continuous; Q = quarterly (4 times/yr); S = semiannual (2 times/yr); A = annual (1 time/yr); T= triennial (1 time every 3 yr). Nonfiltered and filtered samples will be collected for general inorganics (excluding anions). Metals, anions, and perchlorate samples will be filtered. Samples collected for radionuclide analysis will be nonfiltered only for all water media. Organic and HEXP constituents are nonfiltered for all water media.

[a] Continuous monitoring for groundwater refers to the measurement of groundwater levels by a transducer placed in a well and programmed to collect groundwater-level measurements at highly frequent intervals (e.g., every 60 min daily throughout the year). Continuous stream-flow monitoring refers to the measurement of stream flow by a base-flow stream gage that is programmed to collect stream-flow measurements at highly frequent intervals.

[b] Metals analysis includes the 23 TAL metals (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, Zn), plus boron, molybdenum, silicon dioxide, strontium, tin, and uranium.

[c] VOC = Volatile organic compounds; SVOC = semivolatile organic compounds.

[d] HEXP = High explosive (compounds). The HEXP analytical suite includes the Consent Order list of the normal SW-846:8330 analytes plus pentaerythritol tetranitrate (PETN); triaminotrinitrobenzene (TATB); 3,5-dinitroaniline, tri(o-cresyl)phosphate (TOCP); 2,4-diamino-6-nitrotoluene; and 2,6-diamino-4-nitrotoluene. These additional analytes are analyzed by SW-846:8321A.

[e] The radionuclide suite includes gross alpha, gross beta, alpha spectroscopy, gamma spectroscopy, and strontium-90.

[f] Tritium samples may be submitted for analysis by liquid scintillation if average activities are anticipated to exceed 200 pCi/L. Low-level tritium is analyzed using electrolytic enrichment or direct counting.

[g] General inorganic analysis includes major anions (bromide, chloride, fluoride, sulfate); major cations (calcium, magnesium, sodium, potassium); nitrate plus nitrite (as N); total Kjeldahl nitrogen (TKN); ammonia; total phosphorus, total organic carbon (TOC); total dissolved solids (TDS); alkalinity; specific conductivity; pH; and hardness.

[h] Analysis for perchlorate using high-performance liquid chromatography coupled with electrospray ionization mass spectrometry or tandem mass spectrometry (EPA Method 6850).

[i] Suspended sed = Suspended sediment concentration.

[j] Field parameters include pH, turbidity, specific conductance, dissolved oxygen, and temperature at all locations. Oxidation-reduction potential (ORP) will be measured if a flow-through cell is used and will not be measured in surface water, spring water, or water collected from Westbay sampling systems unless specified otherwise.

[k] — = This analytical suite is not scheduled to be collected for this type of water at locations assigned to this monitoring group.

09755

Table 7.4-1
Interim Monitoring Plan for MDA AB Monitoring Group

Old Location Name	New Location Name	Watershed	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites							
						Metals	Organics			Radionuclides		Inorganics	Field[h]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Low-Level Tritium[f]	Gen Inorganics[g]	DO, ORP, pH, SC, T, Turb
R-29	R-29	Ancho	Located downgradient of TA-49 MDA AB. Installed to determine whether zones of perched-intermediate groundwater occur under MDA AB. Completed March 12, 2010.	Regional	C	A	A	A	A	A	A	A	A
R-30	R-30	Ancho	Located at the eastern edge of TA-49 and downgradient of MDA AB. Installed to determine whether zones of perched-intermediate groundwater occur under MDA AB. Completed April 3, 2010.	Regional	C	A	A	A	A	A	A	A	A
R-27i	R-27i	Water	Monitors potential contamination associated with the perched-intermediate zone downgradient of historical TA-16 sources.	Intermediate	C	A	A	A	A	A	A	A	A
R-27	R-27	Water	Monitors TA-16 in support of the TA-16 260 Outfall CME. Background location in GBIR R4.	Regional	C	A	A	A	A	A	A	A	A

09-25-13

Table 7.4-1 (continued)

Notes: Sampling suites and frequencies: C = continuous; Q = quarterly (4 times/yr); S = semiannual (2 times/yr); A = annual (1 time/yr); T= triennial (1 time every 3 yr). Nonfiltered and filtered samples will be collected for general inorganics (excluding anions). Metals, anions, and perchlorate samples will be filtered. Samples collected for radionuclide analysis will be nonfiltered only for all water media. Organic and HEXP constituents are nonfiltered for all water media.

[a] Continuous monitoring for groundwater refers to the measurement of groundwater levels by a transducer placed in a well and programmed to collect groundwater-level measurements at highly frequent intervals (e.g., every 60 min daily throughout the year). Continuous stream-flow monitoring refers to the measurement of stream flow by a base-flow stream gage that is programmed to collect stream-flow measurements at highly frequent intervals.

[b] Metals analysis includes the 23 TAL metals (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, Zn), plus boron, molybdenum, silicon dioxide, strontium, tin, and uranium.

[c] VOC = Volatile organic compounds; SVOC = semivolatile organic compounds.

[d] HEXP = High explosive (compounds). The HEXP analytical suite includes the Consent Order list of the normal SW-846:8330 analytes plus pentaerythritol tetranitrate (PETN); triaminotrinitrobenzene (TATB); 3,5-dinitroaniline, tri(o-cresyl)phosphate (TOCP); 2,4-diamino-6-nitrotoluene; and 2,6-diamino-4-nitrotoluene. These additional analytes are analyzed by SW-846:8321A.

[e] The radionuclide suite includes gross alpha, gross beta, alpha spectroscopy, gamma spectroscopy, and strontium-90.

[f] Tritium samples may be submitted for analysis by liquid scintillation if average activities are anticipated to exceed 200 pCi/L. Low-level tritium is analyzed using electrolytic enrichment or direct counting.

[g] General inorganic analysis includes major anions (bromide, chloride, fluoride, sulfate); major cations (calcium, magnesium, sodium, potassium); nitrate plus nitrite (as N); total Kjeldahl nitrogen (TKN); ammonia; total phosphorus, total organic carbon (TOC); total dissolved solids (TDS); alkalinity; specific conductivity; pH; and hardness.

[h] Field parameters include pH, turbidity, specific conductance, dissolved oxygen, and temperature at all locations. Oxidation-reduction potential (ORP) will be measured if a flow-through cell is used and will not be measured in surface water, spring water, or water collected from Westbay sampling systems unless specified otherwise.

LM987

Table 8.3-1
Interim Monitoring Plan for General Surveillance Monitoring

Old Location Name	New Location Name	Watershed	Comment	Zone	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides		Inorganics			Field[j]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	Suspended Sed[i]	DO, ORP, pH, SC, T, Turb
LAO-3a	LAO-3a	Upper Los Alamos Canyon	Monitors net effect of mixing of alluvial groundwater from Los Alamos and DP Canyons. Located just downcanyon of the confluence of Los Alamos and DP Canyons.	Alluvial	C	A	—[k]	—	—	A	—	A	A	—	A
LAOI-7	LAOI-7	Upper Los Alamos Canyon	Monitors downgradient location for potential contaminants from upper Los Alamos and DP Canyons and TA-21.	Intermediate	C	A	—	—	—	A	A	A	A	—	A
R-9i screen 1	R-9i S1	Upper Los Alamos Canyon	Monitors downgradient location for potential contaminants from upper Los Alamos and DP Canyons and TA-21 and possible southward perched-zone migration from Pueblo Canyon.	Intermediate	C	A	—	—	—	A	—	A	A	—	A
R-9i screen 2	R-9i S2	Upper Los Alamos Canyon	Monitors downgradient location for potential contaminants from upper Los Alamos and DP Canyons and TA-21 and possible southward perched-zone migration from Pueblo Canyon.	Intermediate	C	A	—	—	—	A	—	A	A	—	A

259107

Table 8.3-1 (continued)

Old Location Name	New Location Name	Watershed	Comment	Zone	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides		Inorganics			Field[j]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	Suspended Sed[i]	DO, ORP, pH, SC, T, Turb
R-8 screen 1	R-8 S1	Upper Los Alamos Canyon	Monitors downgradient location for potential contaminants from upper Los Alamos and DP Canyons and TA-21.	Regional	C	A	—	—	—	A	—	A	A	—	A
R-8 screen 2	R-8 S2	Upper Los Alamos Canyon	Monitors downgradient location for potential contaminants from upper Los Alamos and DP Canyons and TA-21.	Regional	C	A	—	—	—	A	—	A	A	—	A
R-9	R-9	Upper Los Alamos Canyon	Monitors downgradient location for potential contaminants from upper Los Alamos and DP Canyons and TA-21 and or possible southward perched-zone migration from Pueblo Canyon.	Regional	C	A	—	—	—	A	—	A	A	—	A
APCO-1	APCO-1	Pueblo	Monitors within the wetland below the Pueblo WWTP. Most downcanyon monitoring point in Pueblo Canyon.	Alluvial	C	A	—	—	—	A	—	A	A	—	A
POI-4	POI-4	Pueblo	Monitors for potential contaminants from upper Pueblo and Acid Canyons sources.	Intermediate	C	A	—	—	—	A	—	A	A	—	A
R-3i	R-3i	Pueblo	Monitors along the potential infiltration pathway originating in lower Pueblo Canyon.	Intermediate	C	A	A	A	—	A	—	A	A	—	A

07859

Table 8.3-1 (continued)

Old Location Name	New Location Name	Watershed	Comment	Zone	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides		Inorganics			Field[j]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	Suspended Sed[i]	DO, ORP, pH, SC, T, Turb
TW-2Ar	TW-2Ar	Pueblo	Replacement monitoring well for TW-2A. Monitors perched-intermediate groundwater in lower Pueblo Canyon. Completed March 4, 2010.	Intermediate	C	A	—	—	—	A	A	A	A	—	A
R-2	R-2	Pueblo	Monitors for potential contaminants from upper Pueblo and Acid Canyons. Background location in GBIR R4.	Regional	C	A	—	—	—	A	—	A	A	—	A
R-3	R-3	Pueblo	Located in Pueblo Canyon, near the eastern boundary of TA-74. Monitors potential contaminant flow paths near municipal production well Otowi 1. Completed June 21, 2010.	Regional	C	A	—	—	—	A	—	A	A	—	A
R-4	R-4	Pueblo	Monitors for potential contaminants from upper Pueblo and Acid Canyons.	Regional	C	A	—	—	—	A	—	A	A	—	A
R-24	R-24	Pueblo	Monitors for potential contaminants from upper Pueblo and Acid Canyons and Guaje Canyon. Background location in GBIR R4.	Regional	C	A	—	—	—	A	—	A	A	—	A

09-5176

Table 8.3-1 (continued)

Old Location Name	New Location Name	Watershed	Comment	Zone	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides		Inorganics			Field[j]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	Suspended Sed[i]	DO, ORP, pH, SC, T, Turb
Los Alamos Canyon near Otowi Bridge (E110)	LA Canyon near Otowi Bridge	Lower Los Alamos Canyon	Measures quality of persistent surface water in Los Alamos Canyon above the confluence of Los Alamos Canyon and Rio Grande. Located on San Ildefonso land and sampled under the MOU.	Base flow	A	A	A	A	T	A	—	A	A	A	A
Basalt Spring/Vine Tree Spring	Basalt Spring	Lower Los Alamos Canyon	Basalt Spring water quality indicates a relation to perched-intermediate groundwater in lower Pueblo Canyon. Located on San Ildefonso land immediately downgradient of the Laboratory boundary and sampled under the MOU. Sample Basalt Spring; if not possible, sample Vine Tree Spring.	Spring	S	S	S	T	T	S	—	S	S	S	S
Los Alamos Spring	Los Alamos Spring	Lower Los Alamos Canyon	Los Alamos Spring water quality indicates a relation to perched-intermediate groundwater, possibly originating beneath Los Alamos Canyon. Located on San Ildefonso land and sampled under the MOU.	Spring	A	A	A	T	T	A	—	A	A	A	A

Table 8.3-1 (continued)

Old Location Name	New Location Name	Watershed	Comment	Zone	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides		Inorganics			Field[j]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	Suspended Sed[i]	DO, ORP, pH, SC, T, Turb
LLAO-1b	LLAO-1b	Lower Los Alamos Canyon	Monitors upper portion of San Ildefonso Pueblo reach in lower Los Alamos Canyon. Water quality is consistent with recharge of water that emerges at Basalt Spring. Located on San Ildefonso land and sampled under the MOU.	Alluvial	C	A	A	T	T	A	—	A	A	—	A
LLAO-4	LLAO-4	Lower Los Alamos Canyon	Monitors lower San Ildefonso Pueblo reach in lower Los Alamos Canyon near the confluence with Rio Grande. Water quality appears to reflect mixing with regional groundwater near the Rio Grande. Located on San Ildefonso land and sampled under the MOU.	Alluvial	C	A	A	T	T	A	—	A	A	—	A
SCA-2	SCA-2	Sandia	Located at the upper portion of the lower canyon where the valley floor first opens up and the first significant alluvial storage is present along the canyon.	Alluvial	C[MP]	A	—	—	—	A	—	A	A	—	A
R-12 screen 1	R-12 S1	Sandia	Monitors for potential contaminants from Sandia Canyon or possibly Los Alamos or Pueblo Canyons.	Intermediate	C	A	—	—	—	A	—	A	A	—	A

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Table 8.3-1 (continued)

Old Location Name	New Location Name	Watershed	Comment	Zone	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides		Inorganics			Field[j]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	Suspended Sed[i]	DO, ORP, pH, SC, T, Turb
R-12 screen 2	R-12 S2	Sandia	Monitors for potential contaminants from Sandia Canyon or possibly Los Alamos or Pueblo Canyons.	Intermediate	C	A	—	—	—	A	—	A	A	—	A
R-10 screen 1	R-10 S1	Sandia	Monitors for potential contaminants from Sandia Canyon and possibly Los Alamos or Pueblo Canyons. Located on San Ildefonso land and sampled under the MOU. Background location in GBIR R4.	Regional	C	A	A	A	T	A	—	A	A	—	A
R-10 screen 2	R-10 S2	Sandia	Monitors for potential contaminants from Sandia Canyon and possibly Los Alamos or Pueblo Canyons. Located on San Ildefonso land and sampled under the MOU. Background location in GBIR R4.	Regional	C	A	A	A	T	A	—	A	A	—	A
R-10a	R-10a	Sandia	Monitors for potential contaminants from Sandia Canyon and possibly Los Alamos or Pueblo Canyons. Located on San Ildefonso land and sampled under the MOU.	Regional	C	A	A	A	T	A	—	A	A	—	A

09-6723

Table 8.3-1 (continued)

Old Location Name	New Location Name	Watershed	Comment	Zone	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides		Inorganics			Field[j]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	Suspended Sed[i]	DO, ORP, pH, SC, T, Turb
CDBO-6	CDBO-6	Mortandad	Located in a small spatially limited saturated zone below Cañada del Buey in shallow bedrock. Monitors infiltration of runoff through the canyon floor.	Alluvial	C	A	—	—	—	A	—	A	A	—	A
MCO-5	MCO-5	Mortandad	Monitors trends in alluvial groundwater quality following upgrades to the RLWTF.	Alluvial	C	A	—	—	—	A	A	A	A	—	A
MCO-7	MCO-7	Mortandad	Near recent downcanyon extent of alluvial saturation. Monitors trends in alluvial groundwater quality following upgrades to the RLWTF. Monitoring required for RLWTF Discharge Permit DP-1132.	Alluvial	C	A	—	—	—	A	A	A	A	—	A
R-16 screen 2	R-16 S2	Mortandad	Downgradient monitoring location for TA-54 or other possible sources in Pajarito Canyon or canyons to the north.	Regional	C	A	—	—	—	A	—	A	A	—	A
R-16 screen 4	R-16 S4	Mortandad	Downgradient monitoring location for TA-54 or other possible sources in Pajarito Canyon or canyons to the north.	Regional	C	A	—	—	—	A	—	A	A	—	A

EES-14

Table 8.3-1 (continued)

Old Location Name	New Location Name	Watershed	Comment	Zone	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides		Inorganics			Field[j]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	Suspended Sed[i]	DO, ORP, pH, SC, T, Turb
R-16r	R-16r	Mortandad	Downgradient monitoring location for TA-54 or other possible sources in Pajarito Canyon or canyons to the north. Replaces screen 1 in R-16. Background location in GBIR R4.	Regional	C	A	—	—	—	A	—	A	A	—	A
R-33 screen 1	R-33 S1	Mortandad	Monitors for potential contaminants from upper Ten Site or Mortandad Canyons. Background location in GBIR R4.	Regional	C	A	—	—	—	A	—	A	A	—	A
R-33 screen 2	R-33 S2	Mortandad	Monitors for potential contaminants from upper Ten Site or Mortandad Canyons. Background location in GBIR R4.	Regional	C	A	—	—	—	A	—	A	A	—	A
R-34	R-34	Mortandad	Monitors regional groundwater for potential contaminants originating beneath Los Alamos, Sandia, or Mortandad Canyons. Key monitoring location for San Ildefonso and Buckman Well Field. Located on San Ildefonso land and sampled under the MOU. Background location in GBIR R4.	Regional	C	Q	A	A	T	A	—	Q	A	—	Q
Bulldog Spring	Bulldog Spring	Pajarito	Monitors HE contamination downgradient of TA-09.	Spring	A	A	—	—	A	A	—	A	A	A	A

EES-16-09-13

Table 8.3-1 (continued)

Old Location Name	New Location Name	Watershed	Comment	Zone	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides		Inorganics			Field[j]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	Suspended Sed[i]	DO, ORP, pH, SC, T, Turb
18-MW-18	18-MW-18	Pajarito	Part of a group of alluvial wells within the former TA-18 complex. Monitoring point for potential releases associated with historical sewage lagoons on lower Pajarito Canyon.	Alluvial	C[MP]	A	—	—	A	A	—	A	A	—	A
PCAO-8	PCAO-8	Pajarito	Characterizes potential impacts from runoff associated with TA-54 near PCTH-5 (between PCO 2 and PCO-3).	Alluvial	C	A	—	—	A	A	—	A	A	—	A
03-B-13	03-B-13	Pajarito	Near TA-03, building SM-30. Monitored in support of project at SWMU 03-010(a).	Intermediate	C	S	S	S	A	A	A	S	A	—	S
R-19 screen 2	R-19 S2	Pajarito	Monitors for potential contaminants from TA-16. Also provides baseline characterization data for downgradient areas, including TA-54.	Intermediate	C	A	—	—	A	A	—	A	A	—	A
PCI-2	PCI-2	Pajarito	Monitors perched-intermediate groundwater at the confluence of Twomile and Pajarito Canyons. Provides baseline characterization data for areas upgradient of TA-54. Background location in GBIR R4.	Intermediate	C	A	—	—	A	A	—	A	A	—	A

Table 8.3-1 (continued)

Old Location Name	New Location Name	Watershed	Comment	Zone	Water Level or Flow[a]	Analytical Suites									
						Metals	Organics			Radionuclides		Inorganics			Field[j]
						Metals (Filtered)[b]	VOCs[c]	SVOCs[c]	HEXP[d]	Radionuclide[e]	Tritium[f]	Gen Inorganics[g]	Perchlorate[h]	Suspended Sed[i]	DO, ORP, pH, SC, T, Turb
R-17 screen 1	R-17 S1	Pajarito	Monitors MDA C, TA-16, and potential sources in upper Pajarito watershed. Background location in GBIR R4.	Regional	C	A	—	—	A	A	—	A	A	—	A
R-17 screen 2	R-17 S2	Pajarito	Monitors MDA C, TA-16, and potential sources in upper Pajarito watershed. Background location in GBIR R4.	Regional	C	A	—	—	A	A	—	A	A	—	A
R-19 screen 3	R-19 S3	Pajarito	Monitors for potential contaminants from TA-16. Also provides baseline characterization data for downgradient areas including TA-54.	Regional	C	A	—	—	A	A	—	A	A	—	A
R-19 screen 4	R-19 S4	Pajarito	Monitors for potential contaminants from TA-16. Also provides baseline characterization data for downgradient areas including TA-54.	Regional	C	A	—	—	A	A	—	A	A	—	A
WCO-1r	WCO-1r	Water	Replacement well for MCO-1.	Alluvial	C	A	—	—	A	A	—	A	A	—	A
R-31 screen 4	R-31 S4	Frijoles, Ancho, and Chaquehui	Part of interim monitoring network pending well network assessment for MDA AB.	Regional	C	A	—	—	A	A	—	A	A	—	A
R-31 screen 5	R-31 S5	Frijoles, Ancho, and Chaquehui	Part of interim monitoring network pending well network assessment for MDA AB.	Regional	C	A	—	—	A	A	—	A	A	—	A

LA-UR-11-05717

Table 8.3-1 (continued)

Notes: Sampling suites and frequencies: C = continuous; Q = quarterly (4 times/yr); S = semiannual (2 times/yr); A = annual (1 time/yr); T= triennial (1 time every 3 yr). Nonfiltered and filtered samples will be collected for general inorganics (excluding anions). Metals, anions, and perchlorate samples will be filtered. Samples collected for radionuclide analysis will be nonfiltered only for all water media. Organic and HEXP constituents are nonfiltered for all water media.

[a] Continuous monitoring for groundwater refers to the measurement of groundwater levels by a transducer placed in a well and programmed to collect groundwater-level measurements at highly frequent intervals (e.g., every 60 min daily throughout the year). Continuous stream-flow monitoring refers to the measurement of stream flow by a base-flow stream gage that is programmed to collect stream-flow measurements at highly frequent intervals. The superscript MP indicates water levels will be monitored at highly frequent intervals using a multiparameter probe that measures specific conductance, water level, and temperature. Spring discharge is measured during semiannual (S) or annual (A) sampling.

[b] Metals analysis includes the 23 TAL metals (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, Zn), plus boron, molybdenum, silicon dioxide, strontium, tin, and uranium.

[c] VOC = Volatile organic compounds; SVOC = semivolatile organic compounds.

[d] HEXP = High explosive (compounds). The HEXP analytical suite includes the Consent Order list of the normal SW-846:8330 analytes plus pentaerythritol tetranitrate (PETN); triaminotrinitrobenzene (TATB); 3,5-dinitroaniline, tri(o-cresyl)phosphate (TOCP); 2,4-diamino-6-nitrotoluene; and 2,6-diamino-4-nitrotoluene. These additional analytes are analyzed by SW-846:8321A.

[e] The radionuclide suite includes gross alpha, gross beta, alpha spectroscopy, gamma spectroscopy, and strontium-90.

[f] Tritium samples may be submitted for analysis by liquid scintillation if average activities are anticipated to exceed 200 pCi/L. Low-level tritium is analyzed using electrolytic enrichment or direct counting.

[g] General inorganic analysis includes major anions (bromide, chloride, fluoride, sulfate); major cations (calcium, magnesium, sodium, potassium); nitrate plus nitrite (as N); total Kjeldahl nitrogen (TKN); ammonia; total phosphorus, total organic carbon (TOC); total dissolved solids (TDS); alkalinity; specific conductivity; pH; and hardness.

[h] Analysis for perchlorate using high-performance liquid chromatography coupled with electrospray ionization mass spectrometry or tandem mass spectrometry (EPA Method 6850).

[i] Suspended sed = Suspended sediment concentration.

[j] Field parameters include pH, turbidity, specific conductance, dissolved oxygen, and temperature at all locations. Oxidation-reduction potential (ORP) will be measured if a flow-through cell is used and will not be measured in surface water, spring water, or water collected from Westbay sampling systems unless specified otherwise.

[k] — = This analytical suite is not scheduled to be collected for this type of water at locations assigned to this monitoring group.

5715

Table 8.3-2
Interim Monitoring Plan for White Rock Canyon and Rio Grande Watershed

Location	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites														
				Metals	Organics						Radionuclides			Inorganics				Field[l]
				Metals[b]	VOCs[c]	SVOCs[c]	Pesticides	PCB[d]	HEXP[e]	Dioxins/Furans	Radionuclide[f]	Tritium[g]	Low-Level Tritium[g]	Gen Inorganics[h]	Perchlorate[i]	Stable Isotopes[j]	Suspended Sed[k]	DO, ORP, pH, SC, T, Turb, ALK
Ancho at Rio Grande	Historical annual sampling site. Monitors base flow from Ancho at Rio Grande. If base flow is not reaching the Rio Grande, a surface water sample will be collected at the first upstream location with sufficient flow that is no farther than 1000 ft from the confluence with the Rio Grande.	Base flow	A	A	A	T	T	T	T	T	A	—[m]	—	A	A	—	A	A
Frijoles at Rio Grande	Perimeter station for the Laboratory. Sampled in fall, during White Rock and Rio Grande watershed sampling event. If base flow is not reaching the Rio Grande, a surface water sample will be collected at the first upstream location with sufficient flow that is no farther than 1000 ft from the confluence with the Rio Grande.	Base flow	A	A	A	T	T	T	T	T	A	—	—	A	A	—	A	A
Mortandad at Rio Grande	Located on San Ildefonso land and sampled under the MOU. If base flow is not reaching the Rio Grande, a surface water sample will be collected at the first upstream location with sufficient flow that is no farther than 1000 ft from the confluence with the Rio Grande.	Base flow	A	A	A	A	T	A	A	T	A	—	A	A	A	—	A	A

EES-19-09-0179

Table 8.3-2 (continued)

Location	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites															
				Metals	Organics						Radionuclides			Inorganics				Field[l]
				Metals[b]	VOCs[c]	SVOCs[c]	Pesticides	PCB[d]	HEXP[e]	Dioxins/Furans	Radionuclide[f]	Tritium[g]	Low-Level Tritium[g]	Gen Inorganics[h]	Perchlorate[i]	Stable Isotopes[j]	Suspended Sed[k]	DO, ORP, pH, SC, T, Turb, ALK
Pajarito at Rio Grande	Monitors base flow from Pajarito at the Rio Grande. If base flow is not reaching the Rio Grande, a surface water sample will be collected at the first upstream location with sufficient flow that is no farther than 1000 ft from the confluence with the Rio Grande.	Base flow	A	A	A	T	T	T	T	T	A	—	—	A	A	—	A	A
Rio Grande at Frijoles	Monitors base flow in the Rio Grande at Frijoles Canyon.	Base flow	A	A	A	T	T	T	T	T	A	—	—	A	A	—	A	A
Rio Grande at Otowi Upper	Monitors base flow in the Rio Grande at Otowi Bridge. Located on San Ildefonso land and sampled under the MOU.	Base flow	A	A	A	A	T	A	A	T	A	—	A	A	A	—	A	A
La Mesita Spring	Monitors regional aquifer downgradient of the Laboratory. Located on San Ildefonso land and sampled under the MOU.	Spring	A	A	A	T	T	T	T	T	A	—	A	A	A	—	A	A
Sacred Spring	Off-site spring that monitors regional aquifer downgradient of the Laboratory. Background location. Located on San Ildefonso land and sampled under the MOU. Background location in GBIR R3 and GBIR R4.	Spring	A	A	A	T	T	T	T	T	A	—	A	A	A	—	A	A
Sandia Spring	Monitors regional aquifer downgradient of the Laboratory. Located on San Ildefonso land and sampled under the MOU. Background location in GBIR R4.	Spring	A	A	A	T	T	T	T	T	A	—	A	A	A	—	A	A

09-6139

Table 8.3-2 (continued)

Location	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites															
				Metals	Organics						Radionuclides			Inorganics				Field[l]
				Metals[b]	VOCs[c]	SVOCs[c]	Pesticides	PCB[d]	HEXP[e]	Dioxins/Furans	Radionuclide[f]	Tritium[g]	Low-Level Tritium[g]	Gen Inorganics[h]	Perchlorate[i]	Stable Isotopes[j]	Suspended Sed[k]	DO, ORP, pH, SC, T, Turb, ALK
Spring 1	Monitors regional aquifer downgradient of the Laboratory. Background location. Located on San Ildefonso land and sampled under the MOU. Background location in GBIR R3 and GBIR R4.	Spring	A	A	A	T	T	T	T	T	A	—	A	A	A	—	A	A
Spring 2	Monitors regional aquifer downgradient of the Laboratory. Located on San Ildefonso land and sampled under the MOU.	Spring	A	A	A	T	T	T	T	T	A	—	A	A	A	—	A	A
Spring 2B	Monitors regional aquifer downgradient of the Laboratory.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A
Spring 3	Monitors regional aquifer downgradient of the Laboratory.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A
Spring 3A	Monitors regional aquifer downgradient of the Laboratory.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A
Spring 3AA	Monitors regional aquifer downgradient of the Laboratory.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A
Spring 4	Monitors regional aquifer downgradient of the Laboratory.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A
Spring 4A	Monitors regional aquifer downgradient of the Laboratory.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A
Spring 4AA	Monitors regional aquifer downgradient of the Laboratory.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A
Spring 4B	Monitors regional aquifer downgradient of the Laboratory.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A

07661

Table 8.3-2 (continued)

Location	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites															
				Metals	Organics						Radionuclides			Inorganics				Field[l]
				Metals[b]	VOCs[c]	SVOCs[c]	Pesticides	PCB[d]	HEXP[e]	Dioxins/Furans	Radionuclide[f]	Tritium[g]	Low-Level Tritium[g]	Gen Inorganics[h]	Perchlorate[i]	Stable Isotopes[j]	Suspended Sed[k]	DO, ORP, pH, SC, T, Turb, ALK
Ancho Spring	Monitors regional aquifer downgradient of the Laboratory. Background location in GBIR R3 and GBIR R4.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A
Spring 5	Monitors regional aquifer downgradient of the Laboratory.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A
Spring 5A	Monitors regional aquifer downgradient of the Laboratory.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A
Spring 5B	Monitors regional aquifer downgradient of the Laboratory. Background location in GBIR R3.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A
Spring 6	Monitors regional aquifer downgradient of the Laboratory. Background location in GBIR R3 and GBIR R4.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A
Spring 6A	Monitors regional aquifer downgradient of the Laboratory. Background location in GBIR R3 and GBIR R4.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A
Spring 8A	Monitors regional aquifer downgradient of the Laboratory. Background location in GBIR R3.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A
Spring 9	Monitors regional aquifer downgradient of the Laboratory. Background location in GBIR R3 and GBIR R4.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A

97682

Table 8.3-2 (continued)

Location	Rationale for Selection of Location	Surface Water Body or Source Aquifer	Water Level or Flow[a]	Analytical Suites															
				Metals	Organics						Radionuclides			Inorganics				Field[l]
				Metals[b]	VOCs[c]	SVOCs[c]	Pesticides	PCB[d]	HEXP[e]	Dioxins/Furans	Radionuclide[f]	Tritium[g]	Low-Level Tritium[g]	Gen Inorganics[h]	Perchlorate[i]	Stable Isotopes[j]	Suspended Sed[k]	DO, ORP, pH, SC, T, Turb, ALK
Spring 9A	Monitors regional aquifer downgradient of the Laboratory. Background location in GBIR R3 and GBIR R4.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	
Spring 9B	Monitors regional aquifer downgradient of the Laboratory. Background location in GBIR R3 and GBIR R4.	Spring	A	A	A	A	T	T	A	T	A	—	A	A	A	—	A	A

01993

Table 8.3-2 (continued)

Notes: Sampling suites and frequencies: C = continuous; Q = quarterly (4 times/yr); S = semiannual (2 times/yr); A = annual (1 time/yr); T= triennial (1 time every 3 yr). Some locations may be assigned analytical suites or frequencies that differ from those indicated for the general surveillance monitoring group in Table 1.6-3 for site-specific reasons summarized in Table D-8.8-3.

Nonfiltered and filtered samples will be collected for general inorganics (excluding anions) and metals. Anions and perchlorate samples will be filtered. Samples collected for radionuclide analysis will be nonfiltered only for all water media. Organic and HEXP constituents are nonfiltered for all water media. Stable isotope samples for nitrogen isotopes are filtered; stable isotope samples for deuterium and oxygen isotopes are not filtered.

[a] Continuous monitoring for groundwater refers to the measurement of groundwater levels by a transducer placed in a well and programmed to collect groundwater-level measurements at highly frequent intervals (e.g., every 60 min daily throughout the year). Continuous stream-flow monitoring refers to the measurement of stream flow by a base-flow stream gage that is programmed to collect stream-flow measurements at highly frequent intervals. The superscript MP indicates water levels will be monitored at highly frequent intervals using a multiparameter probe that measures specific conductance, water level, and temperature. The superscript HD indicates that this sampling location is historically dry.

[b] Metals analysis includes the 23 TAL metals, plus boron, molybdenum, silicon dioxide, strontium, tin, and uranium.

[c] VOC = Volatile organic compounds; SVOC = semivolatile organic compounds.

[d] PCB = Polychlorinated biphenyl (compound).

[e] HEXP = High explosive (compounds). The HEXP analytical suite includes the Consent Order list of the normal SW-846:8330 analytes plus pentaerythritol tetranitrate (PETN); triaminotrinitrobenzene (TATB); 3,5-dinitroaniline, tri(o-cresyl)phosphate (TOCP); 2,4-diamino-6-nitrotoluene; and 2,6-diamino-4-nitrotoluene. These additional analytes are analyzed by SW-846:8321A.

[f] The radionuclide suite includes gross alpha, gross beta, alpha spectroscopy, gamma spectroscopy, and strontium-90.

[g] Tritium samples may be submitted for analysis by liquid scintillation if average activities are anticipated to exceed 200 pCi/L. Low-level tritium is analyzed using electrolytic enrichment or direct counting.

[h] General inorganic analysis includes major anions (bromide, chloride, fluoride, sulfate); major cations (calcium, magnesium, sodium, potassium); nitrate plus nitrite (as N); total Kjeldahl nitrogen (TKN); ammonia; total phosphorus, total organic carbon (TOC); total dissolved solids (TDS); alkalinity; specific conductivity; pH; and hardness.

[i] Analysis for perchlorate using high-performance liquid chromatography coupled with electrospray ionization mass spectrometry or tandem mass spectrometry (EPA Method 6850).

[j] Analysis for stable nitrogen, deuterium, and oxygen isotopes. The collection of samples for stable isotopic analysis is considered a special sampling campaign that is outside the scope of the regulatory process. In general, samples for isotopic analysis are collected semiannually from "new" wells (those which completed construction, rehabilitation, or conversion on or after October 1, 2010) until at least four sets of data have been collected. Any subsequent sampling for stable isotope analysis will be decided on the basis of site-specific conditions.

[k] Suspended sed = Suspended sediment concentration.

[l] Field parameters include pH, turbidity, specific conductance, dissolved oxygen, and temperature at all locations. Oxidation-reduction potential (ORP) will be measured if a flow-through cell is used and will not be measured in surface water, spring water, or water collected from Westbay sampling systems unless specified otherwise. Alkalinity (ALK) will be measured for all samples either in the field or at the on-site EES-14 laboratory.

[m] — = This analytical suite is not scheduled to be collected for this type of water at locations assigned to this monitoring group.

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Appendix A

Acronyms and Abbreviations,
Metric Conversion Table, and Data Qualifier Definitions

A-1.0 ACRONYMS AND ABBREVIATIONS

ALK	alkalinity
AK	acceptable knowledge
AOC	area of concern
BCG	Biota Concentration Guides (DOE)
bgs	below ground surface
cfs	cubic feet per second
CFR	Code of Federal Regulations
CME	corrective measures evaluation
CMI	corrective measures implementation
Consent Order	Compliance Order on Consent
COPC	chemical of potential concern
CV	casing volume
DCG	Derived Concentration Guidelines (DOE)
DO	dissolved oxygen
DOE	Department of Energy (U.S.)
EES-14	Earth Systems Observations (Laboratory group)
EP	Environmental Programs (Directorate)
EPA	Environmental Protection Agency (U.S.)
F	filtered
FD	frequency of detection
FY	fiscal year
GBIR	Groundwater Background Investigation Report
GFM	geologic framework model
GW	groundwater
HE	high explosives (also HEXP)
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
IDW	investigation-derived waste
Interim Plan	Interim Facility-Wide Groundwater Monitoring Plan
IR	investigation report
LANL	Los Alamos National Laboratory
MCL	maximum contaminant level
MDA	material disposal area
MDL	method detection limit

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meq	milliequivalents
MOU	memorandum of understanding
MP	multiport system (Westbay)
MY	monitoring year
NIST	National Institute of Standards and Technology
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
NOI	notice of intent
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity unit
ORP	oxygen-reduction potential
PCB	polychlorinated biphenyl
PEB	performance evaluation blank
PETN	pentaerythritol tetranitrate
PMR	periodic monitoring report
PQL	practical quantitation limit
QA	quality assurance
QC	quality control
RACER	Risk Analysis, Communication, Evaluation, and Reduction (database)
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5,trinitro-1,3,5-triazine
RFI	RCRA facility investigation
RLWTF	Radioactive Liquid Waste Treatment Facility
RPF	Records Processing Facility
RSL	Regional Screening Level (EPA)
SC	specific conductance
SMO	Sample Management Office
SOP	standard operating procedure
SU	standard unit
SVOC	semivolatile organic compound
SWMU	solid waste management unit
SWSC	Sanitary Wastewater Systems Consolidation
SWWS	Sanitary Wastewater Systems
TA	technical area

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TAL	target analyte list (EPA)
TATB	triaminotrinitrobenzene
TBD	to be determined
TCE	trichloroethene
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TNT	trinitrotoluene(2,4,6)
TNX	hexahydro-1,3,5-trinitroso-1,3,5-triazine
TOC	total organic carbon
TOCP	tri(o-cresyl)phosphate
TW	Test Well
UF	unfiltered
USGS	U.S. Geological Survey
USFS	U.S. Forest Service
VOC	volatile organic compound
WCSF	waste characterization strategy form
WWTP	waste water treatment plant

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A-2.0 METRIC CONVERSION TABLE

Multiply SI (Metric) Unit	by	To Obtain U.S. Customary Unit
kilometers (km)	0.622	miles (mi)
kilometers (km)	3281	feet (ft)
meters (m)	3.281	feet (ft)
meters (m)	39.37	inches (in.)
centimeters (cm)	0.03281	feet (ft)
centimeters (cm)	0.394	inches (in.)
millimeters (mm)	0.0394	inches (in.)
micrometers or microns (µm)	0.0000394	inches (in.)
square kilometers (km^2)	0.3861	square miles (mi^2)
hectares (ha)	2.5	acres
square meters (m^2)	10.764	square feet (ft^2)
cubic meters (m^3)	35.31	cubic feet (ft^3)
kilograms (kg)	2.2046	pounds (lb)
grams (g)	0.0353	ounces (oz)
grams per cubic centimeter (g/cm^3)	62.422	pounds per cubic foot (lb/ft^3)
milligrams per kilogram (mg/kg)	1	parts per million (ppm)
micrograms per gram (µg/g)	1	parts per million (ppm)
liters (L)	0.26	gallons (gal.)
milligrams per liter (mg/L)	1	parts per million (ppm)
degrees Celsius (°C)	9/5 + 32	degrees Fahrenheit (°F)

A-3.0 DATA QUALIFIER DEFINITIONS

Data Qualifier	Definition
U	The analyte was analyzed for but not detected.
J	The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.
J+	The analyte was positively identified, and the result is likely to be biased high.
J-	The analyte was positively identified, and the result is likely to be biased low.
UJ	The analyte was not positively identified in the sample, and the associated value is an estimate of the sample-specific detection or quantitation limit.
R	The data are rejected as a result of major problems with quality assurance/quality control (QA/QC) parameters.

Appendix B

Screening Information

B-1.0 OVERVIEW

Attachment B-1 to this appendix presents screening tables for groundwater and base-flow water-quality data used to optimize monitoring strategies for watersheds and area-specific monitoring groups in the Interim Facility-Wide Groundwater Monitoring Plan (the Interim Plan, prepared by Los Alamos National Laboratory (the Laboratory). Selection of the screening values for groundwater data follows the approach prescribed for the development of groundwater cleanup levels in Section VIII of the Compliance Order on Consent (the Consent Order). An analogous protocol is used to select screening values for base-flow surface-water data. The process used to select the cleanup levels from applicable standards or screening levels (Table B-1.0-1) is described in section B-2.0 for groundwater and section B-3.0 for base flow.

Groundwater and base-flow data from 2006 to 2010 are screened against one-half of the groundwater or base-flow cleanup level. Groundwater data are also screened against the Laboratory's groundwater background values (LANL 2007, 095817), where available.

The screening implemented in the tables (Attachment B-1 on CD) serves as a high-level screening tool consistent with U.S. Environmental Protection Agency (EPA) regulatory guidance (EPA 1996, 065402). The screening does not trigger actions or define unacceptable levels of contaminants in water. In this appendix, "screening" refers to identification of locations in a watershed or area-specific monitoring group where contaminant concentrations fall below screening levels and therefore do not require additional evaluation. On the other hand, where contaminant concentrations exceed a screening level, additional evaluation may be needed to determine actions. The screening levels include assumptions—such as residential land-use scenarios—that are protective for a wide range of site conditions but are generally more stringent than site-specific levels.

Attachment B-1 (on CD) presents screening tables organized by the six area-specific monitoring groups plus the general surveillance monitoring group in seven watersheds. Within each watershed or area-specific monitoring group, these screening tables are organized by analytical suite for each water type sampled. Groundwater types include springs, alluvial groundwater, intermediate-perched groundwater, and regional groundwater; surface water types are ephemeral and perennial base flow. Four screening tables are included in Attachment B-1:

- Table B1-1, Analytical Data Screening for Frequency of Detection in Each Watershed or Area-Specific Monitoring Group: Groundwater (Including Springs)
- Table B1-2, Analytical Data Screening for Frequency of Detection in Each Watershed or Area-Specific Monitoring Group: Base Flow
- Table B1-3, Analytical Data Screening for Frequency of Detection at Locations in Each Watershed or Area-Specific Monitoring Group: Groundwater (Including Springs)
- Table B1-4, Analytical Data Screening for Frequency of Detection at Locations in Each Watershed or Area-Specific Monitoring Group: Base Flow

For each water type in each watershed or area-specific monitoring group, the screening tables report statistics for analytes categorized by analytical suite, with statistics tabulated separately for filtered (F) and unfiltered (UF) samples:

- diesel range organics (DRO)
- dioxin/furans (DIOX/FUR)
- gasoline range organics (GRO)

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- general inorganics (GENINORG)
- herbicides (HERB)
- high explosives (HEXP)
- metals (METALS)
- polychlorinated biphenyls (PCB)
- PCB congeners (PCB CONGENER or PCB CONG)
- pesticides (PEST)
- radioactivity (RAD)
- semivolatile organic analytes (SVOA)
- volatile organic analytes (VOA)

The list of analytical suites and water types compiled for individual watersheds or area-specific monitoring group varies according to the availability of sampling locations and analytical data in that watershed for 2006 to 2010, the period of time covered by these tables. Table columns in Tables B1-1 and B1-2 summarize the following types of information:

- Analyte—the name of the analyte screened
- Method—analytical method(s)
- Units—unit of measurement
- Number of analyses—number of analyses available for screening, preceded by the less-than symbol (<) if all of the available analyses are classified as not detected
- Number of Detects—number of values classified as detected
- Number of Nondetects—number of values classified as not detected
- Min, Mean, and Max—minimum, mean, and maximum of detected values (or if in italics, minimum, mean, and maximum of the minimum detection levels)
- BV—applicable numerical background value, if available, used for screening
- Number >BV—number of detections greater than the background value
- Std—numerical value for the groundwater or base-flow cleanup level used for screening, if available
- Number>Std—number of detected values greater than the groundwater or base-flow cleanup level
- 1/2 Std—one-half of the numerical value for the groundwater or base-flow cleanup level
- Number >1/2 Std—number of detected values greater than one-half the groundwater or base-flow cleanup level
- Std Type—a reference for the groundwater or base-flow cleanup level

Abbreviations used for standards and screening levels in the table column "Std Type" are provided in Table B-1.0-1.

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B-2.0 PROTOCOL FOR SELECTING SCREENING LEVELS FOR GROUNDWATER DATA

Water quality data for groundwater (including springs) are compared to the groundwater cleanup levels, determined according to the process described in Section VIII of the Consent Order. The cleanup levels are selected from the lowest applicable standard or screening level (Table B-1.0-1):

- New Mexico Water Quality Control Commission (NMWQCC) Standards for Ground Water (20.6.2.3103 New Mexico Administrative Code [NMAC])
- EPA National Primary Drinking Water Regulations: maximum contaminant levels (MCLs) (40 Code of Federal Regulations [CFR] Part 141 through July 1, 2007)
- Consent Order groundwater screening level for perchlorate (Section VIII.A.1)
- U.S. Department of Energy (DOE) Derived Concentration Guidelines (DCGs) for radionuclides (ingested-water DCG based on a target limit of 4 mrem/yr) (DOE 5400.5, Figure III-1)

If no standard exists for a chemical analyte, groundwater data are compared against the EPA's Regional screening levels (RSLs) for tap water (EPA 2011, 204336). For compounds with screening levels based on cancer risk, the EPA's screening values in the RSL tables are based on a cancer risk of 10^{-6}. These risk levels are adjusted to a cancer risk of 10^{-5}, consistent with requirements in the Consent Order, by moving the decimal point one place to the right.

The screening process for groundwater also compares each analyte against background values for naturally occurring metals and general chemical parameters at or near the Laboratory. The background values for each groundwater zone (alluvial, intermediate, or regional) are from the groundwater background investigation report (LANL 2007, 094856; LANL 2010, 110535).

B-3.0 PROTOCOL FOR SCREENING BASE-FLOW SURFACE WATER DATA

The NMWQCC establishes surface water standards in the State of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC). Certain reaches of watercourses may have specific classification and have segment-specific designated uses. The designated uses for surface water are associated with use-specific water-quality criteria, including numeric criteria. Nonclassified surface waters are described as ephemeral, intermittent, or perennial, each of which also has corresponding designated uses described in 20.6.4 NMAC.

The Laboratory's sitewide monitoring program includes base-flow stations in reaches that are assigned to different watercourse classifications in 20.6.4 NMAC, each of which has its own set of water-quality criteria. In addition, the Laboratory collects samples from surface waters under tribal regulatory jurisdiction. Although these waters are specifically excluded from state regulation (20.6.4.7[DD] NMAC), they are nonetheless included in the screening in this Interim Plan.

The base-flow monitoring locations are assigned to one of two screening categories—perennial or ephemeral (Table B-3.0-1). Along with a hardness value, this category determines the screening levels used for data at each monitoring location. Water-quality data from these locations are compared with the base-flow cleanup level, determined as the lowest numeric standard among the designated uses.

Hardness-dependent screening levels used to screen data at each base-flow monitoring location in the 2011 Interim Plan are the geometric mean of hardness data (mg/L as $CaCO_3$) collected since 2006 at each location (Table B-3.0-1). Hardness-dependent acute and chronic criteria for dissolved aluminum, cadmium, chromium, copper, lead, manganese, nickel, silver, and zinc were used in accordance with the requirements of 20.6.4 NMAC.

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Radionuclide data for ephemeral and perennial surface-water locations are compared with the DOE Biota Concentration Guides (BCGs) (DOE 2002, 085637), as modified by site-specific BCGs for selected radionuclides (McNaughton et al. 2008, 106501).

B-4.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the New Mexico Environment Department Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

DOE (U.S. Department of Energy), July 2002. "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota," DOE Standard No. DOE-STD-1153-2002, U.S. Department of Energy, Washington, D.C. (DOE 2002, 085637)

EPA (U.S. Environmental Protection Agency), April 1996. "Soil Screening Guidance: User's Guide," EPA/540/R-96/018, Office of Solid Waste and Emergency Response, Washington, D.C. (EPA 1996, 065402)

EPA (U.S. Environmental Protection Agency), June 3011. "Regional Screening Level (RSL) Composite Table June 2011," Regional Screening Levels for Chemical Contaminants at Superfund Sites screening level/preliminary remediation goal website, tables available online at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm, Washington, D.C. (EPA 2011, 204336)

LANL (Los Alamos National Laboratory), May 2007. "Groundwater Background Investigation Report, Revision 3," Los Alamos National Laboratory document LA-UR-07-2853, Los Alamos, New Mexico. (LANL 2007, 095817)

LANL (Los Alamos National Laboratory), February 2007. "Groundwater Background Investigation Report, Revision 2," Los Alamos National Laboratory document LA-UR-07-0755, Los Alamos, New Mexico. (LANL 2007, 094856)

LANL (Los Alamos National Laboratory), August 2010. "Groundwater Background Investigation Report, Revision 4," Los Alamos National Laboratory document LA-UR-10-4827, Los Alamos, New Mexico. (LANL 2010, 110535)

McNaughton, M., P. Fresquez, and W. Eisele, May 2008. "Site-Representative Biota Concentration Guides at Los Alamos," Los Alamos National Laboratory document LA-UR-08-2783, Los Alamos, New Mexico. (McNaughton et al. 2008, 106501)

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Table B-1.0-1
Potentially Applicable Standards Used to Select Screening Levels

Type	Source	Description	Abbreviation[a]	Potential Applicability					
				Perennial Surface Water		Ephemeral Surface Water		Groundwater (Includes Springs)	
				F	UF	F	UF	F	UF
NMWQCC									
Standard	NMAC 20.6.4	Livestock Watering	NM LVSTK WTR STD	X	X	X	X		
Standard	NMAC 20.6.4	Wildlife Habitat	NM WQCC WLDLF HAB		X		X		
Standard	NMAC 20.6.4	Aquatic Life Acute	NM Aqu Acute[b]			X	X		
Standard	NMAC 20.6.4	Aquatic Life Chronic	NM Aqu Chronic[b]	X	X				
Standard	NMAC 20.6.4	Human Health Standard	NM HH OO	X	X	X	X		
Standard	NMAC 20.6.2	Groundwater Human Health Standards, Other Standards for Domestic Water Supply and Standards for Irrigation Use	NM GW STD					X	X
Consent Order									
Screening Level	Consent Order	Screening Level for Perchlorate in Groundwater	NM GW CONS					X	X
EPA									
Standard	40 CFR 141	EPA maximum contaminant levels	EPA MCL					X	X
Risk—human	EPA RSLs[c]	EPA Regional Screening Levels for Tapwater	EPA TAP SCRN LVL					X	X
DOE									
Risk—ecological	DOE Order 5400.5	DOE Biota Concentration Guides	DOE BCG WATER	X	X	X	X		
Risk—human	DOE Order 5400.5	DOE 4-mrem Drinking Water Derived Concentration Guidelines	DOE DW DCG					X	X

[a] Abbreviations used here and in the screening tables in Attachment B-1.

[b] Hardness-dependent.

[c] EPA RSLs (EPA 2011, 204336).

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Table B-3.0-1
Hardness Assignments Used to Select Screening Levels

Watershed	Location	Stream Type	Hardness (mg/L as $CaCO_3$)
Guaje	Guaje above Rendija	Ephemeral	40
Pueblo	Acid above Pueblo	Ephemeral	50
Pueblo	Pueblo 3	Ephemeral	80
Pueblo	Pueblo above Acid	Ephemeral	80
Pueblo	Pueblo above SR-502	Perennial	70
Los Alamos	DP above TA-21	Ephemeral	100
Los Alamos	DP below Meadow at TA-21	Ephemeral	100
Los Alamos	Los Alamos above DP Canyon	Ephemeral	50
Los Alamos	Los Alamos above SR-4	Ephemeral	60
Los Alamos	Los Alamos below Ice Rink	Perennial	40
Los Alamos	Los Alamos below LA Weir	Ephemeral	60
Los Alamos	Los Alamos Canyon near Otowi Bridge	Ephemeral	100
Sandia	Middle Sandia Canyon at terminus of persistent baseflow	Ephemeral	90
Sandia	Sandia below Wetlands	Perennial	100
Sandia	Sandia left fork at Asphalt Plant	Perennial	100
Sandia	Sandia right fork at Power Plant	Perennial	100
Sandia	South Fork of Sandia Canyon at E122	Ephemeral	100
Mortandad	E-1E	Ephemeral	90
Mortandad	E-1FW	Ephemeral	80
Mortandad	E-1W	Ephemeral	100
Mortandad	M-1E	Ephemeral	60
Mortandad	M-1W	Ephemeral	50
Mortandad	M-2E	Ephemeral	90
Mortandad	Mortandad below Effluent Canyon	Ephemeral	60
Mortandad	TS-1W	Ephemeral	60
Mortandad	TS-2E	Ephemeral	70
Pajarito	Pajarito 0.5 mi above SR-501	Perennial	30
Pajarito	Pajarito above Twomile	Ephemeral	50
Pajarito	Pajarito at Rio Grande	Ephemeral	70
Pajarito	Pajarito below confluences of South and North Anchor East Basin	Perennial	50
Pajarito	Pajarito below TA-18	Ephemeral	70
Pajarito	Two Mile Canyon below TA-59	Ephemeral	50
Pajarito	Twomile above Pajarito	Ephemeral	50
Water	Between E252 and Water at Beta	Perennial	50
Water	Canon de Valle below MDA P	Perennial	70
Water	Water above SR-501	Perennial	40
Water	Water at Beta	Perennial	50

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Table B-3.0-1 (continued)

Watershed	Location	Stream Type	Hardness (mg/L as $CaCO_3$)
Ancho	Ancho at Rio Grande	Ephemeral	50
Frijoles	Frijoles at Rio Grande	Perennial	40
Frijoles	Rio de los Frijoles at Bandelier	Perennial	30
White Rock	Rio Grande at Otowi Bridge	Perennial	100
White Rock	Buckman Diversion SW	Perennial	100
White Rock	Mortandad at Rio Grande	Ephemeral	100
White Rock	Rio Grande at Frijoles	Perennial	100

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Attachment B-1

Tables B1-1 to B1-4
(on CD included with this document)

Appendix C

Procedures, Methods, and
Investigation-Derived Waste Management

C-1.0 PROCEDURES FOR MEASURING GROUNDWATER LEVELS AND COLLECTING WATER SAMPLES

This section summarizes Los Alamos National Laboratory (LANL or the Laboratory) standard operating procedures (SOPs) used to measure groundwater levels and to collect groundwater, base-flow, and spring samples. These procedures are listed in the table below and are summarized in subsequent sections. These (or equivalent) procedures (or equivalent) will be used during sampling activities conducted in accordance with the revised 2011 Interim Facility-Wide Groundwater Monitoring Plan (the Interim Plan).

Procedure Identifier	Procedure Title	Applicability
Measurement of Groundwater Levels		
SOP-5223	Manual Groundwater Level Measurements	Procedure for measuring depth to groundwater and determining groundwater elevation in a monitoring well or an open borehole
EP-DIV-SOP-10010 (supersedes SOP-5227, R0)	Pressure Transducer Installation, Removal, and Maintenance	Procedure to install, remove, and maintain pressure transducers to monitor and record water-level data in monitoring wells and piezometers
SOP-5226	Westbay Pressure Transducer Installation, Removal, and Maintenance	Procedure to install, remove, and maintain pressure transducers to monitor and record water-level data in Westbay monitoring wells
SOP-5230	Groundwater Level Data Processing	Procedure to review and validate groundwater level data obtained from pressure transducers
EP-DIV-SOP-20006 (supersedes SOP-5260)	Pressure Monitoring of Packer Systems in Monitoring Wells	Procedure for monitoring and maintenance of Baski sampling system packers and temporary packers installed in water wells
Collection of Groundwater Samples		
EP-DIV-SOP-20032 (supersedes SOP-5232, R1)	Groundwater Sampling	Procedure for sampling groundwater using a dedicated submersible pump, Baski sampling system, or a portable pump
SOP-5225	Groundwater Sampling Using Westbay MP System	Procedure for sampling groundwater using the Westbay multiport (MP) system
EP-ERSS-SOP-5061	Field Decontamination of Equipment	Procedure for field decontamination of equipment
SOP-06.03	Sampling for Volatile Organic Compounds in Groundwater	Procedure for collecting groundwater samples for volatile organic compound (VOC) analysis
Collection of Surface Water and Spring Samples		
SOP-5224	Spring and Surface Water Sampling	Procedure for sampling springs and surface water
Measuring Field Parameters		
ENV-DO-203	Field Water Quality Analyses	Procedure for measuring field analytical water-quality parameters
Sample Preparation, Preservation, and Transportation		
EP-ERSS-SOP-5059	Field Quality Control Samples	Procedure for collection of field quality control (QC) samples, including field duplicates, equipment rinsate blanks, and trip blanks
SOP-219	Sample Control and Field Documentation	Procedure for establishing and maintaining sample traceability using sample control and field documentation
EP-ERSS-SOP-5056	Sample Containers and Preservation	Procedure specifying sample containers, collection and preservation techniques, and holding times

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Procedure Identifier	Procedure Title	Applicability
SOP-066	Filtering and Chemical Preservation of Water Samples	Procedure describes the process for the chemical preservation of storm water and groundwater samples
EP-ERSS-SOP-5057	Handling, Packaging, and Transporting Field Samples	Procedure for sample packaging and shipping
ENV-WQH-QP-029	Creating and Maintaining Chain of Custody	Procedure for generating an analytical request and maintaining chain of custody in the collection, management, and processing of water-quality samples
SOP-5255	Shipping of Environmental Samples by the WES SMO	Procedure for receiving, packaging, and shipping samples to analytical laboratories.
Field Activities Documentation		
SOP-5181	Notebook and Logbook Documentation for Environmental Directorate Technical and Field Activities	Procedure for documenting technical work and field activities in a notebook or logbook.
Waste Management		
SOP-5238	Characterization and Management of Environmental Program Waste	Procedure for characterizing and managing generated waste

C-2.0 SUMMARY OF FIELD INVESTIGATION METHODS

Method	Summary
General	The objective of this sampling program is to collect samples from wells, springs, or base-flow stations that are representative of physical and geochemical conditions in the targeted hydrogeologic unit. To meet this objective, sampling equipment, sampling methods, monitoring-well operation and maintenance, and sample-handling procedures are implemented such that the chemistry of the sample is not altered. The procedures summarized below have been developed to meet the above objective and to be consistent with the requirements of the Compliance Order on Consent.
Groundwater Level Measurements Referenced Procedures: • EP-DIV-SOP-10010, Pressure Transducer Installation, Removal, and Maintenance • SOP-5226, Westbay Pressure Transducer Installation, Removal and Maintenance • SOP-5223, Manual Groundwater Level Measurements • SOP-5230, Groundwater Level Data Processing	This summary applies to the collection of groundwater-level data. Groundwater levels are manually measured at predetermined intervals. Additionally, data is downloaded at wells with pressure transducers installed after each sampling event. Water levels cannot be manually measured in wells equipped with the Westbay sampling system; however, data from these wells are downloaded before and after each sampling event. Westbay transducers must be removed before sampling and reinstalled after each sampling event. Two methods are used to collect water-level data: • Pressure transducers are used to measure water levels in individual wells or well screens at specified intervals. Most wells sampled under the Interim Plan are monitored with pressure transducers. • Manual water-level measurements are routinely measured in wells not instrumented with pressure transducers. These measurements are also taken before purging and sampling alluvial wells. Manual water level measurements are also taken periodically to verify transducer readings. Data from pressure transducers are automatically recorded in a data logger for later retrieval and processing to calculate water levels. Information collected during manual water level measurements is documented on the Groundwater Level Measurement Form or Groundwater Level Project Field Form. Pressure transducers are periodically bench-tested to verify calibration.

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<table>
<tr><th>Method</th><th>Summary</th></tr>
<tr><td>Collection of Groundwater Samples Using Dedicated Submersible or Portable Pumping Systems
Referenced Procedures:
• EP-DIV-SOP-20032 Groundwater Sampling
• ENV-DO-203, Field Water Quality Analyses
• EP-ERSS-SOP-5056, Sample Containers and Preservation
• SOP-5238, Characterization and Management of Environmental Program Waste
• SOP-5181, Notebook and Logbook Documentation for Environmental Directorate Technical Field Activities</td><td>This summary applies to the use of an electric gear-driven Submersible Pump system, a bladder-pump system, a Bennett pump system, a Baski pump system, a hand-bailer system, and portable versions of the bladder pump and Bennett pump to sample wells.
• Wells are purged sufficiently before sample collection to ensure samples will be representative of formation water.
• The pumping rate should be adjusted, if possible, during purging so that excessive drawdown does not occur. Field crews may have limited ability to restrict flow, depending on the pumping system. Turning off the pump while purging regional and intermediate wells should be avoided unless absolutely necessary. Instead, the pumping rate should be slowed to prevent drawdown into the screen, whenever possible.
• The discharge rate is calculated either by using an in-line flow meter or by filling a bucket or bottle of known volume and dividing by the fill time. Flow rate is monitored at regular intervals during the purge, preferably once per casing volume and while the drop pipe is being cleared.
• In general, a well may be sampled once the following criteria have been met (see EP-DIV-SOP-20032 or details):
❖ A minimum of one casing volume (CV) has been removed for alluvial wells and a minimum of three CVs (plus drop pipe) have been removed for intermediate or regional wells (unless otherwise requested)
❖ The field indicator parameters have stabilized within their allowable ranges (as listed below) for at least three consecutive measurements taken a minimum of 3 or 5 min apart.
<table><tr><th>Field Parameter</th><th>Stabilization Criteria (Yeskis and Zavala 2002, 204429)</th></tr><tr><td>Turbidity</td><td>± 10% when turbidity is greater than 10 nephelometric turbidity units (NTUs)</td></tr><tr><td>Dissolved Oxygen</td><td>± 0.3 mg/L,</td></tr><tr><td>pH</td><td>± 0.1 Standard Unit (SU)</td></tr><tr><td>Specific Conductance</td><td>± 3%</td></tr><tr><td>Temperature</td><td>± 10% (per the Compliance Order on Consent)</td></tr></table>• Purge water is discharged under the notice of intent (NOI) with the New Mexico Environment Department (NMED) or containerized pending waste determination.
• Sample labels and documentation are completed for each sample following procedures referenced in this Interim Plan. All activities are documented in the field logbook and appropriate field forms.
• Chain-of-custody seals are applied to each sample container before samples are transported from the site.
• All samples are submitted to the Sample Management Office (SMO) and then shipped to the designated off-site analytical laboratory in a timely manner to allow the laboratory to conduct analyses within proper holding times.</td></tr>
</table>

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Method	Summary
Collection of Groundwater Samples Using Westbay System Referenced Procedures: • SOP-5225, Groundwater Sampling Using Westbay Sampling System • SOP-5226, Westbay Pressure Transducer Installation, Removal and Maintenance • ENV-DO-203, Field Water Quality Analyses • EP-ERSS-SOP-5056, Sample Containers and Preservation	This summary applies to the sampling of wells equipped with the Westbay multiport (MP) system, a multilevel groundwater monitoring system. Samples are collected using a dedicated closed-access tube with valved ports that provide access to multiple levels of a borehole through a single well casing. The Westbay system is designed to allow for sampling without purging under normal aquifer conditions and takes samples at an in situ pressure. • The Westbay MP system consists of casing components that are permanently installed in the final casing, portable pressure measurement and sampling probes, and specialized tools. • The sampling probes are lowered to a precise port depth from which the sample is collected. This sampling system is a non-purge system so no purge water is generated. • Samples are collected directly into the sampling probe's sample containers and are transferred into the appropriate sample containers as soon as possible. • Data collected during sampling, including port pressures and field parameters, are documented on the appropriate forms in SOP-5225. • The sample probe and sample containers are the only equipment or materials that are reused and are decontaminated between sampling each port, as described in SOP-5225. • Sample labels and documentation are completed for each sample following procedures referenced in this Interim Plan. Samples are delivered to SMO and shipped to the designated off-site analytical laboratory in a timely manner to allow the samples to be analyzed within proper holding times.
Collection of Spring and Surface Water Samples Referenced Procedures: • ENV-DO-203, Field Water Quality Analyses • SOP-5224, Spring and Surface Water Sampling • EP-ERSS-SOP-5056, Sample Containers and Preservation • ENV-WQH-SOP-009, Operation and Maintenance of Stream Gauge Stations	This summary applies to collecting water-quality samples from base-flow sites and springs. • Permanent spring and base-flow sampling sites are usually identified by posts or gaging stations. However, this may not be possible at some sites. • Ideally, samples are collected from flowing water. In some cases, the samples may need to be collected from pooled or ponded water. Samples are collected far enough upstream of a confluence so the sample is not influenced by water from another stream. If there is any question about whether a representative sample can be collected, field personnel are instructed to contact the requestor before proceeding. • Samples may be collected using either the direct containment method, or by using a peristaltic pump. Filtered samples must be collected using a peristaltic pump. • Where both field conditions and flow conditions allow, take a discharge measurement using one of the methods outlined in SOP-5224. Discharge may be estimated where quantitative measurements are not possible. • Sample labels and documentation are completed for each sample following procedures referenced in this Interim Plan. All activities are documented in the field logbook and appropriate field forms. • Samples are delivered to SMO and shipped to the designated off-site analytical laboratory in a timely manner to allow the samples to be analyzed within proper holding times.

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Method	Summary
Sample Bottles and Preservation of Samples Referenced Procedure: • EP-ERSS-SOP-5056, Sample Containers and Preservation • SOP-066, Filtering and Chemical Preservation of Water Samples	This summary applies to requirements for sampling containers, sample pretreatment, and sample preservation requirements that are applicable to all water-quality samples. • All samples are collected in containers specifically prepared for that given parameter. • Sample containers are pre-cleaned to a 300 Series (I-Chem, ESS) and are commercially available through a number of vendors. • For filtered samples for the analysis of dissolved constituents, the following systems will be used: ❖ in-line 0.45-µm disposable filter capsules, ❖ in-line filter holders with 0.45-µm filter membranes, or ❖ in-line 0.02-µm disposable filter capsules (for samples requiring microfiltration only). • Samples are preserved in accordance with Attachment 1 to SOP-5056. Samples are preserved and pH tested immediately after collection.
Handling, Packaging, and Shipping of Samples Referenced Procedures: • EP-ERSS-SOP-5057, Handling, Packaging, and Transporting Field Samples • SOP-5255, Shipping of Environmental Samples by the WES SMO	This summary applies to requirements for handling, packaging, and shipping of samples. • After all samples are collected and preserved, the sample containers are wiped off and custody tape is applied before packaging. • Samples for off-site analysis are transported to the SMO for shipment to off-site analytical laboratories. • The sampling personnel will coordinate with the SMO regarding shipment of all samples.
Sample Documentation Referenced Procedures: • SOP-219, Sample Control and Field Documentation • ENV-WQH-QP-028, Creating and Maintaining Chain-of-Custody • EP-ERSS-SOP-5057, Handling, Packaging, and Transporting Field Samples • SOP-5181, Notebook and Logbook Documentation for Environmental Directorate Technical Field Activities	This summary applies to requirements for documentation of sample collection. • The requested parameters, preservation and bottle type, chain-of-custody, required field parameters, and any other additional information are included on the analytical request generated from the database. • All sampling activities are documented in the field logbooks and appropriate field forms. • Chain of custody is documented on the analytical request form and signed to verify that the samples were not left unattended. • All field information, date and time of sample, purging and final field parameters, field conditions, and sampling personnel are included in the specific sampling method field sheets.

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Method	Summary
Field Quality Assurance/Quality Control Samples Referenced Procedure: • ENV-WQH-QP-028, Creating and Maintaining Chain-of-Custody	Field quality assurance (QA)/QC samples are required by the Consent Order, and are discussed in detail in Appendix E. Field QA/QC samples to be collected are summarized below. • Field blanks are collected at a frequency of 10% of all samples collected. • Equipment rinsate blanks are collected at a minimum frequency of 1 per day when non-dedicated sampling equipment is used. • Field duplicates are collected at a rate of 10% of all samples by media type, with a minimum of one duplicate collected per sample batch. • Trip blanks are included with any coolers containing samples submitted for VOC analysis. • Performance evaluation blanks will be submitted on an as-needed basis to evaluate the reagent-grade water used for decontamination and preparation of blanks.

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C-3.0 METHODS AND INSTRUMENTS USED FOR FIELD MEASUREMENTS

Field Parameter	Method Description	U.S. Environmental Agency—Approved Methods	Primary Field Instrument(s)	Primary Flow-Through Cell Used/Type	Description
pH	Hydrogen ion, pH (pH units): electrometric measurement	EPA: Method 150.1 Standard Methods,* 4500-H^+ B Editions 18th, 19th, 20th	YSI 650 Handheld Multiparameter Instrument	YSI 650 cell	Samples will be analyzed for pH and temperature in the field using a flow-through cell during well purging and at the time of sample collection. The listed instrument is commercially available with a temperature sensor for automatic compensation. A calibration check is performed on the meter using the manufacturer's instructions with standard buffers traceable to National Institute of Standards and Technology (NIST) and recorded. Standards are purchased from commercial vendors.
Temperature	Temperature, thermometric (°C)	EPA: Method 170.1 Standard Methods, 2550 B Editions 18th, 19th, 20th	YSI 650 Handheld Multiparameter Instrument	YSI 650 cell	Samples will be analyzed for temperature concurrently with pH measurement in the field using a flow-through cell during well purging and at the time of sample collection. The listed instruments are commercially available with a temperature sensor for automatic compensation.
Specific Conductance	Electrical conductance (micromhos/cm at 25°C): Wheatstone bridge	EPA: Method 120.1 Standard Methods, 2510 B Editions 18th, 19th, 20th	YSI 650 Handheld Multiparameter Instrument	YSI 650 cell	Samples will be analyzed for specific conductance in the field using a flow-through cell during well purging and at the time of sample collection. The listed instruments are commercially available with a temperature sensor for automatic compensation. A calibration check is performed on the meter using the manufacturer's instructions with standard buffers traceable to NIST and is recorded. Standards are purchased from commercial vendors.
Dissolved Oxygen	Oxygen, dissolved (mg/L): electrode	EPA: Method 360.1 Standard Methods, 4500-O G Editions 18th, 19th, 20th	YSI 650 Handheld Multiparameter Instrument	YSI 650 cell	Samples will be analyzed for dissolved oxygen in the field using a flow-through cell during well purging and at the time of sample collection. The listed instruments are commercially available with a temperature sensor for automatic compensation. The meter is calibrated using the manufacturer's instructions and is recorded.

Field Parameter	Method Description	U.S. Environmental Agency–Approved Methods	Primary Field Instrument(s)	Primary Flow-Through Cell Used/Type	Description
Turbidity	NTU	EPA: Method 180.1 Standard Methods, 2130 B Editions 18th, 19th, 20th	Hach 2100P, YSI 650 Handheld Multiparameter Instrument	Single sample aliquot application	Samples will be analyzed for turbidity in the field using a single aliquot during well purging and at the time of sample collection. The listed instruments are commercially available, and a calibration check is performed on the meter using the manufacturer's instructions. The YSI 650 Handheld Multiparameter Instrument serves as a back-up in case the primary instrument fails.
Oxidation Reduction Potential	Reduction-oxidation potential (mV): electrode method	Standard Methods, 2580 A Editions 18th, 19th, 20th	YSI 650 Handheld Multiparameter Instrument	YSI 650 cell	Samples will be analyzed for oxidation-reduction potential in the field using a flow-through cell during well purging and at the time of sample collection. The listed instruments are commercially available with a temperature sensor for automatic compensation. A calibration check is performed on the meter using the manufacturer's instructions and is recorded.

* "Standard Methods" refers to editions of the Standard Methods for the Examination of Water and Wastewater, published by the American Public Health Association (Washington, D.C.).

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C-4.0 ANALYTICAL METHODS—GROUNDWATER ANALYTICAL SUITES

C-4.1 Analyses by Accredited Contract Laboratories

Samples for laboratory analysis are submitted to accredited contract laboratories. The contract laboratories are required to establish method detection limits (MDLs) and practical quantitation limits (PQLs) for target analytes.

The MDL is the minimum concentration of an analyte that can be measured and reported with a 99% confidence that the concentration is greater than zero, as determined by the procedure set forth at Appendix B of 40 Code of Federal Regulations Part 136. The MDL is based on prepared spiked samples that go through the entire sample preparation scheme before they are analyzed. Most often, the MDL samples are analyzed by the contract laboratories under ideal conditions when the analytical instrumentation has been recently serviced, cleaned, and calibrated.

The PQL is the lowest concentration that can be reliably measured within specified limits of precision, accuracy, representativeness, completeness, and comparability during *routine* laboratory operating conditions using approved U.S. Environmental Protection Agency (EPA) methods. In most cases the contract laboratories define the low spike on their initial calibration curve as the PQL. Generally, the PQL is 3 to 5 times higher than the MDL and should not be more than 10 times the MDL.

Tables C-4.1-1 and C-4.1-2 provide the mode (that is, most frequent value) for MDL and PQLs reported for 2010 analyses of groundwater and base-flow samples for the Laboratory by contract laboratories, organized by analytical suite and method. The number of sample analyses and detections (that is, results greater than the MDL) for the period from 2006 to 2010 are given. The tables include values for applicable cleanup and/or background levels for each analyte listed. The cleanup levels are derived as described in Appendix B-2.0, Protocol for Selecting Cleanup Levels. The background values are from the most recent NMED-approved report (LANL 2009, 106115, Table 4.2-3; NMED 2010, 109327).

A subset of Tables C-4.1-1 and C-4.1-2 appears in three tables that compare the PQLs with cleanup or background levels.

Table C-4.1-3 shows analytes with a PQL above the applicable groundwater cleanup level.

Table C-4.1-4 shows analytes with a PQL above the background values for alluvial, intermediate, and regional groundwater from Laboratory guidance (LANL 2009, 106115).

Table C-4.1-5 shows analytes with a PQL above the base-flow cleanup level.

Comments in these tables indicate the cases where the MDL is below the cleanup level for the analyte, thus meeting the Consent Order requirement (Section IX).

The background levels for seldom-detected analytes were based on the MDL. In some cases, background values were determined using data from an internal analytical laboratory. As a result of differences in analytical methods and variation of reported MDLs over time, some MDL values are slightly above a groundwater background level.

For comparison, the lowest of background values for intermediate and regional groundwater identified in the Groundwater Background Investigation Report, Revision 4 (LANL 2010, 110535) are also shown in Table C-4.1-4. These background values are substantially higher for several analytes.

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For most of the organic compounds where the MDL is higher than the cleanup level, the compound has seldom or never been detected in years of water samples, as indicated in Table C-4.1-3 for groundwater and Table C-4.1-5 for base flow.

The analytical services provided under contract to the Laboratory meet EPA requirements. Based on EPA 530-R-09-007 Unified Guidance (p. 2-7), "Any practical quantification limit (PQL) approved by the Regional Administrator under §264.97(h) [or §258.53(g)] that is used in the statistical method shall be the lowest concentration level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions available to the facility."

The Laboratory's primary analytical services provider is GEL Laboratories, LLC. GEL's client base includes 15 U.S. Department of Energy sites, 8 districts of the U.S. Army Corps of Engineers, the southern division of the U.S. Navy, several of the largest industrial manufacturers in southeastern U.S., and over 50 nuclear power plants in the U.S.

For the few instances where MDLs for analytes are higher than the cleanup levels for results reported in 2010, the MDLs are based on routine laboratory operating conditions available to the Laboratory. Most of these cases involve volatile or semivolatile organic compounds analyzed by EPA Methods SW-846:8260B and SW-846:8270C. Eighty compounds are analyzed by volatile organic Method SW-846:8260B. Of these 80 compounds, 67 have groundwater cleanup levels, and in 61 of these cases the MDL is below the cleanup level. The Laboratory also receives 80 analytes analyzed by semivolatile organic Method SW-846:8270C. Of these 80 compounds, 69 have groundwater cleanup levels, and in 55 of these cases the MDL is below the cleanup level.

C-4.2 Analyses by On-Site Laboratories

Regulatory analyses that support Laboratory's characterization, cleanup, and monitoring programs are provided by external contract analytical laboratories. However, in some specific situations, samples are most appropriately submitted for on-site analysis by the Geochemistry and Geomaterials Research Laboratories (GGRL) in the Laboratory's Earth Systems Observations Group (EES-14). In-house analyses are often used in the following cases:

- When rapid turnaround data (e.g., less than 24 h) are required to support activities such as drilling, well development, or well rehabilitation. Such rapid turnaround analyses are unavailable (at reasonable cost) from external laboratories.
- When special studies are undertaken to develop and refine conceptual models for contaminant transport in the environment. Examples of such studies are stable isotope analyses and filtration studies.
- When a well screen is impacted by residual effects of drilling and construction and is not producing reliable or representative water-quality data that fully meet monitoring objectives.

Table C-4.2-1 lists the analytical methods, PQLs, and MDLs for analytes reported by GGRL in recent data packages submitted to the Laboratory. The analytical methods used by GGRL are the most recent EPA and industry-accepted extraction and analytical methods for chemical analyses of these analytes.

C-5.0 INVESTIGATION-DERIVED WASTE MANAGEMENT

This section describes how investigation-derived waste (IDW) generated during the groundwater monitoring activities conducted under this Interim Plan will be managed. IDW is waste generated as a

result of field-investigation activities and may include, but is not limited to, purge water, contact waste, decontamination fluids, and all other wastes that has potentially come into contact with contaminants. IDW generated during implementation of the Interim Plan will be managed to protect human health and the environment, comply with applicable regulatory requirements, and adhere to Laboratory waste minimization goals.

All IDW generated during groundwater-monitoring activities will be managed in accordance with applicable Environmental Programs Directorate SOPs, which incorporate the requirements of all applicable EPA and NMED regulations, DOE orders, and Laboratory requirements. The SOP applicable to the characterization and management of IDW is

- SOP-5238, Characterization and Management of Environmental Program Waste, available at http://www.lanl.gov/environment/all/qa/adep.shtml.

The Los Alamos National Security, LLC, Hazardous Waste Minimization Plan (LANL 2009, 109324) will be implemented during groundwater monitoring to minimize waste generation. This document is updated annually as a requirement of Permit Section 2.9 of the Laboratory's Hazardous Waste Facility Permit.

The IDW waste streams associated with groundwater monitoring are identified in the table below and are briefly described below. The estimated volumes of these waste streams that may be generated during the implementation of this Interim Plan are summarized in Table C-5.0-1.

A waste characterization strategy form (WCSF) will be prepared and approved per requirements of SOP-5238. The WCSF will provide detailed information on IDW characterization methods, management, containerization, and potential volumes. IDW characterization is completed through review of sampling data and/or documentation or by direct sampling of the IDW or the media being investigated (e.g., groundwater, surface soil, subsurface soil). Waste characterization may include a review of historical information and process knowledge to identify whether listed hazardous waste may be present (i.e., due diligence reviews). If low levels of hazardous waste from a listed source are identified, a "contained in" determination may be submitted for approval to NMED.

Wastes will be containerized and placed in clearly marked, appropriately constructed waste accumulation areas. Waste accumulation area postings, regulated storage duration, and inspection requirements will be based on the type of IDW and its classification. Container and storage requirements will be detailed in the WCSF and approved before the waste is generated. Transportation and disposal requirements will also be detailed in the WCSF and approved before waste is generated.

Waste Determinations

The number of sampling events needed to make Resource Conservation and Recovery Act (RCRA) waste determinations will be based on acceptable knowledge (AK) of groundwater conditions within a watershed at the well or surface sample location. AK includes a review of historical information and process knowledge to identify whether hazardous waste, from a listed source, may be present (i.e., due diligence reviews).

The number of sampling events needed to make the waste determination for a given location is summarized as follows:

- For locations where existing AK demonstrates no RCRA hazardous waste or hazardous constituents above RCRA regulatory limits, a minimum of one sampling event will be used annually to confirm the nonhazardous waste determination. This waste determination will be reevaluated with data from subsequent sampling campaigns.
- For new wells with no existing AK, two consecutive sampling events will be conducted to ensure reproducibility and to establish reliable AK. Wastes generated during the first sampling event will be characterized by the data collected during the event. These wastes will be managed in accordance with the regulatory classification.
- For locations where RCRA hazardous constituents are suspected to exhibit a characteristic or sporadic, but not confirmed, the waste will initially be managed as hazardous. Once data is received from the first sampling event, waste will be managed and disposed of according to the analytical results. Waste generated from subsequent sampling events will be managed using AK from previous events until analytical data is available.

For new locations at or near a known listed hazardous waste source, that does not have a "contained in" determination, waste will be managed as hazardous until a due diligence can be performed. If a listed hazardous waste source is identified and low levels of listed hazardous waste constituents are detected, a "contained in" determination may be submitted to NMED for approval.

- For locations where IDW has been identified as RCRA hazardous waste, subsequent IDW generated at the location will be managed as hazardous waste until the data from four consecutive sampling events contain no RCRA hazardous waste or hazardous constituents above RCRA regulatory limits. At this point, the waste will be managed as nonhazardous.

Where RCRA constituents are detected, the following steps may be taken to complete the waste determination:

- Where duplicate groundwater samples are collected during the same sampling event and one is a nondetect and the other is detected, the Laboratory assumes the detection is the result of laboratory or field contamination. The detection will not be used for waste determination.
- When an F-, U-, P-, or K-listed contaminant is detected, the sources contributing to the watershed will be evaluated (i.e., due diligence reviews). If there is no documentation that these contaminants are from listed processes, the waste will be managed as nonhazardous.
- Sampling purge water will be managed in accordance with the most current version of ENV-RCRA-SOP-010, Land Application of Groundwater, as amended by the NMED-approved LANL Drilling, Development, Rehabilitation and Sampling Purge Water Decision Tree—Revised 03/12/2010 (NMED 2010, 109025).

Waste Management

Purge water: This waste stream consists of water purged from wells before and during sampling. The management of nonhazardous purge water will comply with ENV-RCRA-SOP-010, Land Application of Groundwater. If the purge water is hazardous, it will be managed in accordance with hazardous waste management requirements.

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Purge water will be characterized based on the results of the analysis of water samples from the well from which the purge water originated or by direct sampling and analysis of the purge water. Purge water will be land applied if it meets the criteria in the NMED-approved NOI for land application of groundwater.

Contact waste: The contact waste stream consists of potentially contaminated wastes that "contacted" purge water during sampling. This waste stream consists primarily of, but is not limited to, personal protective equipment such as gloves; decontamination wastes such as paper wipes; and disposable sampling supplies. Characterization of this waste stream will be performed through AK from analytical results for the environmental media (i.e., purge water) with which it came into contact or direct sampling of the containerized waste and a review of any potentially RCRA Hazardous Listed Waste sources. The Laboratory expects most of these contact wastes will be nonhazardous waste that will be disposed of at a New Mexico solid waste landfill or low-level waste that will be disposed of at Area G at Technical Area 54 (TA-54).

Decontamination fluids: The decontamination fluids waste stream will consist of liquid wastes from decontamination activities (i.e., decontamination solutions and rinse waters). Consistent with waste minimization practices, the Laboratory employs dry decontamination methods to the extent possible. If dry decontamination cannot be performed, liquid decontamination wastes will be collected in containers at the point of generation. The decontamination fluids will be characterized through AK of the waste materials, the levels of contamination observed in the environmental media (e.g., purge water) and, if necessary, direct sampling of the containerized waste. The Laboratory expects most of these wastes to be nonhazardous liquid waste or radioactive liquid waste that will be sent to one of its wastewater treatment facilities or a LANL approved offsite treatment facility.

C-6.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

LANL (Los Alamos National Laboratory), May 2007. "Groundwater Background Investigation Report, Revision 3," Los Alamos National Laboratory document LA-UR-07-2853, Los Alamos, New Mexico. (LANL 2007, 095817)

LANL (Los Alamos National Laboratory), May 2009. "2009 Interim Facility-Wide Groundwater Monitoring Plan," Los Alamos National Laboratory document LA-UR-09-1340, Los Alamos, New Mexico. (LANL 2009, 106115)

LANL (Los Alamos National Laboratory), November 2009. "Los Alamos National Security, LLC, Hazardous Waste Minimization Plan," Los Alamos National Laboratory document LA-UR-09-07682, Los Alamos, New Mexico. (LANL 2009, 109324)

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LANL (Los Alamos National Laboratory), August 2010. "Groundwater Background Investigation Report, Revision 4," Los Alamos National Laboratory document LA-UR-10-4827, Los Alamos, New Mexico. (LANL 2010, 110535)

NMED (New Mexico Environment Department), March 12, 2010. "LANL Drilling, Development, Rehabilitation and Sampling Purge Water Decision Tree Revision," New Mexico Environment Department letter to G. Turner (DOE-LASO) and T. George (LANL) from J.P. Bearzi (NMED-HWB) and W.C. Olsen (NMED-GWQB), Santa Fe, New Mexico. (NMED 2010, 109025)

NMED (New Mexico Environment Department), May 4, 2010. "Approval with Direction, 2009 Interim Facility-Wide Groundwater Monitoring Plan," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2010, 109327)

Yeskis, D., and B. Zavala, May 2002. "Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers," a *Ground Water Forum Issue Paper*, EPA 542-S-02-001, Office of Solid Waste and Emergency Response, Washington, D.C. (Yeskis and Zavala 2002, 204429)

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Table C-4.1-1
Analytes, Analytical Methods, and MDLs and PQLs Obtained for 2010 Analyses of Groundwater Samples by Contract Laboratories and Number of Sample Analyses and Detections for the Period 2006 to 2010

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Background[c]	Unit	Cleanup-Level Type
Diox/Fur	35822-46-9	Heptachlorodibenzodioxin[1,2,3,4,6,7,8-]	525	44	SW-846:8290		0.00005			µg/L	
Diox/Fur	37871-00-4	Heptachlorodibenzodioxins (Total)	525	91	SW-846:8290		0.00005			µg/L	
Diox/Fur	67562-39-4	Heptachlorodibenzofuran[1,2,3,4,6,7,8-]	525	28	SW-846:8290		0.00005			µg/L	
Diox/Fur	55673-89-7	Heptachlorodibenzofuran[1,2,3,4,7,8,9-]	525	0	SW-846:8290		0.00005			µg/L	
Diox/Fur	38998-75-3	Heptachlorodibenzofurans (Total)	525	47	SW-846:8290		0.00005			µg/L	
Diox/Fur	39227-28-6	Hexachlorodibenzodioxin[1,2,3,4,7,8-]	525	1	SW-846:8290		0.00005			µg/L	
Diox/Fur	57653-85-7	Hexachlorodibenzodioxin[1,2,3,6,7,8-]	525	2	SW-846:8290		0.00005			µg/L	
Diox/Fur	19408-74-3	Hexachlorodibenzodioxin[1,2,3,7,8,9-]	525	2	SW-846:8290		0.00005			µg/L	
Diox/Fur	34465-46-8	Hexachlorodibenzodioxins (Total)	525	8	SW-846:8290		0.00005			µg/L	
Diox/Fur	70648-26-9	Hexachlorodibenzofuran[1,2,3,4,7,8-]	525	11	SW-846:8290		0.00005			µg/L	
Diox/Fur	57117-44-9	Hexachlorodibenzofuran[1,2,3,6,7,8-]	525	4	SW-846:8290		0.00005			µg/L	
Diox/Fur	72918-21-9	Hexachlorodibenzofuran[1,2,3,7,8,9-]	525	0	SW-846:8290		0.00005			µg/L	
Diox/Fur	60851-34-5	Hexachlorodibenzofuran[2,3,4,6,7,8-]	525	2	SW-846:8290		0.00005			µg/L	
Diox/Fur	55684-94-1	Hexachlorodibenzofurans (Total)	525	32	SW-846:8290		0.00005			µg/L	
Diox/Fur	3268-87-9	Octachlorodibenzodioxin[1,2,3,4,6,7,8,9-]	525	79	SW-846:8290		0.0001			µg/L	
Diox/Fur	39001-02-0	Octachlorodibenzofuran[1,2,3,4,6,7,8,9-]	525	35	SW-846:8290		0.0001			µg/L	
Diox/Fur	40321-76-4	Pentachlorodibenzodioxin[1,2,3,7,8-]	525	2	SW-846:8290		0.00005			µg/L	
Diox/Fur	36088-22-9	Pentachlorodibenzodioxins (Total)	525	5	SW-846:8290		0.00005			µg/L	
Diox/Fur	57117-41-6	Pentachlorodibenzofuran[1,2,3,7,8-]	525	3	SW-846:8290		0.00005			µg/L	
Diox/Fur	57117-31-4	Pentachlorodibenzofuran[2,3,4,7,8-]	525	5	SW-846:8290		0.00005			µg/L	
Diox/Fur	30402-15-4	Pentachlorodibenzofurans (Totals)	525	26	SW-846:8290		0.00005			µg/L	
Diox/Fur	1746-01-6	Tetrachlorodibenzodioxin[2,3,7,8-]	525	0	SW-846:8290		0.00001	0.00003		µg/L	EPA MCL
Diox/Fur	41903-57-5	Tetrachlorodibenzodioxins (Total)	525	1	SW-846:8290		0.00001			µg/L	
Diox/Fur	51207-31-9	Tetrachlorodibenzofuran[2,3,7,8-]	525	1	SW-846:8290		0.00001			µg/L	
Diox/Fur	55722-27-5	Tetrachlorodibenzofurans (Totals)	525	7	SW-846:8290		0.00001			µg/L	
DRO	TPH-DRO	Total Petroleum Hydrocarbons Diesel Range Organics	64	25	SW-846:8015M	65	200			µg/L	
Geninorg	ALK-CO3	Alkalinity-CO3	2678	351	EPA:310.1	0.73	1			mg/L	
Geninorg	ALK-CO3+HCO3	Alkalinity-CO3+HCO3	2680	2677	EPA:310.1	0.73	1		52	mg/L	
Geninorg	NH3-N	Ammonia as Nitrogen	2706	497	EPA:350.1	0.016	0.05		0.04	mg/L	
Geninorg	Br(-1)	Bromide	2699	669	EPA:300.0	0.066	0.2		0.03	mg/L	
Geninorg	Ca	Calcium	4761	4756	SW-846:6010B	0.05	0.2		17.3	mg/L	
Geninorg	Cl(-1)	Chloride	2733	2727	EPA:300.0	0.066	0.2	250	3.57	mg/L	NM GW STD
Geninorg	CN(TOTAL)	Cyanide (Total)	2169	222	EPA:335.4	0.0017	0.005	0.2		mg/L	EPA MCL
Geninorg	F(-1)	Fluoride	2748	2647	EPA:300.0	0.033	0.1	1.6	0.23	mg/L	NM GW STD
Geninorg	HARDNESS	Hardness	4733	4727	SM:A2340B	0.35	1.24			mg/L	

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Table C-4.1-1 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Background[c]	Unit	Cleanup-Level Type
Geninorg	Mg	Magnesium	4761	4748	SW-846:6010B	0.085	0.3		4.15	mg/L	
Geninorg	NO3+NO2-N	Nitrate-Nitrite as Nitrogen	2700	2343	EPA:353.2	0.01	0.05	10	0.57	mg/L	EPA MCL
Geninorg	C2O4	Oxalate	7	0	EPA:300.0	0.33	1			mg/L	
Geninorg	ClO4	Perchlorate	3364	2541	SW-846:6850	0.05	0.2	4	0.05	µg/L	NM GW CONS
Geninorg	pH	pH	2671	2671	EPA:150.1	0.01	0.1			SU	
Geninorg	K	Potassium	4761	4748	SW-846:6010B	0.05	0.15		2.63	mg/L	
Geninorg	Na	Sodium	4761	4756	SW-846:6010B	0.1	0.3		12.2	mg/L	
Geninorg	SO4(-2)	Sulfate	2731	2712	EPA:300.0	0.1	0.4	600	7.2	mg/L	NM GW STD
Geninorg	SSC	Suspended Sediment Concentration	502	245	EPA:160.2	0.76	3.33			mg/L	
Geninorg	TDS	Total Dissolved Solids	2708	2703	EPA:160.1	2.4	10	1000	127	mg/L	NM GW STD
Geninorg	TKN	Total Kjeldahl Nitrogen	3142	1084	EPA:351.2	0.033	0.1		0.04	mg/L	
Geninorg	TOC	Total Organic Carbon	2273	1898	SW-846:9060	0.33	1		0.33	mg/L	
Geninorg	PO4-P	Total Phosphate as Phosphorus	2606	821	EPA:365.4	0.015	0.05		0.05	mg/L	
Geninorg	TSS	Total Suspended Solids	116	65	EPA:160.2	2.3	10			mg/L	
GRO	TPH-GRO	Total Petroleum Hydrocarbons Gasoline Range Org	11	7	SW-846:8015M	11	50			µg/L	
Herb	94-75-7	D[2,4-]	388	0	SW-846:8151A	0.087	0.26	70		µg/L	EPA MCL
Herb	75-99-0	Dalapon	388	0	SW-846:8151A	1.3	5.3	200		µg/L	EPA MCL
Herb	94-82-6	DB[2,4-]	388	2	SW-846:8151A	0.087	0.26	290		µg/L	EPA TAP SCRN LVL
Herb	1918-00-9	Dicamba	388	0	SW-846:8151A	0.087	0.26	1100		µg/L	EPA TAP SCRN LVL
Herb	120-36-5	Dichlorprop	388	0	SW-846:8151A	0.087	0.26			µg/L	
Herb	88-85-7	Dinoseb	388	0	SW-846:8151A	0.087	0.26	7		µg/L	EPA MCL
Herb	94-74-6	MCPA	388	0	SW-846:8151A	12	53	18		µg/L	EPA TAP SCRN LVL
Herb	93-65-2	MCPP	388	0	SW-846:8151A	11	53	37		µg/L	EPA TAP SCRN LVL
Herb	93-76-5	T[2,4,5-]	388	0	SW-846:8151A	0.087	0.26	370		µg/L	EPA TAP SCRN LVL
Herb	93-72-1	TP[2,4,5-]	388	0	SW-846:8151A	0.087	0.26	50		µg/L	EPA MCL
Hexp	6629-29-4	2,4-Diamino-6-nitrotoluene	1739	17	SW-846:8321	0.39	1.3			µg/L	
Hexp	59229-75-3	2,6-Diamino-4-nitrotoluene	1739	9	SW-846:8321	0.39	1.3			µg/L	
Hexp	618-87-1	3,5-Dinitroaniline	1739	25	SW-846:8321	0.39	1.3			µg/L	
Hexp	19406-51-0	Amino-2,6-dinitrotoluene[4-]	1740	121	SW-846:8321	0.1	0.33	73		µg/L	EPA TAP SCRN LVL
Hexp	35572-78-2	Amino-4,6-dinitrotoluene[2-]	1740	97	SW-846:8321	0.1	0.33	73		µg/L	EPA TAP SCRN LVL
Hexp	99-65-0	Dinitrobenzene[1,3-]	1740	1	SW-846:8321	0.1	0.33	3.7		µg/L	EPA TAP SCRN LVL
Hexp	121-14-2	Dinitrotoluene[2,4-]	1740	14	SW-846:8321	0.1	0.33	2.2		µg/L	EPA TAP SCRN LVL
Hexp	606-20-2	Dinitrotoluene[2,6-]	1740	2	SW-846:8321	0.1	0.33	37		µg/L	EPA TAP SCRN LVL
Hexp	DNX	DNX	1234	42	SW-846:8330	0.069	0.5			µg/L	
Hexp	2691-41-0	HMX	1742	231	SW-846:8321	0.1	0.33	1800		µg/L	EPA TAP SCRN LVL
Hexp	MNX	MNX	1234	80	SW-846:8330	0.091	0.5			µg/L	
Hexp	98-95-3	Nitrobenzene	1740	2	SW-846:8321	0.1	0.33	1.2		µg/L	EPA TAP SCRN LVL

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Table C-4.1-1 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Background[c]	Unit	Cleanup-Level Type
Hexp	88-72-2	Nitrotoluene[2-]	1740	7	SW-846:8321	0.1	0.33	3.1		µg/L	EPA TAP SCRN LVL
Hexp	99-08-1	Nitrotoluene[3-]	1740	1	SW-846:8321	0.1	0.33	3.7		µg/L	EPA TAP SCRN LVL
Hexp	99-99-0	Nitrotoluene[4-]	1740	0	SW-846:8321	0.1	0.65	42		µg/L	EPA TAP SCRN LVL
Hexp	78-11-5	PETN	1740	0	SW-846:8321	0.13	1.3			µg/L	
Hexp	121-82-4	RDX	1742	260	SW-846:8321	0.1	0.33	6.1		µg/L	EPA TAP SCRN LVL
Hexp	3058-38-6	TATB	1739	3	SW-846:8321	0.39	1.3			µg/L	
Hexp	479-45-8	Tetryl	1740	0	SW-846:8321	0.13	0.65	150		µg/L	EPA TAP SCRN LVL
Hexp	TNX	TNX	1234	43	SW-846:8330	0.082	0.5			µg/L	
Hexp	99-35-4	Trinitrobenzene[1,3,5-]	1740	54	SW-846:8321	0.1	0.33	1100		µg/L	EPA TAP SCRN LVL
Hexp	118-96-7	Trinitrotoluene[2,4,6-]	1740	42	SW-846:8321	0.1	0.33	22		µg/L	EPA TAP SCRN LVL
Hexp	78-30-8	Tris (o-cresyl) phosphate	1739	0	SW-846:8321	0.39	1.3			µg/L	
Metals	Al	Aluminum	4766	1573	SW-846:6010B	68	200	5000	68	µg/L	NM GW STD
Metals	Sb	Antimony	4757	130	SW-846:6020	0.5	3	6	0.5	µg/L	EPA MCL
Metals	As	Arsenic	4758	1054	SW-846:6020	1.5	5	10	4.32	µg/L	EPA MCL
Metals	Ba	Barium	4761	4747	SW-846:6010B	1	5	1000	56.8	µg/L	NM GW STD
Metals	Be	Beryllium	4761	59	SW-846:6010B	1	5	4	1	µg/L	EPA MCL
Metals	B	Boron	4752	3373	SW-846:6010B	15	50	750	15.1	µg/L	NM GW STD
Metals	Cd	Cadmium	4756	183	SW-846:6020	0.11	1	5	1	µg/L	EPA MCL
Metals	Cr	Chromium	5093	3290	SW-846:6020	2.5	10	50	1	µg/L	NM GW STD
Metals	Co	Cobalt	4761	458	SW-846:6010B	1	5	50	0.5	µg/L	NM GW STD
Metals	Cu	Copper	4761	702	SW-846:6010B	3	10	1000	3	µg/L	NM GW STD
Metals	Fe	Iron	4766	2600	SW-846:6010B	30	100	1000	21	µg/L	NM GW STD
Metals	Pb	Lead	4756	857	SW-846:6020	0.5	2	15	0.5	µg/L	EPA MCL
Metals	Mn	Manganese	4766	2632	SW-846:6010B	2	10	200	2	µg/L	NM GW STD
Metals	Hg	Mercury	4732	103	EPA:245.2	0.066	0.2	2	0.06	µg/L	EPA MCL
Metals	Mo	Molybdenum	4730	2929	SW-846:6020	0.1	0.5	1000	2	µg/L	NM GW STD
Metals	Ni	Nickel	4756	3849	SW-846:6020	0.5	2	200	1	µg/L	NM GW STD
Metals	Se	Selenium	4756	269	SW-846:6020	1	5	50	6	µg/L	EPA MCL
Metals	SiO2	Silicon Dioxide	1718	1710	SW-846:6010B	0.053	0.213		50.7	mg/L	
Metals	Ag	Silver	4756	157	SW-846:6020	0.2	1	50	1	µg/L	NM GW STD
Metals	Sr	Strontium	4733	4728	SW-846:6010B	1	5	22000	120	µg/L	EPA TAP SCRN LVL
Metals	Tl	Thallium	4756	372	SW-846:6020	0.3	1	2	1	µg/L	EPA MCL
Metals	Sn	Tin	4733	84	SW-846:6010B	2.5	10	22000	3.26	µg/L	EPA TAP SCRN LVL
Metals	U	Uranium	4732	3954	SW-846:6020	0.05	0.2	30	0.72	µg/L	EPA MCL
Metals	V	Vanadium	4761	3819	SW-846:6010B	1	5	180	1	µg/L	EPA TAP SCRN LVL
Metals	Zn	Zinc	4763	2777	SW-846:6010B	3.3	10	10000	2	µg/L	NM GW STD
PCB	12674-11-2	Aroclor-1016	1170	1	SW-846:8082	0.033	0.1	0.5		µg/L	EPA MCL

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Table C-4.1-1 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Background[c]	Unit	Cleanup-Level Type
PCB	11104-28-2	Aroclor-1221	1170	0	SW-846:8082	0.033	0.1	0.5		µg/L	EPA MCL
PCB	11141-16-5	Aroclor-1232	1170	0	SW-846:8082	0.033	0.1	0.5		µg/L	EPA MCL
PCB	53469-21-9	Aroclor-1242	1170	5	SW-846:8082	0.033	0.1	0.5		µg/L	EPA MCL
PCB	12672-29-6	Aroclor-1248	1170	0	SW-846:8082	0.033	0.1	0.5		µg/L	EPA MCL
PCB	11097-69-1	Aroclor-1254	1171	9	SW-846:8082	0.033	0.1	0.5		µg/L	EPA MCL
PCB	11096-82-5	Aroclor-1260	1170	8	SW-846:8082	0.033	0.1	0.5		µg/L	EPA MCL
PCB	37324-23-5	Aroclor-1262	1169	0	SW-846:8082	0.033	0.1	0.5		µg/L	EPA MCL
Pest	309-00-2	Aldrin	1229	4	SW-846:8081A	0.005	0.02	0.04		µg/L	EPA TAP SCRN LVL
Pest	319-84-6	BHC[alpha-]	1229	1	SW-846:8081A	0.005	0.02	0.11		µg/L	EPA TAP SCRN LVL
Pest	319-85-7	BHC[beta-]	1229	1	SW-846:8081A	0.006	0.02	0.37		µg/L	EPA TAP SCRN LVL
Pest	319-86-8	BHC[delta-]	1229	4	SW-846:8081A	0.005	0.02			µg/L	
Pest	58-89-9	BHC[gamma-]	1229	4	SW-846:8081A	0.005	0.02	0.2		µg/L	EPA MCL
Pest	5103-71-9	Chlordane[alpha-]	1229	0	SW-846:8081A	0.005	0.02			µg/L	
Pest	5103-74-2	Chlordane[gamma-]	1229	3	SW-846:8081A	0.005	0.02			µg/L	
Pest	72-54-8	DDD[4,4'-]	1229	14	SW-846:8081A	0.01	0.04	2.8		µg/L	EPA TAP SCRN LVL
Pest	72-55-9	DDE[4,4'-]	1229	15	SW-846:8081A	0.005	0.04	2		µg/L	EPA TAP SCRN LVL
Pest	50-29-3	DDT[4,4'-]	1229	8	SW-846:8081A	0.01	0.04	2		µg/L	EPA TAP SCRN LVL
Pest	60-57-1	Dieldrin	1229	8	SW-846:8081A	0.01	0.04	0.042		µg/L	EPA TAP SCRN LVL
Pest	959-98-8	Endosulfan I	1229	4	SW-846:8081A	0.005	0.02			µg/L	
Pest	33213-65-9	Endosulfan II	1229	5	SW-846:8081A	0.011	0.045			µg/L	
Pest	1031-07-8	Endosulfan Sulfate	1229	6	SW-846:8081A	0.01	0.04			µg/L	
Pest	72-20-8	Endrin	1229	5	SW-846:8081A	0.01	0.04	2		µg/L	EPA MCL
Pest	7421-93-4	Endrin Aldehyde	1229	3	SW-846:8081A	0.005	0.04			µg/L	
Pest	53494-70-5	Endrin Ketone	1229	0	SW-846:8081A	0.01	0.04			µg/L	
Pest	76-44-8	Heptachlor	1229	10	SW-846:8081A	0.005	0.02	0.4		µg/L	EPA MCL
Pest	1024-57-3	Heptachlor Epoxide	1229	3	SW-846:8081A	0.005	0.02	0.2		µg/L	EPA MCL
Pest	72-43-5	Methoxychlor[4,4'-]	1229	0	SW-846:8081A	0.05	0.2	40		µg/L	EPA MCL
Pest	8001-35-2	Toxaphene (Technical Grade)	1229	1	SW-846:8081A	0.15	0.5	3		µg/L	EPA MCL
Rad	Am-241	Americium-241	2578	61	Alpha Spectroscopy	0.05		1.2	0.04	pCi/L	DOE DW DCG
Rad	Cs-137	Cesium-137	2552	3	Gamma Spectroscopy	8		120	5.8	pCi/L	DOE DW DCG
Rad	Co-60	Cobalt-60	2552	0	Gamma Spectroscopy	8		200		pCi/L	DOE DW DCG
Rad	GROSSA	Gross alpha	1821	377	Gas Proportional Counting	3		15	2.98	pCi/L	EPA MCL
Rad	GROSSB	Gross beta	1817	1079	Gas Proportional Counting	3			4	pCi/L	
Rad	GROSSG	Gross gamma	2552	145	Gamma Spectroscopy	120			648	pCi/L	
Rad	Np-237	Neptunium-237	2649	1	Alpha Spectroscopy	0.05		1.2		pCi/L	DOE DW DCG
Rad	Pu-238	Plutonium-238	2551	18	Alpha Spectroscopy	0.05		1.6	0.06	pCi/L	DOE DW DCG
Rad	Pu-239/240	Plutonium-239/240	2551	57	Alpha Spectroscopy	0.05		1.2		pCi/L	DOE DW DCG

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Table C-4.1-1 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Background[c]	Unit	Cleanup-Level Type
Rad	K-40	Potassium-40	2552	12	Gamma Spectroscopy	10		280		pCi/L	DOE DW DCG
Rad	Ra-226	Radium-226	612	187	Gas Proportional Counting	1		4		pCi/L	DOE DW DCG
Rad	Ra-226	Radium-226	612	187	Alpha Spectroscopy	1		4		pCi/L	DOE DW DCG
Rad	Ra-228	Radium-228	615	216	Gas Proportional Counting	1		4		pCi/L	DOE DW DCG
Rad	Na-22	Sodium-22	2552	0	Gamma Spectroscopy	10		400		pCi/L	DOE DW DCG
Rad	Sr-90	Strontium-90	2585	184	Gas Proportional Counting	0.5		8	0.29	pCi/L	EPA MCL
Rad	Tc-99	Technetium-99	60	0	Gas Proportional Counting	1		4000		pCi/L	DOE DW DCG
Rad	Th-228	Thorium-228	163	16	Alpha Spectroscopy	0.05				pCi/L	
Rad	Th-230	Thorium-230	163	10	Alpha Spectroscopy	0.05				pCi/L	
Rad	Th-232	Thorium-232	163	21	Alpha Spectroscopy	0.05				pCi/L	
Rad	H-3	Tritium	2454	1197	Liquid Scintillation Counting	250		20000	0.32	pCi/L	EPA MCL
Rad	U-234	Uranium-234	2559	2177	Alpha Spectroscopy	0.05		20	0.18	pCi/L	DOE DW DCG
Rad	U-235/236	Uranium-235/236	2559	360	Alpha Spectroscopy	0.05		24		pCi/L	DOE DW DCG
Rad	U-238	Uranium-238	2559	2144	Alpha Spectroscopy	0.05		24	0.19	pCi/L	DOE DW DCG
SVOA	83-32-9	Acenaphthene	2074	2	SW-846:8270C	0.33	1.1	2200		µg/L	EPA TAP SCRN LVL
SVOA	208-96-8	Acenaphthylene	2074	3	SW-846:8270C	0.21	1.1			µg/L	
SVOA	62-53-3	Aniline	2074	0	SW-846:8270C	2.5	10	120		µg/L	EPA TAP SCRN LVL
SVOA	120-12-7	Anthracene	2074	4	SW-846:8270C	0.21	1.1	11000		µg/L	EPA TAP SCRN LVL
SVOA	1912-24-9	Atrazine	2074	0	SW-846:8270C	3	10	3		µg/L	EPA MCL
SVOA	103-33-3	Azobenzene	2074	0	SW-846:8270C	2	10	1.3		µg/L	EPA TAP SCRN LVL
SVOA	92-87-5	Benzidine	2074	0	SW-846:8270C	3	10	0.00094		µg/L	EPA TAP SCRN LVL
SVOA	56-55-3	Benzo(a)anthracene	2074	6	SW-846:8270C	0.2	1	0.29		µg/L	EPA TAP SCRN LVL
SVOA	50-32-8	Benzo(a)pyrene	2074	9	SW-846:8270C	0.2	1	0.2		µg/L	EPA MCL
SVOA	205-99-2	Benzo(b)fluoranthene	2074	10	SW-846:8270C	0.2	1	0.29		µg/L	EPA TAP SCRN LVL
SVOA	191-24-2	Benzo(g,h,i)perylene	2074	6	SW-846:8270C	0.2	1			µg/L	
SVOA	207-08-9	Benzo(k)fluoranthene	2074	9	SW-846:8270C	0.2	1	2.9		µg/L	EPA TAP SCRN LVL
SVOA	65-85-0	Benzoic Acid	2074	28	SW-846:8270C	6	20	150000		µg/L	EPA TAP SCRN LVL
SVOA	100-51-6	Benzyl Alcohol	2074	0	SW-846:8270C	2	10	3700		µg/L	EPA TAP SCRN LVL
SVOA	111-91-1	Bis(2-chloroethoxy)methane	2074	0	SW-846:8270C	3	10	110		µg/L	EPA TAP SCRN LVL
SVOA	111-44-4	Bis(2-chloroethyl)ether	2074	0	SW-846:8270C	2	10	0.12		µg/L	EPA TAP SCRN LVL
SVOA	117-81-7	Bis(2-ethylhexyl)phthalate	2074	128	SW-846:8270C	2	10	6		µg/L	EPA MCL
SVOA	101-55-3	Bromophenyl-phenylether[4-]	2074	0	SW-846:8270C	2	10			µg/L	
SVOA	85-68-7	Butylbenzylphthalate	2074	0	SW-846:8270C	2	10	350		µg/L	EPA TAP SCRN LVL
SVOA	59-50-7	Chloro-3-methylphenol[4-]	2074	0	SW-846:8270C	2	10	3700		µg/L	EPA TAP SCRN LVL
SVOA	106-47-8	Chloroaniline[4-]	2074	0	SW-846:8270C	2	10	3.4		µg/L	EPA TAP SCRN LVL
SVOA	91-58-7	Chloronaphthalene[2-]	2074	2	SW-846:8270C	0.3	1	2900		µg/L	EPA TAP SCRN LVL
SVOA	95-57-8	Chlorophenol[2-]	2074	0	SW-846:8270C	2	10	180		µg/L	EPA TAP SCRN LVL

0251.5

Table C-4.1-1 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Background[c]	Unit	Cleanup-Level Type
SVOA	7005-72-3	Chlorophenyl-phenyl[4-] Ether	2074	0	SW-846:8270C	2	10			µg/L	
SVOA	218-01-9	Chrysene	2074	5	SW-846:8270C	0.2	1	29		µg/L	EPA TAP SCRN LVL
SVOA	53-70-3	Dibenz(a,h)anthracene	2074	4	SW-846:8270C	0.2	1	0.029		µg/L	EPA TAP SCRN LVL
SVOA	132-64-9	Dibenzofuran	2074	0	SW-846:8270C	2	10	37		µg/L	EPA TAP SCRN LVL
SVOA	95-50-1	Dichlorobenzene[1,2-]	2074	1	SW-846:8270C	2	10	600		µg/L	EPA MCL
SVOA	541-73-1	Dichlorobenzene[1,3-]	2074	16	SW-846:8270C	2	10			µg/L	
SVOA	106-46-7	Dichlorobenzene[1,4-]	2074	0	SW-846:8270C	2	10	75		µg/L	EPA MCL
SVOA	91-94-1	Dichlorobenzidine[3,3'-]	2074	0	SW-846:8270C	2	10	1.5		µg/L	EPA TAP SCRN LVL
SVOA	120-83-2	Dichlorophenol[2,4-]	2074	0	SW-846:8270C	2	10	110		µg/L	EPA TAP SCRN LVL
SVOA	84-66-2	Diethylphthalate	2074	48	SW-846:8270C	2	10	29000		µg/L	EPA TAP SCRN LVL
SVOA	131-11-3	Dimethyl Phthalate	2074	0	SW-846:8270C	2	10			µg/L	
SVOA	105-67-9	Dimethylphenol[2,4-]	2074	0	SW-846:8270C	2	10	730		µg/L	EPA TAP SCRN LVL
SVOA	84-74-2	Di-n-butylphthalate	2074	0	SW-846:8270C	2	10	3700		µg/L	EPA TAP SCRN LVL
SVOA	534-52-1	Dinitro-2-methylphenol[4,6-]	2074	0	SW-846:8270C	3	10	2.9		µg/L	EPA TAP SCRN LVL
SVOA	51-28-5	Dinitrophenol[2,4-]	2074	0	SW-846:8270C	5	20	73		µg/L	EPA TAP SCRN LVL
SVOA	121-14-2	Dinitrotoluene[2,4-]	2074	14	SW-846:8270C	2	10	2.2		µg/L	EPA TAP SCRN LVL
SVOA	606-20-2	Dinitrotoluene[2,6-]	2073	2	SW-846:8270C	2	10	37		µg/L	EPA TAP SCRN LVL
SVOA	117-84-0	Di-n-octylphthalate	2074	5	SW-846:8270C	3	10			µg/L	
SVOA	88-85-7	Dinoseb	2074	0	SW-846:8270C	2	10	7		µg/L	EPA MCL
SVOA	123-91-1	Dioxane[1,4-]	2010	119	SW-846:8270C	2	10	6.7		µg/L	EPA TAP SCRN LVL
SVOA	122-39-4	Diphenylamine	2069	0	SW-846:8270C	3	10	910		µg/L	EPA TAP SCRN LVL
SVOA	206-44-0	Fluoranthene	2074	4	SW-846:8270C	0.2	1	1500		µg/L	EPA TAP SCRN LVL
SVOA	86-73-7	Fluorene	2074	3	SW-846:8270C	0.2	1	1500		µg/L	EPA TAP SCRN LVL
SVOA	118-74-1	Hexachlorobenzene	2074	0	SW-846:8270C	2	10	1		µg/L	EPA MCL
SVOA	87-68-3	Hexachlorobutadiene	2074	0	SW-846:8270C	2	10	8.6		µg/L	EPA TAP SCRN LVL
SVOA	77-47-4	Hexachlorocyclopentadiene	2074	0	SW-846:8270C	3	10	50		µg/L	EPA MCL
SVOA	67-72-1	Hexachloroethane	2074	0	SW-846:8270C	2	10	48		µg/L	EPA TAP SCRN LVL
SVOA	193-39-5	Indeno(1,2,3-cd)pyrene	2074	5	SW-846:8270C	0.2	1	0.29		µg/L	EPA TAP SCRN LVL
SVOA	78-59-1	Isophorone	2074	0	SW-846:8270C	3	10	710		µg/L	EPA TAP SCRN LVL
SVOA	90-12-0	Methylnaphthalene[1-]	2072	3	SW-846:8270C	0.3	1	23		µg/L	EPA TAP SCRN LVL
SVOA	91-57-6	Methylnaphthalene[2-]	2074	2	SW-846:8270C	0.3	1	150		µg/L	EPA TAP SCRN LVL
SVOA	95-48-7	Methylphenol[2-]	2074	2	SW-846:8270C	2	10	1800		µg/L	EPA TAP SCRN LVL
SVOA	106-44-5	Methylphenol[4-]	1341	2	SW-846:8270C	3	10	180		µg/L	EPA TAP SCRN LVL
SVOA	91-20-3	Naphthalene	2074	3	SW-846:8270C	0.3	1	30		µg/L	NM GW STD
SVOA	88-74-4	Nitroaniline[2-]	2074	0	SW-846:8270C	2	10	370		µg/L	EPA TAP SCRN LVL
SVOA	99-09-2	Nitroaniline[3-]	2074	0	SW-846:8270C	2	10			µg/L	
SVOA	100-01-6	Nitroaniline[4-]	2074	0	SW-846:8270C	3	10	34		µg/L	EPA TAP SCRN LVL

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Table C-4.1-1 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Background[c]	Unit	Cleanup-Level Type
SVOA	98-95-3	Nitrobenzene	2074	2	SW-846:8270C	3	10	1.2		µg/L	EPA TAP SCRN LVL
SVOA	88-75-5	Nitrophenol[2-]	2074	0	SW-846:8270C	2	10			µg/L	
SVOA	100-02-7	Nitrophenol[4-]	2074	0	SW-846:8270C	2	10			µg/L	
SVOA	55-18-5	Nitrosodiethylamine[N-]	2074	0	SW-846:8270C	2	10	0.0014		µg/L	EPA TAP SCRN LVL
SVOA	62-75-9	Nitrosodimethylamine[N-]	2074	0	SW-846:8270C	2	10	0.0042		µg/L	EPA TAP SCRN LVL
SVOA	924-16-3	Nitroso-di-n-butylamine[N-]	2074	0	SW-846:8270C	3	10	0.024		µg/L	EPA TAP SCRN LVL
SVOA	621-64-7	Nitroso-di-n-propylamine[N-]	2074	0	SW-846:8270C	2	10	0.096		µg/L	EPA TAP SCRN LVL
SVOA	930-55-2	Nitrosopyrrolidine[N-]	2074	0	SW-846:8270C	2	10	0.32		µg/L	EPA TAP SCRN LVL
SVOA	108-60-1	Oxybis(1-chloropropane)[2,2'-]	2074	0	SW-846:8270C	2	10	3.2		µg/L	EPA TAP SCRN LVL
SVOA	608-93-5	Pentachlorobenzene	2074	0	SW-846:8270C	3	10	29		µg/L	EPA TAP SCRN LVL
SVOA	87-86-5	Pentachlorophenol	2074	1	SW-846:8270C	2	10	1		µg/L	EPA MCL
SVOA	85-01-8	Phenanthrene	2074	5	SW-846:8270C	0.2	1			µg/L	
SVOA	108-95-2	Phenol	2074	5	SW-846:8270C	1	10	5		µg/L	NM GW STD
SVOA	129-00-0	Pyrene	2074	2	SW-846:8270C	0.3	1	1100		µg/L	EPA TAP SCRN LVL
SVOA	110-86-1	Pyridine	1564	0	SW-846:8270C	3	10	37		µg/L	EPA TAP SCRN LVL
SVOA	95-94-3	Tetrachlorobenzene[1,2,4,5]	2074	0	SW-846:8270C	3	10	11		µg/L	EPA TAP SCRN LVL
SVOA	58-90-2	Tetrachlorophenol[2,3,4,6-]	2074	1	SW-846:8270C	2	10	1100		µg/L	EPA TAP SCRN LVL
SVOA	120-82-1	Trichlorobenzene[1,2,4-]	2074	1	SW-846:8270C	2	10	70		µg/L	EPA MCL
SVOA	95-95-4	Trichlorophenol[2,4,5-]	2074	0	SW-846:8270C	2	10	3700		µg/L	EPA TAP SCRN LVL
SVOA	88-06-2	Trichlorophenol[2,4,6-]	2074	0	SW-846:8270C	2	10	61		µg/L	EPA TAP SCRN LVL
VOA	67-64-1	Acetone	2543	253	SW-846:8260B	3.5	10	22000		µg/L	EPA TAP SCRN LVL
VOA	75-05-8	Acetonitrile	2543	5	SW-846:8260B	6.3	25	130		µg/L	EPA TAP SCRN LVL
VOA	107-02-8	Acrolein	2543	2	SW-846:8260B	1.3	5	0.042		µg/L	EPA TAP SCRN LVL
VOA	107-13-1	Acrylonitrile	2543	0	SW-846:8260B	1	5	0.45		µg/L	EPA TAP SCRN LVL
VOA	71-43-2	Benzene	2543	10	SW-846:8260B	0.3	1	5		µg/L	EPA MCL
VOA	108-86-1	Bromobenzene	2543	0	SW-846:8260B	0.25	1	88		µg/L	EPA TAP SCRN LVL
VOA	74-97-5	Bromochloromethane	2543	0	SW-846:8260B	0.3	1			µg/L	
VOA	75-27-4	Bromodichloromethane	2543	0	SW-846:8260B	0.25	1	80		µg/L	EPA MCL
VOA	75-25-2	Bromoform	2543	1	SW-846:8260B	0.25	1	80		µg/L	EPA MCL
VOA	74-83-9	Bromomethane	2543	2	SW-846:8260B	0.3	1	8.7		µg/L	EPA TAP SCRN LVL
VOA	71-36-3	Butanol[1-]	2004	6	SW-846:8260B	15	50	3700		µg/L	EPA TAP SCRN LVL
VOA	78-93-3	Butanone[2-]	2543	75	SW-846:8260B	1.3	5	7100		µg/L	EPA TAP SCRN LVL
VOA	104-51-8	Butylbenzene[n-]	2543	0	SW-846:8260B	0.25	1			µg/L	
VOA	135-98-8	Butylbenzene[sec-]	2543	0	SW-846:8260B	0.25	1			µg/L	
VOA	98-06-6	Butylbenzene[tert-]	2543	0	SW-846:8260B	0.25	1			µg/L	
VOA	75-15-0	Carbon Disulfide	2543	14	SW-846:8260B	1.3	5	1000		µg/L	EPA TAP SCRN LVL
VOA	56-23-5	Carbon Tetrachloride	2543	0	SW-846:8260B	0.3	1	5		µg/L	EPA MCL

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Table C-4.1-1 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Background[c]	Unit	Cleanup-Level Type
VOA	126-99-8	Chloro-1,3-butadiene[2-]	2543	0	SW-846:8260B	0.3	1	0.16		µg/L	EPA TAP SCRN LVL
VOA	107-05-1	Chloro-1-propene[3-]	2543	0	SW-846:8260B	1.5	5	6.5		µg/L	EPA TAP SCRN LVL
VOA	108-90-7	Chlorobenzene	2543	0	SW-846:8260B	0.25	1	100		µg/L	EPA MCL
VOA	124-48-1	Chlorodibromomethane	2543	1	SW-846:8260B	0.3	1	80		µg/L	EPA MCL
VOA	75-00-3	Chloroethane	2543	0	SW-846:8260B	0.3	1	21000		µg/L	EPA TAP SCRN LVL
VOA	67-66-3	Chloroform	2543	127	SW-846:8260B	0.25	1	80		µg/L	EPA MCL
VOA	74-87-3	Chloromethane	2543	77	SW-846:8260B	0.3	1	190		µg/L	EPA TAP SCRN LVL
VOA	95-49-8	Chlorotoluene[2-]	2543	0	SW-846:8260B	0.25	1	730		µg/L	EPA TAP SCRN LVL
VOA	106-43-4	Chlorotoluene[4-]	2543	0	SW-846:8260B	0.25	1	2600		µg/L	EPA TAP SCRN LVL
VOA	96-12-8	Dibromo-3-Chloropropane[1,2-]	2543	0	SW-846:8260B	0.3	1	0.2		µg/L	EPA MCL
VOA	106-93-4	Dibromoethane[1,2-]	2543	0	SW-846:8260B	0.25	1	0.05		µg/L	EPA MCL
VOA	74-95-3	Dibromomethane	2543	0	SW-846:8260B	0.3	1	8.2		µg/L	EPA TAP SCRN LVL
VOA	95-50-1	Dichlorobenzene[1,2-]	2543	1	SW-846:8260B	0.25	1	600		µg/L	EPA MCL
VOA	541-73-1	Dichlorobenzene[1,3-]	2543	16	SW-846:8260B	0.25	1			µg/L	
VOA	106-46-7	Dichlorobenzene[1,4-]	2543	0	SW-846:8260B	0.25	1	75		µg/L	EPA MCL
VOA	75-71-8	Dichlorodifluoromethane	2543	0	SW-846:8260B	0.3	1	390		µg/L	EPA TAP SCRN LVL
VOA	75-34-3	Dichloroethane[1,1-]	2543	66	SW-846:8260B	0.3	1	25		µg/L	NM GW STD
VOA	107-06-2	Dichloroethane[1,2-]	2543	6	SW-846:8260B	0.25	1	5		µg/L	EPA MCL
VOA	75-35-4	Dichloroethene[1,1-]	2543	65	SW-846:8260B	0.3	1	5		µg/L	NM GW STD
VOA	156-59-2	Dichloroethene[cis-1,2-]	2543	8	SW-846:8260B	0.3	1	70		µg/L	EPA MCL
VOA	156-60-5	Dichloroethene[trans-1,2-]	2543	0	SW-846:8260B	0.3	1	100		µg/L	EPA MCL
VOA	78-87-5	Dichloropropane[1,2-]	2543	0	SW-846:8260B	0.25	1	5		µg/L	EPA MCL
VOA	142-28-9	Dichloropropane[1,3-]	2543	0	SW-846:8260B	0.3	1	730		µg/L	EPA TAP SCRN LVL
VOA	594-20-7	Dichloropropane[2,2-]	2543	0	SW-846:8260B	0.3	1			µg/L	
VOA	563-58-6	Dichloropropene[1,1-]	2543	0	SW-846:8260B	0.25	1			µg/L	
VOA	10061-01-5	Dichloropropene[cis-1,3-]	2543	0	SW-846:8260B	0.25	1			µg/L	
VOA	10061-02-6	Dichloropropene[trans-1,3-]	2543	0	SW-846:8260B	0.25	1			µg/L	
VOA	60-29-7	Diethyl Ether	2004	5	SW-846:8260B	0.3	1	7300		µg/L	EPA TAP SCRN LVL
VOA	97-63-2	Ethyl Methacrylate	2543	0	SW-846:8260B	1	5	3300		µg/L	EPA TAP SCRN LVL
VOA	100-41-4	Ethylbenzene	2543	4	SW-846:8260B	0.25	1	700		µg/L	EPA MCL
VOA	87-68-3	Hexachlorobutadiene	2543	0	SW-846:8260B	0.3	1	8.6		µg/L	EPA TAP SCRN LVL
VOA	591-78-6	Hexanone[2-]	2543	1	SW-846:8260B	1.3	5	47		µg/L	EPA TAP SCRN LVL
VOA	74-88-4	Iodomethane	2543	1	SW-846:8260B	1.3	5			µg/L	
VOA	78-83-1	Isobutyl alcohol	2543	1	SW-846:8260B	13	50	11000		µg/L	EPA TAP SCRN LVL
VOA	98-82-8	Isopropylbenzene	2543	11	SW-846:8260B	0.25	1	680		µg/L	EPA TAP SCRN LVL
VOA	99-87-6	Isopropyltoluene[4-]	2543	4	SW-846:8260B	0.25	1			µg/L	
VOA	126-98-7	Methacrylonitrile	2542	0	SW-846:8260B	1	5	1		µg/L	EPA TAP SCRN LVL

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Table C-4.1-1 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Background[c]	Unit	Cleanup-Level Type
VOA	80-62-6	Methyl Methacrylate	2543	1	SW-846:8260B	1	5	1400		µg/L	EPA TAP SCRN LVL
VOA	1634-04-4	Methyl tert-Butyl Ether	2004	32	SW-846:8260B	0.25	1	120		µg/L	EPA TAP SCRN LVL
VOA	108-10-1	Methyl-2-pentanone[4-]	2543	8	SW-846:8260B	1.3	5	2000		µg/L	EPA TAP SCRN LVL
VOA	75-09-2	Methylene Chloride	2543	15	SW-846:8260B	3	10	5		µg/L	EPA MCL
VOA	91-20-3	Naphthalene	2543	7	SW-846:8260B	0.25	1	30		µg/L	NM GW STD
VOA	107-12-0	Propionitrile	2543	0	SW-846:8260B	1.5	5			µg/L	
VOA	103-65-1	Propylbenzene[1-]	2543	0	SW-846:8260B	0.25	1	1300		µg/L	EPA TAP SCRN LVL
VOA	100-42-5	Styrene	2543	5	SW-846:8260B	0.25	1	100		µg/L	EPA MCL
VOA	630-20-6	Tetrachloroethane[1,1,1,2-]	2543	0	SW-846:8260B	0.3	1	5.2		µg/L	EPA TAP SCRN LVL
VOA	79-34-5	Tetrachloroethane[1,1,2,2-]	2543	0	SW-846:8260B	0.25	1	10		µg/L	NM GW STD
VOA	127-18-4	Tetrachloroethene	2543	86	SW-846:8260B	0.3	1	5		µg/L	EPA MCL
VOA	108-88-3	Toluene	2543	245	SW-846:8260B	0.25	1	750		µg/L	NM GW STD
VOA	76-13-1	Trichloro-1,2,2-trifluoroethane[1,1,2-]	2541	1	SW-846:8260B	1	5	59000		µg/L	EPA TAP SCRN LVL
VOA	87-61-6	Trichlorobenzene[1,2,3-]	2543	2	SW-846:8260B	0.33	1	29		µg/L	EPA TAP SCRN LVL
VOA	120-82-1	Trichlorobenzene[1,2,4-]	2543	1	SW-846:8260B	0.3	1	70		µg/L	EPA MCL
VOA	71-55-6	Trichloroethane[1,1,1-]	2543	54	SW-846:8260B	0.33	1	60		µg/L	NM GW STD
VOA	79-00-5	Trichloroethane[1,1,2-]	2543	9	SW-846:8260B	0.25	1	5		µg/L	EPA MCL
VOA	79-01-6	Trichloroethene	2543	150	SW-846:8260B	0.25	1	5		µg/L	EPA MCL
VOA	75-69-4	Trichlorofluoromethane	2543	0	SW-846:8260B	0.3	1	1300		µg/L	EPA TAP SCRN LVL
VOA	96-18-4	Trichloropropane[1,2,3-]	2543	0	SW-846:8260B	0.3	1	0.0072		µg/L	EPA TAP SCRN LVL
VOA	95-63-6	Trimethylbenzene[1,2,4-]	2543	3	SW-846:8260B	0.25	1	15		µg/L	EPA TAP SCRN LVL
VOA	108-67-8	Trimethylbenzene[1,3,5-]	2543	0	SW-846:8260B	0.25	1	370		µg/L	EPA TAP SCRN LVL
VOA	108-05-4	Vinyl acetate	2543	0	SW-846:8260B	1.5	5	410		µg/L	EPA TAP SCRN LVL
VOA	75-01-4	Vinyl Chloride	2543	0	SW-846:8260B	0.5	1	1		µg/L	NM GW STD
VOA	95-47-6	Xylene[1,2-]	2543	4	SW-846:8260B	0.3	1	1200		µg/L	EPA TAP SCRN LVL
VOA	Xylene[1,3 and 1,4]	Xylene[1,3-]+Xylene[1,4-]	2541	20	SW-846:8260B	0.5	2			µg/L	

Note: Blank cells indicate there are no values.

[a] Mode (most frequent) of values reported for 2010 data.

[b] This value is derived as result of logic provided in Appendix B-2.0, Protocol for Selecting Cleanup Levels.

[c] Lowest of background values for alluvial, intermediate, and regional groundwater as identified in the Laboratory's 2007 groundwater background report (LANL 2007, 095817).

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Table C-4.1-2
Analytes, Analytical Methods, and MDLs and PQLs Obtained for 2010 Analyses of Base-Flow Samples by Contract Laboratories and Number of Sample Analyses and Detections for the Period 2006 to 2010

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Unit	Cleanup-Level Type
Diox/Fur	35822-46-9	Heptachlorodibenzodioxin[1,2,3,4,6,7,8-]	75	27	SW-846:8290		0.00005		µg/L	
Diox/Fur	37871-00-4	Heptachlorodibenzodioxins (Total)	75	45	SW-846:8290		0.00005		µg/L	
Diox/Fur	67562-39-4	Heptachlorodibenzofuran[1,2,3,4,6,7,8-]	75	16	SW-846:8290		0.00005		µg/L	
Diox/Fur	55673-89-7	Heptachlorodibenzofuran[1,2,3,4,7,8,9-]	75	6	SW-846:8290		0.00005		µg/L	
Diox/Fur	38998-75-3	Heptachlorodibenzofurans (Total)	75	28	SW-846:8290		0.00005		µg/L	
Diox/Fur	39227-28-6	Hexachlorodibenzodioxin[1,2,3,4,7,8-]	75	4	SW-846:8290		0.00005		µg/L	
Diox/Fur	57653-85-7	Hexachlorodibenzodioxin[1,2,3,6,7,8-]	75	5	SW-846:8290		0.00005		µg/L	
Diox/Fur	19408-74-3	Hexachlorodibenzodioxin[1,2,3,7,8,9-]	75	4	SW-846:8290		0.00005		µg/L	
Diox/Fur	34465-46-8	Hexachlorodibenzodioxins (Total)	75	14	SW-846:8290		0.00005		µg/L	
Diox/Fur	70648-26-9	Hexachlorodibenzofuran[1,2,3,4,7,8-]	75	5	SW-846:8290		0.00005		µg/L	
Diox/Fur	57117-44-9	Hexachlorodibenzofuran[1,2,3,6,7,8-]	75	4	SW-846:8290		0.00005		µg/L	
Diox/Fur	72918-21-9	Hexachlorodibenzofuran[1,2,3,7,8,9-]	75	1	SW-846:8290		0.00005		µg/L	
Diox/Fur	60851-34-5	Hexachlorodibenzofuran[2,3,4,6,7,8-]	75	6	SW-846:8290		0.00005		µg/L	
Diox/Fur	55684-94-1	Hexachlorodibenzofurans (Total)	75	22	SW-846:8290		0.00005		µg/L	
Diox/Fur	3268-87-9	Octachlorodibenzodioxin[1,2,3,4,6,7,8,9-]	75	37	SW-846:8290		0.0001		µg/L	
Diox/Fur	39001-02-0	Octachlorodibenzofuran[1,2,3,4,6,7,8,9-]	75	21	SW-846:8290		0.0001		µg/L	
Diox/Fur	40321-76-4	Pentachlorodibenzodioxin[1,2,3,7,8-]	75	2	SW-846:8290		0.00005		µg/L	
Diox/Fur	36088-22-9	Pentachlorodibenzodioxins (Total)	75	10	SW-846:8290		0.00005		µg/L	
Diox/Fur	57117-41-6	Pentachlorodibenzofuran[1,2,3,7,8-]	75	6	SW-846:8290		0.00005		µg/L	
Diox/Fur	57117-31-4	Pentachlorodibenzofuran[2,3,4,7,8-]	75	4	SW-846:8290		0.00005		µg/L	
Diox/Fur	30402-15-4	Pentachlorodibenzofurans (Totals)	75	17	SW-846:8290		0.00005		µg/L	
Diox/Fur	1746-01-6	Tetrachlorodibenzodioxin[2,3,7,8-]	75	3	SW-846:8290		0.00001	5.1E-08	µg/L	NM HH OO
Diox/Fur	41903-57-5	Tetrachlorodibenzodioxins (Total)	75	10	SW-846:8290		0.00001		µg/L	
Diox/Fur	51207-31-9	Tetrachlorodibenzofuran[2,3,7,8-]	75	6	SW-846:8290		0.00001		µg/L	
Diox/Fur	55722-27-5	Tetrachlorodibenzofurans (Totals)	75	11	SW-846:8290		0.00001		µg/L	
DRO	TPH-DRO	Total Petroleum Hydrocarbons Diesel Range Organics	1	1	SW-846:8015M	65	200		µg/L	
Geninorg	ALK-CO3	Alkalinity-CO3	399	81	EPA:310.1	0.73	1		mg/L	
Geninorg	ALK-CO3+HCO3	Alkalinity-CO3+HCO3	399	396	EPA:310.1	0.73	1		mg/L	
Geninorg	NH3-N	Ammonia as Nitrogen	404	197	EPA:350.1	0.016	0.05		mg/L	
Geninorg	Br(-1)	Bromide	399	135	EPA:300.0	0.066	0.2		mg/L	
Geninorg	Ca	Calcium	724	724	SW-846:6010B	0.05	0.2		mg/L	
Geninorg	Cl(-1)	Chloride	395	395	EPA:300.0	0.066	0.2		mg/L	
Geninorg	CN(TOTAL)	Cyanide (Total)	338	71	EPA:335.4	0.0017	0.005		mg/L	
Geninorg	F(-1)	Fluoride	402	380	EPA:300.0	0.033	0.1		mg/L	
Geninorg	HARDNESS	Hardness	721	721	SM:A2340B	0.35	1.24		mg/L	

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Table C-4.1-2 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Unit	Cleanup-Level Type
Geninorg	Mg	Magnesium	724	724	SW-846:6010B	0.085	0.3		mg/L	
Geninorg	NO3+NO2-N	Nitrate-Nitrite as Nitrogen	404	247	EPA:353.2	0.01	0.05	132	mg/L	NM LVSTK WTR STD
Geninorg	ClO4	Perchlorate	460	305	SW-846:6850	0.05	0.2		µg/L	
Geninorg	pH	pH	395	395	EPA:150.1	0.01	0.1		SU	
Geninorg	K	Potassium	724	724	SW-846:6010B	0.05	0.15		mg/L	
Geninorg	Na	Sodium	724	724	SW-846:6010B	0.1	0.3		mg/L	
Geninorg	SO4(-2)	Sulfate	402	400	EPA:300.0	0.1	0.4		mg/L	
Geninorg	SSC	Suspended Sediment Concentration	339	262	EPA:160.2	0.76	3.33		mg/L	
Geninorg	TDS	Total Dissolved Solids	392	390	EPA:160.1	2.4	10		mg/L	
Geninorg	TKN	Total Kjeldahl Nitrogen	487	380	EPA:351.2	0.033	0.1		mg/L	
Geninorg	TOC	Total Organic Carbon	353	352	SW-846:9060	0.33	1		mg/L	
Geninorg	PO4-P	Total Phosphate as Phosphorus	398	233	EPA:365.4	0.015	0.05		mg/L	
Geninorg	TSS	Total Suspended Solids	19	15	EPA:160.2	2.3	10		mg/L	
Herb	94-75-7	D[2,4-]	42	0	SW-846:8151A	0.087	0.26		µg/L	
Herb	75-99-0	Dalapon	42	0	SW-846:8151A	1.3	5.3		µg/L	
Herb	94-82-6	DB[2,4-]	42	0	SW-846:8151A	0.087	0.26		µg/L	
Herb	1918-00-9	Dicamba	42	0	SW-846:8151A	0.087	0.26		µg/L	
Herb	120-36-5	Dichlorprop	42	0	SW-846:8151A	0.087	0.26		µg/L	
Herb	88-85-7	Dinoseb	42	0	SW-846:8151A	0.087	0.26		µg/L	
Herb	94-74-6	MCPA	42	0	SW-846:8151A	12	53		µg/L	
Herb	93-65-2	MCPP	42	0	SW-846:8151A	11	53		µg/L	
Herb	93-76-5	T[2,4,5-]	42	0	SW-846:8151A	0.087	0.26		µg/L	
Herb	93-72-1	TP[2,4,5-]	42	0	SW-846:8151A	0.087	0.26		µg/L	
Hexp	6629-29-4	2,4-Diamino-6-nitrotoluene	175	4	SW-846:8321	0.39	1.3		µg/L	
Hexp	59229-75-3	2,6-Diamino-4-nitrotoluene	175	2	SW-846:8321	0.39	1.3		µg/L	
Hexp	618-87-1	3,5-Dinitroaniline	175	1	SW-846:8321	0.39	1.3		µg/L	
Hexp	19406-51-0	Amino-2,6-dinitrotoluene[4-]	175	12	SW-846:8321	0.1	0.33		µg/L	
Hexp	35572-78-2	Amino-4,6-dinitrotoluene[2-]	175	14	SW-846:8321	0.1	0.33		µg/L	
Hexp	99-65-0	Dinitrobenzene[1,3-]	175	0	SW-846:8321	0.1	0.33		µg/L	
Hexp	121-14-2	Dinitrotoluene[2,4-]	175	0	SW-846:8321	0.1	0.33		µg/L	
Hexp	606-20-2	Dinitrotoluene[2,6-]	175	0	SW-846:8321	0.1	0.33		µg/L	
Hexp	DNX	DNX	131	8	SW-846:8330	0.069	0.5		µg/L	
Hexp	2691-41-0	HMX	175	46	SW-846:8321	0.1	0.33		µg/L	
Hexp	MNX	MNX	131	9	SW-846:8330	0.091	0.5		µg/L	
Hexp	98-95-3	Nitrobenzene	175	0	SW-846:8321	0.1	0.33	690	µg/L	NM HH OO
Hexp	88-72-2	Nitrotoluene[2-]	175	0	SW-846:8321	0.1	0.33		µg/L	
Hexp	99-08-1	Nitrotoluene[3-]	175	0	SW-846:8321	0.1	0.33		µg/L	

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Table C-4.1-2 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Unit	Cleanup-Level Type
Hexp	99-99-0	Nitrotoluene[4-]	175	0	SW-846:8321	0.1	0.65		µg/L	
Hexp	78-11-5	PETN	175	0	SW-846:8321	0.13	1.3		µg/L	
Hexp	121-82-4	RDX	175	30	SW-846:8321	0.1	0.33		µg/L	
Hexp	3058-38-6	TATB	175	0	SW-846:8321	0.39	1.3		µg/L	
Hexp	479-45-8	Tetryl	175	0	SW-846:8321	0.13	0.65		µg/L	
Hexp	TNX	TNX	131	7	SW-846:8330	0.082	0.5		µg/L	
Hexp	99-35-4	Trinitrobenzene[1,3,5-]	175	0	SW-846:8321	0.1	0.33		µg/L	
Hexp	118-96-7	Trinitrotoluene[2,4,6-]	175	0	SW-846:8321	0.1	0.33		µg/L	
Hexp	78-30-8	Tris (o-cresyl) phosphate	175	0	SW-846:8321	0.39	1.3		µg/L	
Metals	Al	Aluminum	724	519	SW-846:6010B	68	200	391	µg/L	NM Aqu Chronic 30 mg/L hardness
Metals	Sb	Antimony	724	36	SW-846:6020	0.5	3	640	µg/L	NM HH OO
Metals	As	Arsenic	730	205	SW-846:6020	1.5	5	9	µg/L	NM HH OO
Metals	Ba	Barium	724	724	SW-846:6010B	1	5		µg/L	
Metals	Be	Beryllium	724	20	SW-846:6010B	1	5		µg/L	
Metals	B	Boron	716	540	SW-846:6010B	15	50	5000	µg/L	NM LVSTK WTR STD
Metals	Cd	Cadmium	724	70	SW-846:6020	0.11	1	0.23	µg/L	NM Aqu Chronic 30 mg/L hardness
Metals	Cr	Chromium	728	419	SW-846:6020	2.5	10	35	µg/L	NM Aqu Chronic 30 mg/L hardness
Metals	Co	Cobalt	724	117	SW-846:6010B	1	5	1000	µg/L	NM LVSTK WTR STD
Metals	Cu	Copper	724	264	SW-846:6010B	3	10	4	µg/L	NM Aqu Chronic 30 mg/L hardness
Metals	Fe	Iron	724	627	SW-846:6010B	30	100		µg/L	
Metals	Pb	Lead	724	286	SW-846:6020	0.5	2	1	µg/L	NM Aqu Chronic 30 mg/L hardness
Metals	Mn	Manganese	724	660	SW-846:6010B	2	10	1216	µg/L	NM Aqu Chronic 30 mg/L hardness
Metals	Hg	Mercury	719	17	EPA:245.2	0.066	0.2	0.77	µg/L	NM WQCC WLDLF HAB
Metals	Mo	Molybdenum	724	495	SW-846:6020	0.1	0.5		µg/L	
Metals	Ni	Nickel	724	643	SW-846:6020	0.5	2	24	µg/L	NM Aqu Chronic 30 mg/L hardness
Metals	Se	Selenium	724	45	SW-846:6020	1	5	5	µg/L	NM WQCC WLDLF HAB
Metals	SiO2	Silicon Dioxide	225	225	SW-846:6010B	0.053	0.213		mg/L	
Metals	Ag	Silver	724	78	SW-846:6020	0.2	1	0.7	µg/L	NM Aqu Chronic 30 mg/L hardness
Metals	Sr	Strontium	716	716	SW-846:6010B	1	5		µg/L	
Metals	Tl	Thallium	724	69	SW-846:6020	0.3	1	0.47	µg/L	NM HH OO
Metals	Sn	Tin	716	10	SW-846:6010B	2.5	10		µg/L	
Metals	U	Uranium	716	524	SW-846:6020	0.05	0.2		µg/L	
Metals	V	Vanadium	724	603	SW-846:6010B	1	5	100	µg/L	NM LVSTK WTR STD
Metals	Zn	Zinc	724	490	SW-846:6010B	3.3	10	53	µg/L	NM Aqu Chronic 30 mg/L hardness
PCB	12674-11-2	Aroclor-1016	216	0	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO
PCB	11104-28-2	Aroclor-1221	216	0	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO
PCB	11141-16-5	Aroclor-1232	216	0	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO

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Table C-4.1-2 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Unit	Cleanup-Level Type
PCB	53469-21-9	Aroclor-1242	216	0	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO
PCB	12672-29-6	Aroclor-1248	216	0	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO
PCB	11097-69-1	Aroclor-1254	216	6	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO
PCB	11096-82-5	Aroclor-1260	216	7	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO
PCB	37324-23-5	Aroclor-1262	216	0	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO
PCB Cong	2051-60-7	PCB-1	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	33146-45-1	PCB-10	10	0	EPA:1668A		0.000035		µg/L	
PCB Cong	39485-83-1	PCB-100	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	60145-21-3	PCB-103	53	1	EPA:1668A		0.000028		µg/L	
PCB Cong	56558-16-8	PCB-104	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	32598-14-4	PCB-105	53	7	EPA:1668A		0.000035		µg/L	
PCB Cong	70424-69-0	PCB-106	35	3	EPA:1668A		0.000007		µg/L	
PCB Cong	PCB-106/118	PCB-106/PCB-118	18	3	EPA:1668A		0.0000097		µg/L	
PCB Cong	70424-68-9	PCB-107	35	3	EPA:1668A		0.000007		µg/L	
PCB Cong	PCB-107/109	PCB-107/PCB-109	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-108/112	PCB-108/PCB-112	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-108/124	PCB-108/PCB-124	10	1	EPA:1668A		0.0000139		µg/L	
PCB Cong	2050-67-1	PCB-11	53	4	EPA:1668A		0.000056		µg/L	
PCB Cong	38380-03-9	PCB-110	43	5	EPA:1668A		0.000028		µg/L	
PCB Cong	39635-32-0	PCB-111	35	0	EPA:1668A		0.000007		µg/L	
PCB Cong	PCB-111/115	PCB-111/PCB-115	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	74472-36-9	PCB-112	10	0	EPA:1668A		0.000007		µg/L	
PCB Cong	68194-10-5	PCB-113	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	74472-37-0	PCB-114	53	1	EPA:1668A		0.000007		µg/L	
PCB Cong	56558-17-9	PCB-119	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-12/13	PCB-12/PCB-13	53	0	EPA:1668A		0.000056		µg/L	
PCB Cong	68194-12-7	PCB-120	53	1	EPA:1668A		0.000028		µg/L	
PCB Cong	56558-18-0	PCB-121	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	76842-07-4	PCB-122	53	1	EPA:1668A		0.000028		µg/L	
PCB Cong	65510-44-3	PCB-123	53	1	EPA:1668A		0.000035		µg/L	
PCB Cong	70424-70-3	PCB-124	43	1	EPA:1668A		0.000028		µg/L	
PCB Cong	57465-28-8	PCB-126	53	1	EPA:1668A		0.000007		µg/L	
PCB Cong	39635-33-1	PCB-127	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-128/162	PCB-128/PCB-162	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	55215-18-4	PCB-129	43	1	EPA:1668A		0.000028		µg/L	
PCB Cong	52663-66-8	PCB-130	53	5	EPA:1668A		0.000028		µg/L	
PCB Cong	61798-70-7	PCB-131	53	1	EPA:1668A		0.000028		µg/L	

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Table C-4.1-2 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Unit	Cleanup-Level Type
PCB Cong	PCB-132/161	PCB-132/PCB-161	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	35694-04-3	PCB-133	35	2	EPA:1668A		0.000007		µg/L	
PCB Cong	PCB-133/142	PCB-133/PCB-142	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	52704-70-8	PCB-134	35	2	EPA:1668A		0.000035		µg/L	
PCB Cong	PCB-134/143	PCB-134/PCB-143	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	52744-13-5	PCB-135	43	1	EPA:1668A		0.000028		µg/L	
PCB Cong	38411-22-2	PCB-136	53	6	EPA:1668A		0.000028		µg/L	
PCB Cong	35694-06-5	PCB-137	53	3	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-139/140	PCB-139/PCB-140	10	1	EPA:1668A		0.0000139		µg/L	
PCB Cong	PCB-139/149	PCB-139/PCB-149	18	1	EPA:1668A		0.000028		µg/L	
PCB Cong	34883-41-5	PCB-14	53	0	EPA:1668A		0.000056		µg/L	
PCB Cong	59291-64-4	PCB-140	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	52712-04-6	PCB-141	53	8	EPA:1668A		0.000028		µg/L	
PCB Cong	41411-61-4	PCB-142	10	0	EPA:1668A		0.000007		µg/L	
PCB Cong	68194-15-0	PCB-143	10	0	EPA:1668A		0.000007		µg/L	
PCB Cong	68194-14-9	PCB-144	53	5	EPA:1668A		0.000028		µg/L	
PCB Cong	74472-40-5	PCB-145	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-146/165	PCB-146/PCB-165	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	68194-13-8	PCB-147	43	1	EPA:1668A		0.000028		µg/L	
PCB Cong	74472-41-6	PCB-148	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	2050-68-2	PCB-15	53	3	EPA:1668A		0.000056		µg/L	
PCB Cong	68194-08-1	PCB-150	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	52663-63-5	PCB-151	43	2	EPA:1668A		0.000028		µg/L	
PCB Cong	68194-09-2	PCB-152	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	60145-22-4	PCB-154	53	1	EPA:1668A		0.000028		µg/L	
PCB Cong	33979-03-2	PCB-155	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	38380-08-4	PCB-156	43	5	EPA:1668A		0.000004		µg/L	
PCB Cong	PCB-156/157	PCB-156/PCB-157	10	4	EPA:1668A		0.0000138		µg/L	
PCB Cong	69782-90-7	PCB-157	43	1	EPA:1668A		0.000005		µg/L	
PCB Cong	PCB-158/160	PCB-158/PCB-160	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	39635-35-3	PCB-159	53	1	EPA:1668A		0.000028		µg/L	
PCB Cong	38444-78-9	PCB-16	10	0	EPA:1668A		0.000035		µg/L	
PCB Cong	PCB-16/32	PCB-16/PCB-32	43	2	EPA:1668A		0.000028		µg/L	
PCB Cong	41411-62-5	PCB-160	10	0	EPA:1668A		0.000007		µg/L	
PCB Cong	74472-43-8	PCB-161	10	0	EPA:1668A		0.000007		µg/L	
PCB Cong	39635-34-2	PCB-162	10	0	EPA:1668A		0.000007		µg/L	
PCB Cong	74472-46-1	PCB-165	10	0	EPA:1668A		0.000007		µg/L	

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Table C-4.1-2 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Unit	Cleanup-Level Type
PCB Cong	41411-63-6	PCB-166	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	52663-72-6	PCB-167	53	6	EPA:1668A		0.000007		µg/L	
PCB Cong	59291-65-5	PCB-168	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	32774-16-6	PCB-169	53	0	EPA:1668A		0.000007		µg/L	
PCB Cong	37680-66-3	PCB-17	53	2	EPA:1668A		0.000028		µg/L	
PCB Cong	35065-30-6	PCB-170	53	7	EPA:1668A		0.000028		µg/L	
PCB Cong	52663-71-5	PCB-171	43	1	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-171/173	PCB-171/PCB-173	10	4	EPA:1668A		0.0000138		µg/L	
PCB Cong	52663-74-8	PCB-172	53	5	EPA:1668A		0.000028		µg/L	
PCB Cong	68194-16-1	PCB-173	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	38411-25-5	PCB-174	53	8	EPA:1668A		0.000028		µg/L	
PCB Cong	40186-70-7	PCB-175	53	2	EPA:1668A		0.000028		µg/L	
PCB Cong	52663-65-7	PCB-176	53	5	EPA:1668A		0.000028		µg/L	
PCB Cong	52663-70-4	PCB-177	53	6	EPA:1668A		0.000028		µg/L	
PCB Cong	52663-67-9	PCB-178	53	3	EPA:1668A		0.000028		µg/L	
PCB Cong	52663-64-6	PCB-179	53	7	EPA:1668A		0.000028		µg/L	
PCB Cong	37680-65-2	PCB-18	43	2	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-18/30	PCB-18/PCB-30	10	3	EPA:1668A		0.0000138		µg/L	
PCB Cong	PCB-180/193	PCB-180/PCB-193	10	1	EPA:1668A		0.0000139		µg/L	
PCB Cong	74472-47-2	PCB-181	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	60145-23-5	PCB-182	35	3	EPA:1668A		0.000007		µg/L	
PCB Cong	PCB-182/187	PCB-182/PCB-187	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	52663-69-1	PCB-183	43	2	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-183/185	PCB-183/PCB-185	10	3	EPA:1668A		0.0000139		µg/L	
PCB Cong	74472-48-3	PCB-184	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	52712-05-7	PCB-185	43	1	EPA:1668A		0.000028		µg/L	
PCB Cong	74472-49-4	PCB-186	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	74487-85-7	PCB-188	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	39635-31-9	PCB-189	53	3	EPA:1668A		0.000007		µg/L	
PCB Cong	38444-73-4	PCB-19	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	41411-64-7	PCB-190	53	5	EPA:1668A		0.000028		µg/L	
PCB Cong	74472-50-7	PCB-191	53	3	EPA:1668A		0.000028		µg/L	
PCB Cong	74472-51-8	PCB-192	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	69782-91-8	PCB-193	43	1	EPA:1668A		0.000028		µg/L	
PCB Cong	35694-08-7	PCB-194	53	7	EPA:1668A		0.000028		µg/L	
PCB Cong	52663-78-2	PCB-195	53	5	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-196/203	PCB-196/PCB-203	18	0	EPA:1668A		0.000028		µg/L	

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Table C-4.1-2 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Unit	Cleanup-Level Type
PCB Cong	33091-17-7	PCB-197	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-197/200	PCB-197/PCB-200	10	0	EPA:1668A		0.0000139		µg/L	
PCB Cong	68194-17-2	PCB-198	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	52663-75-9	PCB-199	43	2	EPA:1668A		0.000028		µg/L	
PCB Cong	2051-61-8	PCB-2	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-20/21/33	PCB-20/PCB-21/PCB-33	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	52663-73-7	PCB-200	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	40186-71-8	PCB-201	53	3	EPA:1668A		0.000028		µg/L	
PCB Cong	2136-99-4	PCB-202	53	4	EPA:1668A		0.000028		µg/L	
PCB Cong	74472-52-9	PCB-204	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	74472-53-0	PCB-205	53	1	EPA:1668A		0.000028		µg/L	
PCB Cong	40186-72-9	PCB-206	53	6	EPA:1668A		0.000028		µg/L	
PCB Cong	52663-79-3	PCB-207	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	52663-77-1	PCB-208	53	1	EPA:1668A		0.000028		µg/L	
PCB Cong	2051-24-3	PCB-209	53	1	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-21/33	PCB-21/PCB-33	10	1	EPA:1668A		0.0000139		µg/L	
PCB Cong	38444-85-8	PCB-22	53	4	EPA:1668A		0.000028		µg/L	
PCB Cong	55720-44-0	PCB-23	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	55702-45-9	PCB-24	35	0	EPA:1668A		0.000007		µg/L	
PCB Cong	PCB-24/27	PCB-24/PCB-27	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	55712-37-3	PCB-25	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	38444-81-4	PCB-26	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-26/29	PCB-26/PCB-29	10	0	EPA:1668A		0.0000139		µg/L	
PCB Cong	38444-76-7	PCB-27	10	0	EPA:1668A		0.000007		µg/L	
PCB Cong	7012-37-5	PCB-28	43	2	EPA:1668A		0.000028		µg/L	
PCB Cong	15862-07-4	PCB-29	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	2051-62-9	PCB-3	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	35693-92-6	PCB-30	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	16606-02-3	PCB-31	53	7	EPA:1668A		0.000028		µg/L	
PCB Cong	38444-77-8	PCB-32	10	1	EPA:1668A		0.000007		µg/L	
PCB Cong	37680-68-5	PCB-34	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	37680-69-6	PCB-35	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	38444-87-0	PCB-36	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	38444-90-5	PCB-37	53	4	EPA:1668A		0.000028		µg/L	
PCB Cong	53555-66-1	PCB-38	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	38444-88-1	PCB-39	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	13029-08-8	PCB-4	35	0	EPA:1668A		0.000035		µg/L	

Table C-4.1-2 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Unit	Cleanup-Level Type
PCB Cong	PCB-4/10	PCB-4/PCB-10	18	0	EPA:1668A		0.000056		µg/L	
PCB Cong	38444-93-8	PCB-40	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-40/71	PCB-40/PCB-71	10	1	EPA:1668A		0.0000139		µg/L	
PCB Cong	52663-59-9	PCB-41	35	1	EPA:1668A		0.000035		µg/L	
PCB Cong	PCB-41/64/71/72	PCB-41/PCB-64/PCB-71/PCB-72	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	36559-22-5	PCB-42	35	1	EPA:1668A		0.000007		µg/L	
PCB Cong	PCB-42/59	PCB-42/PCB-59	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	70362-46-8	PCB-43	35	1	EPA:1668A		0.000007		µg/L	
PCB Cong	PCB-43/49	PCB-43/PCB-49	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	41464-39-5	PCB-44	43	2	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-44/47/65	PCB-44/PCB-47/PCB-65	10	1	EPA:1668A		0.00002		µg/L	
PCB Cong	70362-45-7	PCB-45	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-45/51	PCB-45/PCB-51	10	0	EPA:1668A		0.0000139		µg/L	
PCB Cong	41464-47-5	PCB-46	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	70362-47-9	PCB-48	35	0	EPA:1668A		0.000007		µg/L	
PCB Cong	PCB-48/75	PCB-48/PCB-75	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-49/69	PCB-49/PCB-69	10	4	EPA:1668A		0.0000138		µg/L	
PCB Cong	16605-91-7	PCB-5	53	2	EPA:1668A		0.000056		µg/L	
PCB Cong	62796-65-0	PCB-50	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-50/53	PCB-50/PCB-53	10	0	EPA:1668A		0.0000139		µg/L	
PCB Cong	68194-04-7	PCB-51	43	13	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-52/69	PCB-52/PCB-69	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	41464-41-9	PCB-53	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	15968-05-5	PCB-54	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	74338-24-2	PCB-55	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	41464-43-1	PCB-56	35	5	EPA:1668A		0.000007		µg/L	
PCB Cong	PCB-56/60	PCB-56/PCB-60	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	70424-67-8	PCB-57	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	41464-49-7	PCB-58	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-59/62/75	PCB-59/PCB-62/PCB-75	10	0	EPA:1668A		0.00002		µg/L	
PCB Cong	25569-80-6	PCB-6	53	0	EPA:1668A		0.000056		µg/L	
PCB Cong	33025-41-1	PCB-60	10	3	EPA:1668A		0.000007		µg/L	
PCB Cong	PCB-61/70	PCB-61/PCB-70	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	54230-22-7	PCB-62	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	74472-34-7	PCB-63	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	52663-58-8	PCB-64	10	4	EPA:1668A		0.000007		µg/L	
PCB Cong	33284-54-7	PCB-65	43	0	EPA:1668A		0.000028		µg/L	

Table C-4.1-2 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Unit	Cleanup-Level Type
PCB Cong	32598-10-0	PCB-66	10	3	EPA:1668A		0.000035		µg/L	
PCB Cong	PCB-66/PCB-76	PCB-66/PCB-76	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	73575-53-8	PCB-67	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	73575-52-7	PCB-68	53	2	EPA:1668A		0.000028		µg/L	
PCB Cong	33284-50-3	PCB-7	35	0	EPA:1668A		0.000007		µg/L	
PCB Cong	PCB-7/9	PCB-7/PCB-9	18	0	EPA:1668A		0.000056		µg/L	
PCB Cong	41464-42-0	PCB-72	10	1	EPA:1668A		0.000007		µg/L	
PCB Cong	74338-23-1	PCB-73	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	32690-93-0	PCB-74	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	32598-13-3	PCB-77	53	5	EPA:1668A		0.000007		µg/L	
PCB Cong	70362-49-1	PCB-78	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	41464-48-6	PCB-79	53	1	EPA:1668A		0.000028		µg/L	
PCB Cong	34883-43-7	PCB-8	10	2	EPA:1668A		0.0000114		µg/L	
PCB Cong	33284-52-5	PCB-80	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	70362-50-4	PCB-81	53	0	EPA:1668A		0.000007		µg/L	
PCB Cong	52663-62-4	PCB-82	53	5	EPA:1668A		0.000028		µg/L	
PCB Cong	60145-20-2	PCB-83	53	2	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-84/PCB-92	PCB-84/PCB-92	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-85/116	PCB-85/PCB-116	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-85/116/117	PCB-85/PCB-116/PCB-117	10	1	EPA:1668A		0.00002		µg/L	
PCB Cong	55312-69-1	PCB-86	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-87/117/125	PCB-87/PCB-117/PCB-125	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	55215-17-3	PCB-88/91	53	3	EPA:1668A		0.000028		µg/L	
PCB Cong	73575-57-2	PCB-89	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	34883-39-1	PCB-9	10	0	EPA:1668A		0.000007		µg/L	
PCB Cong	PCB-90/101	PCB-90/PCB-101	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	73575-56-1	PCB-93	43	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-93/100	PCB-93/PCB-100	10	0	EPA:1668A		0.0000139		µg/L	
PCB Cong	73575-55-0	PCB-94	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-95/98/102	PCB-95/PCB-98/PCB-102	18	0	EPA:1668A		0.000028		µg/L	
PCB Cong	73575-54-9	PCB-96	53	0	EPA:1668A		0.000028		µg/L	
PCB Cong	41464-51-1	PCB-97	43	1	EPA:1668A		0.000028		µg/L	
PCB Cong	PCB-98/102	PCB-98/PCB-102	10	1	EPA:1668A		0.0000139		µg/L	
PCB Cong	38380-01-7	PCB-99	53	6	EPA:1668A		0.000035		µg/L	
PCB Cong	DECACB(Total)	Total decaCB	53	1	EPA:1668A		0.000028		µg/L	
PCB Cong	25512-42-9	Total diCB	53	8	EPA:1668A		0.000056		µg/L	
PCB Cong	27323-18-8	Total monoCB	53	0	EPA:1668A		0.000028		µg/L	

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Table C-4.1-2 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Unit	Cleanup-Level Type
PCB Cong	53742-07-7	Total nonaCB	53	6	EPA:1668A		0.000028		µg/L	
PCB Cong	55722-26-4	Total octaCB	53	7	EPA:1668A		0.000028		µg/L	
PCB Cong	25429-29-2	Total pentaCB	53	13	EPA:1668A		0.00003		µg/L	
PCB Cong	25323-68-6	Total triCB	53	7	EPA:1668A		0.000028		µg/L	
Pest	309-00-2	Aldrin	197	1	SW-846:8081A	0.005	0.02	0.0005	µg/L	NM HH OO
Pest	319-84-6	BHC[alpha-]	197	1	SW-846:8081A	0.005	0.02		µg/L	
Pest	319-85-7	BHC[beta-]	197	1	SW-846:8081A	0.006	0.02		µg/L	
Pest	319-86-8	BHC[delta-]	197	4	SW-846:8081A	0.005	0.02		µg/L	
Pest	58-89-9	BHC[gamma-]	197	1	SW-846:8081A	0.005	0.02	0.95	µg/L	NM Aqu Acute
Pest	5103-71-9	Chlordane[alpha-]	197	1	SW-846:8081A	0.005	0.02	0.0043	µg/L	NM Aqu Chronic
Pest	5103-74-2	Chlordane[gamma-]	197	2	SW-846:8081A	0.005	0.02	0.0043	µg/L	NM Aqu Chronic
Pest	72-54-8	DDD[4,4'-]	197	3	SW-846:8081A	0.01	0.04	0.001	µg/L	NM WQCC WLDLF HAB
Pest	72-55-9	DDE[4,4'-]	197	5	SW-846:8081A	0.005	0.04	0.001	µg/L	NM WQCC WLDLF HAB
Pest	50-29-3	DDT[4,4'-]	197	4	SW-846:8081A	0.01	0.04	0.001	µg/L	NM WQCC WLDLF HAB
Pest	60-57-1	Dieldrin	197	2	SW-846:8081A	0.01	0.04	0.00054	µg/L	NM HH OO
Pest	959-98-8	Endosulfan I	197	2	SW-846:8081A	0.005	0.02	0.056	µg/L	NM Aqu Chronic
Pest	33213-65-9	Endosulfan II	197	2	SW-846:8081A	0.011	0.045	0.056	µg/L	NM Aqu Chronic
Pest	1031-07-8	Endosulfan Sulfate	197	2	SW-846:8081A	0.01	0.04	89	µg/L	NM HH OO
Pest	72-20-8	Endrin	197	2	SW-846:8081A	0.01	0.04	0.036	µg/L	NM Aqu Chronic
Pest	7421-93-4	Endrin Aldehyde	197	3	SW-846:8081A	0.005	0.04	0.3	µg/L	NM HH OO
Pest	53494-70-5	Endrin Ketone	197	1	SW-846:8081A	0.01	0.04		µg/L	
Pest	76-44-8	Heptachlor	197	2	SW-846:8081A	0.005	0.02	0.0038	µg/L	NM Aqu Chronic
Pest	1024-57-3	Heptachlor Epoxide	197	2	SW-846:8081A	0.005	0.02	0.0038	µg/L	NM Aqu Chronic
Pest	72-43-5	Methoxychlor[4,4'-]	197	1	SW-846:8081A	0.05	0.2		µg/L	
Pest	8001-35-2	Toxaphene (Technical Grade)	197	0	SW-846:8081A	0.15	0.5	0.0002	µg/L	NM Aqu Chronic
Rad	Am-241	Americium-241	434	25	Alpha Spectroscopy	0.05		400	pCi/L	DOE BCG WATER
Rad	Cs-137	Cesium-137	427	9	Gamma Spectroscopy	8		40	pCi/L	DOE BCG WATER
Rad	Co-60	Cobalt-60	427	0	Gamma Spectroscopy	8		4000	pCi/L	DOE BCG WATER
Rad	GROSSA	Gross alpha	292	71	Gas Proportional Counting	3		15	pCi/L	NM LVSTK WTR STD
Rad	GROSSB	Gross beta	292	237	Gas Proportional Counting	3			pCi/L	
Rad	GROSSG	Gross gamma	427	1	Gamma Spectroscopy	120			pCi/L	
Rad	Np-237	Neptunium-237	437	0	Alpha Spectroscopy	0.05			pCi/L	
Rad	Pu-238	Plutonium-238	433	30	Alpha Spectroscopy	0.05			pCi/L	
Rad	Pu-239/240	Plutonium-239/240	433	44	Alpha Spectroscopy	0.05		200	pCi/L	DOE BCG WATER
Rad	K-40	Potassium-40	427	5	Gamma Spectroscopy	10			pCi/L	
Rad	Ra-226	Radium-226	73	11	Alpha Spectroscopy	1		30	pCi/L	NM LVSTK WTR STD
Rad	Ra-226	Radium-226	73	11	Gas Proportional Counting	1		30	pCi/L	NM LVSTK WTR STD

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Table C-4.1-2 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Unit	Cleanup-Level Type
Rad	Ra-228	Radium-228	69	15	Gas Proportional Counting	1		30	pCi/L	NM LVSTK WTR STD
Rad	Na-22	Sodium-22	427	0	Gamma Spectroscopy	10			pCi/L	
Rad	Sr-90	Strontium-90	427	59	Gas Proportional Counting	0.5		300	pCi/L	DOE BCG WATER
Rad	Th-228	Thorium-228	69	21	Alpha Spectroscopy	0.05			pCi/L	
Rad	Th-230	Thorium-230	69	16	Alpha Spectroscopy	0.05			pCi/L	
Rad	Th-232	Thorium-232	69	23	Alpha Spectroscopy	0.05		300	pCi/L	DOE BCG WATER
Rad	H-3	Tritium	195	190	Liquid Scintillation Counting	250		20000	pCi/L	NM LVSTK WTR STD
Rad	U-234	Uranium-234	431	295	Alpha Spectroscopy	0.05		200	pCi/L	DOE BCG WATER
Rad	U-235/236	Uranium-235/236	431	39	Alpha Spectroscopy	0.05			pCi/L	
Rad	U-238	Uranium-238	431	309	Alpha Spectroscopy	0.05		200	pCi/L	DOE BCG WATER
SVOA	83-32-9	Acenaphthene	281	1	SW-846:8270C	0.33	1.1	990	µg/L	NM HH OO
SVOA	208-96-8	Acenaphthylene	281	1	SW-846:8270C	0.21	1.1		µg/L	
SVOA	62-53-3	Aniline	281	0	SW-846:8270C	2.5	10		µg/L	
SVOA	120-12-7	Anthracene	281	2	SW-846:8270C	0.21	1.1	40000	µg/L	NM HH OO
SVOA	1912-24-9	Atrazine	281	0	SW-846:8270C	3	10		µg/L	
SVOA	103-33-3	Azobenzene	281	0	SW-846:8270C	2	10		µg/L	
SVOA	92-87-5	Benzidine	281	0	SW-846:8270C	3	10		µg/L	
SVOA	56-55-3	Benzo(a)anthracene	281	2	SW-846:8270C	0.2	1		µg/L	
SVOA	50-32-8	Benzo(a)pyrene	281	3	SW-846:8270C	0.2	1	0.18	µg/L	NM HH OO
SVOA	205-99-2	Benzo(b)fluoranthene	281	1	SW-846:8270C	0.2	1		µg/L	
SVOA	191-24-2	Benzo(g,h,i)perylene	281	3	SW-846:8270C	0.2	1		µg/L	
SVOA	207-08-9	Benzo(k)fluoranthene	281	3	SW-846:8270C	0.2	1		µg/L	
SVOA	65-85-0	Benzoic Acid	281	3	SW-846:8270C	6	20		µg/L	
SVOA	100-51-6	Benzyl Alcohol	281	1	SW-846:8270C	2	10		µg/L	
SVOA	111-91-1	Bis(2-chloroethoxy)methane	281	1	SW-846:8270C	3	10		µg/L	
SVOA	111-44-4	Bis(2-chloroethyl)ether	281	1	SW-846:8270C	2	10		µg/L	
SVOA	117-81-7	Bis(2-ethylhexyl)phthalate	281	13	SW-846:8270C	2	10		µg/L	
SVOA	101-55-3	Bromophenyl-phenylether[4-]	281	1	SW-846:8270C	2	10		µg/L	
SVOA	85-68-7	Butylbenzylphthalate	281	0	SW-846:8270C	2	10	1900	µg/L	NM HH OO
SVOA	59-50-7	Chloro-3-methylphenol[4-]	281	0	SW-846:8270C	2	10		µg/L	
SVOA	106-47-8	Chloroaniline[4-]	281	0	SW-846:8270C	2	10		µg/L	
SVOA	91-58-7	Chloronaphthalene[2-]	281	1	SW-846:8270C	0.3	1	1600	µg/L	NM HH OO
SVOA	95-57-8	Chlorophenol[2-]	281	0	SW-846:8270C	2	10	150	µg/L	NM HH OO
SVOA	7005-72-3	Chlorophenyl-phenyl[4-] Ether	281	0	SW-846:8270C	2	10		µg/L	
SVOA	218-01-9	Chrysene	281	2	SW-846:8270C	0.2	1		µg/L	
SVOA	53-70-3	Dibenz(a,h)anthracene	281	3	SW-846:8270C	0.2	1		µg/L	
SVOA	132-64-9	Dibenzofuran	281	0	SW-846:8270C	2	10		µg/L	

Table C-4.1-2 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Unit	Cleanup-Level Type
SVOA	95-50-1	Dichlorobenzene[1,2-]	281	0	SW-846:8270C	2	10	1300	µg/L	NM HH OO
SVOA	541-73-1	Dichlorobenzene[1,3-]	281	0	SW-846:8270C	2	10	960	µg/L	NM HH OO
SVOA	106-46-7	Dichlorobenzene[1,4-]	281	1	SW-846:8270C	2	10	190	µg/L	NM HH OO
SVOA	91-94-1	Dichlorobenzidine[3,3'-]	281	0	SW-846:8270C	2	10		µg/L	
SVOA	120-83-2	Dichlorophenol[2,4-]	281	0	SW-846:8270C	2	10	290	µg/L	NM HH OO
SVOA	84-66-2	Diethylphthalate	281	3	SW-846:8270C	2	10	44000	µg/L	NM HH OO
SVOA	131-11-3	Dimethyl Phthalate	281	0	SW-846:8270C	2	10	1100000	µg/L	NM HH OO
SVOA	105-67-9	Dimethylphenol[2,4-]	281	0	SW-846:8270C	2	10	850	µg/L	NM HH OO
SVOA	84-74-2	Di-n-butylphthalate	281	0	SW-846:8270C	2	10	4500	µg/L	NM HH OO
SVOA	534-52-1	Dinitro-2-methylphenol[4,6-]	281	0	SW-846:8270C	3	10	280	µg/L	NM HH OO
SVOA	51-28-5	Dinitrophenol[2,4-]	281	0	SW-846:8270C	5	20	5300	µg/L	NM HH OO
SVOA	121-14-2	Dinitrotoluene[2,4-]	281	0	SW-846:8270C	2	10		µg/L	
SVOA	606-20-2	Dinitrotoluene[2,6-]	281	0	SW-846:8270C	2	10		µg/L	
SVOA	117-84-0	Di-n-octylphthalate	281	0	SW-846:8270C	3	10		µg/L	
SVOA	88-85-7	Dinoseb	281	0	SW-846:8270C	2	10		µg/L	
SVOA	123-91-1	Dioxane[1,4-]	270	6	SW-846:8270C	2	10		µg/L	
SVOA	122-39-4	Diphenylamine	281	0	SW-846:8270C	3	10		µg/L	
SVOA	206-44-0	Fluoranthene	281	2	SW-846:8270C	0.2	1	140	µg/L	NM HH OO
SVOA	86-73-7	Fluorene	281	2	SW-846:8270C	0.2	1	5300	µg/L	NM HH OO
SVOA	118-74-1	Hexachlorobenzene	281	0	SW-846:8270C	2	10	0.0029	µg/L	NM HH OO
SVOA	87-68-3	Hexachlorobutadiene	281	0	SW-846:8270C	2	10		µg/L	
SVOA	77-47-4	Hexachlorocyclopentadiene	281	0	SW-846:8270C	3	10	1100	µg/L	NM HH OO
SVOA	67-72-1	Hexachloroethane	281	0	SW-846:8270C	2	10		µg/L	
SVOA	193-39-5	Indeno(1,2,3-cd)pyrene	281	4	SW-846:8270C	0.2	1		µg/L	
SVOA	78-59-1	Isophorone	281	0	SW-846:8270C	3	10		µg/L	
SVOA	90-12-0	Methylnaphthalene[1-]	281	1	SW-846:8270C	0.3	1		µg/L	
SVOA	91-57-6	Methylnaphthalene[2-]	281	2	SW-846:8270C	0.3	1		µg/L	
SVOA	95-48-7	Methylphenol[2-]	281	0	SW-846:8270C	2	10		µg/L	
SVOA	106-44-5	Methylphenol[4-]	161	0	SW-846:8270C	3	10		µg/L	
SVOA	91-20-3	Naphthalene	281	1	SW-846:8270C	0.3	1		µg/L	
SVOA	88-74-4	Nitroaniline[2-]	281	0	SW-846:8270C	2	10		µg/L	
SVOA	99-09-2	Nitroaniline[3-]	281	1	SW-846:8270C	2	10		µg/L	
SVOA	100-01-6	Nitroaniline[4-]	281	1	SW-846:8270C	3	10		µg/L	
SVOA	98-95-3	Nitrobenzene	281	0	SW-846:8270C	3	10	690	µg/L	NM HH OO
SVOA	88-75-5	Nitrophenol[2-]	281	0	SW-846:8270C	2	10		µg/L	
SVOA	100-02-7	Nitrophenol[4-]	281	0	SW-846:8270C	2	10		µg/L	
SVOA	55-18-5	Nitrosodiethylamine[N-]	281	1	SW-846:8270C	2	10		µg/L	

0 1 3 2 8

Table C-4.1-2 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Unit	Cleanup-Level Type
SVOA	62-75-9	Nitrosodimethylamine[N-]	281	1	SW-846:8270C	2	10		µg/L	
SVOA	924-16-3	Nitroso-di-n-butylamine[N-]	281	1	SW-846:8270C	3	10		µg/L	
SVOA	621-64-7	Nitroso-di-n-propylamine[N-]	281	0	SW-846:8270C	2	10		µg/L	
SVOA	930-55-2	Nitrosopyrrolidine[N-]	281	1	SW-846:8270C	2	10		µg/L	
SVOA	108-60-1	Oxybis(1-chloropropane)[2,2'-]	281	0	SW-846:8270C	2	10	65000	µg/L	NM HH OO
SVOA	608-93-5	Pentachlorobenzene	281	1	SW-846:8270C	3	10		µg/L	
SVOA	87-86-5	Pentachlorophenol	281	0	SW-846:8270C	2	10	15	µg/L	NM Aqu Chronic
SVOA	85-01-8	Phenanthrene	281	3	SW-846:8270C	0.2	1		µg/L	
SVOA	108-95-2	Phenol	281	0	SW-846:8270C	1	10	860000	µg/L	NM HH OO
SVOA	129-00-0	Pyrene	281	1	SW-846:8270C	0.3	1	4000	µg/L	NM HH OO
SVOA	110-86-1	Pyridine	185	0	SW-846:8270C	3	10		µg/L	
SVOA	95-94-3	Tetrachlorobenzene[1,2,4,5]	281	1	SW-846:8270C	3	10		µg/L	
SVOA	58-90-2	Tetrachlorophenol[2,3,4,6-]	281	0	SW-846:8270C	2	10		µg/L	
SVOA	120-82-1	Trichlorobenzene[1,2,4-]	281	0	SW-846:8270C	2	10	70	µg/L	NM HH OO
SVOA	95-95-4	Trichlorophenol[2,4,5-]	281	0	SW-846:8270C	2	10		µg/L	
SVOA	88-06-2	Trichlorophenol[2,4,6-]	281	0	SW-846:8270C	2	10		µg/L	
VOA	67-64-1	Acetone	309	64	SW-846:8260B	3.5	10		µg/L	
VOA	75-05-8	Acetonitrile	309	0	SW-846:8260B	6.3	25		µg/L	
VOA	107-02-8	Acrolein	309	2	SW-846:8260B	1.3	5	9	µg/L	NM HH OO
VOA	107-13-1	Acrylonitrile	309	0	SW-846:8260B	1	5		µg/L	
VOA	71-43-2	Benzene	309	2	SW-846:8260B	0.3	1	510	µg/L	NM HH OO
VOA	108-86-1	Bromobenzene	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	74-97-5	Bromochloromethane	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	75-27-4	Bromodichloromethane	309	9	SW-846:8260B	0.25	1		µg/L	
VOA	75-25-2	Bromoform	309	7	SW-846:8260B	0.25	1		µg/L	
VOA	74-83-9	Bromomethane	309	0	SW-846:8260B	0.3	1	1500	µg/L	NM HH OO
VOA	71-36-3	Butanol[1-]	219	0	SW-846:8260B	15	50		µg/L	
VOA	78-93-3	Butanone[2-]	309	7	SW-846:8260B	1.3	5		µg/L	
VOA	104-51-8	Butylbenzene[n-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	135-98-8	Butylbenzene[sec-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	98-06-6	Butylbenzene[tert-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	75-15-0	Carbon Disulfide	309	0	SW-846:8260B	1.3	5		µg/L	
VOA	56-23-5	Carbon Tetrachloride	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	126-99-8	Chloro-1,3-butadiene[2-]	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	107-05-1	Chloro-1-propene[3-]	294	0	SW-846:8260B	1.5	5		µg/L	
VOA	108-90-7	Chlorobenzene	309	0	SW-846:8260B	0.25	1	1600	µg/L	NM HH OO
VOA	124-48-1	Chlorodibromomethane	309	10	SW-846:8260B	0.3	1		µg/L	

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Table C-4.1-2 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Unit	Cleanup-Level Type
VOA	75-00-3	Chloroethane	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	67-66-3	Chloroform	309	14	SW-846:8260B	0.25	1		µg/L	
VOA	74-87-3	Chloromethane	309	2	SW-846:8260B	0.3	1		µg/L	
VOA	95-49-8	Chlorotoluene[2-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	106-43-4	Chlorotoluene[4-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	96-12-8	Dibromo-3-Chloropropane[1,2-]	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	106-93-4	Dibromoethane[1,2-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	74-95-3	Dibromomethane	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	95-50-1	Dichlorobenzene[1,2-]	309	0	SW-846:8260B	0.25	1	1300	µg/L	NM HH OO
VOA	541-73-1	Dichlorobenzene[1,3-]	309	0	SW-846:8260B	0.25	1	960	µg/L	NM HH OO
VOA	106-46-7	Dichlorobenzene[1,4-]	309	1	SW-846:8260B	0.25	1	190	µg/L	NM HH OO
VOA	75-71-8	Dichlorodifluoromethane	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	75-34-3	Dichloroethane[1,1-]	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	107-06-2	Dichloroethane[1,2-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	75-35-4	Dichloroethene[1,1-]	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	156-59-2	Dichloroethene[cis-1,2-]	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	156-60-5	Dichloroethene[trans-1,2-]	309	0	SW-846:8260B	0.3	1	10000	µg/L	NM HH OO
VOA	78-87-5	Dichloropropane[1,2-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	142-28-9	Dichloropropane[1,3-]	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	594-20-7	Dichloropropane[2,2-]	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	563-58-6	Dichloropropene[1,1-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	10061-01-5	Dichloropropene[cis-1,3-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	10061-02-6	Dichloropropene[trans-1,3-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	60-29-7	Diethyl Ether	219	3	SW-846:8260B	0.3	1		µg/L	
VOA	97-63-2	Ethyl Methacrylate	309	0	SW-846:8260B	1	5		µg/L	
VOA	100-41-4	Ethylbenzene	309	0	SW-846:8260B	0.25	1	2100	µg/L	NM HH OO
VOA	87-68-3	Hexachlorobutadiene	309	0	SW-846:8260B	0.3	1	180	µg/L	NM HH OO
VOA	591-78-6	Hexanone[2-]	309	0	SW-846:8260B	1.3	5		µg/L	
VOA	74-88-4	Iodomethane	309	0	SW-846:8260B	1.3	5		µg/L	
VOA	78-83-1	Isobutyl alcohol	309	0	SW-846:8260B	13	50		µg/L	
VOA	98-82-8	Isopropylbenzene	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	99-87-6	Isopropyltoluene[4-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	126-98-7	Methacrylonitrile	309	0	SW-846:8260B	1	5		µg/L	
VOA	80-62-6	Methyl Methacrylate	309	0	SW-846:8260B	1	5		µg/L	
VOA	1634-04-4	Methyl tert-Butyl Ether	219	0	SW-846:8260B	0.25	1		µg/L	
VOA	108-10-1	Methyl-2-pentanone[4-]	309	0	SW-846:8260B	1.3	5		µg/L	
VOA	75-09-2	Methylene Chloride	309	2	SW-846:8260B	3	10		µg/L	

Table C-4.1-2 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Unit	Cleanup-Level Type
VOA	91-20-3	Naphthalene	309	1	SW-846:8260B	0.25	1		µg/L	
VOA	107-12-0	Propionitrile	309	0	SW-846:8260B	1.5	5		µg/L	
VOA	103-65-1	Propylbenzene[1-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	100-42-5	Styrene	309	1	SW-846:8260B	0.25	1		µg/L	
VOA	630-20-6	Tetrachloroethane[1,1,1,2-]	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	79-34-5	Tetrachloroethane[1,1,2,2-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	127-18-4	Tetrachloroethene	309	0	SW-846:8260B	0.3	1	33	µg/L	NM HH OO
VOA	108-88-3	Toluene	309	5	SW-846:8260B	0.25	1	15000	µg/L	NM HH OO
VOA	76-13-1	Trichloro-1,2,2-trifluoroethane[1,1,2-]	309	0	SW-846:8260B	1	5		µg/L	
VOA	87-61-6	Trichlorobenzene[1,2,3-]	309	0	SW-846:8260B	0.33	1		µg/L	
VOA	120-82-1	Trichlorobenzene[1,2,4-]	309	0	SW-846:8260B	0.3	1	70	µg/L	NM HH OO
VOA	71-55-6	Trichloroethane[1,1,1-]	309	2	SW-846:8260B	0.33	1		µg/L	
VOA	79-00-5	Trichloroethane[1,1,2-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	79-01-6	Trichloroethene	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	75-69-4	Trichlorofluoromethane	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	96-18-4	Trichloropropane[1,2,3-]	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	95-63-6	Trimethylbenzene[1,2,4-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	108-67-8	Trimethylbenzene[1,3,5-]	309	0	SW-846:8260B	0.25	1		µg/L	
VOA	108-05-4	Vinyl acetate	309	0	SW-846:8260B	1.5	5		µg/L	
VOA	75-01-4	Vinyl Chloride	309	0	SW-846:8260B	0.5	1		µg/L	
VOA	95-47-6	Xylene[1,2-]	309	0	SW-846:8260B	0.3	1		µg/L	
VOA	Xylene[1,3 and 1,4]	Xylene[1,3-]+Xylene[1,4-]	308	0	SW-846:8260B	0.5	2		µg/L	

Note: Blank cells indicate there are no values.

[a] Mode (most frequent) of values reported for 2010 data.

[b] This value is derived as a result of logic provided in Appendix B-2.0, Protocol for Selecting Cleanup Levels.

Table C-4.1-3
Analytes with PQLs above Groundwater Cleanup Levels

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Background[c]	Background[d]	Unit	Cleanup-Level Type	Comment
Herb	94-74-6	MCPA	388	0	SW-846:8151A	12	53	18			µg/L	EPA TAP SCRN LVL	Although the PQL is higher, the MDL is less than the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Herb	93-65-2	MCPP	388	0	SW-846:8151A	11	53	37			µg/L	EPA TAP SCRN LVL	Although the PQL is higher, the MDL is less than the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Metals	Be	Beryllium	4761	59	SW-846:6010B	1	5	4	1	1	µg/L	EPA MCL	Although the PQL is higher, the MDL is less than the EPA maximum contaminant level (MCL). The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	1912-24-9	Atrazine	2074	0	SW-846:8270C	3	10	3			µg/L	EPA MCL	Although the PQL is higher, the MDL is equal to the EPA MCL. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	103-33-3	Azobenzene	2074	0	SW-846:8270C	2	10	1.3			µg/L	EPA TAP SCRN LVL	The MDL exceeds the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	92-87-5	Benzidine	2074	0	SW-846:8270C	3	10	0.00094			µg/L	EPA TAP SCRN LVL	The MDL exceeds the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	56-55-3	Benzo(a)anthracene	2074	6	SW-846:8270C	0.2	1	0.29			µg/L	EPA TAP SCRN LVL	Although the PQL is higher, the MDL is less than the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	50-32-8	Benzo(a)pyrene	2074	9	SW-846:8270C	0.2	1	0.2			µg/L	EPA MCL	Although the PQL is higher, the MDL is equal to the EPA MCL. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	205-99-2	Benzo(b)fluoranthene	2074	10	SW-846:8270C	0.2	1	0.29			µg/L	EPA TAP SCRN LVL	Although the PQL is higher, the MDL is less than the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	111-44-4	Bis(2-chloroethyl)ether	2074	0	SW-846:8270C	2	10	0.12			µg/L	EPA TAP SCRN LVL	The MDL exceeds the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	117-81-7	Bis(2-ethylhexyl)phthalate	2074	128	SW-846:8270C	2	10	6			µg/L	EPA MCL	Although the PQL is higher, the MDL is less than the EPA MCL. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	106-47-8	Chloroaniline[4-]	2074	0	SW-846:8270C	2	10	3.4			µg/L	EPA TAP SCRN LVL	Although the PQL is higher, the MDL is less than the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	53-70-3	Dibenz(a,h)anthracene	2074	4	SW-846:8270C	0.2	1	0.029			µg/L	EPA TAP SCRN LVL	The MDL exceeds the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	91-94-1	Dichlorobenzidine[3,3'-]	2074	0	SW-846:8270C	2	10	1.5			µg/L	EPA TAP SCRN LVL	The MDL exceeds the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	534-52-1	Dinitro-2-methylphenol[4,6-]	2074	0	SW-846:8270C	3	10	2.9			µg/L	EPA TAP SCRN LVL	The MDL exceeds the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.

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Table C-4.1-3 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Background[c]	Background[d]	Unit	Cleanup-Level Type	Comment
SVOA	121-14-2	Dinitrotoluene[2,4-]	2074	14	SW-846:8270C	2	10	2.2			µg/L	EPA TAP SCRN LVL	The Laboratory also analyzes this compound by SW-846:8321; that PQL is below the EPA tap water screening level.
SVOA	88-85-7	Dinoseb	2074	0	SW-846:8270C	2	10	7			µg/L	EPA MCL	The Laboratory also analyzes this compound by SW-846:8151A; that PQL is below the EPA MCL.
SVOA	123-91-1	Dioxane[1,4-]	2010	119	SW-846:8270C	2	10	6.7			µg/L	EPA TAP SCRN LVL	Although the PQL is higher, the MDL is less than the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	118-74-1	Hexachlorobenzene	2074	0	SW-846:8270C	2	10	1			µg/L	EPA MCL	The MDL exceeds the EPA MCL. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	87-68-3	Hexachlorobutadiene	2074	0	SW-846:8270C	2	10	8.6			µg/L	EPA TAP SCRN LVL	The Laboratory also analyzes this compound by SW-846:8260B; that PQL is below the EPA tap water screening level
SVOA	193-39-5	Indeno(1,2,3-cd)pyrene	2074	5	SW-846:8270C	0.2	1	0.29			µg/L	EPA TAP SCRN LVL	Although the PQL is higher, the MDL is less than the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	98-95-3	Nitrobenzene	2074	2	SW-846:8270C	3	10	1.2			µg/L	EPA TAP SCRN LVL	The Laboratory also analyzes this compound by SW-846:8321; that PQL is below the EPA tap water screening level
SVOA	55-18-5	Nitrosodiethylamine[N-]	2074	0	SW-846:8270C	2	10	0.0014			µg/L	EPA TAP SCRN LVL	The MDL exceeds the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	62-75-9	Nitrosodimethylamine[N-]	2074	0	SW-846:8270C	2	10	0.0042			µg/L	EPA TAP SCRN LVL	The MDL exceeds the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	924-16-3	Nitroso-di-n-butylamine[N-]	2074	0	SW-846:8270C	3	10	0.024			µg/L	EPA TAP SCRN LVL	The MDL exceeds the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	621-64-7	Nitroso-di-n-propylamine[N-]	2074	0	SW-846:8270C	2	10	0.096			µg/L	EPA TAP SCRN LVL	The MDL exceeds the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	930-55-2	Nitrosopyrrolidine[N-]	2074	0	SW-846:8270C	2	10	0.32			µg/L	EPA TAP SCRN LVL	The MDL exceeds the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	108-60-1	Oxybis(1-chloropropane)[2,2'-]	2074	0	SW-846:8270C	2	10	3.2			µg/L	EPA TAP SCRN LVL	Although the PQL is higher, the MDL is less than the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	87-86-5	Pentachlorophenol	2074	1	SW-846:8270C	2	10	1			µg/L	EPA MCL	The MDL exceeds the EPA MCL. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	108-95-2	Phenol	2074	5	SW-846:8270C	1	10	5			µg/L	NM GW STD	Although the PQL is higher, the MDL is less than the NM groundwater standard. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
VOA	107-02-8	Acrolein	2543	2	SW-846:8260B	1.3	5	0.042			µg/L	EPA TAP SCRN LVL	The MDL exceeds the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.

Table C-4.1-3 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Background[c]	Background[d]	Unit	Cleanup-Level Type	Comment
VOA	107-13-1	Acrylonitrile	2543	0	SW-846:8260B	1	5	0.45			µg/L	EPA TAP SCRN LVL	The MDL exceeds the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
VOA	126-99-8	Chloro-1,3-butadiene[2-]	2543	0	SW-846:8260B	0.3	1	0.16			µg/L	EPA TAP SCRN LVL	The MDL exceeds the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
VOA	96-12-8	Dibromo-3-Chloropropane[1,2-]	2543	0	SW-846:8260B	0.3	1	0.2			µg/L	EPA MCL	The MDL exceeds the EPA MCL. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
VOA	106-93-4	Dibromoethane[1,2-]	2543	0	SW-846:8260B	0.25	1	0.05			µg/L	EPA MCL	The MDL exceeds the EPA MCL. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
VOA	126-98-7	Methacrylonitrile	2542	0	SW-846:8260B	1	5	1			µg/L	EPA TAP SCRN LVL	Although the PQL is higher, the MDL is equal to the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
VOA	75-09-2	Methylene Chloride	2543	15	SW-846:8260B	3	10	5			µg/L	EPA MCL	Although the PQL is higher, the MDL is less than the EPA MCL. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
VOA	96-18-4	Trichloropropane[1,2,3-]	2543	0	SW-846:8260B	0.3	1	0.0072			µg/L	EPA TAP SCRN LVL	The MDL exceeds the EPA tap water screening level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.

Note: Blank cells indicate there are no values.

[a] Mode (most frequent) of values reported for 2010 data.

[b] This value is derived as result of logic provided in Appendix B-2.0, Protocol for Selecting Cleanup Levels.

[c] Lowest of background values for alluvial, intermediate, and regional groundwater as identified in the Laboratory's 2007 groundwater background report (LANL 2007, 095817).

[d] Lowest of background values for intermediate and regional groundwater as identified in the Laboratory's 2010 groundwater background report (LANL 2010, 110535).

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Table C-4.1-4
Analytes with PQLs above Groundwater Background Levels

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Background[c]	Background[d]	Unit	Cleanup-Level Type	Comment
Geninorg	NH3-N	Ammonia as Nitrogen	2706	497	EPA:350.1	0.016	0.05		0.04	0.07	mg/L		The PQL exceeds the background. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Geninorg	Br(-1)	Bromide	2699	669	EPA:300.0	0.066	0.2		0.03	0.07	mg/L		The MDL exceeds the background. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Geninorg	ClO4	Perchlorate	3364	2541	SW-846:6850	0.05	0.2	4	0.05	0.48	µg/L	NM GW CONS	While the PQL is above background, the MDL and the PQL are less than the Consent Order screening value
Geninorg	TKN	Total Kjeldahl Nitrogen	3142	1084	EPA:351.2	0.033	0.1		0.04	0.29	mg/L		The PQL exceeds the background. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Geninorg	TOC	Total Organic Carbon	2273	1898	SW-846:9060	0.33	1		0.33	0.07	mg/L		The PQL exceeds the background. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Metals	Al	Aluminum	4766	1573	SW-846:6010B	68	200	5000	68	68	µg/L	NM GW STD	While the PQL is above background, the MDL and the PQL are less than the NM groundwater standard.
Metals	Sb	Antimony	4757	130	SW-846:6020	0.5	3	6	0.5	0.5	µg/L	EPA MCL	While the PQL is above background, the MDL and the PQL are less than the EPA MCL.
Metals	As	Arsenic	4758	1054	SW-846:6020	1.5	5	10	4.32	3.43	µg/L	EPA MCL	While the PQL is above background, the MDL and the PQL are less than the EPA MCL.
Metals	Be	Beryllium	4761	59	SW-846:6010B	1	5	4	1	1	µg/L	EPA MCL	The MDL is less than the EPA MCL. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Metals	B	Boron	4752	3373	SW-846:6010B	15	50	750	15.1	35.42	µg/L	NM GW STD	While the PQL is above background, the MDL and the PQL are less than the NM groundwater standard.
Metals	Cr	Chromium	5093	3290	SW-846:6020	2.5	10	50	1	4.74	µg/L	NM GW STD	The MDL is less than the New Mexico groundwater standard. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Metals	Co	Cobalt	4761	458	SW-846:6010B	1	5	50	0.5	1	µg/L	NM GW STD	The MDL is less than the New Mexico groundwater standard. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Metals	Cu	Copper	4761	702	SW-846:6010B	3	10	1000	3	3	µg/L	NM GW STD	While the PQL is above background, the MDL and the PQL are less than the NM groundwater standard
Metals	Fe	Iron	4766	2600	SW-846:6010B	30	100	1000	21	30	µg/L	NM GW STD	The MDL is less than the New Mexico groundwater standard. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Metals	Pb	Lead	4756	857	SW-846:6020	0.5	2	15	0.5	0.5	µg/L	EPA MCL	While the PQL is above background, the MDL and the PQL are less than the EPA MCL.
Metals	Mn	Manganese	4766	2632	SW-846:6010B	2	10	200	2	36	µg/L	NM GW STD	While the PQL is above background, the MDL and the PQL are less than the NM groundwater standard.
Metals	Hg	Mercury	4732	103	EPA:245.2	0.066	0.2	2	0.06	0.07	µg/L	EPA MCL	The MDL is less than the EPA MCL. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Metals	Ni	Nickel	4756	3849	SW-846:6020	0.5	2	200	1	2.98	µg/L	NM GW STD	While the PQL is above background, the MDL and the PQL are less than the NM groundwater standard.
Metals	Sn	Tin	4733	84	SW-846:6010B	2.5	10	22000	3.26	25	µg/L	EPA TAP SCRN LVL	While the PQL is above background, the MDL and the PQL are less than the EPA tap water screening level
Metals	V	Vanadium	4761	3819	SW-846:6010B	1	5	180	1	15.21	µg/L	EPA TAP SCRN LVL	While the PQL is above background, the MDL and the PQL are less than the EPA tap water screening level

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Table C-4.1-4 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Cleanup Level[b]	Background[c]	Background[d]	Unit	Cleanup-Level Type	Comment
Metals	Zn	Zinc	4763	2777	SW-846:6010B	3.3	10	10000	2	3.3	µg/L	NM GW STD	The MDL is less than the New Mexico groundwater standard. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Rad	Am-241	Americium-241	2578	61	Alpha Spectroscopy	0.05		1.2	0.04	0.05	pCi/L	DOE DW DCG	The MDA is less than the DOE Derived Concentration Guidelines (DCG). The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Rad	Cs-137	Cesium-137	2552	3	Gamma Spectroscopy	8		120	5.8	6.92	pCi/L	DOE DW DCG	The minimum detectable activity is less than the DOE DCG. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Rad	GROSSA	Gross alpha	1821	377	Gas Proportional Counting	3		15	2.98	2.75	pCi/L	EPA action level	The minimum detectable activity is less than the EPA action level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Rad	Sr-90	Strontium-90	2585	184	Gas Proportional Counting	0.5		8	0.29	0.51	pCi/L	EPA action level	The minimum detectable activity is less than the EPA action level. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Rad	H-3	Tritium	2454	1197	Liquid Scintillation Counting	250		20000	0.32	6.26	pCi/L	EPA action level	The MDL exceeds the background but is below the EPA action level. This background value was determined using data from a laboratory no longer under contract. The Laboratory uses a routine analytical method for this compound under its contract analytical program.

Note: Blank cells indicate there are no values.

[a] Mode (most frequent) of values reported for 2010 data.

[b] This value is derived as result of logic provided in Appendix B-2.0, Protocol for Selecting Cleanup Levels.

[c] Lowest of background values for alluvial, intermediate, and regional groundwater as identified in the Laboratory's 2007 groundwater background report (LANL 2007, 095817).

[d] Lowest of background values for intermediate and regional groundwater as identified in the Laboratory's 2010 groundwater background report (LANL 2010, 110535).

Table C-4.1-5
Analytes with a PQL above Base-Flow Cleanup Levels

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Screening Level[b]	Unit	Screening-Level Type	Comment
Diox/Fur	1746-01-6	Tetrachlorodibenzodioxin[2,3,7,8-]	75	3	SW-846:8290		0.00001	5.1E-08	µg/L	NM HH OO	The PQL exceeds the New Mexico human health numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Metals	Cd	Cadmium	724	70	SW-846:6020	0.11	1	0.23	µg/L	NM Aqu Chronic 30 mg/L hardness	Although the PQL is higher, the MDL is less than the New Mexico aquatic chronic numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Metals	Cu	Copper	724	264	SW-846:6010B	3	10	4	µg/L	NM Aqu Chronic 30 mg/L hardness	Although the PQL is higher, the MDL is less than the New Mexico aquatic chronic numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Metals	Pb	Lead	724	286	SW-846:6020	0.5	2	1	µg/L	NM Aqu Chronic 30 mg/L hardness	Although the PQL is higher, the MDL is less than the New Mexico aquatic chronic numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Metals	Ag	Silver	724	78	SW-846:6020	0.2	1	0.7	µg/L	NM Aqu Chronic 30 mg/L hardness	Although the PQL is higher, the MDL is less than the New Mexico aquatic chronic numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Metals	Tl	Thallium	724	69	SW-846:6020	0.3	1	0.47	µg/L	NM HH OO	Although the PQL is higher, the MDL is less than the New Mexico human health numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
PCB	12674-11-2	Aroclor-1016	216	0	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO	The Laboratory also analyzes PCBs by EPA:1668A; the PQL for that method is less than the New Mexico human health numerical criterion.
PCB	11104-28-2	Aroclor-1221	216	0	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO	The Laboratory also analyzes PCBs by EPA:1668A; the PQL for that method is less than the New Mexico human health numerical criterion.
PCB	11141-16-5	Aroclor-1232	216	0	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO	The Laboratory also analyzes PCBs by EPA:1668A; the PQL for that method is less than the New Mexico human health numerical criterion.
PCB	53469-21-9	Aroclor-1242	216	0	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO	The Laboratory also analyzes PCBs by EPA:1668A; the PQL for that method is less than the New Mexico human health numerical criterion.
PCB	12672-29-6	Aroclor-1248	216	0	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO	The Laboratory also analyzes PCBs by EPA:1668A; the PQL for that method is less than the New Mexico human health numerical criterion.
PCB	11097-69-1	Aroclor-1254	216	6	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO	The Laboratory also analyzes PCBs by EPA:1668A; the PQL for that method is less than the New Mexico human health numerical criterion.
PCB	11096-82-5	Aroclor-1260	216	7	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO	The Laboratory also analyzes PCBs by EPA:1668A; the PQL for that method is less than the New Mexico human health numerical criterion.
PCB	37324-23-5	Aroclor-1262	216	0	SW-846:8082	0.033	0.1	0.00064	µg/L	NM HH OO	The Laboratory also analyzes PCBs by EPA:1668A; the PQL for that method is less than the New Mexico human health numerical criterion.
Pest	309-00-2	Aldrin	197	1	SW-846:8081A	0.005	0.02	0.0005	µg/L	NM HH OO	The MDL exceeds the New Mexico human health numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Pest	5103-71-9	Chlordane[alpha-]	197	1	SW-846:8081A	0.005	0.02	0.0043	µg/L	NM Aqu Chronic	The MDL exceeds the New Mexico aquatic chronic numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Pest	5103-74-2	Chlordane[gamma-]	197	2	SW-846:8081A	0.005	0.02	0.0043	µg/L	NM Aqu Chronic	The MDL exceeds the New Mexico aquatic chronic numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Pest	72-54-8	DDD[4,4'-]	197	3	SW-846:8081A	0.01	0.04	0.001	µg/L	NM WQCC WLDLF HAB	The MDL exceeds the New Mexico wildlife habitat numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Pest	72-55-9	DDE[4,4'-]	197	5	SW-846:8081A	0.005	0.04	0.001	µg/L	NM WQCC WLDLF HAB	The MDL exceeds the New Mexico wildlife habitat numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.

Table C-4.1-5 (continued)

Suite	Analyte or CAS No.	Analyte Name	Total Samples 2006–2010	Total Detects 2006–2010	Method	MDL[a]	PQL[a]	Screening Level[b]	Unit	Screening-Level Type	Comment
Pest	50-29-3	DDT[4,4'-]	197	4	SW-846:8081A	0.01	0.04	0.001	µg/L	NM WQCC WLDLF HAB	The MDL exceeds the New Mexico wildlife habitat numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Pest	60-57-1	Dieldrin	197	2	SW-846:8081A	0.01	0.04	0.00054	µg/L	NM HH OO	The MDL exceeds the New Mexico human health numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Pest	72-20-8	Endrin	197	2	SW-846:8081A	0.01	0.04	0.036	µg/L	NM Aqu Chronic	Although the PQL is higher, the MDL is less than the New Mexico aquatic chronic numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Pest	76-44-8	Heptachlor	197	2	SW-846:8081A	0.005	0.02	0.0038	µg/L	NM Aqu Chronic	The MDL exceeds the New Mexico aquatic chronic numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Pest	1024-57-3	Heptachlor Epoxide	197	2	SW-846:8081A	0.005	0.02	0.0038	µg/L	NM Aqu Chronic	The MDL exceeds the New Mexico aquatic chronic numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
Pest	8001-35-2	Toxaphene (Technical Grade)	197	0	SW-846:8081A	0.15	0.5	0.0002	µg/L	NM Aqu Chronic	The MDL exceeds the New Mexico aquatic chronic numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	50-32-8	Benzo(a)pyrene	281	3	SW-846:8270C	0.2	1	0.18	µg/L	NM HH OO	The MDL exceeds the New Mexico human health numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.
SVOA	118-74-1	Hexachlorobenzene	281	0	SW-846:8270C	2	10	0.0029	µg/L	NM HH OO	The MDL exceeds the New Mexico human health numerical criterion. The Laboratory uses a routine analytical method for this compound under its contract analytical program.

Note: Blank cells indicate there are no values.

[a] Mode (most frequent) of values reported for 2010 data.

[b] This value is derived as result of logic provided in Appendix B-2.0, Protocol for Selecting Screening Levels.

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Table C-4.2-1
Analytical Methods, PQLs, and MDLs for Analytes Reported by GGRL

Analyte	Analytical Method	Method Description	MDL	PQL	Unit
General Inorganics					
Alkalinity-CO_3	EPA:310.1	Titrimetric	0.8	4	mg/L
Alkalinity-CO_3+HCO_3	EPA:310.1	Titrimetric	0.8	4	mg/L
Ammonia as Nitrogen	EPA:350.3	Ion selective electrode	0.1	0.5	mg/L
Bromide	EPA:300.0	Ion chromatography	0.01	0.05	mg/L
Calcium	EPA:200.7	ICP-AES[a]	0.01	0.05	mg/L
Chloride	EPA:300.0	Ion chromatography	0.01	0.05	mg/L
Fluoride	EPA:300.0	Ion chromatography	0.01	0.05	mg/L
Magnesium	EPA:200.7	ICP-AES	0.01	0.05	mg/L
Nitrite as Nitrogen	EPA:300.0	Ion chromatography	0.003	0.015	mg/L
Nitrate as Nitrogen	EPA:300.0	Ion chromatography	0.002	0.01	mg/L
Oxalate	EPA:300.0	Ion chromatography	0.01	0.05	mg/L
Perchlorate	EPA:314.0	Ion chromatography	2	10	µg/L
pH	EPA:150.1	pH meter	—[b]	—	SU
Phosphorus, Orthophosphate (Expressed as PO_4)	EPA:300.0	Ion chromatography	0.01	—	mg/L
Potassium	EPA:200.7	ICP-AES	0.01	—	mg/L
Sodium	EPA:200.7	ICP-AES	0.01	0.05	mg/L
Sulfate	EPA:300.0	Ion chromatography	0.01	0.05	mg/L
Total Organic Carbon	SW-846:9060	Carbonaceous analyzer	0.2	1	mg/L
Sulfide, Total	EPA:376.2	Colorimetric	0.01	0.05	mg/L
Metals					
Aluminum	EPA:200.7	ICP-AES	1	5	µg/L
Antimony	EPA:200.8	ICP-MS[c]	1	5	µg/L
Arsenic	EPA:200.8	ICP-MS	0.2	1	µg/L
Barium	EPA:200.7	ICP-AES	1	5	µg/L
Beryllium	EPA:200.8	ICP-MS	1	5	µg/L
Boron	EPA:200.7	ICP-AES	2	10	µg/L
Cadmium	EPA:200.8	ICP-MS	1	5	µg/L
Cesium	EPA:200.8	ICP-MS	1	5	µg/L
Chromium	EPA:200.8	ICP-MS	1	5	µg/L
Chromium Hexavalent Ion	SW-846:7196A	Ultraviolet–Visible Spectrophotometry	0.05	0.25	µg/L
Cobalt	EPA:200.8	ICP-MS	1	5	µg/L
Copper	EPA:200.8	ICP-MS	1	5	µg/L
Iron	EPA:200.7	ICP-AES	10	50	µg/L
Lithium	EPA:200.7	ICP-AES	1	5	µg/L
Lead	EPA:200.8	ICP-MS	0.2	1	µg/L
Manganese	EPA:200.7	ICP-AES	1	5	µg/L
Mercury	EPA:200.8	ICP-MS	0.05	0.25	µg/L

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Table C-4.2-1 (continued)

Analyte	Analytical Method	Method Description	MDL	PQL	Unit
Molybdenum	EPA:200.8	ICP-MS	1	5	µg/L
Nickel	EPA:200.8	ICP-MS	1	5	µg/L
Selenium	EPA:200.8	ICP-MS	1	5	µg/L
Silicon Dioxide	EPA:200.7	ICP-AES	0.0214	0.107	mg/L
Silver	EPA:200.8	ICP-MS	1	5	µg/L
Strontium	EPA:200.7	ICP-AES	1	5	µg/L
Thallium	EPA:200.8	ICP-MS	1	5	µg/L
Tin	EPA:200.8	ICP-MS	1	5	µg/L
Titanium	EPA:200.7	ICP-AES	2	10	µg/L
Uranium	EPA:200.8	ICP-MS	0.2	1	µg/L
Vanadium	EPA:200.8	ICP-MS	1	5	µg/L
Zinc	EPA:200.7	ICP-AES	1	5	µg/L
Isotope					
Deuterium Ratio	Generic:Deuterium Ratio	Isotope ratio mass spectrometry	—	—	permil
Oxygen-18/Oxygen-16 Ratio	Generic:Oxygen Isotope Ratio	Isotope ratio mass spectrometry	—	—	permil
Nitrogen-15/Nitrogen-14 Ratio	Generic:Nitrogen Isotope Ratio	Isotope ratio mass spectrometry	—	—	permil

[a] ICP-AES = inductively coupled plasma atomic emission spectroscopy.

[b] — = Not applicable.

[c] ICP-MS = inductively coupled mass spectrometry.

Table C-5.0-1
Waste Stream, Estimated Volumes, and Management of IDW

Waste Stream	Estimated Volume	On-Site Management and Final Disposition
Purge water	5 to 3000 gal. per well per sampling event	Land application per ENV-RCRA-SOP-010, Land Application of Groundwater
Contact waste	Less than 110 gal. per watershed monitoring campaign	Accumulation in 55-gal. drums with drum liners. Disposal off-site at a New Mexico solid waste landfill or on-site disposal at TA-54, Area G
Decontamination fluids	Less than 55 gal. per watershed monitoring campaign	Treatment at an on-site or Laboratory-approved off-site wastewater treatment facility for which waste meets waste acceptance criteria

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Appendix D

Supplemental Information for
Assigned Sampling Suites and Frequencies

Appendix D provides supplemental information relevant to sampling frequencies and analytical suites assigned to locations in each area-specific monitoring group or watershed. The following are primary considerations used to define sampling frequencies and analytical suites that are protective of groundwater:

- general types of contaminants released from upgradient sources
- extent to which contaminant nature and extent have been defined
- expected transport characteristics of the released contaminants
- frequency of detection of contaminants in the monitoring group
- magnitude of concentrations relative to the lowest applicable standard
- nature and rate of change of contaminant concentrations

The highest sampling frequencies apply to areas in which a mobile contaminant has been detected above a standard but where its nature and extent may not be characterized sufficiently to support decisions about potential remedial actions to be taken. Lower sampling frequencies apply to analytes that are not of significance for a given monitoring group, are relatively immobile in the subsurface, and have not been detected or have been detected infrequently.

The following general rules of thumb were used to define the lowest sampling frequencies for specific analytical suites (excluding those locations undergoing characterization sampling).

Inorganic Constituents. General inorganics and metals are sampled annually if these suites contain one or more significant contaminants for a monitoring group, the nature and extent of those constituents are well characterized, and additional data are not needed to support regulatory decision-making, such as an investigation report or a corrective measures evaluation (CME). To the extent that additional data are needed to meet project objectives or for new wells, the relevant analytical suite is sampled more frequently. Metals are not sampled from areas that have no evidence of metals migration. Perchlorate is sampled annually or more frequently in new wells and in the northern monitoring groups where it is a potentially significant constituent. Perchlorate is no longer sampled for in wells from the southern monitoring groups where it was not used.

Organic Constituents. The main characteristic used to determine the lowest sampling frequency for an organic analytical suite is the mobility of its constituents. Suites containing organic constituents with moderate to high mobility in the environment (volatile organic compounds [VOCs] and, to a lesser extent, semivolatile organic compounds [SVOCs]) are sampled annually or not sampled in areas for which there is a history of nondetections and where additional data are not needed to support regulatory decision-making, such as an investigation report or a CME. If consistently detected or if additional data are needed to meet project objectives, then the relevant suite is sampled annually or more frequently. Data from across Los Alamos National Laboratory show a history of nondetections for dioxins/furans, pesticides, and polychlorinated biphenyls (PCBs) in deeper groundwater zones. This is consistent with the expected inability for these highly adsorptive constituents to migrate to deeper groundwater zones. Therefore, these constituents have been eliminated from the groundwater sampling suite. Similarly, high explosives (HEXP) are not present in the northern watersheds (those north of Pajarito Canyon) and are not part of the analytical suite after initial characterization sampling of new wells has been completed.

Radionuclides (Excluding Tritium). If there is a history of nondetections or if detections fall within the range of natural background (for naturally occurring radionuclides), then the lowest sampling frequency applies, which is quarterly or semiannually for new wells, annual if radionuclides are among the significant

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constituents for an area being monitored, and biennial otherwise. The frequency is increased to semiannual if one or more radionuclides is detected above background, if the nature and extent of radionuclide constituents are not well characterized, or if additional data are needed to support decision-making.

Tritium. Tritium samples are collected only from springs and deep groundwater. Annual or higher frequencies apply except where tritium is not a significant contaminant, such as in the Technical Area 16 (TA-16) 260 monitoring group and in some general surveillance locations. Samples are collected for low-level tritium analysis at locations where a very low minimum detectable activity is useful to support a conceptual model for fate and transport.

Table D-1 provides background information and the objectives used to generally define the sampling frequencies and analytical suites for the area-specific monitoring groups. The specific sampling frequencies and analytical suites for individual sampling locations are provided in Tables 2.4-1 through 8.3-2 of the monitoring plan.

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Table D-1
Background Information and Objectives Used to Determine
Sampling Frequencies and Analytical Suites for Area-Specific Monitoring Groups

Monitoring Group	Background*	Proposed Frequency	Proposed Analyte Suites	Objectives
TA-21	• Nature and extent of groundwater contamination generally understood • No concentrations exceed standards or screening levels (SLs) in regional groundwater	• Quarterly sampling of new regional wells • Annual sampling of all other intermediate and regional wells	• Metals, VOCs, SVOCs, radionuclides, low-level tritium, general inorganics, and perchlorate analyses for all quarterly samples from new wells; HEXP semiannually at new wells • Radionuclides, tritium or low-level tritium, and general inorganics and perchlorate analyses annually for other wells • Annual VOC and SVOC analysis at R-6i	• Focus on mobile constituents and radionuclides
Chromium (Cr)	• Nature and extent of groundwater contamination generally understood • Cr concentrations in regional aquifer exceed New Mexico Groundwater Standard (NM GW STD) • Perchlorate concentrations in regional aquifer exceed Consent Order SL • No constituent concentrations exceed standards or SLs in regional groundwater • Cr concentrations at the down-gradient portion of the plume below NM GW STD and stable, especially in deeper screens where concentrations are at background concentrations	• Quarterly sampling of new regional wells • Quarterly sampling of intermediate and regional wells with chromium (Cr) concentrations that exceed 25 µg/L (half the NM GW STD) • Quarterly sampling of intermediate and regional wells with significant rate of change in Cr concentrations • Semiannual sampling of intermediate and regional wells with Cr concentrations that are above 10.44 µg/L (background upper tolerance limit) but less than 25 µg/L (half the NM GW STD) • Annual sampling of intermediate and regional with Cr concentrations at background levels	• Metals, general inorganics, and perchlorate analyses for all quarterly samples from new regional wells; VOCs, SVOCs, HEXP, radionuclides, and low-level tritium semiannually from new regional wells • Metals, general inorganics, and perchlorate analyses for all samples; perchlorate annually at R-44 and R-45 because of low concentrations • Annual VOC and SVOC analysis for samples from intermediate Mortandad Canyon wells with consistently detected 1,4-dioxane • Annual analysis for radionuclides at intermediate wells; biennial for regional wells that are not new	• Focus highest frequency sampling and analysis for mobile constituents, including perchlorate • Focus highest frequency sampling and analysis at locations with highest Cr concentrations • Monitor wells located where potential for greatest rate of change is possible because of the presence of Cr in the vadose zone • Monitor wells located at downgradient edge of Cr plume • Monitor wells located between Cr plume and water-supply wells

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Table D-1 (continued)

Monitoring Group	Background*	Proposed Frequency	Proposed Analyte Suites	Objectives
MDA C	• Current data sufficient to support remedy selection for Material Disposal Area (MDA) C CME • No concentrations of constituents exceed standards or SLs in regional groundwater • Determination that groundwater is protected is supported by vapor-phase VOC sampling conducted to date	• Semiannual sampling of all wells	• VOC, SVOC, and low-level tritium analyses for all samples • Metals analysis for all R-60 samples • Annual analysis for radionuclides and general inorganics for all locations	• Focus highest frequency analysis for mobile constituents known to be present beneath MDA C
TA-54	• Current data sufficient to support remedy selection; CMEs for MDAs G, H and L submitted to the New Mexico Environment Department (09/09/2011) • No constituent concentrations exceed standards or SLs in regional groundwater • Determination that groundwater is protected is supported by vapor-phase VOC sampling conducted to date	• Semiannual sampling of all intermediate and regional wells	• Metals, VOCs, SVOCs, HEXP, low-level tritium, general inorganics, and perchlorate analyses for all samples from new well R-55i; radionuclides annually • VOC and low-level tritium analyses for all other samples • Semiannual SVOC analysis for R-37 screen 1 (consistently detected 1,4-dioxane) • VOCs and low-level tritium analysis only at R-40 screen 1 because of low yield • Annual metals, SVOCs, radionuclides, general inorganics, and perchlorate analyses for all other locations	• Focus highest frequency analysis for mobile constituents known to present beneath TA-54 MDAs

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Table D-1 (continued)

Monitoring Group	Background*	Proposed Frequency	Proposed Analyte Suites	Objectives
TA-16-260	• Increased runoff following Las Conchas fire may impact near-surface hydrology and contaminant distributions • Nature and extent of groundwater contamination generally understood • RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine) exceeds U.S. Environmental Protection Agency tap water SL in intermediate groundwater • No constituent concentrations exceed standards or SLs in regional groundwater • Historical rate of change in RDX concentrations doesn't require high-frequency (e.g., quarterly) sampling	• Monitor semiannually or annually at key base-flow location, alluvial monitoring wells, and springs • Semiannual sampling of new or reconfigured wells with an extra quarterly round in R-63 • Semiannual sampling of springs, and alluvial, intermediate, and regional wells with elevated RDX concentrations • Annual sampling of springs and wells without significant RDX detections	• Metals, VOCs, SVOCs, HEXP, low-level tritium, general inorganics, and perchlorate analyses for all samples from new or reconfigured wells; annual analysis for radionuclides • Metals, VOCs, and HEXP analyses for all other samples • Annual analysis for general inorganics and biennial analysis for radionuclides for all other locations	• Reestablish baseline conditions for shallow system following Las Conchas fire • Focus highest frequency analysis for mobile constituents known to be released at the 260 Outfall
MDA AB	• No constituent concentrations exceed standards or SLs in regional groundwater	• Annual sampling of all intermediate and regional wells	• Metals, VOCs, SVOCs, HEXP, radionuclides, low-level tritium, and general inorganics analyses for all samples	• General analyte suite for constituents that may have been released from MDA AB

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Table D-1 (continued)

Monitoring Group	Background*	Proposed Frequency	Proposed Analyte Suites	Objectives
General Surveillance	• Number of outfalls significantly reduced and remaining outfalls have improved water quality • Nature and extent of groundwater contamination generally understood • Canyons investigations are complete and show contribution to risk from surface water is low and within acceptable limits • Generally, constituent concentrations are below standards or SLs	• Continuous field-parameters sampling at key base-flow locations • Annual monitoring at key alluvial monitoring wells and springs to capture unexpected near-surface conditions • Annual sampling of all intermediate and regional wells	• Metals, radionuclides, general inorganics, and perchlorate analyses for all samples • Analysis of additional constituents at monitoring well 03-B-13 • HEXP analysis for southern watersheds • VOCs and SVOCs analysis for selected areas	• Focus highest frequency analysis for mobile constituents known to be present in particular watershed • Limit monitoring in the alluvial groundwater because of limited contamination • Focus on intermediate and regional locations for groundwater protection

* Constituents discussed in this column do not include detections of spurious organic constituents, naturally occurring constituents, or constituents related to well corrosion or to potential drilling effects.

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Appendix E

Field Quality Assurance/Quality Control Samples

Sample Type	Summary
General	This appendix summarizes field quality assurance/quality control (QA/QC) samples to be collected during interim facility-wide groundwater monitoring activities. Field QA/QC samples are collected in accordance with the Compliance Order on Consent, Section IX.B and include field blanks, equipment rinsate blanks, performance evaluation blanks, field duplicates, and field trip blanks. Field QA/QC samples are used to detect possible field or analytical laboratory contamination and to track analytical laboratory performance. Differences in analytical results between field-duplicate samples, for example, may indicate the samples were not uniform or significant variation occurred during analyses. Detection of analytes in deionized water field blanks may indicate contamination of the deionized water source or sample bottles or contamination from the analytical laboratory. This summary also addresses how field QA/QC results are used and the types of corrective actions that may be taken to address exceedances of target measures for each QA/QC sample type.
Field Blanks	Field blanks are used to monitor for contamination during sampling and are collected at a minimum frequency of 10% of all samples collected in a sampling campaign. Field blanks are collected by filling sample containers in the field with deionized water to check for sources of sample contamination in the field. Field blanks are analyzed for the organic constituents sampled for during the sampling campaign, with the exception of high explosive compounds, which are not analyzed in field or equipment rinsate blanks. Field-blank results are evaluated as part of the secondary data validation process by using the results to validate the associated sample results. If any analytes are detected in the field blank, the result from the associated sample is qualified as undetected if the result is less than 5 times the amount for the analyte found in the associated field blank. A validation reason code is also assigned to describe why the data were qualified.
Equipment Rinsate Blanks	Equipment rinsate blanks are used to detect any contamination resulting from contaminated equipment or poor decontamination techniques. The equipment rinsate blank is prepared by passing deionized water through unused or decontaminated sampling equipment, including Westbay sample bottles. Equipment rinsate blanks are collected before a well is sampled with a nondedicated pump. An equipment rinsate blank is also collected before sampling each well equipped with a Westbay sampling system for which samples are being collected for off-site analysis. Equipment rinsate blanks are not required for wells equipped with Westbay sampling systems from which samples are being collected only for on-site analysis. Equipment rinsate blanks are analyzed for the organic constituents sampled for in the associated well, with the exception of high explosive compounds, which are not analyzed in rinsate blanks. During the secondary data validation process, equipment rinsate blanks are evaluated in the same manner as field blanks, and any detected analytes are qualified in the samples associated with the equipment rinsate blank.
Performance Evaluation Blanks	Performance evaluation blanks (PEBs) are deionized water blanks submitted as regular samples, without any indication that they are QC samples. PEBs are used to evaluate the reagent-grade deionized water used to decontaminate sampling equipment and to prepare the blank samples discussed above. One PEB is collected per sampling campaign and analyzed for total organic carbon and for the full suite of constituents analyzed during the watershed sampling campaign, including metals, organic chemicals, general inorganics, and radionuclides. PEBs are not analyzed for stable isotopes or specialized analytes that may be requested for the sampling campaign.

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Sample Type	Summary
Field Duplicates	Field duplicates are split samples that provide information about field variation of sampling results as well as analytical laboratory variation. They may reveal sampling techniques with poor reproducibility and provide information on the reproducibility of the sampling process. Field duplicates are collected at a rate of 10% of all samples collected in a sampling campaign. Field-duplicate samples should be distributed proportionally among surface water, alluvial groundwater, and intermediate/regional groundwater to the relative number of samples collected for each type of media. Field-duplicate samples are selected from robust sampling locations requiring full analytical suites and yielding plenty of sample volume. Field-duplicate samples should be analyzed for the same suite of analytes for which the primary samples are analyzed. However, field-duplicate samples need not be analyzed for specialized nonroutine analytes that may be requested for a sampling campaign, unless directed by the project leader. These analytes include stable isotopes and parameters for which microfiltration is requested. Field-duplicate results are compared with the associated sample results, and a relative percent difference is calculated. The acceptable threshold for relative percent differences is 20% for data greater than 5 times the reporting limit.
Field Trip Blanks	Field trip blanks accompany samples collected for volatile organic compound (VOC) analyses and are used to identify potential VOC contamination that may occur during sample handling, shipping, and storage or at the analytical laboratory. Field trip blanks consist of organic-free deionized water prepared by an independent off-site laboratory and are analyzed only for VOCs. A minimum of one trip blank is required for each cooler containing samples for VOC analyses. However, to facilitate data validation and verification, one trip blank may be included with each sample submitted for VOC analysis. During the secondary data validation process, field trip blanks are evaluated the same as field blanks, and any detected analytes are qualified in the samples associated with the trip blank. If any analytes are detected in the field trip blank, the result from the associated sample is qualified as undetected if the result is less than 5 times the amount of the concentration of the analyte found in the associated field blank. These results are given a validation reason code to describe why the data were qualified.
QA/QC Corrective Actions	Exceedances of target measures for each of the QA/QC sections summarized above triggers any number of potential corrective actions. Potential corrective actions are considered on a case-by-case basis and generally follow a graded approach. Corrective actions to be considered include the following. **Data review/focused validation:** A typical first step is to review field paperwork (e.g., chains-of-custody forms, sample collection logs) to ensure sample identifiers align with analytical results. Detailed data review and focused validation may also provide insights into improper use of sample preservatives and other similar errors in sample collection. **Reanalysis:** Review of QA/QC results sometimes detects problems that occur with sample analysis. In these instances, reanalysis of an aliquot of the original sample may be requested of the analytical laboratory, assuming no holding-time issues are associated with the sample aliquot. **Resampling:** If the QA/QC problem is not resolved using the approaches described above, resampling may be necessary. The decision to resample depends largely on the schedule for the subsequent sampling round. For instance, if a site is sampled quarterly, the sample collected for that round should suffice in filling the data gap. If the site is sampled annually, it may be necessary to resample after the discovery of a QA/QC concern if it would result in an important data gap. If an unacceptable QA/QC condition persists, then determining the source of the problem and making root-level corrections in a specific portion of the process will be initiated. For example, corrections or modifications may be made to an equipment decontamination process.

Appendix F

Protocols for Assessing
the Performance of Deep Groundwater Monitoring Wells

F-1.0 OBJECTIVES AND SCOPE

This appendix establishes a "watch list" identifying perched-intermediate and regional groundwater monitoring wells (hereafter referred to as the deep monitoring wells) for which the representativeness of water-quality data for certain constituents is questionable. These deep monitoring wells are sampled at Los Alamos National Laboratory (the Laboratory) under the Interim Facility-Wide Groundwater Monitoring Plan (the Interim Plan). Table F-1.0-1 lists the preliminary watch list of deep monitoring wells for the 2011 Interim Monitoring Plan, and describes the reason for this condition.

This appendix describes approaches for tracking the performance of deep monitoring wells at the Laboratory under the Interim Monitoring Plan.

- Section F-2.0 identifies deep monitoring wells that are purged less than 3 casing volumes (CVs).
- Section F-3.0 defines a protocol for assigning deep monitoring wells to watch lists with appropriate follow-up actions when questions arise concerning the reliability and representativeness of water-quality data from those wells.
- Section F-4.0 outlines an approach for conducting reliability assessments of deep monitoring wells to determine their capability for producing representative water-quality samples and to identify any potential effects of well installation, rehabilitation, or sampling protocol on data quality.

One well is also included on the watch list because of possible construction issues. In addition to wells described in Table F-1.0-1, the representativeness of new water quality samples from other wells is continually reviewed for possible addition to the watch list. The results from newly drilled wells and recently converted Westbay wells are part of this evaluation.

Inclusion of a well on the watch list is intended to be used as a general indicator of data quality and should not be construed as a definitive identification of data usability. The watch list is also dynamic insofar as it will be updated as conditions evolve. Changes will occur when additional water-quality data justify the removal or addition of wells from the list.

F-2.0 DEEP WELLS WITH LIMITED PURGE VOLUMES

Water that remains in a monitoring well for a period of time may not be representative of formation water because of physical, chemical, or biological changes that may occur as the water remains in contact with the well casing, dedicated sampling equipment, and the air space in the upper casing. This stagnant water may not represent formation water at the time of sampling. To ensure samples collected from a monitoring well are representative of formation water, stagnant water in the casing is generally removed (i.e., purged) from the sampling zone within the well before it is sampled. As prescribed in Standard Operating Procedure (SOP) EP-DIV-SOP-20032, Groundwater Sampling, the Laboratory's standard practice is to purge perched-intermediate and regional wells a minimum of 3 CVs plus the volume of the drop pipe and to continue purging until water-quality parameters stabilize. Once the parameters stabilize, it is presumed that all stagnant water has been removed from the well and that fresh formation water is available for sampling.

However, purging 3 CVs is not always possible or feasible, particularly in low-producing monitoring wells that purge dry at low pumping rates. SOP-EP-DIV-SOP-20032 allows deviation from the 3-CV purge requirement for such conditions. However, data users may want to be aware of deep wells at which the 3-CV purge requirement generally cannot be met to consider potential impacts for data reliability. Table F-1.0-1 lists deep well screens which cannot meet the 3-CV purge requirement and describes the reason for this condition.

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F-3.0 WATCH LIST ASSIGNMENTS

This appendix section discusses additional watch list criteria for deep monitoring wells in this Interim Plan for which the representativeness of water-quality data is questionable.

Data examined for the assessment includes field parameters monitored during purging before sample collection, field parameters associated with samples at the time of collection, major-ion concentrations, trace-metal concentrations, and detections of organic constituents. The assessments are based on site-specific geochemical criteria. The assessment may result in recommendations concerning the well's configuration, sampling protocols (such as purging volumes), extension or limitation of the analytical suites to be collected from the well screen, or caveats about data usability.

The specific objective of a reliability assessment is to determine the current reliability of a well (including its sampling system) as it relates to the water-quality data objectives of the specific monitoring network to which it is assigned. In general, reliability assessments may be conducted for a subset of the wells assigned to the watch list described in the preceding section or for deep wells within the context of a specific monitoring network.

The watch list presented in Table F-1.0-1 includes deep well screens for which field parameters monitored during purging consistently fail to meet stability criteria as well as deep well screens which show anomalous chemistry data suggesting groundwater in the screened interval may not be fully equilibrated following construction or rehabilitation. Table F-1.0-1 also provides the rationale for each listed well screen and lists recommended follow-up actions.

F-4.0 RELIABILITY ASSESSMENT PROTOCOL

The specific objective of a reliability assessment is to determine the current reliability of a well (including its sampling system) as it relates to the water-quality data objectives of the specific monitoring network to which it is assigned. In general, reliability assessments may be conducted for a subset of the wells assigned to the watch lists described in the preceding section or for deep wells within the context of a specific monitoring network.

Data examined for the assessment includes field parameters monitored during purging before sample collection, field parameters associated with samples at the time of collection, major-ion concentrations, trace-metal concentrations, and detections of organic constituents. The assessments are based on site-specific geochemical criteria and generally focus on data obtained for the four most recent sampling events. The assessment may result in recommendations concerning the well's configuration, sampling protocols (such as purging volumes), extension or limitation of the analytical suites to be collected from the well screen, or caveats about data usability.

Field parameters. Time-series data for field parameters monitored during purging before sample collection are examined for attainment of stable values by the end of purging. Stabilization criteria are prescribed in SOP EP-DIV-SOP-20032, Groundwater Sampling, and are derived from the stabilization criteria recommended by EPA (Yeskis and Zavala 2002, 204429) and from the Compliance Order on Consent (the Consent Order). The most sensitive indicator parameters are dissolved oxygen (DO) and turbidity. Other parameters such as water temperature, specific conductance, pH, and oxidation-reduction potential (ORP) are also monitored but are considered less sensitive indicators of formation water.

Field parameters are examined for stability during individual sampling events, and trends are compared for a sequence of events at the same location. Final field-parameter values associated with the sample at the time of collection are compared with the range observed in background locations for perched-intermediate groundwater and regional groundwater.

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Inorganic analytes. Analytical data for common inorganic ions and trace metals are examined for stability and for excursions from background concentrations as follows:

- trends in concentrations of key indicators for the presence of the specific materials used in the screened interval, such as sodium, sulfate, and total organic carbon (TOC);
- trends in relative concentrations of major ions; and
- comparison of concentrations for major ions and selected trace metals with lower and upper concentration ranges for plateau-scale and site-specific background groundwater, as described below.

Concentration trends may be depicted using time-series plots, standard trilinear diagrams, or modified Schoeller plots.

- Trilinear diagrams, also called Piper plots, show major ions as percentages of milliequivalents (meq) in two base triangles. The total cations and the total anions are set equal to 100%, and the data points in the two triangles are projected onto an adjacent grid. The main purpose of the Piper diagram is to show clustering of data points to indicate samples that have similar compositions.
- Schoeller plots are semilogarithmic diagrams originally developed to represent major ion analyses in meq/L and to demonstrate different hydrochemical water types on the same diagram. This type of graphical representation has the advantage that, unlike the trilinear diagrams, actual sample concentrations are displayed and compared. The modified Schoeller plot used for the reliability assessment represents analyses as mg/L or µg/L to avoid the need to make assumptions about ion speciation, which may be particularly problematic for trace metals.

Organic analytes. Detections of volatile and semivolatile organic compounds are compiled for examination of temporal trends and comparison against area-specific chemicals of potential concern.

Field documentation. As appropriate, field notes, groundwater sampling logs, and sample collection logs for each sampling event are also examined for observations about unusual odors, colors, or other indications of impacted water samples.

Plateau-scale background values for assessment. For naturally occurring analytes, statistical summaries of water-quality data for background groundwater locations establish a range of concentrations against which data from the assessed wells are compared for a preliminary assessment step. Lower and upper bounds of plateau-scale background ranges used in the reliability assessments are derived primarily from statistical tables in the most recent New Mexico Environment Department– (NMED-) approved Groundwater Background Investigation Report.

Site-specific background values for assessment. Representativeness may be assessed with greater specificity by comparing analytical concentrations with those in groundwater from other deep wells in sufficiently similar hydrogeologic settings and at which effects from downhole materials or local contaminants are known to be absent or negligible. The approach allows for the inclusion of wells not hydraulically upgradient of the well being assessed. This is similar to the interwell comparison approach described in sections 5.2.4 and 6.3.2 of the EPA guidance document, "Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities" ("Unified Guidance") (EPA 2009, 110369). The development and use of site-specific background values is illustrated in the Reliability Assessment of Well R-47i (LANL 2011, 201564).

Under some conditions, some or all of the constituents measured in the sample collected at the end of development may also be appropriate to use as the basis of site-specific background values or to augment

the background dataset compiled for the interwell comparison. This is similar to the intrawell comparison approach described in sections 5.2.4 and 6.3.2 of EPA's Unified Guidance (EPA 2009, 110369).

F-5.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

EPA (U.S. Environmental Protection Agency), March 2009. "Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance," EPA 530-R-09-007, Office of Resource Conservation and Recovery, Washington, D.C. (EPA 2009, 110369)

LANL (Los Alamos National Laboratory), March 2011. "Reliability Assessment for Well R-47i," Los Alamos National Laboratory document LA-UR-11-0933, Los Alamos, New Mexico. (LANL 2011, 201564)

Yeskis, D., and B. Zavala, May 2002. "Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers," a *Ground Water Forum Issue Paper*, EPA 542-S-02-001, Office of Solid Waste and Emergency Response, Washington, D.C. (Yeskis and Zavala 2002, 204429)

: 07970

Table F-1.0-1
Preliminary Watch List of Deep Monitoring Wells in the 2011 Interim Plan

Location	Monitoring Group	Watch List Rationale	Description of Condition	Action
Limited Water Volume				
MCOI-4	Cr Investigation	Limited water volume	Low volume of water. Field parameters do not stabilize.	Prioritize analytical suites for collection
SCI-1	Cr Investigation	Limited water volume	Low volume of water. Field parameters do not stabilize.	Prioritize analytical suites for collection
R-26 PZ-2	TA-16 260	Limited water volume	Sampled with bailer. Often bails dry. High turbidity.	Prioritize analytical suites for collection
R-40 S1	TA-54	Limited water volume	Low volume of water. Typically yields only 1 CV	Prioritize analytical suites for collection
Water-Quality Issues				
R-61 S1	Cr Investigation	High iron and manganese	Two sample events, concentrations rising.	Track performance and propose action if appropriate
R-61 S2	Cr Investigation	High iron and manganese	Two sample events, concentrations rising.	Track performance and propose action if appropriate
R-25 S1	TA-16 260	Steel corrosion	Westbay screen. Unreliable metal data from steel corrosion.	Do not sample for metals. Final disposition will be proposed in TA-16 monitoring well network evaluation.
R-40 Si (formerly R-40i)	TA-54	High iron, manganese	Residual drilling effects	Track performance and propose action if appropriate
R-54 S1	TA-54	High iron and manganese	Seven sampling events, concentrations high	Track performance and propose action if appropriate

: 07971

Appendix G

Geologic Cross-Sections

This appendix presents six east-west and three north-south geologic cross-sections that show the relationship of sampling locations in this Interim Facility-Wide Groundwater Monitoring Plan (the Interim Plan) to the hydrogeologic setting of the Los Alamos National Laboratory (the Laboratory) site. Figure G-1 is an overview of the cross-section locations.

The east-west cross-sections follow the stream channel in the following canyons:

- A–A' Water Canyon/Cañon de Valle (Figure G-2)
- B–B' Pajarito Canyon (Figure G-3)
- C–C' Mortandad Canyon (Figure G-4)
- D–D' Sandia Canyon (Figure G-5)
- E–E' Los Alamos Canyon (Figure G-6)
- F–F' Pueblo Canyon (Figure G-7)

The north-south cross-sections are distributed across the Laboratory site and include the following:

- G–G' in the eastern part of the Laboratory (Figure G-8)
- H–H' in the central part of the Laboratory (Figure G-9)
- I–I' in the western part of the Laboratory (Figure G-10)

The cross-sections are based on the three-dimensional geologic framework model (GFM) for the Laboratory that was developed using borehole and outcrop map data. The geologic model used in this report is an updated version of the Laboratory's fiscal year (FY) 2009 three-dimensional geologic framework model (Cole et al. 2010, 106101). The GFM was developed using the geospatial modeling software EarthVision, developed by Dynamic Graphics, Inc., in 2008. The updated GFM model is designated WC11a and incorporates new regional and perched intermediate wells installed since 2009, reinterpretation of stratigraphic contacts in a few existing well logs, and the addition of shallow Technical Area 21 (TA-21) and data that were not incorporated into the FY2009 model. The cross-sections were generated using the updated WC11a model to best represent the current conceptual understanding of the Laboratory's hydrogeology.

No faults are presented on the cross-sections because no known or mapped faults lie within the GFM domain used to develop these geologic cross-sections. Buried, inferred, and possible faults have not yet been incorporated into the WC11a model.

The cross-sections show sampling locations that fall within a 1500-ft buffer on both sides of the respective transect lines. Perched-intermediate and regional monitoring wells are shown as vertical lines, and the locations of well screens are shown as boxes presented to actual scale. Wells located within 500 ft of transects are indicated by solid lines, and wells offset more than 500 ft are demarcated by a dashed pattern. Because of their offset from the transect, some well screens in the outer portions of the buffer zones may not appear to plot within the proper geologic unit because of dipping geologic contacts. The relative positions of alluvial wells, surface-water sampling stations, and springs located along the transects are arrayed horizontally above the cross-sections to show the spatial relationship between the shallow, intermediate, and deep water-quality monitoring network and the GFM. Only sampling locations in the 2011 Interim Plan are shown on the cross-sections.

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REFERENCE

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the New Mexico Environment Department Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

Cole, G., D. Coblentz, E. Jacobs, D. Koning, D. Broxton, D. Vaniman, F. Goff, and G. WoldeGabriel, April 2010. "The 2009 Three-Dimensional Geologic Models of the Los Alamos National Laboratory Site, Southern Española Basin, and Española Basin," Los Alamos National Laboratory document LA-UR-09-3701, Los Alamos, New Mexico. (Cole et al. 2010, 106101)

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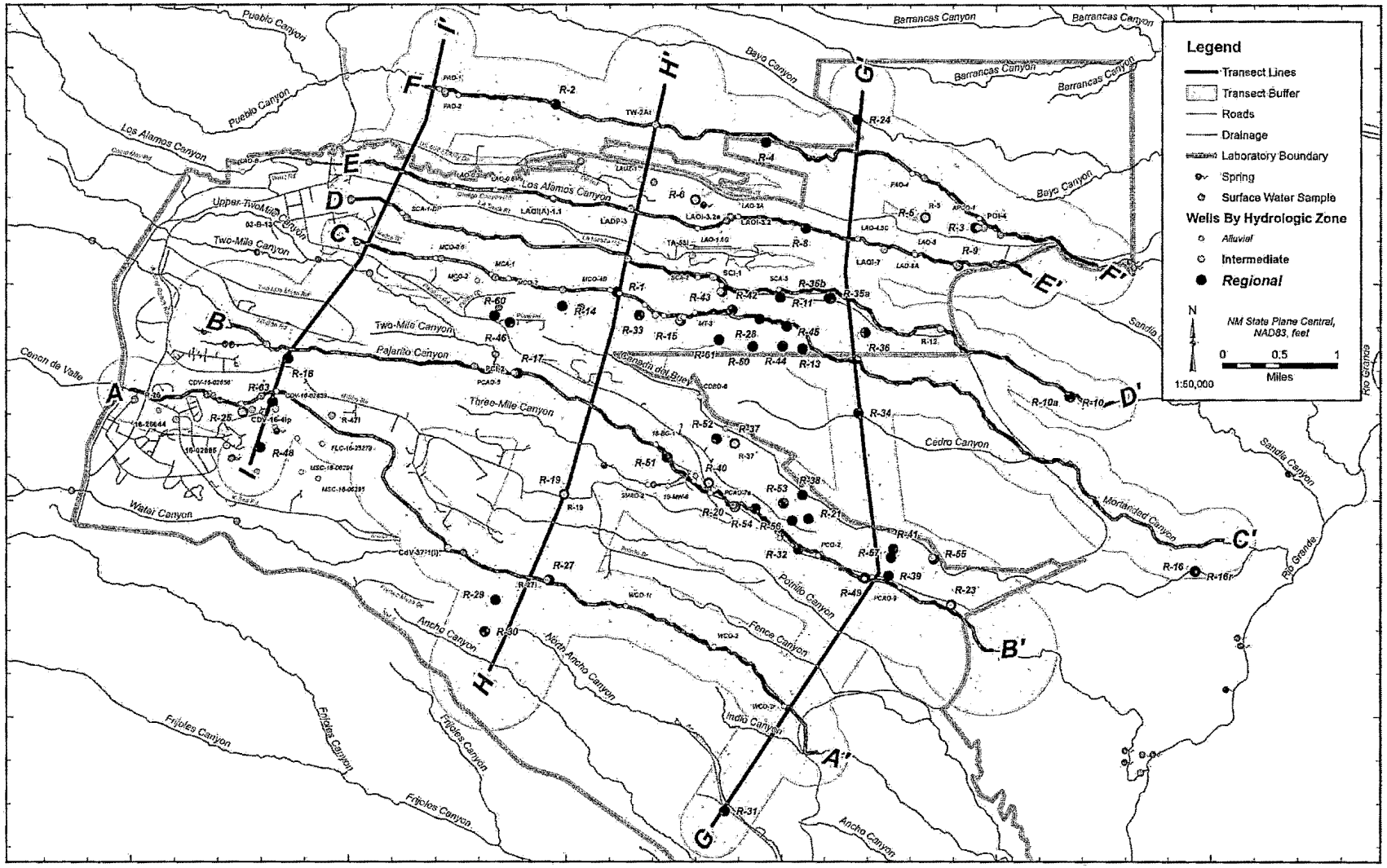
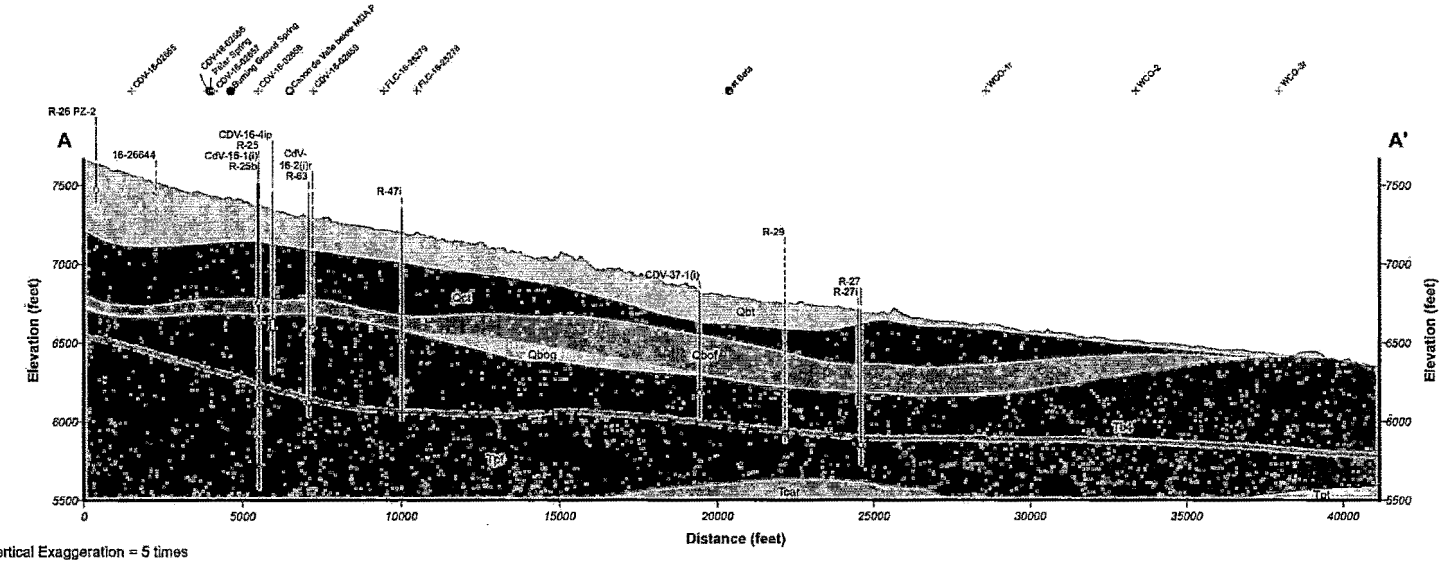


Figure G-1 Transect location map

LA-UR-12-24529



Legend

Borehole Offset
- —< 500-ft
- —< 1000-ft
- ---> 1000-ft

Deep Wellbores
- Well Screen (Intermediate)
- Well Screen (Regional)

Alluvial System and Springs
- Well (Alluvial)
- Spring (Alluvial)
- Spring (Intermediate)
- Surface Water Sample
- Regional Water Table

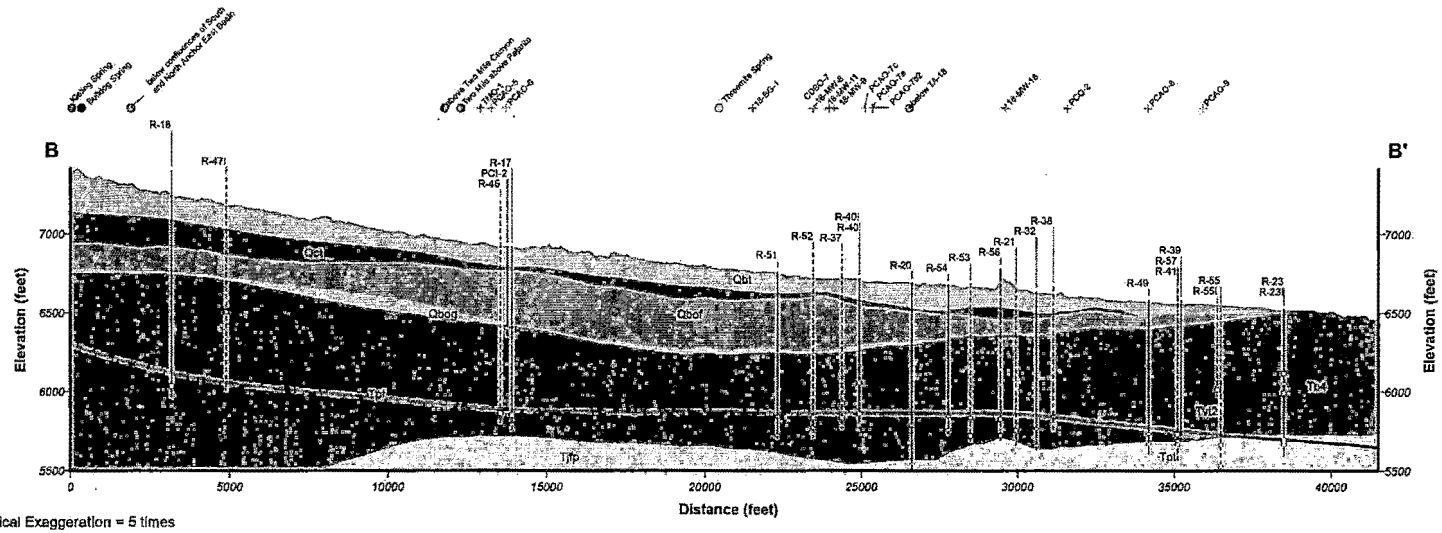
Geologic Unit
- Qbt - Tshirege Member, Bandelier Tuff
- Qct - Cerro Toledo Formation
- Qbof - Otowi Member, Bandelier Tuff
- Qbog - Guaje Pumice Bed
- Tb4 - Cerros del Rio Basalts
- Tvt2 - Younger dacite flows
- Tvt1 - Older Tschicoma dacite flows
- Tpf - Puye Formation, fanglomerate
- Tpt - Puye Fm, Totavi Lentil
- Tjfp - Miocene pumiceous sediments (Bearhead equivalent)
- Tcar - Chamita Formation
- Tb2 - Miocene Basalt
- Ttc - Tesuque Formation (Chama-El Rito Member)

Notes:

1. *This cross-section was extracted from Weston's WC11e update to LANL's FY09 GFM (Cole et al. 2010, 106101). The WC11e model accounts for several new regional borings, revisions to a few existing borehole logs by LANL geologists, and some shallow TA-21 and data that were not incorporated into the FY09 model.*
2. *A 1500-ft transect line buffer was used to filter the data to those points having the largest influence on the geology depicted on the cross-section. Because of the potential 1500-ft offset from the transect however, some layer contacts may not appear to honor the data. The line pattern for the borehole trace is used to quality the offset of the data from the section.*

Figure G-2 Cross-section A–A' Water Canyon/Cañon de Valle

EP2010-0768



Legend

Borehole Offset
- < 500-ft
- < 1000-ft
- > 1000-ft

Deep Wellbores
- Well Screen (Intermediate)
- Well Screen (Regional)

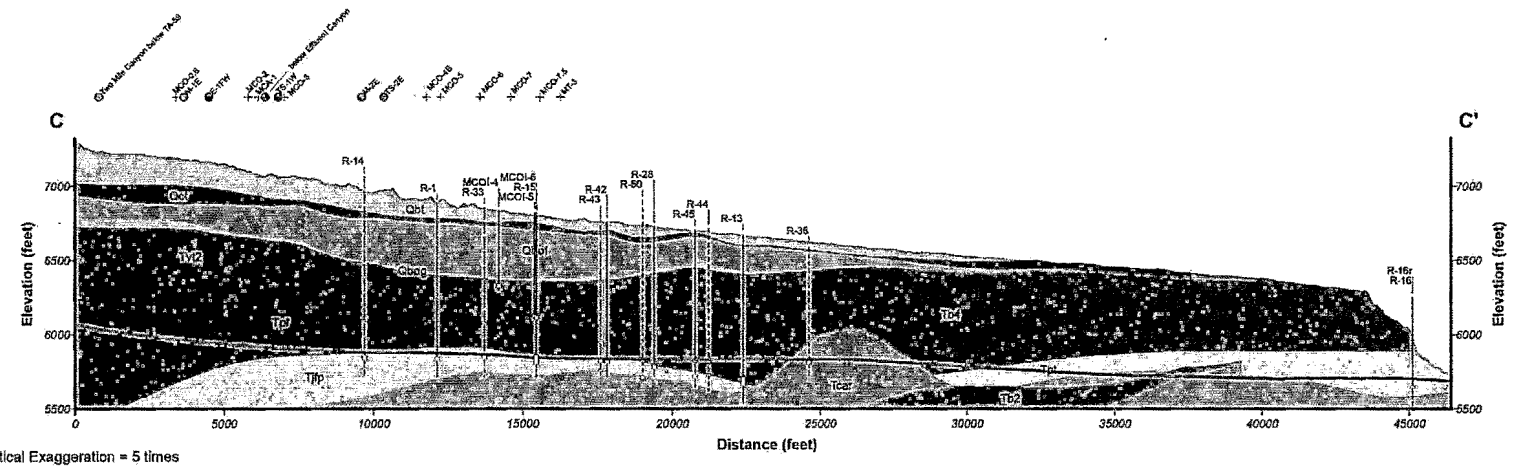
Alluvial System and Springs
- Well (Alluvial)
- Spring (Alluvial)
- Spring (Intermediate)
- Surface Water Sample
- Regional Water Table

Geologic Unit
- Qbt - Tshirege Member, Bandelier Tuff
- Qct - Cerro Toledo Formation
- Qbof - Otowi Member, Bandelier Tuff
- Qbog - Guaje Pumice Bed
- Tb4 - Cerros del Rio Basalts
- Tvt2 - Younger dacite flows
- Tvt1 - Older Tschicoma dacite flows
- Tpf - Puye Formation, fanglomerate
- Tpt - Puye Fm, Totavi Lentil
- Tjfp - Miocene pumiceous sediments (Bearhead equivalent)
- Tcar - Chamita Formation
- Tb2 - Miocene Basalt
- Ttc - Tesuque Formation (Chama-El Rito Member)

Notes:

1. *This cross-section was extracted from Weston's WC11a update to LANL's FY09 GFM (Cole et al. 2010, 105101). The WC11a model accounts for several new regional borings, revisions to a few existing borehole logs by LANL geologists, and some shallow TA-21 and data that were not incorporated into the FY09 model.*
2. *A 3000-ft transect line buffer was used to filter the data to those points having the largest influence on the geology depicted on the cross-section. Because of the potential 3000-ft offset from the transect however, some layer contacts may not appear to honor the data. The line pattern for the borehole trace is used to qualify the offset of the data from the section.*

Figure G-3 Cross-section B–B′ Pajarito Canyon



Vertical Exaggeration = 5 times

Legend

Borehole Offset
- —< 500-ft
- —< 1000-ft
- ---> 1000-ft

Deep Wellbores
- ═ Well Screen (Intermediate)
- ═ Well Screen (Regional)

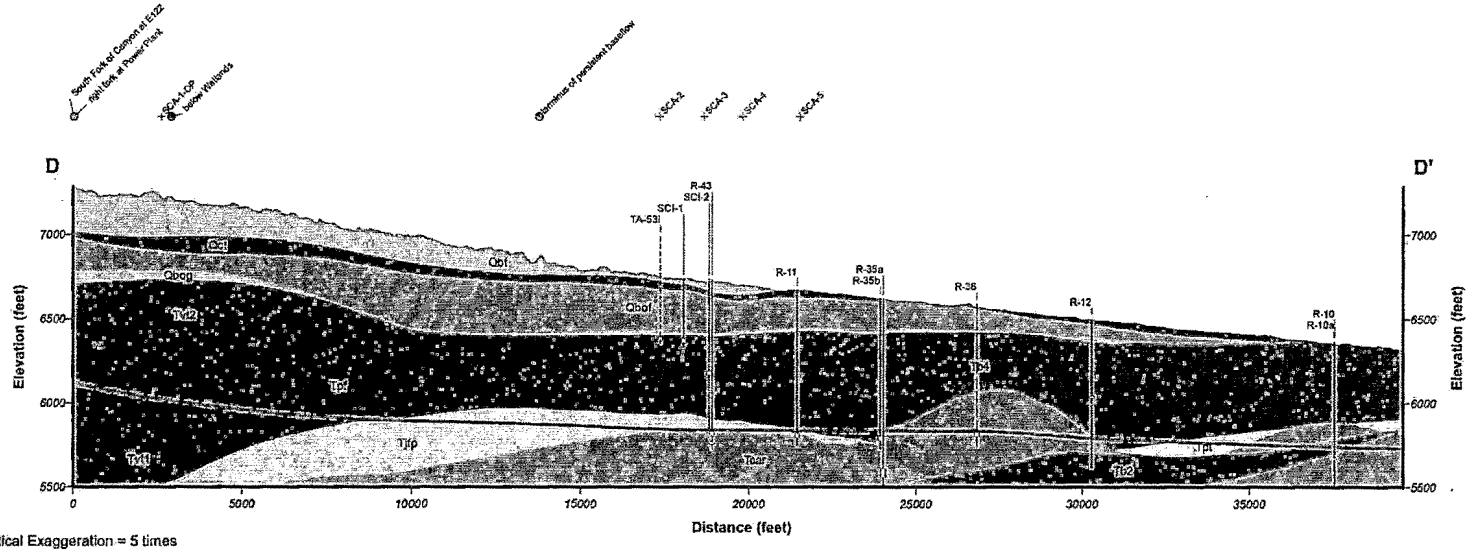
Alluvial System and Springs
- + Well (Alluvial)
- ○ Spring (Alluvial)
- ● Spring (Intermediate)
- ◘ Surface Water Sample
- — Regional Water Table

Geologic Unit
- Qbt - Tshirege Member, Bandelier Tuff
- Qct - Cerro Toledo Formation
- Qbof - Otowi Member, Bandelier Tuff
- Qbog - Guaje Pumice Bed
- Tb4 - Cerros del Rio Basalts
- Tvt2 - Younger dacite flows
- Tvt1 - Older Tschicoma dacite flows
- Tpf - Puye Formation, fanglomerate
- Tpt - Puye Fm, Totavi Lentil
- Tjfp - Miocene pumiceous sediments (Bearhead equivalent)
- Tcar - Chamita Formation
- Tb2 - Miocene Basalt
- Ttc - Tesuque Formation (Chama-El Rito Member)

Notes:

1. This cross-section was extracted from Weston's WC11e update to LANL's FY09 GFM (Cole et al. 2010, 106101). The WC11e model accounts for several new regional borings, revisions to a few existing borehole logs by LANL geologists, and some shallow TA-21 and data that were not incorporated into the FY09 model.
2. A 1500-ft transect line buffer was used to filter the data to those points having the largest influence on the geology depicted on the cross-section. Because of the potential 1500-ft offset from the transect however, some layer contacts may not appear to honor the data. The line pattern for the borehole trace is used to quantify the offset of the data from the section.

Figure G-4 Cross-section C–C' Mortandad Canyon



Legend

Borehole Offset
- —< 500-ft
- —< 1000-ft
- ---> 1000-ft

Deep Wellbores
- Well Screen (Intermediate)
- Well Screen (Regional)

Alluvial System and Springs
- Well (Alluvial)
- Spring (Alluvial)
- Spring (Intermediate)
- Surface Water Sample
- Regional Water Table

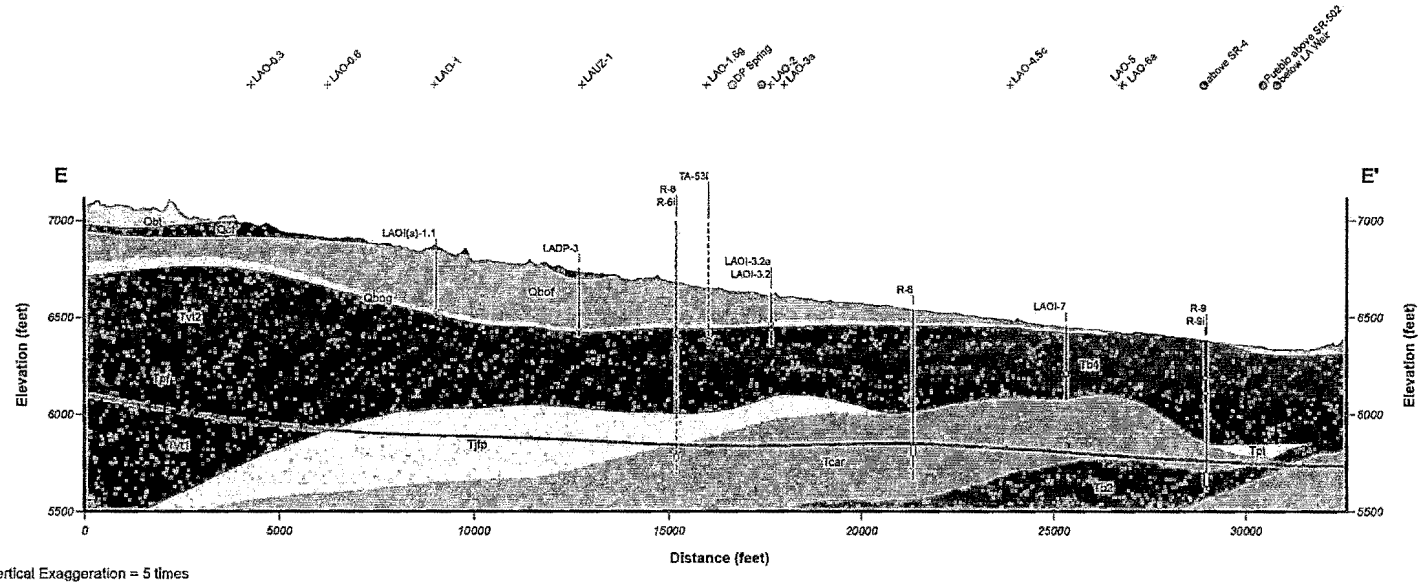
Geologic Unit
- Qbt - Tshirege Member, Bandelier Tuff
- Qct - Cerro Toledo Formation
- Qbof - Otowi Member, Bandelier Tuff
- Qbog - Guaje Pumice Bed
- Tb4 - Cerros del Rio Basalts
- Tvt2 - Younger dacite flows
- Tvt1 - Older Tschicoma dacite flows
- Tpf - Puye Formation, fanglomerate
- Tpt - Puye Fm, Totavi Lentil
- Tjfp - Miocene pumiceous sediments (Bearhead equivalent)
- Tcar - Chamita Formation
- Tb2 - Miocene Basalt
- Ttc - Tesuque Formation (Chama-El Rito Member)

Notes:

1. *This cross-section was extracted from Weston's WC11a update to LANL's FY09 GFM (Cole et al. 2010, 106101). The WC11a model accounts for several new regional borings, revisions to a few existing borehole logs by LANL geologists, and some shallow TA-21 and data that were not incorporated into the FY09 model.*
2. *A 1100-ft transect line buffer was used to filter the data to those points having the largest influence on the geology depicted on the cross-section. Because of the potential 1100-ft offset from the transect however, some layer contacts may not appear to honor the data. The line pattern for the borehole trace is used to quantify the offset of the data from the section.*

Figure G-5 Cross-section D–D' Sandia Canyon

EES-14



Vertical Exaggeration = 5 times

Legend

Borehole Offset
- — < 500-ft
- - - < 1000-ft
- - - > 1000-ft

Deep Wellbores
- Well Screen (Intermediate)
- Well Screen (Regional)

Alluvial System and Springs
- Well (Alluvial)
- Spring (Alluvial)
- Spring (Intermediate)
- Surface Water Sample
- Regional Water Table

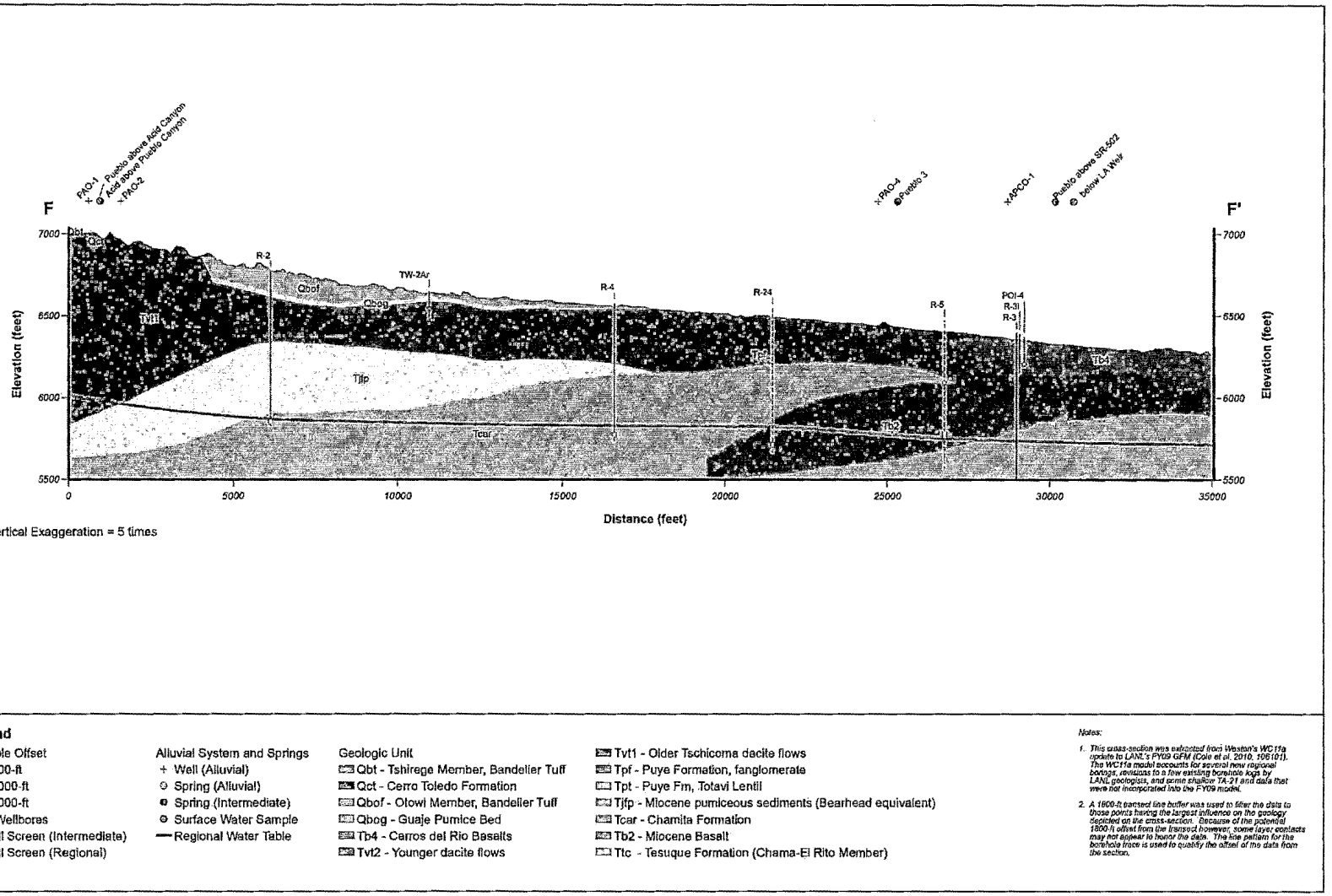
Geologic Unit
- Qbt - Tshirege Member, Bandelier Tuff
- Qct - Cerro Toledo Formation
- Qbof - Otowi Member, Bandelier Tuff
- Qbog - Guaje Pumice Bed
- Tb4 - Cerros del Rio Basalts
- Tvt2 - Younger dacite flows
- Tvt1 - Older Tschicoma dacite flows
- Tpf - Puye Formation, fanglomerate
- Tpt - Puye Fm, Totavi Lentil
- Tjfp - Miocene pumiceous sediments (Bearhead equivalent)
- Tcar - Chamita Formation
- Tb2 - Miocene Basalt
- Ttc - Tesuque Formation (Chama-El Rito Member)

Notes:

1. *This cross-section was extracted from Weston's WC11a update to LANL's FY09 GFM (Cole et al. 2010, 106101). The WC11a model accounts for several new regional borings, revisions to a few existing borehole logs by LANL geologists, and some shallow TA-21 and data that were not incorporated into the FY09 model.*
2. *A 1500-ft transect line buffer was used to filter the data to those points having the largest influence on the geology depicted on the cross-section. Because of the potential 1500-ft offset from the transect however, some layer contacts may not appear to honor the data. The line pattern for the borehole trace is used to qualify the offset of the data from the section.*

Figure G-6 Cross-section E–E' Los Alamos Canyon

EES-13 09/29/10



Legend

Borehole Offset
- < 500-ft
- < 1000-ft
- > 1000-ft

Deep Wellbores
- Well Screen (Intermediate)
- Well Screen (Regional)

Alluvial System and Springs
- Well (Alluvial)
- Spring (Alluvial)
- Spring (Intermediate)
- Surface Water Sample
- Regional Water Table

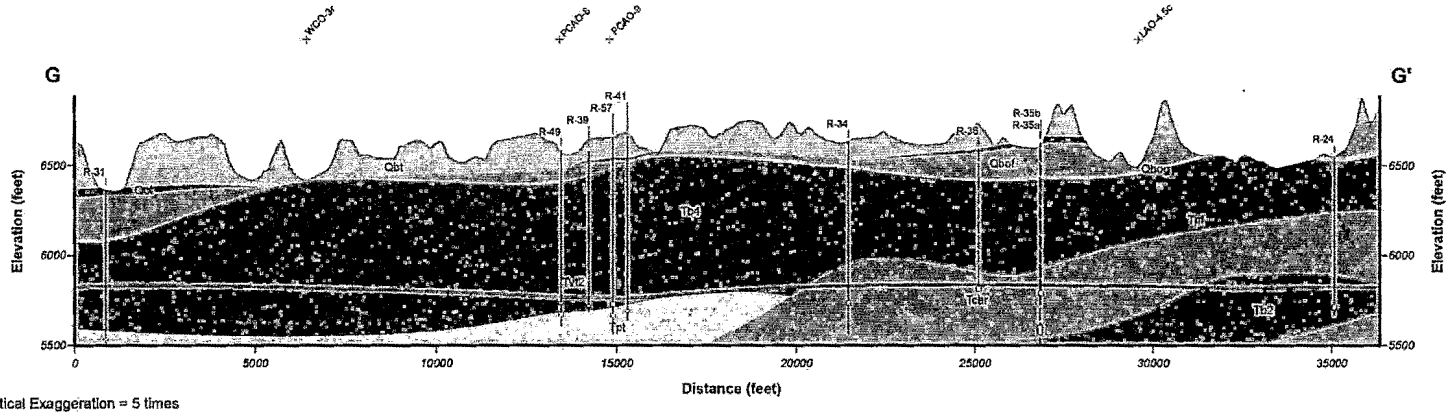
Geologic Unit
- Qbt - Tshirege Member, Bandelier Tuff
- Qct - Cerro Toledo Formation
- Qbof - Otowi Member, Bandelier Tuff
- Qbog - Guaje Pumice Bed
- Tb4 - Carros del Rio Basalts
- Tvt2 - Younger dacite flows
- Tvt1 - Older Tschicoma dacite flows
- Tpf - Puye Formation, fanglomerate
- Tpt - Puye Fm, Totavi Lentil
- Tjfp - Miocene pumiceous sediments (Bearhead equivalent)
- Tcar - Chamita Formation
- Tb2 - Miocene Basalt
- Ttc - Tesuque Formation (Chama-El Rito Member)

Notes:

1. *This cross-section was extracted from Weston's WC11a update to LANL's FY09 GFM (Cole et al. 2010, 106101). The WC11a model accounts for several new regional borings, revisions to a few existing borehole logs by LANL geologists, and some shallow TA-21 and data that were not incorporated into the FY09 model.*
2. *A 1600-ft centered line buffer was used to filter the data to those points having the largest influence on the geology depicted on the cross-section. Because of the potential 1600-ft offset from the transect however, some layer contacts may not appear to honor the data. The line pattern for the borehole trace is used to qualify the offset of the data from the section.*

Figure G-7 Cross-section F–F' Pueblo Canyon

EES-13 09/15/11



Legend

Borehole Offset
- < 500-ft
- < 1000-ft
- > 1000-ft

Deep Wellbores
- Well Screen (Intermediate)
- Well Screen (Regional)

Alluvial System and Springs
- Well (Alluvial)
- Spring (Alluvial)
- Spring (Intermediate)
- Surface Water Sample
- Regional Water Table

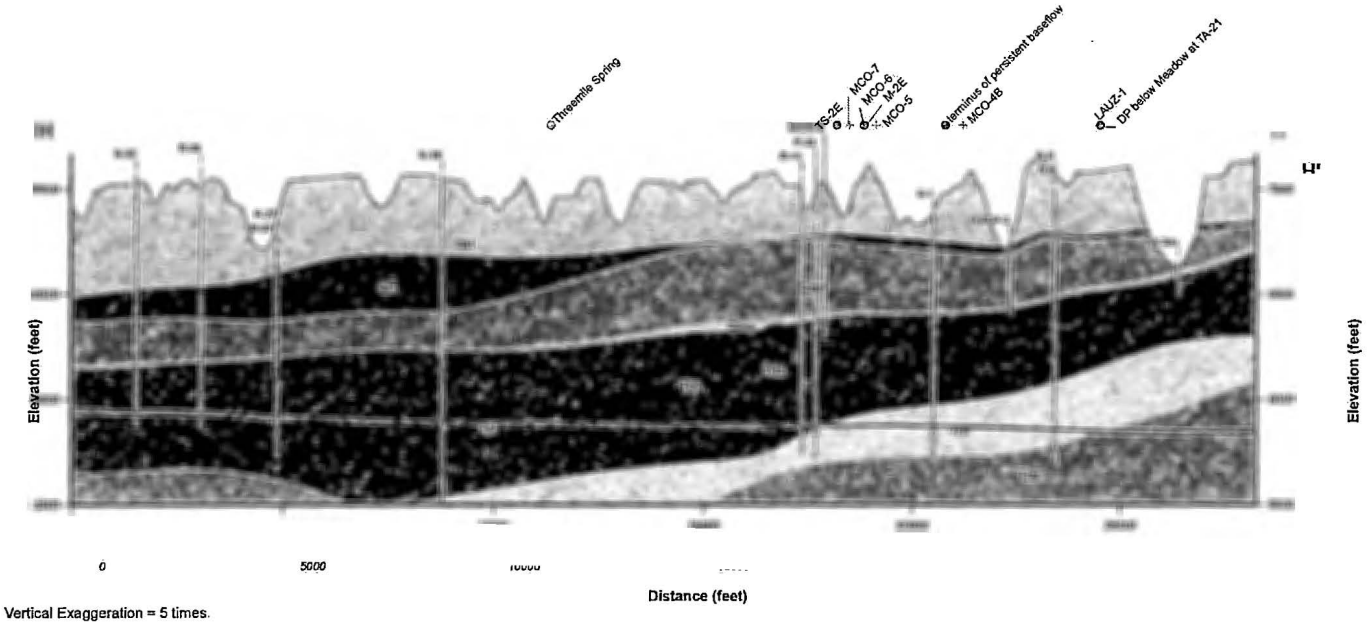
Geologic Unit
- Qbt - Tshirege Member, Bandelier Tuff
- Qct - Cerro Toledo Formation
- Qbof - Otowi Member, Bandelier Tuff
- Qbog - Guaje Pumice Bed
- Tb4 - Cerros del Rio Basalts
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- Tvt1 - Older Tschicoma dacite flows
- Tpf - Puye Formation, fanglomerate
- Tpt - Puye Fm, Totavi Lentil
- Tjfp - Miocene pumiceous sediments (Bearhead equivalent)
- Tcar - Chamita Formation
- Tb2 - Miocene Basalt
- Ttc - Tesuque Formation (Chama-El Rito Member)

Notes:

1. *This cross-section was extracted from Weston's WC11a update to LANL's FY09 GFM (Cole et al. 2010, 106101). The WC11a model accounts for several new regional borings, revisions to a few existing borehole logs by LANL geologists, and some shallow TA-21 end data that were not incorporated into the FY09 model.*
2. *A 1500-ft transect line buffer was used to filter the data to those points having the largest influence on the geology depicted on the cross-section. Because of the potential 1500-ft offset from the transect however, some layer contacts may not appear to honor the data. The line pattern for the borehole trace is used to quality the offset of the data from the section.*

Figure G-8 Cross-section G–G' in the eastern part of the Laboratory (north-south)

09781



Vertical Exaggeration = 5 times.

Legend

Borehole Offset
- < 500-ft
- < 1000-ft
- > 1000-ft

Deep Wellbores
- Well Screen (Intermediate)
- Well Screen (Regional)

Alluvial System and Springs
- Well (Alluvial)
- Spring (Alluvial)
- Spring (Intermediate)
- Surface Water Sample
- Regional Water Table

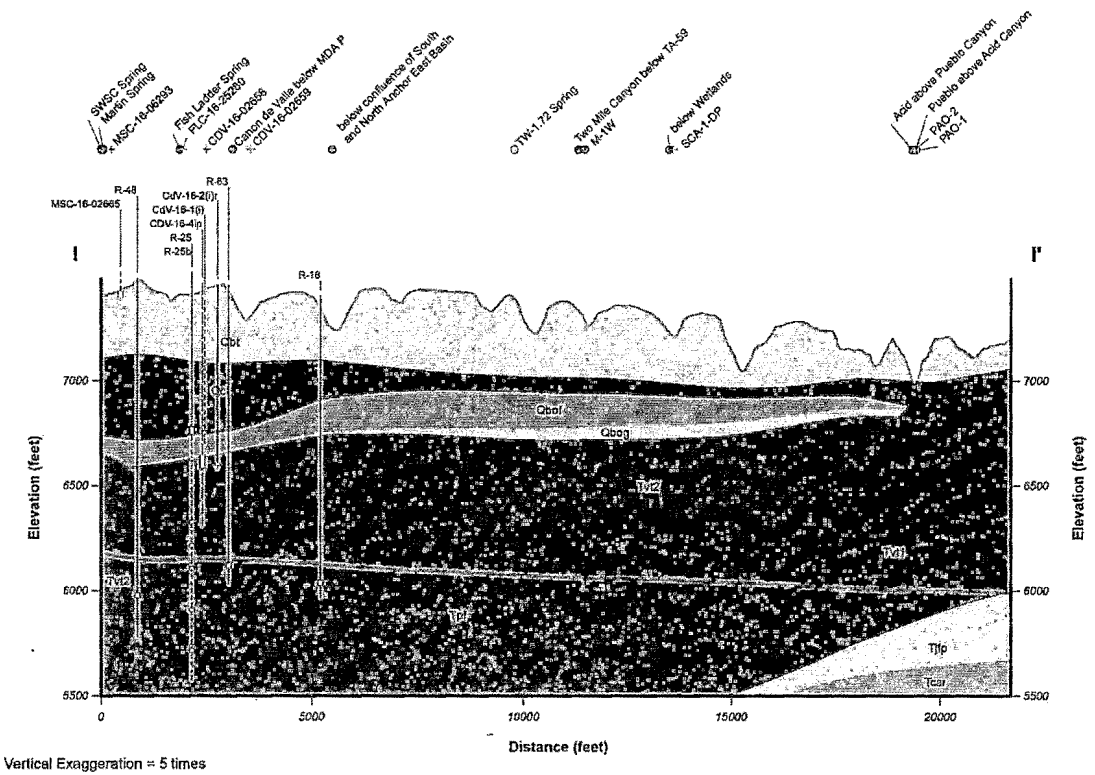
Geologic Unit
- Qbt - Tshirege Member, Bandelier Tuff
- Qct - Cerro Toledo Formation
- Qbof - Otowi Member, Bandelier Tuff
- Qbog - Guaje Pumice Bed
- Tb4 - Cerros del Rio Basalts
- Tvt2 - Younger dacite flows
- Tvt1 - Older Tschicoma dacite flows
- Tpf - Puye Formation, fanglomerate
- Tpt - Puye Fm, Totavi Lentil
- Tjfp - Miocene pumiceous sediments (Bearhead equivalent)
- Tcar - Chamita Formation
- Tb2 - Miocene Basalt
- Ttc - Tesuque Formation (Chama-El Rito Member)

Notes:

1. *This cross-section was extracted from Weston's WC11a update to LANL's FY09 GFM (Cole et al. 2010, 106101). The WC11a model accounts for several new regional borings, revisions to a few existing borehole logs by LANL geologists, and some shallow TA-21 and data that were not incorporated into the FY09 model.*
2. *A 2800-ft transect line buffer was used to filter the data to those points having the largest influence on the geology depicted on the cross-section. Because of the potential 2800-ft offset from the transect however, some layer contacts may not appear to honor the data. The line pattern for the borehole trace is used to qualify the offset of the data from the section.*

Figure G-9 Cross-section H–H' in the central part of the Laboratory (north-south)

EES-16 07985



Legend

Borehole Offset
- < 500-ft
- < 1000-ft
- > 1000-ft

Deep Wellbores
- Well Screen (Intermediate)
- Well Screen (Regional)

Alluvial System and Springs
- Well (Alluvial)
- Spring (Alluvial)
- Spring (Intermediate)
- Surface Water Sample
- Regional Water Table

Geologic Unit
- Qbt - Tshirege Member, Bandelier Tuff
- Qct - Cerro Toledo Formation
- Qbof - Otowi Member, Bandelier Tuff
- Qbog - Guaje Pumice Bed
- Tb4 - Cerros del Rio Basalts
- Tvt2 - Younger dacite flows
- Tvt1 - Older Tschicoma dacite flows
- Tpf - Puye Formation, fanglomerate
- Tpt - Puye Fm, Totavi Lentil
- Tjfp - Miocene pumiceous sediments (Bearhead equivalent)
- Tcar - Chamita Formation
- Tb2 - Miocene Basalt
- Ttc - Tesuque Formation (Chama-El Rito Member)

Notes:

1. *This cross-section was extracted from Weston's WC11a update to LANL's FY09 GFM (Cole et al. 2010, 106101). The WC11a model accounts for several new regional borings, revisions to a few existing borehole logs by LANL geologists, and some shallow TA-21 and data that were not incorporated into the FY09 model.*
2. *A 1500-ft transect line buffer was used to filter the data to those points having the largest influence on the geology depicted on the cross-section. Because of the potential 1500-ft offset from the transect however, some layer contacts may not appear to honor the data. This line pattern for the borehole trace is used to qualify the offset of the data from the section.*

Figure G-10 Cross-section I–I' in the western part of the Laboratory (north-south)

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Conceptual Models of Vadose Zone Flow and Transport beneath the Pajarito Plateau, Los Alamos, New Mexico

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ABSTRACT

The Pajarito Plateau in northern New Mexico, on which the Los Alamos National Laboratory is situated, is characterized by a thick vadose zone overlying the regional aquifer of the western Espanola Basin. In this study, conceptual models of vadose zone flow and transport processes are presented and then supported through the interpretation of field data, including synthesis with numerical models. The conceptual models differentiate the rate of percolation by their location and surface hydrologic setting, including wet and dry canyons, and wet, dry, and disturbed mesas. Net infiltration beneath wet canyons is the highest, with rates on the order of a meter per year (100–1000 mm yr^{-1}). Transport to the regional aquifer beneath the wettest canyons is likely on the order of several years to several decades, depending on the thicknesses of the various hydrostratigraphic layers. Perched water is sometimes found beneath wetter canyons and is associated with near-surface alluvial systems and at intermediate depths along low-permeability interfaces such as buried soils or unfractured regions of basalt flows. Percolation through the volcanic tuffs is generally considered to be via matrix-dominated flow, whereas fracture flow may play a key role in contaminant transport through densely welded tuffs or basalt units beneath wet canyons. Infiltration beneath dry canyons and dry mesas is much slower (10 mm yr^{-1} or less), yielding transport times to the aquifer of hundreds to several thousands of years. However, long-term surface disturbances at mesa-top locations may alter infiltration rates such that at a local scale, the infiltration rates temporarily approach those of wetter canyons.

"A CONCEPTUAL MODEL is an evolving hypothesis identifying the important features, processes, and events controlling fluid flow and contaminant transport of consequence at a specific field site in the context of a recognized problem" (National Research Council, 2001). A well-defined site conceptual model is a useful tool for compiling and interpreting site data, focusing characterization work, developing the framework for numerical models, conveying information about the site to interested parties, and determining possible receptors that may be affected by disposal operations at the site. In fact, at a workshop sponsored by the National Research Council (2001), a panel of experts concluded that conceptual model development is the most important step in the overall modeling process used for site evaluation. They also pointed out that appropriate controlling processes can be identified through the development of alternative conceptual models accompanied by the evaluation of these alternatives through comparison with field observations. To best develop and test conceptual models, supporting data should be derived using a number of observational techniques and include a variety of data types.

Los Alamos National Laboratory (the Laboratory or LANL; Fig. 1) has performed research and development in nuclear weapons technologies and other national defense activities for more than 60 yr, beginning with the Manhattan Project in the 1940s. During this time, Laboratory operations have been accompanied by both disposal of and intentional or accidental releases of chemical contaminants into the environment at a variety of sites. Contaminants with possible negative impacts to groundwater include high explosives, radionuclides, chemical solvents, and metals. Today, the Laboratory is responsible for ensuring that none of its past contaminant releases pose a threat to human health now or in the future, and to carry out remediation activities to clean up contaminated sites. One of the key potential risks is groundwater contamination, possibly affecting drinking water quality in municipal or private wells. Contaminants must travel through a thick vadose zone to reach the regional aquifer. Therefore, a well-developed conceptual model describing vadose zone flow and transport beneath the Pajarito Plateau is key to assessing groundwater risk.

The conceptual models for vadose zone flow and transport for the plateau are used to characterize the hydrologic setting located between the ground surface and the regional aquifer and to help determine the fate, transport, and potential future risk of contaminants that have been released into the environment by the Laboratory. Because the Laboratory is large (>100 km^2) and covers complex terrain (Fig. 1), hydrologic conditions vary by location. For this reason, we have chosen to present the conceptual model for the plateau as multiple conceptual models that vary by location to more easily make distinctions between the varying hydrologic conditions. The ideas are based on ongoing observations of hydrologic processes that have been made since the mid 1940s (Griggs, 1964; Abrahams et al., 1961). Refinement of the conceptual models has occurred over the years and especially recently with the interpretation of data collected across the entire thickness of the vadose zone during the drilling of well-characterized regional aquifer wells (Vaniman et al., 2002; Broxton et al., 2002a; Ball et al., 2002; Longmire, 2002).

Our main purpose here is to describe the conceptual models of vadose zone flow and transport for the Pajarito Plateau and then to support these models by providing comprehensive sets of evidence from across the plateau. Toward that purpose, we briefly characterize the

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Abbreviations: ET, evapotranspiration; LANL, Los Alamos National Laboratory; MDA, material disposal area; RLWTF, radioactive liquid-waste treatment facility; TA, technical area.

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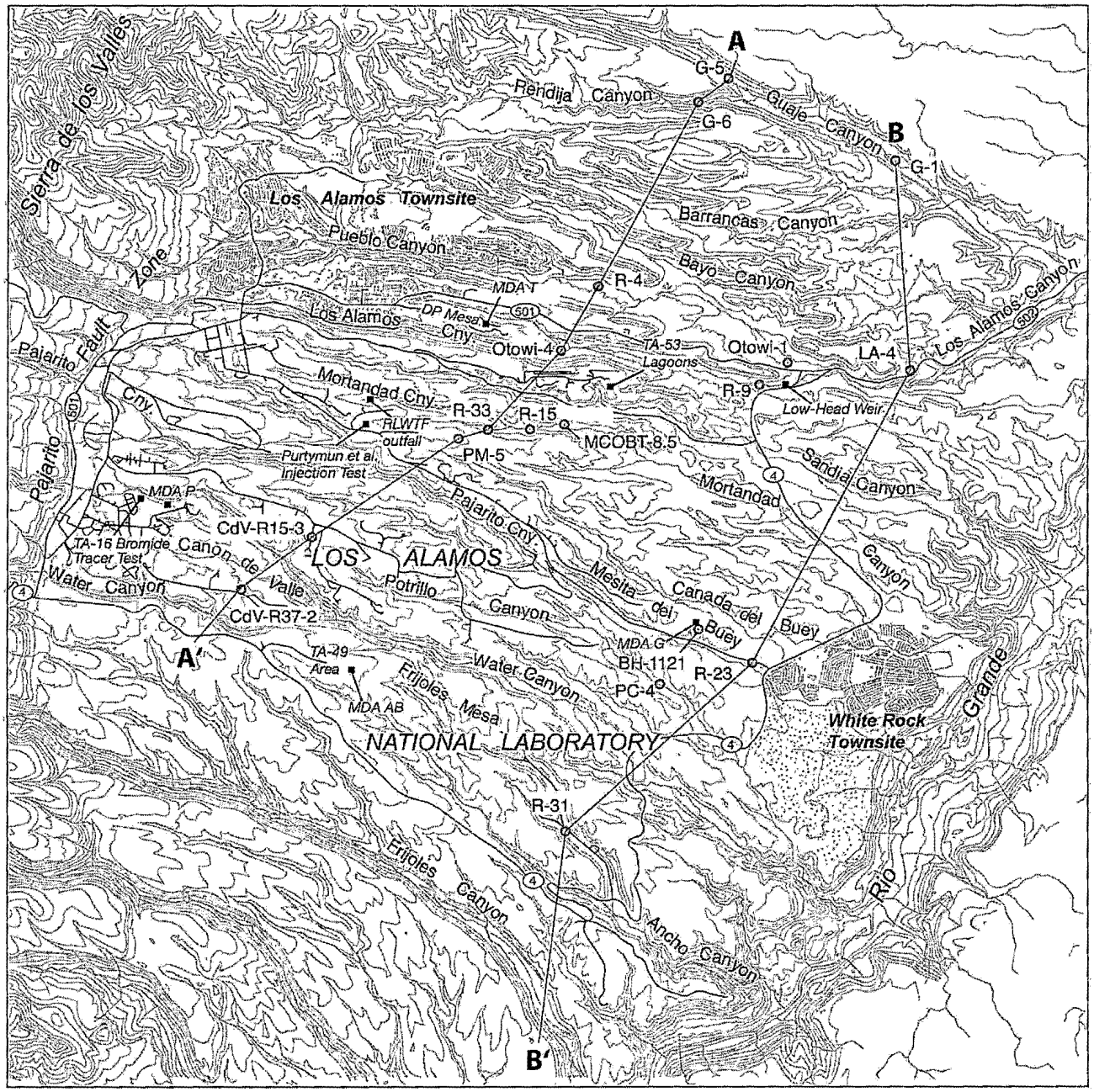


Fig. 1. Site map showing topography, Los Alamos National Laboratory boundary, and locations of cross sections, canyons, mesas, and other example sites discussed in text.

geohydrologic setting of the Pajarito Plateau, describe the hydrologic conceptual models, and then provide supporting evidence. The evidence consists of data sets, observations, and interpretation through numerical simulations. By compiling these sets of evidence into a comprehensive explanation of the processes that occur across the plateau, the credibility of the conceptual models is enhanced.

SITE DESCRIPTION

Topography and Stratigraphy

The Pajarito Plateau is a high, east-tilted tableland eroded into a series of narrow mesas separated by deep canyons. The map view in Fig. 1 and the two cross sections in Fig. 2 illustrate the topographic contrast between the mesa and canyons across the plateau. Mesa-top elevations range from approximately 2400 m on the west to about 1900 m on the east. About 1.22 and 1.61 Ma (Izett and Obradovich, 1994; Spell et al., 1990, 1996) cataclysmic eruptions from calderas in the central part of the Jemez Mountains deposited thick blankets of tuff over the area. Intense heat and hot volcanic gases welded these tuffs into hard, resistant deposits that make up the upper surface of the plateau. Streams flowing eastward across the plateau from the Jemez Mountains to the Rio Grande have cut canyons deep into the tuff, forming the striking mesas and canyons that character-

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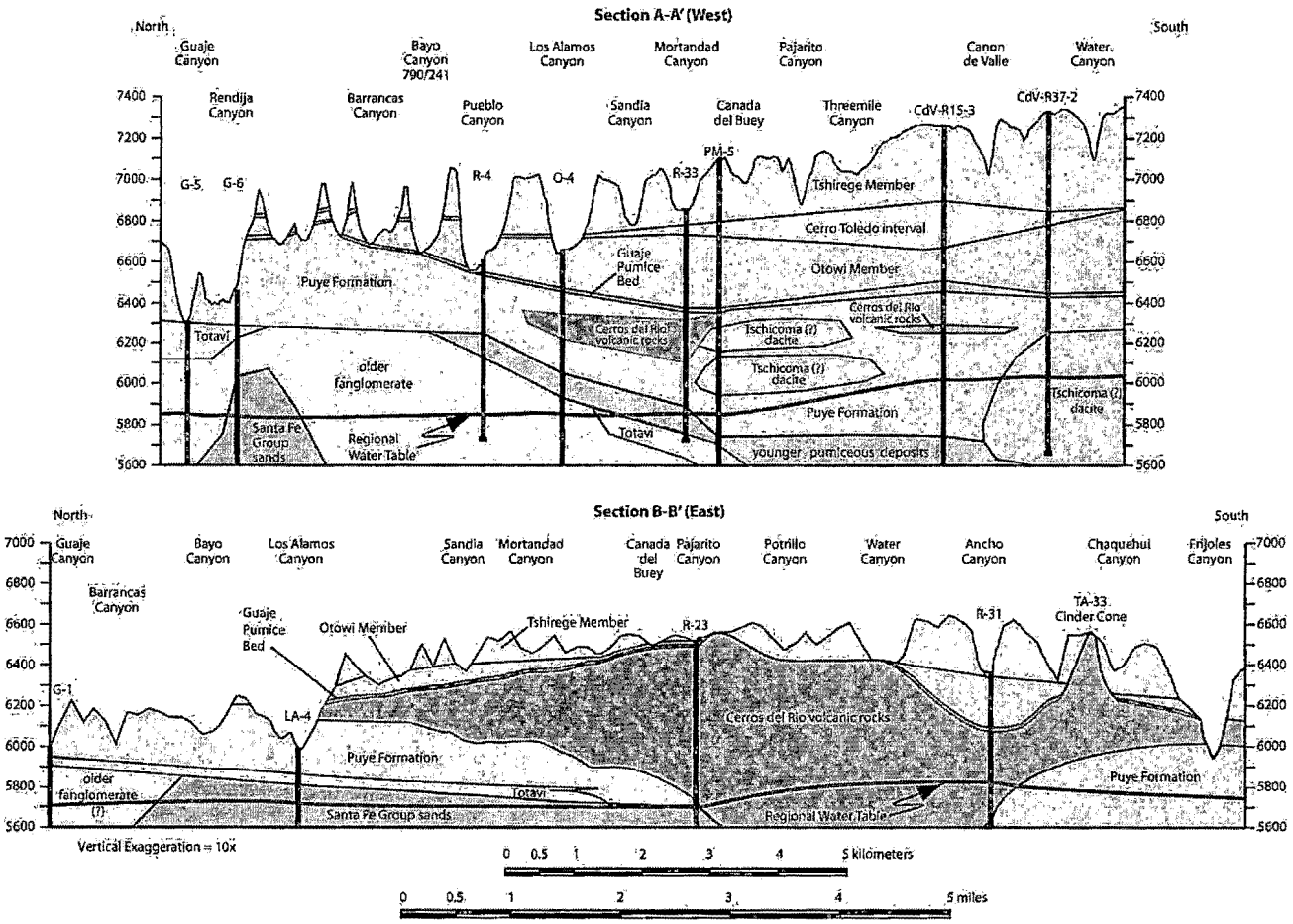


Fig. 2. Cross sections on the Pajarito Plateau, (a) A–A′ on the western end, (b) B–B′ on the eastern end, as indicated in Fig. 1.

ize the landscape. The canyons tend to be deep and narrow in the western part of the plateau where streams are incised in the most strongly welded tuff units (Fig. 2a). The canyons become wider and shallower eastward, where thinner, less-welded tuffs overlie resistant basalt and coarse volcaniclastic deposits (Fig. 2b).

A comprehensive description of the regional hydrogeologic setting of the Pajarito Plateau is given in a companion paper by Broxton and Vaniman (2005). This section provides a brief overview of vadose zone stratigraphy that establishes a geologic framework for discussing conceptual models of contaminant transport. The two cross sections in Fig. 2 illustrate the lateral variations in vadose zone geology. The principal geologic units include, in descending order, the Tshirege and Otowi Members of the Bandelier Tuff, Puye Formation, and Cerros del Rio basalt. Descriptions of alluvial deposits and of other relatively minor bedrock units can be found in Broxton and Vaniman (2005).

The upper part of the vadose zone consists of an eastward-thinning wedge of Bandelier Tuff. The Bandelier Tuff is subdivided into two stratigraphic members, each consisting of a basal pumice fall overlain by a succession of rhyolitic ash-flow tuffs (Bailey et al., 1969). The Tshirege Member, which forms the surface outcrops throughout the plateau, is a compound-cooling unit consisting of alternating layers of nonwelded to moderately welded rhyolitic ash-flow tuffs. Welding within subunits of the Tshirege increases from east to west across the plateau, with some tuffs becoming densely welded near the western mountain front where they are thicker and more proximal to their source area. Within the Tshirege Member, welded tuffs are typically more highly fractured than the nonwelded tuffs that separate them. Fractures originating in welded zones, which include both cooling joints and tectonic fractures, commonly die out in overlying and underlying nonwelded tuffs. The Tshirege Member is up to 170 m thick in the south-central part of the Laboratory (Stimac et al., 2002). The Tsankawi Pumice Bed, a 0.3- to 1.2-m-thick fall deposit, marks the base of the Tshirege Member. The Otowi Member underlies the Tshirege Member and is exposed in lower canyon slopes in the northern part of the plateau. It is a multiple-flow unit made up of a relatively uniform sequence of nonwelded ash-flow tuffs. The maximum thickness of the Otowi Member is 128 m in the southwest part of the Laboratory. The Guaje Pumice Bed is a 2- to 15-m-thick stratified fall deposit at the base of the Otowi Member. The nonwelded portions of the Tshirege Member and all of the tuffs within the Otowi Member lack the pervasive cooling joints that characterize the welded portions of the Tshirege Member. Although high-

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angle fractures tend to be rare in nonwelded tuffs, a few were documented by borehole videos and core samples (Broxton et al., 2002a).

The Puye Formation commonly underlies the Guaje Pumice Bed and consists of highly stratified, poorly cemented gravels and conglomerates consisting of subrounded dacitic and andesitic lava clasts in a poorly sorted, sandy to silty matrix. Debris flows, ash beds, pumiceous volcaniclastic sediments, and beds of fluvial sand and silt are interbedded with the gravels and conglomerates. Basaltic ash and lacustrine deposits are present in the upper part of the Puye Formation on the eastern side of the plateau. The formation reaches a maximum thickness of >335 m beneath the western part of the plateau but thins to 15 m in the northeast part of the plateau near the Rio Grande. Ancestral Rio Grande deposits called the Totavi Lentil are interbedded with the lower part of the Puye Formation on the east side of the plateau. These riverine deposits contain subangular dacitic detritus derived from volcanic sources to the west and rounded cobbles and boulders of quartzite, granite, and pegmatite derived from Precambrian highlands to the north and east. In some parts of the plateau, a distinctive pumice-rich rock unit beneath the Puye Formation, labeled younger pumiceous deposits in Fig. 2, overlies the Totavi Lentil. Borehole geophysical logs show that these pumiceous deposits typically have a higher porosity and lower bulk density than overlying fanglomerates. Thick deposits of older fanglomerate occur beneath the pumiceous deposits. These deposits, which are similar to but predate rocks normally assigned to the Puye Formation, are informally called older fanglomerate (Broxton and Vaniman, 2005).

Basaltic rocks of the Cerros del Rio volcanic field are intercalated with the upper part of the Puye Formation in the central and eastern part of the Pajarito Plateau. These basalts occur as numerous lava flows separated by interflow breccia, scoria, ash, and fluvial deposits. The lava flows typically contain highly brecciated tops and bottoms that provide zones of highly interconnected porosity over distances of tens to hundreds of meters. In some areas, the permeability of these zones is reduced by clays deposited in the pores of the breccias. Studies of basalts on the Columbia River Plateau found that, under saturated conditions, groundwater is most readily transmitted through the breccia zones at the tops and bottoms of basalt flows (Whiteman et al., 1994). The interiors of the flows are made up of dense, impermeable basalt. Fractures provide the primary source of permeability for the transport of liquid water and vapor in the dense flow interiors. Fracture patterns vary vertically within a flow unit with vertical columnar joints commonly occurring in the lower part of flow and irregular, complexly fanning fractures occurring in the upper part. Horizontal platy joints are also present near the base of some flow units.

Sources of Contamination

Many of the processes used to carry out the Laboratory's past and present missions use hazardous and radioactive materials. Throughout the Laboratory's history, some of these materials have been disposed of on Laboratory property or released into the environment. Since World War II, environmental legislation has evolved to become increasingly protective, and the Laboratory's operations have evolved with the legislation.

The Laboratory's Environmental Restoration Program is actively working to identify and restore contaminated sites. Original contaminant sources include, for example, septic tanks and lines, wastewater outfalls, material disposal areas (MDAs), firing ranges, and surface spills. In this paper, the focus is largely on contaminants associated with wastewater outfalls and MDAs. Wastewater from Laboratory technical areas (TAs) was historically drained through pipes and allowed to discharge into nearby canyons or mesa top lagoons. The outfalls are those areas below these effluent pipes and are a source of potential contamination for local canyons. Material disposal areas are generally mesa-top sites where waste was historically placed in near-surface pits or shafts. A variety of contaminants were disposed of in MDAs, including solid and liquid radioactive wastes, heavy metals, and organic wastes. These sites were intended to be permanent disposal facilities, and assessments are underway to determine whether any of these facilities pose long-term risks.

Climate and Near-Surface Hydrology

Arid and semiarid regions have common characteristics, such as thick vadose zones, infiltration that is often focused in topographic lows or beneath surface water bodies, and average annual potential evapotranspiration (ET) rates that far exceed precipitation rates. Under these conditions, infiltration events that propagate beneath the root zone are sporadic and occur only when the short-term infiltration rate exceeds the ET rate, such as during snowmelt or after large rainstorms. Consequently, the rates for deeper infiltration are difficult to quantify through traditional water balance studies because this component of the water balance can be orders of magnitude less than the other components (de Vries and Simmers, 2002; Scanlon et al., 2002; Sophocleous, 2002; Sanford, 2002; Flint et al., 2002). These generalities apply to the Pajarito Plateau, which has a semiarid climate and a vadose zone that ranges in thickness between approximately 100 and 400 m (Fig. 2).

Average annual precipitation across the Pajarito Plateau ranges from >0.5 m along the western boundary near the Jemez Mountains to <0.36 m to the east at the Rio Grande (Bowen, 1990). Most precipitation occurs either as winter and spring snow or as summer "monsoonal" rains. As a result, infiltration occurs episodically during spring snowmelts or the intense summer thunderstorm season and is often focused by runoff into the canyons.

Surface water flow in the canyons is generally ephemeral or intermittent, although a few canyons have short stretches with perennial surface flow. Anthropogenic discharges from water treatment outfalls can be a significant source of water in some canyons. Infiltration of

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these surface sources form shallow perched alluvial groundwater systems in many of the canyons (Stone et al., 2001). These alluvial groundwaters are not sufficiently extensive for domestic use, but nevertheless, they are an important component of the subsurface hydrologic system. Because of their close association with surface waters, these shallow perched systems generally show the earliest and most pronounced impacts of laboratory contamination of all groundwaters. They also serve as lateral pathways for the down-canyon migration of contaminants and provide storage for groundwater infiltrating to deeper parts of the vadose zone.

VADOSE ZONE CONCEPTUAL MODELS OF THE PAJARITO PLATEAU

The conceptual models for vadose zone flow and transport beneath the Pajarito Plateau identify wet canyons as being hydrologically different from dry canyons and dry mesas (LANL, 1998a; Rogers et al., 1996; Neeper and Gilkeson, 1996; Turin and Rosenberg, 1996; Birdsell et al., 2000). Table 1 shows a compilation of infiltration rates estimated using a variety of interpretive techniques for locations across the plateau. These data begin to illustrate the difference in infiltration rate depending on location (i.e., mesa or canyon). In addition, Kwicklis et al. (2005) developed a map of average annual "net infiltration" in the Los Alamos area, on the basis of physical features such as elevation, vegetation, surface geology, and stream flow. They defined net infiltration as that water remaining after accounting for evapotranspiration in the shallow subsurface (i.e., the root zone). The highest net infiltration rates occur in the larger canyon systems, especially those that head in the mountains, with magnitudes of up to a few hundred millimeters per year caused by channelized runoff. In contrast, much lower net infiltration rates occur across mesas and in the smaller canyons that head on the plateau. These geographic variations in infiltration rates are key components of the site conceptual models.

In the subsections that follow, conceptual models are presented for (i) wet canyons, (ii) dry canyons, (iii) dry and disturbed mesas, and (iv) mountain-front mesas. First, however, a comparison of porous matrix flow and transport with more rapid fracture flow and transport is presented because this topic is relevant to the four location-specific conceptual models. Then, the location-specific conceptual models are given. Each conceptual model includes field observations and interpretations that support the application of these models to the Pajarito Plateau. Finally, a contrast between subsurface observations at mesa top and canyon sites is presented that further supports the distinction between canyons and mesas.

Along with each conceptual model description, field observations and/or interpretation are presented as evidence to support the model. Many of these cases are interpreted through numerical simulation using the Finite Element Heat and Mass (FEHM) code (Zyvoloski et al., 1997). This code has been used extensively to model unsaturated and saturated flow and contaminant transport in porous and fractured media (Robinson and Bussod, 2000; Robinson et al., 2005a; Keating et al., 2005). The numerical studies that follow employ the water characteristic-curve formulation of van Genuchten (1980) because that formulation was used to fit the available site data measured on core samples.

Matrix vs. Fracture Flow and Transport

Vadose zone flow through nonwelded to moderately welded units of the Bandelier Tuff is thought to occur through the porous matrix. Within densely welded tuffs and dense basalts, the vadose zone flow regime may be dominated by fracture flow. In contrast, matrix flow may occur within the more porous, brecciated zones in the basalt. The following evidence supports these hypotheses.

Matrix Flow in Nonwelded and Moderately Welded Tuffs

Across most of the plateau, the uppermost vadose zone consists of nonwelded to moderately welded Tshirege

Table 1. Estimated net infiltration rates across the Pajarito Plateau. (Negative infiltration rate implies upward flow.)

Location	Classification	Estimated net infiltration rate	Technique used for estimation	Reference
		mm yr^{-1}		
Los Alamos Canyon	wet canyon (natural with previous discharges)	213–1076	water balance study	Gray, 1997
Mortandad Canyon	wet canyon (anthropogenic recharge)	0.13, 0.25, and 1.5	analyzed vertical head gradients	Rogers et al., 1996
		transient, decreasing from 2400 to 150	depths of subsurface tritium peaks	Kwicklis et al., 2005
Cañada del Buey	dry canyon	−0.22 and 2.0	analyzed vertical head gradients	Rogers et al., 1996
Potrillo Canyon	dry canyon	0.12	analyzed vertical head gradients	Rogers et al., 1996
Mesita del Buey	dry mesa	6.9,-7.0, 0.07, −0.06, and 0.26	analyzed vertical head gradients	Rogers et al., 1996
		0.2 and 3.3	chloride mass-balance approach	Bergfeld and Newman, 2001
		1–5	moisture matching	Birdsell et al., 2000
MDA G on Mesita del Buey	disturbed dry mesa site with waste disposal	9	chloride mass-balance approach	Newman et al., 2005
Frijoles Mesa, 210-m hole near MDA AB	dry mesa	0.3–2.0	chloride mass-balance approach	Newman et al., 1997
MDA AB on Frijoles Mesa	disturbed mesa site with asphalt cover	300	water balance based on subsurface moisture	Rofer et al., 1999
MDA P	disturbed mesa site with waste disposal	95	analyzed vertical head gradients	Rogers et al., 1996
TA-53 Lagoons on Mesita de los Alamos	disturbed mesa site with liquid waste disposal	230	analyzed vertical head gradients	Rogers et al., 1996

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Member ash-flow tuffs and nonwelded Otowi Member ash-flow tuffs (Fig. 2). Unsaturated flow and transport through these tuffs is assumed to occur predominantly through the porous matrix. These units have typical porosities of 40 to 50%, moderate saturated hydraulic conductivities (e.g., 10^{-4} cm s^{-1}), and water contents that are generally far below saturated conditions (2–25%) (Abrahams et al., 1961; Rogers et al., 1996; Birdsell et al., 2000; Springer, 2005). Although these tuffs are often fractured, water flow is expected to be matrix dominated unless conditions approach full saturation (Soll and Birdsell, 1998), such as beneath liquid-waste disposal pits or outfalls. In contrast, under background conditions where the fractured tuffs form the dry finger mesas on the eastern side of the plateau, air is thought to circulate freely through the fractures resulting in evaporation of pore water (Neeper, 2002; Stauffer et al., 2005).

Field observations and analyses support the matrix-flow hypothesis. Robinson et al. (2005a) modeled a vadose zone, wellbore injection test that was performed on a mesa north of Pajarito Canyon in moderately welded tuffs of the Tshirege Member (Purtymun et al., 1989) (Fig. 1). Through a numerical analysis incorporating different conceptual models of fracture flow behavior, they showed that the observed moisture distribution was consistent with a continuum model without fractures. The agreement between the numerical model and the observations was acceptable, both qualitatively and quantitatively. Dual-permeability and discrete-fracture conceptual models could also reproduce the observations, but only by muting the effect of the fractures. They estimated an equivalent infiltration rate during the injection phase of about 2.7×10^4 mm yr^{-1}, which is greater than most estimates of infiltration across the plateau (Kwicklis et al., 2005). They concluded that if matrix-dominated flow is observed at the high effective infiltration rate of this injection test, then it is even more likely to be the case under natural conditions on the plateau.

Evidence of fracture transport in a nonwelded to partially welded tuff exists beneath an historic liquid-waste disposal facility at MDA T on DP Mesa (Fig. 1). The disposal facility consisted of four adsorption beds dug 1.2 m deep into the mesa top and filled with cobbles and gravel. The beds received liquid wastes primarily between 1945 and 1950, with occasional disposals through 1967. Subsurface contaminant data from 1960, 1978, and 1996 collected beneath the adsorption beds show evidence of contaminant transport associated with fractures, while subsurface data collected in boreholes adjacent to the beds shows none (Nyhan et al., 1984; LANL, 2004b). However, the 1978 study, which targeted data collection in fractures beneath the adsorption beds, concluded that most fractures (8 of 10) did not enhance contaminant transport. The two observations of transport in fractures in that investigation occurred at similar depths (<7 m below the ground surface) to those cited in the 1960 study, even though the four investigative boreholes drilled in 1978 extended deeper (to 30 m) (Nyhan et al., 1984). Although the 1996 data show contamination in a 20-m-deep fracture, the general assumption is that fracture transport occurred while the beds actively received liquid waste and that the contaminants associated with the fractures are remnants of previous fracture flow episodes (LANL, 2004b). These data support the idea that some fractures in the nonwelded to moderately welded tuff will flow when the matrix is saturated.

Fracture Flow in Densely Welded Tuffs

In areas near the mountain front on the western edge of the plateau, the majority of tuffs making up the Tshirege Member are moderately to densely welded. These strongly welded tuffs are characterized by porosities ranging from 17 to 40%, unsaturated volumetric water contents from 3 to 12%, and low saturated hydraulic conductivities (e.g., 10^{-6} to 10^{-9} cm s^{-1}) (LANL, 2003b). These tuffs are also more fractured in the vicinity of the Pajarito fault zone along the western mountain front and can support fracture flow and transport when sufficient water is present. A bromide tracer test and high explosives contaminant distributions suggest that both fracture-dominated and matrix-dominated flow occur near the mountain front, depending on the degree of welding of the tuff (LANL, 1998b; LANL, 2003b).

Fracture Flow in Dense Basalts; Matrix Flow in Brecciated Basalts

Like the densely welded tuff units, fracture flow is hypothesized to occur through the dense, low-porosity flow interiors of the Cerros del Rio basalt. Evidence for fracture flow in basalt comes from a field experiment on the upstream side of a low-head weir located in lower Los Alamos Canyon (Fig. 1; Stone and Newell, 2002; Stone et al., 2004). The objective of the experiment was to monitor water flow and bromide tracer transport through fractured basalt under transient, unsaturated and periodically ponded conditions using three observation boreholes. Following three ponding events, the bromide tracer advanced quickly downward to a depth of several tens of meters within 10 to 14 d after the first ponding event (Stone et al., 2004). The rapid advance of bromide indicates that fracture flow and transport occur through basalts under ponded conditions. Model calibration of bromide transport yields an effective fracture porosity in the range of 10^{-2} to 10^{-3} and saturated hydraulic conductivity in the range of 10^{-2} to 10^{-3} cm s^{-1} (Stauffer and Stone, 2005; Stone et al., 2004). The data and simulations both indicate that the bromide continued to advance through the fractured system even after the ponds had drained.

Perched groundwater has been identified in a number of boreholes on the plateau (Robinson et al., 2005b; Broxton and Vaniman, 2005) and is often located beneath the larger wet canyons and within the more porous, breccia zones in basalt. An example of perched water in basalt occurs at Well R-9 in lower Los Alamos Canyon (Fig. 1), where groundwater was found from 55 to 70 m deep in the middle of the 86-m sequence of stacked lava flows (Broxton et al., 2001). The groundwater is located within a breccia zone and an underlying highly fractured basalt flow. The base of the perched zone occurs where the highly fractured basalt grades

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downward into a massive flow interior with few fractures. Tritium concentrations in the perched water reveal that it is no more than a few decades old (Broxton et al., 2001).

It is apparent that groundwater flow in basalts occurs both as porous flow through breccia zones and as fracture flow where dense flow interiors are broken by interconnected fracture systems. Flow direction is likely controlled by the geometry of the interflow breccias and by fracture orientation, both of which are heterogeneous. Perched zones may be stagnant or may flow laterally. For contaminant transport calculations, water flow through the basalt is commonly purposely predicted to be via fast-flowing vertical fractures because so little is known about the true nature of flow through the basalt units (Birdsell et al., 2000).

Wet Canyons

Wet Canyon Conceptual Model

Figure 3 is a photograph of Cañon de Valle, a wet canyon on the western boundary of the plateau. Several features characterize the large, deep naturally wet canyons on the Pajarito Plateau, such as Los Alamos and Pueblo Canyons (Fig. 1 and 2). Their headwaters are in the mountains, they have large catchment areas (13–26 km^2), surface flow occurs frequently, and perched alluvial groundwaters exist beneath the canyon floors. In some cases, discharges from anthropogenic sources such as outfalls and wastewater treatment plants increase flows sufficiently that smaller dry canyons that head on the plateau act like wet canyons (e.g., Mortandad Canyon, Fig. 1 and 2). Often, deeper, intermediate perched zones are associated with wet canyons. The geometry of wet canyons promotes hydrologic conditions that yield relatively fast, unsaturated flow and transport as described in the paragraphs that follow.

Wet canyons collect large runoff volumes, either through channeling of mountain-front precipitation from large contributing areas or through wastewater discharges. This runoff, in turn, creates surface water flow along canyon bottoms, which subsequently infiltrates to form perched alluvial water bodies. Lateral flow and transport through surface water and in the alluvial systems are rapid compared with other subsurface hydrologic processes on the plateau. Rates of lateral transport are most rapid during surface flow events, which occur more frequently in the larger wet watersheds than in other areas of the plateau. Sorbing species transport slowly in alluvial waters and more commonly migrate down the canyon floor by sediment transport (LANL, 2004a; Lopes and Dionne, 1998; Solomons and Forstner, 1984; Watters et al., 1983). Since some of the wet canyons received liquid-waste discharges from outfalls, the alluvial systems then act as line sources for both water and contaminants to deeper parts of the vadose zone beneath the canyon floor. The resulting net percolation rates beneath the perched alluvial systems to the underlying unsaturated zone are expected to be among the highest across the plateau, approaching a meter per year (100–1000 mm yr^{-1}) (Gray, 1997; Kwicklis et al., 2005; Table 1).

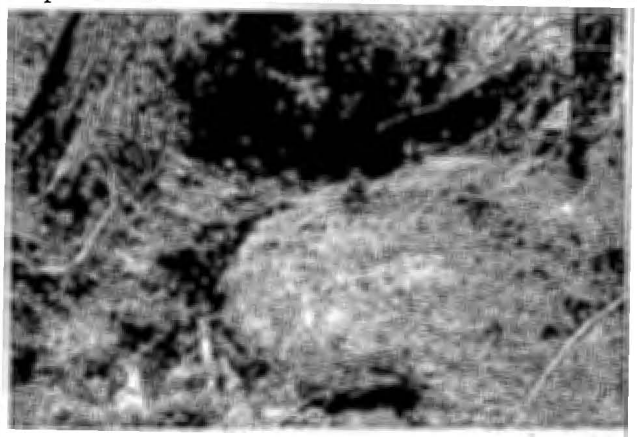


Fig. 3. Photograph of Cañon de Valle, a wet canyon on the western edge of the plateau.

From west to east, the vadose zone becomes progressively thinner and the geology becomes dominated by pre-Bandelier rock units, as can be seen by comparing Fig. 2a and 2b. This is especially true for the deep wet canyons, which are deeply incised into the underlying strata. In the eastern part of the plateau, contaminants transported laterally down canyon via surface flow or in alluvial groundwater often percolate through a geologic column consisting primarily of basalt and fanglomerate with little or no overlying tuff. Downward percolation is believed to be more rapid in the basalt than through porous tuff, as discussed in the matrix vs. fracture flow section above. Thus, especially along the eastern end of the plateau, the wet canyons have thinner vadose zones (compare, e.g., Los Alamos Canyon in Fig. 2a and 2b) and a shorter portion of the flow path that has matrix-dominated flow (compare, e.g., Pajarito Canyon in Fig. 2a and 2b) than for the less eroded areas of the plateau. These stratigraphic factors compounded by the relatively high net infiltration rates in wet canyons likely yield the fastest vadose zone travel times for contaminants from the land surface of the plateau to the regional aquifer. Transport to the regional aquifer beneath wet canyons is predicted to be on the order of decades to hundreds of years (LANL, 2003b; Nylander et al., 2003).

Wet Canyon Examples

Mortandad Canyon has the physical features of a dry canyon (Fig. 1 and 2). However, this canyon is classified as wet because it has received significant effluent discharge since the late 1950s. Since 1963, a radioactive liquid-waste treatment facility (RLWTF, Fig. 1) has released treated effluent in excess of 10^7 L yr^{-1} to Mortandad Canyon via a small side canyon (LANL, 1997). Discharge volumes and contaminant masses for the RLWTF outfall are well documented. As such, data for this canyon prove useful for conceptual model validation. Discharge volumes have declined steadily since 1982.

A perched alluvium system fills the canyon floor and varies in thickness from near zero to more than 30 m near the eastern boundary of the Laboratory (McLin

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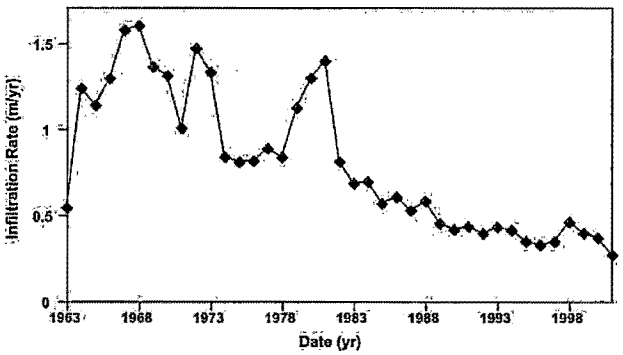


Fig. 4. Time-varying percolation rate at the alluvium–tuff interface, estimated for Mortandad Canyon near Well R-15 (Hollis et al., 2005).

et al., 1997). Purtymun (1974) observed that lateral transport of tritium and chloride was rapid through the alluvial system. He estimated lateral transport velocities between alluvial wells varying from 620 to 7300 m yr^{-1}. The alluvial wells in Mortandad Canyon cover more than a 3-km distance downstream from the RLWTF and have been monitored for nitrate and radionuclides regularly since 1963 (LANL, 1997, 2001). Nitrate and tritium concentrations at the wells are roughly within a factor of two to three of each other, indicating that these nonsorbing species are well mixed throughout the alluvial groundwater. The rapid lateral transport and mixing of nonsorbing species support the concept that the wet alluvial systems spread contaminants down canyon such that they act as a line source of water and well-mixed contaminants to the deeper vadose zone. In contrast, the concentrations of adsorbing species, such as strontium and plutonium, in the alluvial water decline by an order of magnitude or more as the water flows down canyon (LANL, 1997). This variation in concentration with distance would need to be considered when predicting transport of adsorbing species from the alluvial aquifer.

A series of one-dimensional vadose zone flow and transport simulations, using 38 columns to represent the canyon bottom, were performed to support a probabilistic risk assessment of Mortandad Canyon (Hollis et al., 2005). As an upper-boundary condition, the simulations apply a water balance to the alluvial aquifer to estimate recharge from the alluvial aquifer to the deeper vadose zone. The water balance approach assumes that the volume of water entering the canyon is a function of the discharge volume from the RLWTF, the main anthropogenic water source to the canyon, and that recharge is a function of the distance from the source. An estimate of the time-varying percolation rate at the alluvium–tuff interface in the vicinity of Well R-15 (Fig. 1) developed for the stochastic analysis is shown in Fig. 4. This particular example uses mean values for the three parameters in the study that define the distribution of infiltrating water throughout the canyon floor, with the main control being the assumed dilution of the recorded RLWTF discharge volumes (Hollis et al., 2005). The percolation estimates are indicative of rates expected in wet canyons; they range from 300 mm yr^{-1} to >1.5 m yr^{-1}.

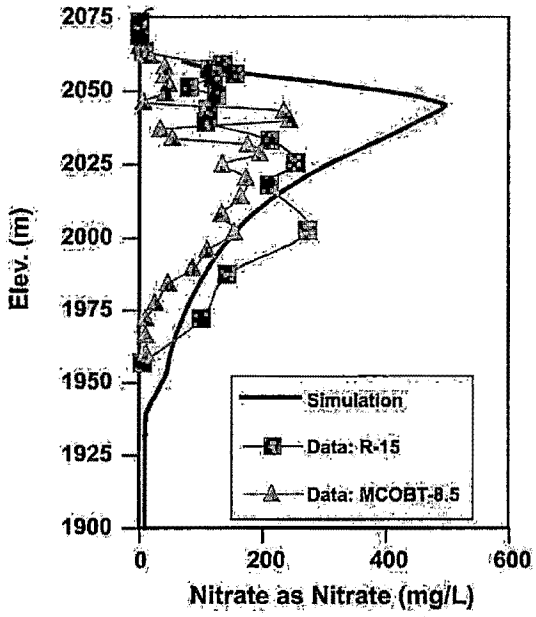


Fig. 5. Nitrate concentration profiles as a function of elevation in Wells R-15 (Longmire et al., 2001) and MCOBT-8.5 (Broxton et al., 2002b) and for a one-dimensional simulation (Hollis et al., 2005).

Nitrate concentration data collected in core from two vadose zone boreholes, R-15 and MCOBT-8.5 (Longmire et al., 2001; Broxton et al., 2002b), also confirm wet canyon behavior in Mortandad Canyon. Here nitrate has migrated to a depth of at least 100 m in the vadose zone in approximately 40 yr, as shown in Fig. 5. An example nitrate concentration profile predicted at the location of Well R-15 with the transient one-dimensional, vadose zone simulation described above agrees well with the concentration data (Fig. 5). The simulation uses the transient percolation rate shown in Fig. 4 and measured nitrate releases from the RLWTF (LANL, 1997), although one-half the nitrate mass is assumed to be degraded due to denitrification (Hollis et al., 2005). The simulation also assumes that water flow through the tuff units is matrix dominated, and flow through the basalt is fracture dominated.

Nitrate has also been observed in the regional aquifer at levels near 2 mg L^{-1} (LANL, 2003a) in Well R-15. This well is 337 m deep and extends 44 m into the regional aquifer. These nitrate levels are elevated relative to background levels in regional groundwater and are believed to be the result of Laboratory liquid-effluent discharges to Mortandad Canyon (Longmire, 2002).

Los Alamos Canyon is a large canyon that is both naturally wet and has previously received wastewater discharges. Laboratory derived contaminants (tritium, perchlorate) released in liquid effluents into this canyon and the adjacent Pueblo Canyon have reached the regional aquifer and are present in one municipal water supply well (Otowi-1) (LANL, 2004c). Well Otowi-1, located in Pueblo Canyon near the confluence with Los Alamos Canyon (Fig. 1), is in an area in which alluvium sits directly on top of basalts and the Puye formation. Further up Los Alamos and Pueblo Canyons, significant thicknesses of Bandelier Tuff are present. In contrast to

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Fig. 6. Photograph of a dry canyon, lower Sandia Canyon.

Otowi-1, no contaminants have been detected in water supply well Otowi-4 (LANL, 2004c), located in a region in which more than 50 m of Bandelier Tuff is present (Fig. 1). Thus, the Otowi-4 result is consistent with a conceptual model of matrix-dominated flow and longer travel times through the nonwelded Bandelier Tuff, and the Otowi-1 observation is consistent with fracture flow through the basalt units. The numerical model of Los Alamos Canyon developed in Robinson et al. (2005c) yielded results consistent with these observations.

To summarize, these data and interpretation demonstrate several of the features included in the wet canyon conceptual model. First, lateral transport by both surface water and perched alluvial groundwater spreads nonsorbing contaminants down canyon to create a line source of contamination to the deeper vadose zone. Next, wastewater discharges can cause wet-canyon hydrologic behavior in small canyons that would otherwise likely have little net infiltration, as discussed in the upcoming section. Also, a matrix-flow model for the tuff units appears to adequately capture infiltration beneath Mortandad Canyon even though a perched system sits atop the tuff, and the transient percolation rate is estimated to have been on the order of a meter per year. In contrast, near Otowi-1, at the confluence of Los Alamos and Pueblo Canyons, little or no tuff is present, and a rapid fracture flow model through the basalts best explains the contaminant observations. Finally, the presence of anthropogenic contaminants in regional groundwater confirms that beneath wet canyons some vadose zone pathways have travel times on the order of a few decades.

Dry Canyons

Dry Canyon Conceptual Model

Figure 6 is a photograph of lower Sandia Canyon (Fig. 1), which is considered a dry canyon. In contrast to wet canyons, dry canyons head on the plateau, have smaller catchment areas (<13 km^2), experience infrequent surface flows, and have limited or no saturated alluvial systems in their floors. If anthropogenic sources are present, they are small volume sources. These hydrologic factors yield little lateral near-surface contaminant migration and slower unsaturated flow and transport from the surface to the regional aquifer. For example, because surface and alluvial waters are less common, contaminants remain near their original sources. Pathways through the vadose zone tend to be longer in the shallow dry canyons, which have thicker sections of nonwelded to moderately welded tuff than in the deeper-cut wet canyons; see, for example, Cañada del Buey in Fig. 2. Net infiltration beneath dry canyons is much slower, with rates generally believed to be less than tens of millimeters per year and commonly on the order of 1 mm yr^{-1}. Finally, transport times to the aquifer beneath dry canyons are expected to be from hundreds to several thousands of years (Nylander et al., 2003).

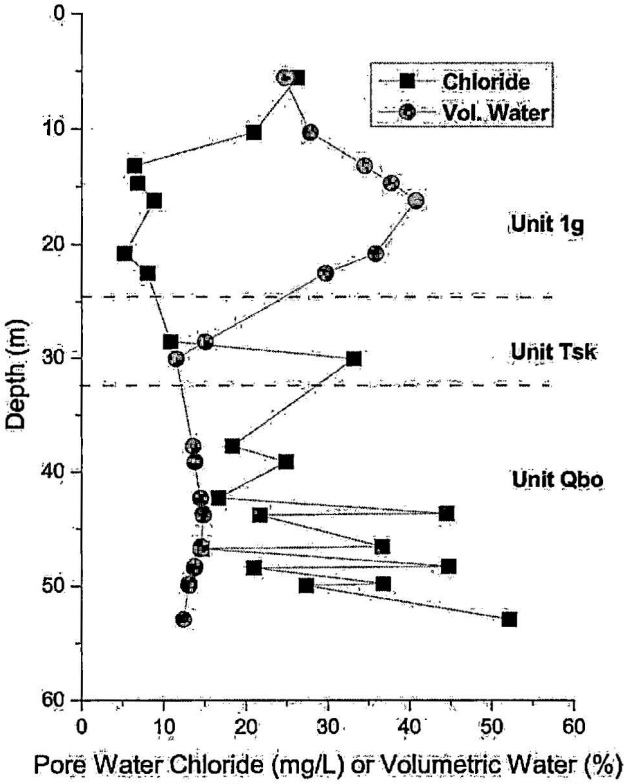


Fig. 7. Pore water chloride and volumetric water content profiles in Potrillo Canyon for Borehole PC-4 (Newman, 2002, unpublished data). Stratigraphic contacts are also shown (Qbt-1g is the Tshierege 1g unit, Tsk is the Tsankawi Pumice Bed, and Qbo is the Otowi Member of the Bandelier Tuff).

Dry Canyon Examples

Estimated net infiltration rates by Rogers et al. (1996) (Table 1) suggest fluxes of a few millimeters per year or less for two dry canyon locations, Potrillo Canyon and Cañada del Buey. Water content and chloride profiles from Potrillo Canyon Borehole PC-4 are presented in Fig. 7. The example shows that even in a "dry" canyon there can be zones of high water content (i.e., water contents are in the 40% range at about 17 m). However, the chloride mass-balance estimate of flux from this borehole is only 4.5 mm yr^{-1}, and the chloride-based vadose zone residence time exceeds 1700 yr.

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Fig. 8. Photo of a dry mesa located north of Cañada del Buey, on the eastern side of the Laboratory.

Dry Mesas

Dry and Disturbed Mesa Conceptual Model

Dry finger mesas constitute most of the mesa coverage on the plateau. The hydrologic conditions on the surface and within these dry mesas lead to slow unsaturated flow and transport. Figure 8 is a photograph of a dry mesa near the eastern boundary of the laboratory. Dry mesas shed precipitation as surface runoff to the surrounding canyons such that most deep infiltration occurs episodically following snowmelt. Much of the water that does enter the soil zone is lost through evapotranspiration. In fact, potential ET was estimated to exceed precipitation at a climate station on the eastern portion of the plateau by a ratio of 6:1 (LANL, 2003c). As a result, annual net infiltration rates for dry mesas are <10 mm yr^{-1} and are more often estimated to be on the order of 1 mm yr^{-1} or less (Kwicklis et al., 2005). Since the dry mesas are generally comprised of nonwelded to moderately welded tuffs with low water content, flow is matrix dominated. Travel times for contaminants migrating through mesas to the regional aquifer are expected to be several hundred to thousands of years (Newman, 1996; Newman et al., 1997b; Birdsell et al., 2000; Nylander et al., 2003).

The topographic relief of these steep-sided mesas influences their internal hydrologic conditions as well. High solar radiation, strong winds, and fluctuations in barometric pressure cause temperature and pressure gradients between the surface of the mesa and its interior. These gradients enhance air circulation through the mesas, which is thought to enhance deep evaporation (Neeper, 2002; Neeper and Gilkeson, 1996; Newman, 1996; Newman et al., 1997b). This additional drying in the mesa-top units further slows downward water flow and transport of dissolved species. However, these same conditions enhance vapor transport of volatile species (Stauffer et al., 2005).

Anthropogenic discharges and surface disturbances from laboratory operations can drive infiltration rates higher in normally dry mesas. In some cases, multiyear disturbances of mesa sites through liquid waste disposal, asphalt covers, and/or devegetation have temporarily caused mesa infiltration rates to increase to near wet canyon levels (Table 1). Even with elevated infiltration, at most sites flow remains matrix dominated. Fracture flow has occurred beneath a long-term liquid disposal site with ponded conditions, as discussed above. However, fracture flow is thought to cease once liquid disposals stop (Soll and Birdsell, 1998). Infiltration rates are expected to return to low, near-background levels when the surface and vegetation return to native conditions.

Dry and Disturbed Mesa Examples

Two examples of vadose zone conditions from dry and disturbed mesas are discussed. The first example uses volumetric water content and chloride profiles from four boreholes (Fig. 9) from Mesita del Buey located near the eastern boundary of the laboratory (Fig. 1). In this mesa, vadose zone water contents above the level of the adjacent canyon bottoms are variable, but a large fraction of the mesa has extremely low water contents of $<5\%$ ($<12\%$ saturation). Chloride accumulation in the vadose zone is also variable, but all four boreholes have significant chloride inventories. Some samples have pore water chloride concentrations that exceed 1000 mg L^{-1}. The chloride data (Newman, 1996) and numerical modeling (Birdsell et al., 2000) indicate that downward fluxes vary with depth and across the mesa. Chloride mass-balance flux estimates range from 0.03 to 6 mm yr^{-1}, with the highest fluxes associated with the upper 6 to 9 m. However, all four boreholes have a depth interval where fluxes are <1 mm yr^{-1}. Chloride-based residence times range from 1300 to 17 000 yr (Newman, 1996). The low fluxes and long residence times suggest that there is little water movement through the mesa.

Even though the natural conditions in dry mesas result in low downward fluxes, disturbance can alter how quickly water moves through the vadose zone. Rogers et al. (1996) showed that addition of water or focusing of flow on mesa tops (e.g., waste water lagoons or storm water diversion ditches) can result in flux increases of tens to hundreds of millimeters per year (Table 1). Another example of how rapidly dry mesa conditions can shift from disturbance is provided by periodic water content monitoring of Borehole 1121 on Mesita del Buey. When the borehole was drilled, chloride and water content data reflected the native conditions in the mesa (Fig. 10). Subsequently, focused runoff from an asphalt pad resulted in transient ponding in a localized area around Borehole 1121. Periodic water content monitoring in Borehole 1121 using neutron probe revealed increasing water contents down to about 24 m in <10 yr (Fig. 10; Newell, 1996 and 2000, unpublished data). This example shows that transient ponding can affect deep portions of dry-mesa vadose zones in less than a decade.

The second dry or disturbed mesa example is from Frijoles Mesa, located at the south-central portion of the Laboratory (Fig. 1). Explosives experiments were conducted at MDA AB on Frijoles Mesa in 1960 and

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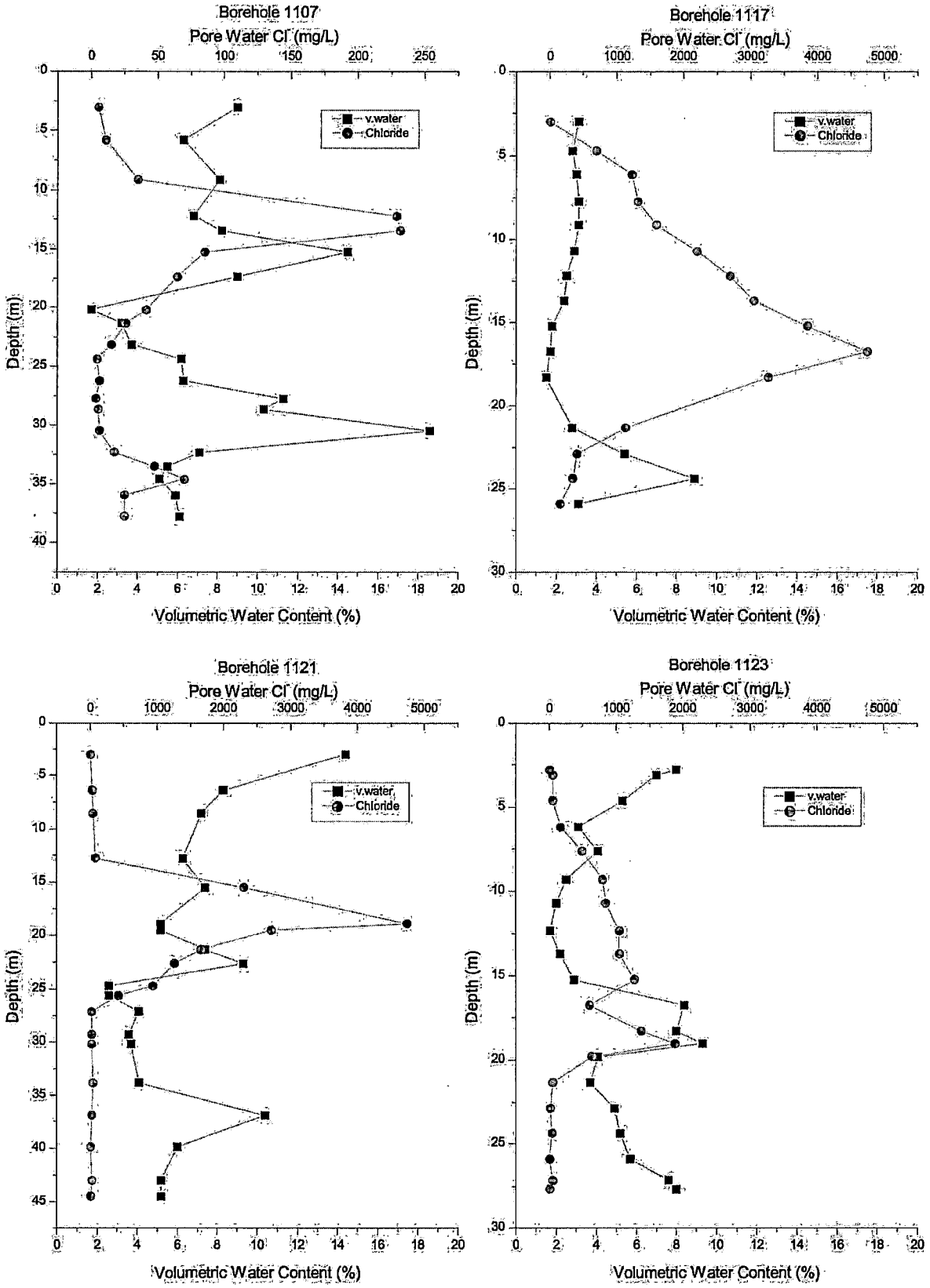


Fig. 9. Water content and chloride profiles from MDA G (Newman, 1996).

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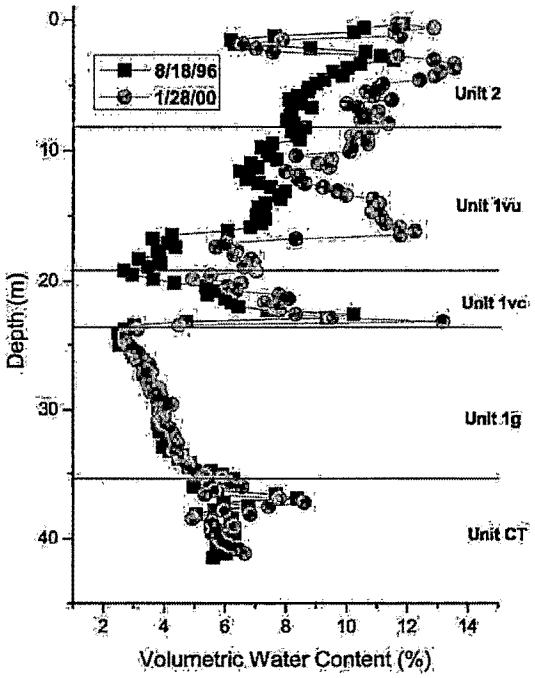


Fig. 10. Changes in volumetric water content in borehole 1121 as a result of episodic ponding (Newell, 1996 and 2000, unpublished data). Ponding occurred from focused runoff from an asphalted area.

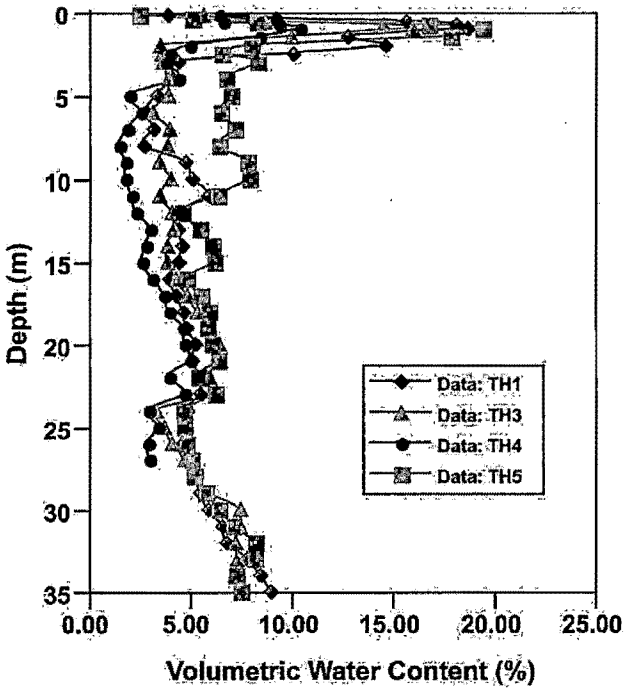


Fig. 11. Volumetric Water Content in four boreholes for background conditions at TA-49 near MDA AB (Levitt et al., 2005).

1961 at the bottom of shafts dug approximately 20 to 24 m into the Tshirege Member of the Bandelier Tuff. One area at the site was paved with asphalt in 1961 to minimize the spread of accidental surface contamination. It was later found that the elevated asphalt pad unfavorably altered the naturally dry hydrologic characteristics of the site by inhibiting evapotranspiration and by damming surface water along its edge. At several times, the asphalt was found to be in disrepair, and estimates of leakage through the cracked asphalt pad ranged from 60 to 388 mm yr^{-1} (Table 1; LANL, 1992; Rofer et al., 1999).

Background water content profiles measured in four 37-m boreholes (Fig. 11) and a 210-m borehole (Levitt et al., 2005) illustrate the site's dry background conditions. Water content of the tuff below about 3 m is <10%. Newman et al. (1997b) estimated infiltration rates in the range 0.3 to 2.0 mm yr^{-1} based on the chloride profile from the 210-m borehole at the site (Table 1). Water content profiles from beneath the asphalt were measured in two 46-m boreholes in 1994 (Fig. 12). These data clearly show elevated water contents to a depth of 18 m.

Two-dimensional numerical simulations, assuming matrix properties for the tuff units, were run to determine the asphalt's effect on the subsurface water balance and to predict the possible recovery of the site following asphalt removal (Birdsell et al., 1999). A simulated background infiltration rate of 0.1 mm yr^{-1} fits the background, water content data well and was used as an initial condition for transient simulations of the paved area. The transient simulations assumed an immediate increase in the infiltration rate in 1961, when the site was paved, to a new steady value of 60, 150, or 388 mm yr^{-1}, based on the leakage estimate cited above. Figure 12 shows the predicted water content profiles for the 60 and 150 mm yr^{-1} infiltration rate cases for a simulation time equivalent to 1994. The water content profile, based on a net infiltration rate of 60 mm yr^{-1} (a 600-

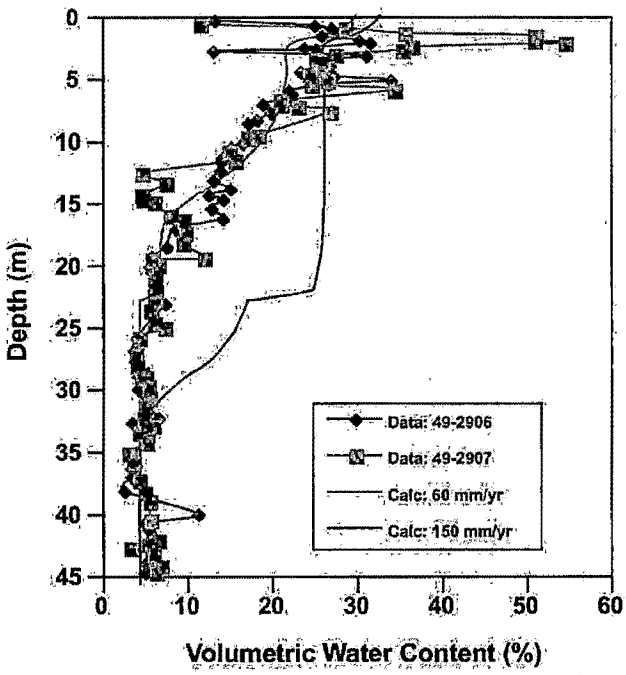


Fig. 12. Volumetric water content for disturbed conditions at TA-49, MDA AB. Data are for two boreholes beneath an asphalt area (Farley, 1994, unpublished data). Simulation results are for transient simulations with increased deep percolation during asphalt lifetime (Birdsell et al., 1999).

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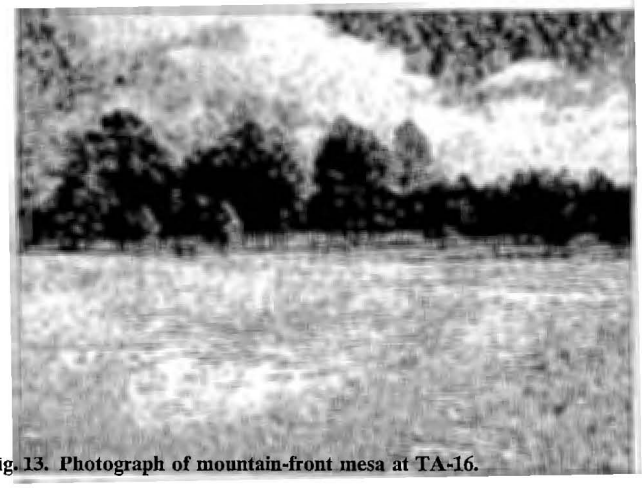


Fig. 13. Photograph of mountain-front mesa at TA-16.

fold increase) applied from 1961 through 1994, matches the 1994 water content data well. The simulations indicate that if the site returned to a 0.1 mm yr^{-1} infiltration rate, the soil would show detectable signs of drying in a 5-yr period. However, the water content of the uppermost tuff unit might increase slightly as the steep gradient in the top few meters, as seen in Fig. 12, relaxes downward.

To return the site to a more natural state, the asphalt was removed in 1998. The site was then regraded, capped with an ET cover, and revegetated. From 2000 through 2004, monitoring has shown slow drying in the upper 6 m of the soil layer beneath the ET cover (Levitt et al., 2005). Water contents at 12-m to 18-m depths show a slight increase in time (Levitt et al., 2005), as predicted, because of the steep water content profile that existed before removal of the asphalt is relaxing.

Data and simulations for MDA AB support several of the assumptions of the dry mesa conceptual model under both background and disturbed conditions. First, the matrix flow model adequately matches water content data at both background and enhanced infiltration conditions. Second, native conditions of this mesa are dry with predicted infiltration rates between 0.1 mm yr^{-1} (simulations) and 2.0 mm yr^{-1} (chloride). Third, the surface disturbance significantly enhanced net infiltration. Finally, the site seems to be returning to a drier condition. However, since the asphalt was in place for several decades, water accumulation in the disturbed area is significant. The simulations indicate that it may take hundreds of years for water content levels within the tuff units to return to near-background conditions.

Mountain-Front Mesas

Mountain-Front Mesa Conceptual Model

Mesas along the mountain front of the plateau are classified as being naturally wet mesas. Figure 13 shows a photograph of a mountain-front mesa area at TA-16 (Fig. 1). In contrast to the dry mesas, these mesas receive greater precipitation (e.g., 500 mm yr^{-1}) and increased runoff and infiltration. The wet, mountain-front mesas contain numerous perennial and ephemeral springs. Such springs are rare in the dry mesas of the eastern part of the plateau, except where the regional groundwater aquifer discharges along the Rio Grande. Duffy (2004) discusses the importance of mountain-front processes and conditions in semiarid landscapes and suggests that the mountain block and mountain-front areas are the dominant recharge zones in semiarid landscapes. Thus, hydrologic conditions are quite different along the wet mountain-front mesas. One other important difference is that the upper tuff units along the mountain front are often moderately to strongly welded because of the close proximity to the caldera source. Welding results in increased fracturing during cooling, and because the mountain-front mesas lie within the Pajarito Fault Zone, additional fracturing and minor faulting of the tuff units have resulted. The welded tuffs create a hydraulic condition where matrix hydraulic conductivities are low (e.g., 10^{-7} to 10^{-9} cm s^{-1}), but fracture densities are relatively high. Thus, there is a propensity for significant fracture flow. Fracturing appears to control the locations of natural springs along the mountain-front mesas. Also, fracture flow related to outfalls and wastewater lagoons is suggested by water content and contaminant distributions (LANL, 2003b).

Mountain-Front Mesa Examples

To illustrate how rapidly vadose zone flow and transport can occur in wet, mountain-front mesas, a bromide tracer test is described. This tracer experiment was conducted in a former high explosives outfall pond at TA-16. Use of the outfall had been discontinued, and ponded water conditions no longer existed at the site. In 1997, 100 kg of potassium bromide were applied to the outfall pond with 3028 L of water. The main goal of the study was to determine whether there was a connection between the mesa-top outfall pond and two high explosives–contaminated springs that flowed along the north side of the mesa. Except for the tracer solution, no additional water was added to the site. Thus, precipitation was the dominant driver for tracer transport. Borehole monitoring and drilling during the test showed that the vadose zone was largely unsaturated. Tracer was observed in the first spring after only 4 mo. These observations indicate more than 300 m of lateral transport and 33 m of vertical transport. Tracer was observed in the second spring after about 7 mo. Such rapid movement of tracer to the springs is inconsistent with fluxes that would be expected under unsaturated, matrix-type flow conditions (LANL, 1998b, 2003b). Thus, rapid movement along locally saturated fractures (possibly in combination with matrix flow) is implied. It is also worth noting that <2% of the applied tracer mass actually made it to the springs. Subsequent drilling and sampling in the application area 3 yr after the tracer was released suggests nearly all of the tracer mass was still in the top 1.2 m of the vadose zone (LANL, 2003b). This result illustrates that vadose fluxes in the mountain-front zone are not always large and that there can be a great deal

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Table 2. Comparison of canyon and mesa hydrogeochemical characteristics.

	Max. Cl^-	Avg. Cl^-	Max. SO_4^{2-}	Avg. SO_4^{2-}	Max. $\delta^{18}O$	Avg. $\delta^{18}O$	Max. θ_v	Avg. θ_v
	mg L^{-1}				‰		%	
Canyons	172	30	641	78	−7	−10	52	20
Mesas	1761	398	8913	766	−1	−8	18	7
Difference	1589	368	8272	688	6	2	−33	−13

of variation in fluxes, depending on whether fracture or matrix flow (or both) occur.

Mesa–Canyon Comparison

To further demonstrate the pronounced difference between the subsurface hydrologic conditions beneath mesas and canyons, a direct comparison of data collected at a variety of mesa and canyon sites is presented in this section. A statistical examination of vadose zone water content, anion concentrations (e.g., chloride), and stable isotopes ($\delta^{18}O$ and δD) supports the hypothesis that canyons are hydrologically different from mesas. These characteristics serve as sensitive indicators for differences in recharge through the vadose zones. Cores from nine canyon and 13 mesa boreholes from relatively undisturbed locations were examined. Water content and anion and stable isotope data from the core samples were collected following Newman et al. (1997a). For each borehole, the average and maximum values of pore water chloride and sulfate concentrations, pore water $\delta^{18}O$ values, and volumetric water contents were determined. Data for each characteristic (averaged for all canyon and mesa boreholes, respectively) are shown in Table 2 along with the difference between the values. The differences between the canyons and mesas are substantial in most cases.

To test whether these differences were significant, the nonparametric Mann–Whitney U test was run using the various mesa and canyon borehole values. The nonparametric test was used primarily because of the small number of analyses available. For a p value of 0.05, the tests showed that all of the characteristics for both the maximum and average values were significantly different for the mesas and canyons. The dramatic differences between the mesa and canyon characteristics can also be seen from box and whisker plots of water content and chloride concentration shown in Fig. 14 and 15. These comparisons of mesa and canyon vadose zone characteristics support the conceptual model that there are significant differences between the mesas and the canyons in hydrologic behavior and in downward fluxes. Unfortunately, there are not enough data to test for significant differences between dry and wet canyons.

SUMMARY AND CONCLUSIONS

Field observations, data and numerical models were used in conjunction to develop and test the conceptual models of vadose zone hydrology beneath the Pajarito Plateau. Many of our findings have relevance to studies being conducted in other arid and semiarid regions and provide insights into flow and transport mechanisms, the role of hydrogeology in controlling vadose zone flow, and the influence of topographic and surface water flow conditions on infiltration and deep percolation. Therefore, understanding of the unsaturated zone hydrologic processes studied here should have a general applicability and interest that goes beyond the characterization of the Pajarito Plateau in north-central New Mexico. Our principle findings and the means for reaching these conclusions are summarized below.

Topography and Surface-Water Setting. The conceptual models distinguish differences among wet canyons, dry canyons and mesas, and mountain-front mesas. Wet canyons receive larger quantities of deep infiltration due to surface and shallow groundwater flow in alluvium. In contrast, little net infiltration occurs beneath dry canyons and mesas. Mountain-front mesas receive consid-

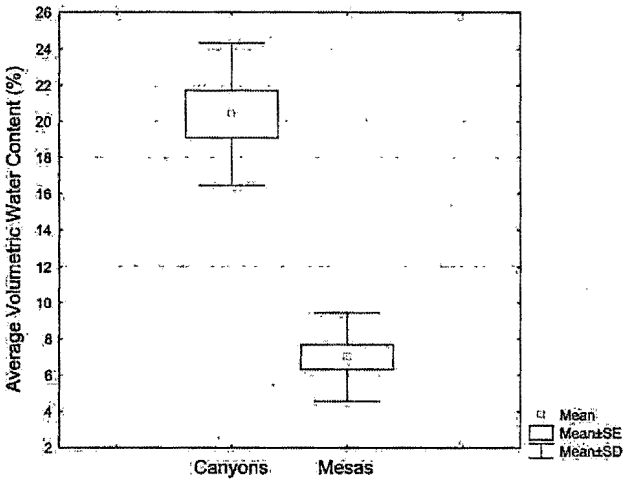


Fig. 14. Box and whisker plot comparing canyon and mesa volumetric water contents.

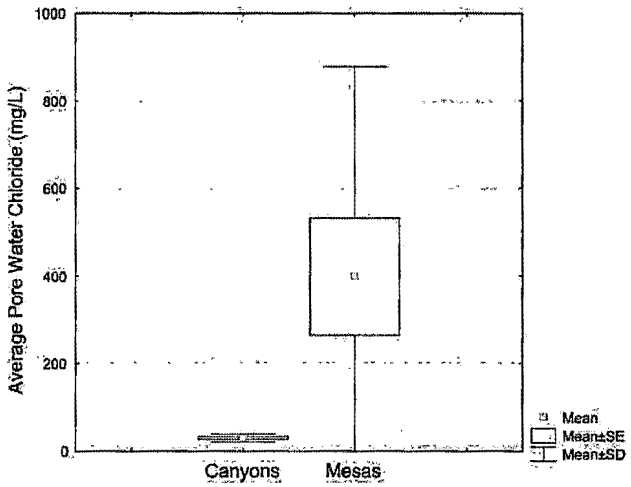


Fig. 15. Box and whisker plot comparing canyon and mesa pore water chloride concentrations.

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erably more infiltration, and the particular hydrostratigraphic conditions give rise to localized perched water, and lateral flow through fractures to nearby springs. These ideas are supported by the following observations and interpretations of data from across the plateau:

- Moisture profile measurements and numerical simulation of vadose zone flow
- Major ion, stable-isotope, and contaminant concentration measurements
- Water budget studies in individual canyons (Gray, 1997; Kwicklis et al., 2005)
- Tracer tests in perched water for the mountain-front mesa case

Anthropogenic Impacts. Both canyons and mesas can be significantly changed from their natural conditions by human activities. On mesas, asphalt pavements on mesas reduce ET, and moisture builds up underneath. If the asphalt focuses runoff or subsequently cracks, localized high infiltration can take place in a location where it ordinarily would not. In canyons, effluent discharges from LANL or Los Alamos County sources can significantly increase surface and alluvial groundwater flow, which in turns typically increases the infiltration rate to the deeper vadose zone. These ideas are supported by the following observations and interpretations:

- Measurements and numerical modeling of water contents beneath and adjacent to areas paved to support LANL facilities
- Water content and contaminant transport measurements and numerical modeling of canyons impacted by LANL facilities

Flow and Transport Mechanisms. The two principle stratigraphic units of interest for vadose zone flow and transport beneath the Pajarito Plateau are the Bandelier Tuff and Cerros del Rio basalt. Water percolates through the porous and permeable matrix of most subunits of the Bandelier Tuff. Many of these units are sparsely fractured, but even for those with fractures, water quickly imbibes into the matrix. An exception is the uppermost units of the Tshirege Member, present in the western part of the Laboratory, near the mountain front, where rapid lateral transport through fractures has been observed. The basaltic rocks exhibit rapid flow and transport through fractures. These ideas are supported by the following observations and interpretations:

- Water content, major ion, and contaminant transport measurements and numerical modeling
- Field measurements at an instrumented site in basalt (Stauffer and Stone, 2005)
- Fluid injection tests in the Bandelier Tuff (Robinson et al., 2005a)

Vadose Zone Travel Times. Travel times of contaminants from wet canyons to the regional aquifer can be as short as several years to several decades. The shortest travel times occur when water infiltrates directly into fractured basalt. When significant thickness of Bandelier tuff is present, travel times on the order of decades are more common. Travel times to the water table for dry canyons or undisturbed mesas are much longer; times in excess of thousands of years are consistent with the available data. These ideas are supported by the following observations and interpretations:

- Numerical modeling of wet canyons (Robinson et al., 2005c)
- Contaminant profiles in vadose zone boreholes
- Chloride and isotope profiles in mesa-top boreholes
- Regional aquifer contaminant concentrations from groundwater surveillance activities (LANL, 2004c, 2003a)

In conclusion, the conceptual models provide a general picture of the relevant processes controlling vadose zone flow and transport at the LANL site. Preliminary assessments of a particular site on the Pajarito Plateau can be based on the results presented herein. More detailed, site-specific investigations may be required to develop in-depth understanding and models with predictive capability. In those cases, the conceptual models serve as guiding sets of principles on which site-specific data-collection programs can be based.

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