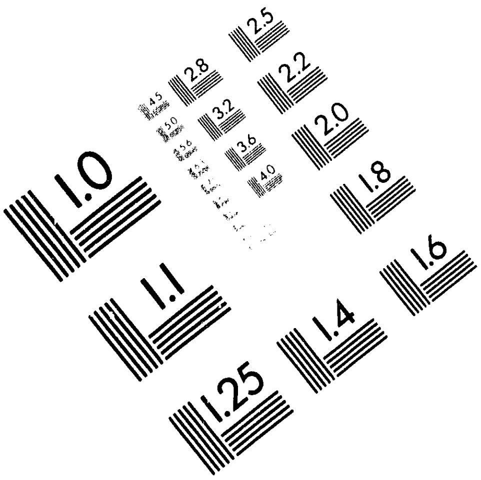

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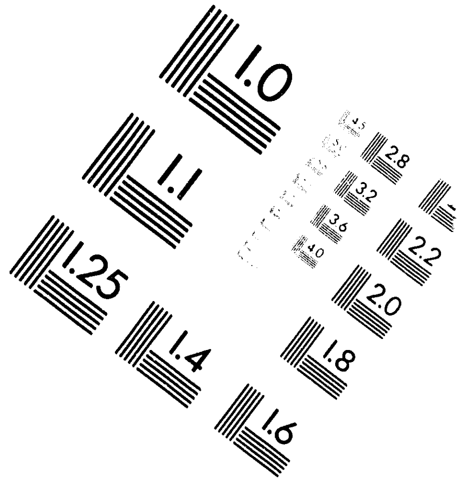

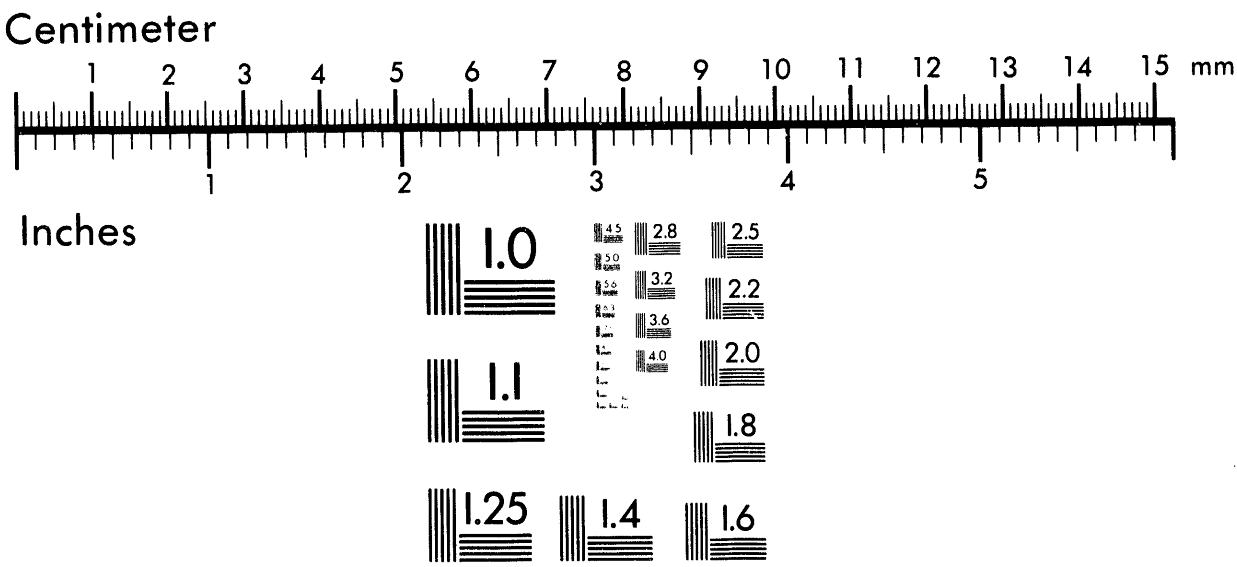

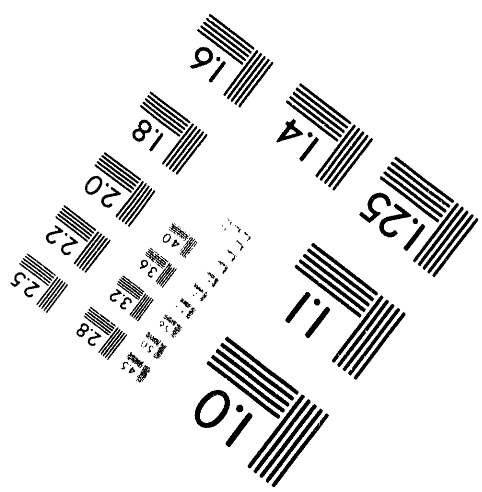

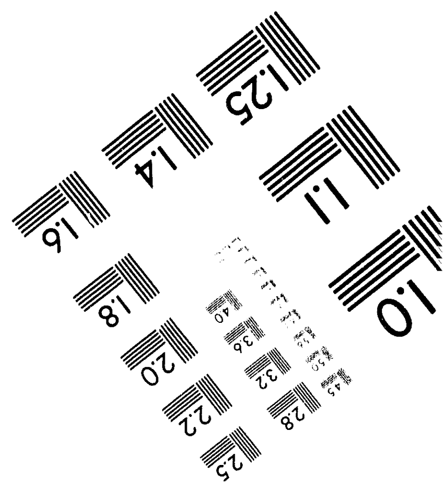

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REV. 3

SURFACE AND SUBSURFACE CLEANUP PROTOCOL FOR RADIONUCLIDES GUNNISON, COLORADO, UMTRA PROJECT PROCESSING SITE

Final

May 1994

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SURFACE AND SUBSURFACE CLEANUP PROTOCOL FOR RADIONUCLIDES GUNNISON, COLORADO, UMTRA PROJECT PROCESSING SITE

Final

May 1994

U.S. Department of Energy
UMTRA Project Office
Albuquerque, New Mexico

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Definition
ALARA	as low as reasonably achievable
CDH	Colorado Department of Health
CFR	Code of Federal Regulations
cm	centimeter
EPA	U.S. Environmental Protection Agency
ft	foot, feet
in	inch
m	meter
NRC	Nuclear Regulatory Commission
pCi/g	picocuries per gram
Ra-226	radium-226
m^2	square meter
Th-230	thorium-230

1.0 INTRODUCTION

The supplemental standards provisions of Title 40, *Code of Federal Regulations*, Part 192 (40 CFR Part 192) require the cleanup of radionuclides other than radium-226 (Ra-226) to levels "as low as reasonably achievable" (ALARA), taking into account site-specific conditions, if sufficient quantities and concentrations are present to constitute a significant radiation hazard. In this context, thorium-230 (Th-230) at the Gunnison, Colorado, processing site will require remediation. However, a seasonally fluctuating groundwater table at the site significantly complicates conventional remedial action with respect to cleanup. Characterization data indicate that in the offpile areas, the removal of residual *in situ* bulk Ra-226 and Th-230 such that the 1000-year projected Ra-226 concentration (Ra-226 concentration in 1000 years due to the decay of *in situ* Ra-226 and the in-growth of Ra-226 from *in situ* Th-230) complies with the U.S. Environmental Protection Agency (EPA) cleanup standard for *in situ* Ra-226 and the cleanup protocol for *in situ* Th-230 can be readily achieved using conventional excavation techniques for bulk contamination without encountering significant impacts due to groundwater. The EPA cleanup standard and criterion for Ra-226 and the 1000-year projected Ra-226 are 5 and 15 picocuries per gram (pCi/g) above background, respectively, averaged over 15-centimeter (cm) deep surface and subsurface intervals and 100-square-meter (m^2) grid areas.

Differential migration of Th-230 relative to Ra-226 does not occur in approximately 60 percent of the subpile area. However, significant differential migration of Th-230 relative to Ra-226 has occurred over the remaining 40 percent of the subpile area. Due to the shallow fluctuating groundwater at the site, the need for groundwater management will be a major obstacle to the cost-effective cleanup of elevated Th-230 during the normal May-to-November construction season.

The excavation of elevated residual bulk Th-230 concentrations at depth (in the absence of *in situ* bulk Ra-226 concentrations significantly elevated above background levels) would be very costly given the existing groundwater conditions at the site, and would not result in substantial improvements for the public and the environment. Major costs could result from:

- Extensive dewatering of large areas, with associated pumping and water treatment costs.
- Low production rates due to dewatering and drying of subpile material for transport and disposal cell stabilization.
- Potential disposal cell redesign to accommodate additional unanticipated quantities of contaminated material.
- Schedule delays and subcontract changes.

Therefore, to effectively remediate the site with respect to Ra-226 and Th-230, the following supplemental standard is proposed:

- *In situ* Ra-226 will be remediated to the EPA soil cleanup standards independent of groundwater considerations. If excavation for *in situ* Ra-226 compliance is in excess of 1 foot (ft) [0.30 meter (m)] below the groundwater elevation at the time of excavation, no additional excavation will be mandated for Th-230 removal.

- *In situ* Th-230 concentrations will be remediated in the region above the encountered water table so that the 1000-year projected Ra-226 concentration complies with the EPA soil cleanup concentration limits for *in situ* Ra-226.

- If elevated Th-230 in the absence of Ra-226 persists to the water table, an additional foot (0.30 m) of excavation will be performed and the grid will be backfilled without regard to Th-230 concentration.

- Excavated 100-m^2 grids will be backfilled to the final remedial action grade with clean cobbly soil, which may also include select backfill soil layers, depending on final residual Th-230 concentrations and ALARA considerations.

- Final grid verification that is required below the water table will be performed by extracting and analyzing a single bulk soil sample with the bucket of a backhoe. Grid verification that occurs above the water table will be performed with standard nine-plug composites.

- For each 100-m^2 grid in the subpile area, and other grids having results for Th-230, documentation will consist of bulk Ra-226, Th-230, and 1000-year projected Ra-226 concentrations obtained from the 6-inch (in) (15 cm) soil layer below the final excavation. For grids where soil was excavated below the prevailing water table, and Th-230 concentrations are such that the 1000-year projected Ra-226 concentration criterion was not attained, modeled surface radon flux values will be estimated and documented. The modeling will be based on 1000-year projected bulk Ra-226 values and the characteristics of the residually contaminated cobbly soil left in place (Gonzales et al., 1991) and backfill actually placed.

- A recommendation will be made that land records should be annotated to identify the presence of residual Th-230.

Therefore, to support the application of this supplemental standard, the following analyses will be performed to evaluate the regulatory requirements which must be met and current site conditions. In addition, an excavation protocol to implement the supplemental standards during construction will be developed.

2.0 REGULATORY REQUIREMENTS

Surface and subsurface soil cleanup protocols for the Gunnison, Colorado, processing site are summarized as follows:

- In accordance with EPA-promulgated land cleanup standards (40 CFR Part 192), *in situ* Ra-226 is to be cleaned up based on bulk concentrations not exceeding 5 and 15 pCi/g above background in 15-cm surface and subsurface depth increments, averaged over 100-m^2 grid blocks, where the parent Ra-226 concentrations are greater than, or in secular equilibrium with, the Th-230 parent. A bulk interpretation of these EPA standards has been accepted by the U.S. Nuclear Regulatory Commission (NRC), and while the concentration of the finer-sized soil fraction less than a #4 mesh sieve contains the higher concentration of radioactivity, the bulk approach integrates the total sample radioactivity over the entire sample mass.

- In locations where Th-230 has differentially migrated in subsoil relative to Ra-226, a Th-230 cleanup protocol has been developed in accordance with Supplemental Standard provisions of 40 CFR Part 192 for NRC/Colorado Department of Health (CDH) approval for timely implementation. Detailed elements of the protocol are contained in the current "Generic Protocol for Thorium-230 Cleanup/Verification at UMTRA Project Processing Sites," submitted to the NRC for approval.

- The cleanup of other radionuclides or nonradiological hazards (e.g., uranium, arsenic, selenium, etc.) that pose a significant threat to the public and the environment will be determined and implemented in accordance with pathway analysis to assess impacts and the implications of ALARA specified in 40 CFR Part 192 relative to supplemental standards.

3.0 CONDITIONS AT THE GUNNISON, COLORADO, PROCESSING SITE

The foundation soil at the Gunnison, Colorado, processing site is cobbly in nature. The results of 33 test pits (28 subpile, 5 offpile) distributed over the site and vicinity properties contiguous to the site indicate that, on average, approximately 23 percent by weight of the bulk soil passes a #4 mesh sieve (DOE, 1993). The distribution of test pits over the subpile region, and the corresponding areas for which each test pit is assumed to characterize subpile conditions, are shown in Figure 3.1. Accordingly, characterization, excavation control, and verification activities at the Gunnison site will be conducted using an NRC-accepted procedure for cobbly soils (DOE, 1993) when applicable. This procedure evaluates the bulk radionuclide concentrations through the following methods:

- Radiometrically or radiochemically measuring the radioactivity of only the finer soil fraction passing a #4 mesh sieve.
- Statistically deriving the partition function (the mass fractions retained on a #4 mesh sieve divided by the mass fraction passing the sieve).
- Determining representative radionuclide concentrations of the larger soil fraction retained on a #4 mesh sieve.

In addition to developing the statistical mass partition function for the site, average concentrations for Ra-226 and Th-230 for the larger-size soil fraction have also been determined as a function of offpile and subpile locations (DOE, 1993). In the offpile locations, essentially average background concentrations were obtained for this soil size fraction. However, in the subpile area, background concentrations for the larger-size soil fraction were obtained only for Ra-226, and Th-230 concentrations in the subpile area, on average, were elevated to 16.8 pCi/g compared to 2.73 pCi/g for corresponding background cobbles. Therefore, to accommodate this observable difference in the geochemical behavior of these radionuclides in the offpile and subpile locations, two separate area-specific calculation schemes were developed for determining bulk radionuclide concentrations.

An analysis of the Ra-226 and Th-230 depth profiles observed for test pits constructed on the site, in nominal 1-ft (0.30 m) increments, revealed that significant differential migration of Th-230 relative to Ra-226 had occurred in a portion of the subpile region. However, previous data analysis indicated that this differential migration does not occur in offpile areas (DOE, 1993).

Table 3.1 gives subpile test pit radiological depth profiles as a function of soil size fraction, and calculated 1000-year Ra-226 concentrations for 29 of the test pits shown in Figure 3.1 for which 1-ft (0.30 m) increment soil samples are available. No excavation below the tailings/subpile interface would be required to remediate *in situ* bulk Ra-226 to comply with EPA standards.

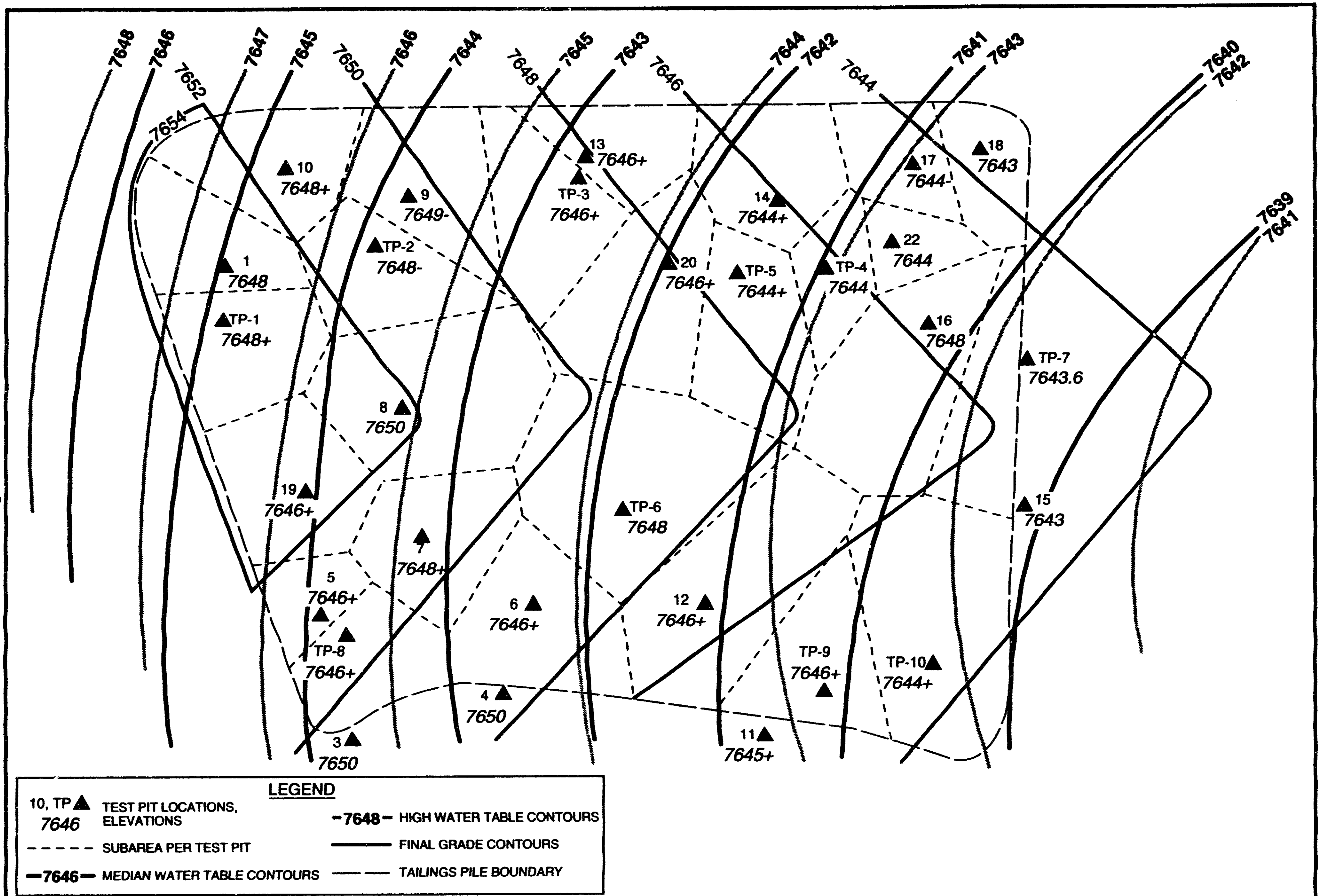

FIGURE 3.1
SUBPILE TEST PIT LOCATIONS, WITH INTERFACE ELEVATIONS, FINAL GRADE CONTOURS, AND WATER TABLE CONTOURS FOR HIGH (H) AND MEDIAN (M) WATER TABLES

MAC: SITE/GUN/SURFPROTO/SUBPITTEST

Table 3.1 Subpile test pit radiological concentration depth profile as a function of soil size fraction, and calculated 1000-year bulk Ra-226 concentrations, November 1992 (DOE, 1993)

Test pit number	Depth interval (ft)	Ra-226 (pCi/g) <#4	Ra-226 (pCi/g) Bulk	Th-230 (pCi/g) <#4	Th-230 (pCi/g) Bulk	1000-year bulk Ra-226 (pCi/g)
1	0.0 - 1.0	32	9.6	75	37	19
	1.0 - 2.0	12	4.8	47	30	14
3	0.0 - 1.0	0.8	2	4.8	19	8
	1.0 - 2.0	2.6	2.5	100	40	20
	2.0 - 3.0	2.2	2.4	100	40	20
	3.0 - 4.0	2.5	2.4	150	55	21
	4.0 - 5.0	4.2	2.9	500	100	40
4	0.0 - 1.0	1.3	2.2	3.8	19	8.2
	1.0 - 2.0	1.7	2.3	5.0	20	8
	2.0 - 3.0	1.4	2.2	2.3	19	8.1
	3.0 - 4.0	1.2	2.1	2.6	19	8.0
	4.0 - 5.0	0.8	2	2.4	19	8
5	0.1 - 1.0	3.7	2.7	122	47.9	19
	1.0 - 2.0	2.9	2.5	97	42	16
	2.0 - 3.0	3.3	2.6	123	48.2	19
	3.0 - 4.0	2.9	2.5	83	38	15
6	0.0 - 1.0	1.8	2.3	12	21	8.9
	1.0 - 2.0	2.9	2.5	13	21	9.2
	2.0 - 3.0	2.0	2.3	1.0	19	8.0
	3.0 - 4.0	1.2	2.1	1.9	19	8.0
	4.0 - 5.0	2.1	2.3	3.9	19	8.3
7	0.0 - 1.0	3.9	2.8	102	43.1	17
	1.0 - 2.0	3.1	2.6	86	39	15
	2.0 - 3.0	2.1	2.3	23	24	10
	3.0 - 4.0	1.5	2.2	26	25	10
	4.0 - 5.0	1.9	2.3	54	31	13

Table 3.1 Subpile test pit radiological concentration depth profile as a function of soil size fraction, and calculated 1000-year bulk Ra-226 concentrations, November 1992 (DOE, 1993) (Continued)

Test pit number	Depth interval (ft)	Ra-226 (pCi/g) <#4	Ra-226 (pCi/g) Bulk	Th-230 (pCi/g) <#4	Th-230 (pCi/g) Bulk	1000-year bulk Ra-226 (pCi/g)
8	0.0 - 1.0	1.3	2.2	1.8	19	8.0
	1.0 - 2.0	1.1	2.1	3.0	19	8.1
	2.0 - 3.0	0.4	2	1.6	19	8
	3.0 - 4.0	0.6	2	1.5	19	8
9	0.0 - 1.0	3.4	2.7	180	62	23
	1.0 - 2.0	5.8	3.2	380	111	41
	2.0 - 3.0	4.5	2.9	130	50	19
	3.0 - 4.0	2.5	2.4	120	47	18
10	0.0 - 1.0	3.6	2.7	53	31	13
	1.0 - 2.0	2.3	2.4	75	37	14
	2.0 - 3.0	2.7	2.5	80	40	20
11	0.0 - 1.0	1.8	2.3	1.3	19	8.0
	1.0 - 2.0	1.4	2.2	1.3	19	8.0
	2.0 - 3.0	1.9	2.3	1.3	19	8.0
	3.0 - 4.0	1.6	2.2	25	24	10
	4.0 - 5.0	4.2	2.9	43	29	12
12	0.0 - 1.0	1.1	1.3	1.6	2.7	1.8
	1.0 - 2.0	0.7	1	2.8	3.0	2
	2.0 - 3.0	1.0	1.2	7.3	4.2	2.3
	3.0 - 4.0	0.9	1	3.3	3.2	2
	4.0 - 5.0	1.1	1.2	6.1	3.9	2.1
13	0.0 - 1.0	5.0	3.1	190	64	25
	1.0 - 2.0	3.5	2.7	160	57	22
	2.0 - 3.0	4.2	2.9	220	72	27
	3.0 - 4.0	4.3	2.9	160	57	22
	4.0 - 5.0	4.6	3.0	190	64	25

Table 3.1 Subpile test pit radiological concentration depth profile as a function of soil size fraction, and calculated 1000-year bulk Ra-226 concentrations, November 1992 (DOE, 1993) (Continued)

Test pit number	Depth interval (ft)	Ra-226 (pCi/g)		Th-230 (pCi/g)		1000-year bulk Ra-226 (pCi/g)
		<#4	Bulk	<#4	Bulk	
14	0.0 - 1.0	1.0	2.1	3.5	19	8.1
	1.0 - 2.0	1.3	2.2	54	31	12
	2.0 - 3.0	3.5	2.7	130	50	19
	3.0 - 4.0	2.3	2.4	104	43.6	17
16	0.0 - 1.0	7.0	3.5	130	50	20
	1.0 - 2.0	2.3	2.4	62	33	13
	2.0 - 3.0	2.0	2.3	47	30	12
	3.0 - 4.0	2.6	2.5	40	30	10
	4.0 - 5.0	2.3	2.4	38	28	11
17	0.0 - 1.0	2.3	2.4	35	27	11
	1.0 - 2.0	2.3	2.4	48	30	12
	2.0 - 3.0	3.4	2.7	59	33	13
18	0.0 - 1.0	7.5	3.7	490	140	51
	1.0 - 2.0	3.5	2.7	180	62	24
	2.0 - 3.0	5.4	3.2	390	110	41
	3.0 - 4.0	3.2	2.6	230	74	28
	4.0 - 5.0	1.9	2.3	260	81	30
19	0.0 - 1.0	4.1	2.8	52	31	13
	1.0 - 2.0	4.9	3.0	51	31	13
	2.0 - 3.0	3.4	2.7	56	32	13
	3.0 - 4.0	2.3	2.4	37	27	11
	4.0 - 5.0	3.6	2.7	48	30	12
20	0.0 - 1.0	6.2	3.3	210	69	26
	1.0 - 2.0	5.2	3.1	200	70	30
	2.0 - 3.0	5.5	3.2	200	70	30

Table 3.1 Subpile test pit radiological concentration depth profile as a function of soil size fraction, and calculated 1000-year bulk Ra-226 concentrations, November 1992 (DOE, 1993) (Continued)

Test pit number	Depth interval (ft)	Ra-226 (pCi/g)		Th-230 (pCi/g)		1000-year bulk Ra-226 (pCi/g)
		<#4	Bulk	<#4	Bulk	
22	0.0 - 1.0	8.7	4.0	850	230	83
	1.0 - 2.0	11	4.5	930	240	87
	2.0 - 3.0	9.9	4.2	730	196	71
	3.0 - 4.0	5.8	3.2	790	210	76
	4.0 - 5.0	11	4.5	1030	270	98

Table 3.1 Subpile test pit radiological concentration depth profile as a function of soil size fraction, and calculated 1000-year bulk Ra-226 concentrations, June 1990

Test pit number	Depth interval (ft)	Ra-226 (pCi/g)		Th-230 (pCi/g)		1000-year bulk Ra-226 (pCi/g)
		< #4	Bulk	< #4	Bulk	
1	0.5 - 1.5	1.7	2.3	93	41	16
	2.0 - 2.75	3.1	2.6	58	32	13
	2.75 - 3.25	1.3	2.2	7.7	20	8.5
	4.0 - 4.5	3.8	2.8	240	77	29
2	0.75 - 1.50	2.5	2.4	83	38	15
	1.5 - 2.50	6.6	3.4	190	64	25
	2.50 - 3.0	4.0	2.8	60	30	10
	3.5 - 4.0	6.4	3.4	51	31	13
	4.5 - 5.0	5.4	3.2	54	31	13
3	0.25 - 1.0	54	14.9	200	70	30
	1.5 - 2.0	27	8.4	103	43.3	21
	2.0 - 3.5	15	5.5	116	46.5	20
4	1.0 - 2.5	110	29	91	40	33
	2.5 - 3.0	20	7	16	20	10

Table 3.1 Subpile test pit radiological concentration depth profile as a function of soil size fraction, and calculated 1000-year bulk Ra-226 concentrations, June 1990 (Concluded)

Test pit number	Depth interval (ft)	Ra-226 (pCi/g)		Th-230 (pCi/g)		1000-year bulk Ra-226 (pCi/g)
		<#4	Bulk	<#4	Bulk	
5	1.5 - 2.5	4.6	3.0	69	35	14
	2.5 - 3.5	8.3	3.9	55	32	14
6	1.75 - 2.25	1.0	2.1	2.6	19	8.0
	2.25 - 3.0	1.4	2.2	1.0	19	7.9
	3.25 - 3.75	1.0	2.1	1.9	19	7.9
	5.50 - 6.0	1.5	2.2	0.9	20	8
7	1.0 - 1.5	2.2	2.4	74	36	14
	1.5 - 2.0	4.4	2.9	92	41	16
	2.0 - 3.0	4.1	2.8	32	26	11
	3.0 - 3.5	2.5	2.4	11	21	9.0
8	0.0 - 1.0	3.2	2.6	140	52	20
9	0.0 - 1.0	2.3	2.4	84	39	15
	1.0 - 2.0	2.1	2.3	73	36	14
10	1.0 - 2.0	2.3	2.4	99	42	16
	3.0 - 3.5	2.9	2.5	103	43.3	17
	4.0 - 4.5	8.4	3.9	22	24	11
	5.0 - 5.5	0.4	2	5.2	20	8

However, the presence of elevated Th-230 concentrations relative to Ra-226 in some areas requires that the excavation be conducted in accordance with the generic Th-230 cleanup protocol, which considers both Ra-226 and Th-230 through the 1000-year projected total Ra-226 concentration. Figure 3.2 illustrates effective 1000-year projected Ra-226 as a function of depth and test pit, and estimated excavation depths below the tailings pile/subpile interface to comply with regulatory requirements for Ra-226 and Th-230. On analysis, it may be concluded that approximately 40 percent of the subpile area would require excavation deeper than 2 ft (0.61 m) in order to comply with the generic Th-230 protocol in the absence of groundwater encounters during excavation.

Isopleths of groundwater depths for high, median, and low water tables are shown in Figure 3.1 and illustrated for each test pit in Figure 3.2. Approximate annual groundwater fluctuation is such that the high, median, and low groundwater elevations occur during the months of April to July, August to October, and November to April, respectively. Based on analyses, it is assumed that 25, 29, and 46 percent of the time the groundwater resides at the high, median, and low water depths, respectively. Table 3.1 and Figure 3.2 data reveal that the removal of elevated Th-230 to comply with the 15 pCi/g above background, 1000-year projected subsoil Ra-226 criteria will entail varying degrees of excavation into the groundwater for areas represented by test pit numbers 3, 5, 9, 13, 14, 18, 20, 22, TP-1, TP-2, TP-3, TP-4, TP-5, TP-8, and, potentially, TP-10, depending on the time of excavation. Given the climatic structure of the Gunnison, Colorado, area, construction activities are likely to occur during median to high water conditions during the months of May through early November. Excavation during periods for which the groundwater is between the median to low water tables is considered untenable due to the severe winter conditions that normally prevail in the Gunnison area. The remainder of the subpile area (approximately 60 percent), characterized by test pits not listed above, could potentially be remediated to the 1000-year projected Ra-226 bulk soil standard without encountering groundwater.

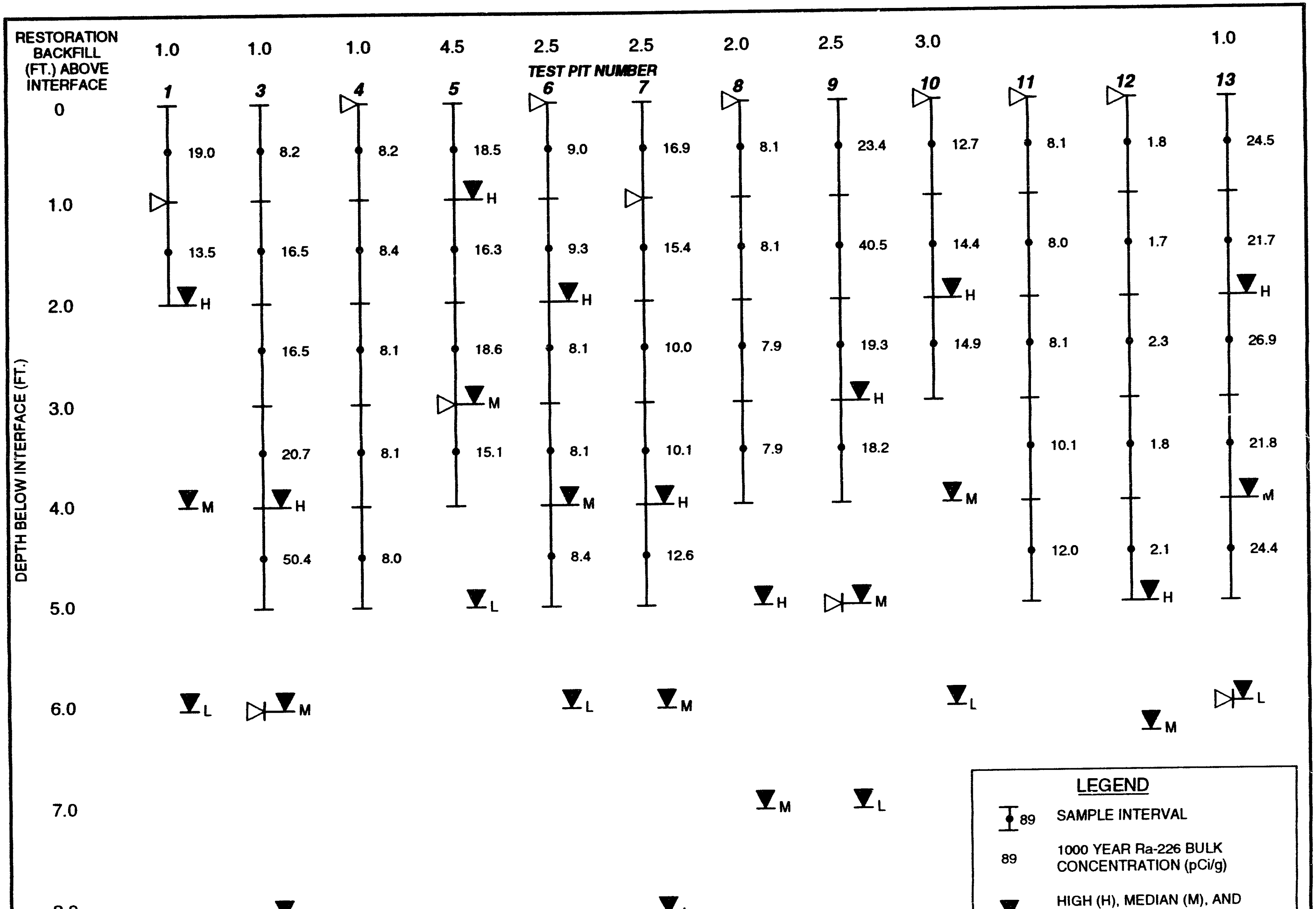

FIGURE 3.2
SUBPILE TEST PIT

MAC: SITE/GUN/SURFPROTO/COBTOFINE1

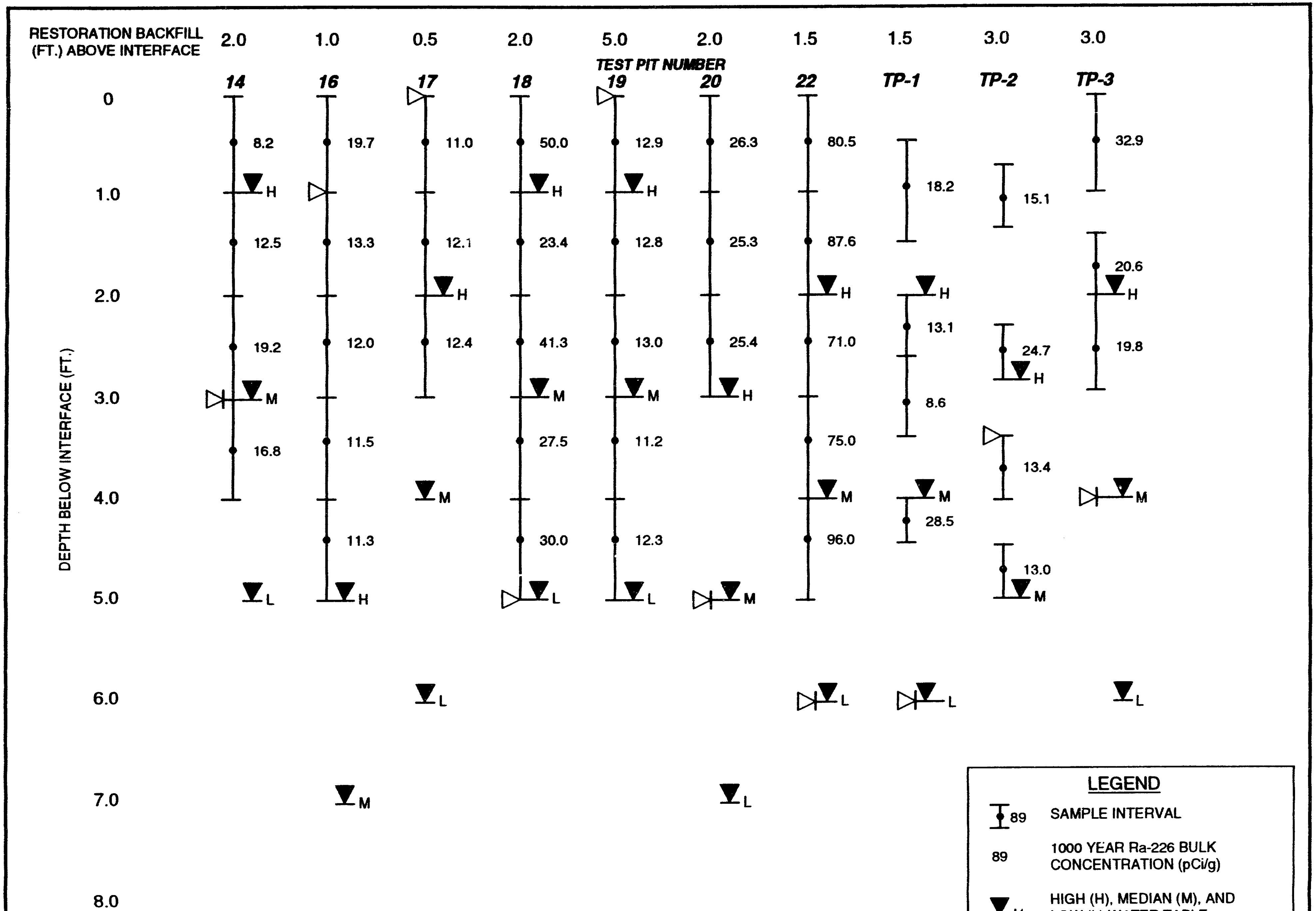

FIGURE 3.2 (CONT.)
SUBPILE TEST PIT

MAC: SITE/GUN/SURFPROTO/COBTOFINE2

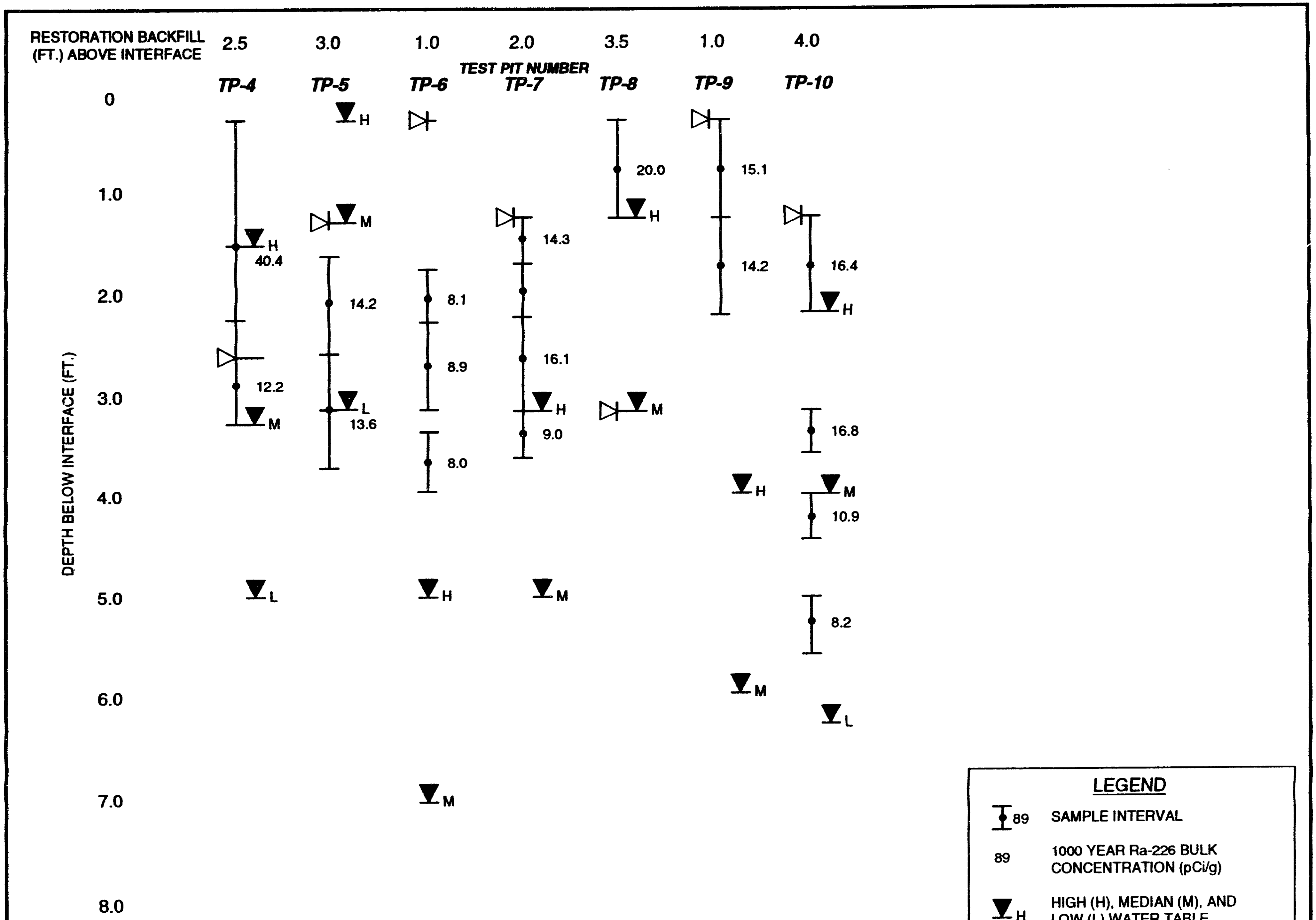

FIGURE 3.2 (CONCLUDED)
SUBPILE TEST PIT

MAC: SITE/GUN/SURFPROTO/COBTOFINE3

4.0 EXCAVATION PROTOCOL

The following excavation protocol is proposed to provide reasonable assurance that remedial action goals are attained.

1. In grid areas containing a high percentage of cobbles, several relations will be used to determine bulk radiological concentrations, based on radiometric or radiological concentrations of the fine fraction passing a #4 mesh sieve.

   Offpile areas

   For cobbly subsoil to comply with the bulk cleanup standards (total Ra-226 concentrations from residual Ra-226 and Th-230 not to exceed 15 pCi/g above background, 1.8 pCi/g bulk Ra-226 concentration), the corresponding concentrations in the finer-soil size fraction (passing a #4 mesh sieve) in the offpile areas could vary as follows:

   a) $C_{<\#4\,Ra} \leq$ 58.8 pCi/g Ra-226, when the Th-230 concentrations on the finer fraction, $C_{<\#4\,Th}$, are less than or equal to 62.2 pCi/g;

   b) $C_{<\#4\,Th} \leq$ 168.4 pCi/g Th-230, if there is evidence that the Th-230 has differentially migrated relative to Ra-226, and the residual bulk Ra-226 concentration is 1.8 pCi/g, corresponding to average background concentrations; or

   c) Allowable Th-230 concentrations are determined by the Ra-226 concentrations measured on the finer-soil size fraction, $C_{<\#4\,Ra}$, in the range of 1.7 to 58.8 pCi/g by the following relation:

   $$C_{<\#4\,Th} \leq 171.6 - 1.86 \times C_{<\#4\,Ra}$$

   Subpile areas

   Excavation control and verification in about 40 percent of the subpile area will depend on Th-230 concentrations. Accordingly, for the subpile area, the maximum residual Ra-226 and Th-230 concentrations on the finer-soil size fraction that would comply with the bulk Ra-226/Th-230 standards (15 pCi/g above background, 1.8 pCi/g bulk Ra-226 concentration, total residual 1000-year projected Ra-226) are:

   a) 99.7 pCi/g Th-230, if there is evidence that the Th-230 has differentially migrated relative to Ra-226, and the residual bulk Ra-226 concentration is 1.8 pCi/g, corresponding to average background concentrations;

   b) Allowable Th-230 concentrations (pCi/g) are determined from the residual Ra-226 concentrations measured on the finer-soil size fraction, $C_{<\#4\,Ra}$, in the range of 1.7 to 55 pCi/g by the relation:

   $$C_{<\#4\,Th} \leq 102.9 - 1.86 \times C_{<\#4\,Ra}$$

2. If the application of the cobble-to-fine calculation methodology for determining bulk radionuclide concentrations (Item 1) to specific grids is questionable (for example, where the percentage of cobbles is small), the statistically derived mass partition function shall not be utilized. For such cases, compliance shall be verified either by the normal (non-cobbly) soil sampling procedure or, alternatively, a grid-specific mass partition function developed per RAC-OP-003-4.

3. Excavation control will be performed by either soil sampling and analysis or gamma count rate correlated to Ra-226 concentrations in cobbly soil, or a combination of both techniques.

4. For verification above and down to the water table, a nine-plug composite sample procedure will be implemented in accordance with instructions delineated in RAC procedures RAC-OP-003-4 or RAC-OP-003-1, as applicable. Soil verification below the water table at the time of excavation will be performed by extracting a representative sample of the fine soil fraction from a bulk sample of cobbly soil obtained from the center of the 100-m^2 grid with the bucket of a backhoe.

5. Final 1000-year projected Ra-226 concentrations used to demonstrate regulatory compliance will be based on 20-day equilibrated Ra-226 measurements and the Th-230 analytical results.

6. Bulk *in situ* Ra-226 will be remediated to 40 CFR Part 192 standards independent of the water table.

7. After the *in situ* bulk Ra-226 remediation requirements specified in Item 6 above have been attained, the bulk Th-230 concentrations will be assessed to determine whether the 1000-year projected bulk Ra-226 average concentration criterion (35 percent of the *in situ* bulk Th-230 concentration plus 65 percent of the *in situ* bulk Ra-226 concentration) has been attained.

8. In addition to the assessment in Item 7, additional test pits will be excavated to the water table as necessary to assess Th-230 concentrations in areas where characterization data indicate the potential for elevated Th-230 concentrations at depth.

9. If the *in situ* Ra-226 concentration standard has been attained and the 1000-year projected bulk Ra-226 concentration is not fulfilled, excavation for Th-230 remediation will continue until the 1000-year projected Ra-226 standard is satisfied or groundwater is encountered, whichever comes first.

10. If groundwater is encountered before the 1000-year projected Ra-226 criterion is satisfied, an additional foot (0.30 m) of subsoil will be excavated from below the water table. A single bulk verification sample a minimum depth of 6 in (15 cm) below the final excavation elevation, as specified in Item 4 above, will be collected and analyzed for Ra-226 and Th-230 to determine the 1000-year projected bulk Ra-226 concentration.

11. The decision to select backfill similar to the original subpile material, with or without a clayey-silty soil layer placed just below the high water table, is at the Site Manager's discretion but will be based on the magnitude of Th-230 concentration on the finer-size soil fraction retained on a #4 mesh sieve just below the water table and on ALARA considerations. When the Th-230 concentration in the finer-size soil fraction exceeds 175 pCi/g, the placement of a minimum of 1 ft (0.30 m) of clayey-silty soil backfill as low in the excavation profile as practicable, followed by cobbly soil backfill to final remediation grade, is recommended.

For the nine 100-m^2 grids located at and surrounding test pit number 3, a minimum 1-ft (0.30-m) layer of clayey-silty soil backfill will be placed as low in the excavation profile as practicable.

5.0 LIST OF CONTRIBUTORS

The following individuals contributed to the preparation of this report.

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6.0 REFERENCES

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CODE OF FEDERAL REGULATIONS

40 CFR Part 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," Title 40, *Code of Federal Regulations*, Part 192, U.S. Environmental Protection Agency, Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

DATE FILMED

7/25/94

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