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Canonie Environmental

Volume II - Tables, Figures

Tailings Reclamation Plan
As Approved by NRC March 1, 1991
License No. SUA - 1475

Church Rock Site
Gallup, New Mexico

Prepared For:

United Nuclear Corporation
Gallup, New Mexico

Volume II - Tables, Figures

Tailings Reclamation Plan
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Canonie Environmental

LIST OF TABLES

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF FIGURES

LIST OF FIGURES
(Continued)

LIST OF FIGURES
(Continued)

LIST OF FIGURES
(Continued)

LIST OF FIGURES
(Continued)

LIST OF FIGURES
(Continued)

TABLES

TABLES

1.0

TABLE 1.1

PRECIPITATION - EVAPORATION DATA (a)
CHURCH ROCK

Year	Average Temperature °F High	Average Temperature °F Low	Total Pan Evaporation: Tailings Solution (inches)	Total Pan Evaporation: Tap Water (inches)	Precipitation (inches)	Net Pan Evaporation (inches)
1980	No data		75	84	10.5	65
1981	No data		73	76	11.9	61
1982	67.3	35.9	66	67	16.1	50
1983	66.7	29.7	60	57	16.5	44
1984	68.5	28.7	65	69	12.1	53
1985	67.8	28.6	59	67	13.5	45
1986	67.6	31.2	58	59	18.0	41
1987	68.5	28.1	58	60	17.21	41
1988	68.4	31.7	64	66	11.66	52
1989	68.9	30.8	98	98	7.70	90
1990	67.5	32.4	82	84	16.63	65
Average (b)	67.6	30.8	68	68	14.1	54

Annual average temperature extremes: -20 to 100°F.

(a) On-site data collected by United Nuclear personnel.

(b) Average of values from 1980 to 1986 used since 1987 in water balance calculations for the site.

TABLE 2.1

BACKGROUND Ra-226 ACTIVITY CONCENTRATION

	Background Plot Number		
	Plot #1	Plot #2	Plot #3
Number of measurements	13	10	13
Mean (pCi Ra-226/g soil)	0.65	0.88	0.84
Standard deviation	0.30	0.83	0.43
Standard deviation of the mean	0.083	0.26	0.12

Notes:

1. Weighted overall mean = 0.78 pCi/g.

2. Analysis of variance shows no significant difference among means. The pooled standard deviation for all 36 samples is 0.53 pCi/g.

3. Ninety-five percent confidence limits on overall mean: 0.61 pCi/g $\pm$ 0.95 pCi/g.

4. Samples in Plots No. 1 and No. 3 were composited from drillholes and are representative of soils from 0-60 cm. Due to the rocky nature of Plot No. 2, all 10 samples were obtained from the surface.

TABLE 2.2

BACKGROUND GAMMA EXPOSURE RATE READINGS
(uR/hr)

Background Plot Number	n	Mean	Standard Deviation
1	55	11.3	0.92
2	44	11.5	1.6
3	52	11.6	1.5

Notes:

1. Weighted overall mean = 11.46 uR/hr.

2. Corrected * weighted overall mean = 11.46(0.81) + 5.6 = 14.9 uR/hr.

3. Only two significant figures are considered reasonable for use in any further analyses. Therefore, the mean background external gamma radiation exposure rate is taken to be equal to 15 uR/hr.

4. Analysis of variance shows no significant difference between the means of the three plots. The pooled standard deviation for the three plots is 1.35, or 12 percent. That is, 95 percent of the observations will fall between 15 $\pm$ (1.96)(0.12)(15) uR/hr, or 11.5 to 18.5 uR/hr. The probability of observing a gamma exposure rate due only to background greater than 18.5 uR/hr is 2.5 percent. The probability of observing a gamma exposure rate due only to background greater than 18 uR/hr is 5.0 percent.

* The correction factor is based on calibration against the Pressurized Ion Chamber.

TABLE 2.3

Ra-226 SOIL ACTIVITY CONCENTRATION VERSUS
MEASURED GAMMA RAY EXPOSURE RATE

X (uR/hr)	Ra-226 (pCi/g) Estimated Mean
18	0.6
19	1.5
20	2.5
21	3.5
22	4.6
23	5.6
24	6.7
25	7.7

Notes:

1. Ra-226 activity concentration = 6 pCi/g.

2. X (uR/hr) = 23.

TABLE 2.4

SUMMARY OF BACKGROUND DRILLHOLE READINGS (a)

	Plot #1	Plot #2
Mean Surface Reading	1.3	1.2
Number of measurements	13	13
Standard deviation	0.28	0.27
Standard deviation of the mean	0.08	0.08
Mean Reading 0-15 cm	1.4	1.4
Number of measurements	13	13
Standard deviation	0.30	0.35
Standard deviation of the mean	0.08	0.10
Mean Reading 15-30 cm	1.7	1.7
Number of measurements	13	13
Standard deviation	0.25	0.50
Standard deviation of the mean	0.07	0.14
Mean reading >30 cm	1.9	2.1
Number of measurements	13	13
Standard deviation	0.23	0.74
Standard deviation of the mean	0.06	0.21
Overall mean 0-50 cm	1.7	1.7
Pooled standard deviation	0.27	0.56
Pooled standard deviation total	0.44	

Due to the rocky nature of Background Plot No. 2, no drillholes could be advanced. Only surface soil samples were taken in this area. Drillholes were advanced with a gas auger.

(a) All borehole measurements are reported as readings with no units. The meter reads in counts/minute or mR/hr. However, neither of these units has any meaning except as a relative measurement. The meter must be calibrated for a particular probe under specific conditions of use. The borehole logger (BHL) was read on the mR/hr scale for ease of reading, but reporting these readings as exposure in mR/hr would be very misleading and incorrect.

TABLE 2.5

Ra-226 ACTIVITY CONCENTRATION VERSUS
BHL READING FOR BOREHOLES

BHL Reading (a)	Ra-226 (pCi/g) Estimated Mean
3.0	2.4
4.0	3.8
5.0	5.2
6.0	6.6
7.0	8.0
8.0	9.4
9.0	10.8
10.0	12.2
11.0	13.6
12.0	14.9
13.0	16.3

Ra-226 activity concentration = 6 pCi/g
BHL reading = 5.6

Ra-226 activity concentration = 16 pCi/g
BHL reading = 12.8

(a) BHL readings are reported without units as the units have significance only when the instrument is properly calibrated.

TABLE 2.6

Ra-226 ACTIVITY CONCENTRATION VERSUS
BHL READING FOR DRILLHOLES

BHL Reading (a)	Ra-226 (pCi/g) Estimated Mean
3.0	4.5
4.0	6.2
5.0	7.8
6.0	9.4
7.0	11.0
8.0	12.7
9.0	14.3
10.0	15.9
11.0	13.6
12.0	14.9
13.0	16.3

Ra-226 activity concentration = 6 pCi/g
BHL reading = 3.9

Ra-226 activity concentration = 16 pCi/g
BHL reading = 10.1

(a) BHL readings are reported without units as the units have significance only when the instrument is properly calibrated.

TABLE 2.7A

BOREHOLE LOGGING RESULTS FOR DRILLHOLES LOCATED AROUND TAILINGS DISPOSAL AREA - RADIALS

Background borehole logger reading = 1.7
95 percent confidence limits for a single reading, 0.8 - 2.6

Estimated mean borehole logger reading for 6 pCi/g = 3.9
estimated mean borehole logger reading for 16 pCi/g = 10.1

	Radial Coordinate				
Depth	C 30	C 55	C 80	D 50	D 65
Surface	15.0 (a)	10.0 (a)	7.3 (a)	9.0 (a)	10.0 (a)
15 cm (0.5 ft)	8.5	7.5	7.0	5.0	6.1
30 cm (1.0 ft)	4.7	5.8	5.0	3.5	3.5
45 cm (1.5 ft)	3.5	5.0	3.9		2.6
60 cm (2.0 ft)		3.5	3.8		1.7
75 cm (2.4 ft)					1.6

	Radial Coordinate				
Depth	D 100	D 200	D 300	D 450	E 100
Surface	6.5 (a)	4.0 (a)	3.2 (a)	2.4 (a)	8.0 (a)
15 cm (0.5 ft)	5.8	4.1	2.6	2.0	6.0
30 cm (1.0 ft)	3.5	3.9	2.2	2.0	3.9
45 cm (1.5 ft)	2.5	2.5	2.0	2.0	3.5
60 cm (2.0 ft)	2.1	2.0	2.0		

	Radial Coordinate				
Depth	E 390	E 494	G 200	G 300	H 350
Surface	3.4 (a)	2.1 (a)	2.6 (a)	2.3 (a)	2.0 (a)
15 cm (0.5 ft)	2.5	2.0	2.0	1.9	2.5
30 cm (1.0 ft)	2.1	2.0	1.4	1.7	3.0
45 cm (1.5 ft)	2.0	2.1	1.3	1.9	2.9
60 cm (2.0 ft)	2.1			1.9	

(a) Borehole logger readings.

TABLE 2.7A

BOREHOLE LOGGING RESULTS FOR DRILLHOLES LOCATED AROUND TAILINGS DISPOSAL AREA - RADIALS
(Continued)

	Radial Coordinate				
Depth	I 300	J 400	K 400	K 450	M 850
Surface	2.6 (a)	2.8 (a)	3.2 (a)	2.5 (a)	2.5 (a)
15 cm (0.5 ft)	1.9	2.8	2.8	2.1	3.3
30 cm (1.0 ft)	1.7	3.2	2.3	2.0	5.0
45 cm (1.5 ft)	1.9				
60 cm (2.0 ft)	2.0				

(a) Borehole logger readings.

TABLE 2.7B

BOREHOLE LOGGING RESULTS FOR DRILLHOLES
LOCATED SOUTH OF THE DIVERSION DITCH

Background borehole logger reading = 1.7
95 percent confidence limits for a single reading, 0.8 - 2.6

Estimated mean borehole logger reading for 6 pCi/g = 3.9
Estimated mean borehole logger reading for 16 pCi/g = 10.1

	Location		
Depth	SBDD-1	SBDD-2	SBDD-3
Surface	2.2	2.2	2.9
15 cm (0.5 ft)	1.7	1.7	1.9
30 cm (1.0 ft)	1.7	1.4	1.5
45 cm (1.5 ft)	1.6	1.8	1.5
60 cm (2.0 ft)	1.6		

TABLE 2.7C

BOREHOLE LOGGING RESULTS FOR DRILLHOLES LOCATED AROUND TAILINGS DISPOSAL AREA - EAST FENCELINE

Background borehole logger reading = 1.7
95 percent confidence limits for a single reading, 0.8 - 2.6

Estimated mean borehole logger reading for 6 pCi/g = 3.9
Estimated mean borehole logger reading for 16 pCi/g = 10.1

	Location		
Depth	FL 1	FL 2	FL 3
Surface	3.7	2.4	3.3
15 cm (0.5 ft)	3.7	2.0	2.7
30 cm (1.0 ft)	2.8	1.7	2.5
45 cm (1.5 ft)	2.6	1.8	2.4
60 cm (2.0 ft)		2.0	2.4
75 cm (2.4 ft)		1.9	2.3

TABLE 2.7D

BOREHOLE LOGGING RESULTS FOR DRILLHOLES LOCATED AROUND TAILINGS DISPOSAL AREA - WEST OF TAILINGS DISPOSAL AREA

Background borehole logger reading = 1.7
95 percent confidence limits for a single reading, 0.8 - 2.6

Estimated mean borehole logger reading for 6 pCi/g = 3.9
Estimated mean borehole logger reading for 16 pCi/g = 10.1

Depth	Location			
	Catch Basin No. 1		Catch Basin No. 2	
	Hole 1	Hole 2	Hole 1	Hole 2
Surface	8.6	12.5	75.0	51.0
15 cm (0.5 ft)	6.5	27.0	114.0	87.0
30 cm (1.0 ft)	3.0	52.0	162.0	159.0
45 cm (1.5 ft)	2.2	55.0	100.0	off scale
60 cm (2.0 ft)	2.0	43.0	31.0	off scale
75 cm (2.4 ft)	1.6	10.5	8.6	161.0
90 cm (2.9 ft)	1.8	3.7	6.0	75.0
105 cm (3.4 ft)	1.8	2.5	5.1	35.0
120 cm (3.9 ft)		1.9	4.2	10.5
135 cm (4.4 ft)			3.9	7.8
150 cm (4.9 ft)			3.2	6.4
165 cm (5.4 ft)				6.2

Depth	Location	
	WTA 3-1	WTA 3-2
Surface	4.1	4.1
15 cm (0.5 ft)	3.2	2.6
30 cm (1.0 ft)	3.9	2.6
45 cm (1.5 ft)	5.1	
60 cm (2.0 ft)	4.1	
75 cm (2.4 ft)	3.5	

TABLE 2.7E

BOREHOLE LOGGING RESULTS FOR DRILLHOLES LOCATED AROUND TAILINGS AREA - ELEVATED ACTIVITY AREA ON RADIAL "N"

	Radial Coordinate															
Depth	N-1	N-2	N-3	N-4	N-5	N-6	N-7	N-8	N-9	N-10	N-11	N-12	N-13	N-14	N-100 A	N-150 D
Surface	15.0	2.0	2.1	5.9	1.8	1.4	1.9	6.1	11.0	3.6	1.3	1.5	3.5	4.5	12.8	25.0
15 cm (0.5 ft)	35.0	2.1	2.2	12.0	1.6	1.2	5.0	11.1	34.0	7.6	1.2	1.7	4.5	6.2	29.0	42.0
30 cm (1.0 ft)	14.1	2.5	2.6	32.0	1.6	1.3	12.6	36.0	52.0	30.0	1.5	1.7	7.5	8.6	13.9	50.0
45 cm (1.5 ft)	5.8	2.5	2.6	35.0	2.1	1.2	32.0	54.0	41.0	40.0	1.6	1.5	8.5	9.2	5.7	17.5
60 cm (2.0 ft)	3.2	2.5	2.7	16.6	3.2		39.0	41.0	11.5	11.2	1.8	1.7	7.5	8.1	3.1	6.1
75 cm (2.4 ft)	2.2		2.1		7.4		48.0	12.6	4.8	4.4	1.8	1.8	5.3		2.5	3.0
90 cm (2.9 ft)					26.0		14.4	3.9	2.6	2.2					2.1	2.1
105 cm (3.4 ft)					37.0			2.0	2.1	1.8					2.1	2.1
120 cm (3.9 ft)					29.0			1.8	2.1	1.7						
135 cm (4.4 ft)					9.5											
150 cm (4.9 ft)					4.5											

Note: Background borehole logger reading = 1.7
95 percent confidence limits for a single reading, 0.8 - 2.6

Estimated mean borehole logger reading for 6 pCi/g = 3.9
Estimated mean borehole logger reading for 16 pCi/g = 10.1

TABLE 2.8

DEPTH TO Ra-226 ACTIVITY CONCENTRATION LEVELS LESS THAN 16 pCi/g BELOW THE SURFACE OR 6 pCi/g AT THE SURFACE

Borehole Number	Depth	Borehole Number	Depth
R1	-- (a)	R27	15 cm (0.5 ft)
R2	--	R28	240 cm (7.9 ft)
R3	--	R29	210 cm (6.9 ft)
R4	--	R30	195 cm (6.4 ft)
R5	--	R31	210 cm (6.9 ft)
R6	--	R32	225 cm (7.4 ft)
R7	45 cm (1.5 ft)	R33	>240 cm (7.9 ft)
R8	--	R34	210 cm (6.9 ft)
R9	--	R35	225 cm (7.4 ft)
R10	--	R36	>225 cm (7.4 ft)
R11	--	R37	>225 cm (7.4 ft)
R12	15 cm (0.5 ft)	R38	>210 cm (6.9 ft)
R13	225 cm (7.4 ft)	R39	15 cm (0.5 ft) (b)
R14	15 cm (0.5 ft)	R40	-- (2)
R15	210 cm (6.9 ft)	R41	-- (2)
R16	135 cm (4.4 ft)	R42	>225 cm (7.4 ft)
R17	15 cm (0.5 ft)	R43	>240 cm (7.9 ft)
R18	--	R44	--
R19	--	R45	--
R20	--	R46	--
R21	--	R47	--
R22	--	R48	--
R23	15 cm (0.5 ft)	R49	--
R24	15 cm (0.5 ft)	R50	--
R25	15 cm (0.5 ft)	R51	--
R26	15 cm (0.5 ft)	R52	--

(a) Less than 16 pCi/g at depths greater than 15 cm (0.5 ft) or less than 6 pCi/g at depths less than 15 cm.

(b) Borehole logger readings increasing at maximum depth indicating possible Ra-226 concentrations greater than 16 pCi/g below maximum hole depth.

TABLE 2.9A

Ra-226 ACTIVITY CONCENTRATIONS IN SOIL SAMPLES OBTAINED IN THE VICINITY OF THE TAILINGS DISPOSAL AREA - ALONG RADIALS

	Ra-226 (pCi/g)				U-238/Ra-226
Depth:	0 - 15 cm 0 - 0.5 ft		15 - 30 cm 0.5 - 1 ft		0 - 15 cm 0 - 0.5 ft
Radial Coordinate					
C 30	46.0(a)	(3.0)(b)	3.6	(0.20)	0.75
C 55	19.0	(1.2)	11.0	(0.12)	0.88
C 80	35.0	(2.2)	3.8	(0.23)	0.59
C 150	2.8	(0.21)	2.6	(0.28)	0.78
C 200	1.1	(0.10)	3.5	(0.14)	1.8
D 50	53.0	(3.4)			0.74
D 65	23.0	(0.36)	2.5	(0.12)	0.77
D 100	13.0	(0.87)	5.0	(0.36)	0.62
D 200	17.0	(0.44)	13.0	(1.2)	1.4
D 300	15.0	(0.97)	1.5	(0.13)	4.3
D 450	2.6	(0.19)	1.7	(0.12)	1.9
E 100	110.0	(5.4)	18.0	(0.79)	0.37
E 390	11.0	(0.13)	2.5	(0.10)	<0.11
E 400	3.5	(0.21)	7.7	(0.50)	2.1
E 410	2.2	(0.25)	2.1	(0.25)	2.8
E 494	6.7	(0.31)	0.94	(0.11)	1.1
G 200	1.0	(0.10)	0.51	(0.05)	4.0
G 300	0.82	(0.11)	0.88	(0.07)	7.1
H 350	1.7	(0.14)	2.5	(0.21)	4.0
I 300	0.72	(0.05)	0.50	(0.08)	6.1
J 400	1.5	(0.14)	1.5	(0.16)	6.2
K 400	1.1	(0.14)	1.2	(0.17)	6.6
K 450	0.96	(0.12)	0.85	(0.09)	3.9
K 475	1.6	(0.14)			5.1
M 850	0.96	(0.18)	3.7	(0.30)	<1.4
M - A	6.0	(0.15)	17.0	(0.71)	1.1

(a) Measured value of Ra-226 in pCi/g.

(b) Number in parentheses is the value to be added or subtracted from the measured value to show the range at the 95 percent confidence level.

TABLE 2.9B

Ra-226 ACTIVITY CONCENTRATIONS IN SOIL SAMPLES
OBTAINED IN THE VICINITY OF THE TAILINGS
DISPOSAL AREA - BOREHOLES

	Ra-226 (pCi/g)				U-238/Ra-226
Depth:	0 - 15 cm 0 - 0.5 ft		15 - 30 cm 0.5 - 1 ft		0 - 15 cm 0 - 0.5 ft
Borehole Number					
R 5	1.0 (a)	(0.06) (b)	--	--	6.9
R 7	5.0	(0.48)	27.0 (a)	(0.57) (b)	2.6
R 8	2.4	(0.13)	1.4	(0.04)	3.3
R 9	1.4	(0.11)	1.5	(0.11)	4.2
R 15	106.0	(3.4)	--	--	0.41
R 16	72.0	(0.46)	22.0	(0.53)	0.63
R 28	9.1	(1.4)	--	--	1.3
R 29	11.0	(0.27)	--	--	1.2
R 42	42.0	(0.61)	88.0	(0.44)	0.57
R 46	2.5	(0.24)	1.7	(0.07)	6.6

(a) Measured value of Ra-226 in pCi/g.

(b) Number in parentheses is the value to be added or subtracted from the measured value to show the range at the 95 percent confidence level.

TABLE 2.9C

Ra-226 ACTIVITY CONCENTRATIONS IN SOIL SAMPLES
OBTAINED IN THE VICINITY OF THE TAILINGS DISPOSAL AREA -
SOUTH OF BORROW PIT NO. 2

	Ra-226 (pCi/g)				U-238/Ra-226
Depth:	0 - 15 cm 0 - 0.5 ft		15 - 30 cm 0.5 - 1 ft		0 - 15 cm 0 - 0.5 ft
Location					
SBDD-1	0.97 (a)	(0.04) (b)	0.64 (a)	(0.10) (b)	4.5
SBDD-2	1.1	(0.09)	0.80	(0.10)	5.2
SBDD-3	1.1	(0.12)	0.76	(0.05)	5.6

(a) Measured value of Ra-226 in pCi/g.

(b) Number in parentheses is the value to be added or subtracted from the measured value to show the range at the 95 percent confidence level.

TABLE 2.9D

Ra-226 ACTIVITY CONCENTRATIONS IN SOIL SAMPLES
OBTAINED IN THE VICINITY OF THE TAILINGS DISPOSAL AREA -
NORTHEAST TAILINGS AREA

	Ra-226 (pCi/g)				U-238/Ra-226
Depth:	0 - 15 cm 0 - 0.5 ft		15 - 30 cm 0.5 - 1 ft		0 - 15 cm 0 - 0.5 ft
Location					
B 4	2.0 (a)	(0.04) (b)	2.1 (a)	(0.11) (b)	1.4
B 6	7.5	(0.50)	2.1	(0.21)	<0.52
B 5	4.4	(0.23)			2.1
B 3	18.0	(0.18)			0.80
B 7	21.0	(0.93)			1.4
B 1	8.4	(0.59)	0.65	(0.10)	
B 2	8.6	(0.60)	1.8	(0.15)	
E 100	110.0	(5.4)			0.37
E 494	6.7	(0.31)	0.94	(0.11)	1.4
E 450	7.0	(0.25)			1.2
E 400	3.5	(0.21)	7.7	(0.50)	2.1
E 410	2.2	(0.25)	2.1	(0.25)	2.4
E 390	11.0	(0.13)	2.5	(0.10)	<0.11
FL 141	16.0	(0.92)			0.56
FL 400	6.5	(0.30)			1.1
FL 446	7.4	(0.52)			
NT-1	11.0	(0.29)			1.0
NT-2	9.6	(0.33)			0.99
NT-3	10.4	(0.85)			1.3

(a) Measured value of Ra-226 in pCi/g.

(b) Number in parentheses is the value to be added or subtracted from the measured value to show the range at the 95 percent confidence level.

TABLE 2.9E

Ra-226 ACTIVITY CONCENTRATIONS IN SOIL SAMPLES OBTAINED IN THE VICINITY OF THE TAILINGS DISPOSAL AREA - WEST TAILINGS AREA

	Ra-226 (pCi/g)		U-238/Ra-226
Depth:	0 - 15 cm 0 - 0.5 ft		0 - 15 cm 0 - 0.5 ft
Location			
WTA 1-1	5.3 (a)	(0.37) (b)	2.3
WTA 1-2	6.3	(0.41)	2.6
WTA 1-3	26.0	(0.77)	0.83
WTA 1-4	3.1	(0.33)	1.9
WTA 3-1	4.0	(0.10)	2.4
WTA 3-2	1.2	(0.05)	3.8

(a) Measured value of Ra-226 in pCi/g.

(b) Number in parentheses is the value to be added or subtracted from the measured value to show the range at the 95 percent confidence level.

TABLE 2.9F

Ra-226 ACTIVITY CONCENTRATIONS IN SOIL SAMPLES OBTAINED IN THE VICINITY OF TAILINGS DISPOSAL AREA - ELEVATED ACTIVITY AREA ON RADIAL "N"

	Ra-226 (pCi/g)				U-238/Ra-226
Depth: Radial Coordinate	0-15 cm 0-0.5 ft	15-30 cm 0.5-1 ft	30-45 cm 1-1.5 ft	45-60 cm 1.5-2 ft	0-15 cm 0-0.5 ft
N 13	17.0 (a)	20.0 (a)	11.0 (a)	21.0 (a)	1.1
N 150D	58.0	106.0	61.0		0.69
N 150	0.95				0.39
N 150A	0.84	13.0			<1.8

(a) Measured value of Ra-226 concentration in pCi/g.

TABLE 2.9G

Ra-226 ACTIVITY CONCENTRATIONS IN SOIL SAMPLES OBTAINED AT MISCELLANEOUS LOCATIONS IN THE TAILINGS AND MILL AREAS

Location	Description (a) of Surface Sampling Location	Ra-226		U-238/Ra-226
MF-1	NE corner of mill fence (outside mill area	24(b)	(0.97)(c)	1.7
MF-2		89	(0.95)	
566-1	NE corner of Hwy 566 and tailings road	31	(1.9)	0.68
566-2		99	(1.1)	1.3
566-3	NE side of Hwy 566; 1,600 ft from tailings road	47	(2.8)	0.75
566-4		43	(0.19)	0.62
CB No. 2 30 - 45 cm (1 - 1.5 ft)	Center of catch basin	405	(6.4)	1.5
Tailings	Central Cell			
F1-F5		721	(11.8)	<0.01
F6-F10		724	(16.6)	<0.11

(a) Unless otherwise noted.

(b) Measured value of Ra-226 in pCi/g.

(c) Number in parenthesis is the value to be added or subtracted from the measured value to show the range at the 95 percent confidence level.

TABLE 2.10

DEPTH TO 16 pCi/g FOR BOREHOLES IN THE MILL AREA

Borehole Number	Depth to <16 pCi/g cm (ft)	Borehole Number	Depth to <16 pCi/g cm (ft)
R 56	*	R 82	--
R 57	*	R 83	*
R 58	**	R 84	*
R 59	*	R 85	*
R 60	*	R 86	135 (4.4)***
R 61	*	R 87	*
R 62	*	R 88	*
R 63	*	R 89	*
R 64	*	R 90	*
R 65	**	R 91	*
R 66	*	R 92	45 (1.5)
R 67	*	R 93	45 (1.5)
R 68	*	R 94	*
R 69	*	R 95	*
R 70	45 (1.5)	R 102	*
R 71	**	R 103	*
R 72	**	R 104	*
R 73	45 (1.5)	R 105	*
R 74	45 (1.5)	R 106	*
R 75	**	R 107	*
R 76	**	R 108	*
R 77	**	R 109	*
R 78	15 (0.5)	R 110	*
R 79	**	R 111	*
R 80	**	R 112	*
R 81	**	R 113	*

* Less than 6 pCi/g at surface, less than 16 pCi/g below 15 cm.

** Greater than 6 pCi/g at surface, less than 16 pCi/g below 15 cm.

*** Sediment on top of concrete to approximately 1.5 meters.

TABLE 2.11

Ra-226 ACTIVITY CONCENTRATIONS IN SOIL SAMPLES
OBTAINED FROM THE MILL AREA BOREHOLES

	Ra-226 (pCi/g)			
Depth: Borehole Number	0 - 15 cm 0 - 0.5 ft		15 - 30 cm 0.5 - 1 ft	
R 57	1.9 (a)	(0.26) (b)	1.2 (a)	(0.06) (b)
R 58	6.6	(0.29)	--	--
R 65	5.5	(0.17)	11.0	(1.0)
R 70	--	--	26.0	(1.3)
R 72	25.0	(0.89)	6.2	(0.33)
R 73	27.0	(0.44)	19.0	(0.93)
R 74	--	--	40.0	(0.63)
R 79	--	--	1.9	(0.18)

(a) Measured value of Ra-226 concentration in pCi/g.

(b) Number in parenthesis is the value to be added or subtracted from the measured value to show the range at the 95 percent confidence level.

TABLE 2.12

ORE STORAGE PAD BOREHOLE LOGGING RESULTS

Background borehole logger reading = 1.7
95 percent confidence limits for a single reading, 0.8 - 2.6

Estimated mean borehole logger reading for 6 pCi/g = 5.6
Estimated mean borehole logger reading for 16 pCi/g = 12.8

	Borehole Number (a)						
Depth	M-1	M-2	M-4	M-5	M-6	M-7	M-8
Surface	1.8	1.7	6.1	2.0	3.9	7.8	17.0
15 cm	1.8	1.9	4.1	1.5	2.2	10.4	30.0
30 cm	2.0	2.0	2.3	1.5	1.7	14.0	25.0
45 cm	2.0	2.0	2.3	1.7	1.5	10.9	6.8
60 cm	2.0	1.9	2.5	2.0	1.7	11.4	3.8
75 cm	1.9	2.0	2.0	2.0	1.7	4.5	2.8
90 cm	2.0	2.0	1.9	2.1	1.9	2.5	2.3
105 cm	1.9	2.0	1.9	2.1	1.9	2.0	2.2
120 cm	2.0	2.0	1.9	2.0	2.0	2.0	rock

135 and below - all readings less than 3.0

	Borehole Number						
Depth	M-9	M-10	M-11	M-12	M-13	M-14	M-15
Surface	39.0	31.0	7.2	7.0	35.0	38.0	6.2
15 cm	60.0	45.0	3.8	3.0	23.0	50.0	3.6
30 cm	86.0	35.0	2.1	2.2	8.0	30.0	2.0
45 cm	88.0	13.5	2.1	2.2	3.2	9.2	2.0
60 cm	56.0	5.5	2.5	2.2	2.5	4.0	2.0
75 cm	23.0	3.0	3.0	2.2	2.2	3.2	1.8
90 cm	7.6	2.9	mud	water	mud	mud	1.7
105 cm	5.0	---	---	---	---	---	1.8
120 cm	3.1	---	---	---	---	---	mud
135 cm	2.9	---	---	---	---	---	---

150 and below - all readings less than 3.0

(a) Borehole No. M-3 not drilled.

3.0

TAE 3.1

SUMMARY OF GEOTECHNICAL PROPERTIES
PIPELINE ARROYO BORROW MATERIAL

Sample Identification	Depth of Sample	Liquid Limit	Plasticity Index	Unified Soil Classification	Grain-Size Analysis (U.S. Standard Sieve Size Numbers) Percent Passing						
					200	100	40	10	4	3/8	3/4
74 SHB-2	10	38	20	CL	92	98	99	99	100		
78 SHB-7	2.5-4.5	26	5	ML-CL	57	84	99				
	6.0-7.7	--	NP	SM	31	67	99				
78 SHB-8	9.5-10.5	31	14	CL	63	84	96	98	100		
78 SHB-13	0-1.5	22	1	SM	49	81	99				
78 SHB-14	0-1.5	28	12	CL	57	80	91	94	95	99	100
78 SHB-30	9.5-11	--	NP	SM	23	74	100				
78 SHB-31	4.5-6	29	14	CL	55	79	90	95	98	100	
78 SHB-42	4.5-6	28	14	CL	65	74	82	87	92	96	100
86-RP-P2	10.5-11	NT	NT	CL	100						
86-RP-P3	10.5-11	NT	NT	SM	66	96	100				
86-RP-P4	5.5-6	NT	NT	SM-ML	32	56	84	97	98	100	
86-RP-P5	0-3	NT	NT	ML	65	86	98	99	100		
86-RP-P5	3-6	NT	NT	ML	68	87	98	99	99	100	
86-RP-P5	6-6.5	NT	NT	SM	48	83	95	97	98	100	
86-RP-P6	0-3	NT	NT	CL	70	89	98	99	100		
86-RP-P6	3-6	NT	NT	SM	51	80	97	98	99	99	100
86-RP-P8	11-11.5	NT	NT	ML	93	99	100				
86-RP-TP1	5-6	NT	NT	SM	18	32	87	97	98	100	
86-RP-TP2	6-7	NT	NT	SM-ML	40	67	95	97	98	100	
86-RP-TP3	0-10	NT	NT	CL-ML	85	97	99	100			
				Average:	58.5	80.6	95.5	97.9	98.8	99.7	100.0
				Standard Deviation:	22.5	16.0	5.48	3.05	2.02	0.90	0.0
				95 Percent Confidence Level (+/-):	9.61	6.84	2.34	1.30	0.86	0.39	0.0

Notes:
1. NT = Not tested.
2. NP = Non-plastic.
3. Data also include the South Diversion Ditch and the Runoff Control Ditch material.
4. Results provided in Appendix A.

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TABL 2

SUMMARY OF GEOTECHNICAL PROPERTIES
EXISTING SOIL STOCKPILE

Boring Identification	Depth of Sample	Liquid Limit	Plasticity Index	Unified Soil Classification	Grain-Size Analysis (U.S. Standard Sieve Size Numbers) Percent Passing						
					200	100	40	10	4	3/8	3/4
78 SHB-18	4.5	26	11	CL	52	79	90	95	99		100
	14.5	32	11	CL	92	98	99	100			
78 SHB-19	4.5	22	NP	SM	41	64	82	88	94	98	100
78 SHB-31	9.5	26	11	CL	52	83	98	99	100		
78 SHB-33	4.5	27	9	CL	51	77	98	100			
	14.5	21	NP	SM	47	86	99	100			
78 SHB-32	4.5	--	NP	SM	29	70	96	100			
89 SS-1	SURFACE	--	NP	ML	55	80	97	99	100		
90 SS-1	SURFACE	23	3	SC-SM	50	79	92	94	96	98	100
90 SS-2	10.5-12.5	26	7	ML-CL	54	84	94	97	98	100	
				Average:	52.3	80.0	94.5	97.2	98.7	99.6	100.0
				Standard Deviation:	16.0	9.1	5.34	3.91	2.11	0.84	0.0
				95 Percent Confidence Level (+/-):	9.92	5.64	3.31	2.42	1.31	0.52	0.0

Notes:

1. NP = Non-plastic
2. Results provided in Appendix A

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TAE 3.3

SUMMARY OF GEOTECHNICAL PROPERTIES
NORTH AND CENTRAL CELL INTERIM COVER SOILS

Sample Identification	Depth of Sample	Liquid Limit	Plasticity Index	Unified Soil Classification	(U.S. Standard Sieve Size Numbers) Percent Passing						
					200	100	40	10	4	3/8	3/4
North Cell:											
89 NC-1	0-5	26	10	CL	61	80	94	96	96		100
89 NC-2	0-5	--	NP	SM	47	70	92	98	99	100	
89 NC-3	0-5	27	10	CL	61	84	95	98	100		
89 NC-4	0-4	33	16	CL	70	89	97	99	100		
89 NC-5	0-1	--	NP	SM	45	69	99	100			
89 NC-6	0-1	25	8	CL	56	76	87	92	97	100	
89 NC-7	0-2	27	8	SC - SM	48	63	70	74	79	86	93
89 NC-8	0-1	31	13	CL	63	80	96	97	98	99	100
89 NC-9	0-1	34	17	CL	60	85	98	99	100		
89 NC-10	0-1	--	NP	SM	20	25	43	48	56	63	73
89 NC-11	0-1	22	7	SC - SM	43	63	90	98	99	99	100
89 NC-12	0-1	43	21	CL	63	82	100				
Central Cell:											
90 CC-1	SURFACE	27	9	CL	60	83	94	96	97	99	100
90 CC-2	SURFACE	32	16	CL	61	84	96	99	100		
90 CC-3	SURFACE	35	15	CL	65	86	96	98	99	100	
90 CC-4	SURFACE	30	15	CL	68	86	96	98	99	100	
90 CC-5	SURFACE	31	11	CL	66	87	96	98	99	100	
90 CC-6	SURFACE	26	12	SC	48	56	90	93	94	96	98
90 CC-7	SURFACE	26	8	CL	59	85	95	97	98	99	100
				Average:	56.0	75.4	90.7	93.6	95.3	96.9	98.1
				Standard Deviation:	11.9	15.5	13.3	12.4	10.6	8.82	6.30
				95 Percent Confidence Level (+/-):	5.33	6.96	5.97	5.59	4.78	3.97	2.03

Notes:
1. NP = Non-plastic
2. Results provided in Appendix A

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TABLE 3.4

LIMESTONE ROCK QUALITY RATINGS
GALLUP SOURCE

Best-Case Results

Lab Test	Result	Score	Weight	Score x Weight	Maximum Score
Specific Gravity	2.64	8	12	96	120
Absorption, %	1.1	5	13	65	130
Sodium Sulfate, %	2	9.5	4	38	40
L.A. Abrasion, %	19	2	1	2	10
Totals				201	300
Rating				201/300 X 100% = 67.0	

Worst-Case Results

Lab Test	Result	Score	Weight	Score x Weight	Maximum Score
Specific Gravity	2.64	8	12	96	120
Absorption, %	1.5	4	13	65	130
Sodium Sulfate, %	2	5.5	4	22	40
L.A. Abrasion, %	22	2	1	2	10
Totals				172	300
Rating				172/300 X 100% = 57.3	

Source: Gallup Sand and Gravel Quarry, 7 miles north of Thoreau, New Mexico.

TABLE 3.5

BASALT ROCK QUALITY RATINGS
GRANTS SOURCE

Lab Test	Result	Score	Weight	Score x Weight	Maximum Score
Specific Gravity	2.805	10	9	90	90
Absorption, %	0.4	8.5	2	17	20
Sodium Sulfate, %	1.7	9.6	11	105.6	110
L.A. Abrasion, %	21	1.8	1	1.8	10
Totals				214.4	230
Rating				214.4/230 X 100% = 93.2	

Source: Marinelli Construction Quarry, 18 miles east of Grants, New Mexico.

TABLE 4.1

ESTIMATED INTERIM STABILIZATION
EARTHWORK QUANTITIES

Description	Area (acres)	Cut Volume (bank cubic yards)	Fill Volume (bank cubic yards)
Tailings Regrading	100	490,000	490,000
Wind-blown Tailings	50	37,000	37,000
Embankment Grading	--	164,000	24,000
Interim Soil Cover	100	NA	161,000
Borrow Stockpile	--	20,000	NA
Mill Area/Ore Pad	25	70,000	NA
Mill Area Cap	16	NA	26,000
Catch Basins	8	30,000	NA

TABLE 4.2

PERMANENT SEED MIXTURE AND APPLICATION RATES
FOR NORTH CELL, WIND-BLOWN, AND DISTURBED AREAS

Scientific Name	Common Name	Growth (b) Habit	Application Rate (a) Pounds Pure Live Seed/Acre
Agropyron smithii	Western wheatgrass	NS	5.0
Bouteloua gracilis	Blue grama	NB	2.0
Oryzopsis hymenoides	Indian ricegrass	NB	4.0
Sporobolus airoides	Alkali sacaton	NB	0.5
Bouteloua curtipendula	Sideoats grama	NB	2.0
Hilaria jamisii	Galleta	NS	3.0

(a) Seeding rate is for drill seeding. If broadcast seeding is used, the seeding rate will be doubled.

(b) NB = native bunchgrass
NS = native sodgrass

TABLE 4.3

TEMPORARY SEED MIXTURE AND APPLICATION RATES
FOR CENTRAL CELL

Scientific Name	Common Name	Growth (b) Habit	Application Rate (a) Pounds Pure Live Seed/Acre
Agropyron tricophorum	Pubescent wheatgrass	IS	8.0
Agropyron intermadium	Intermediate wheatgrass	IS	4.0
Agropyron elongatum	Tall wheatgrass	IB	8.0
Agropyron desertorum	Crested wheatgrass	IB	2.0
Elymus juncas	Russian wildrye	IB	2.0

(a) Seeding rate is for drill seeding. If broadcast seeding is used, the seeding rate will be doubled.

(b) IS = introduced sodformer
IB = introduced bunchgrass

COARSE TAILINGS LABORATORY TEST DATA

General Description	Boring Number	Depth (feet)	Specific Gravity	Dry Bulk Density (pcf)	Porosity	Moisture Content (percent) (a)	Radium Content (pCi/g)	Diffusion Coefficient (cm2/sec) (b)	Emanation Coefficient
Tailings	658	15	NT	105	0.40	NT	NT	NT	NT
Sands	658	20	2.83	104	0.41	23.5	160	0.0000053	0.32
	658	30	2.81	98	0.44	23.4	141	0.000019	0.27
	658	40	2.89	92	0.49	31.2	212	0.000002	0.25
	659	10	2.84	95	0.46	6.1	125	0.037	0.18
	659	20	2.83	94	0.47	10.5	227	0.023	0.21
	659	30	2.74	97	0.43	13.1	132	0.016	0.20
	659	32.5	NT	106	0.47	8.1	115	0.042	0.27
	662	20	NT	97	0.49	34.1	NT	NT	NT
	662	25	2.78	96	0.36	25.1	108	0.0000025	0.33
	662	30	2.79	94	0.46	29.6	177	0.0000013	0.28
Supplemental (c)							143.1		
Average			2.81	97.5	0.45	20.47	154	NA	0.26
95 Percent Confidence Interval			2.77 to 2.84	NA	0.43 to 0.47	NA	125.0 to 183	NA	0.25 to 0.27

NT = Not tested

(a) Moisture contents are not indicative of long-term values, which will typically be lower; therefore, the radon computer model default value of 60 percent was used.

(b) Diffusion coefficients are typically low due to the high moisture content values; therefore, calculated values will be used.

(c) Value for radium content from Environmental Report on Uranium Mill Tailings Backfill presented in April 8, 1981 letter from United Nuclear to the New Mexico Environmental Improvement Division.

TABLE 5.2

FINE TAILINGS LABORATORY TEST DATA

General Description	Boring Number	Depth (feet)	Specific Gravity	Dry Bulk Density (pcf)	Porosity	Moisture Content (percent)	Radium Content (pCi/g)	Diffusion Coefficient (cm2/sec)	Emanation Coefficient
Fine-Grained	659	37.5	2.72	78	0.54	29.6	602	0.0056	0.16
Tailings	660	8.0	2.81	74	0.58	44.27	341	0.0000011	0.37
Slimes	660	15.0	2.84	94	0.47	60.0	1099	0.0000016	0.31
	660	27.5	2.75	89	0.48	32.2	285	0.0000016	0.26
	660	37.5	2.84	79	0.56	41.4	526	0.0000027	0.28
	662	40.0	2.72	84	0.51	36.4	574	0.0000062	0.21
	662	42.5	NT	89	0.55	43.8	NT	NT	NT
	658	10.0	2.81	88	0.50	17.4	402	0.0067	0.22
	658	32.5	NT	97	0.55	43.6	NT	NT	NT
Average			2.78	86	0.53	38.7	547	0.00076	0.26
95 Percent Confidence Interval			2.73 to 2.83	NA	0.50 to 0.56	29.7 to 47.7	296 to 798	0.00022 to 0.0053	0.20 to 0.32

NT = Not tested

TABLE 5.3

SOIL COVER THICKNESS DESIGN PARAMETERS USING
RADON COMPUTER CODE

Trial No.	Layer Type	Porosity	Mass Density (gm/cm3)	Radium Activity (pCi/g)	Weight Percent Moisture	Diffusion Coefficient (cm2/sec)	Emanation Coefficient	Thickness (ft)
Final Design	Fine-grained tailings	0.48	1.45	547	6.0 (a)	0.0400 (b)	0.26	16.4
	Coarse-grained tailings	0.47	1.56	154	6.0 (a)	0.0360 (b)	0.26	7.0
	Soil cover	0.33	1.73	0	12.9	0.0036 (b)	NA	1.5

(a) Default value from NRC Regulatory Guide 3.64.

(b) Diffusion coefficient calculated by RADON computer model.

NA = Not applicable.

TABLE 5.4

SUMMARY OF THE FIELD TESTING AND INSPECTION PLAN

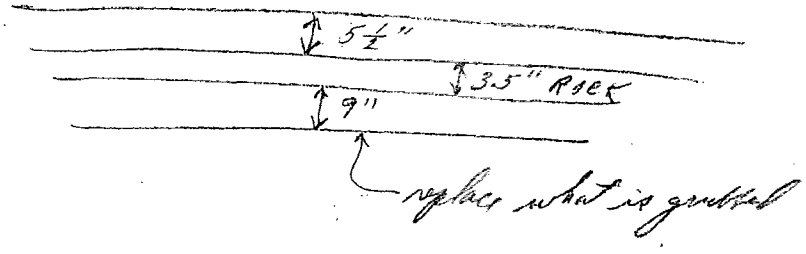
Quality Control Activity	NRC Staff Technical Position Frequency (a)
Full Proctor tests (ASTM D 698)	One test per every 15 field density tests
One-point Proctor tests	One test per every 5 field density tests
Field test for moisture/density	One test for each 500 cubic yards (cy) of cover soil or a minimum of two tests for each day of cover soil in excess of 150 cy
Nuclear density guage correlation (if appropriate)	One sand cone test and one oven-dry test per every 10 nuclear density tests
Gradation and classification testing of cover soil (includes Atterberg limits)	Minimum of one test each day of cover soil in excess of 150 cy and one test per 1,000 cy
Rock durability tests (specific gravity, absorption, soundness, L.A. Abrasion)	One test series at 10,000 cy and 20,000 cy riprap placed, then one test series per 10,000 cy of riprap placed in excess of 30,000 cy

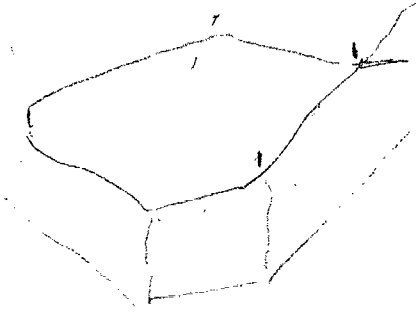
(a) The August 1990 NRC Staff Position Paper is officially titled "Testing and Inspection Plans during Construction of DOE's Remedial Action at Inactive Uranium Mill Tailings Sites."

TABLE 5.5

BRANCH SWALE CHARACTERISTICS

Swale Designation	Length (ft)	Slope (ft/ft)	Bottom Width (ft)	Peak Discharge (cfs)	Depth of Flow (ft)	Minimum Swale Depth (ft)	Riprap D 50 (in)	Riprap Thickness (in)
A	2,600	0.0038	10	40	0.98	2.0	1.5	3.0
B	3,600	0.0083	20	97	0.97	2.0	1.5	3.0
C	3,400	0.0050	10	75	1.38	2.0	1.5	3.0
D	3,200	0.0028	10	68	1.43	2.0	1.5	3.0
E	1,350	0.0037	10	85	1.53	2.5	1.5	3.0
F	1,600	0.0031	10	126	2.00	2.5	1.5	3.0
G	1,400	0.0021	10	99	1.88	2.5	1.5	3.0
H 21.675'	2,550	0.0085	20	284	1.90	2.5	3.0	6.0
I +2.261'	550	0.0040	20	385	2.65	3.5	3.0	6.0
J	1,900	0.0047	10	101	1.66	2.5	1.5	3.0





Note: See Figures 5-1 and 5-2 for swale locations.

TABLE 5.6

RIPRAP MATERIAL GRADATION REQUIREMENTS (a)

Location	D 50 (b) (inches)	Layer Thickness (inches)	Sieve Size:	Percent Passing by Weight									
				20 Inch	15 Inch	12 Inch	10 Inch	6 Inch	5 Inch	4 Inch	3 Inch	1 Inch	No. 4
Upper Section													
South Cell	9	15											
Drainage Channel	15	23		100		28-40		8-21		2-14	0-10		
North Cell													
Drainage Channel	9	15			100		45-58		10-33		0-23		
North Diversion													
Ditch	6.0	10					100	28-51		13-36		0-9	
Buried Jetty	6.0	96					100	28-51		13-36		0-9	
Branch Swales H and I, Lower Reach of Runoff Control Ditch	3.0	6						100		45-67		0-22	
Soil/Rock Matrix, Branch Swales, Upper Reach of Runoff Control Ditch	1.5	3									100	8-37	0-8

(a) The rock quality will be determined in accordance with Appendix D of the NRC's Staff Technical Position (STP) on "Design of Erosion Protection Covers" dated August 1990.
(b) Rock sizes shown will be oversized, if required, based on their rock quality rating by the methods provided in Appendix D of the NRC's STP.
(c) See Table 5.7 for bedding material requirements.

TABLE 5.7

Revised: July 8, 1992

BEDDING MATERIAL REQUIREMENTS

Location	Bedding Layers	Bedding D 50 (inches)	Thickness (inches)
Upper Section South Cell Drainage Channel	Layer 1	0.02	3
	Layer 2	0.35	3
North Cell Drainage Channel	Layer 1	0.02	3
	Layer 2	0.35	3
North Diversion Ditch	Layer 1	0.02	3
	Layer 2	0.35	3
Buried Jetty	None	NA	NA
Branch Swales H and I and Lower Reach of Runoff Control Ditch	Layer 1	0.02	3
	Layer 2	0.35	3
Soil/Rock Matrix	None	NA	NA
Branch Swales and Upper Reach of Runoff Control Ditch	Layer 1	0.02	3

Sieve Size:	Bedding D 50 (inches)	Bedding Material Gradation					
		3-inch	3/4 inch	No. 4	No. 10	No. 40	No. 200
Bedding Layer 1	0.02	100	85-100	65-100	47-94	23-70	15-30
Bedding Layer 2	0.35	65-100	43-80	22-60	15-38	5-12	0-10

CanonieEnvironmental

TABLE 5.8

NORTH DIVERSION DITCH CHARACTERISTICS

Section	Average Sideslopes (H:V)	Base Width (ft)	Channel Slope (ft/ft)	Contributing Drainage Basins	Maximum Flow Rate of PMF (cfs)	Normal Depth of Flow (ft)	Average Flow Velocity (fps)
T	2.5:1	18	0.0054	A_2	1081	4.2	9.0
U	2.1:1	20	0.0071	A_1+A_2	2265	5.7	12.0
V	7.6:1	20	0.0075	A_1+A_2	2265	4.3	9.9
W	3.3:1	22	0.0075	A_1+A_2+B	5850	8.0	16.4
X	1.1:1	12	0.0075	A_1+A_2+B	5850	12.5	18.0

Note: See Figure 5-6 for section locations.

TABLE 5.9

NORTH DIVERSION DITCH
TOTAL HEAD COMPARISONS AT CONFLUENCES
WITH CONTRIBUTING TRIBUTARIES

Cross Section Location	Peak Discharge (cfs)	Channel Slope (ft/ft)	Depth of Flow (ft)	Flow Velocity (fps)	Velocity Head (ft)	Total Head (ft)
K	1081	0.00544	4.22	9.0	1.26	5.48
A1	383	0.044	0.88	11.2	1.95	2.93
L	2265	0.00714	5.69	12.5	2.43	8.12
A2	765	0.020	1.81	10.8	1.82	3.63
M	2265	0.00746	4.34	9.8	1.49	5.83
B	2046	0.019	2.48	13.2	2.17	5.19
N	5850	0.00746	8.02	15.1	3.54	11.56

Note: Figure 5-7 provides the cross section locations.

TABLE 5.10

GEOMORPHOLOGICAL PARAMETERS FOR
PIPELINE ARROYO AND NORTH FORK RIO PUERCO

Area	Parameter	Date			
		1952	1978	1983	1985
Upstream of Nickpoint	Sinuosity	1.05	1.06	1.09	1.08
	Width/Depth Ratio	10	40	50	40
	Meander Wavelength (ft)	230	650	500	360
	Meander Amplitude (ft)	50	170	150	110
Downstream of Nickpoint	Sinuosity	1.13	1.03	1.08	1.12
	Width/Depth Ratio	4	2	2	2
	Meander Wavelength (ft)	310	640	500	320
	Meander Amplitude (ft)	95	105	145	145
North Fork Rio Puerco downstream of confluence with Pipeline Arroyo	Sinuosity	1.51	NA	NA	1.37
	Width/Depth Ratio	6	NA	NA	6
	Meander Wavelength (ft)	690	NA	NA	620
	Meander Amplitude (ft)	425	NA	NA	470

NA = not available

TABLE 5.11

DRAINAGE BASIN DESCRIPTIONS

Basin Destination	Area (square miles)	Maximum Relief (feet)	Longest Drainage Path (miles)	Curve Number	PMP (inches)	PMF (cfs)
Pipeline Arroyo (a)	18.20	819	6.18	79	6.2	26300
North and South Diversion Ditches (a)						
A1	0.15	200	0.62	80	8.4	1220
A2	0.12	360	0.62	80	8.4	1080
B	0.57	440	1.23	80	8.4	3950
C	0.17	400	0.73	80	8.4	1370
Runoff Control Area (b)	0.052	88	1.06	80	8.5	270
South Cell (b)	0.20	66	0.59	77	8.5	1260
North Cell (b)						
Main Swale	0.15	55	0.75	77	8.5	840
Typical Branch	0.05	23	0.47	77	8.5	315

(a) See Figure 5-5 for basin locations.

(b) See Figures 5-1 and 5-2 for basin locations.

TABLE 5.12

SUMMARY OF MEANDER PATTERNS

Pipeline Arroyo

Elevation Contour	Channel Distance (ft)	Slope (ft/ft)	Valley Distance (ft)	Sinuosity (ft/ft)	Average Meander Amplitude (ft)	Average Meander Wave Length (ft)
6840						
6880	3800	0.011	3375	1.126	200	1150
6920	5200	0.008	5025	1.035	150	1250
6960	7000	0.006	6500	1.077	100	2275
7000	2000	0.020	1675	1.194	100	2000
7040	7200	0.006	6025	1.195	100	1750
7080	3600	0.011	3225	1.116	200	750

Watershed Area = 20.12 square miles
Maximum Amplitude = 570 feet

Hard Ground Canyon

Elevation Contour	Channel Distance (ft)	Slope (ft/ft)	Valley Distance (ft)	Sinuosity (ft/ft)	Average Meander Amplitude (ft)	Average Meander Wave Length (ft)
6800	0					
6840	5600	0.007	5300	1.057	150	1050
6880	3400	0.012	3300	1.030	150	675
6920	7000	0.006	6800	1.029	200	1800
6960	3300	0.012	2500	1.320	350	1000
7000	7900	0.005	7500	1.053	150	1780
7040	2800	0.014	2600	1.077	100	1400
7080	2300	0.017	2150	1.070	75	2000

Watershed Area = 14.11 square miles
Maximum Amplitude = 350 feet

TABLE 5.13

ESTIMATED FINAL RECLAMATION
EARTHWORK QUANTITIES

Description	Estimated Area (acres)	Estimated Cut Volume (cubic yards)	Estimated Fill Volume (cubic yards)
Pipeline Arroyo and Runoff Control Ditch	27	36,000	103,000
Buried Jetty	--	8,500 (a)	5,050
South Drainage Channel	1	84,000 (a)	NA
Evaporation Pond Closure	10	NA	49,000
Soil Cover	100		109,000
Soil/Rock Matrix (Soil)	110	NA	60,000
Borrow Pit No. 2 Backfill	9		155,000
Soil Stockpile	10	352,600 (b)	

(a) Excess material used in fill sections near arroyo.

(b) Indicates anticipated volume of soil to be borrowed from stockpile.

6.0

TABLE 6.1

NRC GROUND WATER PROTECTION STANDARDS
AND THEIR EXCEEDANCES
BY FORMATION OF CONCERN (a)

Chemical Constituent	Ground Water (b) Protection Standard	Zone 3	Zone 1	Southwest Alluvium
Arsenic	= 0.05	X	--	--
Beryllium	= 0.05	X	X	--
Cadmium	= 0.01	X	X	--
Chloroform	= 0.001	X	--	--
Cyanide	= 0.005	X	X	X
Gross alpha (c)	= 15.0 (pCi/l)	X	X	X
Lead	= 0.05	X	--	X
Lead-210	= 1.0 (pCi/l)	X	X	--
Naphthalene	= 0.001	X	--	--
Nickel	= 0.05	X	X	--
Selenium	= 0.01	X	X	X
Combined Radium-226 and Radium-228	= 5.0 (pCi/l)	X	X	X
Uranium	= 0.3	X	--	--
Thorium-230	= 5.0 (pCi/l)	X	X	X
Vanadium	= 0.1	X	--	--

(a) X denotes that the NRC Standard is exceeded in the indicated formation.
-- denotes that the standard has not been exceeded.

(b) mg/l except as noted.

(c) Minus gross alpha contribution from radon and uranium.

TABLE 6.2

EPA CONTAMINANT-SPECIFIC GROUND WATER ARARs
AND THEIR EXCEEDANCES BY
FORMATION OF CONCERN (a)

Chemical Constituent	Applicable or Relevant and Appropriate Requirements (ARARs) (b)	Zone 3	Zone 1	Southwest Alluvium
Aluminum	5.0	X	X	--
Antimony	0.014	--	--	--
Arsenic (c)	0.05	X	X	--
Barium	1.0	--	--	--
Beryllium	0.017	--	--	--
Cadmium (c)	0.01	X	X	X
Chromium	0.05	--	--	--
Cobalt (c)	0.05	X	X	X
Copper	1.0	--	--	--
Iron	5.5	--	--	--
Lead	0.05	--	--	--
Manganese	2.6	X	X	X
mercury	0.002	--	--	--
Molybdenum	1.0	X	X	X
Nickel (c)	0.2	X	X	X
Selenium (c)	0.01	X	X	X
Silver	0.05	--	--	--
Thallium	0.014	--	--	--
Vanadium	0.7	--	--	--
Zinc	10.0	--	--	--
Chloride	250.0	--	--	--
Sulfate	2,160.0	--	--	--
Nitrate as N	30.0	X	X	X
TDS	3,170.0	X	X	X
Uranium-238	5.0	--	--	--
Thorium-230	15 pCi/l	--	--	--
Gross Alpha (c)	15 pCi/l (d)	X	X	X
Combined Radium-226 and Radium-228 (c)	5 pCi/l	X	--	--

(a) X denotes that the NRC Standard is exceeded in the indicated formation.
-- denotes that the standard has not been exceeded.

(b) mg/l except as noted.

(c) These constituents are of primary concern as identified in EPA's ROD (EPA, 1988a).

(d) Minus gross alpha contribution from radon and uranium.

TABLE 6.3

PERFORMANCE MONITORING ANALYTES (a)

Arsenic
Aluminum
Cadmium
Chloride
Cobalt
Nitrate
Sulfate
Ammonia
Manganese
Molybdenum
Calcium
Magnesium
Sodium bicarbonate
Potassium
TDS
Beryllium
Chloroform
Cyanide
Lead
Lead 210
Naphthalene
Nickel
Combined Radium-226, Radium-228
Selenium
Thorium-230
Uranium
Gross Alpha
Vanadium

(a) Field pH and water levels will be measured when samples are collected.

TABLE 6.4

IMPLEMENTATION OF THE CORRECTIVE ACTION PROGRAM
UNITED NUCLEAR CHURCH ROCK SITE

	Activity	Date Started or Submitted	Date Completed	Date Start Operation
1.	Installation of Evaporation Disposal System o Two-cell Evaporation Pond o Pond Misters o Distribution lines connecting the extraction wells to the system o Distribution lines to the mist evaporation system on the tailings	10/88	1/89	1/5/89
2.	Dewater Borrow Pit No. 2 o Originally scheduled to be completed by 10/89 o Continue operation of Zone 1 wells although borrow pit is dry	1/5/89	4/29/89	N/A
3.	Installation of Zone 3 Extraction Wells o Install Wells 708 - 712 o Aquifer Test using Wells 708 - 712 o Refine system design based on test; eliminate Well 704 from system	5/3/89	6/29/89	8/7/89
4.	Install Southwest Alluvium Extraction and Monitoring Wells o Install Extraction Wells 801 - 803 o Install Monitoring Wells 804 - 807 o Aquifer test o Install and test distribution lines to evaporation disposal system	8/3/89	8/30/89	10/16/89
5.	Submit 1989 Annual Review o Well Installation o Dewater Borrow Pit No. 2 o Performance monitoring evaluation of Zone 3 and Zone 1 (water levels and water quality) o Performance monitoring evaluation of Southwest Alluvium not applicable because system had not operated long enough to generate data for this report o Evaporation disposal system performance o Recommendations for continued operation	12/31/89	N/A	N/A

TABLE 6.4

IMPLEMENTATION OF THE CORRECTIVE ACTION PROGRAM
UNITED NUCLEAR CHURCH ROCK SITE
(Continued)

	Activity	Date Started or Submitted	Date Completed	Date Start Operation
6.	NRC and EPA submit comments to the 1989 Annual Review o Zone 3 system operating as designed o Add additional monitoring well to Zone 3 system o Continue operation of Zone 1 extraction wells although Borrow Pit No. 2 is dry; propose a modified pumping program o Continue operation of Southwest Alluvium system	2/90	N/A	N/A
7.	United Nuclear Response to Comments o Add Well 126 as performance monitoring well for Zone 3 o Demonstrate that mound in Zone 1 is dissipating in response to dewatering; however, the process is slow because of the low hydraulic conductivity of the formation o Request permission to turn off existing Zone 1 wells. o Continue operation of Southwest Alluvium system	3/90	N/A	
8.	Modified Zone 1 Pumping Program o Required by NRC and EPA, request to turn off Zone 1 pumping wells denied. o Decommission existing east and north cross-dike pump-back wells o Operate revised east pump-back system consisting of Wells 615, 616, 617, and EPA 7 o Continue to monitor performance monitoring wells designated in the RD	6/11/90	Agency Approval	9/24/90
9.	Submit 1990 Annual Review o Zone 3 system continues to perform as designed o Zone 1 revised east pump-back system performance further demonstrates that active remediation is not feasible o Southwest Alluvium system performs as designed	12/31/90		

TABLE 6.4

IMPLEMENTATION OF THE CORRECTIVE ACTION PROGRAM
UNITED NUCLEAR CHURCH ROCK SITE
(Continued)

	Activity	Date Started or Submitted	Date Completed	Date Start Operation
10.	NRC and EPA submit comments to the 1990 Annual Review o Zone 3 performing as designed o Requires installation of the Zone 3 Stage II wells as designed in the RD o Requires proposal for final demonstration that active remediation in Zone 1 is not feasible o Requires proposal for additional extraction well(s) in Southwest Alluvium to enhance the hydraulic barrier currently created by the system o Requires revision to the data presentation in the next annual reviews including: - Calculate the mass of hazardous constituents removed by the corrective action systems in all three formations - Include water quality data for all wells monitored in tabular form within the main body of the report - Include an isopach map of saturated thickness	2/91		
11.	United Nuclear response to comments o Amendment request for installation of the Zone 3 Stage II wells (Wells 714 - 720) at the locations designated on Figure 2-4 of the RD o Amendment request for installation of a well o Presentation of data in future annual reviews will be modified as requested	4/91		
12.	United Nuclear proposes program for ALARA Demonstration	7/91		
13.	NRC and EPA approve proposals for amendments to Zone 3 and Southwest Alluvium systems, incorporated as Amendment 12	7/91		
14.	Install Wells o Zone 3 Stage II, Wells 714-720 o Southwest Alluvium Well 808	5/20/91	6/14/91	6/24/91

TABLE 6.5

DATA FROM ZONE 3 WELLS
USED TO GENERATE ISOPACH MAP
OF SATURATED THICKNESS (FIGURE 6-6)

Well Number	Top of Zone 3 (elevation, feet)	Bottom of Zone 3 (elevation, feet)	Water Level October 1987 (elevation, feet)	Saturated Thickness (feet)
TWQ-121	6,959.9	6,879.9	6,918.6	18.7
TWQ-125	6,938.4	6,883.4	6,902.5	19.1
TWQ-126	6,931.2	6,866.2	6,905.4	39.2
TWQ-127	6,926.3	6,851.3	6,900.4	49.1
510B	6,948.8	6,868.8	6,892.2	23.4
502B	6,913.9	6,943.9	6,896.3	52.4
503B	6,928.4	6,855.4	6,896.6	41.2
518	6,924.0	6,860.0	6,902.1	42.1
EPA-3	6,939.3	6,887.3	6,899.2	11.9
EPA-6	6,950.1	6,901.1	6,914.0	12.9
EPA-9	6,952.9	6,902.9	6,911.1	8.2
EPA-13	6,920.5	6,856.5	6,882.7	26.2
EPA-15	6,895.4	6,829.4	6,895.8	66.4
EPA-18	6,938.9	6,881.9	6,488.7	2.8
EPA-19	6,939.2	6,878.2	6,887.5	9.3

Source: United Nuclear NRC monitoring program and well logs (United Nuclear, personal communication).

TABLE 6.6

PUMPING RATES FOR ZONE 3
COMPUTER MODEL PERFORMANCE SIMULATION

Well Number	Year 1 Pumping Rate (gpm) (b)	Year 2 Pumping Rate (gpm) (b)	Year 3 Pumping Rate (gpm) (b)
701	5	4	2
702	5	4	0
703	5	2	0
704	5	2	0
705	5	2	0
706	5	2	1.5
707	5	2	1.5
708	2.5	2	0
709	5	4	1.5
710	5	4	0
711	2.5	2	0
712	5	4	1.5
713	5	2	2
714	0	0	2
715	0	0	5
716	0	0	5
717	0	0	2
718	0	0	5
719	0	0	5
720	0	0	5
Total	60	36	39

3-year average pumping rate: 45 gpm

(a) These pumping rates utilized from the end of year 2 to the end of the model simulation at time equals 2.5 years.

(b) Well showing a zero pumping rate is either decommissioned or not installed.

TABLE 6.7

ZONE 3 PERFORMANCE MONITORING WELLS

Wells Specified in License Condition Parts A and B (a)	Extraction System Wells (b)
TWQ 106D	701
TWQ 9D	702
517	703
518	704 (c)
504-B	705
502-B	706
501-B	707
420	708
411	709
EPA-18	710
EPA-17	711
EPA-15	712
EPA-14	713
EPA-13	714
EPA-12	715
EPA-11 (d)	716
EPA-9	717
EPA-3	718
EPA-1	719
	720
	TWQ 126 (e)

(a) Wells in this column will be sampled quarterly for water level and constituents specified in Table 6.3.

(b) Wells in this column will be monitored for water level only.

(c) Well 704 was not installed because the results of the aquifer test conducted during installation of the Stage I wells indicated that inclusion of this well would detract from the performance of the system.

(d) Well EPA 11 was abandoned after second quarter 1990 with approval from the NRC and EPA. The water level had dropped below the pump intake and the pump could not be lowered in the well.

(e) Well TWQ 126 was added to monitor water levels at the request of the NRC and EPA in their comments to the 1989 Annual Review (Canonie, 1989c).

TABLE 6.8

IMPLEMENTATION OF THE ZONE 3 CORRECTIVE ACTION PROGRAM

	Activity	Date Started or Submitted	Date Completed
1.	Install Zone 3 Stage I Extraction Wells o Install Wells 708 - 712 o Aquifer Test using Wells 708 - 712 o Refine system design based on test; eliminate Well 704 from system o Install Wells 701 - 707 excluding Well 704	5/3/89	6/29/89
2.	Start Zone 3 Stage I well operation	8/89	N/A
3.	Submit 1989 Annual Review o Description of Zone 3 Stage I Well Installation o Performance monitoring evaluation of Zone 3 (water levels and water quality) o Recommendations for continued operation	12/89	N/A
4.	NRC and EPA submit comments to the 1989 Annual Review o Zone 3 system operating as designed o Add additional monitoring well to Zone 3 system	2/90	N/A
5.	United Nuclear Response to Comments o Add Well 126 as performance monitoring well for Zone 3	3/90	7/90
6.	Well 126 added to Performance Monitoring Program o Included in Amendment 7 to the NRC License		4/90
7.	Submit 1990 Annual Review o Zone 3 system continues to perform as designed o Well EPA 11 abandoned	12/90	
8.	NRC and EPA submit comments to the 1990 Annual Review o Zone 3 performing as designed o Requires installation of the Zone 3 Stage II wells as designed in the RD	2/91	N/A

TABLE 6.8

IMPLEMENTATION OF THE ZONE 3 CORRECTIVE ACTION PROGRAM
(Continued)

	Activity	Date Started or Submitted	Date Completed
9.	United Nuclear Response to Comments o Amendment request for installation of the Zone 3 - Stage II wells (Wells 714 - 720) at the locations designated on Figure 2-4 of the RD (Canonie, 1989d)	4/91	N/A
10.	NRC and EPA approve proposals for amendment to Zone 3 o Included in Amendment 12 to the NRC License	7/91	N/A
11.	Install Zone 3 - Stage II Wells o Install and test Wells 714-720	5/91	6/91
12.	Start operation of Zone 3 - Stage II wells	8/91	N/A

TABLE 6.9

SUMMARY OF 1989 OPERATIONAL DATA
ZONE 3 - STAGE I WELLS

Well Number	Automatic Control (yes/no) (a)	Initial Pumping Rate (gpm)	Current Pumping Rate (gpm) (b)	Average Pumping Rate (gpm) (c)	Design Pumping Rate (gpm) (d)
701	No	4.2	6.3	5.4	5
702	Yes	1.3	0.4	~1.0	5
703	No	3.7	2.0	3.0	5
705	No	1.0	1.4	1.7	5
706	No	5.0	8.0	8.2	5
707	No	4.0	3.8	4.3	5
708	No	2.5	4.0	4.7	2.5
709	No	5.0	2.4	2.8	5
710	No	2.0	0.8	1.1	5
711	No	3.8	5.3	5.0	2.5
712	Yes	4.3	2.1	~2.7	5
713	Yes	3.0	2.6	3.0	5
			Total	43	55

Total Volume Pumped = 5.6 million gallons (c)

(a) Wells equipped with the automatic control pump in cycles. If the well is not pumping at the time of inspection, then the pumping rate cannot be recorded. The well meters record the cumulative flow and the flow rate is calculated based on these readings and the time elapsed between readings.

(b) Average pumping rate reported for the week of November 10 through November 17, 1989.

(c) Pumping rate and total volume pumped estimated for the period between August 7 through November 17, 1989.

(d) The total design pumping rate presented in the RD (Canonie, 1989a) was 60 gpm. This rate included 5 gpm for Well 704, which has been excluded from the system.