APPENDIX C

RADON EMANATION

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C.1 INTRODUCTION

This appendix presents the calculations of radon-222 emanation and gamma radiation exposure from the cover over the proposed Sequoyah Fuels Corporation (SFC) disposal cell. These calculations comprise an update of analyses presented in the Preliminary Design Report (Reclamation Plan Appendix C), reflecting the multilayered cover system design and phased construction of the disposal cell. In addition, gamma radiation exposure calculations are summarized in Section C.6 of this appendix.

C.1.1 Background

The performance objective for the maximum rate of radon-222 emanation from the surface of reclaimed facilities is 20 pCi/m²-sec, as outlined in Criterion 6 (1), Appendix A of NRC regulations (10 CFR 40). This maximum rate of emanation is an average over "the entire surface of each disposal area." This average accounts for minor variations in cover material and byproduct material properties as well as natural variations in cover material moisture content, vegetation cover, and other effects over the long-term design life of the reclaimed facility.

Due to the short half-life of radon-222 (3.8 days), the key factor in control of radon emanation through a soil cover is the travel time through the pore spaces in the cover. This attenuation of radon can be achieved with a layer of low-permeability material (such as clay) or a thicker layer of more permeable material (such as sand). This evaluation was conducted to calculate that the average rate of radon-222 emanation from the soil cover surface for comparison with the NRC performance standard of 20 pCi/m^2 -sec.

C.1.2 RADON Model

The modeling was conducted with the RADON model (NRC, 1989), the standard model used to estimate emanation of radon-222 from materials containing radium-226. This model is accepted and approved by the US Nuclear Regulatory Commission (NRC), and documented in NRC publications NUREG/CR-3533 and Regulatory Guide 3.64 (NRC, 1984, 1989).

The RADON model has been shown to provide a conservative estimate of radon emanation from reclaimed uranium tailings impoundments, because actual measured radon emanation rates from reclaimed facilities are typically an order of magnitude lower than values calculated during reclamation plan design with the RADON model.

The modeling was also conducted utilizing previous information from evaluation of a multi-layered cover system for the disposal cell documented in ESCI (1996 and 1998), as well as soil property and radiological data collected by SFC.

C.2 ANALYZED PROFILES

The disposal cell profiles analyzed with the RADON model are based on the phases of cell construction and the materials planned for disposal in each cell phase. This phasing is outlined in Appendix A of this report. The cell phases are shown in Figure C.1. The profiles for the phases of the cell are shown in Figures C.2 through C.5. These profiles do not include the cover synthetic liner in the RADON modeling, to be consistent with NRC guidance.

These profiles include four specific types of contaminated material below the reclamation cover (material Types A through D). The general disposal scenario is based on placing the materials with the highest radium-226 and thorium-230 activity concentrations lowest in the profile. As shown in Figures C.2 through C.5, the materials to be placed in the disposal cell are primarily on-site soils (generally sandy, silty clays). Exceptions are material Type A, which consist of sludges and sediments, and material Type C, which consist of structural materials, miscellaneous buried materials and calcium fluoride solids.

The physical properties of the disposed materials and cover materials are based on drill logs and testing described in Appendix A of MFG (2002b). For the RADON modeling, the critical physical properties of these materials are porosity and long-term moisture content. The radiological properties are activity concentrations of radium-226 and thorium-230 (which decays to radium-226). These radiological properties are presented in Attachment C.1 and are summarized in the sections below.

C.3 MATERIAL PHYSICAL PROPERTIES

The physical properties of disposed materials and cover materials are summarized in Table C.1. The material density values are based on testing of site materials by SFC. Long-term moisture content values are either 6 percent for primarily sandy material (the conservative default value in NRC Regulatory Guide 3.64), 15 percent for on-site silty clays (that have Standard Proctor optimum values of 18 percent), or other values measured by SFC.

Material	Description	Porosity	Dry Unit Weight (pcf)	Water Content (%)	Degree of Saturation (%)		
COVER	· · · · · · · · · · · · · · · · · · ·						
Topsoil	Sandy loam	0.49	84.4	6	17		
Subsoil	Sandy silt	0.45	91.0	6, 15	19, 49		
Liner cover	Sand	0.40	99.3	6	24		
Clay liner	Silty clay	0.39	100.9	15	62		
TYPE D	TYPE D						
Contaminated soils	Sandy silt and sed. rock	0.40	99.3	6	24		
TYPE C							
Structural materials	Soil and debris	0.20, 0.40	132, 99.3	6	64, 24		
Calcium fluoride sludge	Chemical precipitate	0.70	49.6	15	17		
Buried materials	Sandy silt and debris	0.70	49.6	15	17		
TYPE B							
Soil liner and subsoils	Sandy and clayey silt	0.70	49.6	15	17		
TYPE A							
Raffinated sludge	Chemical precipitate	0.80	33.1	100, 50	66, 33		
Pond 2 residual materials	Chemical precipitate	0.70	49.6	15	17		
Pond sediments	Chemical precipitate	0.70	49.6	15	17		

1 able C.1 Physical Properties of Materials Used in the Mode	Fable C.1	Physical Properties of Materials Used in the Model
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C.4 MATERIAL RADIOLOGICAL PROPERTIES

The radiological properties used in the RADON model for the contaminated soils are based on information presented in Attachment C.1. The radon emanation fraction from materials with a radium-226 activity concentration was 0.35 (the conservative default value used in the RADON model). The radon diffusion coefficient for cover and disposed materials was calculated by the RADON model (from void ratio and moisture content).

C.4.1 Radium-226 Values

Radium-226 activity concentrations of the materials in the disposal cell were estimated for each layer as a weighted average value from the individual material values to be placed in each phase of cell construction. The volumes, weights and radionuclide activity concentration values are listed in Attachment C.1.

Initial radiological properties of the disposal cell materials were derived from the SRC (SFC, 1998). Due to the relatively high activity concentration values of material Type A (the raffinate sludge, Pond 2 residual materials, and basin sediments), the Type A materials are the key source term parameters for the RADON modeling. As a result, the radium-226 and thorium-230 activity concentration values of these materials were evaluated in more detail for the RADON modeling. From review of sample analysis data

by SFC, statistical summaries of natural uranium, radium-226 and thorium-230 activity concentrations were developed. The summary values for these materials are summarized in Attachment C.1. The mean values and 95 percent upper confidence interval values were selected to conservatively represent the range of source-term conditions for the RADON modeling.

Due to the amount of thorium-230 in these materials, the amount of radium-226 ingrowth due to thorium-230 decay was considered for the material Type A source-term conditions. Natural uranium was not considered due to its significantly longer half-life. Ingrowth due to thorium-230 decay was evaluated with time for the Type A materials, with the maximum radium-226 values calculated at approximately 1,000 and 10,000 years from the present. For the RADON modeling, two source-term scenarios were evaluated: (1) 95 percent upper confidence-interval (UCI) values at 1,000 years, and (2) 95 percent UCI values in 10,000 years accounting for thorium-230 decay. The 95 percent upper confidence-interval values represent conservative source term values. The 10,000 year from present radium-226 values are beyond the required design life for the facility, but were evaluated as a sensitivity analysis of calculated radon emanation. In addition, radionuclide activity concentrations were conservatively based on the dry weights of these materials.

C.4.2 Values by Disposal Cell Phases

The radiological parameters used in the RADON modeling are presented in terms of the phases of cell construction. The radium-226 activity concentrations incorporate decay of thorium-230 to radium-226, and are calculated values at 1,000 and 10,000 years. The radiological parameters and layer thicknesses for the Phase I area of the disposal cell (Figure C.1) are summarized in Table C.2. The modeled profile is shown in Figure C.2.

Material	Volume (cu ft)	Fraction of Total (%)	Layer Thick- ness (ft)	Radium–226 Activity at 1,000 yrs (pCi/g)	Radium-226 Activity at 10,000 yrs (pCi/g)
TYPE A MATERIALS					
Emergency basin sediment	14,600	32		10,519	
North ditch sediment	20,770	45		184	
Sanitary lagoon sediment	10,365	23		405	
TOTAL/WEIGHTED AVERAGE		100	2.0	3,542	9,013
TYPE B-D MATERIALS					
Emergency basin soils	162,500	50		90.1	
North ditch soils	87,500	27		90.1	
Sanitary lagoon soils	56,356	17		21.3	
Solid waste burials (No. 1)	20,000	6		21.3	
TOTAL/WEIGHTED AVERAGE		100	14.0	74.3	81.5

 Table C.2
 Radiological Properties for Phase I Area Disposed Materials



The radiological parameters and layer thicknesses for the Phase IIA area of the disposal cell (Figure C.1) are summarized in Table C.3. The modeled profile is shown in Figure C.3.

Material	Volume (cu ft)	Fraction of Total (%)	Layer Thick- ness (ft)	Radium–226 Activity at 1,000 yrs (pCi/g)	Radium–226 Activity at 10,000 yrs (pCi/g)	
TYPE A MATERIALS						
Raffinate sludge (28,600 sq ft area)	355,000	32	12.4	7,183	18, 587	
Pond 2 residual material	762,000	68	4.2	1,038	2,568	
TOTAL/WEIGHTED AVERAGE		100	16.6			
TYPE B–D MATERIALS						
Structural material	568,600	100	8.4	30.9	75.3	
TOTAL/WEIGHTED AVERAGE		100	8.4			

Table C.3	Radiological Propertie	s for Phase IIA Area Dis	posed Materials
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The radiological parameters and layer thicknesses for the Phase IIB area of the disposal cell (Figure C.1) are summarized in Table C.4. The modeled profile is shown in Figure C.4.

Material	Volume (cu ft)	Fraction of Total (%)	Layer Thick- ness (ft)	Radium-226 Activity at 1,000 yrs (pCi/g)	Radium–226 Activityat 10,000 yrs (pCi/g)	
TYPE A MATERIALS						
Pond 2 residual material	762,000	100	14.3	1,038	2,568	
TOTAL/WEIGHTED AVERAGE		100	14.3			
TYPE B-D MATERIALS						
Structural material	568,600	100	10.7	30.9	75.3	
TOTAL/WEIGHTED AVERAGE		100	10.7			

 Table C.4
 Radiological Properties for Phase IIB Area Disposed Materials

The radiological parameters and layer thicknesses for the Phase III area of the disposal cell (Figure C.1) are summarized in Table C.5. The modeled profile is shown in Figure C.5.

Table C.5	Radiological Properties	for Phase III Area Dis	posed Materials

Material	Volume (cu ft)	Fraction of Total (%)	Layer Thick- ness (ft)	Radium–226 Activityat 1,000 yrs (pCi/g)	Radium–226 Activity at 10,000 yrs (pCi/g)
TYPE B-D MATERIALS					
Fluoride holding basin 1	171,400	18		3.4	
Fluoride holding basin 2	186,000	19		3.4	
Fluoride settling basin and clarifier	114,000	12		3.4	
Buried calcium fluoride	96,000	10		3.4	
Buried fluoride holding basin 1	57,000	6		3.4	
UF6 cylinders	15,500	2		3.4	
Clarifier liners	332,400	34		90.1	
TOTAL/WEIGHTED AVERAGE		100	15.0	32.9	38.4

Appendix C

C.5 RADON MODEL RESULTS

The RADON model output for the four scenarios outlined above is provided in Attachment C.2. The calculated radon-222 flux values through the top of the cover (in pCi/m^2 -sec) are presented in the Table C.6 below.

Cell Phase Area	Radium-226 Value	Water Content Variations	Radon-222 Flux (pCi/m ² -sec)
Phase I	1,000 years	Subsoil at 15%	2.0
	10,000 years	Subsoil at 15%	2.9
	10,000 years	Subsoil at 6%	7.7
Phase IIA	1,000 years	Subsoil at 15%	1.0
	1,000 years	Raffinate at 50%	1.0
	1,000 years	Lower debris density	3.0
	10,000 years	Subsoil at 15%	2.4
· · · · · · · · · · · · · · · · · · ·	10,000 years	Subsoil at 6%	6.3
Phase IIB	1,000 years	Subsoil at 15%	1.0
	10,000 years	Subsoil at 15%	2.4
	10,000 years	Subsoil at 6%	12.5
Phase III	1,000 years	Subsoil at 15%	0.2
	10,000 years	Subsoil at 15%	0.2
	10,000 years	Subsoil at 6%	0.6

Table C.6	RADON	Model Results

C.5.1 General Conclusions

The proposed cover system was evaluated for acceptable performance in reduction of radon-222 emanation from the disposal materials using modeling recommended by NRC, with the results compared with NRC criteria for maximum rate of radon emanation. Conservative assumptions in cover and disposal material porosity and moisture content were made, and conservatively high radium-226 activity concentrations were used.

The radiological parameters used in the model were based on a limited number of samples, with analysis results showing significant variability. The existing data was evaluated statistically, with mean and 95 percent upper confidence interval values used in the modeling to represent a conservative range of source term parameters.

With these conservative assumptions and values, the modeling results show that the proposed cover (and planned order of material disposal) maintains radon-222 emanation rates from the top of the cover within NRC performance standards for conditions over the design life (up to 1,000 years). Analyses

representing conditions of maximum thorium-230 ingrowth (although beyond the design life at 10,000 years) show acceptable radon-222 emanation rates.

C.5.2 Variability Due to Root Penetration

The effect of root penetration into the cover on radon emanation was evaluated based on a percentage of the cover having root holes (of relatively large diameter) extending to the bottom of the cover (through the synthetic liner and two-foot thick clay layer). One percent of the cover surface area was evaluated with a higher radon emanation rate, equivalent to two one-inch diameter root holes for each square foot of cover surface area.

This higher rate of radon emanation was calculated with the RADON model with no cover over the disposed materials. For maximum ingrowth conditions, this rate is approximately 46 pCi/m²-sec in the Phase I area and 38 pCi/m²-sec in the Phase IIA and IIB areas. If one percent of the cover surface area had this higher rate of radon emanation, the average radon emanation rate from the top of the cover increases from approximately 7.7 to 8.1 pCi/m²-sec in the Phase I area and approximately 12.5 to 12.8 pCi/m²-sec in the Phase IIB area, or an increase of up to 5 percent.

Actual root holes from vegetation on the cover would not be continuous from the top to the bottom of the cover, and the travel time of radon-222 migrating through pore spaces and root holes through the 10-foot thick cover would reduce the radon emanation rate at the cover surface, so this calculation is extremely conservative.

These calculations show that the effects of root penetration into the SFC disposal cell cover do not have a significant impact on the rate of radon emanation from the cover surface. Root penetration deep into the cover with subsequent decay of plant material may increase the average rate of radon emanation from the cover surface by a few percent, but would not significantly affect the rate of radon emanation relative to the performance standard of 20 pCi/m²-sec.

C.6 GAMMA RADIATION EXPOSURE

The gamma radiation exposure from covered areas of the site was estimated from exposure relationships presented in Schiager (1974) and Shleien (1992). The effect of a soil cover in reducing exposure from a gamma radiation source is calculated as the ratio of the shielded exposure rate (due to the soil) to the unshielded exposure rate. Using coefficients for soil, the shielded exposure rate is approximately 1/10 of

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the unshielded rate at a soil cover thickness of one foot. This ratio is 1/100 at a soil cover thickness of over two feet, and is 1/1000 at a soil cover thickness of over three feet. For a soil cover thickness of 10 feet, the ratio is approximately $1/10^9$. These calculations show that gamma radiation exposure is significantly reduced by a small thickness of soil cover.

C.7 **REFERENCES**

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1.5 TOPSOIL 5.0' -.SUBSOIL ZONE COVER 10.0' SYSTEM 1.5' 12 T 2.0' **CLAY LINER** 11 11 / / / / ✓ EMÉRGENCY BASIN SÉDÍMÉNT / 14' NORTH DITCH SEDIMENT SANITARY LAGOON SEDIMENT /////// //////// 111 / / /////////// 11 11 ///// Ż $\overline{\ }$ $\overline{\ }$ \mathbf{i} \mathbf{i} **EMERGENCY BASIN SOILS** NORTH DITCH SOILS SANITARY LAGOON SOILS SOLID WASTE BURIALS (NO. 1) **FIGURE C.2** Date: DECEMBER 2007 MFG, Inc. **PHASE | AREA** Project: 180734 consulting scientists and engineers TYPICAL INTERIOR CELL PROFILE File: CELL-FIG-XS.DWG





PHASE III AREA **TYPICAL INTERIOR CELL PROFILE**





ATTACHMENT C.1

DISPOSAL MATERIAL CHARACTERIZATION SUMMARY

Updated Disposal Material Radiological Characterization Summary

Type A Material

		Number	Th-230, pCi/g		Ra-226, pCi/g			Ra-226 @ 1000 yrs, pCi/g			
	Vol.	Of		Std	UCL,			UCL,		Std	UCL,
Location	(ft ³⁾)	Samples	Mean	Dev	95%	Mean	Std Dev	95%	Mean	Dev	95%
Raffinate Sludge	355,000	11	11100	13400	20200	128	62.2	170	3970	4732	7183
Pond 2 Residual Materials	762,000	52	2100	2460	2790	71.5	79.6	93.7	782	913	1038
Emergency Basin Sediment	14,600	Estimate	16300	10300	29100	332	142	508	5923	3699	10519
North Ditch Sediment	20,770	Estimate	211	232	499	7.18	5.41	13.9	78.5	84.7	184
Sanitary Lagoon Sediment	10,365	Estimate	276	338	1120	5.77	5.61	19.7	100	122	405

Type B Material

		Number	Th-230, pCi/g			Ra-226, pCi/g			Ra-226 @ 1000 yrs, pCi/g		
	Vol.	Of		Std	UCL,			UCL,		Std	UCL,
Location	(ft ³)	Samples	Mean	Dev	95%	Mean	Std Dev	95%	Mean	Dev	95%
Clarifier & Pond 4 Liners	332,400	28	149	238	241	5.42	8.62	8.77	55.7	88.9	90.1
Calcium Fluoride Basin Liner	95,285	Estimate	4.91	2.87	7.91	0.703	0.236	0.95	2.2	1.2	3.4
Emergency Basin Soils	162,500	Estimate	149	238	241	5.42	8.62	8.77	55.7	88.9	90.1
North Ditch Soils	87,500	Estimate	149	238	241	5.42	8.62	8.77	55.7	88.9	90.1
Sanitary Lagoon Liner	56,356	Estimate	47.1	36.1	56.6	2.11	0.882	2.34	17.9	13.2	21.3
Pond 1 Spoils Pile	437,400	59	47.1	36.1	56.6	2.11	0.882	2.34	17.9	13.2	21.3
Chipped Pallets	3,000										

Type C Material

		Number	T	h-230, pC	Ci/g		Ra-226, pC	i/g	Ra-226	Ra-226 @ 1000 yrs, pCi/g		
	Vol.	Of		Std	UCL,			UCL,		Std	UCL,	
Location	(ft ³)	Samples	Mean	Dev	95%	Mean	Std Dev	95%	Mean	Dev	95%	
Fluoride Holding Basin #1	171,400	Estimate	4.91	2.87	7.91	0.703	0.236	0.95	2.2	1.2	3.4	
Fluoride Holding Basin #2	186,000	Estimate	4.91	2.87	7.91	0.703	0.236	0.95	2.2	1.2	3.4	
Fluoride Settling Basins & Clar.	114,300	Estimate	4.91	2.87	7.91	0.703	0.236	0.95	2.2	1.2	3.4	
Buried Calcium Fluoride	96,380	6	4.91	2.87	7.91	0.703	0.236	0.95	2.2	1.2	3.4	
Buried Fluoride Holding Basin												
1	57,200	Estimate	4.91	2.87	7.91	0.703	0.236	0.95	2.2	· 1.2	3.4	
Interim Storage Cell	154,887	Estimate	47.1	36.1	56.6	2.11	0.882	2.34	17.9	13.2	21.3	
Solid Waste Burials (No. 1)	43,000	Estimate	47.1	36.1	56.6	2.11	0.882	2.34	17.9	13.2	21.3	
Solid Waste Burials (No. 2)	8,100	Estimate	47.1	36.1	56.6	2.11	0.882	2.34	17.9	13.2	21.3	
UF6 Cyliners	15,500											
DUF4 Drummed Contam.												
Trash	2,200											
Other Drummed Contam. Trash	4,050											
Empty Contam. Drums	2,000											
Main Process Building	436,600											
Solvent Extraction Building	36,000											
DUF4 Building	56,200											
ADU/Misc. Digestion Bldg	15,000											
Laundry Building	2,500											
Centrifuge Building	3,000											
Bechtel Building	5,400											
Solid Waste Building	3,600											
Cooling Tower	6,000			-								
RCC Evaporator	3,700						*.					
Incinerator	1,500											
Concrete and Asphalt	511,795											
Scrap Metal	50,000											

Type D Material

,		Number	Th-230, pCi/g		Ra-226, pCi/g			Ra-226 @ 1000 yrs, pCi/g			
	Vol.			Std	UCL,			UCL,		Std	UCL,
Location	(ft ³)	Samples	Mean	Dev	95%	Mean	Std Dev	95%	Mean	Dev	95%
Site Soils	600,000	8	36.5	54.1	81.8	2.48	1.26	3.54	14.4	19.8	30.9.

Initial Disposal Material Characterization Summary*

Matarial	SCU No ^a	Item	Layer	Volume	Weight	Nat. Ura	nium	Thoriu	m-230	Radiu	m -226
Material	SCUNO.	No. ^b	No. ^c	(cu ft) ^d	(10^9 g)	pCi/g	Ci	pCi/g	Ci	pCi/g	Ci
SLUDGES & SEDIMENTS		_									
Raffinate sludge	17	· 5	А	1,064,000	6.76	5914	37.14	9611.1	60.4	118.1	0.7
Pond 2 residual materials	18	8	Α	635,000	17.8	288	10.77	1284	48.03	43.0	1.61
Emergency basin sediment	6	11	А	14,600	0.139	3864	0.54	33,900	4.71	885	0.123
North ditch sediment	9	11	А	20,770	0.198	3865	0.77	698	0.137	170	0.033
Sanitary lagoon sediment	7	10	Α	10,365	0.099	12,884	1.28	276	0.50	5.8	0.008
Fluoride holding basin #1	13	7	Č –	171,400	2.62	311	0.82	4.8	0.013	0.8	0.002
Fluoride holding basin #2	12	7	С	186,000	2.85	356	1.02	4.8	0.014	0.8	0.002
Fluoride settling basins & clarifier	14	7	С	114,300	1.79	520	0.92	4.8	0.008	0.8	0.001
Buried calcium fluoride	15	7	C	96,380			1.52				
Buried fluoride holding basin #1	15	7	С	57,200	0.875	313	0.27	4.8	0.004	0.8	0.001
LINER SOILS & SUBSOILS											
Clarifier liners	17	8	В	332,400	16.6	28	0.47	70	1.16	0.5	0.008
Calcium fluoride basin liner	12, 13, 14	8	В	95,285	4.76	13.3	0.064				
Pond 3E clay liner	24	8	В	88,232	4.41	4.9	0.02			~-	
Emergency basin soils	6	11	В	162,500	8.12	95	0.78				
North ditch soils	9	11	В	87,500	4.37	68	0.30				
Sanitary lagoon liner	7	10	B	56,356	2.81	28	0.08	70	0.20	0.5	0.001
BURIED MATERIALS & DRUMS											
Pond 1 spoils pile	8	8	В	437,400	21.8	4.8	0.11	47	1.02	2.1	0.046
Interim storage cell	9	35	C	154,887	7.74	373	2.89	2.1	0.016	0.21	0.0016
Solid waste burials	5	12	С	51,100	•••		0.681				
DUF ₄ drummed contaminated trash		2	С	2,200			0.37 ^e				
Other drummed contaminated trash	-	6	С	4,050			0.015				
Empty contam. Drums		3	С	2,000			0.015				

* From SCR (SFC, 1998).







Initial Disposal Material Characterization Summary (continued)*

Material	erial SCU No. ^a		Layer	Volume	Weight	Nat. U	ranium	Thorium-230		Radium -226	
			No."	(cu ft)	(10° g)	pCi/g	Ci	pCi/g	Ci	pCi/g	Ci
STRUCTURAL MATERIALS	(see below)	(see below)		568,550	51.6	168	8.67				
Main plant building	1	13	С	[2,178,000]							
Solvent Extraction Building	2	13	С	[180,000]							
DUF ₄ Building	29	13	С	[281,000]							
ADU/Misc. digestion building	· 21	13	С	[75,000]							
Laundry building	17	13	С	[12,500]							
Centrifuge building	17	13	С	[15,000]							
Bechtel building	30	13	С	[27,000]							
Solid waste building	10	13	С	[18,000]	•						
Cooling tower	2	13	С	[30,000]							
RCC evaporator	2	13	C	[18,750]			,				
Incinerator	10	. 13	С	[7,500]							
Concrete and asphalt	Various	13	С	511,795	46.5	168	7.81				
Scrap metal		4	C	100,000			0.15			·	
Chipped pallets			В	3,000				~-			
SUBSOILS & BEDROCK											
Contaminated materials ^t	Various	14	D	3,574,000	178.5	250	44.8				

* From SCR (SFC, 1998).

a Site characterization unit number from Section 4 of SCR (SFC, 1998).

١

b Calculation item number in Attachment III of SCR. c Layer number in disposal cell sequence.

d Values are from Attachment III of SCR; values in brackets are calculated building volumes from floor area and building height; disposal volume is 20 percent of building volume.

e Depleted uranium value

f Materials above 27 pCi/g natural uranium.

ATTACHMENT C.2

RADON MODEL OUTPUT

-----*****! RADON !*****-----

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: phase I 95% ucl

DESCRIPTION: no

-57

CONSTANTS

RADON	DECAY	CONS	TANT		.0	000021	s^-1
RADON	WATER,	/AIR	PARTITION	COEFFICIEN	IT .2	6	
DEFAU	GT SPEC	CIFIC	GRAVITY (OF COVER &	TAILINGS		2.65

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	б	
NO LIMIT ON RADON FLUX		
LAYER THICKNESS NOT OPTIMIZED		
DEFAULT SURFACE RADON CONCENTRATION	0	pCi 1^-1
SURFACE FLUX PRECISION	. 1	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 layer A

THICKNESS POROSITY	61 . 7	Cm
CALCULATED MASS DENSITY	.795	g cm^-3
MEASURED RADIUM ACTIVITY	3542	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	,
CALCULATED SOURCE TERM CONCENTRATION	2.957D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	15	£
MOISTURE SATURATION FRACTION	.170	
CALCULATED DIFFUSION COEFFICIENT	4.942D-02	cm^2 s^-1

LAYER 2 layer b-d

THICKNESS 426 cm POROSITY . 4 CALCULATED MASS DENSITY 1.59 g cm^-3 MEASURED RADIUM ACTIVITY 74.3 pCi/g^-1 DEFAULT LAYER EMANATION COEFFICIENT .35 2.1710-04 CALCULATED SOURCE TERM CONCENTRATION pCi cm^-3 s^-1 WEIGHT % MOISTURE 6 3 .238 MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT 3.131D-02 cm^2 s^-1

LAYER 3 clay liner

THICKNESS	61	cm
POROSITY	. 39	
CALCULATED MASS DENSITY	1.6165	g cm^-3
MEASURED RADIUM ACTIVITY	0.	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm [^] -3 s [^] -1
WEIGHT % MOISTURE	15	ક
MOISTURE SATURATION FRACTION	.622	
CALCULATED DIFFUSION COEFFICIENT	5.861D-03	cm^2 s^-1

LAYER 4 liner cover

THICKNESS	46	cm
POROSITY	. 4	
CALCULATED MASS DENSITY	1.59	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-l
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	₽.
MOISTURE SATURATION FRACTION	.238	
CALCULATED DIFFUSION COEFFICIENT	3.131D-02	cm^2 s^-1

LAYER 5 subsoil

THICKNESS	152	Cm
POROSITY	.45	
CALCULATED MASS DENSITY	1.4575	g_cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	15	Ş
MOISTURE SATURATION FRACTION	.486	
CALCULATED DIFFUSION COEFFICIENT	1.334D-02	cm^2 s^-1

LAYER 6 topsoil

THICKNESS	46	CM
POROSITY	.49	
CALCULATED MASS DENSITY	1.3515	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/q^-l
DEFAULT LAYER EMANATION COEFFICIENT	. 35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	£
MOISTURE SATURATION FRACTION	.165	
CALCULATED DIFFUSION COEFFICIENT	4.231D-02	cm^2 s^-1

r* .**

DATA SENT TO THE FILE 'RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC	
6	-1.000D+00	0.000D+00	0	0.000D+00	1.000D-01	
LAYER	DX	D	Р	Q	XMS	RHO
1	6.100D+01	4.942D-02	7.000D-01	2.957D-03	1.704D-01	0.795
2	4.260D+02	3.131D-02	4.000D-01	2.171D-04	2.385D-01	1.590
3	6.100D+01	5.861D-03	3.900D-01	0.000D+00	6.217D-01	1.617
4	4.600D+01	3.131D-02	4.000D-01	0.000D+00	2.385D-01	1.590
5	1.520D+02	1.334D-02	4.500D-01	0.000D+00	4.858D-01	1.458
6	4.600D+01	4.231D-02	4.900D-01	0.000D+00	1.655D-01	1.352

BARE SOURCE FLUX FROM LAYER 1: 1.021D+03 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS	EXIT FLUX	EXIT CONC.
	(cm)	(pCi m^-2 s^-1)	(pCi l^-1)
1.	6.100D+01	4.935D+02	6.192D+05
2	4.260D+02	3.175D+01	1.018D+05
3	6.100D+01	1.412D+01	1.151D+04
4	4.600D+01	8.192D+00	1.351D+04
5	1.520D+02	2.139D+00	3.347D+02
6	4.600D+01	2.031D+00	0.000D+00

----*****! RADON !*****-----

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: raff storage 95% UCL for Ra

AREA ITA

.

s^-1

2.65

.0000021

DESCRIPTION: no

RADON DECAY CONSTANT

800

.

CONSTANTS

RADON WATER/AIR PARTITION COEFFICIENT .26 DEFAULT SPECIFIC GRAVITY OF COVER & TAILINGS

	GENERAL INPUT PARAMETERS		
	LAYERS OF COVER AND TAILINGS NO LIMIT ON RADON FLUX	7	
	LAYER THICKNESS NOT OPTIMIZED		
	DEFAULT SURFACE RADON CONCENTRATION	0	pCi 1^-1
	SURFACE FLUX PRECISION	.1	pCi m^-2 s^-1
	LAYER INPUT PARAMETERS		
	LAYER 1 raff sludge		
	THICKNESS	377	CM
	POROSITY	.8	
	CALCULATED MASS DENSITY	.5299999999999	99999 g cm^-3
	MEASURED RADIUM ACTIVITY	7183	pCi/g^-1
	DEFAULT LAYER EMANATION COEFFICIENT	.35	
	CALCULATED SOURCE TERM CONCENTRATION	3.4980-03	pui cm ⁻³ s ⁻¹
	WEIGHT & MOISTORE	100	ž
	MOISTURE SATURATION FRACTION	.662	
	CALCULATED DIFFUSION COEFFICIENT	1.0180-02	cm//2 s/-1
			· - *
	LAYER 2 nond 2		
	THICKNESS	128	Cm
	POROSITY	.7	
e	CALCULATED MASS DENSITY	.795	'g cm^-3
	MEASURED RADIUM ACTIVITY	1038	pCi/g^-1
	DEFAULT LAYER EMANATION COEFFICIENT	.35	
	CALCULATED SOURCE TERM CONCENTRATION	8.6650-04	pCi cm^-3 s^-1
	WEIGHT % MOISTURE	15	
	MOISTURE SATURATION FRACTION	.170	
	CALCULATED DIFFUSION COEFFICIENT	4.942D-02	cm^2 s^-1

LAYER 3 struct debris

1

THICKNESS	256	Cm
POROSITY	• .2	· · · ·
CALCULATED MASS DENSITY	2.12	g cm^-3
MEASURED RADIUM ACTIVITY	30.9	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	2.407D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	Dis contraction of the second s
MOISTURE SATURATION FRACTION	. 636	
CALCULATED DIFFUSION COEFFICIENT	4.015D-03	cm^2 s^-1

LAYER 4 clay liner

THICKNESS 61 CM POROSITY .39 g cm^-3 CALCULATED MASS DENSITY 1.6165 MEASURED RADIUM ACTIVITY 0 pCi/g^-1 DEFAULT LAYER EMANATION COEFFICIENT .35 CALCULATED SOURCE TERM CONCENTRATION 0.000D+00 pCi cm^-3 s^-1 WEIGHT % MOISTURE 15 8 MOISTURE SATURATION FRACTION .622 CALCULATED DIFFUSION COEFFICIENT 5.861D-03 cm^2 s^-1

LAYER 5 liner cover

THICKNESS	46	Cm
POROSITY	. 4	
CALCULATED MASS DENSITY	1.59	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	- <u>-</u>
MOISTURE SATURATION FRACTION	.238	
CALCULATED DIFFUSION COEFFICIENT	3.131D-02	cm^2 s^-1

LAYER 6 subsoil

152 THICKNESS CIN POROSITY .45 CALCULATED MASS DENSITY 1.4575 g cm^-3 MEASURED RADIUM ACTIVITY 0 pCi/g^-1 DÉFAULT LAYER EMANATION COEFFICIENT .35 pCi cm^-3 s^-1 CALCULATED SOURCE TERM CONCENTRATION 0.000D+00 WEIGHT % MOISTURE 15 , s .486 · MOISTURE SATURATION FRACTION 1.334D-02 cm^2 s^-1 CALCULATED DIFFUSION COEFFICIENT

LAYER 7 topsoil

THICKNESS	46	cm
POROSITY	.49	
CALCULATED MASS DENSITY	1.3515	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-l
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	3
MOISTURE SATURATION FRACTION	.165	
CALCULATED DIFFUSION COEFFICIENT	4.231D-02	cm^2 s^-1

DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC	
7	-1.000D+00	0.000D+00	0	0.000D+00	1.000D-01	
TAVED	537	ñ	*3	0	17140	
LAILR	DX	IJ	P	Q	XMS	KHO
1	3.770D+02	1.618D-02	8.000D-01	3.498D-03	6.625D-01	0.530
2	1.280D+02	4.942D-02	7.000D-01	8.665D-04	1.704D-01	0.795
3	2.560D+02	4.015D-03	2.000D-01	2.407D-04	6.360D-01	2.120
4	6.100D+01	5.861D-03	3.900D-01	0.000D+00	6.217D-01	1.617
5	4.600D+01	3.131D-02	4.000D-01	0.000D+00	2.385D-01	1.590
6	1.520D+02	1.334D-02	4.500D-01	0.000D+00	4.858D-01	1.458
7	4.600D+01	4.231D-02	4.900D-01	0.000D+00	1.655D-01	1.352

BARE SOURCE FLUX FROM LAYER 1: 2.422D+03 pCi m^-2 s^-1

.

RESÚLTS	OF	THE	RADON	DIFFUSION	CALCULATIONS

LAYER	THICKNESS	EXIT FLUX	EXIT CONC.
	(cm)	(pCi m^-2 s^-1)	(pCi 1^-1)
1	3.770D+02	1.350D+03	7.2730+05
2	1.280D+02	8.971D+01	9.950D+05
3	2.560D+02	1.565D+01	3.224D+04
4	6.100D+01	6.960D+00	5.673D+03
5	4.600D+01	4.037D+00	6.657D+03
6	1.520D+02	1.054D+00	1.649D+02
7	4.600D+01	1.001D+00	0.000D+00



----*****! RADON !*****-----

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: phase 2 wo raff

AREA ITB

DESCRIPTION: no

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
DEFAULT SPECIFIC GRAVITY OF COVER & TAIL	.26 INGS	2.65
GENERAL INPUT PARAMETERS		
LAYERS OF COVER AND TAILINGS NO LIMIT ON RADON FLUX	6	
LAYER THICKNESS NOT OPTIMIZED		
DEFAULT SURFACE RADON CONCENTRATION	0	pCi 1^-1
SORFACE FLOX PRECISION	• .L·	pui m ² s ² -1
LAYER INPUT PARAMETERS		
LAYER 1 pond 2		
		· .
THICKNESS	505	cm [†]
POROSITY	.7	1
CALCULATED MASS DENSITY	.795	g cm^-3
MEASURED RADIUM ACTIVITY	1038	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	8.665D-04	pCi. cm^-3 s^-:
WEIGHT & MOISTURE	15	ş

MOISTURE SATURATION FRACTION

CALCULATED DIFFUSION COEFFICIENT

LAYER 2 struct debris

THICKNESS POROSITY CALCULATED MASS DENSITY MEASURED RADIUM ACTIVITY DEFAULT LAYER EMANATION COEFFICIENT CALCULATED SOURCE TERM CONCENTRATION WEIGHT % MOISTURE MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT 256 cm .2 2.12 g cm^-3 30.9 pCi/g^-1 .35 2.407D-04 pCi cm^-3 s^-1 6 % .636 4.015D-03 cm^2 s^-1

cm^2 s^-1

.170

4.942D-02

ca,S

LAYER 4 liner cover		
THICKNESS	46	cm ·
POROSITY	. 4	
CALCULATED MASS DENSITY	1.59	g cm ⁻³
MEASURED RADIUM ACTIVITY	0 ·	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	-
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT & MOISTURE	6	ş
MOISTURE SATURATION FRACTION	.238	
CALCULATED DIFFUSION COEFFICIENT	3.131D-02	cm^2 s^-1
LAYER 5 subsoil		
	1.50	
PAPOATAL	102	Cm
PORUSITY ONLONG DENSITY	.45	
CALCULATED MASS DENSITY	1.4575	g cm ² -3
MEASURED RADIUM AUTIVITY	U SE	pul/gn=1
OBFAULT LAIER EMANATION COEFFICIENT		
VELOUATED SOURCE TERM CONCENTRATION	1 =	901 CH1-3 51-1
WEIGHI 5 MUIDIURE	10	3
CALCHINGED DIFFUSION COFFEEDINE	.400 1 2240 00	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
CALCOLAIDD DIFFOSION COLFFICIENT	1.3390-02	$Cm \ge S = 1$
LAYER 6 topsoil		•
· · ·	у I 1	
THICKNESS	46	CM
POROSITY	.49 .	
CALCULATED MASS DENSITY	1.3515	g cm^-3
MEASURED RADIUM ACTIVITY	. 0 .	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1

6

.165

4.231D-02

8

cm^2 s^-1

WEIGHT % MOISTURE

MOISTURE SATURATION FRACTION

CALCULATED DIFFUSION COEFFICIENT

clay liner

THICKNESS 61 CIR.39 POROSITY CALCULATED MASS DENSITY 1.6165 g cm^-3 pCi/g^-l MEASURED RADIUM ACTIVITY 0 DEFAULT LAYER EMANATION COEFFICIENT .35 CALCULATED SOURCE TERM CONCENTRATION 0.000D+00 pCi cm^-3 s^-1 WEIGHT % MOISTURE 15 3 MOISTURE SATURATION FRACTION .622 CALCULATED DIFFUSION COEFFICIENT 5.861D-03 cm^2 s^-1

LAYER 3

DATA SENT TO THE FILE 'RNDATA' ON DRIVE A:

N	F01	CN1	ICOST -	CRITJ	ACC	
6	-1.000D+00	0.000D+00	0	0.000D+00	1.000D-01	
LAYER	DX	D	P	Q	XMS	RHO
1	5.050D+02	4.942D-02	7.000D-01	8.665D-04	1.704D-01	0.795
2	2.560D+02	4.015D-03	2.000D-01	2.407D-04	6.360D-01	2.120
3	6.100D+01	5.861D-03	3.900D-01	0.000D+00	6.217D-01	1.617
4	4.600D+01	3.131D-02	4.000D-01	0.000D+00	2.385D-01	1.590
5	1.520D+02	1.334D-02	4.500D-01	0.000D+00	4.858D-01	1.458
6	4.600D+01	4.231D-02	4.900D-01	0.000D+00	1.655D-01	1.352

BARE SOURCE FLUX FROM LAYER 1: 8.948D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS	EXIT FLUX	EXIT CONC.
·	(Chr)	(por m 2 5 1)	(Por r . r)
1	5.050D+02	2.220D+01	3.880D+05
2	2.560D+02	1.537D+01	3.166D+04
3	6.100D+01	6.835D+00	5.571D+03
4	4.600D+01	3.964D+00	6.537D+03
5	1.520D+02	1.035D+00	1.620D+02
6	4.600D+01	9.829D-01	0.000D+00

----*****! RADON !*****-----

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: phase 3

AREA

DESCRIPTION: no

*

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
DEFAULT SPECIFIC GRAVITY OF COVER & TAILING	.20 GS	2.65
GENERAL INPUT PARAMETERS		
LAYERS OF COVER AND TAILINGS NO LIMIT ON RADON FLUX	5	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi 1^-1
SURFACE FLUX PRECISION	.1	pCi m^-2 s^-1
LAYER INPUT PARAMETERS		
LAYER 1 layer b-d		
THICKNESS	457	Cm .
POROSITY	.7	
CALCULATED MASS DENSITY		g_cm^-3
MEASURED RADIUM ACTIVITY	32.9	pCi/g^-l
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	2.7460-05	pCi cm^-3 s^-1
MEIGHT & MOISTURE MOISTURE CATURATION FRACTION	15	8
CALCULATED DIFFUSION COEFFICIENT	4.942D-02	cm^2 s^-1
LAYER 2 clay liner		

THICKNESS 61 сn POROSITY .39 CALCULATED MASS DENSITY 1.6165 g cm^-3 MEASURED RADIUM ACTIVITY pCi/g^-1 0 DEFAULT LAYER EMANATION COEFFICIENT .35 CALCULATED SOURCE TERM CONCENTRATION 0.000D+00 pCi cm^-3 s^-1 WEIGHT % MOISTURE 15 ş MOISTURE SATURATION FRACTION .622 CALCULATED DIFFUSION COEFFICIENT 5.861D-03 cm^2 s^-1

LAYER 3

۳.

. **b**.

liner cover

46	CM
. 4	
1.59	g cm^-3
0	pCi/g^-l
.35	
0.000D+00	pCi cm^-3 s^-1
6	30
.238	
3.131D-02	cm^2 s^-1
	46 .4 1.59 0 .35 0.000D+00 6 .238 3.131D-02

LAYER 4 subsoil

THICKNESS	152	Cm
POROSITY	.45	
CALCULATED MASS DENSITY	1.4575	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-l
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	15	05
MOISTURE SATURATION FRACTION	.486	
CALCULATED DIFFUSION COEFFICIENT	1.334D-02	cm^2 s^-1

LAYER 5 topsoil

THICKNESS	46	cm
POROSITY	.49	
CALCULATED MASS DENSITY	1.3515	g_cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-l
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm ⁻³ s ⁻¹
WEIGHT % MOISTURE	6	8
MOISTURE SATURATION FRACTION	.165	
CALCULATED DIFFUSION COEFFICIENT	4.231D-02	cm^2 s^-1

DATA SENT TO THE FILE 'RNDATA' ON DRIVE A:

)1
RHO
0.795
01 1.617
01 1.590
01 1.458
01 1.352

BARE SOURCE FLUX FROM LAYER 1: 2.793D+01 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

.

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi 1^-1)
1	4.570D+02	3.236D+00	1.101D+04
2	6.100D+01	1.439D+00	1.173D+03
3	4.600D+01	8.349D-01	1.377D+03
4	1.520D+02	2.1800-01	3.411D+01
5	4.600D+01	2.0700-01	0.000D+00

-----*****! RADON !*****-----

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: raff sludge - lower debris density

DESCRIPTION: no

£

AREA ITA - Low Debris Density

CONSTANTS

RADON DECAY CONSTANT RADON WATER/AIR PARTITION COEFFICIENT	.0000021 .26	s^-1
DEFAULT SPECIFIC GRAVITY OF COVER & TAILIN	NGS	2.65
GENERAL INPUT PARAMETERS		
LAYERS OF COVER AND TAILINGS	7	,
NO LIMIT ON RADON FLUX		
LAYER THICKNESS NOT OPTIMIZED		
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-l
SURFACE FLUX PRECISION	.1	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 raff sludge

THICKNESS POROSITY	377	cm
CALCULATED MASS DENSITY	.529999999999	99999 g cm^-3
MEASURED RADIUM ACTIVITY	7183	pCi/g^-l
DEFAULT LAYER EMANATION COEFFICIENT	. 35	
CALCULATED SOURCE TERM CONCENTRATION	3.498D-03	pCi [·] cm ⁻³ s ⁻¹
WEIGHT % MOISTURE	1.00	8
MOISTURE SATURATION FRACTION	.662	
CALCULATED DIFFUSION COEFFICIENT	1.618D-02	cm^2 s^-1

LAYER 2 pond 2

THICKNESS	128	Cm
POROSITY	. 7	
CALCULATED MASS DENSITY	,795	g cm ⁻³
MEASURED RADIUM ACTIVITY	1038	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	. 35	
CALCULATED SOURCE TERM CONCENTRATION	8.665D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	15	8 6
MOISTURE SATURATION FRACTION	.170	
CALCULATED DIFFUSION COEFFICIENT	4.942D-02	cm^2 s^-1

LAYER 3 struc debris

THICKNESS

THICKNESS	256	сл
POROSITY	. 4	
CALCULATED MASS DENSITY	1.59	g cm ⁻³
MEASURED RADIUM ACTIVITY	30.9	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	9.028D-05	pCi cm^-3 s^-1
WEIGHT & MOISTURE	6	8
MOISTURE SATURATION FRACTION	.238	
CALCULATED DIFFUSION COEFFICIENT	3.131D-02	cm^2 s^-1

61

CM

용

g cm^-3

pCi/g^-1

-cm^2_s^-1

pCi cm^-3 s^-1

POROSITY .39 CALCULATED MASS DENSITY 1.6165 MEASURED RADIUM ACTIVITY 0 DEFAULT LAYER EMANATION COEFFICIENT . 35 CALCULATED SOURCE TERM CONCENTRATION 0.000D+00 WEIGHT % MOISTURE 15 MOISTURE SATURATION FRACTION . 622 CALCULATED DIFFUSION COEFFICIENT 5.861D-03

LAYER 5 liner cover

LAYER 4 clay liner

THICKNESS 46 CMPOROSITY . 4 CALCULATED MASS DENSITY 1.59 g_cm^-3 MEASURED RADIUM ACTIVITY 0 pCi/g^-l DEFAULT LAYER EMANATION COEFFICIENT .35 pCi cm^-3 s^-1 CALCULATED SOURCE TERM CONCENTRATION 0.000D+00 WEIGHT % MOISTURE 6 2 MOISTURE SATURATION FRACTION .238 CALCULATED DIFFUSION COEFFICIENT 3.131D-02 cm^2 s^-1

LAYER 6

subsoil

THICKNESS POROSITY CALCULATED MASS DENSITY MEASURED RADIUM ACTIVITY DEFAULT LAYER EMANATION COEFFICIENT CALCULATED SOURCE TERM CONCENTRATION WEIGHT & MOISTURE MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT

152 CM.45 1.4575 g cm^-3 0 pCi/g^-l .35 0.000D+00 pCi cm^-3 s^-1 15 8 .486 1.334D-02 cm^2 s^-1

LAYER 7 topsoil

THICKNESS	46	Cm
POROSITY	. 49	
CALCULATED MASS DENSITY	1.3515	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-l
DEFAULT LAYER EMANATION COEFFICIENT	. 35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	ş
MOISTURE SATURATION FRACTION	.165	
CALCULATED DIFFUSION COEFFICIENT	4.231D-02	cm^2 s^-1
		•

DATA SENT TO THE FILE 'RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC	
7	-1.000D+00	0.000D+00	0	0.000D+00	1.000D-01	
TAVED	DV.	а	D	0	VMC	DUO
THE LEAK	DA	D	. E	¥ .	A110	RIU
1	3.770D+02	1.618D-02	8.000D-01	3.498D-03	6.625D-01	0.530
2	1.280D+02	4.942D-02	7.000D-01	8.665D-04	1.704D-01	0.795
3	2.560D+02	3.131D-02	4.000D-01	9.028D-05	2.385D-01	1.590
4	6.100D+01	5.861D-03	3.900D-01	0.000D+00	6.217D-01	1.617
5	4.600D+01	3.131D-02	4.000D-01	0.000D+00	2.385D-01	1.590
6	1.520D+02	1.334D-02	4.500D-01	0.000D+00	4.858D-01	1.458
7	4.600D+01	4.231D-02	4.900D-01	0.000D+00	1.655D-01	1.352

BARE SOURCE FLUX FROM LAYER 1: 2.422D+03 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS	EXIT FLUX	EXIT CONC.
	(cm)	(pCi m^-2 s^-1)	(pCi 1^-1)
1.	3.770D+02	1.493D+03	6.307D+05
2	1.280D+02	6.337D+02	7.093D+05
3	2.560D+02	4.683D+01	1.501D+05
4	6.100D+01	2.083D+01	1.698D+04
5	4.600D+01	1.208D+01	1.992D+04
6	1.520D+02	3.154D+00	4.937D+02
7	4.600D+01	2.996D+00	0.000D+00

-----*****! RADON !*****-----

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: raff sludge - lower water content

DESCRIPTION: no

RADON DECAY CONSTANT

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AREA IT A - Low Shudge W

s^-1 -

.0000021

8.665D-04

15

.170

pCi cm^-3 s^-1

8

4.942D-02 cm^2 s^-1

CONSTANTS

CALCULATED SOURCE TERM CONCENTRATION

MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT

WEIGHT % MOISTURE

RADON WATER/AIR PARTITION COEFFICIENT DEFAULT SPECIFIC GRAVITY OF COVER & TAIL	.26 JINGS	2.65
GENERAL INPUT PARAMETERS		
LAYERS OF COVER AND TAILINGS NO LIMIT ON RADON FLUX	7	
LAYER THICKNESS NOT OPTIMIZED		
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-l
SURFACE FLUX PRECISION	.1	pCi m^-2 s^-1
LAYER INPUT PARAMETERS		
LAYER 1 raff sludge		
THICKNESS	377	cm
POROSITY	. 8	
CALCULATED MASS DENSITY	.5299999999	9999999 g cm^-3
MEASURED RADIUM ACTIVITY	7183	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	3.498D-03	pCi cm^-3 s^-1
WEIGHT & MOISTURE	50	9. 10
MOISTURE SATURATION FRACTION	.331	
CALCULATED DIFFUSION COEFFICIENT	4.276D-02	cm^2 s^-1
DATER Z 'PODG Z		
THICKNESS	128	~~YD
POROSTTY	.7	Carr .
CALCULATED MASS DENSITY	.795	a cm^-3
MEASURED RADIUM ACTIVITY	1038	pCi/q^{-1}
DEFAULT LAYER EMANATION COEFFICIENT	35	E A *

4 1

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LAYER 3 struct debris

THICKNESS	256	Cm
POROSITY	.2	
CALCULATED MASS DENSITY	2.12	g cm^-3
MEASURED RADIUM ACTIVITY	30.9	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	2.407D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	9. 9
MOISTURE SATURATION FRACTION	.636	
CALCULATED DIFFUSION COEFFICIENT	4.015D-03	cm^2 s^-1

LAYER 4 clay liner

THICKNESS	61	Cm
POROSITY	.39	
CALCULATED MASS DENSITY	1.6165	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	15 .	q .
MOISTURE SATURATION FRACTION	.622	
CALCULATED DIFFUSION COEFFICIENT	5.861D-03	cm^2 s^-1

LAYER 5 liner cover

THICKNESS	46	CM
POROSITY	. 4	
CALCULATED MASS DENSITY	1.59	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-l
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	9 1
MOISTURE SATURATION FRACTION	.238	
CALCULATED DIFFUSION COEFFICIENT	3.131D-02	cm^2 s^-1

LAYER 6 subsoil

152	Cm
.45	
1.4575	g_cm^-3
0	pCi/g^-1
.35	
0.000D+00	pCi cm^-3 s^-1
15	8
.486	
1.334D-02	cm^2 s^-1
	152 .45 1.4575 0 .35 0.000D+00 15 .486 1.334D-02

LAYER 7 topsoil

THICKNESS	46	Cm
POROSITY	.49	
CALCULATED MASS DENSITY	1.3515	g cm ⁻³
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	б	Cio
MOISTURE SATURATION FRACTION	.165	
CALCULATED DIFFUSION COEFFICIENT	4.231D-02	cm^2 s^-1

DATA SENT TO THE FILE 'RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC	
7	-1.000D+00	0.000D+00	0	0.000D+00	1.000D-01	
LAYER	DX	D	Р	Q	XMS	RHO
1	3.770D+02	4.276D-02	8.000D-01	3.498D-03	3.312D-01	0.530
2	1.280D+02	4.942D-02	7.000D-01	8.665D-04	1.704D-01	0.795
3	2.560D+02	4.015Ď-03	2.000D-01	2.407D-04	6.360D-01	2,120
4	6.100D+01	5.861D-03	3.900D-01	0.000D+00	6.217D-01	1.617
5	4.600D+01	3.131D-02	4.000D-01	0.000D+00	2.385D-01	1.590
6	1.520D+02	1.334D-02	4.500D-01	0.000D+00	4.858D-01	1.458
7	4.600D+01	4.231D-02	4.900D-01	0.000D+00	1.655D-01	1.352

BARE SOURCE FLUX FROM LAYER 1: 3.693D+03 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-l)
1	3.770D+02	1.257D+03	1.027D+06
2	1.280D+02	8.513D+01	9.538D+05
3	2.560D+02	1.563D+01	3.220D+04
4	6.100D+01	6.952D+00	5.666D+03
5	4.600D+01	4.032D+00	6.649D+03
6	1.520D+02	1.053D+00	1.647D+02
7	4.600D+01	9.997D-01	0.000D+00

----*****! RADON !*****-----

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: 10000 I

AREA I, 10,000 YRS

DESCRIPTION: no

CONSTANTS

RADON DECAY CONS	TANT	.0000021	s^-1
RADON WATER/AIR	PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC	GRAVITY OF COVER & TAI	LINGS	2.65

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	б	
NO LIMIT ON RADON FLUX		
LAYER THICKNESS NOT OPTIMIZED		
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-l
SURFACE FLUX PRECISION	.1	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1

layer A

61	cm
.7	
.795	g_cm^-3
9013	pCi/g^-l
.35	
7.524D-03	pCi cm^-3 s^-1
15	c,ło
.170	
4.942D-02	cm^2 s^-1
	61 .7 .795 9013 .35 7.524D-03 15 .170 4.942D-02

LAYER 2 layer b-d

THICKNESS 426 сm POROSITY . 4 CALCULATED MASS DENSITY 1.59 g cm^-3 MEASURED RADIUM ACTIVITY 81.5 pCi/g^-l DEFAULT LAYER EMANATION COEFFICIENT .35 pCi cm^-3 s^-1 CALCULATED SOURCE TERM CONCENTRATION 2.3810-04 WEIGHT % MOISTURE 6 MOISTURE SATURATION FRACTION .238 CALCULATED DIFFUSION COEFFICIENT 3.131D-02 cm^2 s^-1

LAYER 3 clay layer

THICKNESS	61	cm
POROSITY	.39	
CALCULATED MASS DENSITY	1.6165	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	15	3
MOISTURE SATURATION FRACTION	.622	
CALCULATED DIFFUSION COEFFICIENT	5.861D-03	cm^2 s^-1

LAYER 4 liner cover

THICKNESS	46	CM
POROSITY	. 4	
CALCULATED MASS DENSITY	1.59	g cm ⁻³
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT & MOISTURE	б	- %
MOISTURE SATURATION FRACTION	.238	
CALCULATED DIFFUSION COEFFICIENT	3.131D-02	cm^2 s^-1

LAYER 5 subsoil

THICKNESS	152	CM	
POROSITY	.45		
CALCULATED MASS DENSITY	1.4575	g cm^-3	
MEASURED RADIUM ACTIVITY	0	pCi/g^-1	
DEFAULT LAYER EMANATION COEFFICIENT	.35		
CALCULATED SOURCE TERM CONCENTRATION	0.000D÷00	pCi cm^-3 s^-1	
WEIGHT % MOISTURE	15	8	,
MOISTURE SATURATION FRACTION	.486		
CALCULATED DIFFUSION COEFFICIENT	1.334D-02	cm^2 s^-1	

LAYER 6 topsoil

THICKNESS 46 CM POROSITY . 49 CALCULATED MASS DENSITY g cm^-3 1.3515 pCi/g^-1 MEASURED RADIUM ACTIVITY 0 DEFAULT LAYER EMANATION COEFFICIENT .35 CALCULATED SOURCE TERM CONCENTRATION 0.000D+00 pCi cm^-3 s^-1 6 WEIGHT & MOISTURE સ .165 4.231D-02 MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT cm^2 s^-1

DATA SENT TO THE FILE 'RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC	
• 6	-1.000D+00	0.000D+00	0	0.000D+00	1.000D-01	
LAYER	DX	D	P	Q	XMS	RHO
1	6.100D+01	4.942D-02	7.000D-01	7.524D-03	1.704D-01	0.795
2	4.260D+02	3.131D-02	4.000D-01	2.381D-04	2.385D-01	1.590
3	6.100D+01	5.861D-03	3.900D-01	0.000D+00	6.217D-01	1.617
4	4.600D+01	3.131D-02	4.000D-01	0.000D+00	2.385D-01	1.590
5	1.520D+02	1.334D-02	4.500D-01	0.000D+00	4.858D-01	1.458
6	4.600D+01	4.231D-02	4.900D-01	0.000D+00	1.655D-01	1.352

BARE SOURCE FLUX FROM LAYER 1: 2.599D+03 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS	EXIT FLUX	EXIT CONC.
	(cm)	(pCi m^-2 s^-1)	(pCi 1^-1)
1	6.100D+01	1.327D+03	1.493D+06
2	4.260D+02	4.602D+01	1.475D+05
3	6.100D+01	2.047D+01	1.669D+04
4	4.600D+01	1.187D+01	1.958D+04
5	1.520D+02	3.100D+00	4.852D+02
6	4.600D+01	2.944D+00	0.0000+00

----*****! RADON !*****-----

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: 10000 IIA

AREA ITA. - 10,000 YRS

ćm^-3

DESCRIPTION: no

CONSTANTS

MOISTURE SATURATION FRACTION

CALCULATED DIFFUSION COEFFICIENT

RADON DECAY CONSTANT	.0000021	s^-1
DEFAULT SPECIFIC GRAVITY OF COVER	& TAILINGS	2.65
	are c	
GENERAL INFOI PARAME	ILKS	· · · ·
LAYERS OF COVER AND TAILINGS NO LIMIT ON RADON FLUX LAYER THICKNESS NOT OPTIMIZED	7	· .
DEFAULT SURFACE RADON CONCENTRATIO	N O	pCi 1^-1
SURFACE FLUX PRECISION	.1	pCi m^-2 s^-1
LAYER INPUT PARAMETE	RS	
LAYER 1 raff sludge		
BUTCHNECC	× د د د	
POROSTEV	ġ	Citi
CALCULATED MASS DENSITY	52999999999	999999 7
MEASURED RADIUM ACTIVITY	18587	DCi/g^~1
DEFAULT LAYER EMANATION COEFFICIEN	T .35	
CALCULATED SOURCE TERM CONCENTRATI	ON 9.051D-03	pCi cm^-3 s^-1
WEIGHT & MOISTURE	100	- - -
MOISTURE SATURATION FRACTION	.662	
CALCULATED DIFFUSION COEFFICIENT	1.618D-02	cm^2 s^-1
LAYER 2 pond 2		
THICKNESS	128	CM
POROSITY	.7	
CALCULATED MASS DENSITY	.795	g cm^-3
MEASURED RADIUM ACTIVITY	2568	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIEN	T .35	$\sim - \gamma $
CALCULATED SOURCE TERM CONCENTRATI	ON 2.144D-03	pCi cm^-3 s^-1
WEIGHT & MOISTURE	15	<u>9</u>

.170

4.942D-02 cm^2 s^-1

LAYER 3 struc debris

THICKNESS	256	cm
POROSITY	.2	
CALCULATED MASS DENSITY	2.12	g cm^-3
MEASURED RADIUM ACTIVITY	75.3	pCi/g^-l
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	5.867D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	10
MOISTURE SATURATION FRACTION	.636	
CALCULATED DIFFUSION COEFFICIENT	4.015D-03	cm^2 s^-1

LAYER 4 clay liner

THICKNESS POROSITY	61 .39	cm
CALCULATED MASS DENSITY	1.6165	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-l
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	15	8
MOISTURE SATURATION FRACTION	.622	
CALCULATED DIFFUSION COEFFICIENT	5.861D-03	cm^2 s^-1

LAYER 5 liner cover

THICKNESS	46	cm
POROSITY	. 4	
CALCULATED MASS DENSITY	1.59	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/q^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	- 12
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^+3 s^-1
WEIGHT % MOISTURE	6	- 23
MOISTURE SATURATION FRACTION	.238	
CALCULATED DIFFUSION COEFFICIENT	3.131D-02	cm^2 s^-1

LAYER 6 subsoil

152 cm THICKNESS POROSITY .45 CALCULATED MASS DENSITY 1.4575 g cm^-3 MEASURED RADIUM ACTIVITY 0 pCi/g^-1 DEFAULT LAYER EMANATION COEFFICIENT .35 CALCULATED SOURCE TERM CONCENTRATION 0.000D+00 pCi cm^-3 s^-1 WEIGHT & MOISTURE 15 je Je MOISTURE SATURATION FRACTION .486 CALCULATED DIFFUSION COEFFICIENT 1.334D-02 cm^2 s^-1

LAYER 7 topsoil

THICKNESS	46	cm
POROSITY	.49	,
CALCULATED MASS DENSITY	1.3515	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	· <u>9</u>
MOISTURE SATURATION FRACTION	.165	
CALCULATED DIFFUSION COEFFICIENT	4.231D-02	cm^2 s^-1

DATA SENT TO THE FILE 'RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC	
7	-1.000D+00	0.000D+00	0	0.000D+00	1.000D-01	
LAYER	DX	D	P	Q	XMS	RHO
1	3.770D+02	1.618D-02	8.000D-01	9.051D-03	6.625D-01	0.530
2	1.280D+02	4.942D-02	7.000D-01	2.144D-03	1.704D-01	0.795
3	2.560D+02	4.015D-03	2.000D-01	5.867D-04	6.360D-01	2.120
4	6.100D+01	5.861D-03	3.900D-01	0.000D+00	6.217D-01	1.617
5	4.600D+01	3.131D-02	4.000D-01	0.000D+00	2.385D-01	1.590
6	1.520D+02	1.334D-02	4.500D-01	:0.000D+00	4.858D-01	1.458
7	4.600D+01	4.231D-02	4.900D-01	0.000D+00	1.655D-01	1.352

BARE SOURCE FLUX FROM LAYER 1: 6.268D+03 pCi m^-2 s^-1

LAYER	THICKNESS	EXIT FLUX	EXIT CONC.
•	(cm).	(pCi m^-2 s^-1)	(pCi 1^-1)
		· · ·	
1.	3.770D+02	3.520D+03	1.865D+06
2	1.2800+02	2.315D+02	2:540D+06
3	2.560D+02	3.818D+01	7.867D+04
4	6.100D+01	1.698D+01	1.384D+04
5	4.600D+01	9.851D+00	1.624D+04
6	1.520D+02	2.572D+00	4.025D+02
7	4.600D+01	2.442D+00	0.000D+00

RESULTS OF THE RADON DIFFUSION CALCULATIONS

----*****! RADON !*****-----

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: 10000 IIB

AREA ITB - 10,000 YES

DESCRIPTION: no

· CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILI	NGS	2.65

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	6	•
NO LIMIT ON RADON FLUX		
LAYER THICKNESS NOT OPTIMIZED		· .
DEFAULT SURFACE RADON CONCENTRATION	0	pCi 1^-1
SURFACE FLUX PRECISION	. 1	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 p

pond	2
pond	4

THICKNESS 50	05 cm
POROSITY	7
CALCULATED MASS DENSITY	795 g cm^-3
MEASURED RADIUM ACTIVITY 2!	568 pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	35
CALCULATED SOURCE TERM CONCENTRATION 2	.144D-03 pCi cm^-3 s^-1
WEIGHT % MOISTURE	5 &
MOISTURE SATURATION FRACTION	170
CALCULATED DIFFUSION COEFFICIENT	.942D-02 cm^2 s^-1

LAYER 2 struc debris

256	cm
.2	
2.12	g cm^-3
75.3	pCi/g^-l
.35	
5.867D-04	pCi cm^-3 s^-1
· 6	8
.636	
4.015D-03	cm^2 s^-1
	256 .2 2.12 75.3 .35 5.867D-04 6 .636 4.015D-03

LAYER 3 clay liner

1

61	Cm
.39	
1.6165	g cm^-3
0	pCi/g^-1
.35	
0.000D+00	pCi cm^-3 s^-1
15	8
.622	
5.861D-03	cm^2 s^-1
	61 .39 1.6165 0 .35 0.000D+00 15 .622 5.861D-03

LAYER 4 . liner cover

THICKNESS	46	CM
POROSITY	. 4	
CALCULATED MASS DENSITY	1.59	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-l
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	9. 10
MOISTURE SATURATION FRACTION	.238	
CALCULATED DIFFUSION COEFFICIENT	3.131D-02	cm^2 s^-1

LAYER 5 subsoil

THICKNESS	152	CIN
POROSITY	.45	
CALCULATED MASS DENSITY	1.4575	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-l
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	15	2 75
MOISTURE SATURATION FRACTION	.486	
CALCULATED DIFFUSION COEFFICIENT	1.334D-02	cm^2 s^-1

LAYER 6 topsoil

THICKNESS POROSITY	46 .49	CIN
CALCULATED MASS DENSITY	1.3515	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	1
MOISTURE SATURATION FRACTION	.165	
CALCULATED DIFFUSION COEFFICIENT	4.231D-02	cm^2 s^-1

DATA SENT TO THE FILE 'RNDATA' ON DRIVE A:

N	FOl	CN1	ICOST	CRITJ	ACC	
6	-1.000D+00	0.000D+00	• 0	0.000D+00	1.000D-01	
LAYER	DX	D	P	Q	XMS	RHO
1	5.050D+02	4.942D-02	7.000D-01	2.144D-03	1.704D-01	0.795
2	2.560D+02	4.015D-03	2.000D-01	5.867D-04	6.360D-01	2.120
3	6,100D+01	5.861D-03	3.900D-01	0.000D+00	6.217D-01	1.617
4	4.600D+01	3.131D-02	4.000D-01	0.000D+00	2.385D-01	1.590
5	1.520D+02	1.334D-02	4.500D-01	0.000D+00	4.858D-01	1.458
6	4.600D+01	4.231D-02	4.900D-01	0.000D+00	1.655D-01	1.352

BARE SOURCE FLUX FROM LAYER 1: 2.214D+03 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS	EXIT FLUX	EXIT CONC.
	(cm)	(pCi m^-2 s^-1)	(pCi 1^-1)
1	5.050D+02	5.565D+01	9.596D+05
2	2.560D+02	3.745D+01	7.717D+04
3.	6.100D+01	1.666D+01	1.358D+04
4	4.600D+01	9.662D+00	1.593D+04
5	1.520D+02	2.523D+00	3.948D+02
6	4.600D+01	2.396D+00	0.000D+00

-----*****! RADON !*****-----

Version 1.2 - MAY 22, 1989 - G.F. Birchard tel.# (301)492-7000 U.S. Nuclear Regulatory Commission Office of Research

RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: 10000 III

AREA III - 10,000 YRS

DESCRIPTION: no

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILIN	NGS	2.65

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	-5	
NO LIMIT ON RADON FLUX		
LAYER THICKNESS NOT OPTIMIZED		
DEFAULT SURFACE RADON CONCENTRATION	0	pCi 1^-1
SURFACE FLUX PRECISION	.1	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 layer b-d

THICKNESS	457	CM
POROSITY	.7	
CALCULATED MASS DENSITY	.795	g cm^-3
MEASURED RADIUM ACTIVITY	38.4	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	3.205D-05	pCi cm^-3 s^-1
WEIGHT & MOISTURE	15	ġ
MOISTURE SATURATION FRACTION	.170	
CALCULATED DIFFUSION COEFFICIENT	4.942D-02	cm^2 s^-1

LAYER 2 clay liner

THICKNESS	61	cm
POROSITY	.39	•
CALCULATED MASS DENSITY	1.6165	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT & MOISTURE	15	- 0
MOISTURE SATURATION FRACTION	.622	
CALCULATED DIFFUSION COEFFICIENT	5.861D-03	cm^2 s^-1

LAYER 3 liner cover

THICKNESS	46	Cm
POROSITY	. 4	
CALCULATED MASS DENSITY	1.59	g cm^-3
MEASURED RADIUM ACTIVITY	. 0	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT & MOISTURE	6	00 00
MOISTURE SATURATION FRACTION	.238	
CALCULATED DIFFUSION COEFFICIENT	3.131D-02	cm^2 s^-1

LAYER 4 subsoil

152	CM
.45	
1.4575	g cm^-3
0	pCi/g^-1
.35	
0.000D+00	pCi cm^-3 s^-1
15	8
.486	
1.334D-02	cm^2 s^-1
	152 .45 1.4575 0 .35 0.000D+00 15 .486 1.334D-02

LAYER 5 topsoil

· THICKNESS 46 сm POROSITY .49 g cm^-3 CALCULATED MASS DENSITY 1.3515 0 MEASURED RADIUM ACTIVITY pCi/g^-l DEFAULT LAYER EMANATION COEFFICIENT .35 CALCULATED SOURCE TERM CONCENTRATION 0.000D+00 pCi cm^-3 s^-1 WEIGHT % MOISTURE 6 ç, MOISTURE SATURATION FRACTION .165 CALCULATED DIFFUSION COEFFICIENT 4.231D-02 cm^2 s^-1

DATA SENT TO THE FILE 'RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC	
5	-1.000D+00	0.000D+00	0	0.000D+00	1.000D-01	
LAYER	DX	D	P	Q.	XMS	RHO
1	4.570D+02	4.942D-02	7.000D-01	3.205D-05	1.704D-01	0.795
2	6.100D+01	5.861D-03	3.900D-01	0.000D+00	6.217D-01	1.617
3	4.600D+01	3.131D-02	4.000D-01	0.000D+00	2.385D-01	1.590
4	1.520D+02	1.334D-02	4.500D-01	0.000D+00	4.858D-01	1.458
5	4.600D+01	4.231D-02	4.900D-01	0.000D+00	1.6550-01	1.352

BARE SOURCE FLUX FROM LAYER 1: 3.260D+01 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m ⁻² s ⁻¹)	EXIT CONC. (pCi 1^-1)
1	4.570D+02	3.777D+00	1.285D+04
2	6.100D+01	1.680D+00	1.369D+03
3	4.600D+01	9.744D-01	1.607D+03
4	1.520D+02	2.544D-01	3.982D+01
5	4.600D+01	2.416D-01	0.000D+00

.

Image: Appendix products Image:	Parameters	Area I, 1	0,000 Years	Parameters	Area IIA	, 10,000 Years	Parametera	Area IIB,	10,000 Years	Parameters	Area III	10,000 Years
Example Continue 0.00 0.00 Description 0.00 Description 0.00 0.00 Description 0.00	Layer A			Raff Sludge	,		Pond 2			Laver b-d		
Construint Open 10 Construint Open 10	Specific Gravity	0.80	0.80	Specific Gravity	0.53	0.53	Specific Gravity	0.80	0.80	Specific Gravity	0.80	0.80
Control (1) 4.3 1.3 Control (2) Contro (2) Contro (2) <thcontr< td=""><td>Porosity Density (g/cc)</td><td>0.7 0.795</td><td>0.7 0.795</td><td>Porosity Density (g/cc)</td><td>0.8 0.53</td><td>0.8 0.53</td><td>Porosity Density (g/cc)</td><td>0.7</td><td>0.7 0.795</td><td>Porosity Density (g/cc)</td><td>0.7 0.795</td><td>0.7 0.795</td></thcontr<>	Porosity Density (g/cc)	0.7 0.795	0.7 0.795	Porosity Density (g/cc)	0.8 0.53	0.8 0.53	Porosity Density (g/cc)	0.7	0.7 0.795	Porosity Density (g/cc)	0.7 0.795	0.7 0.795
Standard (N) 0.17 0.17 Person and interface (N) 0.17	Density (pcf) Moisture Content (%)	49.6 15	49,6 16	Density (pcf) Moisture Content (%)	33.1 100	33.1 100	Density (pcf) Moisture Content (%)	49.6 15	49.6 ·	Density (pcf) Moisture Content (%)	49.6 15	49.6 15
Diffusion Carl (mm/bits) Diffusion Carl (mm/bits) <thdiffusion (mm="" bits)<="" carl="" th=""> <thdiffusion< td=""><td>Degree of Saturation (%) Radium Activity (rectin)</td><td>0.17</td><td>0.17</td><td>Degree of Saturation (%) Radium Activity (ocida)</td><td>0.662</td><td>0.662 18587</td><td>Degree of Saturation (%) Radium Activity (m. 1/m)</td><td>0.17</td><td>0.17</td><td>Degree of Saturation (%) Radium Activity (pCI/d)</td><td>0.17 38.4</td><td>0.17 98.4</td></thdiffusion<></thdiffusion>	Degree of Saturation (%) Radium Activity (rectin)	0.17	0.17	Degree of Saturation (%) Radium Activity (ocida)	0.662	0.662 18587	Degree of Saturation (%) Radium Activity (m. 1/m)	0.17	0.17	Degree of Saturation (%) Radium Activity (pCI/d)	0.17 38.4	0.17 98.4
International product Distance product <thdistance prod<="" td=""><td>Diffusion Coef (cm²/sec)</td><td>0.04942</td><td>0.04942</td><td>Diffusion Coef (cm²/sec)</td><td>0.01618</td><td>0.01618</td><td>Diffusion Coet (cm²/sec)</td><td>0.04942</td><td>0.04942</td><td>Diffusion Coef (cm²/sec)</td><td>0.04942</td><td>0.04942</td></thdistance>	Diffusion Coef (cm ² /sec)	0.04942	0.04942	Diffusion Coef (cm ² /sec)	0.01618	0.01618	Diffusion Coet (cm²/sec)	0.04942	0.04942	Diffusion Coef (cm ² /sec)	0.04942	0.04942
Besch Flassperify 192	Thickness (cm)	61. 2.0	61 2.0	Thickness (cm)	377 12.4	377 12,4	Thickness (cm) Thickness (ff)	505 16.6	505 16,6	Thickness (cm) Thickness (ff)	457 15.0	457 15.0
Exercise Start 2 <	Radon Flux (pCi/m ² -sec)	1327	1327	Radon Flux (pCi/m ² -sec)	3520	3520	Radon Flux (pCi/m ² -sec)	55.65	55.65	Radon Flux (pCi/m²-sec)	3.777	3.777
Section 158 154	Laver b-d	1	l	Pond 2			Struc Debris	1		Clay Liner		
Description 16.4 6.4 6.4 6.2 12 <th12< th=""> 12 12</th12<>	Specific Gravity	1 59	1.59	Specific Gravity	0.80	0.80	Specific Gravity	2 12	2 12	Specific Gravity	1.67	1.62
Description Ins.3 First State Description First State Description First State First State <th< td=""><td>Porosity</td><td>0.4</td><td>0.4</td><td>Porosity</td><td>0.7</td><td>0.7</td><td>Porosity</td><td>0.2</td><td>0.2</td><td>Porosity</td><td>0.39</td><td>0.39</td></th<>	Porosity	0.4	0.4	Porosity	0.7	0.7	Porosity	0.2	0.2	Porosity	0.39	0.39
Biogram Status Color	Density (pcf)	99.3	99.3	Density (pcf)	49.6	49.6	Density (pcf)	132.3	132.3	Density (pcf)	100.9	100.9
Description 13.1 Description Descrin Descrin Descrin<	Degree of Saturation (%)	0.238	0.238	Degree of Saturation (%)	0.17	0.17	Degree of Saturation (%)	0.636	0.636	Degree of Saturation (%)	0.622	0.622
Employee (nut) 44.0 44.0 10.0 12.0	Radium Activity (pCi/g) Diffusion Coef (cm ² /sec)	81.5 0.03131	81.5 0.03131	Radium Activity (pCi/g) Diffusion Coef (cm ² /sec)	2568 0.0494	2568 0.0494	Radium Activity (pCi/g) Diffusion Coef (cm ² /sec)	75.3	75.3 0.0040	Radium Activity (pCi/g) Diffusion Coef (cm ² /sec)	0 0.0059	0 0.0059
Rader Filts QCUT*SED 44.02 Rader Filts QCUT*SED 37.45 37.47 Reson Filts QCUT*SED 1.68 1.685 Gardin Granth 0.58 Filts Data	Thickness (cm) Thickness (ft)	426 14.0	426 14.0	Thickness (cm): Thickness (ft)	128 4.2	- 128 4.2	Thickness (cm) Thickness (ft)	256 8.4	256 8.4	Thickness (cm) Thickness (ft)	81 2.0	61. 2.0
Instrumentation Instrument	Radon Flux (nCi/m ² nch)	45.00	42.04	Radon Eliny (nC)/m ² co-)	711 =	231 F	Radon Elin (nCilm ² an -)	37.45	37 87	Radon Elux (nC)/m ² and	1.69	1 265
Links And	Clevel (j ≁0.02 1	42.04	Afres Data	231.0	2J1.J	Readin Flux (pc//m-sec)	,4⊃ ⊓	31.81	Nadon Flux (pol/m -sec)	1.00	C08,1
Descrite for ends 1.62 Baseling Grandy 1.62 Baseling Grandy 1.63 Baseling Grandy 1.64 <td>Clay Liner</td> <td></td> <td></td> <td>Struc Debris</td> <td></td> <td></td> <td>Clay Liner</td> <td>1</td> <td></td> <td>Layer 3</td> <td></td> <td></td>	Clay Liner			Struc Debris			Clay Liner	1		Layer 3		
Internity (prim) 14865 Founds (prim) 14865 14865 <th< td=""><td>Specific Gravity Porosity</td><td>1.62 0.39</td><td>1.62 0.39</td><td>Specific Gravity Porosity</td><td>2.12</td><td>2.12 · 0.2</td><td>Specific Gravity Porosity</td><td>1.62</td><td>1.62 0.39</td><td>Specific Gravity Porosity</td><td>1.59 0,4</td><td>1.59 0.4</td></th<>	Specific Gravity Porosity	1.62 0.39	1.62 0.39	Specific Gravity Porosity	2.12	2.12 · 0.2	Specific Gravity Porosity	1.62	1.62 0.39	Specific Gravity Porosity	1.59 0,4	1.59 0.4
Decker Generic 10 0.5 Box 0.6 Box 0.6 Box Construct Construct 20 0.6 Box Construct 20 Construct 20 <t< td=""><td>Density (g/cc) Density (pcf)</td><td>1.6165 100.9</td><td>1.6165 100,9</td><td>Density (g/cc)</td><td>2.12 132.3</td><td>2.12 132.3</td><td>Density (g/cc) Density (pcf)</td><td>1,6165 100,9</td><td>1.6165 100.9</td><td>Density (g/cc) Density (pcf)</td><td>1,59</td><td>1.59 99.3</td></t<>	Density (g/cc) Density (pcf)	1.6165 100.9	1.6165 100,9	Density (g/cc)	2.12 132.3	2.12 132.3	Density (g/cc) Density (pcf)	1,6165 100,9	1.6165 100.9	Density (g/cc) Density (pcf)	1,59	1.59 99.3
Taskern (pc)/m 0 0 Taskern (pc)/m 0 Teakern Activity (pc)/m 0 Teakern Activity (pc)/m 0 0 Teakern Activity (pc)/m 0 0 Diffuence Ceref (mere) 0.00881 Diffuence Ceref (mere) 0.00881 Diffuence Ceref (mere) 0.0013 Diffuence Ceref (mere) 0.0013 Teakern Activity (pc)/m 0 0 Diffuence Ceref (mere) 0.0013 Diffuence Ceref (mere) 0.0013 Teakern Activity (pc)/m 0 0 Diffuence Ceref (mere) 0.0013 Diffuence Ceref (mere) 0.0013 Teakern Activity (pc)/m 0 0 0 Diffuence Ceref (mere) 0.0013 Diffuence Ceref (mere) 0.0013 Teakern Activity (pc)/m 1.52 1.52 Teakern Activity (pc)/m 0.0013 Diffuence Ceref (mere)	Moisture Content (%) Degree of Saturation (%)	15 0.662	15 0.662	Moisture Content (%)	0.636	6 0.636	Moisture Content (%)	15	15	Moisture Content (%)	6 0.238	6
Interviews cmi 20.3 20.9 Interviews (m) 20.3 Produces (m) 20.4 Produces (m) 20.5 Produce (m) 20.5	Radium Activity (pCi/g)	0	0	Radium Activity (pCi/g)	75.3	75.3	Radium Activity (pCi/g)	0	0	Radium Activity (pCi/g)	0	0
Information (tr) 2.00 2.04 2.04 2.04 2.04 2.04 2.04 1.04 1.04 1.05 Reish Plan (pc)(m*sec) 20.47 22.68 Reiden Flan (pc)(m*sec) 38.18 38.48 Reiden Flan (pc)(m*sec) 0.9744 1.393 James Plan (pc)(m*sec) 0.44 0.44 1.58 1.59 Bandin Flan (pc)(m*sec) 0.9744 1.46 1.44 Density (pc) 0.45 0.44 0.45	Thickness (cm)	61	61	Thickness (cm)	256	256	Thickness (cm)	61	61	Thickness (cm)	46	46
Radion Filtur (Collm*acc) 20.47 22.68 Radion Filtur (Collm*acc) 38.10 38.48 Radion Filtur (Collm*acc) 16.66 18.8 Radion Filtur (Collm*acc) 0.7744 1.33 Liner Cover Specific Gravity 1.59 Class Cover Specific Gravity 1.59 Specific Gravity 0.46	Thickness (rg	2.0	2.0	inickness (m)	6.4	1	inickness (n)	20	2,0	Inickness (11)		1.9
Line: Cover Subsoli Subsoli Subsoli British: Grandy 1.6.4 1.6.5 Scripting Grandy 1.6.4 1.4.6	Radon Flux (pCi/m ² -sec)	j 20.47	22.65	Radon Flux (pCi/m ² -sec)	38.18	38.48	Radon Flux (pCi/m ² -sec)	16.66	18.8	Radon Flux (pCi/m ² -sec)	0.9744	1.393
Specific Gravity 1.58 1.58 Specific Gravity 1.52 1.52 1.52 1.58 Specific Gravity 1.46 1.46 1.46 Density (p2c) 1.53 1.58 Density (p2c) 1.58 Density (p2c) 1.46 1.46 0.45 <th0.45< th=""> 0.45 <th0.45< t<="" td=""><td>Liner Cover</td><td>]</td><td>·</td><td>Clay Liner</td><td></td><td></td><td>Liner Cover</td><td>]</td><td></td><td>Subsoil</td><td></td><td></td></th0.45<></th0.45<>	Liner Cover]	·	Clay Liner			Liner Cover]		Subsoil		
Density (pcc) 1.58 1.59 Density (pcc) 1.6165 1.6165 1.6165 1.6165 1.6165 1.6165 1.6165 1.6165 1.6165 1.6165 1.6165 1.6165 1.6165 1.6165 1.6165 1.6165 1.6175 1.629 Density (pcc) 9.3 <td>Specific Gravity Porosity</td> <td>1.59</td> <td>1.59 0.4</td> <td>Specific Gravity</td> <td>1.62</td> <td>1.62 0.39</td> <td>Specific Gravity</td> <td>1.59</td> <td>1.59</td> <td>Specific Gravity Porosity</td> <td>1.46 0.45</td> <td>1.46</td>	Specific Gravity Porosity	1.59	1.59 0.4	Specific Gravity	1.62	1.62 0.39	Specific Gravity	1.59	1.59	Specific Gravity Porosity	1.46 0.45	1.46
Ministration Construction (%) Construction (%) <thconst< td=""><td>Density (g/cc)</td><td>1.59</td><td>1.59</td><td>Density (g/cc)</td><td>1.6165</td><td>1.6165</td><td>Density (g/cc)</td><td>1.59</td><td>1.59</td><td>Density (g/cc)</td><td>1.4575</td><td>1.4575</td></thconst<>	Density (g/cc)	1.59	1.59	Density (g/cc)	1.6165	1.6165	Density (g/cc)	1.59	1.59	Density (g/cc)	1.4575	1.4575
Specifie to submitted (sp.) 0.236 0.236 Diagon of submitted (sp.) Diagon of submit	Molsture Content (%)	6	6	Moisture Content (%)	15	15	Moisture Content (%)	6	6	Molsture Content (%)	15	6
Linksunce Coel (cm*/sec) 0.03131 Diffusion Coe	Radium Activity (pCi/g)	0.230	0.236	Radium Activity (pCi/g)	0.022	0	Radium Activity (pCi/g)	0.230	0.238	Radium Activity (pCi/g)	0.488	0,194
Thickwess (ff) 1.3 1.5 Thickwess (ff) 2.0 2.0 Thickwess (ff) 1.5 1.6 Thickwess (ff) 5.0 5.0 5.0 Radon Flux (pC/Im ² ace) 11.87 16.92 Radon Flux (pC/Im ² ace) 9.652 15.21 Radon Flux (pC/Im ² ace) 0.2544 0.6577 Subsoil Subsoil 1.46 1.46 5.0 5.0 1.35 0.33	Thickness (cm)	0.03131	0.03131	Thickness (cm)	0.00586	61	Thickness (cm)	46	0.03131	Thickness (cm)	0.01334	0.0376
Radon Flux (pCl/m ² -sec) 11.87 16.92 Radon Flux (pCl/m ² -sec) 9.662 15.21 Radon Flux (pCl/m ² -sec) 0.2544 0.6577 Subsoll	Thickness (ft)	1.5	1.5	Thickness (ft)	2.0	2.0	Thickness (ft)	1,5	1.5	Thickness (ft)	5,0	5.0
Subsol/ Subsol/ Subsol/ Subsol/ Subsol/ Subsol/ Specific Gravity 1.45 1.46 Specific Gravity 1.46 Specific Gravity 0.45 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.45	Radon Flux (pCi/m ² -sec)	11.87	16.92	Radon Flux (pCi/m ² -sec)	16.98	18.53	Radon Flux (pCi/m ² -sec)	9.662	15.21	Radon Flux (pCi/m ² -sec)	0.2544	0.6677
Specific Gravity 1.46 1.46 1.46 Specific Gravity 1.46 1.46 Specific Gravity 1.35 1.35 Density (gloc) 1.475 1.4575 Density (gloc) 1.4575 Density (gloc) 1.4575 Density (gloc) 1.4575 Density (gloc) 1.35 1.351 Density (gloc) 1.0 91.0 91.0 91.0 91.0 91.0 91.0 84.4 84.4 Degree of Saturation (%) 0.486 0.186 Gradium Activity (pC/n) 0.486 0.185 Redum Activity (pC/n) 0.466 0.186 6 8 8 4 8 4 8 4 8 4 8 4 8 4 4 8 4 4 8 4 4 8 4 <td>Subsoil</td> <td>] .</td> <td></td> <td>Liner Cover</td> <td>· ·</td> <td></td> <td>Subsoil</td> <td>]</td> <td></td> <td>Topsoil</td> <td></td> <td></td>	Subsoil] .		Liner Cover	· ·		Subsoil]		Topsoil		
Protective Density (pcc) 0.43	Specific Gravity	1.46	1.46	Specific Gravity	1.59	1.59	Specific Gravity	1.46	1.46	Specific Gravity	1.35	1.35
Deneity (pcf) 91.0 91.0 Density (pcf) 93.3 99.3 99.3 99.3 91.0 91.0 91.0 Benzy (pcf) 84.4	Density (g/cc)	1.4575	1.4575	Density (g/cc)	1.59	1.59	Density (g/cc)	1.4575	0.45	Density (g/cc)	1.3515	1,3515
Degree of Saturation (%) 0.485 0.194 Degree of Saturation (%) 0.238 0.238 Degree of Saturation (%) 0.485 0.194 Degree of Saturation (%) 0.165	Density (pcf) Majsture Content (%)	91.0 15	91.0 6	Density (pcf) Molsture Content (%)	99.3 6	99.3 6	Density (pcf) Moisture Content (%)	91.0 15	91.0 6	Density (pcf) Moisture Content (%)	84.4 6	84.4 6
Diffusion Coef (cm7/sec) 0.01334 0.0376 Diffusion Coef (cm7/sec) 0.01334 0.0376 Diffusion Coef (cm7/sec) 0.04231 0.04231 Thickness (cm) 152 Thickness (ff) 15 <td>Degree of Saturation (%) Radium Activity (pCi/g)</td> <td>0.486</td> <td>0.194</td> <td>Degree of Saturation (%) Radium Activity (pCi/g)</td> <td>0.238</td> <td>0.238</td> <td>Degree of Saturation (%) Radium Activity (pCi/g)</td> <td>0.486</td> <td>0.194 0</td> <td>Degree of Saturation (%) Radium Activity (pCi/g)</td> <td>0.165</td> <td>0,165</td>	Degree of Saturation (%) Radium Activity (pCi/g)	0.486	0.194	Degree of Saturation (%) Radium Activity (pCi/g)	0.238	0.238	Degree of Saturation (%) Radium Activity (pCi/g)	0.486	0.194 0	Degree of Saturation (%) Radium Activity (pCi/g)	0.165	0,165
Thickness (t) 5.0 5.0 Thickness (t) 1.5<	Diffusion Coef (cm ² /sec)	0.01334	0.0376	Diffusion Coef (cm ² /sec)	0.03131	0.03131	Diffusion Coef (cm ⁴ /sec)	0.01334	0.0376	Diffusion Coef (cm ² /sec)	0.04231	0.04231
Radon Flux (pCl/m ² -sec) 3.1 8.109 Radon Flux (pCl/m ² -sec) 9.851 13.84 Radon Flux (pCl/m ² -sec) 2.523 3.523 Radon Flux (pCl/m ² -sec) 0.2416 0.6341 Topsoil Specific Gravity 1.35 1.35 Specific Gravity 1.46 1.46 Specific Gravity 1.35 1.35 Parosity 0.49 0.49 O.49 O.4231 O.4231 O.4231 O.4231	Thickness (ft)	5,0	5.0	Thickness (ff)	1,5	1.5	Thickness (ft)	1.5	1.5	Thickness (ff)	1.5 -	1,5
Topsoil Subsoil Topsoil Specific Gravity 1.35 1.35 Specific Gravity 1.46 1.46 Specific Gravity 1.35 1.35 Porosity 0.49 0.49 0.49 0.45 0.45 0.45 0.49 0.4231 0.04231 0.04231 0.04231 0.04231 <td>Radon Flux (pCi/m²-sec)</td> <td>3.1</td> <td>8,109</td> <td>Radon Flux (pCi/m²-sec)</td> <td>9,851</td> <td>13.84</td> <td>Radon Flux (pCi/m²-sec)</td> <td>2.523</td> <td>3.523</td> <td>Radon Flux (pCi/m²-sec)</td> <td>0.2416</td> <td>0.6341</td>	Radon Flux (pCi/m ² -sec)	3.1	8,109	Radon Flux (pCi/m ² -sec)	9,851	13.84	Radon Flux (pCi/m ² -sec)	2.523	3.523	Radon Flux (pCi/m ² -sec)	0.2416	0.6341
Specific Gravity 1.35 1.35 Specific Gravity 1.46 1.46 1.46 Specific Gravity 1.35 1.35 Porosity 0.49 0.49 0.49 0.45 0.45 Density (g/cc) 1.3515 1.3515 Density (g/cc) 1.3515 1.3515 Density (g/cc) 1.4575 1.4575 Density (g/cc) 1.3515 1.3515 Density (g/cc) 84.4 Bensity (g/cc) 91.0 91.0 91.0 Density (g/cc) 84.4 84.4 Degree of Saturation (%) 0.165 Degree of Saturation (%) 0.165 6 6 6 6 6 6 0.165 6 6 6 6 0.165 0.165 6 6 6 6 6 6 0.165 0.165 6 6 6 6 6 1.32 1.16 0.165 6 6 6 6 6 1.32 1.16 0.376 0.165 0.04231 0.04231 0.04231 0.04231 0.04231 <td>Topsoil</td> <td>]</td> <td></td> <td>Subsoil</td> <td>]</td> <td></td> <td>Topsoil</td> <td>]</td> <td></td> <td></td> <td></td> <td></td>	Topsoil]		Subsoil]		Topsoil]				
Porosity 0.49 0.49 Porosity 0.45 0.45 Density (pcc) 0.49 0.49 0.49 Density (pcc) 1.3515 </td <td>Specific Gravity</td> <td>1,35</td> <td>1.35</td> <td>Specific Gravity</td> <td>1.46</td> <td>1.46</td> <td>Specific Gravity</td> <td>1.35</td> <td>1.35</td> <td></td> <td></td> <td>÷</td>	Specific Gravity	1,35	1.35	Specific Gravity	1.46	1.46	Specific Gravity	1.35	1.35			÷
Density (pcf) 84.4 84.4 Density (pcf) 91.0 91.0 Density (pcf) 84.4 64.4 Moisture Content (%) 0 C Moisture Content (%) 15 C Moisture Content (%) 6 6 Moisture Content (%) 6 6 Moisture Content (%) 6 6 Moisture Content (%) 0.165 0.165 6 Moisture Content (%) 0.165 0.165 6 Moisture Content (%) 0.165 1.15 1.15 1.15 1.15 1.15 1.15 1.15 1.15 1.15 1.15	Porosity Depsity (p/cc)	0.49	0.49	Porosity Density (g/cc)	0,45	0.45	Porosity Density (g/cc)	0.49	0.49			
Degree of Saturation (%) 0.165 0.1	Density (pcf)	84.4	84.4	Density (pcf)	91.0	91.0	Density (pcf)	84.4	84.4			
Readum Activity (pc/ig) 0 0 0 Readum Activity (pc/ig) 0 <td>Degree of Saturation (%)</td> <td>0.165</td> <td>0.165</td> <td>Degree of Saturation (%)</td> <td>0.486</td> <td>0.194</td> <td>Degree of Saturation (%)</td> <td>0.165</td> <td>0.165</td> <td></td> <td></td> <td></td>	Degree of Saturation (%)	0.165	0.165	Degree of Saturation (%)	0.486	0.194	Degree of Saturation (%)	0.165	0.165			
Thickness (cm) 46 46 Thickness (cm) 152 1152 Thickness (cm) 46 46 Thickness (ft) 1.5 Thickness (ft) 5.0 5.0 Thickness (ft) 1.5 1.5 Radon Flux (pCl/m*sec) 2.944 7.701 Radon Flux (pCl/m*sec) 2.572 6.633 Radon Flux (pCl/m*sec) 2.396 12.53 Topsel/ Specific Gravity 1.35 1.35 1.35 1.35 1.3515	Diffusion Coef (cm ² /sec)	0.04231	0.04231	Diffusion Coef (cm ² /sec)	0.01334	0.0376	Diffusion Coef (cm²/sec)	0.04 <u>231</u>	0.04231		,	
Radon Flux (pCi/m ² -sec) 2.944 7.701 Radon Flux (pCi/m ² -sec) 2.572 6.633 Radon Flux (pCi/m ² -sec) 2.396 12.53 Topsoil	Thickness (cm) Thickness (ff)	46 1.5	46 1.5	Thickness (cm) Thickness (ft)	152 5:0	152 5.0	Thickness (cm) Thickness (ft)	46 1.5	46 1.5	and a second		
Topsoil Specific Gravity 1.35 1.35 Porosity 0.49 0.49 Density (g/cc) 1.3515 1.3515 Density (pcf) 84.4 84.4 Molisture Content (%) 0.165 0.165	Radon Flux (pCi/m ² -sec)	2.944	7.701	Radon Flux (pCi/m ² -sec)	2.572	6.633	Radon Flux (pCi/m-sec)	2.396	12.53] .		
Specific Gravity 1.35 1.35 Porosity 0.49 0.49 Density (g/cc) 1.3515 1.3515 Density (pcf) 84.4 84.4 Molstare Content (%) .68 .61 Degree of Saturation (%) 0.165 0.165	<u></u>			Tonsoil	 1		<u> </u>			4		
Operation Oracle 1.33 1.33 Porosity 0.49 0.49 0.49 Density (g/cc) 1.3515 1.3515 0.3512 Density (pcf) 84.4 84.4 84.4 MolStare Content (%) 0.165 0.165 0.165			. '	Specific Gravity	4.75	1.25					•	
Uensity (grcc) 1.3515 Density (pcf) 86.4 Moisture Content (%) 8 Degree of Saturation (%) 0.165				Porosity	0.49	0.49						
Moisture Content (%) 6 Degree of Saturation (%) 0.165 0.165	•			Density (g/cc)	84.4	1,3515 84.4						
			•	Degree of Saturation (%)	0.165	0.165	1					

Diffu

Coef

Thickness (ff) Radon Flux (pCi/m²-sec)

Thickness (cm)

0.0423

46

2.442

0423

46

6.3

AREA I 1 -*****! RADON !*****-----

Version 1.2 - MAY 22, 1989 - G.F. Birchard tel.# (301)492-7000 U.S. Nuclear Regulatory Commission Office of Research

RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Area I 10000 Years 6%WC Subsoil

DESCRIPTION: Subsoil is 6% WC instead of 15%

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILIN	NGS	2.65

GENERAL INPUT PARAMETERS

s^-1
s^-1

LAYER INPUT PARAMETERS

LAYER 1 Layer A

61	CM
.7	
.795	q cm^-3
9013	pCi/q^-1
.35	
7.524D-03	pCi cm^-3 s^-1
15	%
.170	
4.942D-02	cm^2 s^-1
	61 .7 .795 9013 .35 7.524D-03 15 .170 4.942D-02

LAYER 2 Layer b-d

	426	cm
MEASURED MASS DENSITY	1.59	g cm∧-3
MEASURED RADIUM ACTIVITY	81.5	pCi/g^-1
CALCULATED SOURCE TERM CONCENTRATION	.35 2 38104	nci cm∆-3 s∆-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT	.238 3.1310-02	cm∧2 s∧-1
	0.2020 02	

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LAYER 3

Clay Liner

	AREA I 1	
THICKNESS	61	CM
POROSITY	. 39	
MEASURED MASS DENSITY	1.6165	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00) pCi cm^-3 s^-1
WEIGHT % MOISTURE	15	%
MOISTURE SATURATION FRACTION	.622	
CALCULATED DIFFUSION COEFFICIENT	5.861D-03	3 cm^2 s^-1
CALCULATED DIFFUSION COEFFICIENT	J.001D-0) CIIVE 3V-1

LAYER 4 Liner Cover

THICKNESS	46	CM
POROSITY	.4	
MEASURED MASS DENSITY	1.59	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.238	
CALCULATED DIFFUSION COEFFICIENT	3.131D-02	cm^2 s^-1

LAYER 5 Subsoil

THICKNESS	152	CM
POROSITY	.45	
MEASURED MASS DENSITY	1.4575	g cm∧-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.194	
CALCULATED DIFFUSION COEFFICIENT	3.762D-02	cm^2 s^-1

LAYER 6 Topsoil

THICKNESS	46	CM
POROSITY	.49	
MEASURED MASS DENSITY	1.3515	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.165	
CALCULATED DIFFUSION COEFFICIENT	4.231D-02	cm∧2 s∧-1

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	DATA	A SENT TO THE	FILE	RNDATA' ON DR	IVE A:	
N 6	F01 -1.000D+00	CN1 0.000D+00	ICOST 0	CRITJ 2.000D+01	ACC 1.000D-03	
LAYER	DX	D	Р	Q Page 2	XMS	RHO

A	REA	Ι	1
	_		

1	6.100D+01	4.942D-02	7.000D-01	7.524D-03	1.704D-01	0.795
2	4.260D+02	3.131D-02	4.000D-01	2.381D-04	2.385D-01	1.590
3	6.100D+01	5.861D-03	3.900D-01	0.000D+00	6.217D-01	1.617
4	4.600D+01	3.131D-02	4.000D-01	0.000D+00	2.385D-01	1.590
5	1.520D+02	3.762D-02	4.500D-01	0.000D+00	1.943D-01	1.458
6	4.600D+01	4.231D-02	4.900D-01	0.000D+00	1.655D-01	1.352

BARE SOURCE FLUX FROM LAYER 1: 2.599D+03 pci m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1 2	6.100D+01 4.260D+02	1.327D+03 4.704D+01	1.493D+06 1.465D+05
3	6.100D+01	2.265D+01	1.219D+04
4	4.600D+01	1.692D+01	1.141D+04
5	1.520D+02	8.109D+00	1.697D+03
6	4.600D+01	7.701D+00	0.000D+00

area 2a

----*****! RADON !*****-----

Version 1.2 - MAY 22, 1989 - G.F. Birchard tel.# (301)492-7000 U.S. Nuclear Regulatory Commission Office of Research

RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Area 2A 10000 Years

DESCRIPTION: Subsoil with 6% wc instead of 15%

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILIN	NGS	2.65

GENERAL INPUT PARAMETERS

7	
20	pCi m^-2 s^-1
	•
0	pCi]^-1
.001	pCi m^-2 s^-1
	7 20 0 .001

LAYER INPUT PARAMETERS

LAYER 1 Raff Sludge

THICKNESS	377	CM
POROSITY	+8. 52	a cmA 2
MEASURED MASS DENSITY MEASURED RADIUM ACTIVITY	18587	$nCi/a\Lambda - 1$
DEFAULT LAYER EMANATION COEFFICIENT	.35	per/ge 1
CALCULATED SOURCE TERM CONCENTRATION	9.051D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	100	%
CALCULATED DIFFUSION COEFFICIENT	.002 1.618D-02	cm^2 s^-1

LAYER 2 Pond 2

THICKNESS	128	CM
MEASURED MASS DENSITY	.7	a cm∆-3
MEASURED RADIUM ACTIVITY	2568	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	2.144D-03	pCi cm^-3 s^-1
WEIGHT % MUISIURE	170	%
CALCULATED DIFFUSION COEFFICIENT	4.942D-02	cm^2 s^-1

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LAYER 3 Struc Debris

Page 1

			·	
	THICKNESS	256	Cm	
	MEASURED MASS DENSITY MEASURED RADIUM ACTIVITY	2.12 75.3	g cm^-3 pCi/g^-1	
	CALCULATED SOURCE TERM CONCENTRATION WEIGHT % MOISTURE	.35 5.867D-04 6	pCi cm^-3 s^-1 %	
	MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT	.636 4.015D-03	cm^2 s^-1	
	LAYER 4 Clay Liner			
	THICKNESS	61	C m	•
	POROSITY	.39		
	MEASURED MASS DENSITY MEASURED RADIUM ACTIVITY	0	g cm/-3 pCi/g/-1	
	CALCULATED SOURCE TERM CONCENTRATION WEIGHT % MOISTURE	0.000D+00 15	pCi cm^-3 s^-1 %	
	MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT	.622 5.861D-03	cm^2 s^-1	
	LAYER 5 Liner Cover			
	THICKNESS	46	cm	,
	MEASURED MASS DENSITY MEASURED RADIUM ACTIVITY	.4 1.59 0	g cm∧-3 pCi/a∧-1	
•	DEFAULT LAYER EMANATION COEFFICIENT CALCULATED SOURCE TERM CONCENTRATION	.35 0.000D+00	pCi cm^-3 s^-1	
	MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT	.238 3.131D-02	∼ cm^2 s^-1	
	LAYER 6 Subsoil		· · · ·	•
	THICKNESS	152	Cm	
	POROSITY MEASURED MASS DENSITY	.45	a cmA-3	
	MEASURED RADIUM ACTIVITY	0	pCi/g^-1	
	CALCULATED SOURCE TERM CONCENTRATION WEIGHT % MOISTURE	0.000D+00 6	pCi cm^-3 s^-1 %	
	CALCULATED DIFFUSION COEFFICIENT	3.762D-02	cm^2 s^-1	
	D LAYER 7 Topsoil			
	THICKNESS	46	Cm	
_	POROSITY MEASURED MASS DENSITY MEASURED RADIUM ACTIVITY	.49 1.3515 0	g cm∧-3 pCi/a∧-1	· · · · · · · · · · · · · · · · · · ·
	DEFAULT LAYER EMANATION COEFFICIENT CALCULATED SOURCE TERM CONCENTRATION	.35 0.000D+00 Page 2	pCi cm^-3 s^-1	
				•

WEIGHT % MOISTURE MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT AREA 2A 6 % .165 4.231D-02 cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 6.268D+03 pci m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS	EXIT FLUX	EXIT CONC.
	(cm)	(pCi m^-2 s^-1)	(pCi 1^-1)
1	3.770D+02	3.520D+03	1.865D+06
2	1.280D+02	2.315D+02	2.540D+06
3	2.560D+02	3.848D+01	7.705D+04
4	6.100D+01	1.853D+01	9.972D+03
5	4.600D+01	1.384D+01	9.335D+03
6	1.520D+02	6.633D+00	1.388D+03
7	4.600D+01	6.300D+00	0.000D+00

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AREA 2B --*****! RADON !*****-----

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Area 2B 10000 Years

DESCRIPTION: Subsoil with 6%wc instead of 15%

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAI	LINGS	2.65

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	6	
DEFAULT RADON FLUX LIMIT	20	pCi m^-2 s^-1
LAYER THICKNESS NOT OPTIMIZED		
DEFAULT SURFACE RADON CONCENTRATION	0	pCi]^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1
		•

LAYER INPUT PARAMETERS

LAYER 1 Pond 2

505	CM
.7	
.795	g cm^-3
2568	pCi/g^-1
.35	• • •
2.144D-03	pci cm^-3 s^-1
15	%
.170	
4.942D-02	cm^2 s^-1
	505 .7 2568 .35 2.144D-03 15 .170 4.942D-02

LAYER 2 Struc Debris

THICKNESS	256	CM
PUKUSIIY MEASURED MASS DENSITY	.2	a cmA 2
MEASURED MASS DENSITY MEASURED RADIUM ACTIVITY	Z.1Z 75 3	$y c_{m/2}$
DEFAULT LAYER EMANATION COEFFICIENT	.35	per/gr I
CALCULATED SOURCE TERM CONCENTRATION	5.867D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.636	
CALCULATED DIFFUSION COEFFICIENT	4.015D-03	cm^2 s^-1

D LAYER 3

Clay Liner

THICKNESS POROSITY MEASURED MASS DENSITY MEASURED RADIUM ACTIVITY DEFAULT LAYER EMANATION COEFFICIENT CALCULATED SOURCE TERM CONCENTRATION WEIGHT % MOISTURE MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT	AREA 2B 61 .39 1.6165 0 .35 0.000D+00 15 .622 5.861D-03	cm g cm^-3 pci/g^-1 pCi cm^-3 s^-1 % cm^2 s^-1
THICKNESS POROSITY MEASURED MASS DENSITY MEASURED RADIUM ACTIVITY DEFAULT LAYER EMANATION COEFFICIENT CALCULATED SOURCE TERM CONCENTRATION WEIGHT % MOISTURE MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT LAYER 5 Subsoil	46 .4 1.59 0 .35 0.000D+00 6 .238 3.131D-02	cm g cm^-3 pCi/g^-1 pCi cm^-3 s^-1 % cm^2 s^-1
THICKNESS POROSITY MEASURED MASS DENSITY MEASURED RADIUM ACTIVITY DEFAULT LAYER EMANATION COEFFICIENT CALCULATED SOURCE TERM CONCENTRATION WEIGHT % MOISTURE MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT LAYER 6 TOPSOI	46 .45 1.4575 0 .35 0.000D+00 6 .194 3.762D-02	cm g cm^-3 pCi/g^-1 pCi cm^-3 s^-1 % cm^2 s^-1
THICKNESS POROSITY MEASURED MASS DENSITY MEASURED RADIUM ACTIVITY DEFAULT LAYER EMANATION COEFFICIENT CALCULATED SOURCE TERM CONCENTRATION WEIGHT % MOISTURE MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT	46 .49 1.3515 0 .35 0.000D+00 6 .165 4.231D-02	cm g cm^-3 pCi/g^-1 pCi cm^-3 s^-1 % cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 2.214D+03 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

EXIT FLUX Page 2 LAYER THICKNESS EXIT CONC. AREA 2B (pCi m^-2 s^-1) (pCi l^-1)

1	5.050D+02	5.565D+01	9.596D+05
2	2.560D+02	3.787D+01	7.491D+04
3	6.100D+01	1.880D+01	8.198D+03
4	4.600D+01	1.521D+01	6.331D+03
5	4.600D+01	1.320D+01	2.761D+03
6	4.600D+01	1.253D+01	0.000D+00

(cm)

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AREA 3 1 ----- *****! RADON !*****-----

Version 1.2 - MAY 22, 1989 - G.F. Birchard tel.# (301)492-7000 U.S. Nuclear Regulatory Commission Office of Research

RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Area 3 10000 Years

DESCRIPTION: Subsoil with 6%wc instead of 15%

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILI	NGS	2.65

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	5	
DEFAULT RADON FLUX LIMIT	20	pCi m^-2 s^-1
LAYER THICKNESS NOT OPTIMIZED		
DEFAULT SURFACE RADON CONCENTRATION	0	pCi]^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 Layer b-d

THICKNESS	457	CM
POROSITY	.7	
MEASURED MASS DENSITY	.795	g cm^-3
MEASURED RADIUM ACTIVITY	38.4	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	3.205D-05	pCi cm^-3 s^-1
WEIGHT % MOISTURE	15	%
MOISTURE SATURATION FRACTION	.170	
CALCULATED DIFFUSION COEFFICIENT	4.942D-02	cm^2 s^-1

Clay Liner LAYER 2

THICKNESS 61 cm POROSITY . 39 MEASURED MASS DENSITY 1.6165 $q cm^{-3}$ pCi/g^-1 MEASURED RADIUM ACTIVITY 0 DEFAULT LAYER EMANATION COEFFICIENT .35 0.000D+00 pCi cm^-3 s^-1 CALCULATED SOURCE TERM CONCENTRATION WEIGHT % MOISTURE 15 % MOISTURE SATURATION FRACTION .622 5.861D-03 CALCULATED DIFFUSION COEFFICIENT cm^2 s^-1

Π LAYER 3 Layer 3

THICKNESS POROSITY MEASURED MASS DENSITY MEASURED RADIUM ACTIVITY DEFAULT LAYER EMANATION COEFFICIENT CALCULATED SOURCE TERM CONCENTRATION WEIGHT % MOISTURE MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT	46 .4 1.59 0 .35 0.000D+00 6 .238 3.131D-02	cm g cm^-3 pCi/g^-1 pCi cm^-3 s^-1 % cm^2 s^-1
THICKNESS POROSITY MEASURED MASS DENSITY MEASURED RADIUM ACTIVITY DEFAULT LAYER EMANATION COEFFICIENT CALCULATED SOURCE TERM CONCENTRATION WEIGHT % MOISTURE MOISTURE SATURATION FRACTION CALCULATED DIFFUSION COEFFICIENT	152 .45 1.4575 0 .35 0.000D+00 6 .194 3.762D-02	cm g cm^-3 pCi/g^-1 pCi cm^-3 s^-1 % cm^2 s^-1
LAYER 5 Topsoil		

THICKNESS	46	CM .
POROSITY	.49	
MEASURED MASS DENSITY	1.3515	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
DEFAULT LAYER EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.165	
CALCULATED DIFFUSION COEFFICIENT	4.231D-02	cm^2 s^-1

BARE SOURCE FLUX FROM LAYER 1: 3.260D+01 pci m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi 1^-1)
1	4.570D+02	3.873D+00	1.280D+04
23	4.600D+01	1.865D+00 1.393D+00	1.004D+03 9.396D+02
4	1.520D+02	6.677D-01	1.397D+02
5.	4.600D+01	6.341D-01	0.000D+00

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