



January 3, 2012

Dr. Peter Lee
United States Regulatory Commission
Division of Nuclear Materials Safety
U.S. NRC Region III
2443 Warrenville Road, Suite 210
Lisle, Illinois 60532-4352

SUBJECT: Amended RESRAD model for lagoon closure and associated information

Dear Dr. Lee:

I am writing to amend the dose estimate emanating from the closure in place of the west lagoon located on our site at 7200 E ABC Lane, Columbia MO pursuant to incorporating the nearest well (which lies on the ABC property) as a source of water. This amends the previous estimate - ML 112770525.

I have included several assessments as attachments: these include the measured water concentrations as the lagoon was de-watered to the public sewer, a grading plan as intended for the grading of the lagoon, a conceptual description of the intended closure with drawing, photos of the lagoon as current, tables of measurements of the lagoon sediment and sidewall concentrations.

All of these show that the doses from the closure in place of the lagoon will result in 0.2 mrem in the highest projected year. We intend to move forward with the closure as soon as state and local approvals are final and of course as weather permits. Please let me know if you have any questions.

Best Regards,

Bradly D. Keck, PhD, CHP
Radiation Safety Officer
Analytical Bio-Chemistry Laboratories, Inc.

Cc: Troy DeVault, ABC

- Attachments:
1. LSC measurements during de-watering
 2. Grading Plan
 3. Table 2-1 and table 2-3.
 4. 2 photographs of present lagoon.
 5. Lagoon closure concept drawing
 6. Revised RESRAD model
 7. Calculation of minimum sample number per MARSSIM

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copy

ID: LAGOON SAMPLE ^④

6 JUN 2011 13:24

USER: 13 COMMENT: LAGOON SAMPLES

PRESET TIME : 10.00

DATA CALC : SL DPM H# : YES SAMPLE REPEATS: 1 PRINTER : STD

COUNT BLANK : YES IC# : NO REPLICATES : 1 RS232 : STD

TWO PHASE : NO AGC : NO CYCLE REPEATS : 1

SCINTILLATOR: LIQUID LUMEX: NO LOW SAMPLE REJ: 0

LOW LEVEL : NO HALF LIFE CORRECTION DATE: none

ISOTOPE 1: 14C %ERROR: 0.00 FACTOR: 1.0000 BKG. SUB: 0

BACKGROUND QUENCH CURVE: Off COLOR QUENCH CORRECTION: On

Quench Limits Low: -5.723 High: 313.72

SAM NO	POS	TIME MIN	H#	<u>14C</u>		14C DPM	14C EFF-1	LUMEX %	ELAPSED TIME
				CPM	%ERROR				
B1	11-1	10.00	64.9	33.10	10.99	35.17	94.10	3.71	10.63
B2	11-2	10.00	64.5	31.50	11.27	33.47	94.12	2.59	21.29
Blank Average				DPM for 14C :		34.32		COEF. OF VAR: 3.513	
1	11-4	10.00	86.6	33.70	10.89	1.77	93.39	4.19	31.98
2	11-5	10.00	87.4	31.80	11.22	-0.26	93.35	3.79	42.67
3	11-6	10.00	72.7	38.50	10.19	6.70	93.86	1.70	53.31
4	11-7	10.00	72.2	34.20	10.81	2.11	93.88	1.63	63.95
5	11-8	10.00	73.7	39.50	10.06	7.78	93.83	2.48	74.59
6	11-9	10.00	72.4	34.70	10.74	2.65	93.87	1.67	85.25

35W
45W
65W

④ 1ml samples from sump on each day of pumping to sanitary sewer.

Added 12/12/11 -- There are 1ml aliquots from the sump in duplicate from each day the sump was run.

$$\begin{aligned}
 \text{MDA} &= \frac{(2.71/10) + 4.65(34.32/10)^{\frac{1}{2}}}{10} \\
 &= 8.9 \text{ DPM/ML}
 \end{aligned}$$

wrong calculation - BOK 12/28/11

$$\begin{aligned}
 \text{Correction: MDA} &= \frac{2.71 + 4.65(32.3 \cdot 10)^{\frac{1}{2}}}{10 \cdot 0.9339} \quad (\text{MRE61556}) \\
 &= 9.2
 \end{aligned}$$

Wells Near ABC Laboratories, Columbia MO.

Report Date: 10/18/2010

Selected By: Two Mile Radius

Selection: 38 57 42 92 14 1

Depth: Total depth of the well

Case: Casing depth

Yield: Amount of water the well can produce (gallons per minute)

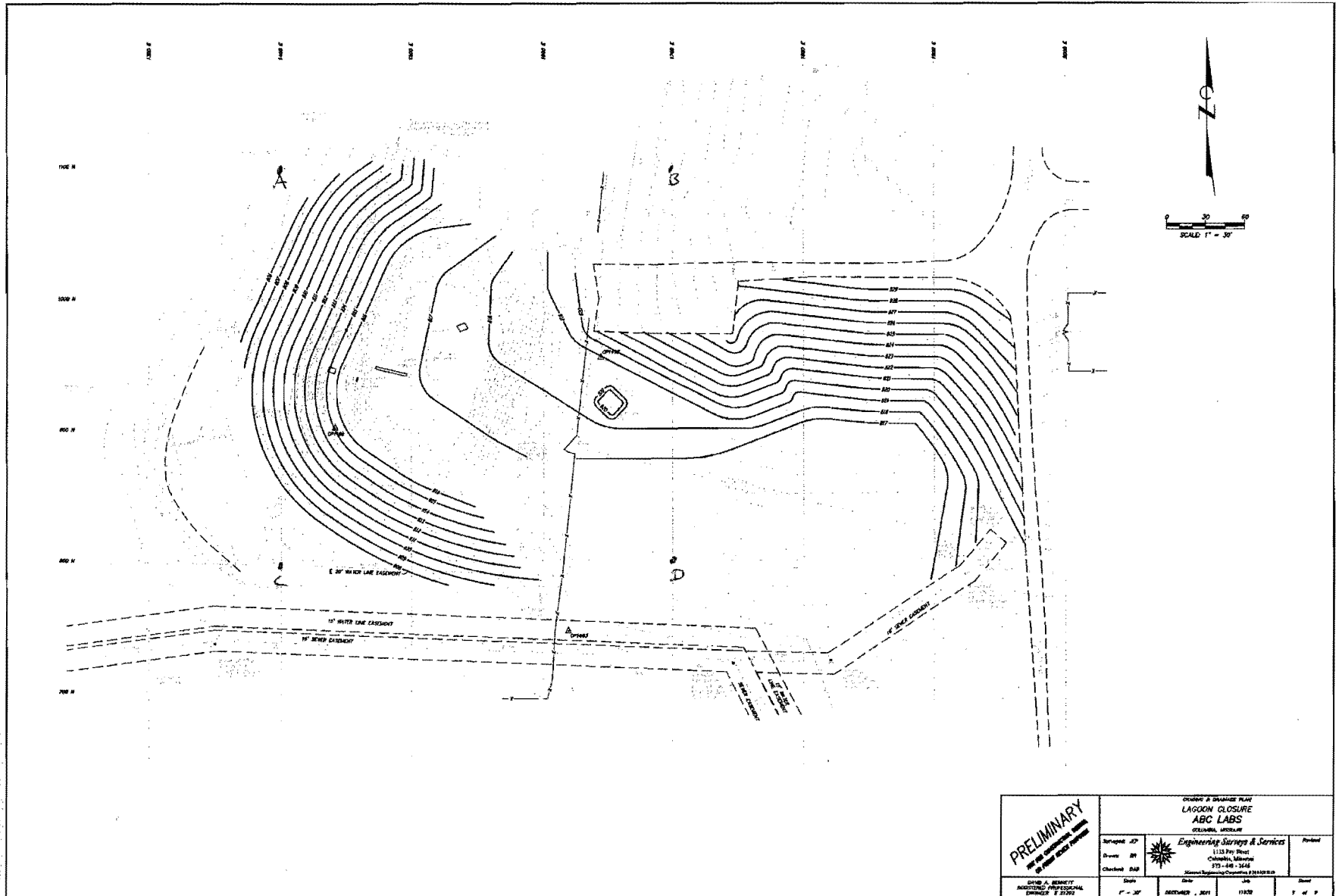
SWL: Static water level; constant level of water in the well

Legal Description Report

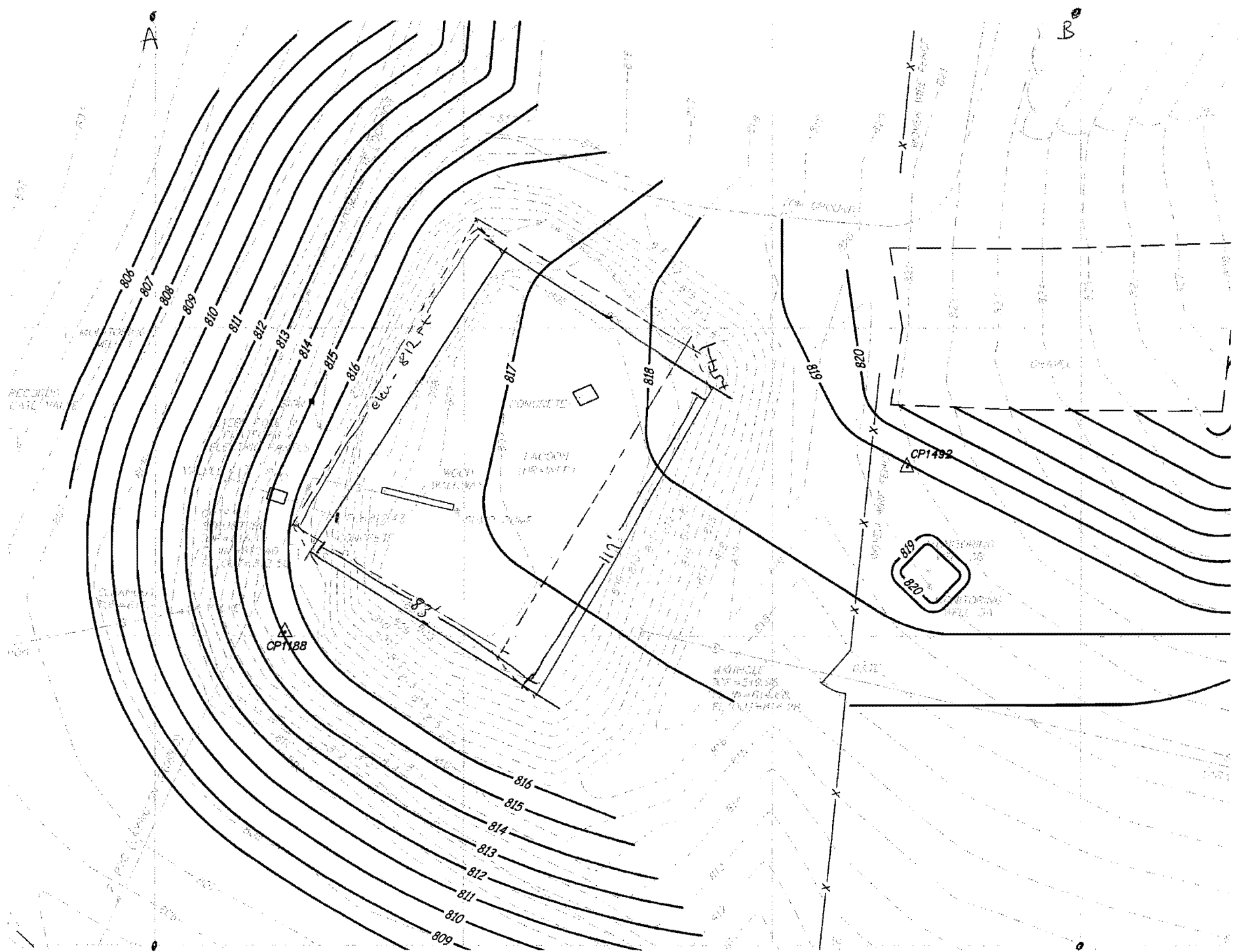
Ref Num	Well Type	Site Address	Business	Last Name	Owner Address	Usage	Depth	SQ	MQ	LQ	Sec	Twn	Rng	Dir	Elev	Case	Yield	SWL
00021563	HEAT PUMP			MURPHY	1305 STABLESTONE LN	COLUMBIA	MO	VERTICAL	180.0			NW	23	48	12	W		
00408390	HEAT PUMP			SCHWARTZ	1015 E OLD HAWTHORNE DR	COLUMBIA	MO	VERTICAL	180.0			SW	14	48	12	W		
00364043	ABANDONED	7301 E TURNER FARM RD	COLUMBIA	WILLIAMS PETROLEUM SERVICES	ONE WILLIAMS CENTER MD-48-6	TULSA	OK	SOILBORING	25.0	NE	SE	SW	13	48	12	W		
00203534	ABANDONED	7301 TURNER FR	COLUMBIA	WILLIAMS PIPELINE	8001 COLLEGE	OVERLAND PARKKS	MO	SOILBORING	12.0	SW	SE	SW	13	48	12	W		
00206716	MONITORING	7301 TURNER FARM RD	COLUMBIA	WILLIAMS PIPELINE	8001 COLLEGE BLVD STE 200	OVERLAND PARKKS	MO	MONITORING	44.0	SW	SE	SW	13	48	12	W		
00206717	MONITORING	7301 TURNER FARM RD	COLUMBIA	WILLIAMS PIPELINE	8001 COLLEGE BLVD STE 200	OVERLAND PARKKS	MO	MONITORING	25.0	SW	SE	SW	13	48	12	W		
00206718	MONITORING	7301 TURNER FARM RD	COLUMBIA	WILLIAMS PIPELINE	8001 COLLEGE BLVD STE 200	OVERLAND PARKKS	MO	MONITORING	20.0	SW	SE	SW	13	48	12	W		
00206719	MONITORING	7301 TURNER FARM RD	COLUMBIA	WILLIAMS PIPELINE	8001 COLLEGE BLVD	OVERLAND PARKKS	MO	MONITORING	54.0	SW	SE	SW	13	48	12	W		
00206720	MONITORING	7301 TURNER FARM RD	COLUMBIA	WILLIAMS PIPELINE	8001 COLLEGE BLVD	OVERLAND PARKKS	MO	MONITORING	43.0	SW	SE	SW	13	48	12	W		12.0
00206721	MONITORING	7301 TURNER FARM RD	COLUMBIA	WILLIAMS PIPELINE	8001 COLLEGE BLVD	OVERLAND PARKKS	MO	MONITORING	29.0	SW	SE	SW	13	48	12	W		12.0
00412015	ABANDONED	7301 E TURNER FARM RD	COLUMBIA	WILLIAMS PETROLEUM SERVICE	ONE WILLIAMS CENTER MD 48-6	TULSA	OK	SOILBORING	25.0				13	48	12	W		
00285067	MONITORING	7301 E TURNER COLUMBIA		WILLIAMS PETROLEUM SERVICES	ONE WILLIAMS CENTER	TULSA	OK	MONITORING	18.5			SW	13	48	12	W		1.0
00285068	MONITORING	7301 E TURNER COLUMBIA		WILLIAMS PETROLEUM SERVICES	ONE WILLIAMS CENTER	TULSA	OK	MONITORING	19.5			SW	13	48	12	W		1.0
00299486	ABANDONED	7301 TURNER FR RD	COLUMBIA	WILLIAMS PETROLEUM SERV LLC	ONE WILLIAMS CENTER MD48-6	TULSA	OK	SOILBORING				SW	13	48	12	W		
00300470	ABANDONED	7301 E TURNER COLUMBIA		WILLIAMS PETROLEUM SERVICES	ONE WILLIAMS CENTER	TULSA	OK	SOILBORING	20.0			SW	13	48	12	W		
00399842	HEAT PUMP			STOHLDRIER	4404 GLEN EAGLE DR	COLUMBIA	MO	VERTICAL	158.0			SE	15	48	12	W		
00399233	HEAT PUMP	811 SUNSTONE LN	COLUMBIA	WELEK CONSTRUCTION	3212 COUNTRY WOODS RD	COLUMBIA	MO	VERTICAL	187.0			SE	15	48	12	W		
00408877	HEAT PUMP	810 SUNSTONE	COLUMBIA	WELEK CONSTRUCTION	3212 COUNTRY WOODS RD	COLUMBIA	MO	VERTICAL	180.0			SE	15	48	12	W		
00408876	HEAT PUMP	808 SUNSTONE	COLUMBIA	WELEK CONSTRUCTION	3212 COUNTRY WOODS RD	COLUMBIA	MO	VERTICAL	187.0			SE	15	48	12	W		
00399232	HEAT PUMP	809 SUNSTONE LN	COLUMBIA	WELEK CONSTRUCTION	3212 COUNTRY WOODS RD	COLUMBIA	MO	VERTICAL	187.0			SE	15	48	12	W		
00399234	HEAT PUMP	800 SUNSTONE LN	COLUMBIA	WELEK CONSTRUCTION	3212 COUNTRY WOODS RD	COLUMBIA	MO	VERTICAL	180.0			SE	15	48	12	W		
00399231	HEAT PUMP	8025 SUNSTONE LN	COLUMBIA	WELEK CONSTRUCTION	3212 COUNTRY WOODS RD	COLUMBIA	MO	VERTICAL	187.0			SE	15	48	12	W		
00399846	HEAT PUMP	806 SUNSTONE	COLUMBIA	WELEK CONSTRUCTION	3212 COUNTRY WOODS RD	COLUMBIA	MO	VERTICAL	187.0			SE	15	48	12	W		
00255505	WELL			WURZER	8010 E RICHLAND ROAD	COLUMBIA	MO	DOMESTIC	790.0				15	48	12	W		337 70.0 320.0
00023868	HEAT PUMP	904 SUNSTONE	COLUMBIA	WELEK CONSTRUCTION	3212 COUNTRY WOODS RD	COLUMBIA	MO	DOMESTIC	187.0			SE	15	48	12	W		
00257375	WELL			BERGSTORM	8040 RICHLAND RD	COLUMBIA	MO	DOMESTIC	648.0	SE	SE	NE	15	48	12	W		840 310 40.0
00112010	ABANDONED			BOONE COUNTY PWSD #9	391 NORTH RANGELINE	COLUMBIA	MO	PUBLIC	925.0			SE	NW	12	48	12	W	871
00121774	MONITORING			MIDWEST PETROLEUM CO	6760 SOUTHWEST AVE	ST LOUIS	MO	MONITORING	24.0	SE	NW	NE	10	48	12	W		
00121775	MONITORING			MIDWEST PETROLEUM CO	6760 SOUTHWEST AVE	ST LOUIS	MO	MONITORING	24.0	SE	NW	NE	10	48	12	W		843
00121776	MONITORING			MIDWEST PETROLEUM CO	6760 SOUTHWEST AVE	ST LOUIS	MO	MONITORING	24.0	SE	NW	NE	10	48	12	W		843
00244706	ABANDONED	5605 I-70 DR SE		RANDY ADAMS CONSTRUCTION	2311 E WALNUT	COLUMBIA	MO	DOMESTIC		SE	NW	NE	10	48	12	W		
00016789	PUMP			ABC LABS	7300 EAST ABC LANE	COLUMBIA	MO	UNKNOWN	895.0			NE	NE	10	48	12	W	
00070494	MONITORING			ABC LABORATORIES	7200 E ABC LN	COLUMBIA	MO	MONITORING	40.0			11	48	12	W		797 1.0	
00070495	MONITORING			ABC LABORATORIES	7200 E ABC LN	COLUMBIA	MO	MONITORING	40.0			11	48	12	W		797 1.0	
00239594	WELL			COLUMBIA PARKS & RECREATION	PO BOX N	COLUMBIA	MO	IRRIGATION	1400.0	SE	NW	SE	2	48	12	W		820 460 400.0 345.0
00278975	ABANDONED			UNITED PARCEL SERVICE	2501 VANDIVER DR	COLUMBIA	MO	SOILBORING	12.0			SE	NE	1	48	12	W	
00200362	WELL			WILLETT	6501 MEXICO GRAVEL RD	COLUMBIA	MO	DOMESTIC	548.0	NW	NE	SW	35	49	12	W		840 210 40.0
00273312	WELL			RIESS	8071 MEXICO GRAVEL	COLUMBIA	MO	DOMESTIC	610.0				36	49	12	W		211 20.0 240.0
00273314	WELL			WOOD	7801 MEXICO GRAVEL RD	COLUMBIA	MO	DOMESTIC	650.0				36	49	12	W		211 50.0 280.0
00323632	ABANDONED	ABC LANE		ABC LABORATORIES INC	7200 E ABC LANE	COLUMBIA	MO	SOILBORING	13.0				36	49	12	W		
00193410	PUMP			WILLET	6501 MEXICO GRAVEL RD	COLUMBIA	MO	DOMESTIC		SW	SE	NW	35	49	12	W		

②
①

1. This well is on the ABC site and is used for aquatic studies, but not drinking supply.
2. These three wells are 1.5, 1.7 and 2.2 miles distant.
3. In general, the prevailing wisdom here suggests that a drinking well needs to be about 1,000 feet deep, while water containing sulfur may be found often at about 600 feet depth and wells shallower than 600 feet are unlikely to have an adequate yield. *BOC 12 DEC 11*



ABC Grading Plan - Draft - 12/6/11 - see inset ABCD



A

B

C

D

ATTCHMENT 2.3

CARBON-14 CONCENTRATIONS IN SIDEWALL COMPOSITE SOIL (PCI/G)

Table 2.3 Samples of Sidewall Soil and Concentrations of carbon-14 in pCi/g.

Sample ID	Concentration of ¹⁴ C (pCi/g)*
LSW8a-101101	38.6
LSW9a-101101	108
LSW10a-101101	121
LSW11a-101101	128
Mean +/- STDEV	98.9 +/- 41

*No Significant figures are indicated here; the result is displayed without rounding.

ATTACHMENT 2.1

CARBON-14 CONCENTRATIONS IN LAGOON SEDIMENT (PCI/G)

Table 2.1 Samples of lagoon sediment and concentrations of carbon-14 in pCi/g.

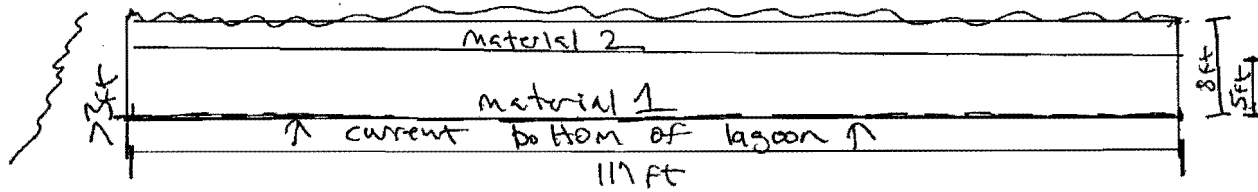
Sample ID	Concentration of ¹⁴ C (pCi/g)*
LGNOCT2010 0001	409
LGNOCT2010 0003	727
LGNOCT2010 0005	280
LGNOCT2010 0007	659
LGNOCT2010 0009	537
LGNOCT2010 0011	645
LGNOCT2010 0013	362
LGNOCT2010 0015	346
LGNOCT2010 0017	444
LGNOCT2010 0019	576
LBS1a-101102	93.1
LBS2a-101102	565
LBS3a-101102	158
LBS4a-101102	291
LBS5a-101102	313
LBS6a-101102	128
LBS7a-101102	1,560
Mean +/- STDEV	476 +/- 337

*No Significant figures are indicated here; the result is displayed without rounding.

ABC Lagoon Closure, conceptual

Long Axis Midline Elevation

NE ————— SW



Material 1 = sediment plus berm plus fresh soil, see source term

Material 2 = fresh soil, uncontaminated surface

grade or contour, separated by >3 ft.

total volume of Material 1 is $83 \times 117 \times 5 = 48,555 \text{ ft}^3 \approx 1,198 \text{ yd}^3$

bdk-21/0011

Summary : RESRAD Lagoon with irrigation

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Time = 0.000E+00	9
Time = 2.500E-01	10
Time = 1.000E+00	11
Time = 3.000E+00	12
Time = 1.000E+01	13
Time = 3.000E+01	14
Time = 1.000E+02	15
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Summary : RESRAD Lagoon with irrigation

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Dose Conversion Factor (and Related) Parameter Summary
 Dose Library: FGR 12 & FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	C-14 (Source: FGR 12)	1.345E-05	1.345E-05	DCF1(1)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	C-14(p) (Class: ORGANIC)	2.090E-06	2.090E-06	DCF2(1)
B-1	C-14(g) (Class: CO2)	2.350E-08	2.350E-08	C14GIInhDCF
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	C-14	2.090E-06	2.090E-06	DCF3(1)
D-34	Food transfer factors:			
D-34	C-14 , plant/soil concentration ratio, dimensionless	5.500E+00	5.500E+00	RTF(1,1)
D-34	C-14 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.100E-02	3.100E-02	RTF(1,2)
D-34	C-14 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.200E-02	1.200E-02	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	C-14 , fish	5.000E+04	5.000E+04	BIOFAC(1,1)
D-5	C-14 , crustacea and mollusks	9.100E+03	9.100E+03	BIOFAC(1,2)

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.

*Base Case means Default.Lib w/o Associate Nuclide contributions.

Summary : RESRAD Lagoon with irrigation

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Site-Specific Parameter Summary

Me1	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	8.810E+02	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.520E+00	2.000E+00	---	THICK0
R011	Fraction of contamination that is submerged	0.000E+00	0.000E+00	---	SUBMFRACT
R011	Length parallel to aquifer flow (m)	2.900E+01	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	5.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	2.500E-01	1.000E+00	---	T (2)
R011	Times for calculations (yr)	1.000E+00	3.000E+00	---	T (3)
R011	Times for calculations (yr)	3.000E+00	1.000E+01	---	T (4)
R011	Times for calculations (yr)	1.000E+01	3.000E+01	---	T (5)
R011	Times for calculations (yr)	3.000E+01	1.000E+02	---	T (6)
R011	Times for calculations (yr)	1.000E+02	3.000E+02	---	T (7)
R011	Times for calculations (yr)	3.000E+02	1.000E+03	---	T (8)
R011	Times for calculations (yr)	1.000E+03	0.000E+00	---	T (9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): C-14	3.270E+01	0.000E+00	---	SI(1)
R012	Concentration in groundwater (pCi/L): C-14	not used	0.000E+00	---	WI(1)
R013	Cover depth (m)	9.000E-01	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.500E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	5.300E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	5.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	3.100E+02	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW

Summary : RESRAD Lagoon with irrigation

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Site-Specific Parameter Summary (continued)

Me#	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	4.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPOZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for C-14				
R016	Contaminated zone (cm**3/g)	-1.000E+00	0.000E+00	1.108E+01	DCNUCC(1)
R016	Unsat. zone 1 (cm**3/g)	-1.000E+00	0.000E+00	1.108E+01	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	-1.000E+00	0.000E+00	1.108E+01	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.523E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	not used	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	not used	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	not used	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R0?	Shape factor flag, external gamma	-1.000E+00	1.000E+00	-1 shows non-circular AREA.	FS
R0:	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	5.000E+01	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	7.071E+01	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	0.000E+00	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	0.000E+00	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	0.000E+00	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	0.000E+00	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	0.000E+00	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	0.000E+00	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	0.000E+00	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	0.000E+00	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	0.000E+00	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	0.000E+00	0.000E+00	---	RAD_SHAPE(12)

Summary : RESRAD Lagoon with irrigation

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Site-Specific Parameter Summary (continued)

Mei	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	1.000E+00	1.000E+00	---	FRACA(1)
R017	Ring 2	2.732E-01	2.732E-01	---	FRACA(2)
R017	Ring 3	0.000E+00	0.000E+00	---	FRACA(3)
R017	Ring 4	0.000E+00	0.000E+00	---	FRACA(4)
R017	Ring 5	0.000E+00	0.000E+00	---	FRACA(5)
R017	Ring 6	0.000E+00	0.000E+00	---	FRACA(6)
R017	Ring 7	0.000E+00	0.000E+00	---	FRACA(7)
R017	Ring 8	0.000E+00	0.000E+00	---	FRACA(8)
R017	Ring 9	0.000E+00	0.000E+00	---	FRACA(9)
R017	Ring 10	0.000E+00	0.000E+00	---	FRACA(10)
R017	Ring 11	0.000E+00	0.000E+00	---	FRACA(11)
R017	Ring 12	0.000E+00	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	not used	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	0.000E+00	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.441E+00	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)

Summary : RESRAD Lagoon with irrigation

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Site-Specific Parameter Summary (continued)

Me	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	2.000E-05	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	3.000E-02	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	2.000E-02	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	9.800E-01	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	3.000E-01	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	7.000E-07	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	1.000E-10	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	8.000E-01	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	2.000E-01	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PHZOCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PHZOFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	RMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TI1	Number of graphical time points	32	---	---	NPTS

Summary : RESRAD Lagoon with irrigation

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Site-Specific Parameter Summary (continued)

Mea	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	suppressed
3 -- plant ingestion	active
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	active
8 -- soil ingestion	suppressed
9 -- radon	suppressed
Find peak pathway doses	active

Summary : RESRAD Lagoon with irrigation

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Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	881.00 square meters	C-14	3.270E+01
Thickness:	1.52 meters		
Cover Depth:	0.90 meters		

Total Dose TDOSE(t), mrem/yr
 Basic Radiation Dose Limit = 2.500E+01 mrem/yr
 Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	2.500E-01	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	5.468E-03	8.328E-03	1.680E-02	3.784E-02	9.579E-02	1.680E-01	9.685E-02	1.920E-03	0.000E+00
M(t):	2.187E-04	3.331E-04	6.720E-04	1.514E-03	3.832E-03	6.720E-03	3.874E-03	7.678E-05	0.000E+00

Maximum TDOSE(t): 1.732E-01 mrem/yr at t = 38.97 ± 0.08 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 3.897E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	2.057E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.732E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.057E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.732E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 3.897E+01 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.732E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.732E-01	1.0000

*Sum of all water independent and dependent pathways.

Summary : RESRAD Lagoon with irrigation

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	9.906E-22	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.468E-03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	9.906E-22	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.468E-03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.468E-03	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.468E-03	1.0000

*Sum of all water independent and dependent pathways.

Summary : RESRAD Lagoon with irrigation

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 2.500E-01 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	9.952E-22	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.328E-03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	9.952E-22	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.328E-03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 2.500E-01 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.328E-03	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.328E-03	1.0000

*Sum of all water independent and dependent pathways.

Summary : RESRAD Lagoon with irrigation

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	1.009E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.680E-02	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.009E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.680E-02	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.680E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.680E-02	1.0000

*Sum of all water independent and dependent pathways.

Summary : RESRAD Lagoon with irrigation

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	1.048E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.784E-02	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.048E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.784E-02	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.784E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.784E-02	1.0000

*Sum of all water independent and dependent pathways.

Summary : RESRAD Lagoon with irrigation

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	1.195E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.579E-02	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.195E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.579E-02	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.579E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.579E-02	1.0000

*Sum of all water independent and dependent pathways.

Summary : RESRAD Lagoon with irrigation

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	1.739E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.680E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.739E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.680E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.680E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.680E-01	1.0000

*Sum of all water independent and dependent pathways.

Summary : RESRAD Lagoon with irrigation

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	6.460E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.396E-02	0.9701	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	6.460E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.396E-02	0.9701	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.892E-03	0.0299	0.000E+00	0.0000	0.000E+00	0.0000	9.685E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.892E-03	0.0299	0.000E+00	0.0000	0.000E+00	0.0000	9.685E-02	1.0000

*Sum of all water independent and dependent pathways.

Summary : RESRAD Lagoon with irrigation

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	2.747E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.766E-03	0.9199	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.747E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.766E-03	0.9199	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.538E-04	0.0801	0.000E+00	0.0000	0.000E+00	0.0000	1.920E-03	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.538E-04	0.0801	0.000E+00	0.0000	0.000E+00	0.0000	1.920E-03	1.0000

*Sum of all water independent and dependent pathways.

Summary : RESRAD Lagoon with irrigation

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Summary : RESRAD Lagoon with irrigation

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Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

i	t	Product	Thread	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g)							
(i)	(j)	Fraction	0.000E+00	2.500E-01	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
C-14	C-14	1.000E+00	1.672E-04	2.547E-04	5.137E-04	1.157E-03	2.929E-03	5.138E-03	2.962E-03	5.870E-05	0.000E+00

The DSR includes contributions from associated (half-life ≤ 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Nuclide	t=	0.000E+00	2.500E-01	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
(i)										
C-14	1.495E+05	9.817E+04	4.866E+04	2.160E+04	8.534E+03	4.866E+03	8.441E+03	4.259E+05	*4.455E+12	

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 38.97 ± 0.08 years

Nuclide	Initial	tmin	DSR(i,tmin)	G(i,tmin)	DSR(i,tmax)	G(i,tmax)
	(pCi/g)	(years)		(pCi/g)		(pCi/g)
C-14	3.270E+01	38.97 ± 0.08	5.298E-03	4.719E+03	5.298E-03	4.719E+03

Summary : RESRAD Lagoon with irrigation

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Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuc (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr								
			t= 0.000E+00	2.500E-01	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
C-14	C-14	1.000E+00	5.468E-03	8.328E-03	1.680E-02	3.784E-02	9.579E-02	1.680E-01	9.685E-02	1.920E-03	0.000E+00

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g								
			t= 0.000E+00	2.500E-01	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
C-14	C-14	1.000E+00	3.270E+01	3.249E+01	3.188E+01	3.031E+01	2.538E+01	1.529E+01	2.592E+00	1.629E-02	0.000E+00

THF(i) is the thread fraction of the parent nuclide.

RESCALC.EXE execution time = 14.69 seconds

Calculation of minimum sample number for distinguishing background from >476 pCi/g, using method C01 at GEL Laboratories, as in MARSSIM Manual.

DGCL = 476 pCi/g: (Mean sediment concentration)

LBGR = ½ DGCL = 238 pCi/g

Typical one sigma uncertainty = 1 pCi/g

$$\Delta / \sigma = (476 - 238) / 1 = 238$$

Sign p = 1 from table 5.4

$$\alpha = 0.05, \beta = 0.05$$

From Table 5.5, N = 14

N/2 = 7, so 7 measurements are needed in any classified area: here, background, sediment or sidewall even if the UBGR is minimally exceeded. Since in practice the varying matrices are different than background by at least an order of magnitude, there is virtually no overlap of uncertainties.

Given that the contaminated area is typically several hundred pCi/g and is not near the UBGR, this is a very conservative estimation of minimum number. Also, just based on conventional analysis of variation, three samples from each matrix would be sufficient to establish significant difference, given the high precision of the method and large differences between matrices.

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