Carroll
MONTANA

January 17, 2005

JAN 24 2005

United States Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Drive
Suite 400
Arlington, Texas 78011

Dear Rachel S. Browder,

This letter is to provide an update on our progress in the decommissioning process of Carroll College materials license (25-07093-01) according to 10CFR30.36(C)(D).

We currently house the sealed sources that are indicated on the updated inventory (Table 1.), one source remains unidentified. Please note that initially 5 unknown sealed sources were indicated, however upon further review of the materials records with the former RSO, Father Harrington Ph.D. Four of the sources that I identified as sealed sources were actually homemade samples in which a drop of either CsCl or $CoCl_2$ was placed between two sheets of plastic and mounted on a small piece of cardboard. We have also drain disposed of all materials that are not check sources in the inventory. I have attached a copy of the drain disposal records, Table 2.

I have contacted one commercial company (qualtech) regarding disposal and plan to contact others. They cannot complete a cost estimate for disposal until all sources are identified. Additionally Bobby Walton from the state of California has expressed interest in a possible transfer of many of our sealed sources. The transfer would be from the Carroll college materials license to the license of the State of California. The major problem we are running into in the disposal is the unidentified source. I have not been able to locate anyone locally with a sodium iodide multichannel analyzer such that we could identify the unidentified sealed source.

Finally in regards to materials that were buried on the Carroll College Campus, June 30, 1961. I am including the RESRAD modeling output for those materials. Given that the materials buried at the site contained Iodine 131, with a half-life of 8.04 days, Gold 198 with a half-life of 2.69 days, and Carbon 14, with a half-life of 5,568 years. The calculations were only performed for Carbon 14.

I appreciate your time and consideration in these matters.

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470386

Sincerely,

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Table 2. Radioactive Materials Disposal Log (Drain Disposal)

Isotope	Chemical Form	Quantity and Date Recieved	Amount Disposed and Date	Volume of Water For Dilutions 24-Hours	Concentration of Material	Allowable Concentration
^{3}H	Thymidine	0.25 mCi 3-14-83	0.25 mCi 9-3-04	24,483 liters	1.02×10^{-5} µCi/mL	1.0×10^{-2} µCi/mL
^{14}C	d-glucose	50 µCi 1-22-86	50 µCi 10-4-04	24,483 liters	2.04×10^{-6} µCi/mL	3.0×10^{-4} µCi/mL
^{14}C	Sodium acetate	30 µCi 2-19-85	30 µCi 10-5-04	24,483 liters	1.23×10^{-6} µCi/mL	3.0×10^{-4} µCi/mL
^{14}C	Palmitic acid	15 µCi 2-03-86	15 µCi 10-5-04	24,483 liters	6.12×10^{-7} µCi/mL	3.0×10^{-4} µCi/mL
^{14}C	Sodium hectate	10 µCi 2-03-84	10 µCi 10-5-04	24,483 liters	4.08×10^{-7} µCi/mL	3.0×10^{-4} µCi/mL
^{60}Co	$CoCl_2$	1 mCi 5-06-61				
			0.5 mCi 9-7-04	24,483 liters	2.04×10^{-5} µCi/mL	3.0×10^{-5} µCi/mL
			0.5 mCi 10-11-04	24,483 liters	2.04×10^{-5} µCi/mL	3.0×10^{-5} µCi/mL
^{137}Cs	CsCl	1 mCi 2-25-61				
			0.2 mCi 8-3-04	24,483 liters	8.17×10^{-6} µCi/mL	1.0×10^{-5} µCi/mL
			0.2 mCi 9-7-04	24,483 liters	8.17×10^{-6} µCi/mL	1.0×10^{-5} µCi/mL

			0.2 mCi	10-5-04	24,483 liters	8.17×10^{-6} μCi/mL	1.0×10^{-5} μCi/mL
			0.2 mCi	11-2-04	24,483 liters	8.17×10^{-6} μCi/mL	1.0×10^{-5} μCi/mL
			0.2 mCi	12-7-04	24,483 liters	8.17×10^{-6} μCi/mL	1.0×10^{-5} μCi/mL

* Isotopes were disposed down the drain of a stainless steel sink in Simperman Hall room 218 with the tap running (measured at approximately 7.5 liters per minute). The tap remained on for 1-hour each time material was disposed of. The waste line from the sink joins into the building sewer line that connects to the sewer lines from two dormitories on the Carroll College campus. The mixture of effluent from these three buildings is discharged into the city sewer system. Based upon water meter readings for these buildings during the lowest water usage months of the year approximately 24,483 liters of water was estimated to leave the campus through this sewer pipe in a 24 hour period. This value (24,483 liters) was used to estimate the dilution of radioactive material such that the material could be drain disposed under NRC guidelines.

Section 5. Radioactive Material

Inventory of stored isotopes stored in the lead brick housing within in the locked cabinet below the fume hood in room 218 Simperman Hall. If the date of receipt is not included in the table below it is not known at this time. All quantities currently held by Carroll College are the maximum amounts that will be stored on site until they can be disposed of through the decommissioning process and termination of license 25-07093-01. No new radioactive materials will be acquired by Carroll College.

Table 1. Radioactive Materials Inventory 2005

Isotope	Chemical Form	Quantity and Date Recieved		Maximum Amount Housed	Disposal
^{3}H	Thymidine	0.25 mCi	3-14-83	CAO*	Disposed
^{14}C	d-glucose	50 μCi	1-22-86	CAO	Disposed
^{14}C	Sodium acetate	30 μCi	2-19-85	CAO	Disposed
^{14}C	Palmitic acid	15 μCi	2-03-86	CAO	Disposed
^{14}C	Sodium hectate	10 μCi	2-03-84	CAO	Disposed
^{60}Co	$CoCl_2$	1 mCi	5-06-61	CAO	Disposed
^{137}Cs	CsCl	1 mCi	2-25-61	CAO	Disposed
^{60}Co	Sealed Source	Pre 1960 (donation)		CAO	
Uranium	Uranium Nitrate	Approx. 1.3 lbs		CAO	
Uranium	Uranium Acetate	Approx 1.0 lbs		CAO	
^{137}Cs	Sealed Source	Pre 1960 (donation)		CAO	
^{137}Cs	Sealed Source	0.05 μCi		CAO	
^{137}Cs	Sealed Source	0.5 μCi		CAO	
^{60}Co	Sealed Source	0.5 μCi		CAO	
^{133}Ba	Sealed Source	0.05 μCi		CAO	
^{137}Cs	Sealed Source	0.05 μCi		CAO	
^{137}Cs	Sealed Source	0.5 μCi		CAO	
^{60}Co	Sealed Source	0.05 μCi		CAO	
^{60}Co	Sealed Source	0.5 μCi		CAO	
^{133}Ba	Sealed Source	0.05 μCi		CAO	
^{133}Ba	Sealed Source	0.5 μCi		CAO	
^{133}Ba	Sealed Source	0.5 μCi		CAO	
^{14}C	Sealed Source	17,000 cpm		CAO	
^{14}C	Sealed Source	Unkown		CAO	
^{90}Sr	Sealed Source	Unknown		CAO	
^{210}Pb	Sealed Source	Unknown		CAO	
^{238}U	Sealed Source	Unknown		CAO	
Radium	Sealed Source	1.0 μCi		CAO	
Radium	Sealed Source	Unknown		CAO	
	Sealed Source	Unknown		CAO	
Unk 1	Dry sample	Unknown		CAO	Disposed
Unk 2	Dry sample	Unknown		CAO	Disposed

Unk 3	Dry sample	Unknown	CAO	Disposed
Unk 4	Dry sample	Unknown	CAO	Disposed
Unk 5	Sealed Source	Unknown	CAO	
^{60}Co	Sealed Source	1.0 μCi	CAO	
^{204}Ti	Sealed Source	0.8 μCi	CAO	
^{204}Ti	Sealed Source	0.8 μCi	CAO	
^{204}Ti	Sealed Source	0.8 μCi	CAO	
^{210}Po	Sealed Source	0.1 μCi	CAO	
^{137}Cs	Sealed Source	Unknown	CAO	
^{90}Sr	Sealed Source	0.1 μCi	CAO	

Unknowns 1-4 were small spots of $CoCl_2$ or CsCl placed between two sheets of plastic and used in student experiments in the early 1960's. Since they were a very small amount of the total quantity received the dried materials (spot) were reconstituted in water and disposed of down the drain as part of the $CoCl_2$ or CsCl disposals.

Unk 5 has still not been identified but is a sealed source.

CAO = Current Amount Only, no additional materials will be obtained or housed at Carroll College.

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Dose Conversion Factor (and Related) Parameter Summary
File: FGR 13 Morbidity

Menu	Parameter	Current Value	Default	Pa
B-1	Dose conversion factors for inhalation, mrem/µCi:			
B-1	C-14	2.090E+00	2.090E+00	DCF
D-1	Dose conversion factors for ingestion, mrem/µCi:			
D-1	C-14	2.090E+00	2.090E+00	DCF
D-34	Food transfer factors:			
D-34	C-14 , plant/soil concentration ratio, dimensionless	5.500E+00	5.500E+00	RTF
D-34	C-14 , beef/livestock-intake ratio, (µCi/kg)/(µCi/d)	3.100E-02	3.100E-02	RTF
D-34	C-14 , milk/livestock-intake ratio, (µCi/L)/(µCi/d)	1.200E-02	1.200E-02	RTF
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	C-14 , fish	5.000E+04	5.000E+04	BIO
D-5	C-14 , crustacea and mollusks	9.100E+03	9.100E+03	BIO

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used b (If different
R011	Area of contaminated zone (m**2)	1.000E-01	1.000E+04	-
R011	Thickness of contaminated zone (m)	2.000E+00	2.000E+00	-
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	-
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	2.500E+01	-
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	-
R011	Times for calculations (yr)	1.000E+00	1.000E+00	-
R011	Times for calculations (yr)	1.000E+01	3.000E+00	-
R011	Times for calculations (yr)	2.000E+01	1.000E+01	-
R011	Times for calculations (yr)	4.000E+01	3.000E+01	-
R011	Times for calculations (yr)	1.000E+02	1.000E+02	-
R011	Times for calculations (yr)	not used	3.000E+02	-
R011	Times for calculations (yr)	not used	1.000E+03	-
R011	Times for calculations (yr)	not used	0.000E+00	-
R011	Times for calculations (yr)	not used	0.000E+00	-
R012	Initial principal radionuclide (µCi/g): C-14	2.500E-01	0.000E+00	assuming "coffee can" size is 200g -
R012	Concentration in groundwater (µCi/L): C-14	not used	0.000E+00	-
R013	Cover depth (m)	1.200E+00	0.000E+00	this is reasonable and conservative. R&Browder
R013	Density of cover material (g/cm**3)	1.500E+00	1.500E+00	-
R013	Cover depth erosion rate (m/yr)	1.000E-03	1.000E-03	-
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	-
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	-
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	-
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	-
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	-
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	-
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	-
R013	Humidity in air (g/m**3)	not used	8.000E+00	-
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	-
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	-
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	-
R013	Irrigation mode	overhead	overhead	-
R013	Runoff coefficient	2.000E-01	2.000E-01	-
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	-
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	-
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	-
R014	Saturated zone total porosity	4.000E-01	4.000E-01	-
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	-
R014	Saturated zone field capacity	2.000E-01	2.000E-01	-
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	-
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	-
R014	Saturated zone b parameter	5.300E+00	5.300E+00	-
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	-
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	-
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	-
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	-
R015	Number of unsaturated zone strata	1	1	-

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used b (If different
R015	Unsat. zone 1, thickness (m)	4.000E+00	4.000E+00	-
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	-
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	-
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	-
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	-
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	-
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	-
R016	Distribution coefficients for C-14			
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	-
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	-
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	-
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.79
R016	Solubility constant	0.000E+00	0.000E+00	not
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	-
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	-
R017	Exposure duration	4.500E+01	3.000E+01	-
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	-
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	-
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	-
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	-
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows ci
R017	Radii of shape factor array (used if FS = -1):			
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	-
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	-
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	-
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	-
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	-
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	-
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	-
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	-
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	-
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	-
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	-
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	-
R017	Fractions of annular areas within AREA:			
R017	Ring 1	not used	1.000E+00	-
R017	Ring 2	not used	2.732E-01	-
R017	Ring 3	not used	0.000E+00	-
R017	Ring 4	not used	0.000E+00	-
R017	Ring 5	not used	0.000E+00	-
R017	Ring 6	not used	0.000E+00	-
R017	Ring 7	not used	0.000E+00	-
R017	Ring 8	not used	0.000E+00	-
R017	Ring 9	not used	0.000E+00	-
R017	Ring 10	not used	0.000E+00	-
R017	Ring 11	not used	0.000E+00	-
R017	Ring 12	not used	0.000E+00	-

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used b (If different
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	-
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	-
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	-
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	-
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	-
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	-
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	-
R018	Drinking water intake (L/yr)	5.100E+02	5.100E+02	-
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	-
R018	Contamination fraction of household water	not used	1.000E+00	-
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	-
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	-
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	-
R018	Contamination fraction of plant food	-1	-1	0.50
R018	Contamination fraction of meat	-1	-1	0.50
R018	Contamination fraction of milk	-1	-1	0.50
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	-
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	-
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	-
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	-
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	-
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	-
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	-
R019	Depth of roots (m)	9.000E-01	9.000E-01	-
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	-
R019	Household water fraction from ground water	not used	1.000E+00	-
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	-
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	-
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	-
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	-
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	-
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	-
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	-
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	-
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	-
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	-
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	-
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	-
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	-
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	-
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	-
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	-
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	-
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	-
C14	C-12 concentration in water (g/cm**3)	2.000E-05	2.000E-05	-
C14	C-12 concentration in contaminated soil (g/g)	3.000E-02	3.000E-02	-
C14	Fraction of vegetation carbon from soil	2.000E-02	2.000E-02	-
C14	Fraction of vegetation carbon from air	9.800E-01	9.800E-01	-

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used b (If different
C14	C-14 evasion layer thickness in soil (m)	3.000E-01	3.000E-01	-
C14	C-14 evasion flux rate from soil (1/sec)	7.000E-07	7.000E-07	-
C14	C-12 evasion flux rate from soil (1/sec)	1.000E-10	1.000E-10	-
C14	Fraction of grain in beef cattle feed	8.000E-01	8.000E-01	-
C14	Fraction of grain in milk cow feed	2.000E-01	2.000E-01	-
C14	DCF correction factor for gaseous forms of C14	8.894E+01	8.894E+01	-
STOR	Storage times of contaminated foodstuffs (days):			
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	-
STOR	Leafy vegetables	1.000E+00	1.000E+00	-
STOR	Milk	1.000E+00	1.000E+00	-
STOR	Meat and poultry	2.000E+01	2.000E+01	-
STOR	Fish	7.000E+00	7.000E+00	-
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	-
STOR	Well water	1.000E+00	1.000E+00	-
STOR	Surface water	1.000E+00	1.000E+00	-
STOR	Livestock fodder	4.500E+01	4.500E+01	-
R021	Thickness of building foundation (m)	not used	1.500E-01	-
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	-
R021	Total porosity of the cover material	not used	4.000E-01	-
R021	Total porosity of the building foundation	not used	1.000E-01	-
R021	Volumetric water content of the cover material	not used	5.000E-02	-
R021	Volumetric water content of the foundation	not used	3.000E-02	-
R021	Diffusion coefficient for radon gas (m/sec):			
R021	in cover material	not used	2.000E-06	-
R021	in foundation material	not used	3.000E-07	-
R021	in contaminated zone soil	not used	2.000E-06	-
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	-
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	-
R021	Height of the building (room) (m)	not used	2.500E+00	-
R021	Building interior area factor	not used	0.000E+00	-
R021	Building depth below ground surface (m)	not used	-1.000E+00	-
R021	Emanating power of Rn-222 gas	not used	2.500E-01	-
R021	Emanating power of Rn-220 gas	not used	1.500E-01	-
TITL	Number of graphical time points	32	---	-
TITL	Maximum number of integration points for dose	17	---	-
TITL	Maximum number of integration points for risk	257	---	-

Summary of Pathway Selections

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

Contaminated Zone Dimensions		Initial Soil Concentrations, µCi/g	
Area:	0.10 square meters	C-14	2.500E-01
Thickness:	2.00 meters		
Cover Depth:	1.20 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	1.000E+00	1.000E+01	2.000E+01	4.000E+01	1.000E+02
TDOSE(t):	9.506E-24	7.046E+00	7.269E-01	3.011E-04	5.164E-11	0.000E+00
M(t):	3.802E-25	2.818E-01	2.908E-02	1.204E-05	2.066E-12	0.000E+00

Maximum TDOSE(t): 3.996E+01 mrem/yr at t = 4.286 ± 0.009 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) an
As mrem/yr and Fraction of Total Dose At t = 4.286E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.
C-14	4.071E-25	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	4.071E-25	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) an
As mrem/yr and Fraction of Total Dose At t = 4.286E+00 years

Water Dependent Pathways

Radio-Nuclide Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.
C-14	2.981E+01	0.7459	1.015E+01	0.2541	0.000E+00	0.0000	2.179E-05	0.0000	9.819E-06	0.0000
Total	2.981E+01	0.7459	1.015E+01	0.2541	0.000E+00	0.0000	2.179E-05	0.0000	9.819E-06	0.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	9.506E-24	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	9.506E-24	1.0000	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) an
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat	
Nuclide	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
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

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	4.558E-24	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	4.558E-24	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) an
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	5.311E+00	0.7537	1.735E+00	0.2463	0.000E+00	0.0000	3.525E-06	0.0000	1.503E-06	0.0000
Total	5.311E+00	0.7537	1.735E+00	0.2463	0.000E+00	0.0000	3.525E-06	0.0000	1.503E-06	0.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat	
Nuclide	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
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

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	5.403E-01	0.7433	1.866E-01	0.2567	0.000E+00	0.0000	4.074E-07	0.0000	1.868E-07	0.0000
Total	5.403E-01	0.7433	1.866E-01	0.2567	0.000E+00	0.0000	4.074E-07	0.0000	1.868E-07	0.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) an
As mrem/yr and Fraction of Total Dose At t = 2.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat	
Nuclide	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
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

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) an
As mrem/yr and Fraction of Total Dose At t = 2.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	2.238E-04	0.7433	7.728E-05	0.2567	0.000E+00	0.0000	1.688E-10	0.0000	7.736E-11	0.0000
Total	2.238E-04	0.7433	7.728E-05	0.2567	0.000E+00	0.0000	1.688E-10	0.0000	7.736E-11	0.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) an
As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat	
Nuclide	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
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

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) an
As mrem/yr and Fraction of Total Dose At t = 4.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	3.839E-11	0.7433	1.326E-11	0.2567	0.000E+00	0.0000	2.895E-17	0.0000	1.327E-17	0.0000
Total	3.839E-11	0.7433	1.326E-11	0.2567	0.000E+00	0.0000	2.895E-17	0.0000	1.327E-17	0.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat	
Nuclide	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
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

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat	
Nuclide	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
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

*Sum of all water independent and dependent pathways.

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

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(µCi/g) t= 0.000E+00	1.000E+00	1.000E+01	2.000E+01	4.000E+01	1.000E+02
C-14	C-14	1.000E+00	3.802E-23	2.818E+01	2.908E+00	1.204E-03	2.066E-10	1.043E-30

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

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

Nuclide (i)	t= 0.000E+00	1.000E+00	1.000E+01	2.000E+01	4.000E+01	1.000E+02
C-14	*4.454E+06	8.870E-01	8.598E+00	2.076E+04	*4.454E+06	*4.454E+06

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(µCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in µCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 4.286 ± 0.009 years

Nuclide (i)	Initial (µCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (µCi/g)	DSR(i,tmax)	G(i,tmax) (µCi/g)
C-14	2.500E-01	4.286 ± 0.009	1.599E+02	1.564E-01	1.599E+02	1.564E-01

Maximum Dose was at 4.286 years
The material was disposed of on June 30, 1961 which is approximately 44.5 years ago, today Jan 12, 2006. RS Broaddus 1-12-06

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

Nuclide (j)	Parent (i)	BRF(i)	t= 0.000E+00	1.000E+00	DOSE(j,t), mrem/yr 1.000E+01	2.000E+01	4.000E+01	1.000E+02
C-14	C-14	1.000E+00	9.506E-24	7.046E+00	7.269E-01	3.011E-04	5.164E-11	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	t= 0.000E+00	1.000E+00	S(j,t), µCi/g 1.000E+01	2.000E+01	4.000E+01	1.000E+02
C-14	C-14	1.000E+00	2.500E-01	1.147E-01	1.033E-04	4.271E-08	7.295E-15	3.636E-35

BRF(i) is the branch fraction of the parent nuclide.

RESCALC.EXE execution time = 3.32 seconds