SCIENTECH

October 21, 2002

Mr. William Snell
Health Physics Manager
U.S. Nuclear Regulatory Commission
Region 3
801 Warrenville Road
Lisle, Illinois 60532

Dear Mr. Snell:

Per our telephone conversation on October 8, 2002, I am submitting the following information for your review.

1. Soil sampling results from 1996 and 2001
2. Summary of a RESRAD Dose assessment for establishing 7.5 pCi/g as a new release criterion for the fill material in the Old Gun Room pits
3. RESRAD output file.
4. Alternate sampling approach for the fill material in the Old Gun Room pits

Please note that the Decommissioning Plan will be revised to incorporate items 2 through 4 above following your approval. Additionally, as requested, SCIENTECH's Radiation Protection Manual and several of SCIENTECH's standard operating procedures have been sent separately. Feel free to contact me at (864) 235-3695 if you have any questions or need additional information.

Regards,

Kevin E. Taylor, P.E.
Sr. Health Physicist

Enclosures (3)

cc: L. Damrau, H.C. Starck, Coldwater, MI

17 College Street, Suite D • Greenville, SC 29601 • Tele: (864) 235-3694 • Fax: (864) 235-8405

OCT 28 2002

ENCLOSURE 2

OLD GUN ROOM PIT FILL MATERIAL DOSE ASSESSMENT AND RESRAD OUTPIT FILE

H.C. STARCK
COLDWATER, MI

SUMMARY OF DOSE ASSESSMENT
OLD GUN ROOM PIT FILL MATERIAL
H.C. STARCK DECOMMISSIONING
COLDWATER, MICHIGAN

The Old Gun Room located at the H.C. Starck manufacturing facility in Coldwater, Michigan, contains three pits that have been filled with aggregate materials (most likely gravel) and capped with several inches of concrete. The facility Decommissioning Plan states that the decommissioning contractor intends to excavate the fill material, decontaminate the pits, and backfill the pits with the original fill materials after confirmation that the fill material meets an acceptable release criterion.

In order to determine an acceptable release criterion for the pit fill material, SCIENTECH modeled the dose from the material to a future site receptor using RESRAD Version 6.1. The model assumes that the material is spread evenly over a residential home site at a thickness of 1 inch. The volume of the three pits is approximately 46.4 cubic meters and results in an affected area of 1,834 square meters, or 0.45 acres. Changing only the density of the layer of residual radioactivity (contamination layer), all other RESRAD parameters were left at their default values. The density of the contamination layer, assumed to be a mixture of soil and gravel with a high concentration of gravel, was estimated as 2.1 grams per cubic centimeter (average density of solid granite at 2.7 and the RESRAD default soil density of 1.5).

With all exposure pathways on (except radon inhalation), SCIENTECH adjusted the concentration of the isotopes in the contamination layer until the resulting dose was less than 25 millirem per year (mrem/yr). The isotopes of concern from the RESRAD library were thorium-232, thorium-228, and radium-228 and the concentrations of each of these isotopes were assumed to be equal. Dose conversion factors in RESRAD also assume that all short-lived decay daughters' respective decay chains are present at equal concentrations.

The modeling exercise resulted in the selection of a fill material release limit of 7.5 pCi/g. This concentration results in a modeled dose of 24.4 mrem/yr. SCIENTECH assumes that, under any conditions where the fill material from the pits would be excavated (e.g., building demolition and slab removal), none of the existing structures with any remaining residual radioactivity would contribute to the on-site resident's dose have been removed.

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary ... 2
Site-Specific Parameter Summary 3
Summary of Pathway Selections 7
Contaminated Zone and Total Dose Summary 8
Total Dose Components
Time = 0.000E+00 9
Time = 1.000E+00 10
Time = 3.000E+00 11
Time = 1.000E+01 12
Time = 3.000E+01 13
Time = 1.000E+02 14
Time = 3.000E+02 15
Time = 1.000E+03 16
Dose/Source Ratios Summed Over All Pathways 17
Single Radionuclide Soil Guidelines 17
Dose Per Nuclide Summed Over All Pathways 18
Soil Concentration Per Nuclide 18

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

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ra-228+D	5.080E-03	5.080E-03	DCF2(1)
B-1	Th-228+D	3.450E-01	3.450E-01	DCF2(2)
B-1	Th-232	1.640E+00	1.640E+00	DCF2(3)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ra-228+D	1.440E-03	1.440E-03	DCF3(1)
D-1	Th-228+D	8.080E-04	8.080E-04	DCF3(2)
D-1	Th-232	2.730E-03	2.730E-03	DCF3(3)
D-34	Food transfer factors:			
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	1.000E-06	1.000E-06	RTF(1,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(1,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(1,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(2,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(2,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(3,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(3,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(3,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(1,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(1,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(2,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(2,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(3,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(3,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Para Na
R011	Area of contaminated zone (m**2)	1.834E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	2.540E-02	2.000E+00	---	THICK
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPA
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ra-228	7.500E+00	0.000E+00	---	S1(1
R012	Initial principal radionuclide (pCi/g): Th-228	7.500E+00	0.000E+00	---	S1(2
R012	Initial principal radionuclide (pCi/g): Th-232	7.500E+00	0.000E+00	---	S1(3
R012	Concentration in groundwater (pCi/L): Ra-228	not used	0.000E+00	---	W1(1
R012	Concentration in groundwater (pCi/L): Th-228	not used	0.000E+00	---	W1(2
R012	Concentration in groundwater (pCi/L): Th-232	not used	0.000E+00	---	W1(3
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSC
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	2.100E+00	1.500E+00	---	DENSC
R013	Contaminated zone erosion rate (m/yr)	0.000E+00	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)	2.000E+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	---	EVAPT
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECI
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITC
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOF
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	---	DENSA
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)	1.000E+01	1.000E+01	---	DWIBW
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Para Na
R014	Well pumping rate (m**3/yr)	2.500E-02	2.500E+02	---	UW
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	---	DENSU
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ(
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(
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(
R016	Distribution coefficients for Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUC
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUC
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUC
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.336E-01	ALEAC
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUB
R016	Distribution coefficients for Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUC
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUC
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUC
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.562E-04	ALEAC
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUB
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUC
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUC
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUC
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.562E-04	ALEAC
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUB
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHAL
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	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
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Para Na
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_S
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_S
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_S
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_S
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_S
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_S
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_S
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_S
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_S
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_S
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_S
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_S
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA
R017	Ring 2	not used	2.732E-01	---	FRACA
R017	Ring 3	not used	0.000E+00	---	FRACA
R017	Ring 4	not used	0.000E+00	---	FRACA
R017	Ring 5	not used	0.000E-00	---	FRACA
R017	Ring 6	not used	0.000E+00	---	FRACA
R017	Ring 7	not used	0.000E+00	---	FRACA
R017	Ring 8	not used	0.000E+00	---	FRACA
R017	Ring 9	not used	0.000E+00	---	FRACA
R017	Ring 10	not used	0.000E+00	---	FRACA
R017	Ring 11	not used	0.000E+00	---	FRACA
R017	Ring 12	not used	0.000E+00	---	FRACA
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+02	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	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLAN
R018	Contamination fraction of meat	-1	-1	0.917E-01	FMEAT
R018	Contamination fraction of milk	-1	-1	0.917E-01	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Para Na
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	1.000E+00	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)	1.100E+00	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)	8.000E-02	8.000E-02	---	TE(3)
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	1.000E+00	1.000E+00	---	TIV(3
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WT
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_
STOR	Milk	1.000E+00	1.000E+00	---	STOR_
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_
STOR	Fish	7.000E+00	7.000E+00	---	STOR_
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_
STOR	Well water	1.000E+00	1.000E+00	---	STOR_
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSF
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	---	PH2OC

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Para Na
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OF
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	---	HMIX
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
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA
TITL	Number of graphical time points	32	---	---	NPTS
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)	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
Find peak pathway doses	active

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	1834.00 square meters	Ra-228	7.500E+00
Thickness:	0.03 meters	Th-228	7.500E+00
Cover Depth:	0.00 meters	Th-232	7.500E+00

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	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	2.439E+01	2.285E+01	1.980E+01	1.381E+01	1.201E+01	1.186E+01	1.150E+01	1.031E+01
M(t):	9.756E-01	9.139E-01	7.920E-01	5.523E-01	4.802E-01	4.745E-01	4.599E-01	4.122E-01

Maximum TDOSE(t): 2.439E+01 mrem/yr at t = 0.000E+00 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 = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	1.088E+01	0.4460	3.787E-03	0.0002	0.000E+00	0.0000	2.239E-03	0.0001	4.780E-03	0.0002	6.824E-03	0.0003	4.83
Th-228	1.249E+01	0.5120	1.974E-02	0.0008	0.000E+00	0.0000	1.256E-02	0.0005	2.544E-04	0.0000	1.850E-05	0.0000	2.35
Th-232	6.398E-01	0.0262	1.120E-01	0.0046	0.000E+00	0.0000	5.077E-02	0.0021	1.299E-03	0.0001	5.028E-04	0.0000	9.78
Total	2.400E+01	0.9842	1.355E-01	0.0056	0.000E+00	0.0000	6.556E-02	0.0027	6.333E-03	0.0003	7.345E-03	0.0003	1.69

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-	Water		Fish		Radon		Plant		Meat		Milk		Al
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	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	1.09
Th-228	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	1.25
Th-232	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	9.02
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	2.43

*Sum of all water independent and dependent pathways.

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-	Ground		Inhalation		Radon		Plant		Meat		Milk		
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	1.176E+01	0.5148	8.193E-03	0.0004	0.000E+00	0.0000	5.060E-03	0.0002	3.785E-03	0.0002	5.298E-03	0.0002	4.37
Th-228	8.690E+00	0.3803	1.374E-02	0.0006	0.000E+00	0.0000	8.739E-03	0.0004	1.771E-04	0.0000	1.287E-05	0.0000	1.64
Th-232	2.020E+00	0.0884	1.127E-01	0.0049	0.000E+00	0.0000	5.123E-02	0.0022	1.809E-03	0.0001	1.229E-03	0.0001	1.03
Total	2.247E+01	0.9836	1.347E-01	0.0059	0.000E+00	0.0000	6.503E-02	0.0028	5.772E-03	0.0003	6.540E-03	0.0003	1.63

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-	Water		Fish		Radon		Plant		Meat		Milk		Al
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	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	1.18
Th-228	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	8.72
Th-232	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	2.29
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	2.28

*Sum of all water independent and dependent pathways.

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-	Ground		Inhalation		Radon		Plant		Meat		Milk		
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	1.048E+01	0.5293	1.031E-02	0.0005	0.000E+00	0.0000	6.468E-03	0.0003	2.346E-03	0.0001	3.192E-03	0.0002	3.27
Th-228	4.209E+00	0.2126	6.653E-03	0.0003	0.000E+00	0.0000	4.233E-03	0.0002	8.576E-05	0.0000	6.235E-06	0.0000	7.94
Th-232	4.751E+00	0.2400	1.151E-01	0.0058	0.000E+00	0.0000	5.269E-02	0.0027	2.535E-03	0.0001	2.231E-03	0.0001	1.12
Total	1.944E+01	0.9819	1.320E-01	0.0067	0.000E+00	0.0000	6.339E-02	0.0032	4.966E-03	0.0003	5.429E-03	0.0003	1.53

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-	Water		Fish		Radon		Plant		Meat		Milk		Al
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	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	1.05
Th-228	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	4.22
Th-232	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	5.03
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	1.98

*Sum of all water independent and dependent pathways.

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-	Ground		Inhalation		Radon		Plant		Meat		Milk		
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	3.032E+00	0.2196	3.737E-03	0.0003	0.000E+00	0.0000	2.362E-03	0.0002	4.217E-04	0.0000	5.406E-04	0.0000	7.91
Th-228	3.329E-01	0.0241	5.261E-04	0.0000	0.000E+00	0.0000	3.347E-04	0.0000	6.782E-06	0.0000	4.930E-07	0.0000	6.28
Th-232	1.011E+01	0.7325	1.210E-01	0.0088	0.000E+00	0.0000	5.642E-02	0.0041	3.481E-03	0.0003	3.488E-03	0.0003	1.27
Total	1.348E+01	0.9762	1.252E-01	0.0091	0.000E+00	0.0000	5.912E-02	0.0043	3.910E-03	0.0003	4.029E-03	0.0003	1.36

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-	Water		Fish		Radon		Plant		Meat		Milk		Al
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	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	3.04
Th-228	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	3.34
Th-232	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	1.04
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	1.38

*Sum of all water independent and dependent pathways.

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-	Ground		Inhalation		Radon		Plant		Meat		Milk		
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	2.491E-02	0.0021	3.282E-05	0.0000	0.000E+00	0.0000	2.079E-05	0.0000	2.739E-06	0.0000	3.360E-06	0.0000	6.05
Th-228	2.365E-04	0.0000	3.738E-07	0.0000	0.000E-00	0.0000	2.378E-07	0.0000	4.819E-09	0.0000	3.503E-10	0.0000	4.46
Th-232	1.166E+01	0.9713	1.226E-01	0.0102	0.000E+00	0.0000	5.751E-02	0.0048	3.672E-03	0.0003	3.731E-03	0.0003	1.31
Total	1.169E+01	0.9734	1.226E-01	0.0102	0.000E+00	0.0000	5.753E-02	0.0048	3.674E-03	0.0003	3.735E-03	0.0003	1.31

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-	Water		Fish		Radon		Plant		Meat		Milk		Al
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	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	2.50
Th-228	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	2.37
Th-232	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	1.19
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	1.20

*Sum of all water independent and dependent pathways.

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-	Ground		Inhalation		Radon		Plant		Meat		Milk		
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	4.820E-10	0.0000	6.391E-13	0.0000	0.000E+00	0.0000	4.048E-13	0.0000	5.167E-14	0.0000	6.304E-14	0.0000	1.16
Th-228	2.262E-15	0.0000	3.575E-18	0.0000	0.000E+00	0.0000	2.275E-18	0.0000	4.608E-20	0.0000	3.350E-21	0.0000	4.26
Th-232	1.155E+01	0.9734	1.213E-01	0.0102	0.000E+00	0.0000	5.689E-02	0.0048	3.633E-03	0.0003	3.692E-03	0.0003	1.29
Total	1.155E+01	0.9734	1.213E-01	0.0102	0.000E+00	0.0000	5.689E-02	0.0048	3.633E-03	0.0003	3.692E-03	0.0003	1.29

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-	Water		Fish		Radon		Plant		Meat		Milk		Al
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	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	4.84
Th-228	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	2.27
Th-232	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	1.18
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	1.18

*Sum of all water independent and dependent pathways.

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-	Ground		Inhalation		Radon		Plant		Meat		Milk		
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	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	0.00
Th-228	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	0.00
Th-232	1.119E+01	0.9734	1.175E-01	0.0102	0.000E+00	0.0000	5.514E-02	0.0048	3.521E-03	0.0003	3.579E-03	0.0003	1.25
Total	1.119E+01	0.9734	1.175E-01	0.0102	0.000E+00	0.0000	5.514E-02	0.0048	3.521E-03	0.0003	3.579E-03	0.0003	1.25

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-	Water		Fish		Radon		Plant		Meat		Milk		Al
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	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	0.00
Th-228	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	0.00
Th-232	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	1.15
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	1.15

*Sum of all water independent and dependent pathways.

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-	Ground		Inhalation		Radon		Plant		Meat		Milk		
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	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	0.00
Th-228	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	0.00
Th-232	1.003E+01	0.9734	1.054E-01	0.0102	0.000E+00	0.0000	4.943E-02	0.0048	3.157E-03	0.0003	3.208E-03	0.0003	1.12
Total	1.003E+01	0.9734	1.054E-01	0.0102	0.000E+00	0.0000	4.943E-02	0.0048	3.157E-03	0.0003	3.208E-03	0.0003	1.12

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-	Water		Fish		Radon		Plant		Meat		Milk		Al
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mre
Ra-228	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	0.00
Th-228	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	0.00
Th-232	9.770E-30	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	1.03
Total	9.770E-30	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	1.03

*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)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-228	Ra-228	1.000E+00	1.164E+00	9.030E-01	5.431E-01	9.167E-02	5.683E-04	1.066E-11	8.933E-34	0.000E+00
Ra-228	Th-228	1.000E+00	2.949E-01	6.741E-01	8.616E-01	3.146E-01	2.769E-03	5.392E-11	4.519E-33	0.000E+00
Ra-228	∑DSR(j)		1.459E+00	1.577E+00	1.405E+00	4.063E-01	3.337E-03	6.458E-11	5.412E-33	0.000E+00
Th-228	Th-228	1.000E+00	1.672E+00	1.164E+00	5.637E-01	4.458E-02	3.168E-05	3.029E-16	0.000E+00	0.000E+00
Th-232	Th-232	1.000E+00	3.467E-02	3.467E-02	3.466E-02	3.462E-02	3.451E-02	3.414E-02	3.309E-02	2.966E-02
Th-232	Ra-228	1.000E+00	7.315E-02	1.971E-01	3.676E-01	5.812E-01	6.225E-01	6.160E-01	5.971E-01	5.352E-01
Th-232	Th-228	1.000E+00	1.247E-02	7.368E-02	2.692E-01	7.742E-01	9.404E-01	9.314E-01	9.028E-01	8.093E-01
Th-232	∑DSR(j)		1.203E-01	3.054E-01	6.715E-01	1.390E+00	1.597E+00	1.582E+00	1.533E+00	1.374E+00

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... B
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

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

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-228	1.713E+01	1.585E+01	1.780E+01	6.154E+01	7.492E+03	3.871E+11	*2.726E+14	*2.726E+14
Th-228	1.495E+01	2.148E+01	4.435E+01	5.608E+02	7.892E+05	*8.192E+14	*8.192E+14	*8.192E+14
Th-232	2.078E+02	8.186E+01	3.723E+01	1.799E+01	1.565E+01	1.581E+01	1.631E+01	1.819E+01

*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 = 0.000E+00 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Ra-228	7.500E+00	1.137 ± 0.002	1.579E+00	1.584E+01	1.459E+00	1.713E+01
Th-228	7.500E+00	0.000E+00	1.672E+00	1.495E+01	1.672E+00	1.495E+01
Th-232	7.500E+00	31.88 ± 0.06	1.598E+00	1.565E+01	1.203E-01	2.078E+02

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

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-228	Ra-228	1.000E+00	8.732E+00	6.772E+00	4.074E+00	6.875E-01	4.262E-03	7.994E-11	0.000E+00	0.000E+00
Ra-228	Th-232	1.000E+00	5.486E-01	1.478E+00	2.757E+00	4.359E+00	4.669E+00	4.620E+00	4.478E+00	4.014E+00
Ra-228	∑DOSE(j)		9.281E+00	8.250E+00	6.831E+00	5.047E+00	4.673E+00	4.620E+00	4.478E+00	4.014E+00
Th-228	Ra-228	1.000E+00	2.212E+00	5.056E+00	6.462E+00	2.359E+00	2.077E-02	4.044E-10	0.000E+00	0.000E+00
Th-228	Th-228	1.000E+00	1.254E+01	8.729E+00	4.228E+00	3.344E-01	2.376E-04	2.272E-15	0.000E+00	0.000E+00
Th-228	Th-232	1.000E+00	9.352E-02	5.526E-01	2.019E+00	5.806E+00	7.053E+00	6.986E+00	6.771E+00	6.069E+00
Th-228	∑DOSE(j)		1.485E+01	1.434E+01	1.271E+01	8.500E+00	7.074E+00	6.986E+00	6.771E+00	6.069E+00
Th-232	Th-232	1.000E+00	2.600E-01	2.600E-01	2.599E-01	2.596E-01	2.588E-01	2.560E-01	2.481E-01	2.224E-01

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)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-228	Ra-228	1.000E+00	7.500E+00	5.817E+00	3.499E+00	5.905E-01	3.661E-03	6.866E-11	5.754E-33	0.000E+00
Ra-228	Th-232	1.000E+00	0.000E+00	7.983E-01	1.897E+00	3.274E+00	3.541E+00	3.504E+00	3.396E+00	3.045E+00
Ra-228	∑S(j):		7.500E+00	6.615E+00	5.396E+00	3.864E+00	3.545E+00	3.504E+00	3.396E+00	3.045E+00
Th-228	Ra-228	1.000E+00	0.000E+00	1.997E+00	3.247E+00	1.307E+00	1.177E-02	2.297E-10	1.925E-32	0.000E+00
Th-228	Th-228	1.000E+00	7.500E+00	5.220E+00	2.528E+00	1.999E-01	1.421E-04	1.359E-15	0.000E+00	0.000E+00
Th-228	Th-232	1.000E+00	0.000E+00	1.337E-01	8.169E-01	2.839E+00	3.537E+00	3.504E+00	3.396E+00	3.045E+00
Th-228	∑S(j):		7.500E+00	7.351E+00	6.592E+00	4.345E+00	3.549E+00	3.504E+00	3.396E+00	3.045E+00
Th-232	Th-232	1.000E+00	7.500E+00	7.499E+00	7.496E+00	7.488E+00	7.465E+00	7.384E+00	7.157E+00	6.415E+00

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

RESCALC.EXE execution time = 12.14 seconds

ENCLOSURE 3

ALTERNATE SAMPLING APPROACH FOR OLD GUN ROOM PIT FILL MATERIAL

H.C. STARCK
COLDWATER, MI

ALTERNATE SAMPLING APPROACH FOR OLD GUN ROOM PIT FILL MATERIAL

After discussions with the NRC, SCIENTECH has revised its approach for determining an appropriate release criterion for the fill material that will be excavated from the three pits in the Old Gun Room at H.C. Starck's Coldwater, Michigan facility. Originally, SCIENTECH proposed to primarily use data from on-site bulk surveying with an *In Situ* Object Counting System (ISOCS) along with 3 or 4 quality control samples sent to an off-site laboratory for independent analysis to release the soils so that they could be placed back into the pits. SCIENTECH was comfortable that the ISOCS survey method would have a minimum detectable concentration (MDC) well below the previously proposed release criteria of 30 picocuries per gram (pCi/g) under reasonable field operating conditions.

The proposed release criterion for the fill material is now 7.5 pCi/g and, at this time, SCIENTECH is unsure of being able to have an MDC less than half of the release criterion using the ISOCS survey method in actual field conditions. Currently SCIENTECH is evaluating this approach at another project site and should be able to determine the appropriate count times and shielding necessary to obtain an appropriate MDC before mobilizing to the Coldwater facility. If SCIENTECH determines that an appropriate MDC can be obtained with survey parameters (e.g., shielding and count time) that are acceptable for efficient field operations, SCIENTECH will use the ISOCS survey method combined with off-site analysis of representative composite samples. If the ISOCS survey method is determined to be unacceptable, then SCIENTECH will rely only on representative composite sampling and gamma spectroscopy analysis at an off-site independent laboratory.

ENCLOSURE 1

SOIL DATA

H.C. STARCK
COLDWATER, MI

NES, Inc. 82A8008 ATTACHMENT A
Survey Cover Sheet

Surveyor Sarah Hayes (Print) _____ (Sign) 8/3/01 (Date)

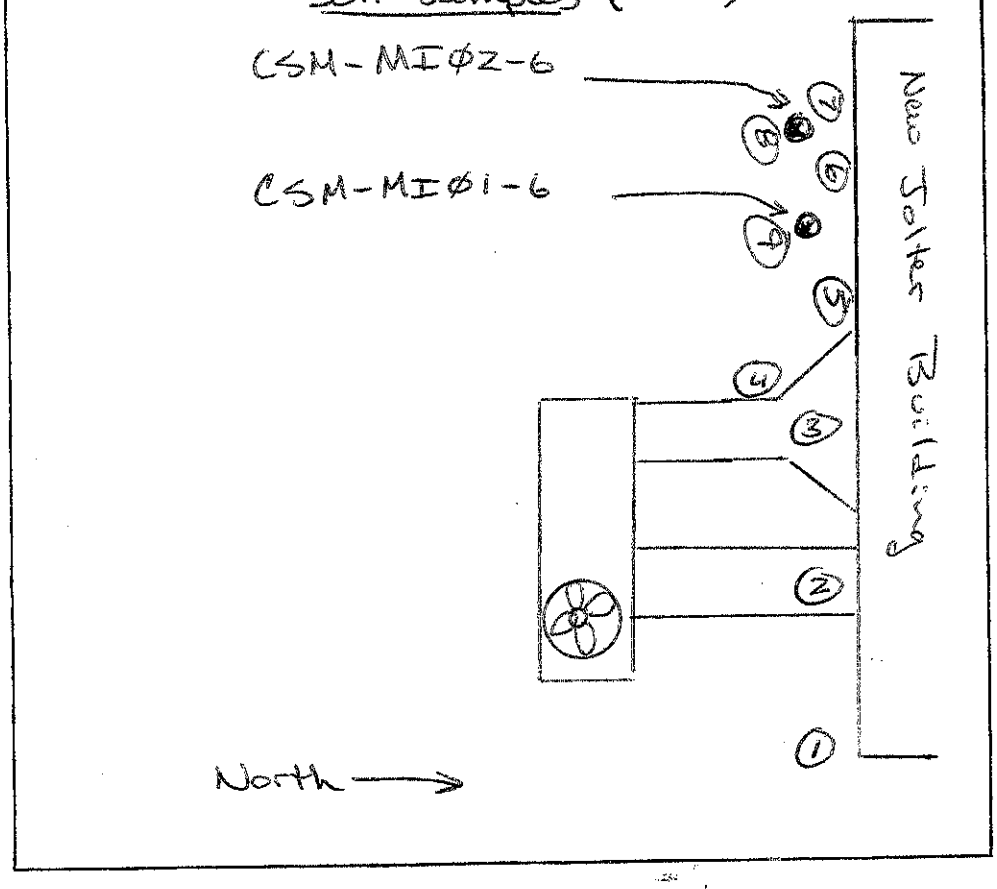
Reviewer Kevin Taylor (Print) _____ (Sign) _____ (Date)

SURVEY METERS

Meter Model #	19	Meter Model #		Meter Model #	
Meter/Probe Serial #	148152	Meter/Probe Serial #		Meter/Probe Serial #	
Cal Due	8/31/01	Cal Due		Cal Due	
Efficiency	NA	Efficiency		Efficiency	
Type (α, βγ)	γ exposure	Type (α, βγ)		Type (α, βγ)	
Sample Time	NA	Sample Time		Sample Time	
Background Time	NA ~~8.5 uR/hr~~	Background Time		Background Time	
BKG	8.5 uR/hr	BKG		BKG	
MDA	NA	MDA		MDA	
Guideline	NA	Guideline		Guideline	
Action level	NA	Action level		Action level	

LOCATION: HC Starck, Coldwater MI

PURPOSE: Exposure rates on HVAC (Jotter Bldg)



~~smear~~ #	~~dpm/100cm²~~ uR/hr βγ	α
1	10	
2	14	
3	33	
4	12	
~~5~~	10	
6	12	
7	14	
8	12	
9	10	

$$MDA = \frac{\frac{2.71}{T_s} + 3.29\sqrt{\frac{R_b}{T_b} + \frac{R_b}{T_s}}}{(eff.)\left(\frac{probe\ area}{100cm^2}\right)}$$

$$A_1 = R_b + ((guideline)\ (eff.))$$

$$dpm/100\ cm^2 = \frac{gross\ cpm - bkg\ cpm}{(efficiency)}$$

where: R_b = background counting rate;
T_b = background counting time;
T_s = sample count time;
A_1 = action level

GENERAL ENGINEERING LABORATORIES

Meeting today's needs with a vision for tomorrow.

Certificate of Analysis

Company : Scientech
Address : 17 College Street
Suite D
Greenville, South Carolina 29601
Contact: Kevin Taylor
Project: Ni Powder Project

Report Date: September 14, 2001

Client Sample ID: CSM-MI01-6
Sample ID: 47669011
Matrix: Soil
Collect Date: 03-AUG-01
Receive Date: 08-AUG-01
Collector: Client

Project: SCIN00301
Client ID: SCIN001

Parameter	Qualifier	Result		DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec												
Gammaspec, Gamma, solid												
Actinium-228		0.658	+/-0.170	0.0472	0.800	pCi/g		CRB	09/05/01	2132	107714	1
Americium-241	U	ND	+/-0.116	0.0888	0.200	pCi/g						
Antimony-124	U	ND	+/-0.0224	0.0188	0.100	pCi/g						
Antimony-125	U	ND	+/-0.0451	0.0375	0.200	pCi/g						
Barium-133	U	ND	+/-0.022	0.0157	0.100	pCi/g						
Barium-140	U	ND	+/-0.304	0.258	0.500	pCi/g						
Beryllium-7	U	ND	+/-0.173	0.148	0.700	pCi/g						
Bismuth-212		0.214	+/-0.216	0.103	0.500	pCi/g						
Bismuth-214		0.641	+/-0.108	0.0278	0.200	pCi/g						
Cerium-139	U	ND	+/-0.0142	0.0116	0.050	pCi/g						
Cerium-141	U	ND	+/-0.0543	0.0329	0.100	pCi/g						
Cerium-144	U	ND	+/-0.0917	0.0799	0.500	pCi/g						
Cesium-134	U	ND	+/-0.0185	0.0121	0.100	pCi/g						
Cesium-136	U	ND	+/-0.139	0.104	0.300	pCi/g						
Cesium-137		0.150	+/-0.0357	0.0128	0.100	pCi/g						
Chromium-51	U	ND	+/-0.281	0.236	0.600	pCi/g						
Cobalt-56	U	ND	+/-0.0227	0.0182	0.100	pCi/g						
Cobalt-57	U	ND	+/-0.0113	0.00986	0.050	pCi/g						
Cobalt-58	U	ND	+/-0.0197	0.0161	0.100	pCi/g						
Cobalt-60	U	ND	+/-0.019	0.0167	0.100	pCi/g						
Europium-152	U	ND	+/-0.0445	0.0373	0.200	pCi/g						
Europium-154	U	ND	+/-0.0603	0.0463	0.500	pCi/g						
Europium-155	U	ND	+/-0.0462	0.0412	0.500	pCi/g						
Iridium-192	U	ND	+/-0.0201	0.0163	0.100	pCi/g						
Iron-59	U	ND	+/-0.0602	0.0495	0.300	pCi/g						
Lead-210	U	ND	+/-5.12	4.07	4.00	pCi/g						
Lead-212		0.629	+/-0.0872	0.0232	0.100	pCi/g						
Lead-214		0.865	+/-0.133	0.0254	0.100	pCi/g						
Manganese-54	U	ND	+/-0.018	0.015	0.100	pCi/g						
Mercury-203	U	ND	+/-0.0247	0.0206	0.100	pCi/g						
Neodymium-147	U	ND	+/-0.778	0.662	1000	pCi/g						
Neptunium-239	U	ND	+/-0.0819	0.0709	2.00	pCi/g						
Niobium-94	U	ND	+/-0.0159	0.0135	1.00	pCi/g						
Niobium-95	U	ND	+/-0.0745	0.0228	0.050	pCi/g						
Potassium-40		12.7	+/-1.69	0.136	1.00	pCi/g						
Promethium-144	U	ND	+/-0.0165	0.0123	0.080	pCi/g						
Promethium-146	U	ND	+/-0.0207	0.0162	1.00	pCi/g						
Radium-228		0.658	+/-0.170	0.0472	0.500	pCi/g						
Ruthenium-106	U	ND	+/-0.146	0.124	0.800	pCi/g						

P O Box 30712 • Charleston, SC 29417 • 2040 Savage Road • 29407
(843) 556-8171 • Fax (843) 766-1178

Printed on recycled paper

GENERAL ENGINEERING LABORATORIES

Meeting today's needs with a vision for tomorrow.

Certificate of Analysis

Company : Scientech
Address : 17 College Street
Suite D
Greenville, South Carolina 29601
Contact: Kevin Taylor
Project: Ni Powder Project

Report Date: September 14, 2001

Client Sample ID: CSM-MI01-6
Sample ID: 47669011

Project: SCIN00301
Client ID: SCIN001

Parameter	Qualifier	Result		DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec											
Gammaspec, Gamma, solid											
Silver-110m	U	ND	+/-0.0183	0.0138	0.080	pCi/g					
Sodium-22	U	ND	+/-0.0218	0.0172	0.080	pCi/g					
Thallium-208		0.208	+/-0.0423	0.0146	0.080	pCi/g					
Thorium-230		0.641	+/-0.108	0.0278	1.00	pCi/g					
Thorium-234		0.839	+/-1.19	0.624	2.00	pCi/g					
Tin-113	U	ND	+/-0.0232	0.0175	0.100	pCi/g					
Uranium-235	U	ND	+/-0.154	0.0833	0.500	pCi/g					
Uranium-238		0.839	+/-1.19	0.624	1.00	pCi/g					
Yttrium-88	U	ND	+/-0.0205	0.0143	0.100	pCi/g					
Zinc-65	U	ND	+/-0.0533	0.0365	0.300	pCi/g					
Zirconium-95	U	ND	+/-0.0403	0.0355	0.200	pCi/g					

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep RAD A-021,A-021B,A-026	KM1	08/21/01	0918	105066

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	DOE EML HASL 300	

Notes:
The Qualifiers in this report are defined as follows :

** Indicates the analyte is a surrogate compound.
< Actual result is less than amount reported
> Actual result is greater than amount reported
E Concentration exceeds instrument calibration range
J Indicates an estimated value. The result was greater than the detection limit, but less than the reporting limit.
U Indicates the compound was analyzed for but not detected above the detection limit
X Lab-specific qualifier - must be fully described in case narrative and data summary package

The above sample is reported on an "as received" basis.

This data report has been prepared and reviewed in accordance with General Engineering Laboratories, Inc. standard operating procedures. Please direct any questions to your Project Manager, Cheryl Jones.

Reviewed by

P O Box 30712 • Charleston, SC 29417 • 2040 Savage Road • 29407
(843) 556-8171 • Fax (843) 766-1178

Printed on recycled paper

GENERAL ENGINEERING LABORATORIES

Meeting today's needs with a vision for tomorrow.

Certificate of Analysis

Company : Scientech
Address : 17 College Street
Suite D
Greenville, South Carolina 29601
Contact: Kevin Taylor
Project: Ni Powder Project

Report Date: September 14, 2001

Client Sample ID: CSM-MI02-6
Sample ID: 47669012
Matrix: Soil
Collect Date: 03-AUG-01
Receive Date: 08-AUG-01
Collector: Client

Proiect: SCIN00301
Client ID: SCIN001

Parameter	Qualifier	Result		DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec												
Gammaspec, Gamma, solid												
Actinium-228		0.556	+/-0.267	0.187	0.800	pCi/g		CRB	09/05/01	2133	107714	1
Americium-241	U	ND	+/-0.0743	0.116	0.200	pCi/g						
Antimony-124	U	ND	+/-0.0402	0.0676	0.100	pCi/g						
Antimony-125	U	ND	+/-0.0758	0.137	0.200	pCi/g						
Barium-133	U	ND	+/-0.0396	0.059	0.100	pCi/g						
Barium-140	U	ND	+/-0.576	0.946	0.500	pCi/g						
Beryllium-7	U	ND	+/-0.348	0.626	0.700	pCi/g						
Bismuth-212		1.00	+/-0.316	0.372	0.500	pCi/g						
Bismuth-214		0.776	+/-0.166	0.0945	0.200	pCi/g						
Cerium-139	U	ND	+/-0.0251	0.0413	0.050	pCi/g						
Cerium-141	U	ND	+/-0.107	0.115	0.100	pCi/g						
Cerium-144	U	ND	+/-0.182	0.272	0.500	pCi/g						
Cesium-134	U	ND	+/-0.0321	0.0461	0.100	pCi/g						
Cesium-136	U	ND	+/-0.257	0.393	0.300	pCi/g						
Cesium-137		0.0927	+/-0.0894	0.0566	0.100	pCi/g						
Chromium-51	U	ND	+/-0.516	0.741	0.600	pCi/g						
Cobalt-56	U	ND	+/-0.0418	0.0721	0.100	pCi/g						
Cobalt-57	U	ND	+/-0.0198	0.0339	0.050	pCi/g						
Cobalt-58	U	ND	+/-0.0394	0.0658	0.100	pCi/g						
Cobalt-60	U	ND	+/-0.0342	0.0553	0.100	pCi/g						
Europium-152	U	ND	+/-0.0746	0.130	0.200	pCi/g						
Europium-154	U	ND	+/-0.0833	0.147	0.500	pCi/g						
Europium-155	U	ND	+/-0.0772	0.130	0.500	pCi/g						
Iridium-192	U	ND	+/-0.0358	0.054	0.100	pCi/g						
Iron-59	U	ND	+/-0.0924	0.159	0.300	pCi/g						
Lead-210	U	ND	+/-1.27	1.23	4.00	pCi/g						
Lead-212		0.637	+/-0.137	0.0776	0.100	pCi/g						
Lead-214		0.703	+/-0.163	0.094	0.100	pCi/g						
Manganese-54	U	ND	+/-0.0305	0.0547	0.100	pCi/g						
Mercury-203	U	ND	+/-0.0402	0.0723	0.100	pCi/g						
Neodymium-147	U	ND	+/-1.39	2.47	1000	pCi/g						
Neptunium-239	U	ND	+/-0.141	0.240	2.00	pCi/g						
Niobium-94	U	ND	+/-0.0302	0.0531	1.00	pCi/g						
Niobium-95	U	ND	+/-0.0656	0.110	0.050	pCi/g						
Potassium-40		11.2	+/-1.70	0.595	1.00	pCi/g						
Promethium-144	U	ND	+/-0.0313	0.0526	0.080	pCi/g						
Promethium-146	U	ND	+/-0.035	0.0621	1.00	pCi/g						
Radium-228		0.556	+/-0.267	0.187	0.500	pCi/g						
Ruthenium-106	U	ND	+/-0.255	0.458	0.800	pCi/g						

P O Box 30712 • Charleston, SC 29417 • 2040 Savage Road • 29407
(843) 556-8171 • Fax (843) 766-1178

GENERAL ENGINEERING LABORATORIES

Meeting today's needs with a vision for tomorrow.

Certificate of Analysis

Company : Scientech
Address : 17 College Street
Suite D
Greenville, South Carolina 29601
Contact: Kevin Taylor
Project: Ni Powder Project

Report Date: September 14, 2001

Client Sample ID: CSM-MI02-6
Sample ID: 47669012

Project: SCIN00301
Client ID: SCIN001

Parameter	Qualifier	Result		DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec											
Gammaspec, Gamma, solid											
Silver-110m	U	ND	+/-0.0389	0.0576	0.080	pCi/g					
Sodium-22	U	ND	+/-0.0301	0.0531	0.080	pCi/g					
Thallium-208		0.229	+/-0.0767	0.0528	0.080	pCi/g					
Thorium-230		0.776	+/-0.166	0.0945	1.00	pCi/g					
Thorium-234	U	ND	+/-1.22	1.04	2.00	pCi/g					
Tin-113	U	ND	+/-0.0407	0.0711	0.100	pCi/g					
Uranium-235	U	ND	+/-0.278	0.283	0.500	pCi/g					
Uranium-238	U	ND	+/-1.22	1.04	1.00	pCi/g					
Yttrium-88	U	ND	+/-0.0274	0.0486	0.100	pCi/g					
Zinc-65	U	ND	+/-0.0807	0.121	0.300	pCi/g					
Zirconium-95	U	ND	+/-0.067	0.124	0.200	pCi/g					

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep RAD A-021,A-021B,A-026	KM1	08/21/01	0918	105066

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	DOE EML HASL 300	

Notes:
The Qualifiers in this report are defined as follows :

** Indicates the analyte is a surrogate compound.
< Actual result is less than amount reported
> Actual result is greater than amount reported
E Concentration exceeds instrument calibration range
J Indicates an estimated value. The result was greater than the detection limit, but less than the reporting limit.
U Indicates the compound was analyzed for but not detected above the detection limit
X Lab-specific qualifier - must be fully described in case narrative and data summary package

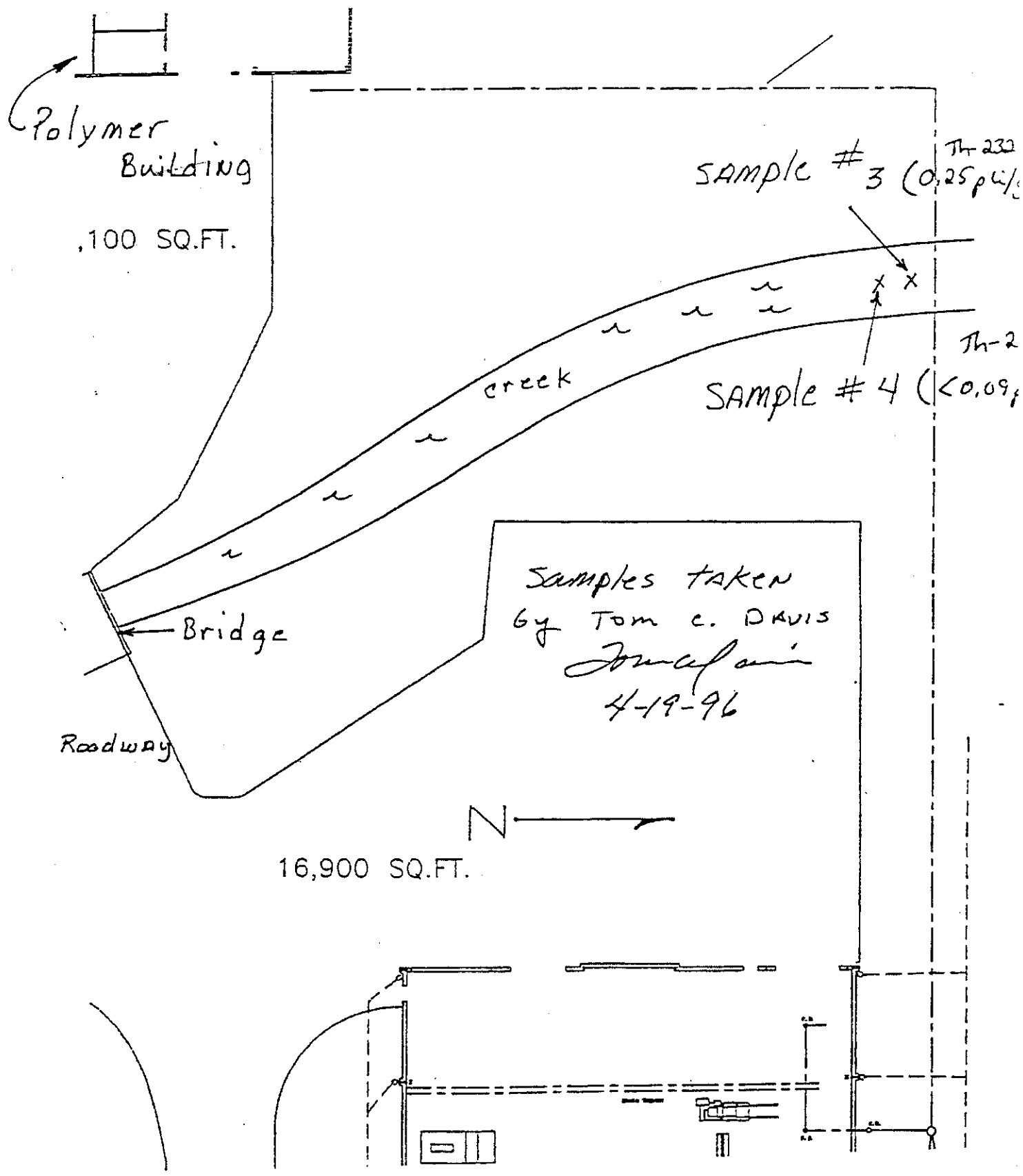
The above sample is reported on an "as received" basis.

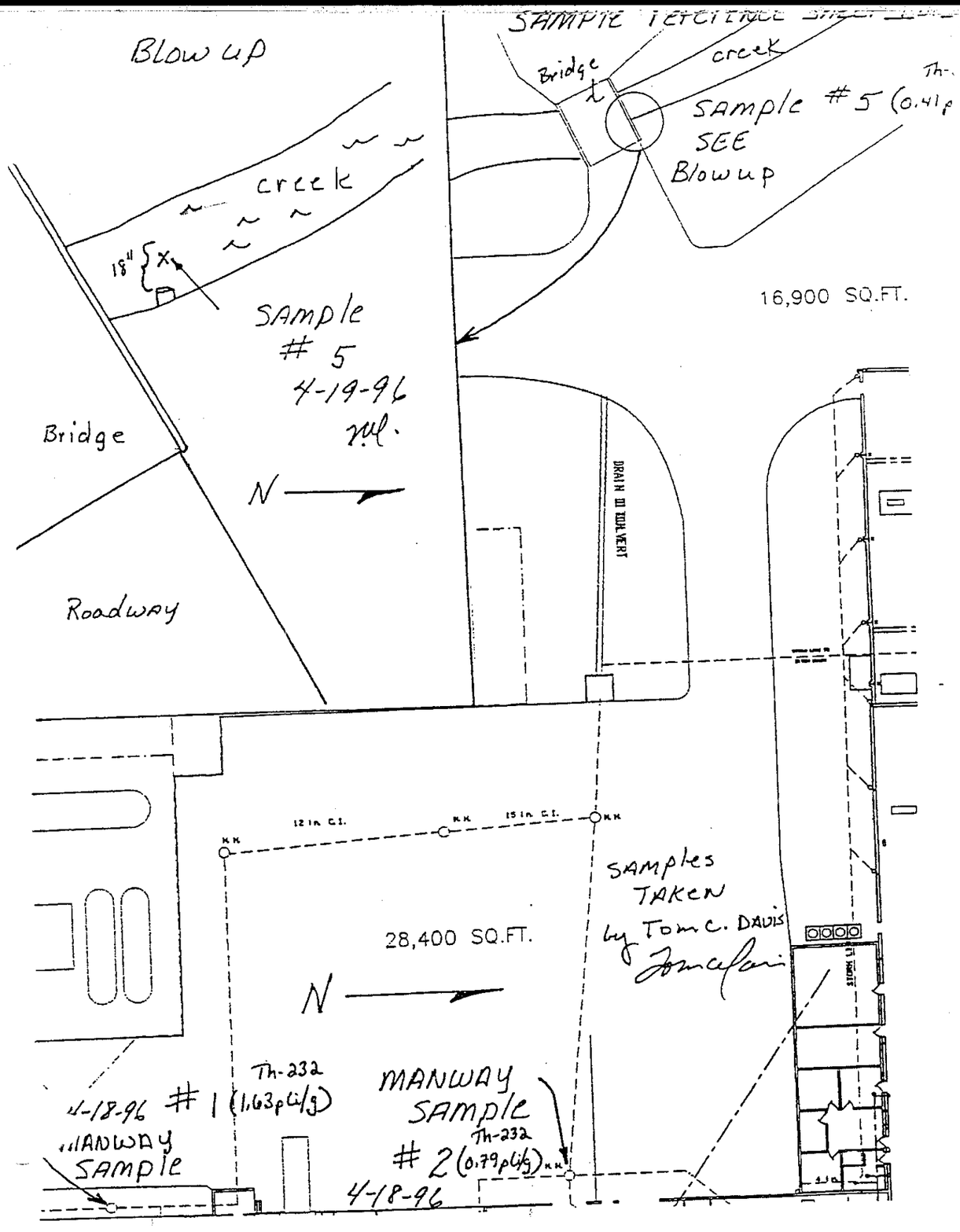
This data report has been prepared and reviewed in accordance with General Engineering Laboratories, Inc. standard operating procedures. Please direct any questions to your Project Manager, Cheryl Jones.

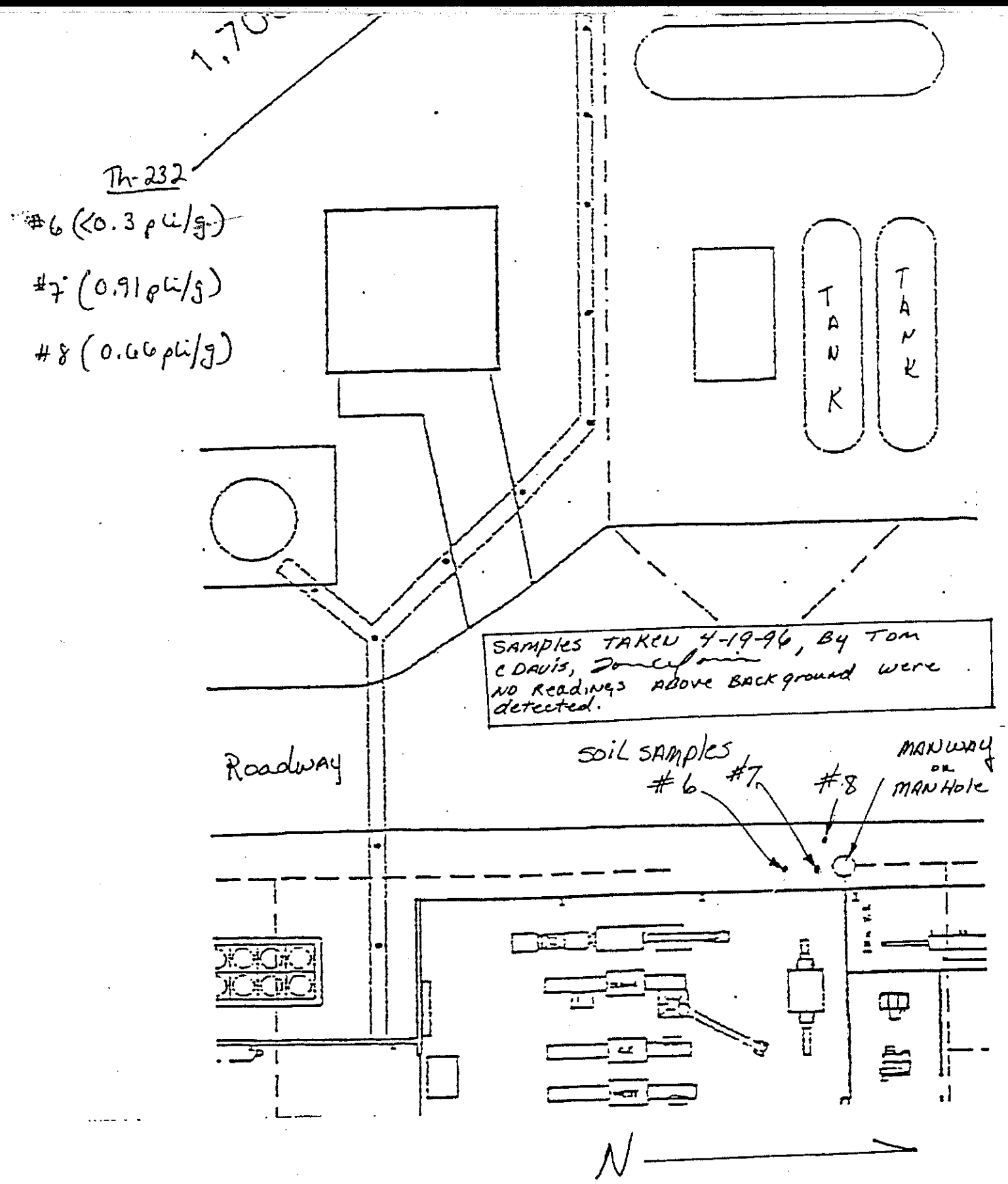
Reviewed by

P O Box 30712 • Charleston, SC 29417 • 2040 Savage Road • 29407
(843) 556-8171 • Fax (843) 766-1178

Printed on recycled paper.


Polymer Building
,100 SQ.FT.
SAMPLE # 3 (0.25 pCi/
Th-230
Th-2
creek
SAMPLE # 4 (<0.09
Samples taken
by Tom C. Davis
4-19-96
Bridge
Roadway
N
16,900 SQ.FT.


Blow up
creek
18"
X
Sample
5
4-19-96
Bridge
N
Roadway
Bridge
creek
Sample #5 (0.41p
SEE
Blowup
16,900 SQ.FT.
DRAIN 111 CULVERT
12 in C.I.
15 in C.I.
KK
KK
KK
28,400 SQ.FT.
N
SAMPLES
TAKEN
by Tom C. DAVIS
Th-232
4-18-96 #1 (1.63pCi/g)
MANWAY
SAMPLE
MANWAY
SAMPLE
Th-232
2 (0.79pCi/g)
4-18-96


1,70
Th-232
#6 (<0.3 pCi/g)
#7 (0.91 pCi/g)
#8 (0.66 pCi/g)
TANK
TANK
SAMPLES TAKEN 4-19-96, BY TOM C DAVIS,
NO READINGS ABOVE BACKGROUND WERE DETECTED.
Roadway
soil samples
#6
#7
#8
MANWAY OR MANHOLE
N