ARCADIS
Infrastructure, environment, buildings

ARCADIS G&M of Michigan, LLC
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Mr. Bruce A. Watson
Branch Chief
Reactor Decommissioning Branch
U.S. Nuclear Regulatory Commission
Rockville, Maryland 20852

ENVIRONMENT

Subject:
CSX Property, Inkster Road, Livonia, Michigan

Date:
August 17, 2010

Contact:
Terri Rubis

Phone:
248.994.2242

Email:
Terri.Rubis@arcadis-us.cor

Our ref:
MI000703.0005

Dear Mr. Watson:

In response to your email inquiry on May 12, 2010, our archived files include the following documents (hard and electronic copies attached) prepared for or by CSX Transportation Inc. (CSXT):

- June 5, 1998- Results of the Radiometric Survey Summary Letter to CSXT from ARCADIS.
- February 24, 1999 – Risk Assessment Feasibility Evaluation Summary Letter to CSXT from ARCADIS.
- October 27, 1999 – Letter to CSX from ARCADIS summarizing RESRAD Model Construction and Initial Modeling Results.
- September 13, 2000 – Request for Closure Determination Letter from CSXT to NRC with the Refined RESRAD Modeling Report as prepared by ARCADIS.
- October27, 2000 – Letter to CSX from Chief Decommissioning Branch in response to letter from CSX regarding final closure determination.
- Core Laboratory Analytical Report dated June 30, 1999.
- STL Analytical Report dated January 13, 2000.

Please let us know how we can help in your sampling effort in September.

Sincerely,

ARCADIS G&M of Michigan, LLC

Terri Rubis
Project Manager

Attachments

ARCADIS
Infrastructure, environment, buildings

ARCADIS Geraghty & Miller, Inc.
41511 Eleven Mile Road
Novi
Michigan 48375
Tel 248 305 9400
Fax 248 305 9401

Mr. Paul Kurzanski
CSX Transportation
500 Water Street, J-275
Jacksonville, Florida 32202

ENVIRONMENTAL

Subject:
Results of the Radiometric Survey, Inkster Road Site, Livonia, Michigan.
CSXT Project Number: 9717003
CSXT Work Order Number: ENV980296PJK1
ARCADIS Geraghty & Miller Project No. MI000652.0001

Novi, Michigan,
June 5, 1998

Contact:
Patrick J. Bartnik, C.P.G.

Extension:
110

Dear Mr. Kurzanski:

On March 29, 1994, the United States Nuclear Regulatory Commission (NRC) informed AAR Manufacturing Group (AAR) that radioactive contamination, which exceeded regulatory guidelines, had been discovered at the AAR facility (NRC 1997). The AAR facility, located at 12633 Inkster Road, Livonia, Michigan, had been licensed by the Atomic Energy Commission to use thorium (contained in a 40% thorium master alloy and in a thorium magnesium alloy) in manufacturing products that contained this licensed material. On December 26, 1996, the NRC performed an independent radiation survey of the CSX Transportation, Inc. (CSXT) right-of-way (ROW) directly adjacent to the AAR facility (see Figure 1). This survey was related to a site characterization report and site remediation plan submitted to the NRC by AAR. During that survey, the NRC detected elevated levels of thorium in soil samples collected from three separate location. In a June 12, 1997 letter to CSXT, Mr. Roy Caniano, Acting Director of the NRC's Division of Nuclear Materials Safety, informed CSXT that the impacts do not represent a safety and health issue, but that the quantities are above the NRC release guideline for unrestricted use.

In a September 8, 1997 letter to CSXT, Mr. B. L. Jorgensen, Chief of the NRC's Decomissioning Branch, requested that CSXT perform an accurate characterization

of the affected areas to more clearly determine the extent of impacts. On behalf of CSXT, ARCADIS Geraghty & Miller performed a survey of the area and presents its findings in this report.

FIELD METHODS

ESTABLISH GRID

ARCADIS Geraghty & Miller began the field work by establishing a grid over the affected area within the CSXT ROW (see Figure 2). The long (east-west) dimension of the grid extended eastward from a point approximately 60 feet west of Inkster Road to a point corresponding to the western property boundary of AAR. The short (north-south) dimension of the grid extended northward from the CSXT rails to the AAR property boundary. Overall grid size was 1,210 feet by 38 feet. The grid was established with 5-foot centers. Permanent markers were painted on the CSXT rails to permit reestablishment of the grid at a future date.

During the establishment of the grid, and all other work within the CSXT ROW, a CSXT flagman was present to watch for and communicate with on-coming rail traffic, to ensure the safety of site workers.

EQUIPMENT

ARCADIS Geraghty & Miller used a Victoreen Survey and Count meter, Model 190, (scintillometer) fitted with a Victoreen GM Probe Model RP-1. This configuration detects alpha, beta, and gamma radiation, and has an operating range of 1 microroentgen per hour (μR/hr) to 1 roentgen per hour (R/hr).

MEASUREMENT

ARCADIS Geraghty & Miller began the survey by collecting a background radiation measurement near the origin of the grid. The background radiation ranged from 0 μR/hr to approximately 24 μR/hr.

ARCADIS Geraghty & Miller measured both surface and subsurface soils with the scintillometer. Radiation readings of surface soils were collected from a height of 6 inches above ground surface. The highest readings were recorded. To measure the subsurface soils, ARCADIS Geraghty & Miller used a tube-sampler soil probe to extract a soil sample from a depth of approximately one foot below ground surface (where crushed stone ballast was present, ARCADIS Geraghty & Miller cleared this ballast away to expose the underlying soil, and then collected a soil sample from a depth of one foot below exposed surface of the soil). The soil sample was removed from the sampler and then measured with the scintillometer. Subsurface measurements were collected at those locations whose surface radiation measurements were the greatest and at other randomly selected locations.

The spacing of the surface soils measurements along the east-west gridlines was 10 feet, beginning at the grid origin (node A,0). The spacing of the surface soils measurements along the north-south gridlines was 5 feet, also beginning at the grid origin. The surface soils measurement collection locations and their values are shown on Figures 3 through 3E.

After the surface soil measurements were evaluated, ARCADIS Geraghty & Miller returned to the site to collect the subsurface soil measurements. These subsurface measurements were collected at those locations where surface soil radiation measurements were elevated, and at other randomly selected locations. The subsurface soils were not measured at all locations. The subsurface soils

measurement collection locations and their values are shown on Figures 4 through 4E.

RESULTS

SURFACE SOIL MEASUREMENTS

The results of the investigation indicate that radiation measurements of surficial soils range from background to 71 μR/hr. The highest readings observed by ARCADIS Geraghty & Miller were noted at coordinates H220 (71.1 μR/hr) and H148 (64 μR/hr). The highest reading recorded by the NRC on December 26, 1996 was 130 μR/hr. The highest ARCADIS Geraghty & Miller reading is approximately 55 percent of the highest NRC reading. This difference may be due to the different instrumentation used by ARCADIS Geraghty & Miller and the NRC.

The greatest number of readings were below 30 μR/hr. As the following list shows, only 19 of the 1,034 measurements were greater than 30 μR/hr. The entire dataset was compared to the value of 30 μR/hr because this value was only slightly greater than the background radiation level, and values greater than this could positively be attributed to environmental impacts.

- East-west gridline A, the gridline coincidental with the CSXT rail, had the overall lowest readings with only one measurement, that at coordinate A74, above 30 μR/hr.
- East-west gridline B, the gridline directly north of gridline A, also only had one measurement, located at coordinate B136 (38.4 μR/hr), above 30 μR/hr.
- East-west gridline C, had only three measurements above 30 μR/hr (C102 [37.7 μR/hr], C148 [32.2 μR/hr], and C150 [31.1 μR/hr]).
- East-west gridline D, had four measurements above 30 μR/hr (D144 [36.5 μR/hr], D126 [32.3 μR/hr], D114 [32μR/hr], and D116 [31.4 μR/hr).
- East-west gridline E had no measurements above 30 μR/hr.

- East-west gridline F had only two measurements above 30 μR/hr (E74 [33.1 μR/hr] and C136 [30.2 μR/hr].
- East-west gridline G had only one measurement above 30 μR/hr (G142 [49.9 μR/hr]).
- East-west gridline H had five measurements above 30 μR/hr (H220 [71.1 μR/hr], H148 [64 μR/hr], H218 [34.4 μR/hr], H64 [32 μR/hr] and H86 [30.1 μR/hr].
- Finally, east-west gridline I had only two measurements above 30 μR/hr (I82 [33.4 μR/hr] and I84 [48 μR/hr]).

SUBSURFACE SOIL MEASUREMENTS

Subsurface soils radiation measurements ranged from background to 50 μR/hr. Sixty subsurface measurements were collected at those locations whose surface radiation measurements were the greatest. Table 2 provides a summary of the locations and their measurements (see also Figures 4 through 4E).

Those surface locations whose radiation readings were highest were I84, G142, H148, and H220. The surface and subsurface radiation readings for these locations are presented in the table below.

Coordinate	Surface Reading	Subsurface Reading
I84	48 μR/hr	41.1 μR/hr
G142	49.9 μR/hr	17.1 μR/hr
H148	64 μR/hr	9.8 μR/hr
H220	71.1 μR/hr	22.1 μR/hr

These data suggest that only one location, coordinate I84, has impacts that extend deeper than the ground surface. However, at several locations, subsurface readings were greater than the surficial readings. These data are presented below.

Coordinate	Surface Reading	Subsurface Reading
D226	10.3μR/hr	50 μR/hr
E222	12 μR/hr	43 μR/hr
E202	7.1 μR/hr	47.6 μR/hr

H192	8 μR/hr	41.1 μR/hr

These coordinates are all located west of the AAR Manufacturing building, approximately one-half way between the building and the AAR Manufacturing western property boundary.

ESTIMATED VOLUME OF IMPACTED SOILS

For the purpose of calculating the volume of soils impacted by radioactive contamination, ARCADIS Geraghty & Miller assumed that:

- only those locations (coordinates) where scintillometer readings exceeded 30 μR/hr required excavation. For these areas, ARCADIS Geraghty & Miller assumes an excavation radius of five feet.
- impacts in all areas do not extend below a depth of one foot, except at those locations where subsurface readings were greater than surface readings. At these locations, ARCADIS Geraghty & Miller assumes impacts extend to a depth of two feet.
- at coordinate I84, whose surface soil measurement was 48 μR/hr and whose subsurface soil measurement was 41.1 μR/hr, the impacts extend to a depth of two feet.

As was reported in the *Results-Surface Soil Measurements* section of this report, scintillometer measurements exceeded 30 μR/hr at 19 locations. Assuming a five foot radius and a depth of one foot, the volume of impacted soils at each location is approximately 0.75 cubic yard (yd^3). The total volume of impacted soils for these 20 locations is, therefore, 15 yd^3.

As was reported in the *Results-Subsurface Soil Measurements* section of this report, at 4 locations, subsurface readings were greater than surface readings. Assuming a five foot radius and a depth of two feet, the volume of impacted soils at each

location is approximately 1.5 yd^3. The total volume of impacted soils for these 4 locations is, therefore, 6 yd^3.

The volume of impacted soils at coordinate I84, assuming a five foot radius and a depth of two feet, is approximately 1.5 yd^3.

Based on the assumptions discussed above, the total volume of impacted soils at the Inkster Road site is approximately, 23 yd^3.

ARCADIS Geraghty & Miller appreciates the opportunity to provide environmental services for CSXT. Should you have any questions or require clarification, please contact Pat Bartnik.

Sincerely,
ARCADIS Geraghty & Miller, Inc.

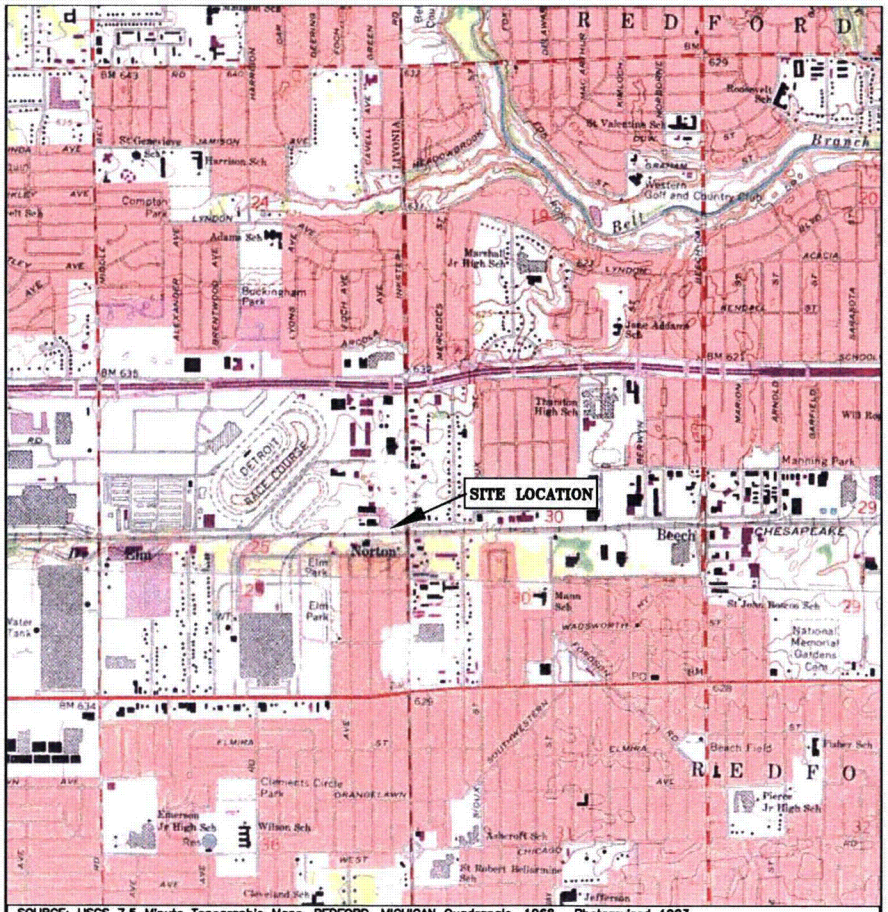
Patrick J. Bartnik, C.P.G.
Staff Scientist/Project Manager

Steve Figgins
Associate/Regional Manager

Enclosures

REFERENCES

United States Nuclear Regulatory Commission 1997. Inspection Report No. 040-00235/97001(DNMS) AAR Manufacturing Inc., Former Brooks & Perkins Facility, Livonia, Michigan . May 15, 1997.



ARCADIS GERAGHTY&MILLER

SITE LOCATION MAP
CSX TRANSPORTATION
CSXT 9717003; ENV9939955PJKK
INKSTER ROAD SITE
LIVONIA, MICHIGAN

DATE: 2/04/03	PROJECT MANAGER: K. PINIGER	DRAWING NAME: TOPO
DRAWN: S. JONES	LEAD DESIGN PROF.:	CHECKED: S. JONES
PROJECT NUMBER: MI000703.003.00001		PAGE NUMBER: 1

Figure 7. Dose vs. time using average isotopic concentrations of November samples as initial conditions, all pathways considered, and assumed residential use with no soil cover.

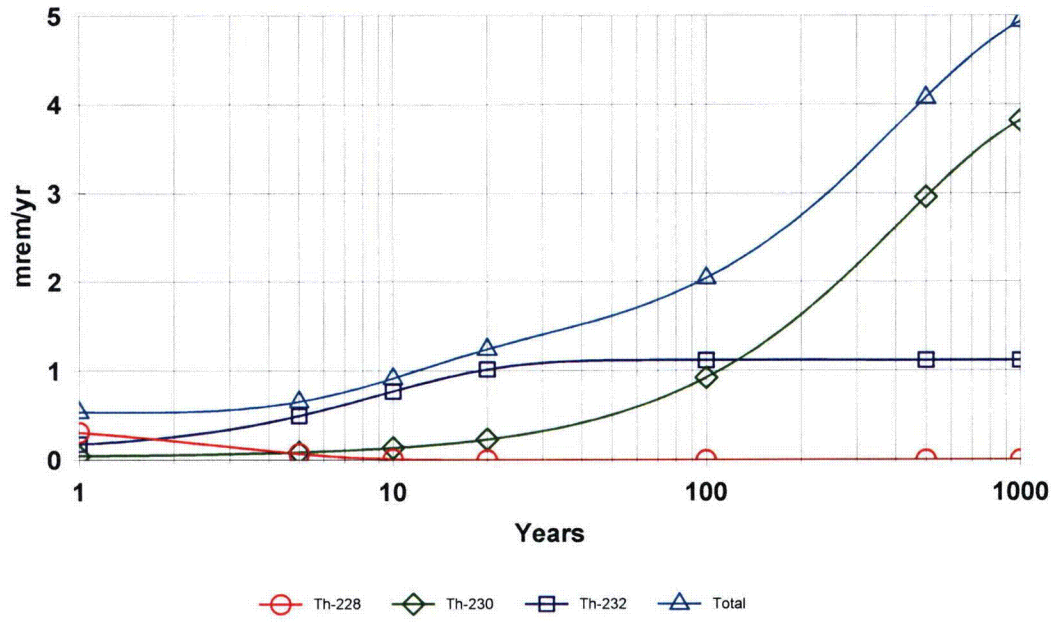


Figure 8. Dose vs. time using average isotopic concentrations of November samples as initial conditions, all pathways considered, and assumed residential use with 6 inch cover.

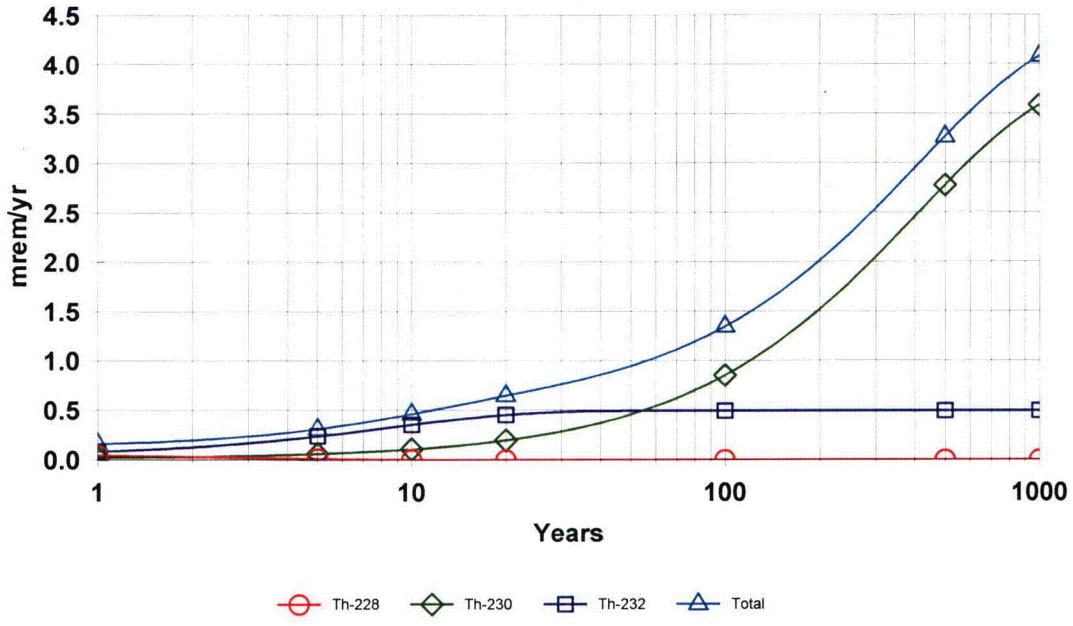


Figure 9. Dose vs. time using average isotopic concentrations of November samples as initial conditions, no plant ingestion, and assumed residential use with no soil cover.

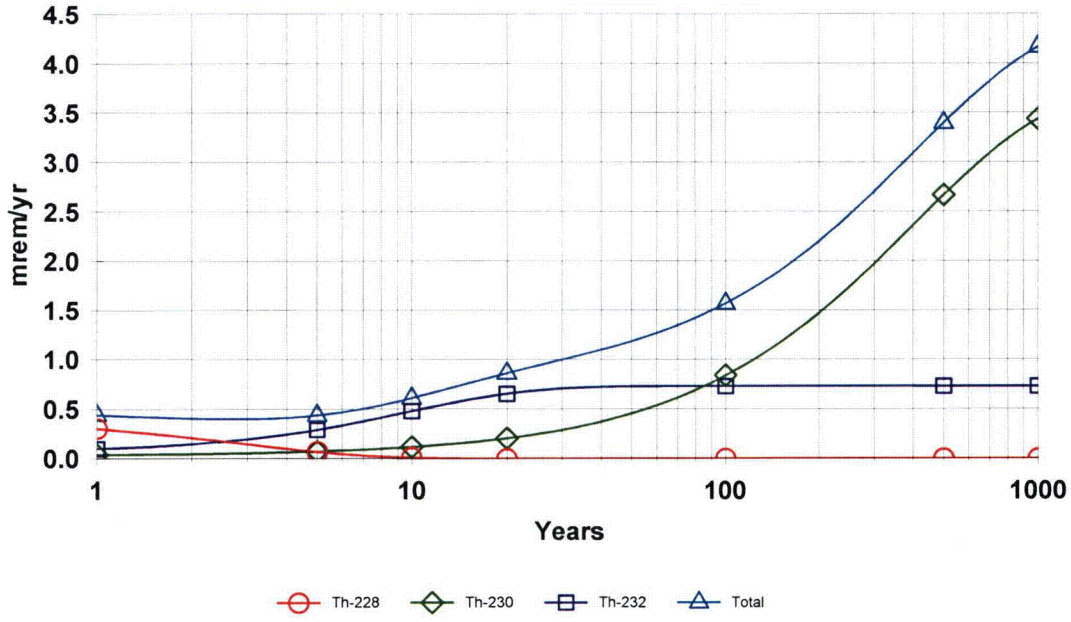


Figure 10. Dose vs. time using average isotopic concentrations of November samples as initial conditions, no plant ingestion, and assumed residential use with 6 inch soil cover.

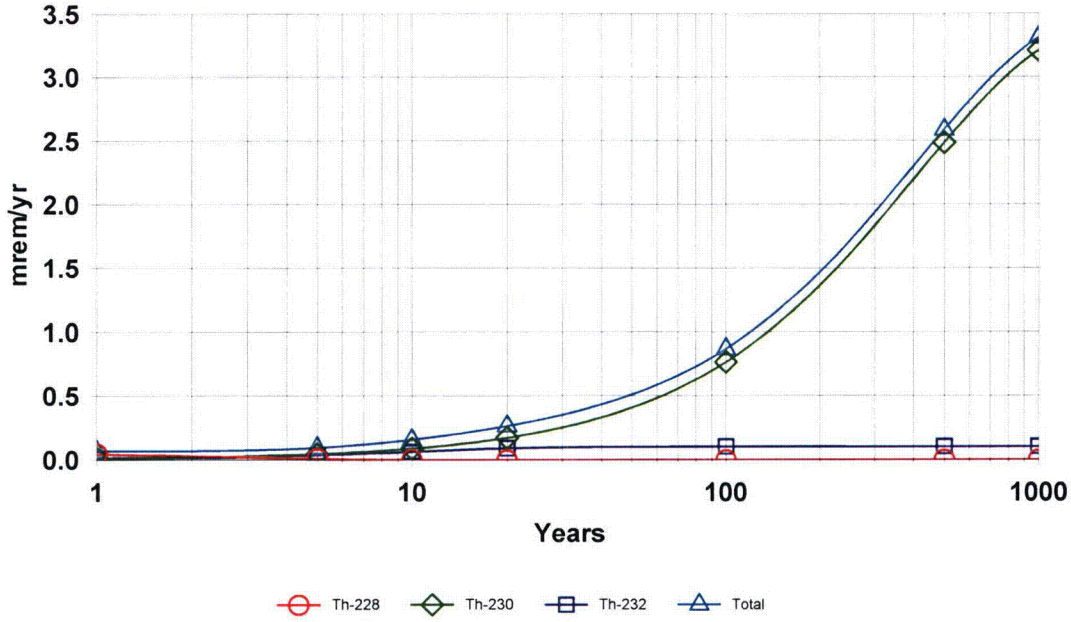


Figure 11. Dose vs. time using average isotopic concentrations of November samples as initial conditions, all pathways considered, and assumed industrial use with no soil cover.

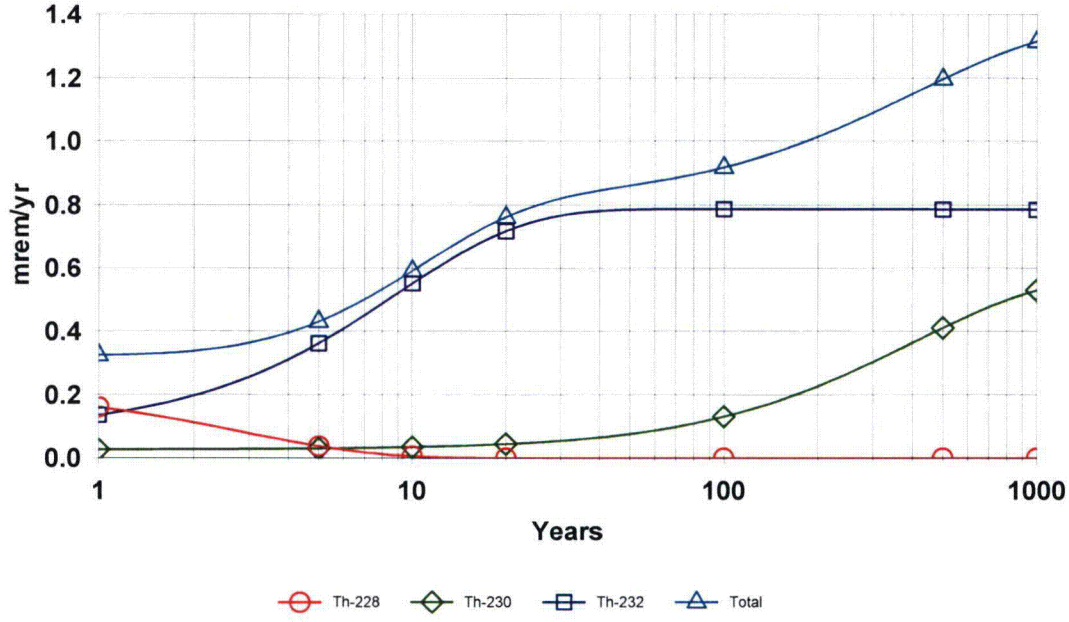


Figure 12. Dose vs. time using average isotopic concentrations of November samples as initial conditions, all pathways considered, and assumed industrial use with 6 inch soil cover.

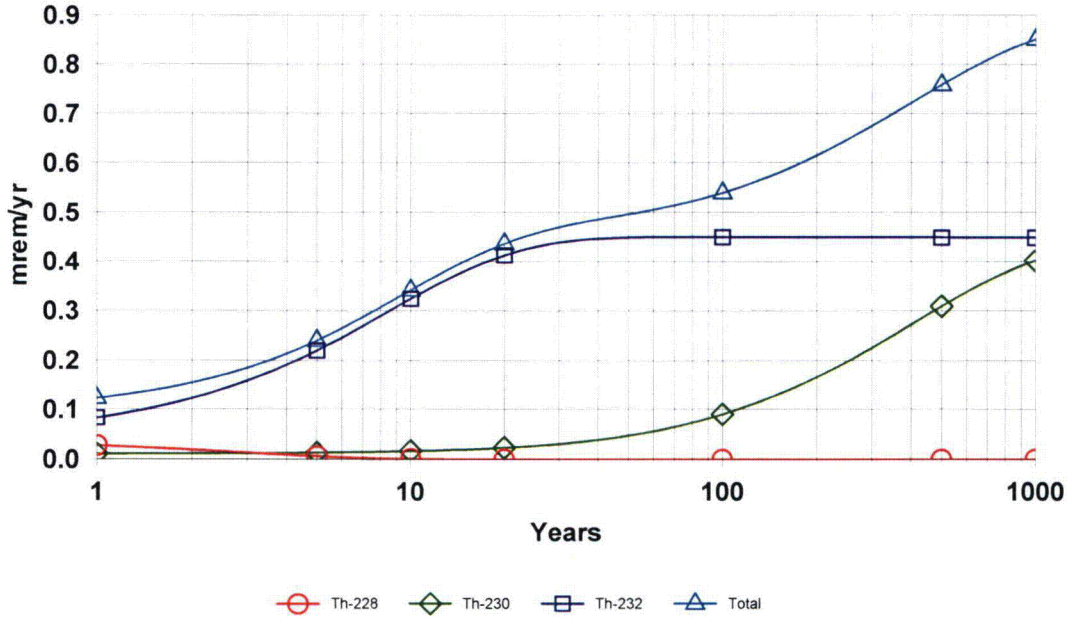


Figure 13. Dose vs. time using average isotopic concentrations of November samples as initial conditions, no plant ingestion, and assumed industrial use with no soil cover.

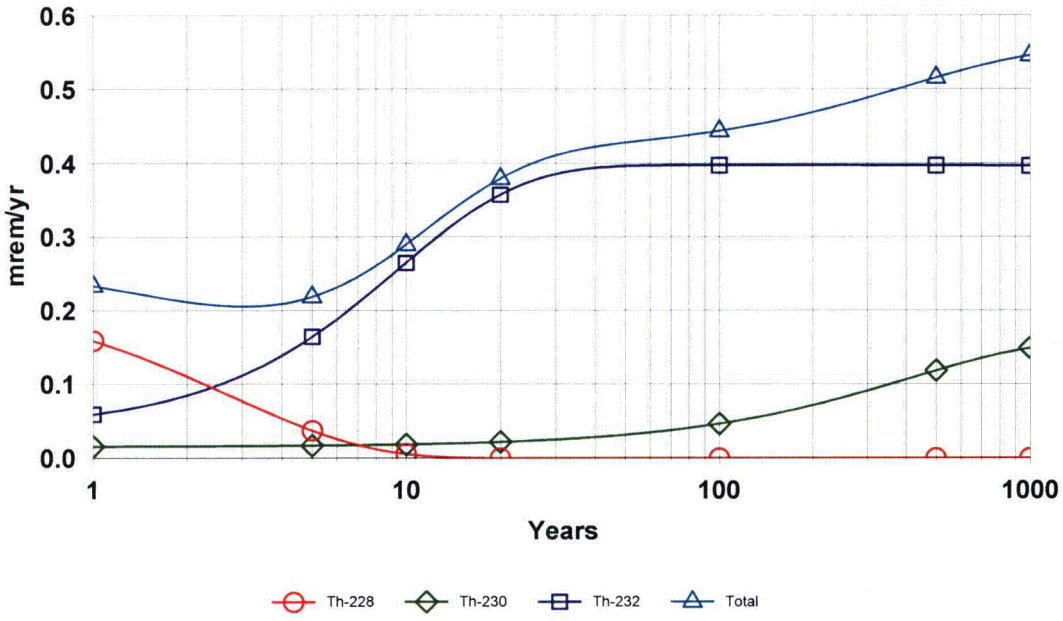
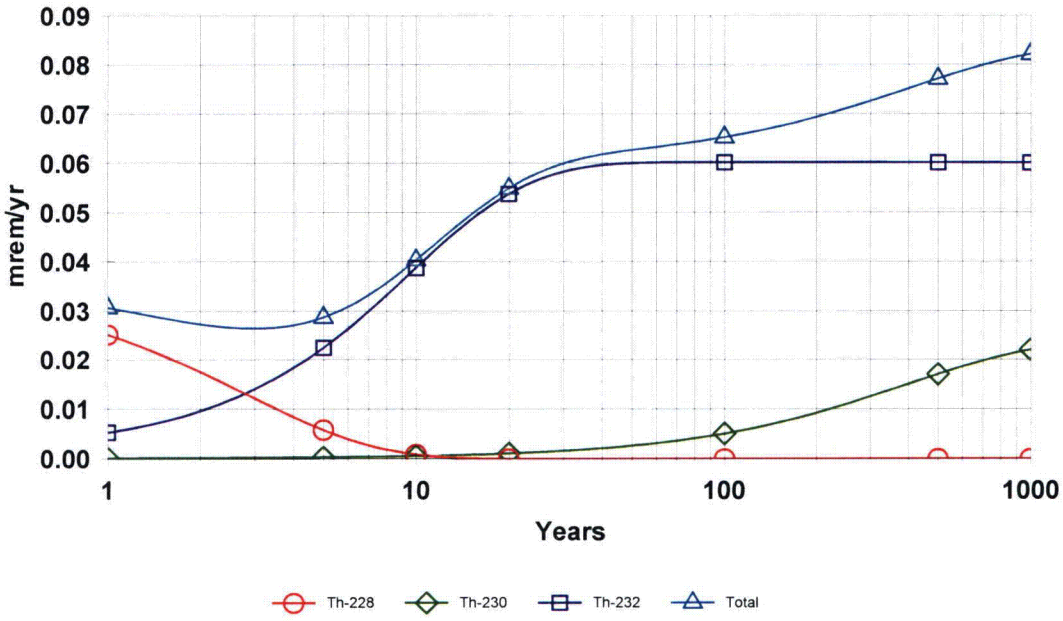
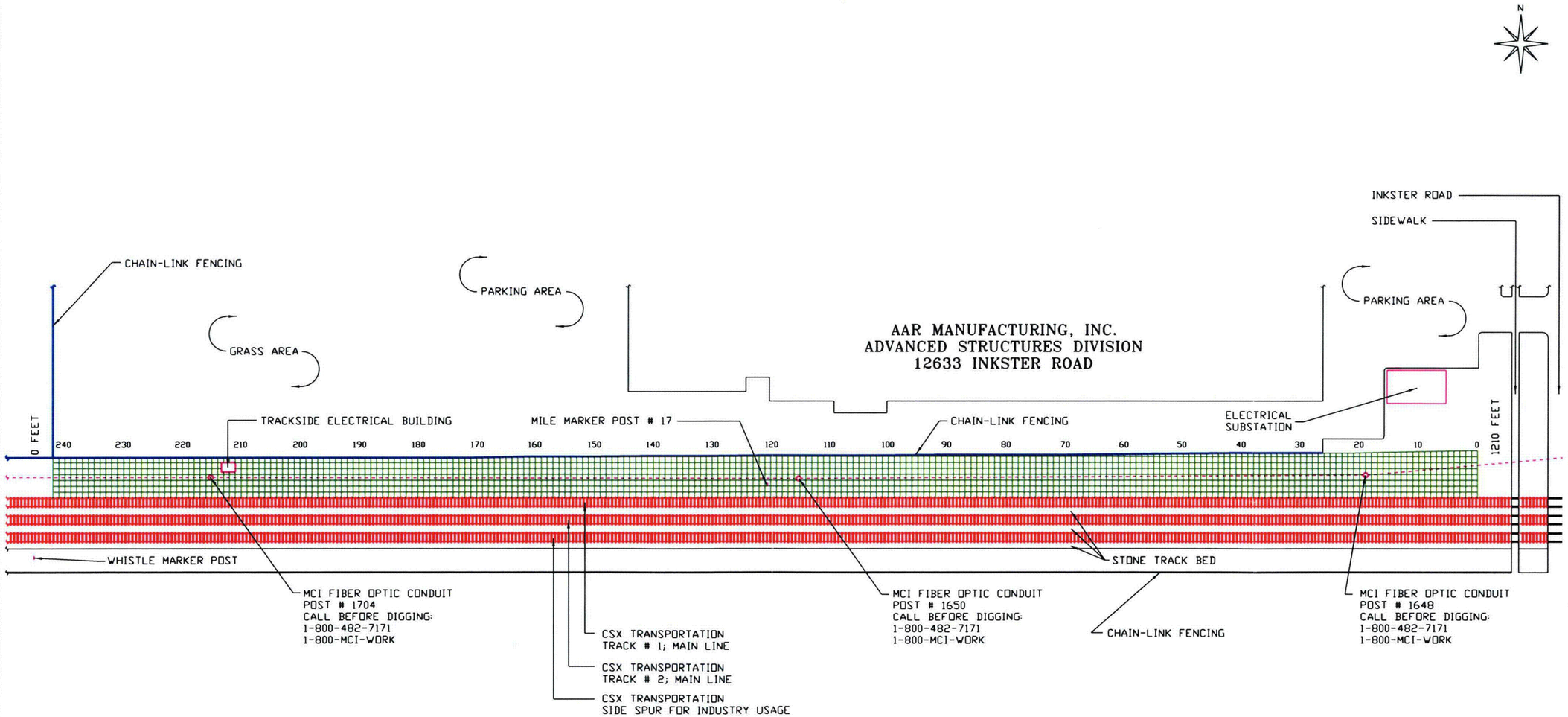


Figure 14. Dose vs. time using average isotopic concentrations of November samples as initial conditions, no plant ingestion, and assumed industrial use with 6 inch soil cover.





RADIOMETRIC SURVEY GRID.
GRID CONSTRUCTED UTILIZING 5 FOOT BY 5 FOOT SQUARES.
APPROXIMATE GRID DIMENSIONS: 1210 FEET LENGTH (E TO W). 34 TO 40 FEET WIDE (N TO S).

NO.	DATE	REVISION DESCRIPTION	BY / CKD

ARCADIS GERAGHTY & MILLER
41511 ELEVEN MILE ROAD
NOVI, MICHIGAN 48375
TEL: 248/305-9400 FAX:248/305-9401

SITE LAYOUT MAP
CSX TRANSPORTATION
CSXT 9717003; ENV993955PJKK
INKSTER ROAD SITE
LIVONIA, MICHIGAN

DRAWN BY: SEAN JERIC	DRAWING DATE: 022198/053000
PROJECT MANAGER: K. PANCZAK	DRAWING NAME: LAYOUT
LEAD DESIGN PROF:	CHECKED: K. PANCZAK
PROJECT NUMBER: MI000703.0003	DRAWING NUMBER: FIGURE 2

N

SCALE IN FEET:

0 20 40

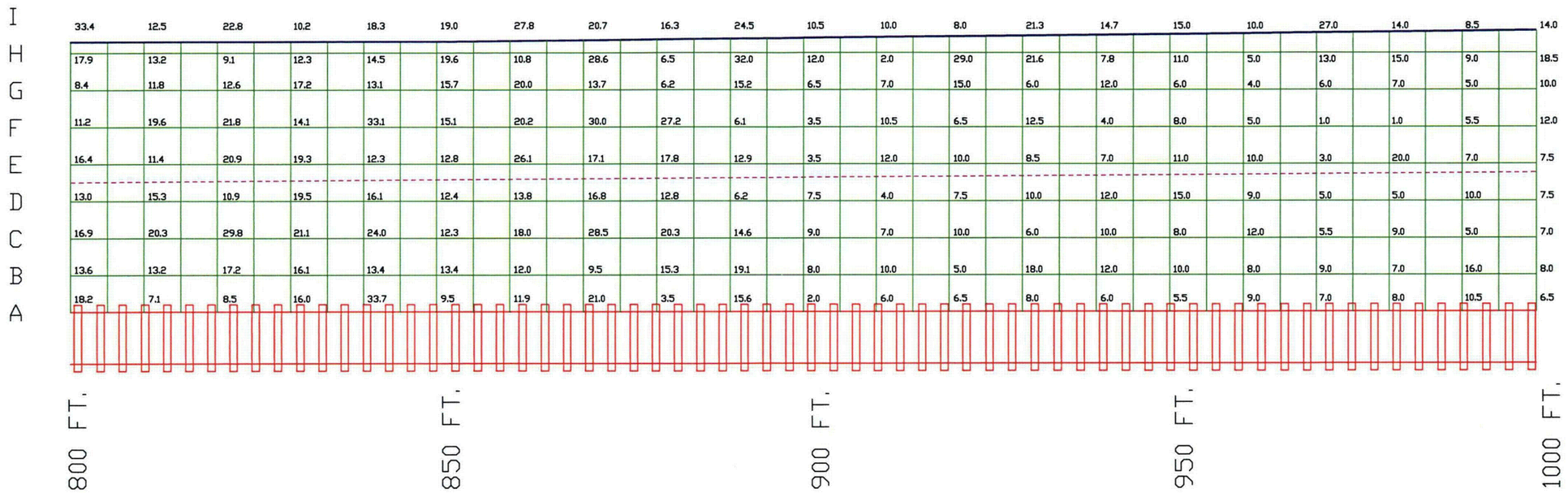
READINGS RECORDED EVERY 10 FEET PER ROW, TAKEN FROM BOTTOM LEFT HAND CORNER.
UNITS: uR / HR
25.0
DEEP WATER, NO READING RECORDED
LOCATION OF SUBSURFACE FIBER OPTIC CONDUIT
CHAIN-LINK FENCING

LEGEND

ARCADIS GERAGHTY & MILLER
41511 ELEVEN MILE ROAD
NOVI, MICHIGAN 48375
TEL: 248/305-9400 FAX-248/305-9401

RADIOMETRIC SURVEY RESULTS
CSX TRANSPORTATION
CSXT 9717003; ENV993955PJKK
INKSTER ROAD SITE
LIVONIA, MICHIGAN

DRAWN BY: SEAN JERIC	DRAWING DATE: 022198/053000
PROJECT MANAGER: K. PANCZAK	DRAWING NAME: SCAN
LEAD DESIGN PROF:	CHECKED: K. PANCZAK
PROJECT NUMBER: MI000703.0003	DRAWING NUMBER: FIGURE 3



SCALE IN FEET:

0 20 40

READINGS RECORDED EVERY 10 FEET PER ROW, TAKEN FROM BOTTOM LEFT HAND CORNER.
25.0
UNITS: uR / HR

LOCATION OF SUBSURFACE FIBER OPTIC CONDUIT

CHAIN-LINK FENCING

LEGEND

ARCADIS GERAGHTY & MILLER

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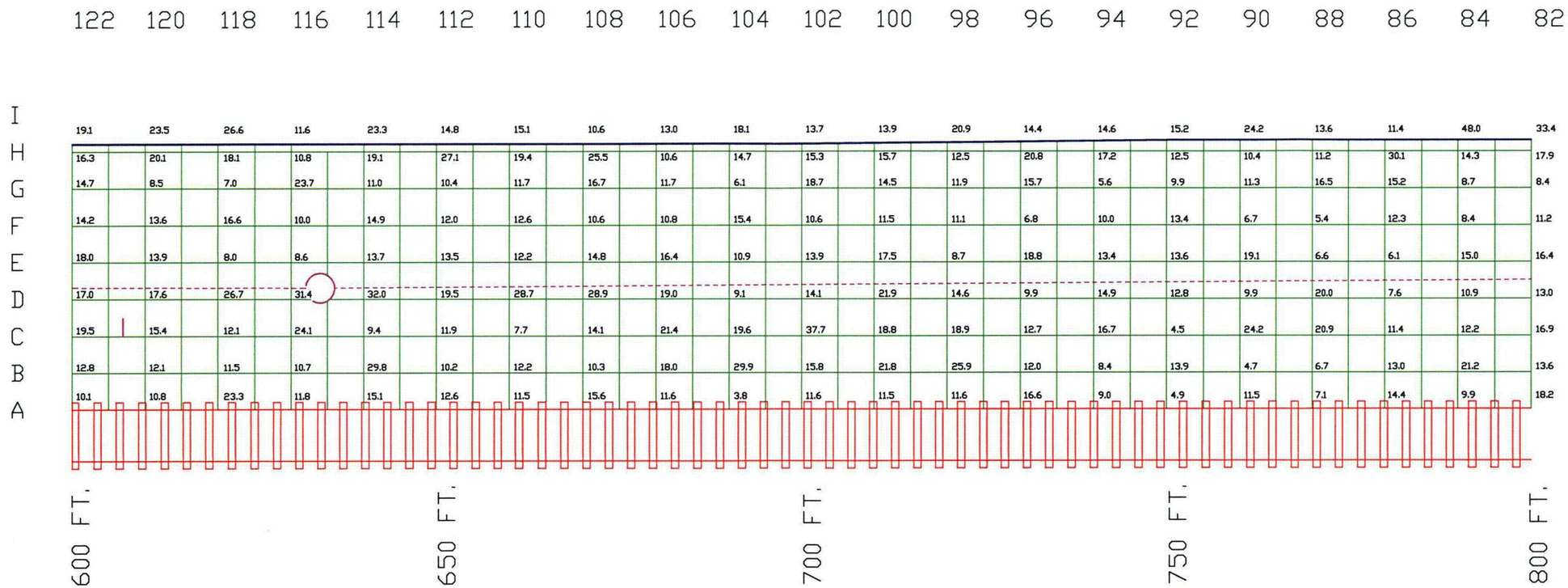
RADIOMETRIC SURVEY RESULTS
CSX TRANSPORTATION
CSXT 9717003; ENV993955PJKK
INKSTER ROAD SITE
LIVONIA, MICHIGAN

DRAWN BY: SEAN JERIC	DRAWING DATE: 022198/053000
PROJECT MANAGER: K. PANCZAK	DRAWING NAME: SCAN
LEAD DESIGN PROF:	CHECKED: K. PANCZAK
PROJECT NUMBER: MI000703.0003	DRAWING NUMBER: FIGURE 3A



N

SCALE IN FEET:

0 20 40

READINGS RECORDED EVERY 10 FEET PER ROW, TAKEN FROM BOTTOM LEFT HAND CORNER.
UNITS: uR / HR

25.0

LOCATION OF SUBSURFACE FIBER OPTIC CONDUIT

CHAIN-LINK FENCING

LEGEND

ARCADIS GERAGHTY & MILLER

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NOVI, MICHIGAN 48375
TEL: 248/305-9400 FAX:248/305-9401

RADIOMETRIC SURVEY RESULTS
CSX TRANSPORTATION
CSXT 9717003; ENV9939PJKK

INKSTER ROAD SITE
LIVONIA, MICHIGAN

DRAWN BY: SEAN JERIC	DRAWING DATE: 022196/063000
PROJECT MANAGER: K. PANCZAK	DRAWING NAME: SCAN
LEAD DESIGN PROF:	CHECKED: K. PANCZAK
PROJECT NUMBER: MI000703.0003	DRAWING NUMBER: FIGURE 3B

	162	160	158	156	154	152	150	148	146	144	142	140	138	136	134	132	130	128	126	124	122	
I																18.8	14.3	28.1	16.7	23.7		19.1
H	12.9	14.3	13.3	11.7	6.1	13.5	29.7	64.0	18.9	11.7	16.6	20.6	13.0	25.8	18.8	23.8	26.5	12.9	15.0	28.5		16.3
G	9.5	8.2	11.6	9.0	8.7	13.2	10.9	28.3	22.7	15.6	49.9	8.8	10.9	19.1	13.9	15.8	18.9	14.7	11.3	11.4		14.7
F	11.2	13.2	9.8	15.5	14.5	29.4	11.6	21.6	9.7	17.4	12.2	15.4	12.8	30.2	15.8	15.0	12.5	12.2	15.4	9.0		14.2
E	12.4	11.2	12.2	13.3	13.0	10.6	13.6	17.9	17.4	16.3	13.3	23.9	20.8	10.5	11.8	13.4	26.4	23.9	13.7	10.8		18.0
D	13.4	11.2	14.8	12.3	16.0	13.9	20.7	13.0	15.7	36.5	13.3	8.1	9.8	10.7	17.2	16.5	12.1	13.2	32.3	26.1		17.0
C	13.5	12.8	12.4	10.9	11.3	12.5	31.3	32.2	17.7	25.0	8.8	10.1	12.0	13.1	20.8	12.1	11.0	12.2	13.0	11.4		19.5
B	14.4	15.9	9.0	13.8	12.9	13.7	16.4	12.0	3.6	10.6	9.2	11.0	11.9	38.4	15.8	18.5	6.5	14.8	12.6	13.5		12.8
A	9.6	7.9	11.9	11.5	18.2	14.5	14.1	12.4	7.9	12.1	10.1	12.0	8.2	8.3	12.2	17.5	13.7	14.4	23.5	11.5		10.1
	400 FT.					450 FT.					500 FT.					550 FT.					600 FT.	

N

SCALE IN FEET:

0 20 40

READINGS RECORDED EVERY 10 FEET PER ROW, TAKEN FROM BOTTOM LEFT HAND CORNER.
UNITS: uR / HR

25.0

LOCATION OF SUBSURFACE FIBER OPTIC CONDUIT

CHAIN-LINK FENCING

LEGEND

ARCADIS GERAGHTY & MILLER

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NOVI, MICHIGAN 48375
TEL: 248/305-9400 FAX248/305-9401

RADIOMETRIC SURVEY RESULTS
CSX TRANSPORTATION
CSXT 9717003; ENV993955PJKK
INKSTER ROAD SITE
LIVONIA, MICHIGAN

DRAWN BY: SEAN JERIC	DRAWING DATE: 022198/053000
PROJECT MANAGER: K. PANCZAK	DRAWING NAME: SCAN
LEAD DESIGN PROF:	CHECKED: K. PANCZAK
PROJECT NUMBER: MI000703.0003	DRAWING NUMBER: FIGURE 3C

	202	200	198	196	194	192	190	188	186	184	182	180	178	176	174	172	170	168	166	164	162	
H	17.5	13.2	10.7	9.3	17.4	8.0	11.3	10.7	12.3	12.5	12.2	12.8	13.6	16.3	13.7	10.5	9.8	11.4	11.4	7.5		12.9
G	10.7	12.6	12.0	13.5	20.6	12.6	12.9	11.4	11.5	16.7	13.5	18.1	11.1	14.3	8.8	10.4	10.6	10.9	8.3	7.9		9.5
F	10.7	6.9	9.9	9.2	8.7	8.2	11.5	10.2	13.0	9.9	8.9	9.9	16.3	10.8	9.3	12.6	13.0	13.4	12.4	17.2		11.2
E	7.1	9.3	13.1	12.5	15.2	9.9	10.4	9.8	15.4	10.9	9.1	11.4	12.1	12.5	10.3	11.7	12.5	10.6	13.8	12.5		12.4
D	14.1	19.6	12.9	12.1	12.9	10.4	13.8	9.3	14.0	10.0	15.1	16.1	12.9	16.7	8.8	10.1	6.5	16.1	9.1	14.7		13.4
C	12.9	15.6	14.5	12.7	18.1	13.7	12.6	13.0	14.2	10.7	10.3	11.5	14.9	13.0	12.7	7.9	4.5	13.5	12.0	12.2		13.5
B	15.3	15.9	8.0	9.9	10.8	10.2	15.9	11.6	13.5	13.7	8.1	11.3	9.0	13.1	7.5	11.2	7.7	13.4	9.7	9.2		14.4
A	9.8	11.4	9.3	14.3	16.7	6.5	12.2	12.5	12.3	7.9	10.4	4.1	9.9	7.8	9.7	8.4	7.0	7.5	14.6	12.0		9.6
		200 FT.				250 FT.				300 FT.						350 FT.					400 FT.	

N

SCALE IN FEET:

0 20 40

READINGS RECORDED EVERY 10 FEET PER ROW, TAKEN FROM BOTTOM LEFT HAND CORNER.
UNITS: uR / HR

25.0

LOCATION OF SUBSURFACE FIBER OPTIC CONDUIT

CHAIN-LINK FENCING

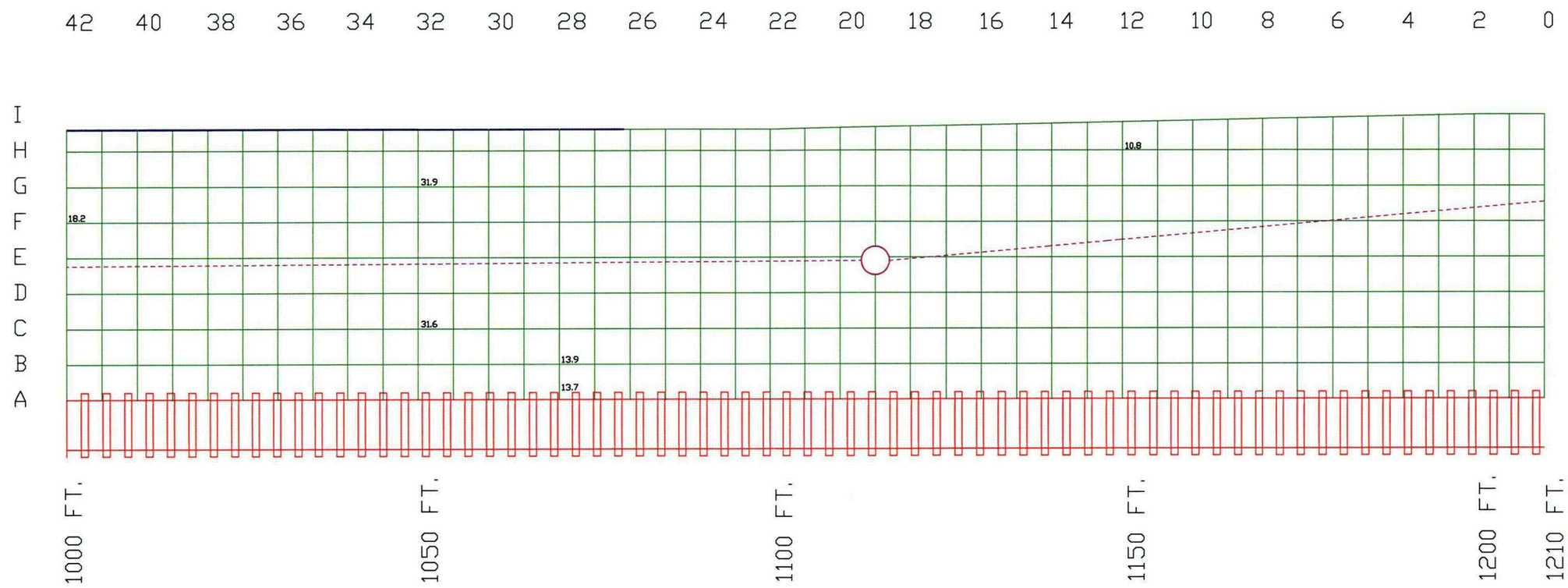
LEGEND

ARCADIS GERAGHTY & MILLER

41511 ELEVEN MILE ROAD
NOVI, MICHIGAN 48375
TEL: 248/305-9400 FAX248/305-9401

RADIOMETRIC SURVEY RESULTS
CSX TRANSPORTATION
CSXT 9717003; ENV993955PJKK
INKSTER ROAD SITE
LIVONIA, MICHIGAN

DRAWN BY: SEAN JERIC	DRAWING DATE: 022198/053000
PROJECT MANAGER: K. PANCZAK	DRAWING NAME: SCAN
LEAD DESIGN PROF:	CHECKED: K. PANCZAK
PROJECT NUMBER: MI000703.0003	DRAWING NUMBER: FIGURE 3D



N

SCALE IN FEET:

0 20 40

READINGS RECORDED EVERY 10 FEET PER ROW, TAKEN FROM BOTTOM LEFT HAND CORNER.
UNITS: uR / HR

25.0

W DEEP WATER, NO READING RECORDED

LOCATION OF SUBSURFACE FIBER OPTIC CONDUIT

CHAIN-LINK FENCING

LEGEND

ARCADIS GERAGHTY & MILLER

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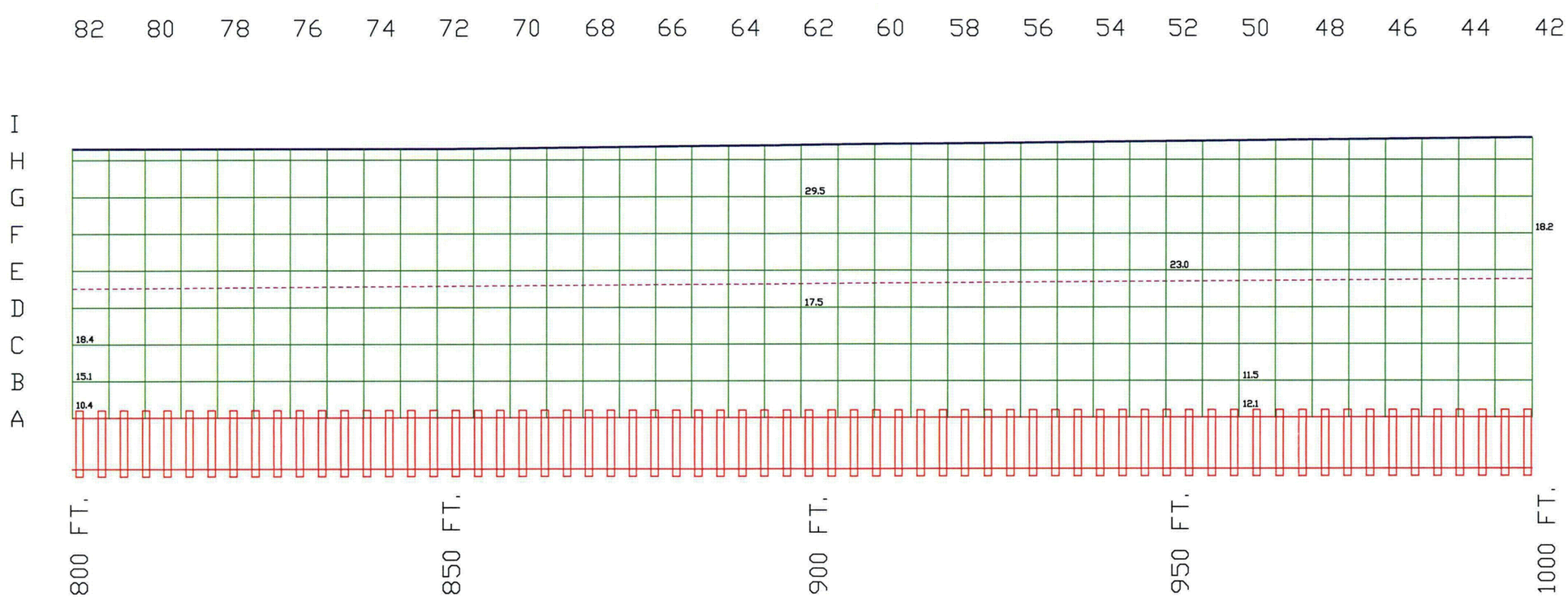
SUBSURFACE RADIOMETRIC SURVEY RESULTS
CSX TRANSPORTATION
CSXT 9717003; ENV993955PJKK
INKSTER ROAD SITE
LIVONIA, MICHIGAN

DRAWN BY: SEAN JERIC	DRAWING DATE: 040698/053000
PROJECT MANAGER: K. PANCZAK	DRAWING NAME: SCAN
LEAD DESIGN PROF:	CHECKED: K. PANCZAK
PROJECT NUMBER: MI000703.0003	DRAWING NUMBER: FIGURE 4



SCALE IN FEET:

0 20 40

READINGS RECORDED EVERY 10 FEET PER ROW, TAKEN FROM BOTTOM LEFT HAND CORNER.
UNITS: uR / HR

25.0

LOCATION OF SUBSURFACE FIBER OPTIC CONDUIT

CHAIN-LINK FENCING

LEGEND

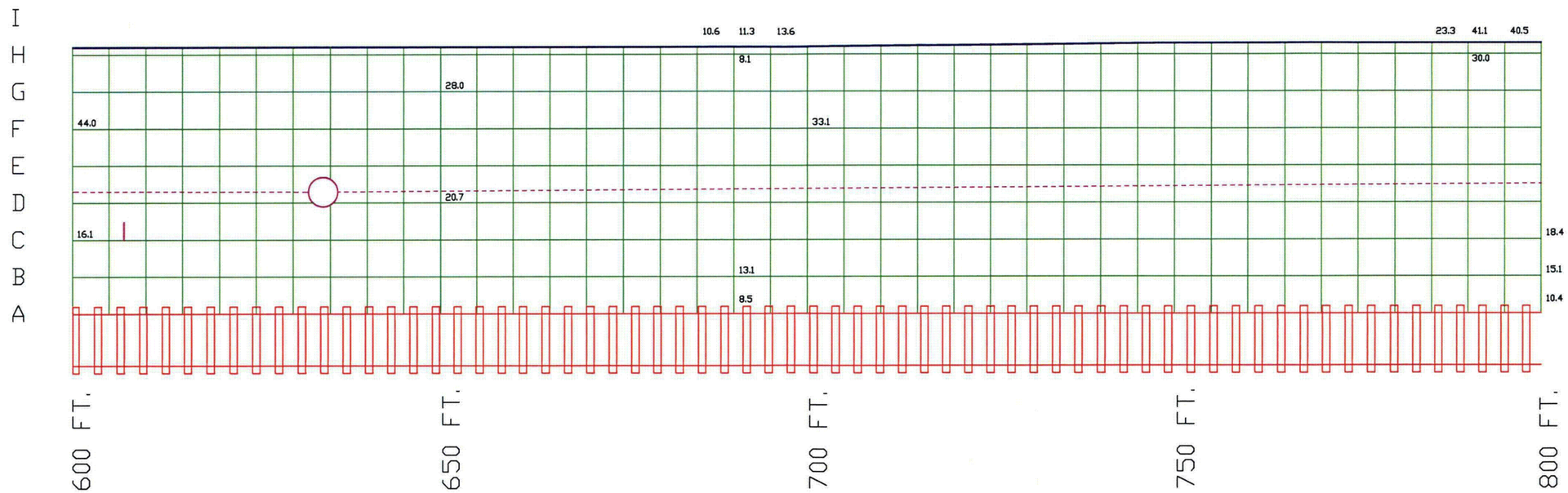
ARCADIS GERAGHTY & MILLER

41511 ELEVEN MILE ROAD
NOVI, MICHIGAN 48375
TEL: 248/305-9400 FAX:248/305-9401

SUBSURFACE RADIOMETRIC SURVEY RESULTS CSX TRANSPORTATION CSXT 9717003; ENV993955PJKK

INKSTER ROAD SITE
LIVONIA, MICHIGAN

DRAWN BY: SEAN JERIC	DRAWING DATE: 040598/053000
PROJECT MANAGER: K. PANCZAK	DRAWING NAME: SCAN
LEAD DESIGN PROF:	CHECKED: K. PANCZAK
PROJECT NUMBER: MI000703.0003	DRAWING NUMBER: FIGURE 4A



N

SCALE IN FEET:

0 20 40

25.0 READINGS RECORDED EVERY 10 FEET PER ROW, TAKEN FROM BOTTOM LEFT HAND CORNER.
UNITS: uR / HR

LOCATION OF SUBSURFACE FIBER OPTIC CONDUIT

CHAIN-LINK FENCING

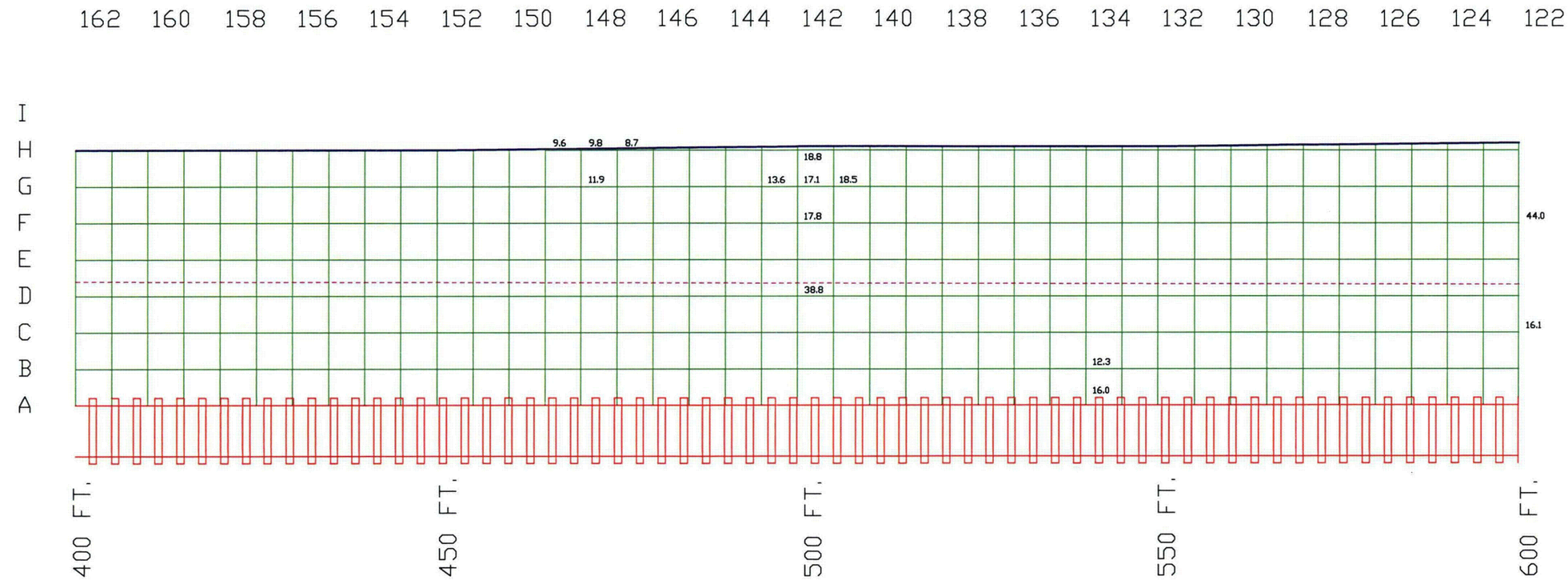
LEGEND

ARCADIS GERAGHTY & MILLER

41511 ELEVEN MILE ROAD
NOVI, MICHIGAN 48375
TEL: 248/305-9400 FAX:248/305-9401

SUBSURFACE RADIOMETRIC SURVEY RESULTS
CSX TRANSPORTATION
CSXT 9717003; ENV993955PJKK
INKSTER ROAD SITE
LIVONIA, MICHIGAN

DRAWN BY: SEAN JERIC	DRAWING DATE: 040598/053000
PROJECT MANAGER: K. PANCZAK	DRAWING NAME: SCAN
LEAD DESIGN PROF:	CHECKED: K. PANCZAK
PROJECT NUMBER: MI000703.0003	DRAWING NUMBER: FIGURE 4B



N

SCALE IN FEET:

0 20 40

READINGS RECORDED EVERY 10 FEET PER ROW, TAKEN FROM BOTTOM LEFT HAND CORNER.
25.0 UNITS: uR / HR
LOCATION OF SUBSURFACE FIBER OPTIC CONDUIT
CHAIN-LINK FENCING

LEGEND

ARCADIS GERAGHTY & MILLER
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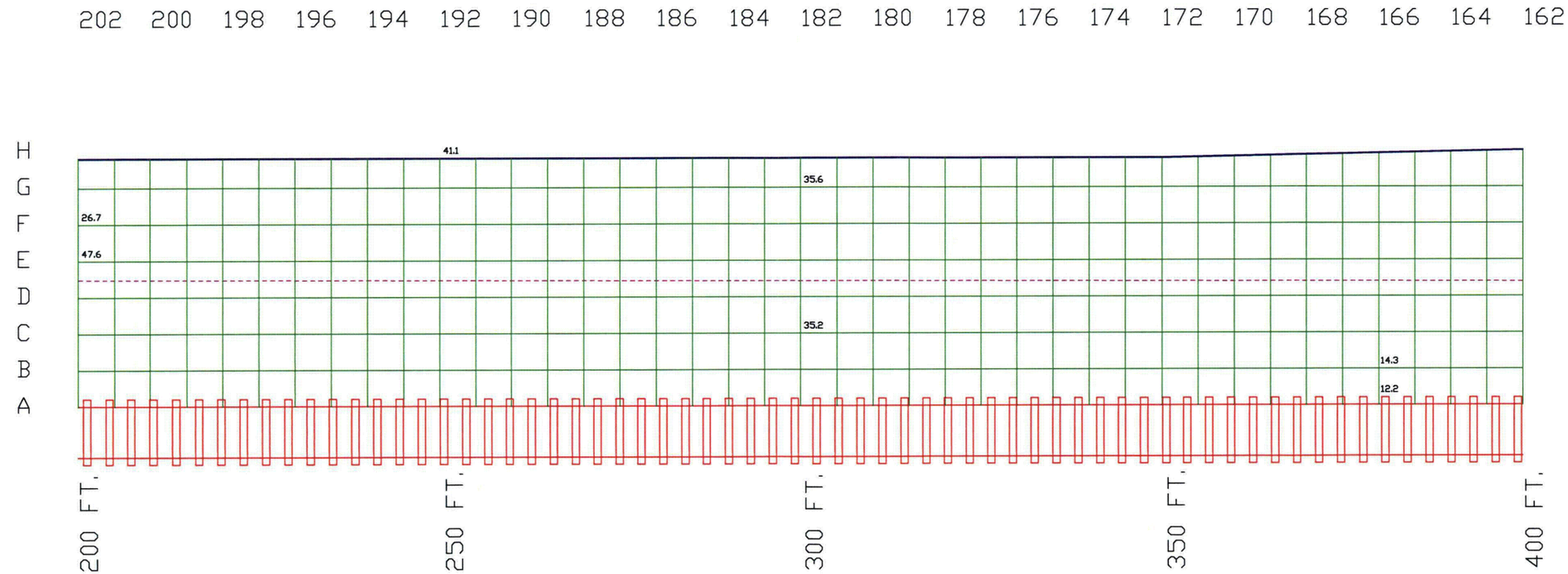
NOVI, MICHIGAN 48375
TEL: 248/305-9400 FAX:248/305-9401

SUBSURFACE RADIOMETRIC SURVEY RESULTS
CSX TRANSPORTATION
CSXT 9717003; ENV993955PJKK
INKSTER ROAD SITE
LIVONIA, MICHIGAN

DRAWN BY: SEAN JERIC	DRAWING DATE: 040598/053000
PROJECT MANAGER: K. PANCZAK	DRAWING NAME: SCAN
LEAD DESIGN PROF:	CHECKED: K. PANCZAK
PROJECT NUMBER: MI000703.0003	DRAWING NUMBER: FIGURE 4C



SCALE IN FEET:

0 20 40

READINGS RECORDED EVERY 10 FEET PER ROW, TAKEN FROM BOTTOM LEFT HAND CORNER.
UNITS: uR / HR

25.0

LOCATION OF SUBSURFACE FIBER OPTIC CONDUIT

CHAIN-LINK FENCING

LEGEND

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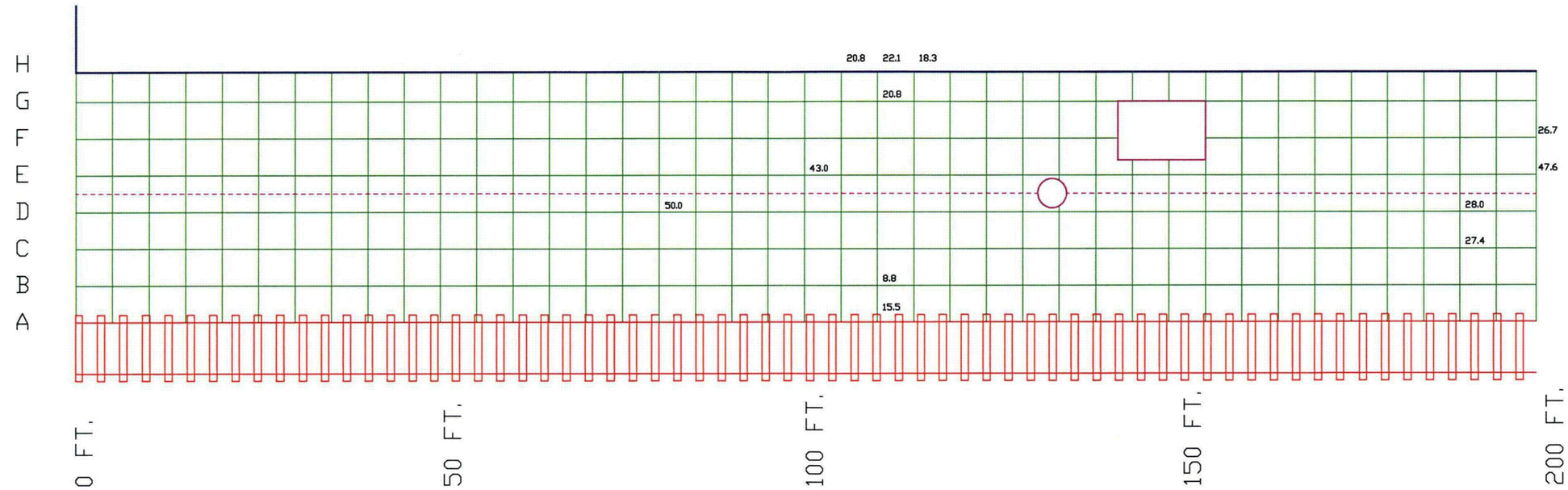
SUBSURFACE RADIOMETRIC SURVEY RESULTS
CSX TRANSPORTATION
CSXT 9717003; ENV993955PJKK
INKSTER ROAD SITE
LIVONIA, MICHIGAN

DRAWN BY: SEAN JERIC	DRAWING DATE: 040598/053000
PROJECT MANAGER: K. PANCZAK	DRAWING NAME: SCAN
LEAD DESIGN PROF:	CHECKED: K. PANCZAK
PROJECT NUMBER: MI000703.0003	DRAWING NUMBER: FIGURE 4D



SCALE IN FEET:

0 20 40

READINGS RECORDED EVERY 10 FEET PER ROW, TAKEN FROM BOTTOM LEFT HAND CORNER.
25.0 UNITS: uR / HR
B BLOCKED AREA, NO READING RECORDED
LOCATION OF SUBSURFACE FIBER OPTIC CONDUIT
CHAIN-LINK FENCING

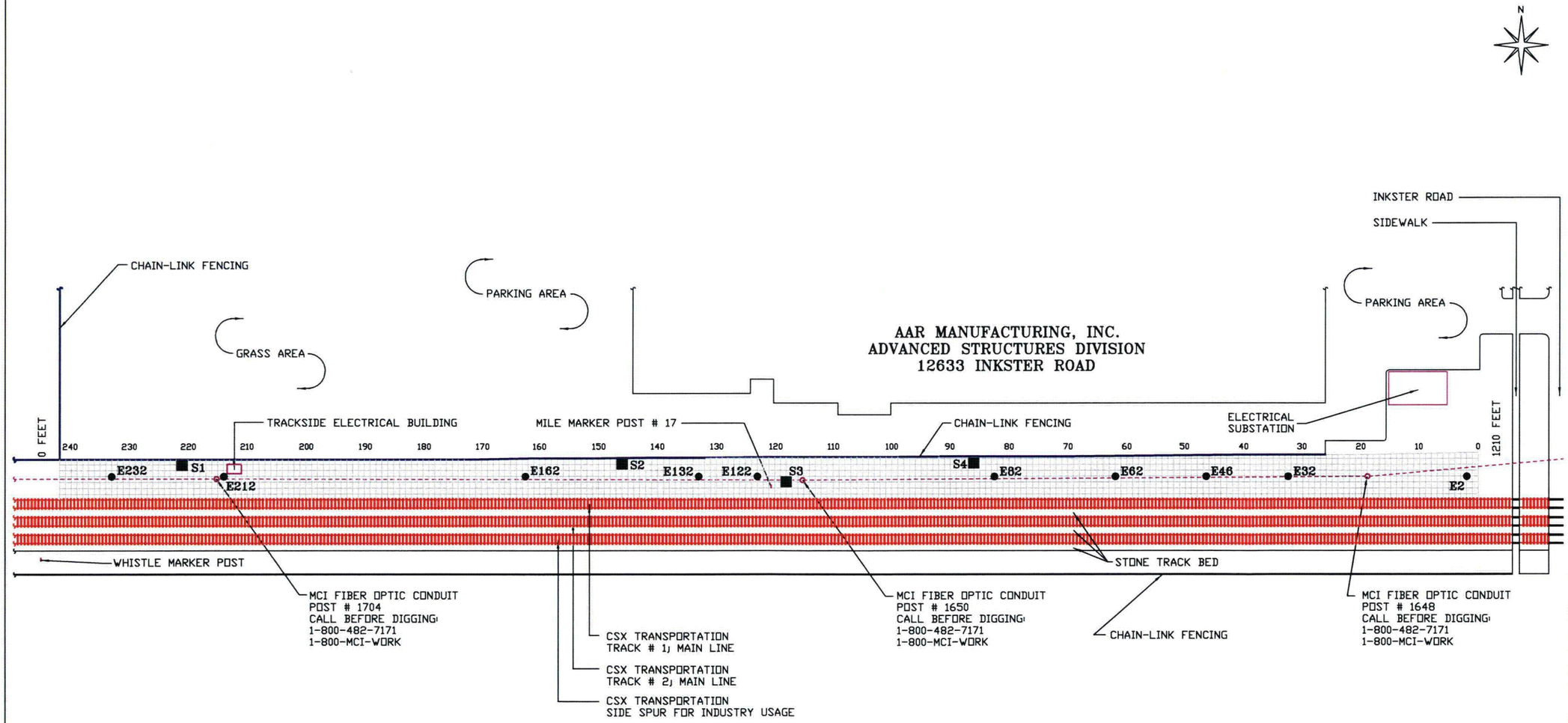
LEGEND

ARCADIS GERAGHTY & MILLER

41511 ELEVEN MILE ROAD
NOVI, MICHIGAN 48375
TEL: 248/305-9400 FAX:248/305-9401

SUBSURFACE RADIOMETRIC SURVEY RESULTS
CSX TRANSPORTATION
CSXT 9717003; ENV993955PJKK
INKSTER ROAD SITE
LIVONIA, MICHIGAN

DRAWN BY: SEAN JERIC	DRAWING DATE: 022198/053000
PROJECT MANAGER: K. PANCZAK	DRAWING NAME: SCAN
LEAD DESIGN PROF:	CHECKED: K. PANCZAK
PROJECT NUMBER: MI000703.0003	DRAWING NUMBER: FIGURE 4E



SCALE IN FEET:

0 20 40 80

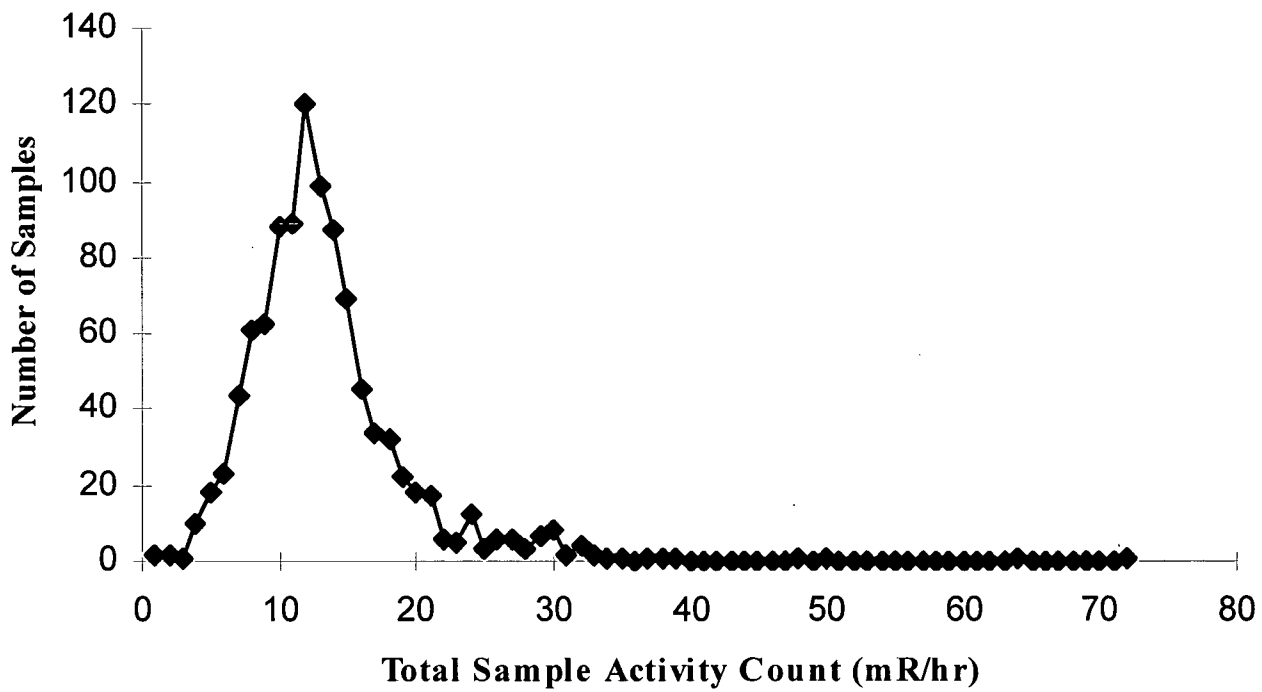
RADIOMETRIC SURVEY GRID.
GRID CONSTRUCTED UTILIZING 5 FOOT BY 5 FOOT SQUARES.
APPROXIMATE GRID DIMENSIONS: 1210 FEET LENGTH (E TO W), 34 TO 40 FEET WIDE (N TO S).

NO.	DATE	REVISION DESCRIPTION	BY	CKD

ARCADIS GERAGHTY & MILLER
41511 ELEVEN MILE ROAD
NOVI, MICHIGAN 48375
TEL: 248/305-9400 FAX:248/305-9401

SAMPLE LOCATIONS
CSX TRANSPORTATION
CSXT 9717003; ENV993955PJKK
INKSTER ROAD SITE
LIVONIA, MICHIGAN

DRAWN BY: SEAN JERIC	DRAWING DATE: 022198/053000
PROJECT MANAGER: K. PANCZAK	DRAWING NAME: LAYOUT
LEAD DESIGN PROF:	CHECKED: K. PANCZAK
PROJECT NUMBER: MI000703.0003	DRAWING NUMBER: FIGURE 6



ARCADIS GERAGHTY&MILLER
41511 ELEVEN MILE ROAD
NOVI, MICHIGAN 48375
TEL: 248/305-9400 FAX: 248/305-9401

DISTRIBUTION OF FEBRUARY 1998
FIELD-SCREENING MEASUREMENTS
CSX TRANSPORTATION
CSXT 9717003; ENV993955PJKK
INKSTER ROAD SITE
LIVONIA, MICHIGAN

DATE	PROJECT MANAGER	DRAWING NAME
30MAY00	K. PANCZAK	GRAPH
DRAWN	LEAD DESIGN PROF.	CHECKED
S. JERIC		K. PANCZAK
PROJECT NUMBER		FIGURE NUMBER
MI000703.0003.00001		5

ARCADIS
Infrastructure, environment, buildings

ARCADIS Geraghty & Miller, Inc.
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Michigan 48375
Tel 248 305 9400
Fax 248 305 9401

Paul J. Kurzanski
Senior Manager Environmental
CSX Transportation
500 Water Street - J275
Jacksonville, FL 32202

ENVIRONMENTAL

Subject:
Risk Assessment Feasibility Evaluation, Inkster Road, Livonia, Michigan.
CSXT 9717003
ENV981800PJKR
ARCADIS Geraghty & Miller Project No. MI000703.0001

Novi
24 February 1999

Contact:
Katie Panczak

Extension:
111

Dear Paul:

Per your request on December 3, 1998, ARCADIS Geraghty & Miller evaluated available information for the Inkster Road, Livonia, Michigan site to determine the feasibility of completing a risk assessment to obtain regulatory closure. The evaluation included researching the United States Nuclear Regulatory Commission (NRC) guidance documents to identify the regulatory and procedural requirements associated with a risk assessment and reviewing site information to identify potential data collection needs.

As a result of this evaluation, ARCADIS Geraghty & Miller determined a specific risk assessment model is approved by the NRC to determine if the site meets regulatory closure requirements. In addition, supplemental soil sampling for isotope-specific analysis would be necessary to correlate site conditions with the regulatory model output. Along with a summary of site conditions and the regulatory requirements, ARCADIS Geraghty & Miller has included in this letter a description of the risk assessment model and a preliminary cost estimate to complete risk assessment modeling. An estimate of the costs are provided in the attached Table 1.

Site Background

On March 29, 1994, the NRC informed the AAR Manufacturing Group (AAR) that radioactive impacts had been discovered at the AAR facility located at 12633 Inkster Road in Livonia, Michigan, adjacent to the CSX Transportation right-of-way (ROW). The AAR facility had been licensed by the Atomic Energy Commission to use thorium (contained in a 40-percent thorium master alloy and in a thorium-magnesium alloy) during product manufacturing. During a subsequent field survey conducted by the NRC, elevated levels of radioactivity were detected in the CSX Transportation ROW.

During spring 1998, ARCADIS Geraghty & Miller completed a radiometric field survey to characterize the CSX Transportation site area and more clearly determine the extent of the radioactive impacts. Consistent with the previously completed NRC survey, a Victoreen Survey and Count meter (scintillometer) fitted with a Victoreen GM Probe Model RP-1 was used during the field survey to detect alpha, beta, and gamma radiation in the surface and near surface (1 foot below grade) site soils.

The radiation measurements were obtained at regularly spaced intervals across the site, and the field survey results indicated surficial soil radiation measurements ranged from the site background measurement (24 microroentgen per hour [uR/hr]) to 71 uR/hr. Subsurface radiation measurements were obtained where surface radiation values were the greatest, and the subsurface soil radiation measurements ranged from background to 50 uR/hr. Sampling and analysis for specific isotope concentrations were not completed during this study, and a more detailed summary of the field survey is presented in the June 5, 1998 ARCADIS Geraghty & Miller report.

Based on the results of the field survey, ARCADIS Geraghty & Miller calculated the volume of affected soil and developed several off-site disposal options that were summarized in a June 19, 1998 letter to you. To explore alternate remedial options, CSX Transportation requested ARCADIS Geraghty & Miller review the feasibility of completing a risk assessment at the site.

Regulatory Risk Assessment Requirements

According to the NRC Region III Branch Chief, Mr. Bruce Jorgensen, the NRC is the governing regulatory agency for sites in Michigan having greater than 0.05 percent by weight thorium. Mr. Jorgensen stated that the NRC regulations are no longer concentration based, and the NRC currently regulates to dose levels. If an exposure is less than 25 millirem per year (mrem/year) from all relevant dose pathways, then regulatory closure could be obtained at the site.

Mr. Jorgensen identified the RESRAD (RESidual RADioactivity) computer model as the approved code to develop dose exposures for thorium-impacted sites. In addition, Mr. Jorgensen indicated all relevant radioactive isotopes at the site should be used to develop the dose concentrations. He referred to the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) document as a comprehensive guidance tool for completing site investigations and risk assessments at radioactive sites.

RESRAD Risk Assessment Model

The objective of the risk assessment is to determine whether thorium-impacted soil can be left in place at the site without violating regulatory radiation dose compliance criteria. Because of radioactivity, certain thorium isotopes and their daughter

products present a possible danger to future users of the site, as well as provide a potential source for off-site exposure. To remain in compliance with the NRC residual radioactivity standards, it must be shown that the dose rate to a member of the average population will not exceed 25 mrem/year during the next 1,000 years.

Given a known thorium concentration distribution in the soil, the dose rate can be simulated by taking into account the various site-specific pathways of environmental transport and human exposure. If this simulation is iterated with different soil concentrations, a concentration distribution can be found that results in the limiting exposure level of 25 mrem/year. This soil concentration distribution can then be used in the remedial alternative decision-making process. Alternately, the computer program RESRAD can solve the inverse approach and conduct simulations to determine a maximum thorium concentration in site soils that will ensure a maximum dose rate of 25 mrem/year or less. This maximum-allowed concentration derived from the RESRAD model can be compared with known thorium concentrations in the site soils to determine compliance with closure criteria.

RESRAD takes into account multiple exposure pathways (groundwater, surface water, plant uptake, direct radiation, etc.) and includes the production, decay, and transport of all daughter products, as well as the parent radionuclide. Changes in constituent concentration and radioactivity are simulated over time in the source soil and in the environmental compartments along exposure pathways between the source and the receptor. Then, the initial limiting concentration of the parent radionuclide is automatically computed by the model for a given total dose rate limit.

RESRAD Input Requirements

The site-specific information listed below can be used to supply input parameters for RESRAD. However, by making conservative assumptions, a useful worst-case scenario can be simulated without knowledge of most of the following parameters:

- Thorium release date.
- Surface area
  - — of contaminated soil,
  - — of the watershed of the nearest stream or pond receiving runoff from the site.
- Length of contaminated zone parallel to groundwater flow.
- Porous media composition (soil type)
  - — of contaminated soil,
  - — of each stratum between contaminated soil and the water table,
  - — of the water-table aquifer.
- Vertical distance between the bottom of the contaminated soil and the water table.
- Hydraulic gradient in the water-table aquifer beneath the site.
- Hydraulic conductivity
  - — in the water-table aquifer beneath the site,
  - — in the contaminated soil,

  - in the cover material,
  - in unsaturated layers between the contaminated soil and the water table.
- Thickness
  - of material covering the contaminated soil (none at this site),
  - of the contaminated soil,
  - of each lithologic layer between the contaminated soil and the water table.
- Rate of erosion
  - of contaminated soil,
  - of the cover material.
- Nearest groundwater well downgradient of the site
  - well pumping rate,
  - distance from contaminated zone to the well,
  - screen depth.
- Distribution coefficient for thorium
  - in the contaminated soil,
  - in each layer of the unsaturated zone between the contaminated soil and the water table,
  - in the water-table aquifer.

Site Application

Although knowledge of the present concentrations of thorium or other radionuclides in the site soil is not needed for RESRAD input, site-specific thorium concentration data are necessary to compare site conditions with the maximum concentration limits determined by the RESRAD analysis.

The MARSSIM document identifies the sampling frequency considered adequate to characterize the site, and the ARCADIS Geraghty & Miller field survey completed in 1998 was conducted in accordance with the MARSSIM approach. However, the field data generated during the survey consist of total alpha, beta, and gamma radiation counts. Therefore, discrete soil sampling and analysis are necessary to quantify the specific radioactive isotope concentrations present. Importantly, however, the results of the field survey can be used to limit the number of isotope-specific samples required for analysis because it can be used to identify zones of varying levels of impacts at the site (i.e., moderately impacted, hot spot). One soil sample can then be collected from the highest-impacted area within each zone and conservatively used to represent the concentration within the entire zone. To ensure the highest-impacted soils within each zone are sampled, the soils should be scanned with a field survey instrument prior to collection. If site conditions indicate soil concentrations within each zone are below the RESRAD-derived maximum, compliance with the 25 mRem/yr dose criteria for closure can be demonstrated.

No site groundwater data currently exists, but the Livonia, Michigan area is characterized by limited saturated horizons, and a conservative assumption of the groundwater-related input parameters is believed to be the appropriate initial step.

Cost Estimate

The level of effort required for this task will depend on the number of samples analyzed, the exposure pathways that need to be included in the simulations, and the availability of input parameters for these pathways. Based on the preliminary evaluation of the field survey data, ARCADIS Geraghty & Miller believes the collection of five soil samples for isotopic thorium analysis would be adequate to characterize the site. Core Laboratories of Casper, Wyoming provided a quote of $140 per sample to complete the isotopic thorium analysis.

The attached table provides a breakdown of the estimated cost to complete the sampling and RESRAD analysis. The table includes a cost estimate to obtain one limiting thorium soil concentration (assumes thorium 232 isotope) based on one set of input parameters and compliance criteria, including all exposure pathways. As summarized in Table 1, the cost to complete sampling and one RESRAD model simulation is estimated at $12,550. The risk assessment sampling and model could be completed in approximately 10 weeks. This schedule is dictated primarily by the four-week turnaround time for isotopic thorium analysis that is considered standard.

Multiple RESRAD analyses could also be conducted to determine the limiting thorium 232 concentration given different sets of input parameters (e.g., with and without a cover of clean soil). This extension of the task scope may be desirable if the site soil concentration is not in compliance with the initial limiting concentration and CSX Transportation wishes to compare different site management scenarios. As indicated in Table 1, the cost to complete each additional scenario simulation is estimated at $4,300. This cost, however, does not include additional site data collection activities, as may be required under a refined input scenario.

ARCADIS Geraghty & Miller appreciates the opportunity to work with CSX Transportation at this site and hopes this summary letter aids in your evaluation of remedial options. Please contact Curt Cramer or me if you have any questions and/or comments regarding the information included in this letter.

Sincerely,

ARCADIS Geraghty & Miller, Inc.

Katherine A. Panczak
Staff Engineer

Curt A. Cramer
Vice President/Eastern Great Lakes Operations Manager

ARCADIS

Table 1. Per-task Cost Estimate to Complete Risk Assessment, CSX Transportation, Inkster Road, Livonia, Michigan.

		ARCADIS Geraghty & Miller		Laboratory	Task
		Labor	Expenses	Expenses	Subtotal
Task 1:	Sampling and Analysis	$950	$300	$700	$1,950
Task 2:	Construction of RESRAD Model	$4,900	$50		$4,950
Task 3:	Predictive Model Simulation	$2,000	$50		$2,050
Task 4:	Data Analysis/Report Preparation	$3,600	$0		$3,600
				Estimated Project Total:	**$12,550**
Optional Task:					
Task 5	Additional Scenario Modeling (Includes input preparation, simulation, and reporting).	$4,200	$100		$4,300
				Cost Per Additional Model Simulation:	**$4,300**

CSXT# 9717003
ENV981800PJKR

g:/aproject/csxt/mi703/tbl1.xls

ARCADIS
Infrastructure, environment, buildings

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41511 Eleven Mile Road
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Michigan 48375
Tel 248 305 9400
Fax 248 305 9401

Mr. Paul J. Kurzanski, REM
Senior Manager Environmental
CSX Transportation
500 Water Street - J275
Jacksonville, Florida 32202

ENVIRONMENTAL

Subject:
Summary of RESRAD Model Construction and Initial Modeling Results, Inkster Road, Livonia, Michigan.
CSXT 9717003; ENV991361PJKK
ARCADIS Geraghty & Miller Project No. MI000703.0002

Novi
27 October 1999

Contact:
Katie Panczak

Extension:
111

Dear Mr. Kurzanski:

In accordance with the May 11, 1999 ARCADIS Geraghty & Miller project proposal, ARCADIS Geraghty & Miller completed the following tasks at the Inkster Road site in Livonia, Michigan:

- Identified maximum levels of impacts through radioactive isotope soil characterization.
- Completed site-specific modeling to evaluate the conservative total dose exposures represented by the site.

The objective of this work was to determine if the thorium-impacted site soil can be left in place without exceeding the Nuclear Regulatory Commission (NRC) guideline concentrations.

The maximum acceptable total site dose exposure established by the NRC is 25 millirem per year (mrem/yr). Results of the ARCADIS Geraghty & Miller modeling, completed using conservative site assumptions, indicate simulated site conditions exceed the NRC dose exposure threshold. However, based on further evaluation of the model as well as communications with the NRC, ARCADIS Geraghty & Miller believes data refinement to reduce conservatism in the assumptions and additional modeling may demonstrate site compliance with the NRC dose exposure limit.

Further information on the soil characterization event, the risk assessment model construction, and the initial modeling results is provided below.

Soil Characterization

In May 1999, ARCADIS Geraghty & Miller reviewed previously collected (February 1998) field screening measurements of total alpha, beta, and gamma counts to determine if radioactivity ranges varied throughout the site. The field screening measurements were obtained at approximately 5-foot intervals within a rectangular grid that overlaid the site thorium investigation area (1,210 feet in length and 38 feet in width). No distinct patterns of total alpha, beta, and gamma counts were observed during the data review, and field screening measurements were noted

to be variable throughout the site. The random pattern of field measurements is consistent with thorium impacts from atmospheric deposition, with the source being the vents at the adjacent former thorium manufacturing facility.

Because distinct areas of impacts do not exist, the site was randomly divided into four zones of varying lengths. The location of the highest field screening measurement within each zone was selected for radioactive isotope characterization. On June 8, 1999, Mr. Kevin Wilson of ARCADIS Geraghty & Miller collected a surface soil sample from each of the four pre-selected locations and submitted them to Core Laboratory of Casper, Wyoming for isotopic thorium analysis. To confirm the most impacted area within each zone was sampled, Mr. Wilson utilized the same type of field instrument that had been used during the February 1998 field survey (Victoreen Survey and Count Meter Model 190 fitted with a Victoreen GM Probe Model RP-1). The isotopic thorium analytical results are summarized in Table 1.

RESRAD Model Construction

ARCADIS Geraghty & Miller used the NRC-approved RESRAD (RESidual RADioactivity) model to evaluate this site. Using site-specific input parameters, RESRAD can calculate the potential human exposure to radiation through various pathways (i.e., direct contact, inhalation, and ingestion through air, surface water, groundwater, soil and food media) over a 1,000 year period. Site-specific input parameters and a current (initial) site concentration dataset are input into the program. RESRAD then evaluates all exposure pathways and calculates the total exposure resulting from the initial input concentration dataset.

Based on the known site source, the following three thorium isotopes were considered in the risk assessment model: thorium-228 (^{228}Th), thorium-230 (^{230}Th), and thorium-232 (^{232}Th). In addition, ARCADIS Geraghty & Miller utilized the following site-specific RESRAD input parameters for the model:

- The volume of impacted soil was assumed to encompass a 1,210-foot by 38-foot rectangle extending 1.5 feet below ground surface, based on the February 1998 field survey.
- The radioactive material was assumed to be deposited at least 15 years ago, based on the known site history.
- The groundwater infiltration rate was set at 4 inches per year, based on existing hydrogeologic studies of the area.
- Surface water was not assumed to leave the site as run-off, based on the site topography and field observations.
- No significant level of erosion was assumed to occur at the site, based on the site topography and field observations.

The results of the June 8, 1999 soil characterization sampling event were used as the initial concentrations input dataset for the RESRAD model (see Table 1). These sample concentrations represent the maximum impacts within each of the four

designated site zones and were conservatively used as input to represent the concentrations present throughout each zone.

Specification of an initial concentration dataset causes RESRAD to perform two functions. First, the model calculates exposure rates based on the input concentrations. Second, the model calculates a guidance concentration for each contaminant initialized (^{228}Th, ^{230}Th, and ^{232}Th). The guidance concentrations represent maximum levels of contaminants (in picoCuries per gram [pCi/g]) currently allowable at the site that would result in a total dose exposure below the NRC guideline of 25 mrem/yr. After the modeling is completed, the current site concentrations can be compared against the calculated guidance concentrations to determine whether additional activities are necessary to reduce and/or prevent unacceptable exposure.

Model Results

When evaluating potential exposures, the NRC conservatively assumes the site use will be a residential farm for the next 1,000 years (resident farmer scenario). If site compliance with the resident farmer scenario is demonstrated, the NRC site closure process is straightforward. The NRC does allow alternative land use scenarios to be considered; however, strong justification must be provided to the NRC to demonstrate the land use for the next 1,000 years will not include a residential farm. In addition, a more-involved NRC review and approval process is required if an alternate scenario is presented.

To ensure potential alternative scenarios were included in the site evaluation, several RESRAD simulations were completed. The model simulations used the previously identified site-specific input parameters as well as additional site assumptions. These additional site assumptions can be divided into three categories: site zoning, site vegetation, and the site shape. Two alternatives were simulated for each assumption category.

Site Zoning

The site zoning assumptions included a future industrial site use alternative and a future residential site use alternative. The two alternatives have differing lengths and types of daily exposure. If the site is maintained as an industrial facility, the potential exposure for any single person can be limited to eight hours per day of outdoor exposure. If the site is rezoned as residential, the exposure for a single person increases to six hours of outdoor exposure and twelve hours of indoor exposure. The indoor exposure pathway affects the guidance concentration calculation because radon (a decay product of ^{230}Th and ^{232}Th) can accumulate within a building, thereby creating an additional long-term exposure component. In the outdoor exposure scenario, however, the surrounding clean air is assumed to mix with the radon and, therefore, results in a lower level of exposure.

Site Vegetation

The ingestion of plants growing in the area of impacts is another exposure pathway evaluated by RESRAD. The first alternative simulated during the RESRAD analyses assumed that plants growing at the site would be consumed by humans (farmer scenario). However, plant ingestion may not be a relevant exposure pathway for this site. Therefore, a second alternative was simulated that did not include plant ingestion.

Site Shape

The plan-view shape of the impacted site area is a very long, thin rectangle (1,210 feet by 38 feet). The RESRAD input data includes specifying the total area of the impact source but not its shape; the source area is assumed to be circular. To account for irregularly shaped areas of impacts, RESRAD allows the input of a shape factor. The shape factor is calculated by enclosing the area of impacts in a circle and relating the area of the circle to the area of impacts. RESRAD simulations were completed with, and without, the calculated shape factor.

Calculated Guidance Concentrations

Table 2 summarizes the guidance concentrations calculated by each of the RESRAD simulations. A bolded number in the table indicates at least one result of the June 8, 1999 sampling event exceeded the RESRAD-calculated guidance concentration. An italicized number in the table indicates all results of the June 8, 1999 sampling event (with laboratory uncertainty considered) are below the RESRAD-calculated guidance concentration. Finally, a number in regular font indicates all results of the June 8, 1999 sampling event (regardless of the laboratory uncertainty) are below the RESRAD-calculated guidance concentration.

The conservative site characterization results (see Table 1) compared with the RESRAD-calculated guidance concentrations (see Table2) indicate the following:

- For all industrial site use model simulations, the maximum concentrations reported in Zones 1 and 3 are below the calculated guidance concentrations, indicating the calculated total dose exposure within these zones are below the NRC threshold limit of 25 mrem/yr.
- The analytical results reported for Zone 3 are below the calculated guidance concentrations for all model simulations, including the resident farmer scenario.
- All site analytical results (all zones and all isotopes) were below the calculated guidance concentrations in the model simulation that assumed future industrial site use, assumed no plant ingestion, and included the shape calculation factor (see shaded area of Table 2).

Conclusions

The modeling results indicate that the site is below the NRC dose exposure limit of 25 mrem/year, provided the following assumptions apply for the next 1,000 years:

- The site will not be zoned for residential use.
- Human exposure will be limited to an eight-hour work day outdoors.
- Plants that grow at the site will not be consumed by humans.

The NRC indicated that deed restrictions and institutional controls are not enough to demonstrate control over future land use for a 1,000 year time frame, and a more detailed argument to justify the alternative land use scenario (identified in the bullets above) must be provided.

An alternate option, that may demonstrate site restrictions are not necessary, is to refine the model input parameters to reduce the conservatism in the current simulations. The calculated guidance concentrations in Table 2 have only been compared against the maximum thorium concentrations observed at the site. Additional soil characterization sampling could be completed at the site to more accurately represent the current site impacts and refine the model. Although it is unknown if compliance with the NRC dose exposure limit would be achieved with the refined model, the additional sampling should help identify specific zones in which concentrations exceed guidelines and enable remedial activities to be limited to those particular zones, if necessary.

ARCADIS Geraghty & Miller appreciates the opportunity to work with you on this site. Please contact Ms. Katie Panczak at (248) 305-9400 if you have any questions or comments during your review of this letter.

Sincerely,

ARCADIS Geraghty & Miller, Inc.

Katherine A. Panczak
Project Engineer

Scott T. Potter, Ph.D., P.E.
Principal Engineer
Copies:

Table 1. Summary of Isotopic Thorium Analytical Results, June 1999, Inkster Road, Livonia, Michigan.

Sample ID:	S-1	S-2	S-3	S-4
Zone ID:	1	2	3	4
Zone Length:	445 feet	110 feet	530 feet	125 feet
Zone Width:	38 feet	38 feet	38 feet	38 feet
Sample Date:	6/8/1999	6/8/1999	6/8/1999	6/8/1999
Isotopic Thorium (pCi/g)				
Thorium-228	2.4 ±0.6	12.8 ±3.0	0.5 ±0.3	21.8 ±6.6
Thorium-230	6.0 ±1.3	19.9 ±4.5	1.2 ±0.4	45.2 ±13.3
Thorium-232	2.6 ±0.7	12.0 ±2.8	0.2 ±0.2	22.8 ±6.8

Notes:

pCi/g picoCuries per gram.
± # Laboratory limits of uncertainty associated with reported concentration.

Table 2. RESRAD-calculated Guidance Concentrations for Acceptable Dose Exposure, Inkster Road, Livonia, Michigan.

Model Simulation Assumptions	Thorium Isotope	Guidance Concentration (pCi/g)	
		Industrial Use[1]	Residential Use[2]
Baseline	^{228}Th	**8.146**	**4.016**
(Plant Ingestion Included)	^{230}Th	**15.52**	**2.351**
(No Shape Factor)	^{232}Th	**3.045**	**1.558**
No Plant Ingestion	^{228}Th	**8.242**	**4.063**
(No Shape Factor)	^{230}Th	*35.18*	**2.83**
	^{232}Th	**4.513**	**2.335**
Shape Factor Calculated[3]	^{228}Th	81.59	35.74
(Plant Ingestion Included)	^{230}Th	**22.32**	**2.59**
	^{232}Th	**6.411**	**3.366**
Shape Factor Calculated[3]	^{228}Th	92.36	39.81
(No Plant Ingestion)	^{230}Th	113.7	**3.183**
	^{232}Th	*20.33*	**11.97**

Notes:

pCi/g	picoCuries per gram.
^{228}Th	Thorium-228 isotope.
^{230}Th	Thorium-230 isotope.
^{232}Th	Thorium-232 isotope.
1	Industrial use assumes 8 hours of outdoor exposure per day.
2	Residential use assumes 6 hours of outdoor exposure and 12 hours of indoor exposure per day.
3	Shape factor calculated based on 1,210-foot by 38-foot rectangle enclosed in a 764.5 foot radius.
Bold	Indicates one or more June 1999 site sample results exceeds guidance concentration.
Italic	Indicates one or more June 1999 site sample results are below guidance concentration when reported laboratory uncertainty is considered.
	Areas shaded in gray represent alternatives where June 1999 site sample results are below guidance concentrations for all isotopes present.

CSX TRANSPORTATION

Paul J. Kurzanski, REM
Director Environmental Remediation

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File: MI, Livonia
Inkster Road
9717003

September 13, 2000

Mr. Bruce Jorgensen
Chief of Decommissioning Branch
Nuclear Regulatory Commission
801 Warrenville Road
Lisle, IL 60543

Request for Closure Determination

Dear Mr. Jorgensen:

Enclosed is the RESRAD Modeling Report prepared for the CSX Transportation, Inc. (CSXT) site in Livonia, Michigan. The CSXT site is located adjacent to the AAR Manufacturing, Inc. (AAR) facility formerly licensed by the Atomic Energy Commission to use radioactive thorium in on-site manufacturing processes. The AAR facility was located at 12633 Inkster Road in Livonia, Michigan, and the CSXT right-of-way is located adjacent to the south of the AAR facility.

As presented in the attached document, the results of the RESRAD modeling demonstrate that the CSXT site does not exceed the total dose exposure standard of 25 millirem per year (mrem/yr) referenced in Title 10 of the Code of Federal Regulations, Part 20, Appendix E (10 CFR 20, App. E). Thus, CSXT requests the Nuclear Regulatory Commission (NRC) make a determination to that effect in writing.

Our environmental consultant, ARCADIS Geraghty & Miller, completed the RESRAD modeling and summary report. Therefore, CSXT requests that you contact Mr. Gary Blinkiewicz of ARCADIS Geraghty & Miller directly at (248) 305-9400 with any questions and/or comments you may have during your review of this document.

Very truly yours,

Paul J. Kurzanski
Director Environmental Remediation

Attachment

cc: Mr. Gary Blinkiewicz, ARCADIS Geraghty & Miller – 41511 Eleven Mile Rd., Novi, MI 48375
Mr. C. Keith Meiser, Senior Counsel - CSXT

ARCADIS
GERAGHTY & MILLER

Refined RESRAD Modeling Report

Inkster Road Site
Livonia, Michigan
CSXT 9717003;
ENV993955PJKK

PREPARED FOR

CSX Transportation, Inc.

ARCADIS GERAGHTY&MILLER

Katherine A. Panczak
Project Engineer

Scott Potter/KH
Scott Potter, Ph.D.
Senior Scientist

Refined RESRAD Modeling Report

Inkster Road Site
Livonia, Michigan
CSXT 9717003;
ENV993955PJKK

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CSX Transportation, Inc.

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Our Ref.:
MI000703.0003

Date:
15 August 2000

Tables

Figures

Introduction

On behalf of CSX Transportation, Inc. (CSXT), ARCADIS Geraghty & Miller conducted a refined analysis of thorium impacts at the CSXT site located in Livonia, Michigan. The refined analysis was completed for the following reasons:

- To evaluate the total dose exposure represented by the site.
- To evaluate whether the thorium-impacted soil can be left in place without exceeding the Nuclear Regulatory Commission (NRC) guideline concentrations.

The maximum-acceptable total site dose exposure established by the NRC is 25 millirem per year (mrem/year).

Consistent with NRC guidance, ARCADIS Geraghty & Miller completed an initial analysis of the site in October 1999 using the NRC-approved RESRAD (RESidual RADioactivity) model and conservative site assumptions based on four samples collected in June 1999. The results of the initial modeling indicated a potential that site conditions could slightly exceed the NRC dose exposure threshold. Because the original four samples were biased toward site hot spots, ARCADIS Geraghty & Miller contacted the NRC and received additional guidance to refine the analysis to be more representative of general site conditions. Based on the NRC's direction, ten additional samples were collected in November 1999, and a more refined analysis was conducted.

ARCADIS Geraghty & Miller completed the refined site analysis using the expanded soil database and the updated version of the computer code RESRAD (Yu et al., Ver. 5.95 11/99), the results of which indicated that the total dose exposure represented by this site does not exceed 25 millirem (mrem/yr). Thus, no remedial action, site restriction, or other similar activity is required at this site.

Site Background

The CSXT site is located adjacent to the south of the AAR Manufacturing, Inc. (AAR) property in Livonia, Michigan (see Figure 1). AAR purchased the property in 1981 from the Brooks and Perkins Corporation, a corporation that was licensed by the Atomic Energy Commission to use radioactive thorium in on-site manufacturing processes. In March 1994, the NRC informed AAR that radioactive impacts had been detected at the site and requested that AAR complete follow-up remedial activities. In a June 12, 1997 letter, the NRC informed CSXT that radioactive impacts related to the AAR site were believed to be present on the CSXT site.

Radiometric Survey

In February 1998, ARCADIS Geraghty & Miller completed field-screening activities at the site to evaluate potential radioactivity. Total alpha, beta, and gamma count field-screening measurements were obtained at approximately 5-foot intervals within a rectangular grid that overlaid the thorium investigation area (1,210 feet in length and 38 feet in width) (see Figure 2). The measurements indicated above-background levels of radioactivity were present in the upper 1.5 feet of soil at various points in the grid.

A detailed summary of the February 1998 field screening radiometric survey was presented to CSXT in a June 5, 1998 ARCADIS Geraghty & Miller Results of the Radiometric Survey letter report, and the measurements recorded during this screening event are presented on Figures 3 through 4E. As can be seen on these figures, no distinct patterns of total alpha, beta, and gamma counts were observed at the site, and the field screening measurements were noted to be variable throughout the site. This random pattern of field measurements is consistent with thorium impacts from atmospheric deposition, with the source being the vents at the adjacent AAR former thorium manufacturing facility.

Site Characterization

A numerical distribution of February 1998 field-screening measurement of total alpha, beta, and gamma activity counts is presented on the graph attached as Figure 5. Consistent with the NRC guidance, the initial site characterization dataset was designed to be conservatively biased. Therefore, in June 1999, isotopic thorium sample collection was completed at sample points where the field sample activity count measurements were 31, 48, 64, and 72 microroentgen per hour (uR/hr). As can be seen on Figure 5, however, the majority of site field-screening measurements were recorded between approximately 5 and 20 uR/hr. Thus, when the initial modeling results (using the conservative analytical data set) indicated site conditions slightly exceeded the NRC total site dose exposure limit, ARCADIS Geraghty & Miller completed a subsequent sampling event in November 1999 and collected ten additional site samples from areas more representative of the total site impacts (with field sample activity count measurements from 5 to 20 uR/hr). In general, the November 1999 sampling event consisted of collecting a sample approximately every 150 feet along a traverse running the length of the site. The sample collection locations for both sampling events are shown on Figure 6.

During each of the two sampling events, ARCADIS Geraghty & Miller scanned the soils prior to sample collection. To ensure the appropriate site areas were sampled, the same field instrument model used during the February 1998 field-screening survey was used during both 1999 sampling events (Victoreen Survey and Count Meter Model 190 fitted with a Victoreen GM Probe Model RP-1). The soil samples collected in June 1999 were submitted to Core Laboratories of Casper Wyoming for isotopic thorium analysis. Due to the closure of the Core Laboratory facility in October 1999, the soil samples collected in November 1999 were submitted to Severn Trent Laboratories (STL) in Whippany, New Jersey for isotopic thorium analysis. The analytical results for both sampling events are summarized in Table 1.

Model Construction

The computer program RESRAD was used to evaluate this site. RESRAD was designed specifically for the implementation of the United States Department of Energy requirements for radioactive material. Using site-specific input parameters, RESRAD evaluates potential human exposure to radiation through various pathways including direct exposure, inhalation, and ingestion through air, surface water, groundwater, soil, and food (plants and meat) over a 1,000-year period.

Site-specific parameters, initial site concentrations of radioisotopes (in picoCuries per gram [pCi/g]) and a maximum allowable exposure (25 mrem/yr total from all radioisotopes) are input to the program. The program evaluates each pathway and calculates the exposure resulting from the initial impact levels observed at the site. The program then calculates the concentration of radioisotopes (pCi/g) that would need to exist initially at the site to result in exactly the maximum exposure which becomes the guideline concentrations. The guideline concentration can be compared with site measurements to determine whether site activities are necessary to reduce and/or prevent exposure.

The RESRAD model constructed for the CSXT site required several site-specific parameters to characterize the area of impacts and the site conditions. Parameter values were based on site-specific data, where available; otherwise, RESRAD default parameter values were used. ARCADIS Geraghty & Miller utilized the following site-specific RESRAD input parameters for the model:

- The volume of impacted soil was delineated as a 1,210-foot by 38-foot rectangle extending 1.5 feet in depth from the ground surface, based on the February 1998 field-screening survey.

- The radioactive material was assumed to have been placed at least 15 years ago, based on the known site history.
- Simulations were performed for 1,000 years, based on the NRC requirements.
- The amount of precipitation percolating into the ground was set at 4 inches per year, based on groundwater modeling studies in the area.
- Surface water was not assumed to leave the site as run-off, based on the site topography and field observations.
- No significant level of erosion was assumed to occur at the site, based on the site topography and field observations.
- The following three thorium isotopes were included in the analysis: thorium-228, thorium-230, and thorium-232, based on the known site source.

As part of the refined analysis, the entire grid area was modeled in RESRAD with the initial thorium isotope concentrations based on the average of the November 1999 samples (see Table 1). The sampling event in June specifically targeted locations with the highest activity; thus, simulations performed using those thorium concentrations are extremely conservatively biased because they assume the high activity counts are uniformly present across the site. Alternately, the November 1999 sampling event was designed to develop a data set characteristic of the total site. Therefore, simulations performed with the initial thorium concentrations based on the average November 1999 sampling results provide the most accurate representation of the total site dose exposure.

Model Results

To account for various assumptions about the potential future use of the site, several alternatives were evaluated using the RESRAD model. The assumptions can be divided into three categories: site zoning, soil cover thickness, and site vegetation. Two alternatives are presented for each category of assumption.

Site Zoning

The alternatives considered for the site zoning are based on the assumption that the site could be used in the future either for industrial or residential use. The model input data

that vary between the alternatives are the length and type of daily exposure. If the site is maintained as an industrial facility, the potential daily exposure for any single person can be limited to eight hours of outdoor exposure. If the site is rezoned as residential, the daily exposure for a single person will be increased to twelve hours of indoor exposure and six hours of outdoor exposure. The additional indoor exposure will affect guidance concentrations because radon, which is a decay product of thorium-230 and thorium-232, will accumulate in a building and cause additional long-term exposure to radiation. In the outdoor case, the wind will mix the radon with the surrounding clean air and result in lower levels of exposure.

Soil Cover

The presence of non-impacted cover soil will reduce exposure to direct radiation and also reduce exposure along inhalation and soil ingestion pathways. Two cases were assessed in the analysis—no cover and 6 inches of cover. In general, impacts at the site are present at the surface or within the first 6 inches of the soil column.

Site Vegetation

One of the exposure pathways evaluated by RESRAD is the ingestion of plants growing in the area of contamination. The first alternative included plant ingestion by humans as an exposure pathway. However, because it is unlikely the site will be zoned for agricultural use, plant ingestion is probably not a relevant pathway. Therefore, a second alternative was modeled in which plant ingestion was excluded from the simulation.

Results Summary

Table 2 summarizes the guideline concentrations for each thorium isotope calculated by the RESRAD model for each alternative considered in the analysis. As can be seen by comparing the average site concentration with the calculated guideline concentrations, the average site concentrations do not exceed any guideline concentrations under site use scenario.

In addition, ARCADIS Geraghty & Miller has included graphical representations of the total site dose exposures calculated during the model simulations. Figures 7 through 14 present the simulated dose exposure rates over 1,000 years using the averages of the November 1999 data set as the initial thorium concentrations. As is

shown in Figures 7 through 14, the total site dose exposure rates do not approach 25 mrem/yr for any future site use alternative.

Conclusions

The modeling results demonstrate that neither remedial measures nor restrictions in site usage are required at this site. The total site dose exposure does not exceed the NRC acceptable exposure criteria of 25 mrem/yr.

Table 1. Thorium Isotope Concentrations Measured in June and November 1999 at the CSX Site, Livonia, Michigan.

Sample ID	Date Sampled	Thorium Concentration (pCi/g) Th-228	Th-230	Th-232
Conservative Samples				
S-1 54	Jun-99	2.4 ± 0.6	6.0 ± 1.3	2.6 ± 0.7
S-2 54	Jun-99	12.8 ± 3.0	19.9 ± 4.5	12.0 ± 2.8
S-3 32	Jun-99	0.5 ± 0.3	1.2 ± 0.4	0.2 ± 0.2
S-4 51	Jun-99	21.8 ± 6.6	45.2 ± 13.3	22.8 ± 6.8
Representative Site Samples				
E2 11	Nov-99	-0.01 ± 0.13 [1]	0.27 ± 0.16	0.05 ± 0.07
E32 9.9	Nov-99	0.17 ± 0.13	0.29 ± 0.16	0.04 ± 0.05
E46 20.2	Nov-99	0.16 ± 0.23	0.37 ± 0.20	0.13 ± 0.14
E62 8.6	Nov-99	0.37 ± 0.15	0.34 ± 0.17	0.09 ± 0.07
E82 12.7	Nov-99	0.22 ± 0.16	0.73 ± 0.24	0.21 ± 0.13
E122 13.3	Nov-99	0.20 ± 0.12	0.55 ± 0.20	0.36 ± 0.15
E132 7.6	Nov-99	0.04 ± 0.10	0.21 ± 0.12	0.10 ± 0.07
E162 16.1	Nov-99	0.02 ± 0.13	0.27 ± 0.12	0.11 ± 0.08
E212 25	Nov-99	0.26 ± 0.14	0.41 ± 0.16	0.21 ± 0.11
E232 16.1	Nov-99	0.28 ± 0.18	0.79 ± 0.27	0.16 ± 0.11
Average of November 1999 Samples		0.171	0.423	0.146
Average of All Samples		2.8	5.47	2.79

Notes:

1 Negative value indicates that the sample has less activity than the instrument background.
pCi/g PicoCuries per gram.
Th-228 Thorium-228
Th-230 Thorium-230
Th-232 Thorium-232

Table 2. RESRAD-calculated Guidance Concentrations for Acceptable Dose Exposure, Inkster Road, Livonia, Michigan.

Model Simulation Assumptions	Thorium Isotope	Guidance Concentration (pCi/g)			
		Industrial Use[1]		Residential Use[2]	
		No Soil Cover	6 inches Cover	No Soil Cover	6 inches Cover
All Exposure Pathways (Plant Ingestion Included)	Th^{228}	18.30	103.30	9.64	60.20
	Th^{230}	19.99	26.28	2.77	2.95
	Th^{232}	4.64	8.12	3.26	7.42
No Plant Ingestion	Th^{228}	18.71	117.90	9.75	64.87
	Th^{230}	7.16	480.30	~~480.30~~ 3.08	3.29
	Th^{232}	9.18	60.63	~~60.63~~ 5.00	35.58

Notes:

pCi/g	picoCuries per gram.
Th^{228}	Thorium-228 isotope.
Th^{230}	Thorium-230 isotope.
Th^{232}	Thorium-232 isotope.
1	Industrial use assumes 8 hours of outdoor exposure per day.
2	Residential use assumes 6 hours of outdoor exposure and 12 hours of indoor exposure per day.

Areas shaded in gray represent alternatives where the average November 1999 site sample results are below guidance concentrations for all isotopes present.

ARCADIS

Infrastructure, environment, buildings

Refined RESRAD Modeling Report

Inkster Road Site
Livonia, Michigan
CSXT 9717003;
ENV993955PJKK

PREPARED FOR

CSX Transportation, Inc.

ARCADIS

Refined RESRAD Modeling Report

Inkster Road Site
Livonia, Michigan
CSXT 9717003;
ENV993955PJKK

Katherine A. Panczak
Project Engineer

Scott Potter, Ph.D.
Senior Scientist

Prepared for:
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Our Ref.:
MI000703.0003

Date:
15 August 2000

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S-3	Jun-99	0.5 ± 0.3	1.2 ± 0.4	0.2 ± 0.2
S-4	Jun-99	21.8 ± 6.6	45.2 ± 13.3	22.8 ± 6.8
Representative Site Samples				
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		No Soil Cover	6 inches Cover	No Soil Cover	6 inches Cover
All Exposure Pathways (Plant Ingestion Included)	Th^{228}	18.30	103.30	9.64	60.20
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	Th^{232}	4.64	8.12	3.26	7.42
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	Th^{230}	71.16	480.30	480.30	3.29
	Th^{232}	9.18	60.63	60.63	35.58

Notes:

pCi/g	picoCuries per gram.
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	Areas shaded in gray represent alternatives where the average November 1999 site sample results are below guidance concentrations for all isotopes present.

Tables

Figures

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- To evaluate whether the thorium-impacted soil can be left in place without exceeding the Nuclear Regulatory Commission (NRC) guideline concentrations.

The maximum-acceptable total site dose exposure established by the NRC is 25 millirem per year (mrem/year).

Consistent with NRC guidance, ARCADIS Geraghty & Miller completed an initial analysis of the site in October 1999 using the NRC-approved RESRAD (RESidual RADioactivity) model and conservative site assumptions based on four samples collected in June 1999. The results of the initial modeling indicated a potential that site conditions could slightly exceed the NRC dose exposure threshold. Because the original four samples were biased toward site hot spots, ARCADIS Geraghty & Miller contacted the NRC and received additional guidance to refine the analysis to be more representative of general site conditions. Based on the NRC's direction, ten additional samples were collected in November 1999, and a more refined analysis was conducted.

ARCADIS Geraghty & Miller completed the refined site analysis using the expanded soil database and the updated version of the computer code RESRAD (Yu et al., Ver. 5.95 11/99), the results of which indicated that the total dose exposure represented by this site does not exceed 25 millirem (mrem/yr). Thus, no remedial action, site restriction, or other similar activity is required at this site.

Site Background

The CSXT site is located adjacent to the south of the AAR Manufacturing, Inc. (AAR) property in Livonia, Michigan (see Figure 1). AAR purchased the property in 1981 from the Brooks and Perkins Corporation, a corporation that was licensed by the Atomic Energy Commission to use radioactive thorium in on-site manufacturing processes. In March 1994, the NRC informed AAR that radioactive impacts had been detected at the site and requested that AAR complete follow-up remedial activities. In a June 12, 1997 letter, the NRC informed CSXT that radioactive impacts related to the AAR site were believed to be present on the CSXT site.

Radiometric Survey

In February 1998, ARCADIS Geraghty & Miller completed field-screening activities at the site to evaluate potential radioactivity. Total alpha, beta, and gamma count field-screening measurements were obtained at approximately 5-foot intervals within a rectangular grid that overlaid the thorium investigation area (1,210 feet in length and 38 feet in width) (see Figure 2). The measurements indicated above-background levels of radioactivity were present in the upper 1.5 feet of soil at various points in the grid.

A detailed summary of the February 1998 field screening radiometric survey was presented to CSXT in a June 5, 1998 ARCADIS Geraghty & Miller Results of the Radiometric Survey letter report, and the measurements recorded during this screening event are presented on Figures 3 through 4E. As can be seen on these figures, no distinct patterns of total alpha, beta, and gamma counts were observed at the site, and the field screening measurements were noted to be variable throughout the site. This random pattern of field measurements is consistent with thorium impacts from atmospheric deposition, with the source being the vents at the adjacent AAR former thorium manufacturing facility.

Site Characterization

A numerical distribution of February 1998 field-screening measurement of total alpha, beta, and gamma activity counts is presented on the graph attached as Figure 5. Consistent with the NRC guidance, the initial site characterization dataset was designed to be conservatively biased. Therefore, in June 1999, isotopic thorium sample collection was completed at sample points where the field sample activity count measurements were 31, 48, 64, and 72 microroentgen per hour (uR/hr). As can be seen on Figure 5, however, the majority of site field-screening measurements were recorded between approximately 5 and 20 uR/hr. Thus, when the initial modeling results (using the conservative analytical data set) indicated site conditions slightly exceeded the NRC total site dose exposure limit, ARCADIS Geraghty & Miller completed a subsequent sampling event in November 1999 and collected ten additional site samples from areas more representative of the total site impacts (with field sample activity count measurements from 5 to 20 uR/hr). In general, the November 1999 sampling event consisted of collecting a sample approximately every 150 feet along a traverse running the length of the site. The sample collection locations for both sampling events are shown on Figure 6.

During each of the two sampling events, ARCADIS Geraghty & Miller scanned the soils prior to sample collection. To ensure the appropriate site areas were sampled, the same field instrument model used during the February 1998 field-screening survey was used during both 1999 sampling events (Victoreen Survey and Count Meter Model 190 fitted with a Victoreen GM Probe Model RP-1). The soil samples collected in June 1999 were submitted to Core Laboratories of Casper Wyoming for isotopic thorium analysis. Due to the closure of the Core Laboratory facility in October 1999, the soil samples collected in November 1999 were submitted to Severn Trent Laboratories (STL) in Whippany, New Jersey for isotopic thorium analysis. The analytical results for both sampling events are summarized in Table 1.

Model Construction

The computer program RESRAD was used to evaluate this site. RESRAD was designed specifically for the implementation of the United States Department of Energy requirements for radioactive material. Using site-specific input parameters, RESRAD evaluates potential human exposure to radiation through various pathways including direct exposure, inhalation, and ingestion through air, surface water, groundwater, soil, and food (plants and meat) over a 1,000-year period.

Site-specific parameters, initial site concentrations of radioisotopes (in picoCuries per gram [pCi/g]) and a maximum allowable exposure (25 mrem/yr total from all radioisotopes) are input to the program. The program evaluates each pathway and calculates the exposure resulting from the initial impact levels observed at the site. The program then calculates the concentration of radioisotopes (pCi/g) that would need to exist initially at the site to result in exactly the maximum exposure which becomes the guideline concentrations. The guideline concentration can be compared with site measurements to determine whether site activities are necessary to reduce and/or prevent exposure.

The RESRAD model constructed for the CSXT site required several site-specific parameters to characterize the area of impacts and the site conditions. Parameter values were based on site-specific data, where available; otherwise, RESRAD default parameter values were used. ARCADIS Geraghty & Miller utilized the following site-specific RESRAD input parameters for the model:

- The volume of impacted soil was delineated as a 1,210-foot by 38-foot rectangle extending 1.5 feet in depth from the ground surface, based on the February 1998 field-screening survey.

- The radioactive material was assumed to have been placed at least 15 years ago, based on the known site history.
- Simulations were performed for 1,000 years, based on the NRC requirements.
- The amount of precipitation percolating into the ground was set at 4 inches per year, based on groundwater modeling studies in the area.
- Surface water was not assumed to leave the site as run-off, based on the site topography and field observations.
- No significant level of erosion was assumed to occur at the site, based on the site topography and field observations.
- The following three thorium isotopes were included in the analysis: thorium-228, thorium-230, and thorium-232, based on the known site source.

As part of the refined analysis, the entire grid area was modeled in RESRAD with the initial thorium isotope concentrations based on the average of the November 1999 samples (see Table 1). The sampling event in June specifically targeted locations with the highest activity; thus, simulations performed using those thorium concentrations are extremely conservatively biased because they assume the high activity counts are uniformly present across the site. Alternately, the November 1999 sampling event was designed to develop a data set characteristic of the total site. Therefore, simulations performed with the initial thorium concentrations based on the average November 1999 sampling results provide the most accurate representation of the total site dose exposure.

Model Results

To account for various assumptions about the potential future use of the site, several alternatives were evaluated using the RESRAD model. The assumptions can be divided into three categories: site zoning, soil cover thickness, and site vegetation. Two alternatives are presented for each category of assumption.

Site Zoning

The alternatives considered for the site zoning are based on the assumption that the site could be used in the future either for industrial or residential use. The model input data

that vary between the alternatives are the length and type of daily exposure. If the site is maintained as an industrial facility, the potential daily exposure for any single person can be limited to eight hours of outdoor exposure. If the site is rezoned as residential, the daily exposure for a single person will be increased to twelve hours of indoor exposure and six hours of outdoor exposure. The additional indoor exposure will affect guidance concentrations because radon, which is a decay product of thorium-230 and thorium-232, will accumulate in a building and cause additional long-term exposure to radiation. In the outdoor case, the wind will mix the radon with the surrounding clean air and result in lower levels of exposure.

Soil Cover

The presence of non-impacted cover soil will reduce exposure to direct radiation and also reduce exposure along inhalation and soil ingestion pathways. Two cases were assessed in the analysis—no cover and 6 inches of cover. In general, impacts at the site are present at the surface or within the first 6 inches of the soil column.

Site Vegetation

One of the exposure pathways evaluated by RESRAD is the ingestion of plants growing in the area of contamination. The first alternative included plant ingestion by humans as an exposure pathway. However, because it is unlikely the site will be zoned for agricultural use, plant ingestion is probably not a relevant pathway. Therefore, a second alternative was modeled in which plant ingestion was excluded from the simulation.

Results Summary

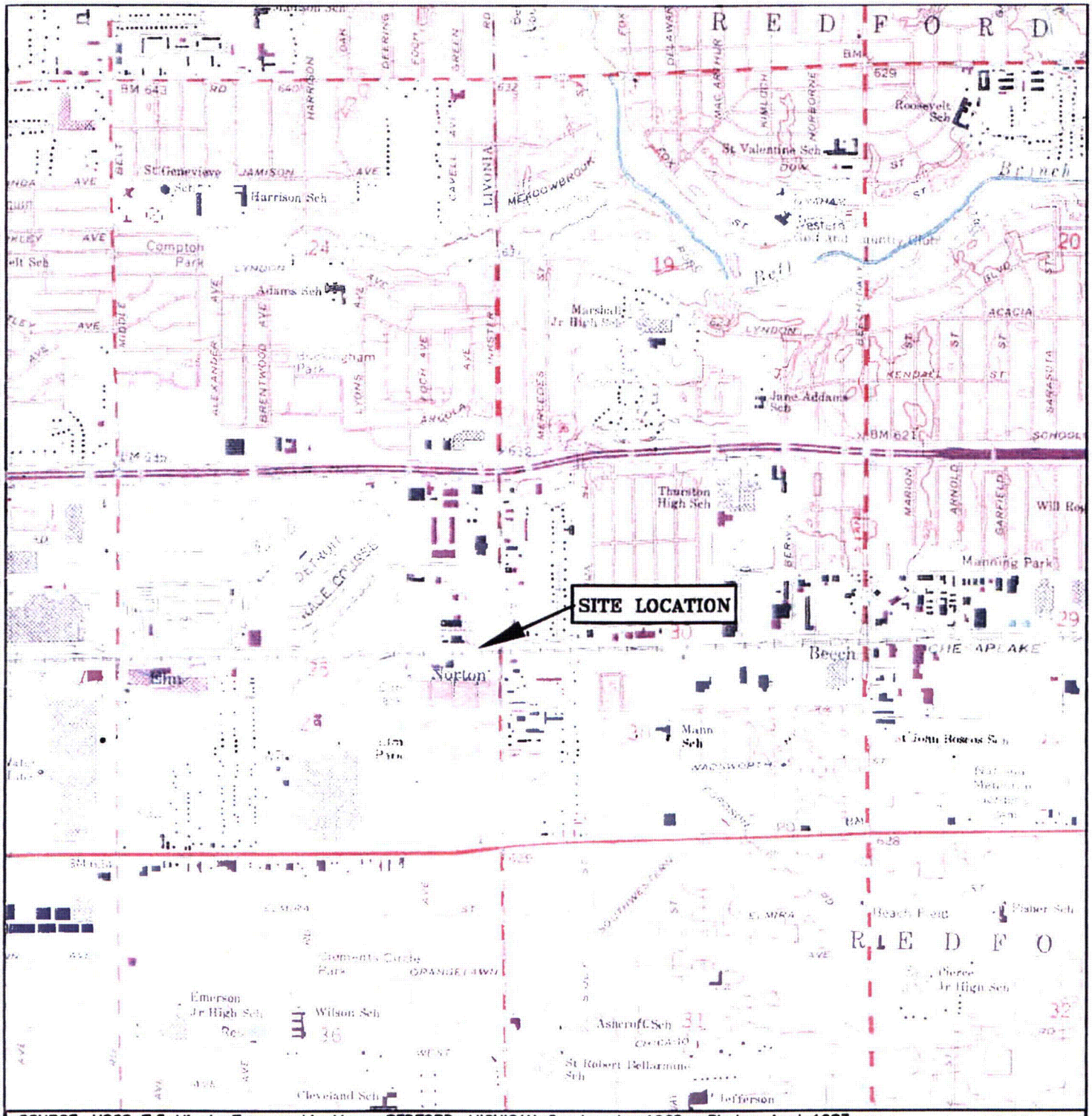
Table 2 summarizes the guideline concentrations for each thorium isotope calculated by the RESRAD model for each alternative considered in the analysis. As can be seen by comparing the average site concentration with the calculated guideline concentrations, the average site concentrations do not exceed any guideline concentrations under site use scenario.

In addition, ARCADIS Geraghty & Miller has included graphical representations of the total site dose exposures calculated during the model simulations. Figures 7 through 14 present the simulated dose exposure rates over 1,000 years using the averages of the November 1999 data set as the initial thorium concentrations. As is

shown in Figures 7 through 14, the total site dose exposure rates do not approach 25 mrem/yr for any future site use alternative.

Conclusions

The modeling results demonstrate that neither remedial measures nor restrictions in site usage are required at this site. The total site dose exposure does not exceed the NRC acceptable exposure criteria of 25 mrem/yr.

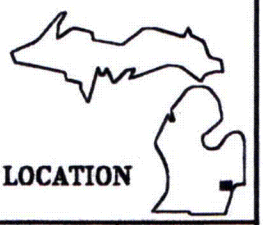


SOURCE: USGS 7.5 Minute Topographic Maps, REDFORD, MICHIGAN Quadrangle, 1968. Photorevised 1983.
USGS 7.5 Minute Topographic Maps, INKSTER, MICHIGAN Quadrangle, 1968. Photorevised 1983.

N

0 1000 2000 4000

SCALE IN FEET

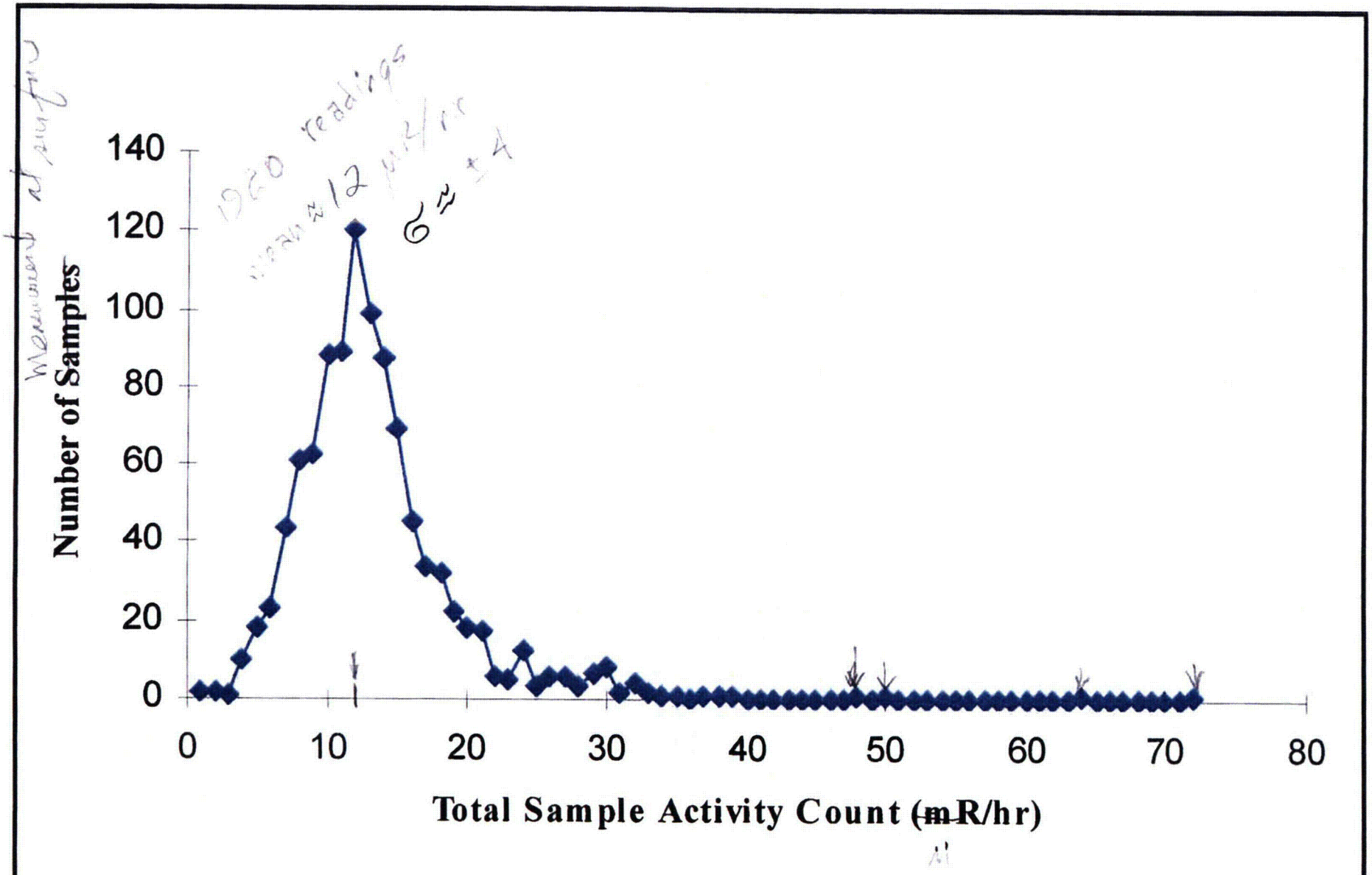


SITE LOCATION

ARCADIS GERAGHTY&MILLER

SITE LOCATION MAP
CSX TRANSPORTATION
CSXT 9717003; ENV0003955PJKK
INKSTER ROAD SITE
LIVONIA, MICHIGAN

DATE	PROJECT MANAGER	DRAWING NAME
3/24/03	K. PANEZAK	TOPO
DRAWN	LEAD DESIGN PROF.	CHECKED
S. JONES		S. JONES
PROJECT NUMBER		FIGURE NUMBER
MI000703.003.00001		1



ARCADIS GERAGHTY & MILLER 41511 ELEVEN MILE ROAD NOVI, MICHIGAN 48375 TEL: 248/305-9400 FAX: 248/305-9401	DISTRIBUTION OF FEBRUARY 1998 FIELD-SCREENING MEASUREMENTS CSX TRANSPORTATION CSXT 9717003; ENV993955PJKK INKSTER ROAD SITE LIVONIA, MICHIGAN	DATE 30MAY00 | PROJECT MANAGER K. PANCZAK | DRAWING NAME GRAPH DRAWN S. JENC | LEAD DESIGN PROF. | CHECKED K. PANCZAK PROJECT NUMBER MI000703.0003.00001 | FIGURE NUMBER 5

Figure 7. Dose Versus Time Using Average Isotopic Concentrations of November Samples as Initial Conditions, All Pathways Considered, and Assumed Residential Use With No Soil Cover.

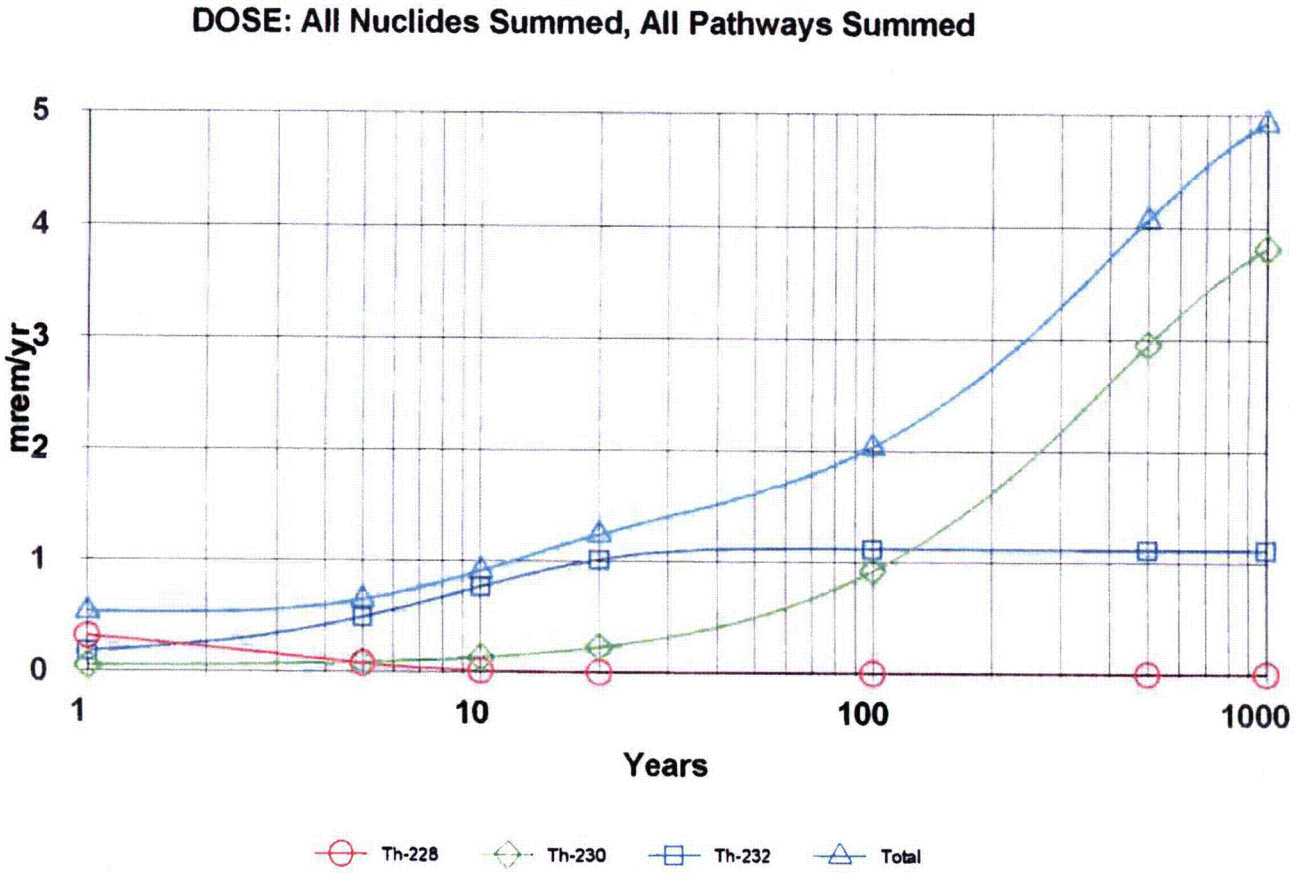


Figure 8. Dose Versus Time Using Average Isotopic Concentrations of November Samples as Initial Conditions, All Pathways Considered, and Assumed Residential Use With 6-inch Soil Cover.

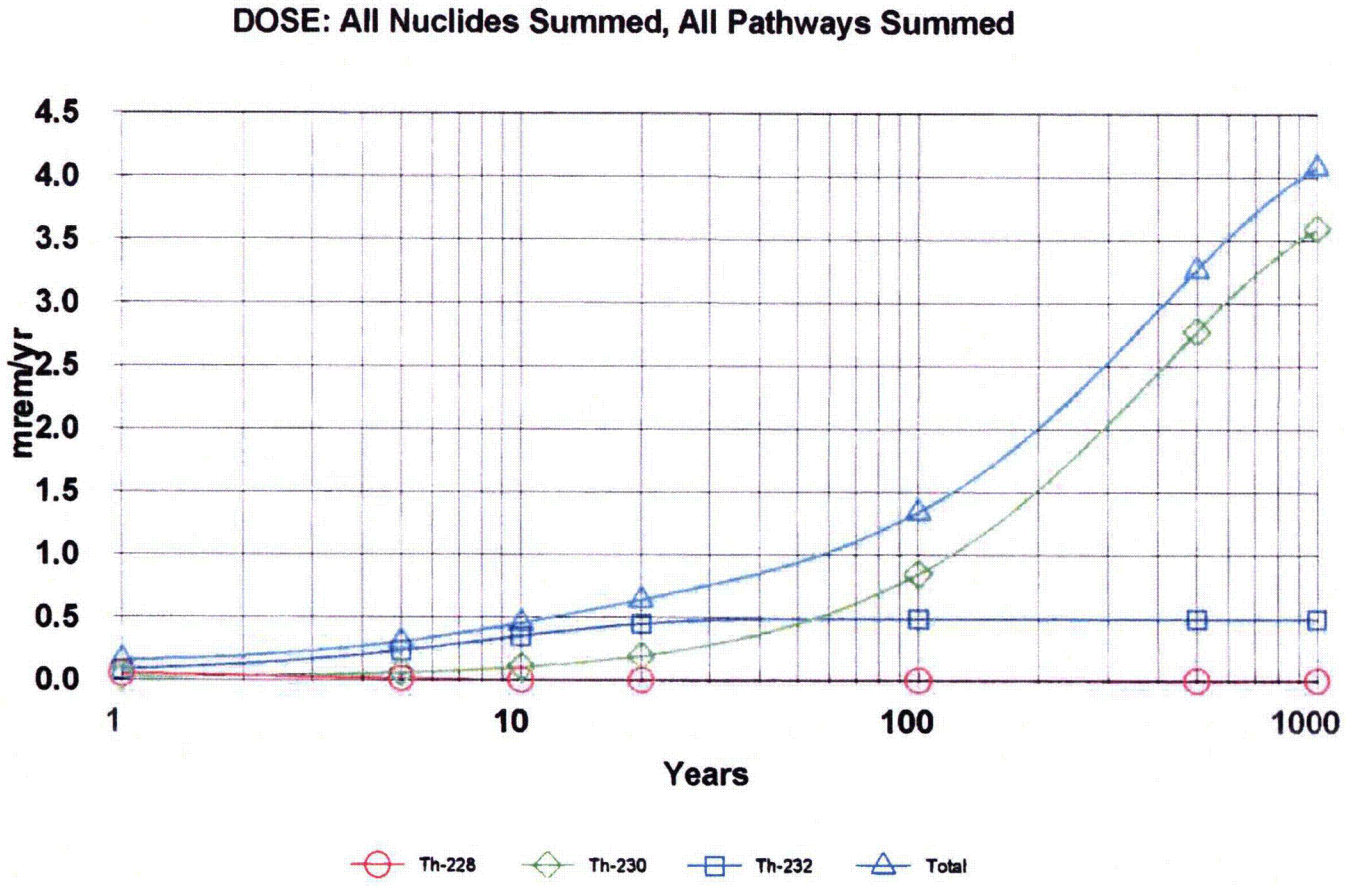


Figure 9. Dose Versus Time Using Average Isotopic Concentrations of November Samples as Initial Conditions, No Plant Ingestion, and Assumed Residential Use With No Soil Cover.

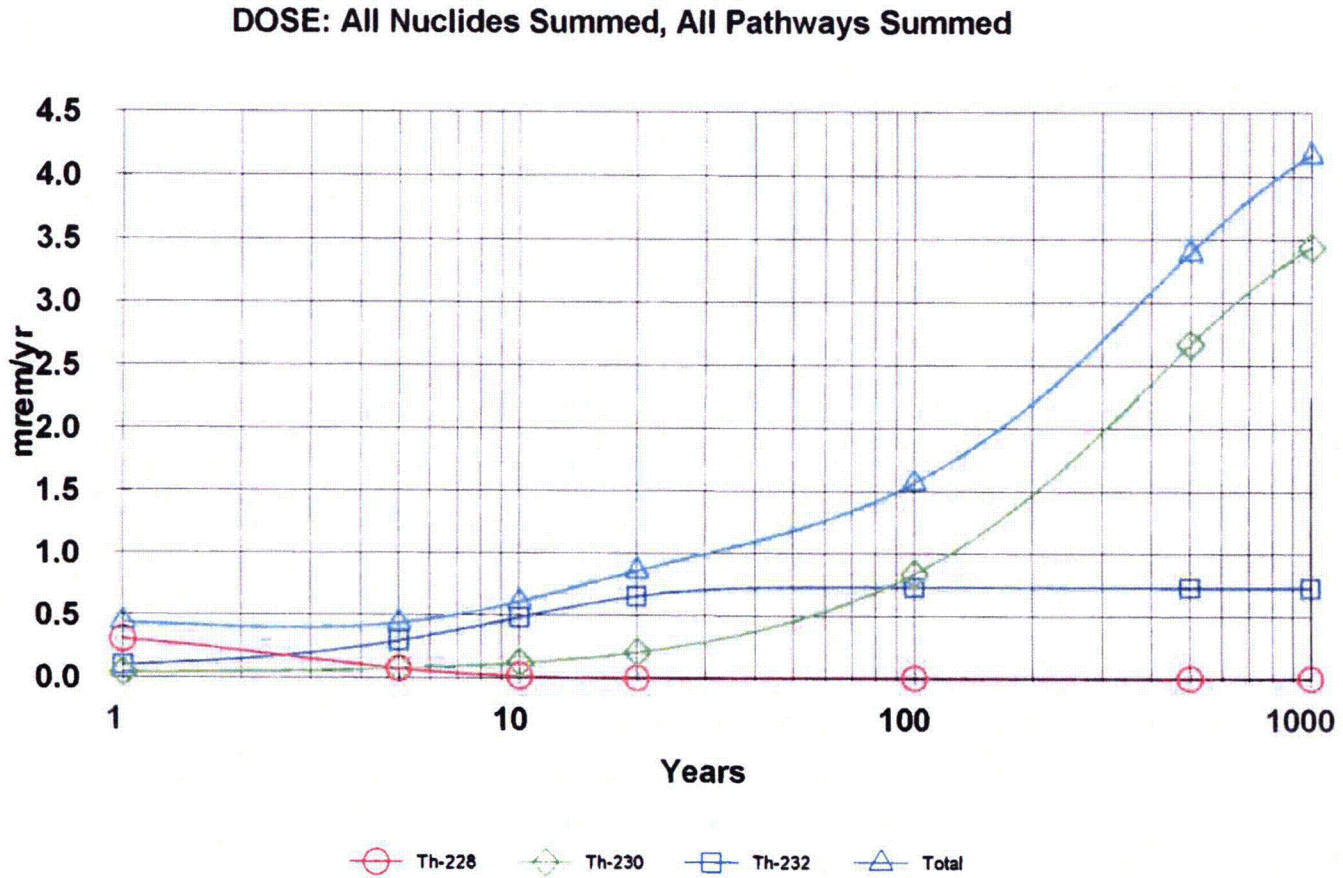


Figure 10. Dose Versus Time Using Average Isotopic Concentrations of November Samples as Initial Conditions, No Plant Ingestion, and Assumed Residential Use With 6-inch Soil Cover.

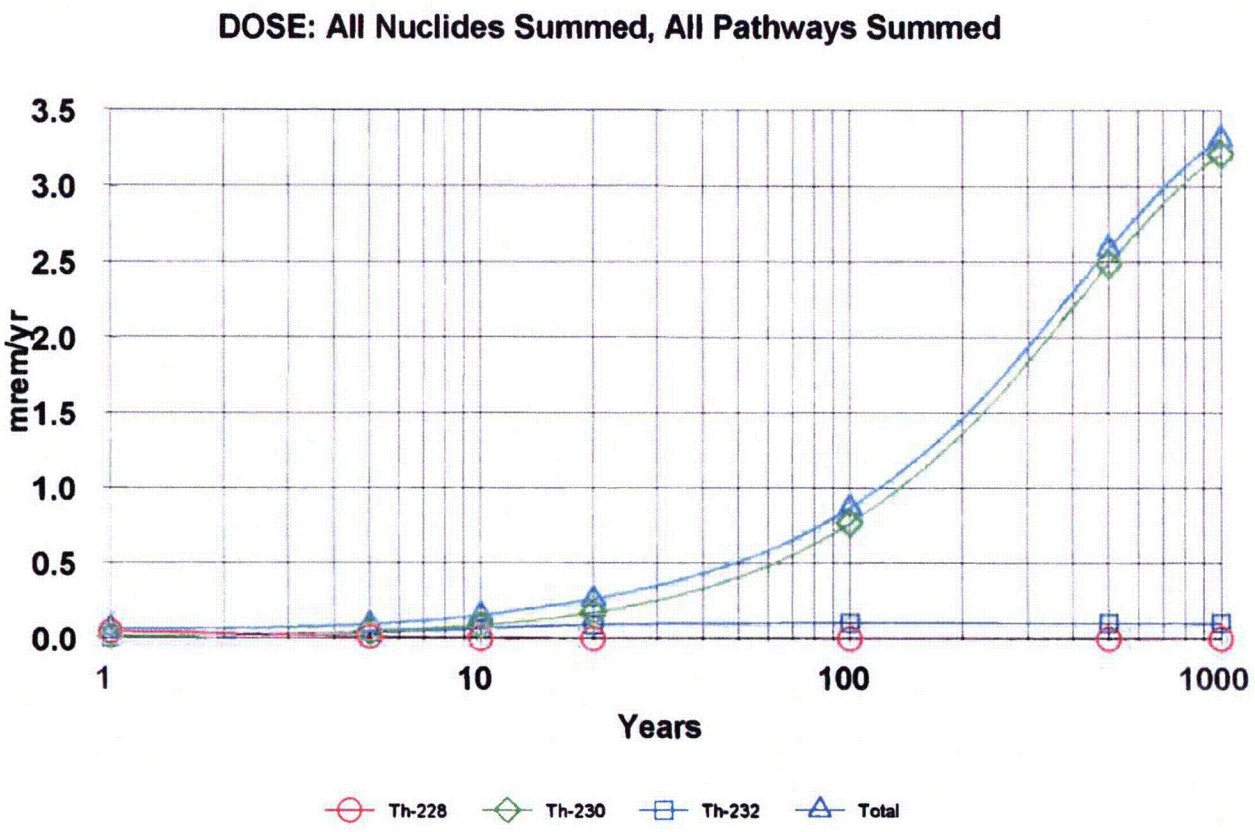


Figure 11. Dose Versus Time Using Average Isotopic Concentrations of November Samples As Initial Conditions, All Pathways Considered, and Assumed Industrial Use With No Soil Cover.

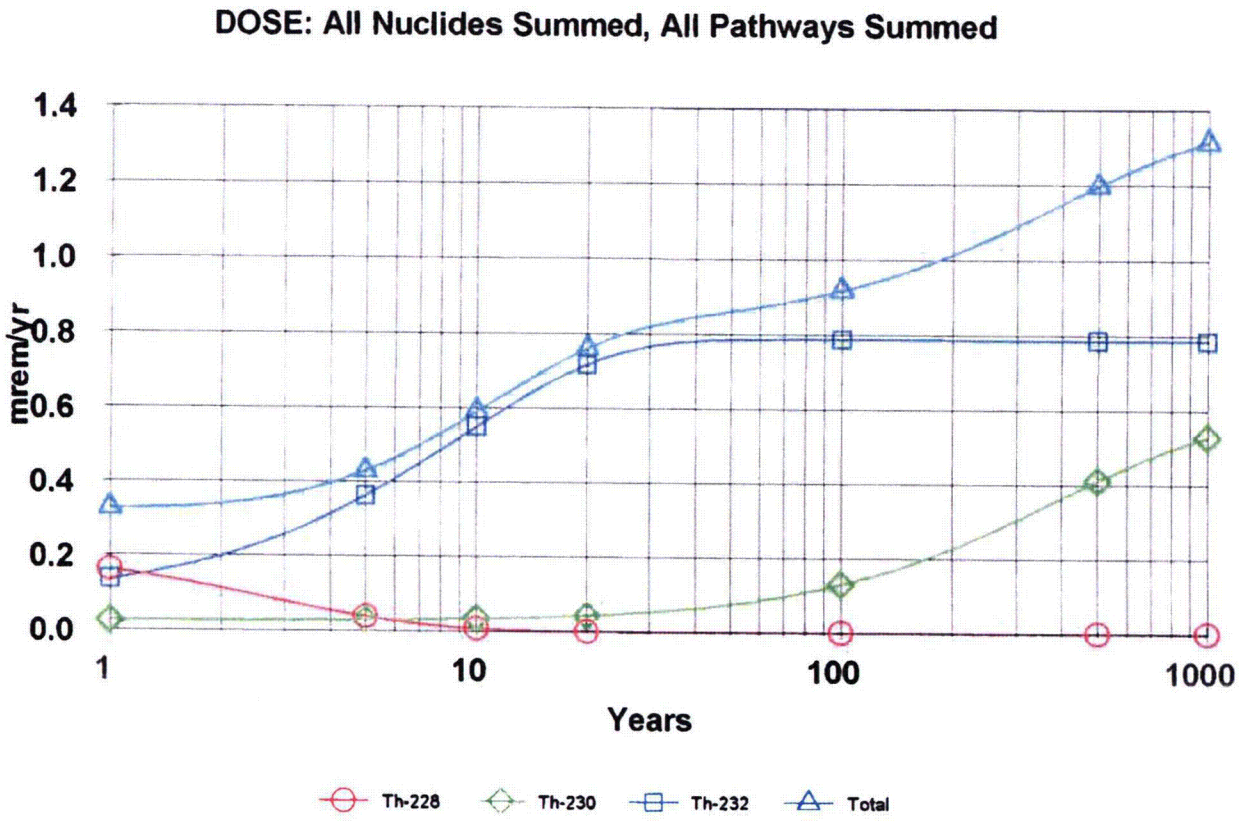


Figure 12. Dose Versus Time Using Average Isotopic Concentrations of November Samples as Initial Conditions, All Pathways Considered, and Assumed Industrial Use With 6-inch Soil Cover.

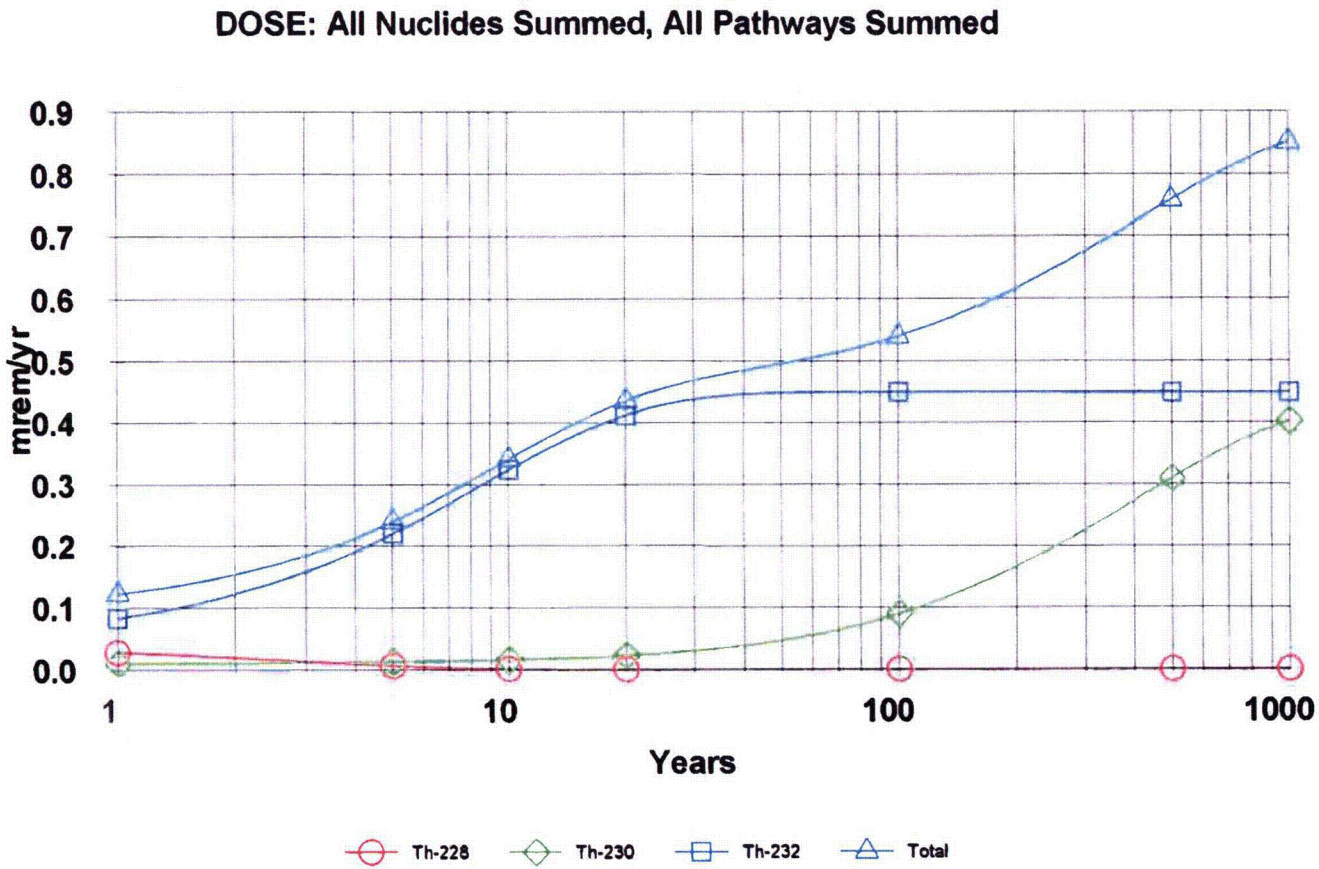


Figure 13. Dose Versus Time Using Average Isotopic Concentrations of November Samples as Initial Conditions, No Plant Ingestion, and Assumed Industrial Use With No Soil Cover.

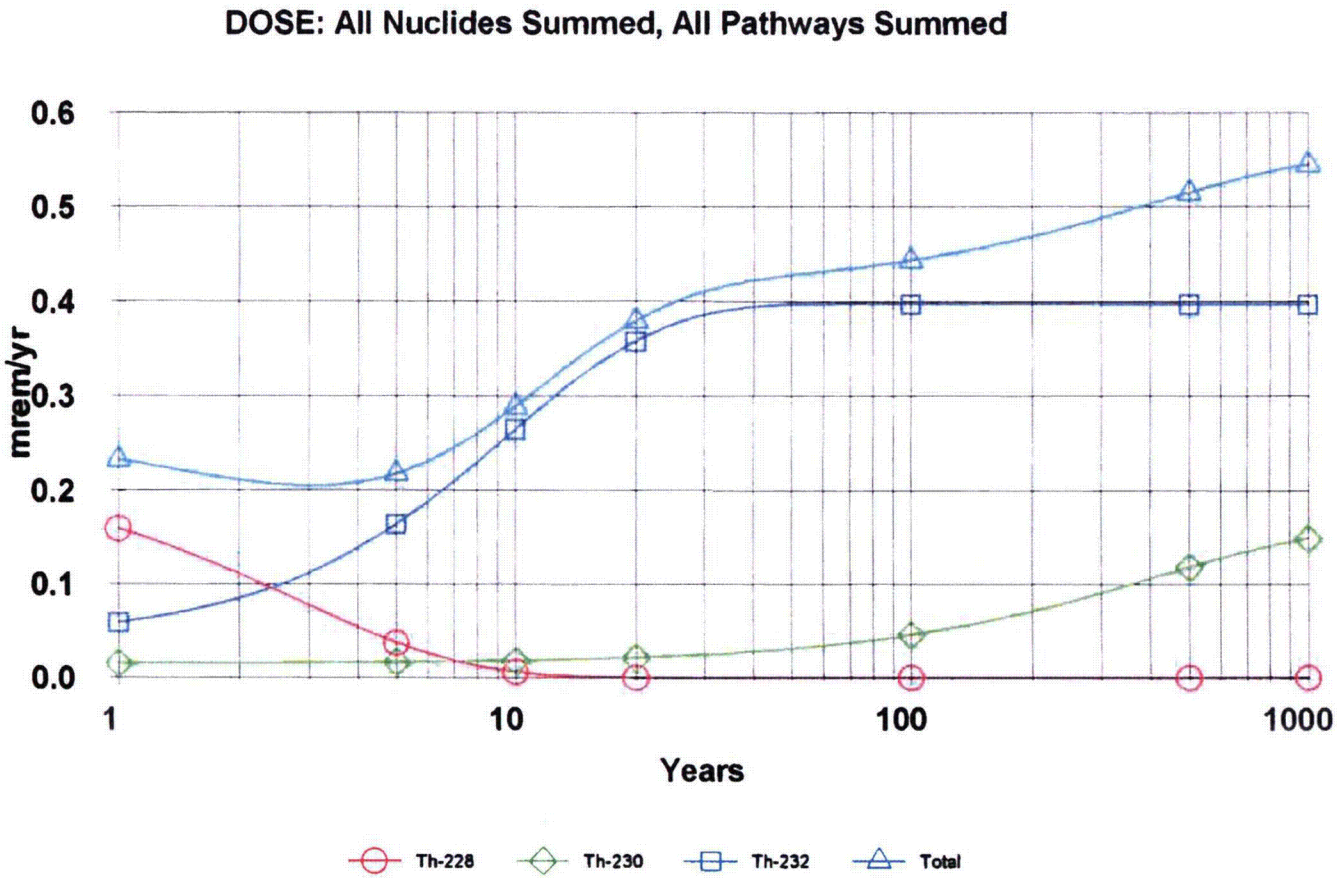
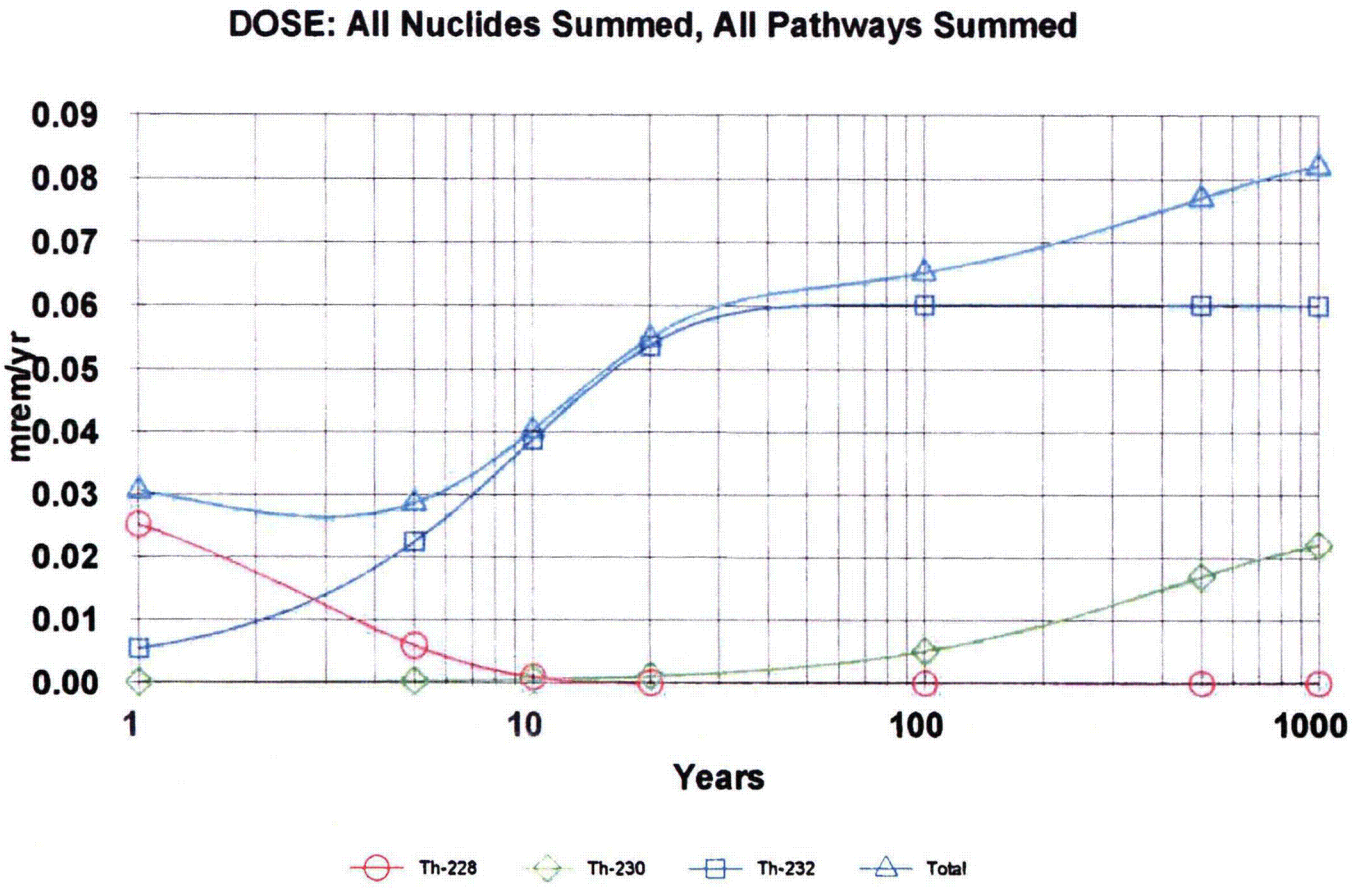


Figure 14. Dose Versus Time Using Average Isotopic Concentrations of November Samples as Initial Conditions, No Plant Ingestion, and Assumed Industrial Use With 6-inch Soil Cover.



October 27, 2000

Mr. Paul J. Kurzanski
Director Environmental Remediation
CSX Transportation
500 Water St. - J275
Jacksonville, FL 32202-4423

Dear Mr. Kurzanski:

This is in response to your letter dated September 13, 2000, which enclosed a RESRAD Modeling Report (the Report) for the CSX Transportation site in Livonia, Michigan, prepared by ARCADIS Geraghty & Miller (ARCADIS). You requested NRC to confirm in writing that this site meets the dose exposure standard of 25 millirem per year, and to make a final closure determination for the site.

We have reviewed the Report and have found that further information or clarification is needed on several items, as discussed below. Pending resolution of these issues, NRC cannot make a final closure determination, as you and we both desire.

Background

We believe this site can be described as generally free of residual radioactive contamination, with a few small areas of low-level contamination by radioactive thorium. The Report seems to confirm this; hundreds of direct radiation readings, taken on a tight (approximately 5 foot) grid pattern, disclose no sizeable areas of elevated direct radiation readings.

Therefore, the evaluation of potential dose consequences depends on accurately determining the amount of residual radioactivity actually contained in the few small areas of contamination.

Issues

Survey Technique

The Report does not make clear whether a 100% scan survey was done. We understood from a 1999 telephone exchange (when ARCADIS contacted NRC to inquire about expanding the soil sampling to make it more "representative"), that such a scan survey had been performed. This is important to developing confidence that all areas of contamination were found.

Please confirm whether the grid-based direct radiation readings were in addition to a 100% scan survey, or whether they constitute the only direct readings taken. If they constitute the only direct radiation readings, some further assessment of the potential number and size of undetected contaminated areas will be needed, to provide some upper bound as an input to potential dose implications.

Survey Results

The Report identified the survey instrument as a Victoreen Model 190 meter fitted with a GM probe, Model RP-1. There are three issues here, as follows.

(1) Our experience has been that GM probes are not optimum for field surveying to detect small radiation variations above background - they usually cannot discern variations from background smaller than about 10 microRoentgens per hour (μR/h). Concentrations of thorium in soil generating 10 μR/h above background may exceed the dose release criterion of 25 mrem/yr. **Please confirm the identity and performance capability of the instrument(s) used.**

(2) The data displayed in Figure 5 of the Report appears as expected for a large number of "background" readings (i.e. all basically the same reading), in that a normal distribution occurs about a mean. The apparent mean, however, is about 12-13 μR/h, which is above the "background" we would expect (6-9 μR/h) in the area of this site. This suggests the readings may be only instrument "noise," or there may be some bias or systematic error in reading the output. **Please address the validity of the apparent "background" readings displayed in Figure 5.**

(3) In the few areas where elevated direct radiation readings were detected, the readings were similar (within a factor of two or three), but the soil analyses from the same areas varied by more than a factor of twenty. This suggests the soil may not represent the source of the direct reading, perhaps because the "hot spot" was missed in sampling, or the contamination is sub-surface. **Please address the inconsistency between direct readings and associated soil analyses.**

Dose Assessment

The NRC criteria for release of properties for unrestricted use are based on potential radiation exposure above background from residual radioactive materials. The RESRAD runs provided in the Report are apparently based entirely on ten soil samples collected at random across the site. Thus, these RESRAD runs appear to establish potential exposures due to uncontaminated soil (background), not due to residual contamination above background. Soil samples from the elevated areas should also be included in the dose evaluation, especially if they are considered representative of the actual contamination [see item (3) above].

NRC must base a closure determination on assessment of the radiation exposure consequences above background. **Please address how information about residual contamination above background affects future potential dose at this site.**

The above items were discussed with Mr. Gary Blinckiewicz of ARCADIS on October 20, 2000. As also discussed, we are providing a copy of this letter to Mr. Blinckiewicz.

At our discretion, NRC may choose to perform independent confirmatory inspection and measurements at the site prior to a final closure determination.

The results of the analyses of all four samples from "elevated" areas of direct radiation readings show thorium concentrations below 116 pCi/g. This is the concentration equivalent to 0.05 percent by weight, defined as an "unimportant quantity" in NRC regulations, which any person may receive, possess, use, transfer or deliver without an NRC license. The Commission is currently considering a revision to the regulation (10 CFR 40.13) such that any person may also "dispose" of unimportant quantities of source material. Should this revision be approved, CSX Transportation would have the option in the future of removing the contaminated soil for routine disposal, rather than disposal to an NRC-licensed burial site.

Should you have any questions regarding this matter, you may contact me at (630) 829-9615.

Sincerely,

/RA by W. Snell acting for/

Bruce L. Jorgensen, Chief
Decommissioning Branch

cc: G. Blinckiewicz, ARCADIS Geraghty & Miller

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OFFICE	RIII		RIII					
NAME	Lee:js		Jorgensen					
DATE	10/27/00		10/27/00					

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CORE LABORATORIES

ANALYTICAL REPORT

JOB NUMBER: 995005

Prepared For:

Arcadis Geraghty & Miller
41511 Eleven Mile Road
NOVI, MI 48375

Attention: Katie Panczak

Date: 06/30/99

Don Ukele
Signature

6/30/99
Date

Name: Don W. Ukele

Title: Project Manager

420 West First Street
Casper, WY 82601

PHONE: 307-235-5741
FAX..: 307-266-1676

CORE LABORATORIES

SAMPLE INFORMATION
Date: 06/30/99

Job Number.: 995005
Customer...: Arcadis Geraghty & Miller
Attn.....: Katie Panczak

Project Number.....: 98000013
Customer Project ID....: MI000703.0002.00001
Project Description....: general radiochemistry

Laboratory Sample ID	Customer Sample ID	Sample Matrix	Date Sampled	Time Sampled	Date Received	Time Received
995005-1	S-1	Soil	06/08/1999	08:20	06/09/1999	09:25
995005-2	S-2	Soil	06/08/1999	08:50	06/09/1999	09:25
995005-3	S-3	Soil	06/08/1999	09:30	06/09/1999	09:25
995005-4	S-4	Soil	06/08/1999	09:50	06/09/1999	09:25

CORE LABORATORIES

LABORATORY TEST RESULTS

Job Number: 995005 Date: 06/30/99

CUSTOMER: Arcadis Geraghty & Miller PROJECT: MI000703.0002.00001 ATTN: Katie Panczak

Customer Sample ID: S-1
Date Sampled.....: 06/08/1999
Time Sampled.....: 08:20
Sample Matrix.....: Soil

Laboratory Sample ID: 995005-1
Date Received.....: 06/09/1999
Time Received.....: 09:25

TEST METHOD	PARAMETER/TEST DESCRIPTION	SAMPLE RESULT	REPORTING LIMIT	UNITS	DATE	TECH
mod. HASL 300	Thorium-228, Activity, Solid	2.4		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-228, Error +/-, Solid	0.6		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-228, LLD, Solid	0.2		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-230, Activity, Solid	6.0		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-230, Error +/-, Solid	1.3		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-230, LLD, Solid	0.1		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-232, Activity, Solid	2.6		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-232, Error +/-, Solid	0.7		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-232, LLD, Solid	0.1		pCi/g	06/17/99	kah

CORE LABORATORIES

LABORATORY TEST RESULTS

Job Number: 995005 Date: 06/30/99

CUSTOMER: Arcadis Geraghty & Miller PROJECT: MI000703.0002.00001 ATTN: Katie Panczak

Customer Sample ID: S-2
Date Sampled.....: 06/08/1999
Time Sampled.....: 08:50
Sample Matrix.....: Soil

Laboratory Sample ID: 995005-2
Date Received.....: 06/09/1999
Time Received.....: 09:25

TEST METHOD	PARAMETER/TEST DESCRIPTION	SAMPLE RESULT	REPORTING LIMIT	UNITS	DATE	TECH
mod. HASL 300	Thorium-228, Activity, Solid	12.8		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-228, Error +/-, Solid	3.0		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-228, LLD, Solid	0.2		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-230, Activity, Solid	19.9		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-230, Error +/-, Solid	4.5		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-230, LLD, Solid	0.1		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-232, Activity, Solid	12.0		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-232, Error +/-, Solid	2.8		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-232, LLD, Solid	0.1		pCi/g	06/17/99	kah

CORE LABORATORIES

LABORATORY TEST RESULTS

Job Number: 995005 Date: 06/30/99

CUSTOMER: Arcadis Geraghty & Miller PROJECT: MI000703.0002.00001 ATTN: Katie Panczak

Customer Sample ID: S-3
Date Sampled.....: 06/08/1999
Time Sampled.....: 09:30
Sample Matrix.....: Soil

Laboratory Sample ID: 995005-3
Date Received.....: 06/09/1999
Time Received.....: 09:25

TEST METHOD	PARAMETER/TEST DESCRIPTION	SAMPLE RESULT	REPORTING LIMIT	UNITS	DATE	TECH
mod. HASL 300	Thorium-228, Activity, Solid	0.5		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-228, Error +/-, Solid	0.3		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-228, LLD, Solid	0.1		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-230, Activity, Solid	1.2		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-230, Error +/-, Solid	0.4		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-230, LLD, Solid	0.1		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-232, Activity, Solid	0.2		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-232, Error +/-, Solid	0.2		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-232, LLD, Solid	0.1		pCi/g	06/17/99	kah

CORE LABORATORIES

LABORATORY TEST RESULTS

Job Number: 995005 Date: 06/30/99

CUSTOMER: Arcadis Geraghty & Miller PROJECT: MI000703.0002.00001 ATTN: Katie Panczak

Customer Sample ID: S-4
Date Sampled.....: 06/08/1999
Time Sampled.....: 09:50
Sample Matrix.....: Soil

Laboratory Sample ID: 995005-4
Date Received.....: 06/09/1999
Time Received.....: 09:25

TEST METHOD	PARAMETER/TEST DESCRIPTION	SAMPLE RESULT	REPORTING LIMIT	UNITS	DATE	TECH
mod. HASL 300	Thorium-228, Activity, Solid	21.8		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-228, Error +/-, Solid	6.6		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-228, LLD, Solid	0.3		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-230, Activity, Solid	45.2		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-230, Error +/-, Solid	13.3		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-230, LLD, Solid	0.2		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-232, Activity, Solid	22.8		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-232, Error +/-, Solid	6.8		pCi/g	06/17/99	kah
mod. HASL 300	Thorium-232, LLD, Solid	0.2		pCi/g	06/17/99	kah

CORE LABORATORIES

QUALITY CONTROL RESULTS

Job Number.: 995005 Report Date.: 06/30/99

CUSTOMER: Arcadis Geraghty & Miller PROJECT: general radiochemistry ATTN: Katie Panczak

Test Method.....: mod. HASL 300 Batch.....: 13439 Analyst...: kah
Method Description.: Isotopic Thorium Units.....: pCi/L
Parameter.....: Thorium-228, Activity

QC	Lab ID	Reagent	QC Result	QC Result	True Value	Orig. Value	Calc. Result	*	Limits	Date	Time
MD	995005-1		2.1			2.4	13.3	R	20	06/17/1999	1150
MB		MBAT0614	ND							06/17/1999	1150

Test Method.....: mod. HASL 300 Batch.....: 13439 Analyst...: kah
Method Description.: Isotopic Thorium Units.....: pCi/L
Parameter.....: Thorium-230, Activity

QC	Lab ID	Reagent	QC Result	QC Result	True Value	Orig. Value	Calc. Result	*	Limits	Date	Time
MD	995005-1		5.5			6.0	8.7	R	20	06/17/1999	1150
MS	995005-2	995005MSTH	24.4		3.9	19.9	115.4	%	70-125	06/17/1999	1150
LCS		LAT061499	4.6		3.9		117.9	%	70-125	06/17/1999	1150
MB		MBAT0614	0.2							06/17/1999	1150

Test Method.....: mod. HASL 300 Batch.....: 13439 Analyst...: kah
Method Description.: Isotopic Thorium Units.....: pCi/L
Parameter.....: Thorium-232, Activity

QC	Lab ID	Reagent	QC Result	QC Result	True Value	Orig. Value	Calc. Result	*	Limits	Date	Time
MB		MBAT0614	ND							06/17/1999	1150
MD	995005-1		2.1			2.6	21.3	R	20	06/17/1999	1150

* %=% REC, R=RPD, A=ABS Diff., D=% Diff.

CORE LABORATORIES

QUALITY CONTROL FOOTER

METHOD REFERENCES

(1) EPA 600/4-79-020, Methods for Chemical Analysis of Water and Wastes, March 1983
(2) EPA SW-846, Test Methods for Evaluating Solid Waste, Third Edition, (9/86), Update I (7/92), Update II (9/94), Update IIA (8/93), Update IIB (1/95), Update III (6/97)
(3) Standard Methods for the Examination of Water and Wastewater, 18th, 1992
(4) EPA 600/4-80-032, Prescribed Procedures for Measurement of Radioactivity in Drinking Water, August 1980
(5) Federal Register, Friday, October 26, 1984 (40 CFR Part 136)
(6) EPA 600/8-78-017, Microbiological Methods for Monitoring the Environment, December 1978

COMMENTS

(1) The data in the Laboratory Test Results Report may differ from the data in the QC Report due to calculations for sample preparation and/or dilutions.
(2) The "Time Analyzed" in the QC Report may not reflect the actual time of each analysis. The "Date Analyzed" is the actual date of analysis.
(3) Soil and sludge samples are reported on a wet basis or on an "as received" basis unless otherwise indicated.
(4) The data in this report are within the limits of uncertainty specified in the referenced method unless otherwise indicated.
(5) Analyses performed by a subcontract laboratory are indicated with an asterisk and associated code in the "Technician" data field.

Subcontract Laboratories	Code	Subcontract Laboratories	Code
Core Laboratories - Anaheim, CA	AN	Core Laboratories - Houston, TX (Pet)	HP
Core Laboratories - Aurora, CO	AU	Core Laboratories - Houston, TX (Env)	HR
Core Laboratories - Casper, WY	CA	Core Laboratories - Indianapolis, IN	IN
Core Laboratories - Corpus Christi, TX	CC	Core Laboratories - Lake Charles, LA	LC
Core Laboratories - Carson, CA	CR	Core Laboratories - Valparaiso, IN	VP
Core Laboratories - Edison, NJ	ED	Other Subcontract Laboratories	XX

DEFINITIONS

(1) NC = Not Calculable due to values lower than the reporting limit.
(2) ND = Not Detected above the reporting limit.

QC SAMPLE IDENTIFICATIONS

BLANKS

MB = Method Blank (also referred to as a preparation blank)
RB = Reagent Blank
IB = Instrument Blank
ICB = Initial Calibration Blank
CCB = Continuing Calibration Blank
HB = Holding Blank (also referred to as a storage blank)

DUPLICATES

MSD = Matrix Spike Duplicate
MD = Method Duplicate

SPIKES

MS = Matrix Spike
MSD = Matrix Spike Duplicate
PDS = Post Digestion Spike
BS = Blank Spike (also referred to as a method spike)
SS = Surrogate Spike

REFERENCE STANDARDS

CS = Calibration Standard
RS = Reference Standard (also referred to as an external reference standard)
ICV = Initial Calibration Verification
CCV = Continuing Calibration Verification
LCS = Laboratory Control Sample

420 West First Street
Casper, WY 82601
(307) 235-5741

CORE LABORATORIES, INC.

Anaheim, CA
1250 E. Gene Autry Way
Anaheim, CA 92805
(714) 937-1094 Fax (714) 937-1170

Aurora, CO
10703 E. Bethany Drive
Aurora, CO 80014
(303) 751-1780 Fax (303) 751-1784

Carson, CA
21730 S. Wilmington Ave. - Suite 201
Carson, CA 90810-1640
(310) 513-2031 Fax (310) 513-2035

Casper, WY
420 W. First Street
Casper, WY 82601
(307) 235-5741 Fax (307) 266-1676

Corpus Christi, TX
1733 N. Padre Island Drive
Corpus Christi, TX 78408
(512) 289-2673 Fax (512) 289-2471

Edison, NJ
284 Raritan Center Parkway
Edison, NJ 08837
(732) 225-6700 Fax (732) 225-6777

Houston, TX (Env)
6310 Rothway Drive
Houston, TX 77040
(713) 690-4444 Fax (713) 690-5646

Houston, TX (Pet)
8210 Mosley Road
Houston, TX 77075
(713) 943-9776 Fax (713) 943-3846

Indianapolis, IN
7726 Moller Road
Indianapolis, IN 46268
(317) 875-5894 Fax (317) 872-6189

Lake Charles, LA
3645 Beglis Parkway
Sulphur, LA 70663
(318) 583-4926 Fax (318) 583-4929

Valparaiso, IN
2400 Cumberland Drive
Valparaiso, IN 46383
(219) 464-2389 Fax (219) 462-2953

Sample Receipt Acknowledgment

Date 06/09/99

Report To:
Arcadis Geraghty & Miller
41511 Eleven Mile Road

NOVI, MI 48375
Katie Panczak

Invoice To:
Arcadis Geraghty & Miller
41511 Eleven Mile Road

NOVI, MI 48375
Katie Panczak

Core Laboratories Job Number	Customer Project ID	
995005	MI000703.0002.00001	07/07/99
Sample No.	**Customer ID**	**Remarks**
1	S-1	
2	S-2	
3	S-3	
4	S-4	

THIS IS NOT AN INVOICE

Order subject to our sales agreement, if any.

Otherwise subject to our current terms of sale as shown on reverse side.

Please contact laboratory immediately, if any discrepancies are observed.

White - Customer Blue - Job File

rpjsmps J o B S a m p l e I n f o V1
06/09/99

Job Number.....: 995005 Location.: 57210 Customer Job ID.....: MI000703.0002.00001 Job Receive Date.: 06/09/99
Project Number.: 98000013 Project Description.: general radiochemistry Project Manager..: dwu
Customer.....: Arcadis Geraghty & Miller Contact.: Katie Panczak

Sample Number.: 1 Customer Sample ID.: S-1

Date Received.: 06/09/99 Time Received.: 09:25 Sample Date.: 06/08/99 Sample Time.: 08:20
Sample Matrix.: SOIL
Containers Received.....:
Comments.....:
Radioactivity Class.....:

Bottle #	Type of Bottle	Preserv.	F	Condition	Volume	Bin #
43727	8oz Glass Bottle	NONE	N			PREP

Sample Number.: 2 Customer Sample ID.: S-2

Date Received.: 06/09/99 Time Received.: 09:25 Sample Date.: 06/08/99 Sample Time.: 08:50
Sample Matrix.: SOIL
Containers Received.....:
Comments.....:
Radioactivity Class.....:

Bottle #	Type of Bottle	Preserv.	F	Condition	Volume	Bin #
43728	8oz Glass Bottle	NONE	N			PREP

Sample Number.: 3 Customer Sample ID.: S-3

Date Received.: 06/09/99 Time Received.: 09:25 Sample Date.: 06/08/99 Sample Time.: 09:30
Sample Matrix.: SOIL
Containers Received.....:
Comments.....:
Radioactivity Class.....:

Bottle #	Type of Bottle	Preserv.	F	Condition	Volume	Bin #
43729	8oz Glass Bottle	NONE	N			PREP

Sample Number.: 4 Customer Sample ID.: S-4

Date Received.: 06/09/99 Time Received.: 09:25 Sample Date.: 06/08/99 Sample Time.: 09:50
Sample Matrix.: SOIL
Containers Received.....:
Comments.....:
Radioactivity Class.....:

Bottle #	Type of Bottle	Preserv.	F	Condition	Volume	Bin #
43730	8oz Glass Bottle	NONE	N			PREP

rpjsdst | Job Test Distribution 06/09/99 | V2

Job Number.....: 995005 Location.: 57210 Customer Job ID.....: MI000703.0002.00001 Job Receive Date.: 06/09/99
Project Number.: 98000013 Project Description.: general radiochemistry Project Manager..: dwu
Customer.....: Arcadis Geraghty & Miller Contact.: Katie Panczak

Method	Method Description / Tests	Test Description	Sample Distribution Mtx	Test Limits	Test Units	Test TAT
ISOTH	Isotopic Thorium		1-4			
	TH232	Thorium-232, Activity	S	0.1	pCi/g	28 DAYS
	TH230	Thorium-230, Activity	S	0.1	pCi/g	28 DAYS
	TH232E	Thorium-232, Error +/-	S	0.1	pCi/g	28 DAYS
	TH232L	Thorium-232, LLD	S	0.1	pCi/g	28 DAYS
	TH230E	Thorium-230, Error +/-	S	0.1	pCi/g	28 DAYS
	TH230L	Thorium-230, LLD	S	0.1	pCi/g	28 DAYS
	TH228	Thorium-228, Activity	S	0.1	pCi/g	28 DAYS
	TH228E	Thorium-228, Error +/-	S	0.1	pCi/g	28 DAYS
	TH228L	Thorium-228, LLD	S	0.1	pCi/g	28 DAYS

ARCADIS GERAGHTY & MILLER

Laboratory Task Order No./P.O. No. _____

CHAIN-OF-CUSTODY RECORD

Page 1 of 1

Project Number/Name MI000703.0002.00001 / CSXT INCSTER

Project Location LIVONIA, MI

Laboratory CORE LABS

Project Manager KATIE PANCZAK

Sampler(s)/Affiliation K. WILSON / AG+M

Sample ID/Location	Matrix	Date/Time Sampled	Lab ID	ANALYSIS / METHOD / SIZE: Isotopic Thorium 8oz Glass						Remarks	Total
S-1	S	6/8/99 08:20		1							1
S-2	S	" 08:50		1							1
S-3	S	" 09:30		1							1
S-4	S	" 09:50		1							1
		* STANDARD TURNAROUND *									
										CSXT 9717003	
										ENV 991361PJKK	

Sample Matrix: L = Liquid; S = Solid; A = Air

Total No. of Bottles/ Containers: 4

					Seal Intact?
Relinquished by: Ken Rittle	Organization: ARCADIS Geraghty+Miller	Date 06/08/99	Time 17:30		
Received by: Michelle Pinsler	Organization: CORE LABS	Date 06/09/99	Time 0925		Yes No N/A
Relinquished by: _____	Organization: _____	Date / /	Time _____		Seal Intact?
Received by: _____	Organization: _____	Date / /	Time _____		Yes No N/A

Special Instructions/Remarks: # 1 COOLER SAMPLES ON ICE

* RESULTS TO: KATIE PANCZAK, ARCADIS Geraghty+Miller, 41511 ELEVEN MILE RD, NOVI MI 48375

PH: (248) 305-9400

Delivery Method: ☐ In Person ☒ Common Carrier FED-EX # 812327902247 ☐ Lab Courier ☐ Other _____ SPECIFY

AG 05-0597

CORE LABORATORIES

Sample Receipt Checklist

Client	Areadis Geraghty Miller	Job Number	9915025

Samples Shipped	UPS	✓	Federal Express	Other:
Samples Hand Delivered	Client		Core Lab Courier	Other

air bill # 8123279 02247

	Yes	No	Comments
1. Chain-of-Custody present?	✓		
2. Custody seal on shipping container?	✓		
If yes, intact on shipping container?	✓		
3. Custody seals on sample container?		✓	
If yes, intact on sample containers?			
4. Samples chilled?	✓		Radium
Temperature of cooler: 4°C±2°C			
5. Samples received intact (good condition)?	✓		
If volatiles required , no headspace?			
6. Correct containers used?	✓		
7, Adequate sample volume provided?	✓		
8. Samples preserved correctly?	✓		
Circle bottle/preservative types checked.			(Plain) HNO_3 HCl H_2SO_4 NaOH Other
9. Samples received within holding time?	✓		
10. Agreement between COC and sample lablels?	✓		
11. Gamma Screen mR/Hr @ surface within Bkg?	✓		CBKG

Additional Comments: _____

Sample Container (Size/Material) 4-680Z

Received and inspected by NVP Date/Time 6/9/99, 0925

ARCADIS GERAGHTY & MILLER

Laboratory Task Order No./P.O. No. _____

CHAIN-OF-CUSTODY RECORD

Page 1 of 1

Project Number/Name MT000703.0002.00001 / CSXT INVSTFR

Project Location LIVONIA, MI

Laboratory CORE LABS

Project Manager KATIE PANCZAK

Sampler(s)/Affiliation K. WILSON / AGTM

Sample ID/Location	Matrix	Date/Time Sampled	Lab ID	ANALYSIS / METHOD / SIZE: Isotopic Thorium	8oz Glass						Remarks	Total
S-1	S	5/18/99 08:20		1								1
S-2	S	" 08:50		1								1
S-3	S	" 09:30		1								1
S-4	S	" 04:50		1								1
		* STANDARD TURNAROUND *										
											CSXT 9717003	
											ENV 991361PJKK	

Sample Matrix: L = Liquid; S = Solid; A = Air

Total No. of Bottles/ Containers: 4

Relinquished by: [signature]	Organization: ARCADIS Geraghty + Miller	Date 06/08/99	Time 17:30	Seal Intact?	
Received by: _____	Organization: _____	Date / /	Time _____	Yes	No N/A
Relinquished by: _____	Organization: _____	Date / /	Time _____	Seal Intact?	
Received by: _____	Organization: _____	Date / /	Time _____	Yes	No N/A

Special Instructions/Remarks: * 1 COOLER SAMPLES ON ICE

* RESULTS TO: KATIE PANCZAK, ARCADIS Geraghty + Miller, 41511 ELEVEN MILE RD, NOVI MI 48375

PH: (248) 305-9400

Delivery Method: ☐ In Person ☒ Common Carrier FED-EX (SPECIFY) ☐ Lab Courier ☐ Other _____ (SPECIFY)

AG 05-0597

Severn Trent Laboratories
628 Route 10
Whippany, NJ 07981

Tel: (973) 428-8181
Fax: (973) 428-5222

January 13, 2000

ARCADIS Geraghty & Miller, Inc.
Attn: Katie Panczak
41511 Eleven Mile Road
Novi, MI 48375

Dear Ms. Panczak:

Please find enclosed the radiological results of ten (10) solid samples. This report contains sections addressing the following information at a minimum:

* Case Narrative
* Sample Summary
* Analytical Results (Forms I through VII)
* Analytical Methodology and Chain-of-Custody
* Raw Data (Level III Only)

STL Project #	MI 703-3-1
STL Work Order #	00-94-470
Client Project ID	MI000703.00003.00001

Copies of this radiological report and supporting data are maintained in our files for a minimum of three years unless special arrangements have been made. Except where specifically indicated, all radiological testing was performed at this laboratory location and no portion of the testing was subcontracted.

We appreciate your selection of our services and welcome any questions or suggestions you may have relative to this report. Please contact Barbra Trulick at (973) 581-6460 for any additional information. Thank you for utilizing our services. We hope you will consider us for your future analytical needs.

Sincerely,

Erik Nielsen
Radiochemical Group Leader
STL-Whippany

EN/bjt

Severn Trent Laboratories
628 Route 10
Whippany, NJ 07981

Tel: (973) 428-8181
Fax: (973) 428-5222

REPORT TRANSMITTAL

JANUARY 13, 2000

ARCADIS GERAGHTY & MILLER, INC.

PROJECT: MI000703.0003.00001

PREPARED BY:

SEVERN TRENT LABORATORIES, INC. (STL)

(NJ CERTIFICATION NUMBER 14530)

STL JOB NO: 20990-94470

VOLUME I OF I

STL

628 Route 10
Whippany, NJ 07981
Phone (973) 428-8181
Fax (973) 428-5222

01/11/2000

Environmental Survey

Cover Page

Radiological Data Analysis Package

Project Number:	MI 703-3-1

Client Sample ID	Lab ID
E162	0094470-01
E132	0094470-02
E62	0094470-03
E122	0094470-04
E212	0094470-05
E46	0094470-06
E232	0094470-07
E82	0094470-08
E2	0094470-09
E32	0094470-10

Comments: _____

Release of the data contained in this package has been authorized by the laboratory manager or the manager's designee, as verified by the following signature.

_____ 1/11/00

Manager, Radiological Laboratory — Date

CASE NARRATIVE

STL-NJ Project Number: MI 703-3-1
STL-NJ Work Order Number: 00-94-470

Samples were received without any discrepancies noted between chain of custody and cooler contents.

One method blank was analyzed for each parameter. The activities of the method blanks were within the acceptance criteria of less than three times the MDL for all parameters.

One blank spike analysis was performed for each parameter. The results were within the 80-120% QC limits.

A matrix spike was analyzed for each parameter. The recoveries for each spike were within the 80-120% QC acceptance limits.

One duplicate sample was analyzed for each parameter. The duplicate analyses all analysis met the acceptance criteria for a Duplicate Error Ratio (DER) of less than 1.5 when the activity is greater than 5 times the MDC. The DER is defined as follows:

$$DER = \frac{|S-D|}{(2\sigma_s + 2\sigma_d)}$$

Where: S = Original Sample Value
D = Duplicate Value
$2\sigma_s$ = Original Sample Uncertainty
$2\sigma_d$ = Duplicate Sample Uncertainty

Erik C. Nielsen.
Radiochemistry Group Leader
01/11/00

C:\NET2\WP\00-94-470

Radiological Analysis Results

01/11/2000

Form I

Client Sample ID	Lab ID	Sample Type	Batch Number	Matrix	Radionuclide	Result	Uncertainty	Q	Units	Analysis Date	Sample Size	MDA
E162	0094470-01	Reg	99120067	Soil	Th-228	0.02	0.13		pCi/g	01/10/2000	1.0000	0.29
E162	0094470-01	Reg	99120067	Soil	Th-230	0.27	0.12		pCi/g	01/10/2000	1.0000	0.06
E162	0094470-01	Reg	99120067	Soil	Th-232	0.11	0.08		pCi/g	01/10/2000	1.0000	0.06
E132	0094470-02	Reg	99120067	Soil	Th-228	0.04	0.10		pCi/g	01/10/2000	1.0000	0.22
E132	0094470-02	Reg	99120067	Soil	Th-230	0.21	0.12		pCi/g	01/10/2000	1.0000	0.09
E132	0094470-02	Reg	99120067	Soil	Th-232	0.10	0.07		pCi/g	01/10/2000	1.0000	0.04
E62	0094470-03	Reg	99120067	Soil	Th-228	0.37	0.15		pCi/g	01/10/2000	1.0000	0.21
E62	0094470-03	Reg	99120067	Soil	Th-230	0.34	0.17		pCi/g	01/10/2000	1.0000	0.14
E62	0094470-03	Reg	99120067	Soil	Th-232	0.09	0.07		pCi/g	01/10/2000	1.0000	0.15
E122	0094470-04	Reg	99120067	Soil	Th-228	0.20	0.12		pCi/g	01/10/2000	1.0000	0.16
E122	0094470-04	Reg	99120067	Soil	Th-230	0.55	0.20		pCi/g	01/10/2000	1.0000	0.06
E122	0094470-04	Reg	99120067	Soil	Th-232	0.36	0.15		pCi/g	01/10/2000	1.0000	0.08
E212	0094470-05	Reg	99120067	Soil	Th-228	0.26	0.14		pCi/g	01/10/2000	1.0000	0.18
E212	0094470-05	Reg	99120067	Soil	Th-230	0.41	0.16		pCi/g	01/10/2000	1.0000	0.03
E212	0094470-05	Reg	99120067	Soil	Th-232	0.21	0.11		pCi/g	01/10/2000	1.0000	0.07
E46	0094470-06	Reg	99120067	Soil	Th-228	0.16	0.23		pCi/g	01/10/2000	1.0000	0.47
E46	0094470-06	Reg	99120067	Soil	Th-230	0.37	0.20		pCi/g	01/10/2000	1.0000	0.17
E46	0094470-06	Reg	99120067	Soil	Th-232	0.13	0.14		pCi/g	01/10/2000	1.0000	0.25
E232	0094470-07	Reg	99120067	Soil	Th-228	0.28	0.18		pCi/g	01/10/2000	1.0000	0.29
E232	0094470-07	Reg	99120067	Soil	Th-230	0.79	0.27		pCi/g	01/10/2000	1.0000	0.14

Key shall be attached

Comments: _____

Radiological Analysis Results

Form I

Client Sample ID	Lab ID	Sample Type	Batch Number	Matrix	Radionuclide	Result	Uncertainty	Q	Units	Analysis Date	Sample Size	MDA
E232	0094470-07	Reg	99120067	Soil	Th-232	0.16	0.11		pCi/g	01/10/2000	1.0000	0.13
E82	0094470-08	Reg	99120067	Soil	Th-228	0.22	0.16		pCi/g	01/10/2000	1.0000	0.26
E82	0094470-08	Reg	99120067	Soil	Th-230	0.73	0.24		pCi/g	01/10/2000	1.0000	0.12
E82	0094470-08	Reg	99120067	Soil	Th-232	0.21	0.13		pCi/g	01/10/2000	1.0000	0.15
E2	0094470-09	Reg	99120067	Soil	Th-228	-0.01	0.13		pCi/g	01/10/2000	1.0000	0.33
E2	0094470-09	Reg	99120067	Soil	Th-230	0.27	0.16		pCi/g	01/10/2000	1.0000	0.14
E2	0094470-09	Reg	99120067	Soil	Th-232	0.05	0.07		pCi/g	01/10/2000	1.0000	0.10
E32	0094470-10	Reg	99120067	Soil	Th-228	0.17	0.13		pCi/g	01/10/2000	1.0000	0.18
E32	0094470-10	Reg	99120067	Soil	Th-230	0.29	0.16		pCi/g	01/10/2000	1.0000	0.05
E32	0094470-10	Reg	99120067	Soil	Th-232	0.04	0.05		pCi/g	01/10/2000	1.0000	0.05

Key shall be attached

Comments: _____

0094470

MDA mode

Project Number: MI 703-3-1

QA/QC Results Summary

Form II

Client Sample ID	Lab ID	Sample Type	Batch Number	Matrix	Radionuclide	Result	Uncertainty	Units	Analysis Date	Sample Size	Inst MDA	ID
Blank Spike	N/A	BS	99120067	Soil	Th-230	9.33	2.28	pCi/g	01/10/2000	1.0000	0.13	3
A99-2	0094580-02	Dup	99120067	Soil	Th-228	0.30	0.27	pCi/g	01/10/2000	1.0000	0.42	3
A99-2	0094580-02	Dup	99120067	Soil	Th-230	0.30	0.22	pCi/g	01/10/2000	1.0000	0.18	3
A99-2	0094580-02	Dup	99120067	Soil	Th-232	0.29	0.22	pCi/g	01/10/2000	1.0000	0.22	3
Method Blank	N/A	MB	99120067	Soil	Th-228	-0.01	0.06	pCi/g	01/10/2000	1.0000	0.19	3
Method Blank	N/A	MB	99120067	Soil	Th-230	0.00	0.04	pCi/g	01/10/2000	1.0000	0.14	3
Method Blank	N/A	MB	99120067	Soil	Th-232	0.01	0.04	pCi/g	01/10/2000	1.0000	0.12	3
E132	0094470-02	MS	99120067	Soil	Th-230	8.17	1.66	pCi/g	01/10/2000	1.0000	0.10	3

Key shall be attached
Comments: _____

Method Blank Summary

01/11/2000

Form III

Client Sample ID	Batch Number	Matrix	Radionuclide	Result	Uncertainty	Q	Units	Analysis Date	Sample Size	Method Number	Inst ID
Method Blank	99120067	Soil	Th-228	-0.01	0.06		pCi/g	01/10/2000	1.0000	RAS09100	3
Method Blank	99120067	Soil	Th-230	0.00	0.04		pCi/g	01/10/2000	1.0000	RAS09100	3
Method Blank	99120067	Soil	Th-232	0.01	0.04		pCi/g	01/10/2000	1.0000	RAS09100	3

Key shall be attached

Comments:

Chemical Recovery

01/11/2000

Form IV

Client Sample ID	Lab ID	Sample Type	Batch Number	Radionuclide	Chemical Tracer	Tracer Result	Tracer Added	Percent Recovery	Q	Tracer Units	Analysis Date	Inst ID
E162	0094470-01	Reg	99120067	Th-228	Th-229	3.08	4.98	61.85 %		pCi	01/10/2000	3
E162	0094470-01	Reg	99120067	Th-230	Th-229	3.08	4.98	61.85 %		pCi	01/10/2000	3
E162	0094470-01	Reg	99120067	Th-232	Th-229	3.08	4.98	61.85 %		pCi	01/10/2000	3
E132	0094470-02	Reg	99120067	Th-228	Th-229	2.72	4.98	54.62 %		pCi	01/10/2000	3
E132	0094470-02	Reg	99120067	Th-230	Th-229	2.72	4.98	54.62 %		pCi	01/10/2000	3
E132	0094470-02	Reg	99120067	Th-232	Th-229	2.72	4.98	54.62 %		pCi	01/10/2000	3
E62	0094470-03	Reg	99120067	Th-228	Th-229	3.30	4.98	66.27 %		pCi	01/10/2000	3
E62	0094470-03	Reg	99120067	Th-230	Th-229	3.30	4.98	66.27 %		pCi	01/10/2000	3
E62	0094470-03	Reg	99120067	Th-232	Th-229	3.30	4.98	66.27 %		pCi	01/10/2000	3
E122	0094470-04	Reg	99120067	Th-228	Th-229	2.91	4.98	58.43 %		pCi	01/10/2000	3
E122	0094470-04	Reg	99120067	Th-230	Th-229	2.91	4.98	58.43 %		pCi	01/10/2000	3
E122	0094470-04	Reg	99120067	Th-232	Th-229	2.91	4.98	58.43 %		pCi	01/10/2000	3
E212	0094470-05	Reg	99120067	Th-228	Th-229	3.08	4.98	61.85 %		pCi	01/10/2000	3
E212	0094470-05	Reg	99120067	Th-230	Th-229	3.08	4.98	61.85 %		pCi	01/10/2000	3
E212	0094470-05	Reg	99120067	Th-232	Th-229	3.08	4.98	61.85 %		pCi	01/10/2000	3
E46	0094470-06	Reg	99120067	Th-228	Th-229	1.77	4.98	35.54 %		pCi	01/10/2000	3
E46	0094470-06	Reg	99120067	Th-230	Th-229	1.77	4.98	35.54 %		pCi	01/10/2000	3
E46	0094470-06	Reg	99120067	Th-232	Th-229	1.77	4.98	35.54 %		pCi	01/10/2000	3
E232	0094470-07	Reg	99120067	Th-228	Th-229	3.42	4.98	68.67 %		pCi	01/10/2000	3
E232	0094470-07	Reg	99120067	Th-230	Th-229	3.42	4.98	68.67 %		pCi	01/10/2000	3

Key shall be attached

Comments: _____

2000

MDA mode

Chemical Recovery

Form IV

Client Sample ID	Lab ID	Sample Type	Batch Number	Radionuclide	Chemical Tracer	Tracer Result	Tracer Added	Percent Recovery	Q	Tracer Units	Analysis Date	Inst ID
E232	0094470-07	Reg	99120067	Th-232	Th-229	3.42	4.98	68.67 %		pCi	01/10/2000	3
E82	0094470-08	Reg	99120067	Th-228	Th-229	3.06	4.98	61.45 %		pCi	01/10/2000	3
E82	0094470-08	Reg	99120067	Th-230	Th-229	3.06	4.98	61.45 %		pCi	01/10/2000	3
E82	0094470-08	Reg	99120067	Th-232	Th-229	3.06	4.98	61.45 %		pCi	01/10/2000	3
E2	0094470-09	Reg	99120067	Th-228	Th-229	2.18	4.98	43.78 %		pCi	01/10/2000	3
E2	0094470-09	Reg	99120067	Th-230	Th-229	2.18	4.98	43.78 %		pCi	01/10/2000	3
E2	0094470-09	Reg	99120067	Th-232	Th-229	2.18	4.98	43.78 %		pCi	01/10/2000	3
E32	0094470-10	Reg	99120067	Th-228	Th-229	2.04	4.98	40.96 %		pCi	01/10/2000	3
E32	0094470-10	Reg	99120067	Th-230	Th-229	2.04	4.98	40.96 %		pCi	01/10/2000	3
E32	0094470-10	Reg	99120067	Th-232	Th-229	2.04	4.98	40.96 %		pCi	01/10/2000	3
Blank Spike	N/A	BS	99120067	Th-230	Th-229	2.39	4.98	47.99 %		pCi	01/10/2000	3
A99-2	0094580-02	Dup	99120067	Th-228	Th-229	1.49	4.98	29.92 %		pCi	01/10/2000	3
A99-2	0094580-02	Dup	99120067	Th-230	Th-229	1.49	4.98	29.92 %		pCi	01/10/2000	3
A99-2	0094580-02	Dup	99120067	Th-232	Th-229	1.49	4.98	29.92 %		pCi	01/10/2000	3
Method Blank	N/A	MB	99120067	Th-228	Th-229	2.55	4.98	51.20 %		pCi	01/10/2000	3
Method Blank	N/A	MB	99120067	Th-230	Th-229	2.55	4.98	51.20 %		pCi	01/10/2000	3
Method Blank	N/A	MB	99120067	Th-232	Th-229	2.55	4.98	51.20 %		pCi	01/10/2000	3
E132	0094470-02	MS	99120067	Th-230	Th-229	3.68	4.98	73.90 %		pCi	01/10/2000	3

Key shall be attached

Comments: _____

_____

_____

MDA mode

STL

Project Number: MI 703-3-1

Blank Spike Results Summary

Form V

Client Sample ID	Batch Number	Matrix	Radionuclide	Spike	Result	Spike Value	Percent Recovery	Q	Units	Analysis Date	Method Number
Blank Spike	99120067	Soil	Th-230	Th-230	9.33	8.41	110.94%		pCi/g	01/10/2000	RAS09100

Key shall be attached

Comments: _____

Matrix Spike Results Summary

Form VI

Client Sample ID	Lab ID	Batch Number	Spike	SSR	Sample Result	Spike Added	Percent Recovery	Q	Units	Analysis Date	Inst ID
E132	0094470-02	99120067	Th-230	8.17	0.21	8.41	94.65 %		pCi/g	01/10/2000	3

Key shall be attached

Comments: _____

Duplicate Results

Form VII

Client Sample ID	Lab ID	Batch Number	Radionuclide	Sample Result	Uncertainty	Dup. Result	Dup. Uncertainty	DER	Q	Units
A99-2	0094580-02	99120067	Th-228	0.24	0.15	0.30	0.27	0.14		pCi/g
A99-2	0094580-02	99120067	Th-230	0.24	0.15	0.30	0.22	0.15		pCi/g
A99-2	0094580-02	99120067	Th-232	0.24	0.15	0.29	0.22	0.12		pCi/g

Key shall be attached
Comments:

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Severn Trent Laboratories
628 Route 10
Whippany NJ 07981

Tel: (973) 428-8181
Fax: (973) 428-5222

REPORT FORM KEY

Instrument ID:

#1 - Gas Proportional Counter
#2 - High Purity Germanium Detectors (HPGe)
#3 - Alpha Spectrometry Counter
#4 - Liquid Scintillation Counter
#5 - Lucas Cell Counter
#6 - Sodium Iodide Detector

Sample Type:

REG - Regular Sample
DUP - Duplicate Sample
MS - Matrix Spike
BS - Blank Spike
MB - Method Blank

Units:

pCi/L - Picocuries per Liter
pCi/g - Picocuries per Gram
pCi/ml - Picocuries per Milliliter
pCi/mg - Picocuries per Milligram
pCi/F - Picocuries per Air Filter

Radionuclides:

H-3	Tritium	C-14	Carbon-14
Cl-36	Chlorine-36	K-40	Potassium-40
Co-60	Cobalt-60	Sr-89	Strontium-89
Sr-90	Strontium-90	Tc-99	Technetium-99
Cs-137	Cesium-137	Tl-208	Thallium-208
Pb-210	Lead-210	Pb-212	Lead-212
Pb-214	Lead-214	Bi-214	Bismuth-214
Ra-226	Radium-226	Ac-228	Actinium-228
Ra-228	Radium-228	Th-234	Thorium-234
Th-227	Thorium-227	Th-232/230/228	Isotopic Thorium
U-234/235/238	Isotopic Uranium	Pu-238	Plutonium-238
Pu-239/240	Plutonium-239&240	Am-241	Americium-241
Np-237	Neptunium-237		

Severn Trent Laboratories
628 Route 10
Whippany, NJ 07981

Tel: (973) 428-8181
Fax: (973) 428-5222

STL - WHIPPANY LAB CERTIFICATIONS

STL - NJ possesses the following regulatory certification and is currently certified to perform analysis in accordance with regulations pertaining to these certifications. Certificates are on file at the laboratory.

State/Agency Certification	Lab ID Number
CLP Organics Contract	68D50011
Connecticut	PH0722
Maryland	195
New Jersey	14530
New York	10997
North Carolina	339
Pennsylvania	68-355
Rhode Island	178
USDA Permit	S-3295 Revised
Delaware	NJ323

rpdata\stlcert.for

Last Updated: 8/18/99

Severn Trent Laboratories
628 Route 10
Whippany NJ 07981
Tel: (973) 428-8181
Fax: (973) 428-5222

2013

No. 72759

CHAIN OF CUSTODY

FIELD BOOK: _____ Pg 1 of 1

(1) Client: ARCADIS Geraghty + Miller

(2) Project Name/no.: MI000703.0003.00001

(3) Client Contact: KATIE PANCZACK

(4) STL Contact: BARBARA TRULICK

(5) TAT: 1wk, 2wk, 3wk, OTHER STANDARD

(6) Proj. Type: NJPDES, NPDES, ISRA, CLP, CERCLA, RCRA, UST, ACO, MOA, OTHER VCP

(7) Protocol: CLP, SW846, EPA 600, DW, OTHER HASL

(8) Reporting Type: NJ Reg Format, ~~NJ Reduced Format~~, CLP, Level II, (Level I (Data Sum)), Other

(14) Bill To: ACCOUNTS PAYABLE
ARCADIS Geraghty + Miller
4151 ELEVEN MILE RD
NOVI MI 48375

PO#: MI000703.0003.00001

(15) ANALYSIS REQUIRED

(9) Client ID (10 CHAR)	(10) Date	(11) Time	(12) Mtx	# OF CONTAINERS (13)	ISOTOPIC TH 8 OR 16 OZ GLASS-NONPRES
E162	11/16/99	09:30	SO	1	✓
E132	11/16/99	09:55	SO	1	✓
E62	11/16/99	10:40	SO	1	✓
E122	11/16/99	09:58	SO	1	✓
E212	11/16/99	08:50	SO	1	✓
E46	11/16/99	10:50	SO	1	✓
E232	11/16/99	08:30	SO	1	✓
E82	11/16/99	10:25	SO	1	✓
E2	11/16/99	11:25	SO	1	✓
E32	11/16/99	11:05	SO	1	✓

For Lab Use Only

LAB ID

Job No. 94470
Quote No.
# of Coolers:
Cooler Temp.(s):
Custody Seal #(s):
Date Due:

PM NON-CONFORMANCE

Preserved: Temp:
Container: Volume:
Broken: Initials:
Holding Time:
Other:

Logged By:

DESCRIPTION

01
02
03
04
05
06
07
08
09
10

(16) COMMENTS: (Please include hazards on site.)

(17)	Print Name and Company	Signature	Custody Seal # (s)	Date/Time
Sampled By:	KEVIN WILSON - ARCADIS GRM	K. Wilson	8417 + 8414	11/16/99 17:00
Received By:	Rachel Malanak STL	R. Malanak		11/17/99 1100
Relinquished By:				/
Received By:				/
Relinquished By:				/
Received By:				/

Mtx = Matrix of Sample. (AI=Air, AQ=Aqueous, LE=Leachate, ML=Misc Liquid, MS=Misc Solids, OIL, SE=Sediment, SL=Sludge, SO=Soil)

(Copies: White and yellow copies should accompany samples to STL. The pink copy should be retained by the client.) See reverse for directions.

000014

STL

WORK ORDER

Lab

Work Order #	00-94-470	# of Samples	10	Recieved Date	11/17/1999	Arcadis Geraghty & Miller	
Client #	2013	# of Tests	10	Load Date	11/17/1999	41511 11 Mile Rd.	
Project	MI 703-3-1	Report Level	2 (OT)	Due Date	12/15/1999	Novi, MI 48375	
Amount	110.00	Quote #		Export Date	/ /	Katie Panczak	
Comment							

(OT) 11/18/99

Lab ID	Sample #	Status	Matrix	Test	Cust ID	Collected
0094470-01	01A	Open	Soil	Isotopic Thorium	E162 ✓	11/16/1999 ✓
0094470-02	02A	Open	Soil	Isotopic Thorium	E132 ✓	11/16/1999
0094470-03	03A	Open	Soil	Isotopic Thorium	E62 ✓	11/16/1999
0094470-04	04A	Open	Soil	Isotopic Thorium	E122 ✓	11/16/1999
0094470-05	05A	Open	Soil	Isotopic Thorium	E212 ✓	11/16/1999
0094470-06	06A	Open	Soil	Isotopic Thorium	E46 ✓	11/16/1999
0094470-07	07A	Open	Soil	Isotopic Thorium	E232 ✓	11/16/1999
0094470-08	08A	Open	Soil	Isotopic Thorium	E82 ✓	11/16/1999
0094470-09	09A	Open	Soil	Isotopic Thorium	E2 ✓	11/16/1999
0094470-10	10A	Open	Soil	Isotopic Thorium	E32 ✓	11/16/1999

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Severn Trent Laboratories
628 Route 10
Whippany, New Jersey 07981

Tel: (973) 428-8181
Fax: (973) 428-5222

Severn Trent Laboratories

INTERNAL CHAIN OF CUSTODY CHRONICLE

RADIOCHEMISTRY

Job/Case # 94470 Sample Ids: 01-10

Relinquished By: R. Malanick Date/Time: 11/17/99

Received By: [signature] Date/Time: 11/17/99

SEVERN TRENT LABORATORIES, Inc. - NEW JERSEY
SAMPLE RECEIPT VERIFICATION FORM

JOB NUMBER: 94470 CLIENT Arcadis DATE RECEIVED: 11/17/99

OF SAMPLES 10 # OF COOLERS 1
CUSTODY SEALS: PRESENT/ ABSENT/ INTACT/ BROKEN TEMPERATURE BLANK PRESENT: YES _ NO

COOLER TEMP/S ° C 3.8 COOLER OUTSIDE 2-6 ° C ___ PRESERVED ICE/BLUE ICE/ NONE
IF OUTSIDE TEMP RANGE - WERE SAMPLES RECEIVED LESS THAN 4 HOURS FROM COLLECTION ? __ YES __ NO

CHAIN OF CUSTODY PRESENT/ ABSENT PROPERLY SIGNED, DATED, TIME: YES _ NO
SAMPLE TAGS PRESENT / ABSENT RECEIVED BY: DRIVER ____ IF SHIPPED AIRBILL PRESENT / # _____

COOLER RADIOACT. SCREEN BELOW 0.50 uR/hr YES / NO ___ (INFORM SAFETY OFFICER IMMED.)
YES __ NO SAMPLE BOTTLES INTACT
YES __ NO PROPER CONTAINERS PER ANALYSIS USED
YES __ NO SAMPLE LABELS INTACT
YES __ NO LABELS COMPLETE AND LEGIBLE (ID, DATE,TIME,SIGNATURE,PRESERVATIVE)
YES __ NO SAMPLES RECEIVED WITHIN HOLDING TIME
YES __ NO SAMPLES PROPERLY PRESERVED
__YES __ NO NO BUBBLES PRESENT VOA WATER MATRIX / NA
YES __ NO SUFFICIENT SAMPLE VOLUME RECEIVED
__YES __ NO DRINKING H20/TREATED H20 – CHECKED FOR RESIDUAL CHLORINE / NA
(DOCUMENT ON pH VERIFICATION LOG FORM

_____ INTIAL _____ DATE - RUSH REPORT ISSUED BY / NA
_____ INTIAL _____ DATE - pH ANALYSIS PERFORMED BY / NA
_____ INTIAL _____ DATE - % MOISTURE PERFORMED BY / NA
_____ INTIAL _____ DATE - SAMPLE COMPOSITE PERFORMED BY / NA

NOTE AND ITEMIZE BY SAMPLE AFFECTED, DISCREPANCIES AND NONCONFORMANCES FOUND: _____

PROJECT MANAGER INFORMED OF DISCREPANCIES: _____ INTIALS _____ DATE. / NA

SUBCONTRACTING OF ANALYSIS REQUIRED __YES __NO SUB COC COMPLETED __YES __NO / NA
SUBCONTRACTED SAMPLES SHIPPED __YES __NO CARRIER USED _____

SAMPLE RECEIPT , LABELING AND STORAGE PROCEDURES PERFORMED BY: R Malanaff

FINAL INSPECTION

BOTTLES CORRECTLY LABELED / YES __NO REVIEWED BY [signature] DATE: 11/17/99
INTERNAL CHAIN OF CUSTODY INITIATED / YES __NO
ALL SIGNATURES AND DATES COMPLETE / YES __NO

CLIENT INFORMED OF DISCREPANCIES/NONCONFORMANCES BY PM _____ DATE ____ TIME ____

NAME CLIENT REPRESENTATIVE INFORMED _____ METHOD : PHONE ___ FAX ___

CORRECTIVE ACTION REQUESTED BY CLIENT: _____

CORRECTIVE ACTION TAKEN: _____

PROJECT MANAGER APPROVED VERIFICATION FORM COMPLETE: [signature] DATE 12/3/99
Print name B. Trulick

Severn Trent Laboratories
628 Route 10
Whippany NJ 07981
Tel: (973) 428-8181
Fax: (973) 428-5222

Committed To Your Success

No: 72759

CHAIN OF CUSTODY

FIELD BOOK: _____ Pg 1 of 1

(1) Client: ARCADIS Geraghty & Miller

(2) Project Name/no.: MI000703.0003.00001

(3) Client Contact: KATIE PANICZACK

(4) STL Contact: BARBARA TRULICK

(5) TAT: 1wk, 2wk, 3wk, OTHER STANDARD

(6) Proj. Type: NJPDES, NPDES, ISRA, CLP, CERCLA, RCRA, UST, ACO, MOA, OTHER VCP

(7) Protocol: CLP, SW846, EPA 600, DW, OTHER HASL

(8) Reporting Type: NJ Reg Format, NJ Reduced Format, CLP, Level II, Level I (Data Sum), Other _____

(14) Bill To: ACCOUNTS PAYABLE
ARCADIS Geraghty & Miller
4151 Eleven Mile Rd
Novi MI 48375

PO#: MI000703.0003.00001

(15) ANALYSIS REQUIRED

(9) Client ID (10 CHAR)	(10) Date	(11) Time	(12) Mtx	# of Containers (13)	ISOTOPIC CL	8 OR 16 OZ GLASS-NO VOA
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E132	11/16/99	09:55	SO	1	✓	
E62	11/16/99	10:40	SO	1	✓	
E127	11/16/99	09:58	SO	1	✓	
E717	11/16/99	08:50	SO	1	✓	
E46	11/16/99	10:50	SO	1	✓	
E737	11/16/99	08:30	SO	1	✓	
E87	11/16/99	10:75	SO	1	✓	
E2	11/16/99	11:75	SO	1	✓	
E37	11/16/99	11:05	SO	1	✓	

LAB ID.

For Lab Use Only

Job No. _____
Quote No. _____
# of Coolers: _____
Cooler Temp.(s) _____
Custody Seal #(s) _____
Date Due: _____

PM NON-CONFORMANCE

Preserved: _____ Temp: _____
Container: _____ Volume: _____
Broken: _____ Initials: _____
Holding Time: _____
Other: _____

Logged By: _____

DESCRIPTION

(16) COMMENTS: (Please include hazards on site.)

(17)	Print Name and Company	Signature	Custody Seal # (s)	Date/Time
Sampled By:	KEVIN WILSON - ARCADIS G+M	Kevin K Wilson	8417 + 8414	11/16/99 17:00
Received By:				/
Relinquished By:				/
Received By:				/
Relinquished By:				/
Received By:				/

Mtx = Matrix of Sample. (AI=Air, AQ=Aqueous, LE=Leachate, ML=Misc Liquid, MS=Misc Solids, OIL, SE=Sediment, SL=Sludge, SO=Soil)

(Copies: White and yellow copies should accompany samples to STL. The pink copy should be retained by the client.) See reverse for directions.