Radiological Investigation
US Ecology Borehole Study
2008

DOH 320-112 September 2016

Executive Summary

In 2008 the Department of Health, Office of Radiation Protection, Waste Management Section performed an investigation at the US Ecology commercial low-level radioactive waste disposal facility to determine if the migration of radionuclides from certain trenches and tanks has occurred. This investigation was performed concurrently with the Model Toxics Control Act site investigation for non-radioactive hazardous substances. The MTCA investigation allowed for the collection of vadose zone soil samples at two depths in the trench and resin tank areas for the analysis of radionuclides. These vadose zone soil samples would not have been feasible through standard environmental sampling methods. The study area focused on the "Pre-1985 Area" (see Figure 1, *Site Map*). This area contains trenches and tanks that were active until 1985, when the facility was banned from receiving and disposing of RCRA waste.

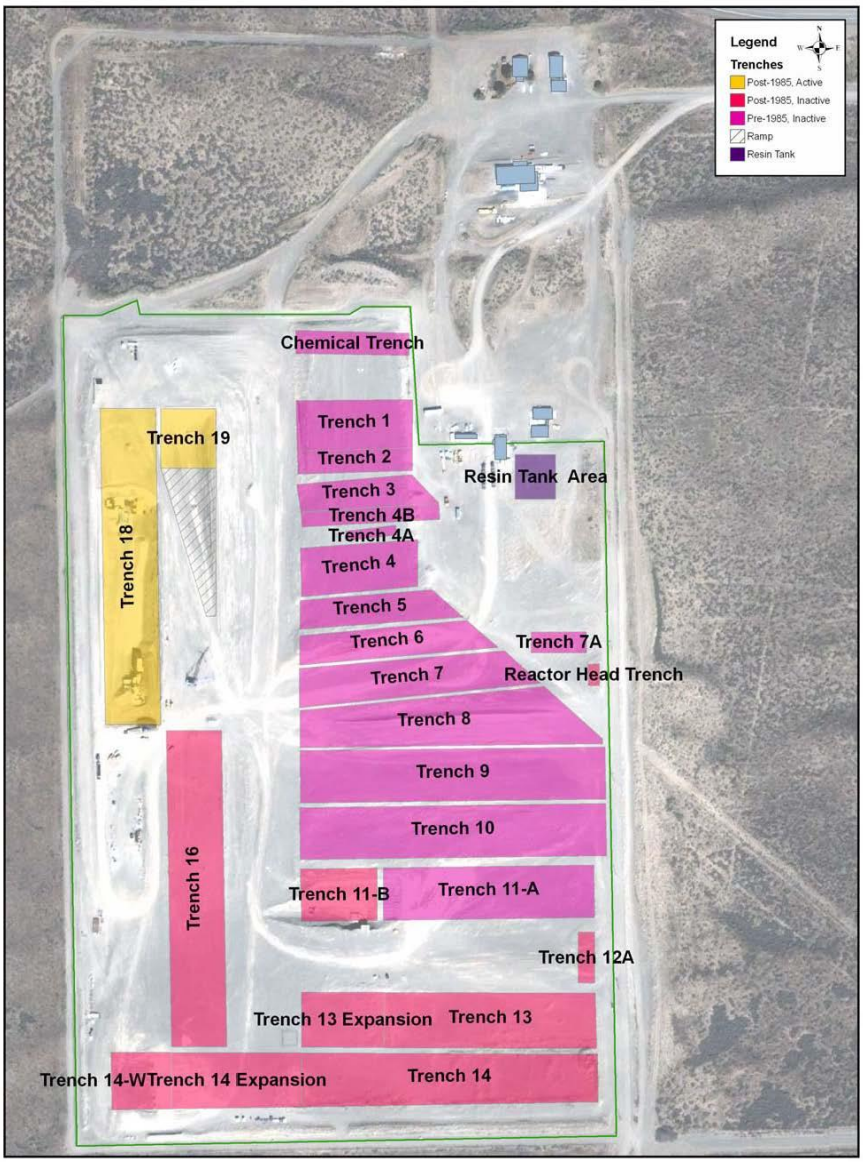


Figure 1. Site Map

Background

In 1998 a Model Toxics Control Act (MTCA) site investigation was performed at the US Ecology commercial low-level radioactive waste disposal facility to characterize the groundwater and vadose zone soils below certain trenches to determine if the release of radionuclides and non-radiological hazardous contaminants at the facility occurred. The 1998 MTCA investigation reported the detection of both non-radiological hazardous contaminants and radionuclides in the vadose zone and groundwater underneath the site. Due to the site operator's lack of a sound chain of custody of the samples obtained during the investigation, backup samples that were held in archive could not be analyzed to support or rule-out the anomalous results. In the absence of other data, the Department of Health (DOH) used this site investigation data to perform dose assessment modeling.

In 2008 the site operator conducted another MTCA investigation into the release of non-radiological contaminates into the soils below the trenches and resin tanks. This study provided DOH an opportunity collect vadose zone soil samples to investigate the potential migration of radionuclides. This data will allow both the performance assessment dose model to be reviewed as well as address the public's concerns regarding the mobility of radionuclides prior to placement of a closure cover at the facility.

Sample Locations

The sampling area consisted of 26 locations in the Pre-1985 Area. There were 18 vertical trench perimeter boreholes, 6 vertical resin tank perimeter boreholes, and 2 slant boreholes under the resin tanks. Trench perimeter samples were taken from sampling locations B10-B-27, as shown in Figures 2, *Trench Area Sample Locations*. Resin tank samples were taken from sampling locations B1-B8, as shown in Figure 3, *Resin Tank Sample Locations*. All sampling locations were dictated by the *US Ecology, Inc. Low Level Radioactive Waste Site Agreed Order Scope of Work,* dated 9/21/2006 (see Attachment 1, *US Ecology, Inc. Scope of Work*).

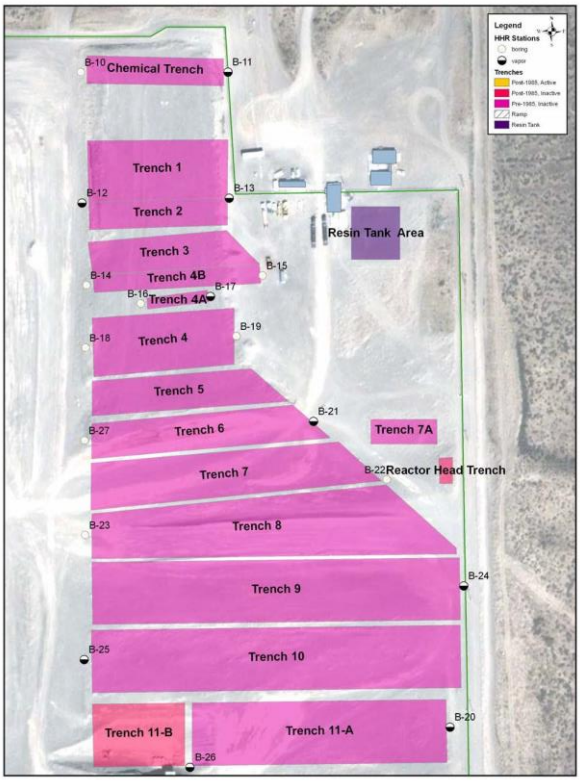


Figure 2. Trench Area Sample Locations, B10-B27

Two samples were obtained per location, one at an "upper depth" and one at a "lower depth". Upper depth samples from the trench area were taken at the perimeter of the trenches, approximately 10 feet below the bottom of the trench, while the lower depth samples were taken at the perimeter

of the trenches near the lowest sampling depth, approximately 45 feet below the bottom of the trench. Likewise, the vertical resin tank area upper depth samples were taken at the perimeter of the tanks, approximately 5 feet below the bottom of the tanks, and the lower depth samples were taken at the perimeter of the tanks near the lowest sampling depth, which was approximately 15 feet below the bottom of the tanks.

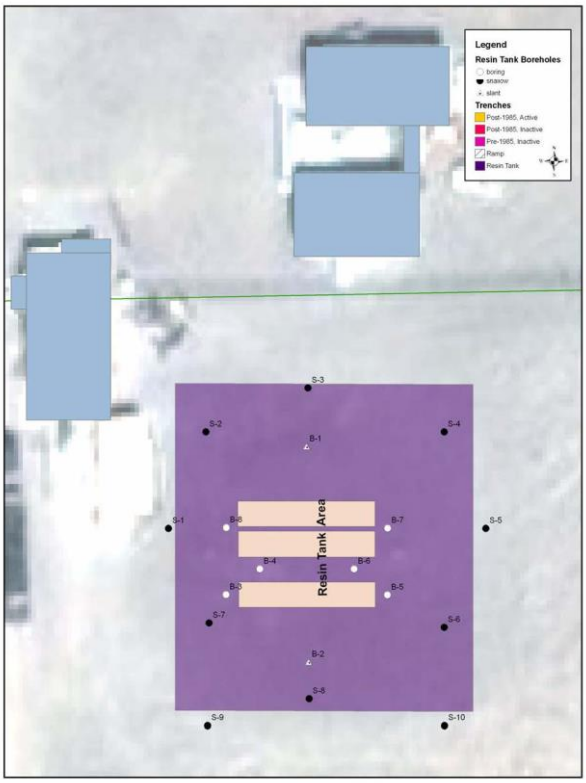


Figure 3. Resin Tank Sample Locations, B1- B8

The slant boreholes under the resin tanks were scoped to be drilled 30º from vertical, with samples collected at the same depths below the tanks as the vertical boreholes. The actual collection depths could not be confirmed due to inconsistencies in the reported boring angle. The typed driller's log did not state the angle, and the various reports referenced conflicting angles. The angles used in this report were 55º and 26º from vertical for sampling locations B1 and B2 respectively[1].

Sample Collection

Department of Health samples were collected by Vista Engineering Technologies, LLC (Vista Engineering) from January 30 through May 20, 2008. Samples were collected in accordance with the following Vista Engineering documents (see Attachment 2, *Vista Engineering Technologies, LLC Documents*):

- *Remedial Investigation Work Plan for US Ecology Site RI/FS*, VET-1405-PLN-01, dated January 8, 2008
- *Quality Assurance Project Plan for US Ecology Site RI/FS*, VET-1405-PLN-02, dated January 8, 2008
- *Sampling and Analysis Plan for US Ecology Site RI/FS*, VET-1405-PLN-03, dated January 8, 2008
- *Standard Operating Procedure for Soil Sampling on the US Ecology Site RI/FS*, VET-1405-PRO-01, dated January 8, 2008
- *Standard Operating Procedure for Record Keeping on the US Ecology Site RI/FS*, VET-1405-PRO-05, dated January 8, 2008
- *Standard Operating Procedure for Pre-Operational Cleaning of Sampling Equipment on the US Ecology Site RI/FS*, VET-1405-PRO-06, dated January 8, 2008

[1] Vista Engineering Technologies, LLC, Final Remedial Investigation Report, VET-1405-RPT-001, p. 44.

All empty sample bottles were pre-labeled, then placed in ziplock bags and custody sealed prior to the beginning of sampling. Empty bottles were transferred to Vista Engineering under chain of custody and in accordance with DOH procedures. Vista Engineering filled and custody sealed the sample bottles in accordance with DOH procedures. Samples were stored on ice and transferred back to DOH under chain of custody in accordance with DOH procedures. Samples were stored under DOH control, in a refrigerator, until the samples were transferred to the laboratory, under chain of custody, for analysis. DOH sample were stored in accordance with DOH procedures, and all sample were physically transported to the laboratory for analysis. All DOH procedures are located in Appendix A, *Department of Health Procedures*):

- *Obtaining Empty Bottles*, Rev 1, dated February 13, 2008
- *Sample Collection*, Rev 1, dated February 13, 2008
- *Sample Cooler Transfer*, Rev 2, dated March 20, 2008
- *Storing of Samples*, Rev 1, dated February 13, 2008

Figure 4. Drill Rig

Department of Health was physically present for the majority of the DOH samples that were collected. Samples were collected, stored, and transferred without incident. A total of 51 of the 52 planned samples were collected. The lower depth sample from location B27, West of Trench 6, was not obtained due to drilling refusal prior to collection of this sample. Figures 4 and 5 show the drill rig and drilling apparatus; Figure 6 shows the sampling process; and Table 1 provides an overview of all samples collected, sample location, ground elevation, and sampling refusal depth. The following documents summarize the sampling activities:

- Vista Engineering, *Field Activity Reports*, Appendix B
- Vista Engineering, *Washington State Department of Health Soil Sample Report*, December 31, 2009, Appendix C
- Department of Health, *Empty Bottles Chain of Custody*, Appendix D
- Department of Health, *Field Log*, Appendix D
- Department of Health, *Sample Chain of Custody Forms*, Appendix D

All sample collection information can be found in the comprehensive Vista Engineering report, *US Ecology Low-Level Radioactive Waste Disposal Site Final Remedial Investigation Report*, VET-1405-RPT-001, dated July 14, 2010 (see Attachment 3).

Figure 5. Drilling Apparatus

Figure 6. Sampling

Table 1. Sample Locations

Location	Easting (ft)	Northing (ft)	Ground Elevation (ft)	Refusal Depth (ft)	Easting (m)	Northing (m)	Ground Elevation (m)	Refusal Depth (m)
B1	1877729	440955	726	41	572333	134403	221	12
B2	1877727	440868	725	45	572332	134377	221	14
B3	1877703	440893	725	36	572325	134384	221	11
B4	1877713	440911	724	36	572328	134390	221	11
B5	1877751	440893	724	36	572340	134384	221	11
B6	1877746	440913	726	36	572338	134390	221	11
B7	1877760	440936	726	36	572342	134397	221	11
B8	1877702	440932	725	38	572325	134396	221	12
B10	1877073	441280	733	69	572133	134502	224	21
B11[1]	1877405	441279	732	67	572234	134502	223	20
B11[2]	1877405.3	441276.0	732.46	5	572234.3	134501.2	223.40	2
B11[3]	1877406.0	441277.3	732.48	21	572234.5	134501.6	223.41	6
B11[4]	1877406.9	441274.7	732.35	65	572234.8	134500.8	223.37	20
B12[1]	1877077.3	440984.6	729.96	78	572134.3	134412.4	222.64	24
B12[2]	1877075.3	440983.4	729.83	32	572133.7	134412.0	222.60	10
B12[3]	1877077.4	440982.9	729.93	7	572134.3	134411.9	222.63	2
B13[1]	1877407.2	440994.2	727.47	77	572234.9	134415.3	221.88	23
B13[2]	1877406.3	440992.3	727.47	31	572234.6	134414.7	221.88	9

Location	Easting (ft)	Northing (ft)	Ground Elevation (ft)	Refusal Depth (ft)	Easting (m)	Northing (m)	Ground Elevation (m)	Refusal Depth (m)
B13[3]	1877408.3	440992.5	727.41	6	572235.2	134414.8	221.86	2
B14	1877087	440802	729	92	572137	134357	222	28
B15	1877483	440828	726	92	572258	134365	221	28
B16	1877208	440760	739	79	572174	134344	225	24
B17[1]	1877365.6	440775.8	739.70	78	572222.2	134348.7	225.61	24
B17[2]	1877364.8	440774.3	739.71	32	572222.0	134348.3	225.61	10
B17[3]	1877362.8	440775.4	739.71	17	572221.3	134348.6	225.61	5
B18	1877084	440674	736	81	572136	134318	224	25
B19	1877425	440688	727	76	572240	134322	222	23
B20[1]	1877904.0	439808.5	726.48	79	572386.3	134053.9	221.58	24
B20[2]	1877904.8	439807.2	726.45	31	572386.5	134053.5	221.57	9
B20[3]	1877906.0	439805.4	726.47	6	572386.9	134053.0	221.57	2
B21[1]	1877597.4	440493.7	726.70	77	572292.8	134262.7	221.64	23
B21[2]	1877598.6	440494.8	726.71	30	572293.2	134263.1	221.65	9
B21[3]	1877600.5	440495.4	726.72	5	572293.8	134263.3	221.65	2
B22	1877761	440366	723	87	572343	134224	221	27
B23	1877082	440241	728	87	572136	134186	222	27
B24[1]	1877928.6	440124.6	724.51	92	572393.8	134150.2	220.98	28
B24[2]	1877928.2	440122.1	724.57	46	572393.7	134149.5	220.99	14
B24[3]	1877928.2	440120.2	724.51	6	572393.7	134148.9	220.98	2
B25[1]	1877083	439959	727	79	572136	134100	222	24
B25[2]	1877079.9	439959.4	726.99	92	572135.1	134099.9	221.73	28
B25[3]	1877081.8	439959.7	726.89	46	572135.7	134100.0	221.70	14
B25[4]	1877080.1	439958.2	726.79	6	572135.1	134099.5	221.67	2
B26[1]	1877320.1	439717.0	729.38	92	572208.3	134026.0	222.46	28
B26[2]	1877320.6	439715.1	729.47	46	572208.5	134025.4	222.49	14
B26[3]	1877321.7	439712.9	729.26	6	572208.8	134024.8	222.43	2
B27	1877082	440453	729	72	572136	134250	222	22

Washington State Plane Coordinates, south zone (NAD83), North American Vertical Datum of 1988
HHR soil boring data were not collected by a civil survey, and are only accurate to ~ 1 ft for both horizontal and vertical positions.

[1, 2, 3, 4] **Subsequent pushes due to drill rig refusal**

Sample Analysis

Fourteen of the samples collected were split with Vista Engineering and analyzed by Shaw Environmental Inc., under the control of Vista Engineering, for physical properties. These analyses included: total soil porosity, bulk density, dry soil bulk density, grain size analysis, plastic limits, pore size distribution, moisture content, pH, cation exchange capacity, fine (percent <200 mesh), and fraction soil organic carbon. The physical properties sample results can be found in the Vista Engineering report, *Washington State Department of Health Soil Sample Report*, December 31, 2009 (see Appendix C, Vista Engineering Technologies, LLC Soils Sample Report).

All 51 samples were analyzed at the Washington State Public Health Laboratory (WA PHL) for 17 analytes,15 radiological analytes, and 2 physical properties. The WA PHL used standard recognized analytical methods for the majority of the analytes, while H-3, Ni-63, Tc-99, and I-129 were analyzed by non-standard, developmental or investigational methods due to lack of standard methods for these analytes in the soil medium. The WA PHL provided a Laboratory Analysis Errata, see Appendix E, that describes the analytical methods utilized for these analytes. The WA PHL sample results can be found in Appendix F, *WA Public Health Laboratory Radiological Sample Results*.

The following table identifies the WA PHL analytes, methods, and detection limits:

Table 2. Analyte Summary

Analyte	Method	Detection Limit (pCi/g)
pH	Ion Selective Electrode	----
Moisture Content	Gravimetric	----
Gross Beta	GFPC	1
Co-60	HPGe Gamma Spec.	0.2
Cs-137	HPGe Gamma Spec.	0.3
K-40[1]	HPGe Gamma Spec.	
H-3[2]	Dist, LSC[3]	
Ni-63	Chem Sep, LSC[3]	3
Sr-90	Chem, Sep. (Rapid), GFPC[3]	0.003
Tc-99[2]	Chem Sep, LSC[3]	
I-129[2]	Ion Exchange, LEGe	
Ra-226	Gamma by Progeny	0.2
U-238, 234, 235	Chem Sep., Alpha Spec[3]	0.2
Pu-238, 239/240	Chem Sep., Alpha Spec[3]	0.005

[1] Detection limit not identified; found naturally in background.

[2] Detection limit not identified; non-standard, developmental or investigational method.

[3] Method measures the requested isotope(s) directly after rigorous and well characterized chemical separation.

Sample Results – Physical Properties

The WA PHL obtained physical properties on all samples, see Appendix F, Tables 1 and 2, and Shaw Environmental obtained the moisture content on 14 samples, see Appendix C.

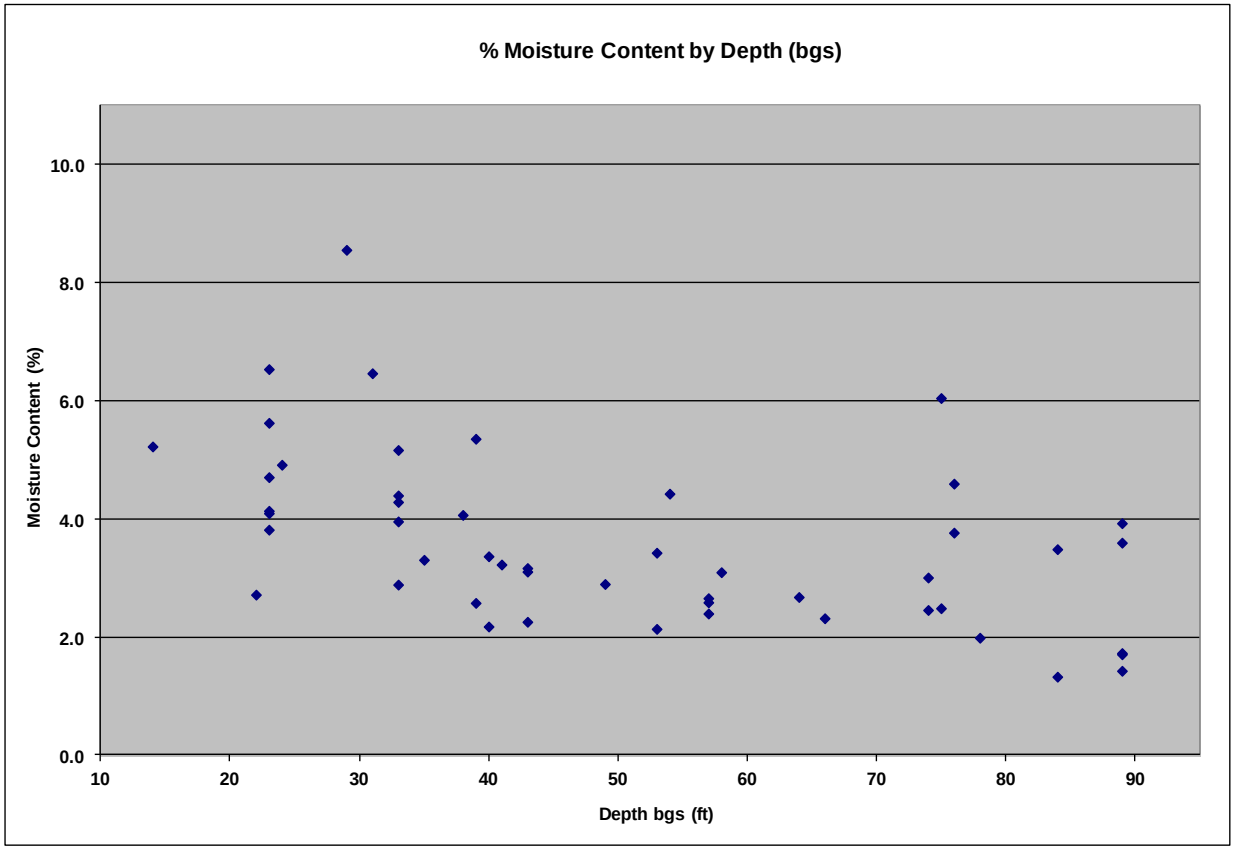
Moisture Content

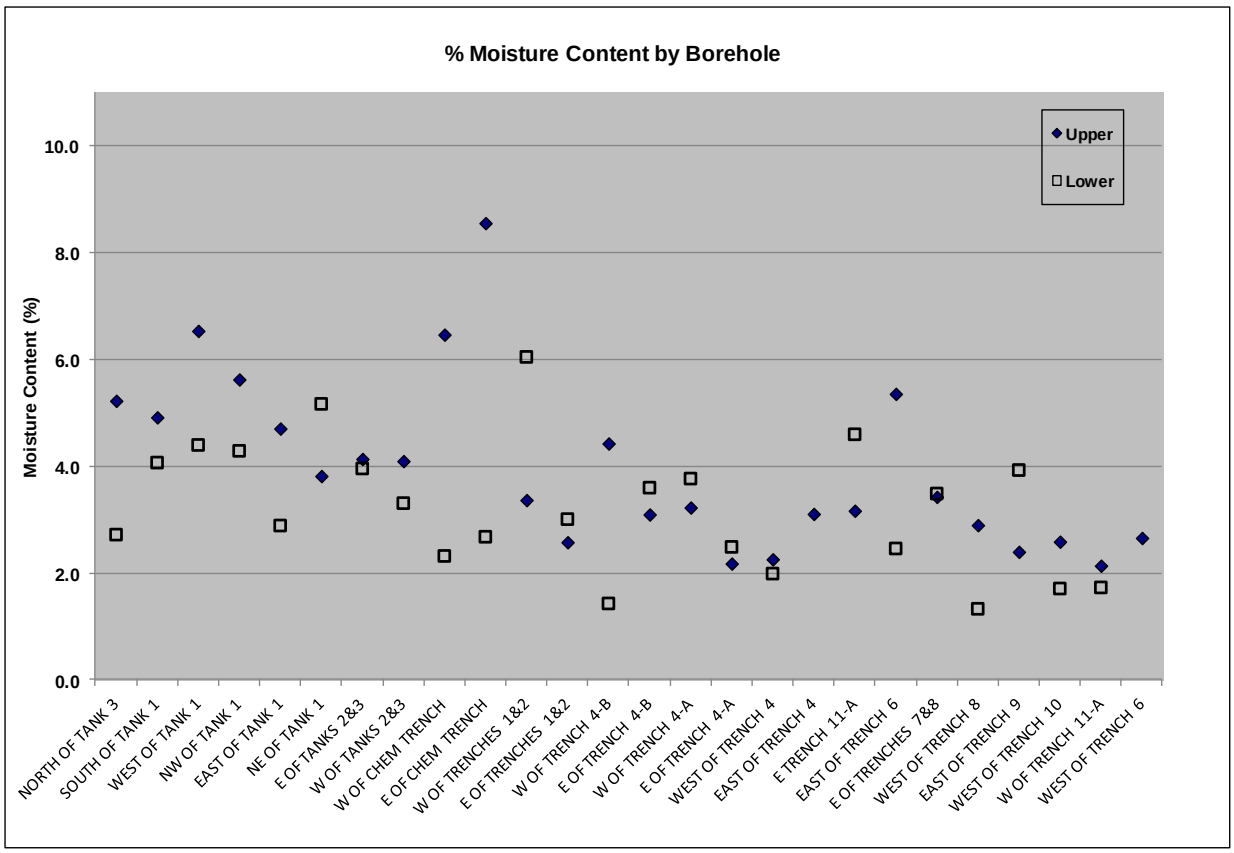
The WA PHL results range from 1.33 to 8.56, as shown in Table 3. Shaw Environmental performed the analysis using two different methods (ASTM D 2216 and SW846, the results range from 2.9 to 10.3. The moisture content trend shows decreasing moisture content with increasing depth. The moisture content was not impacted by collection date.

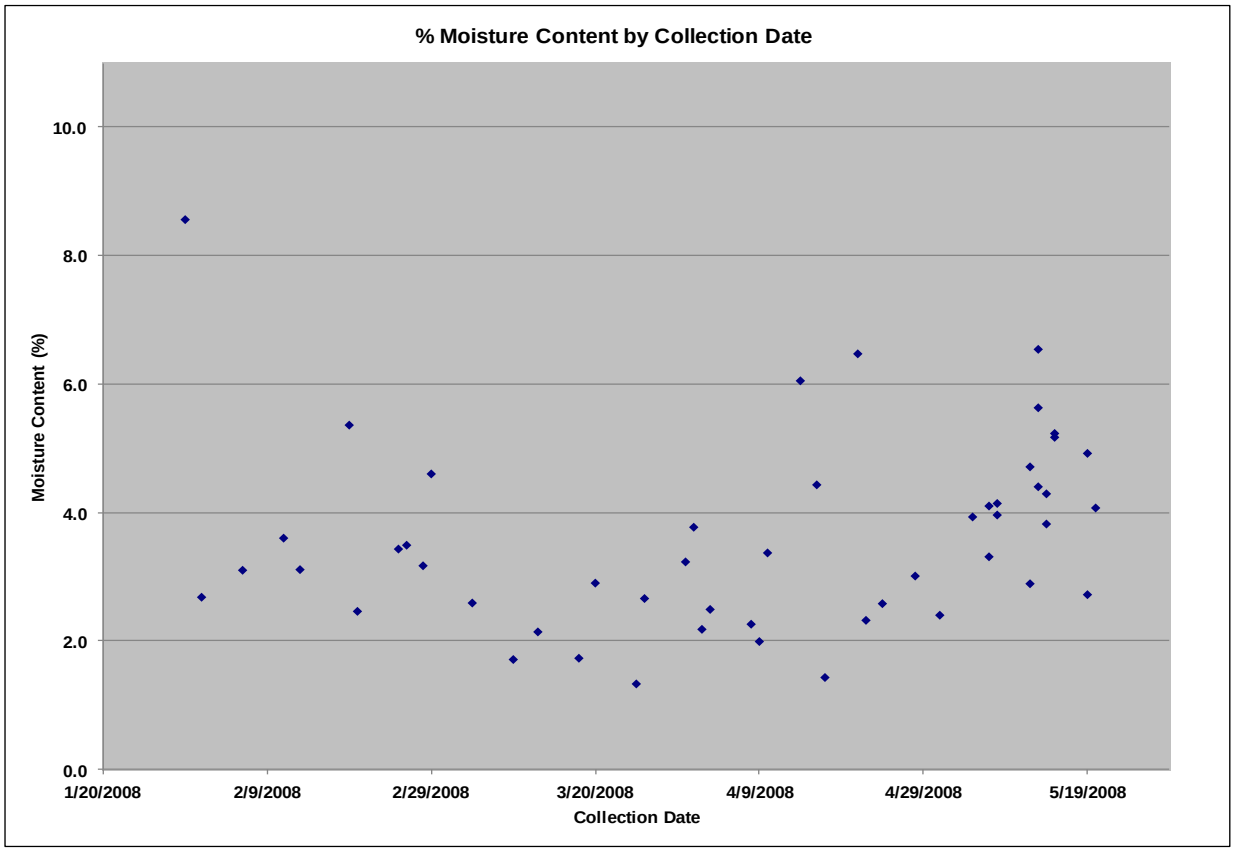
Table 3. WA PHL Moisture Content Results (%)

	Number[1]	Min	Max	Mean	Median	Std Dev	Variance
Moisture Content	50	1.33	8.56	3.61	3.34	1.46	2.14

[1] **Table excludes Moisture Content result for DBID 41610 due to insufficient sample volume.**




% Moisture Content by Borehole
Moisture Content (%)
10.0
8.0
6.0
4.0
2.0
0.0
Upper
Lower
NORTH OF TANK 3
SOUTH OF TANK 1
WEST OF TANK 1
NW OF TANK 1
EAST OF TANK 1
NE OF TANK 1
E OF TANKS 2&3
W OF TANKS 2&3
W OF CHEM TRENCH
E OF CHEM TRENCH
W OF TRENCHES 1&2
E OF TRENCHES 1&2
W OF TRENCH 4-B
E OF TRENCH 4-B
W OF TRENCH 4-A
E OF TRENCH 4-A
WEST OF TRENCH 4
EAST OF TRENCH 4
E TRENCH 11-A
EAST OF TRENCH 6
E OF TRENCHES 7&8
WEST OF TRENCH 8
EAST OF TRENCH 9
EAST OF TRENCH 10
WEST OF TRENCH 11-A
W OF TRENCH 6
WEST OF TRENCH 6

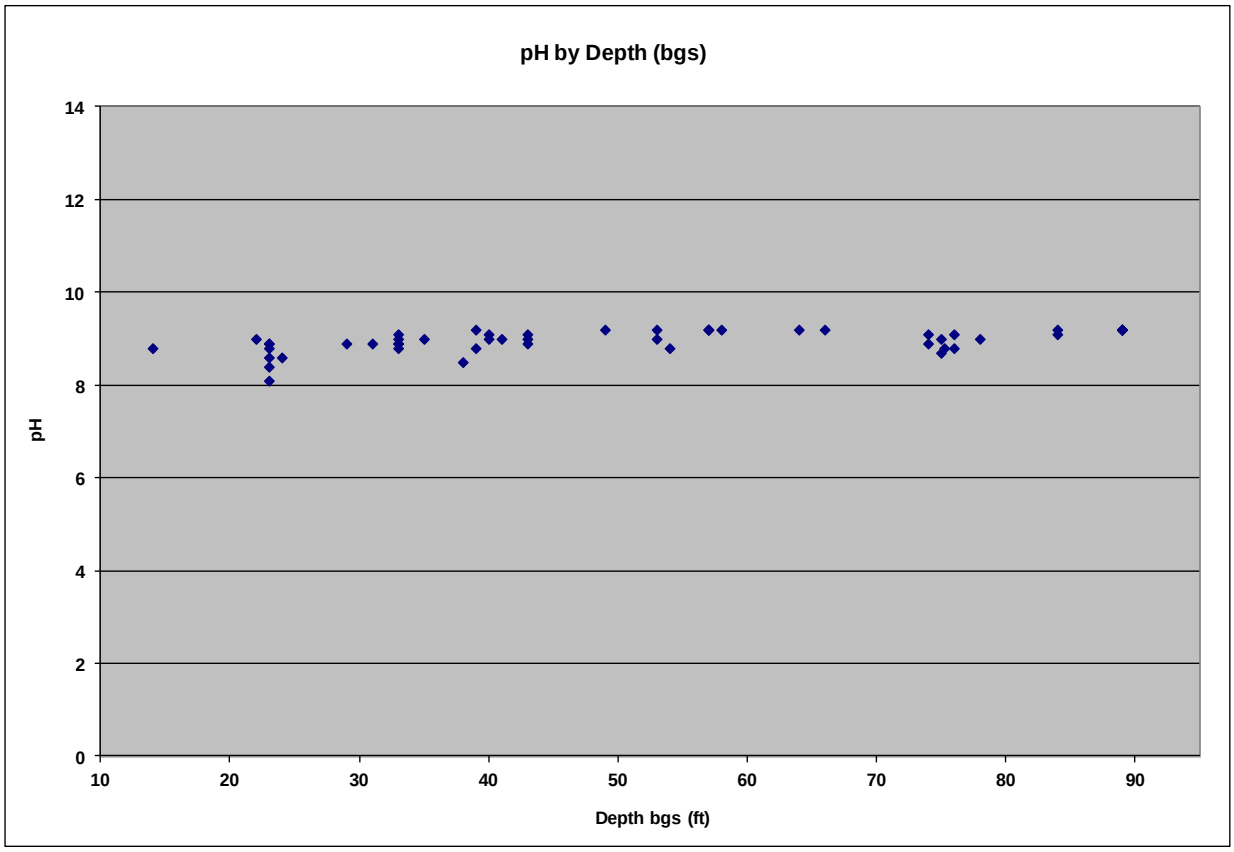

% Moisture Content by Collection Date
Moisture Content (%)
10.0
8.0
6.0
4.0
2.0
0.0
1/20/2008
2/9/2008
2/29/2008
3/20/2008
4/9/2008
4/29/2008
5/19/2008
Collection Date

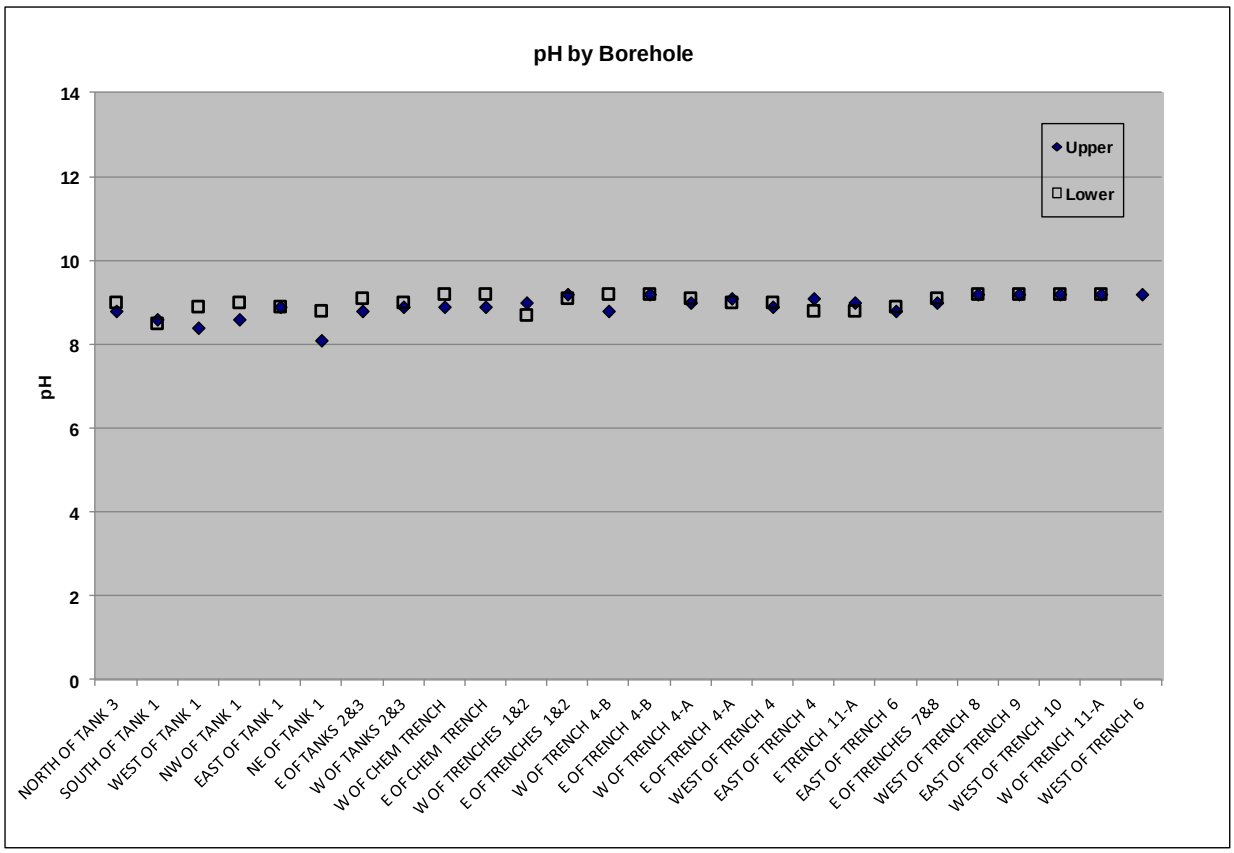
pH

The WA PHL pH results range from 8.1 to 9.2, as shown in Table 4, and the Shaw Environmental results range from 7.52 to 8.41. The pH is independent of depth as seen in the figures below.

Table 4. WA PHL pH Results

	Number	Min	Max	Mean	Median	Std Dev	Variance
pH	51	8.1	9.2	8.97	9	0.24	0.06





Sample Results – Radiological Analyses

The WA PHL analyzed all 51 samples for 15 different radiological analytes; Shaw Environmental did not perform radiological analysis on any samples. The WA PHL sample data can be found in Appendix F, Tables 3 – 17.

Gross Beta

Gross beta is found naturally in background soils. The investigation sample gross beta results were compared against a screening level based on a 14-year dataset of DOH gross beta background values from the US Ecology site (see Attachment 4 for DOH gross beta background statistics). The gross beta screening level was set at 25 pCi/g, based on the 90th percentile of the DOH background data set.

Table 5. Elevated Gross Beta Results

DBID	Depth (bgs-ft)	Depth Below Trench Bottom (ft)	Sample Location ID	Site	Result (pCi/g-Dry)	Error (pCi/g)
41577[1]	24	6	B2A	S of Tank 1	173	6.0
41579	23	5	B3A	W of Tank 1	89.0	12
41581	23	5	B4A	NW of Tank 1	56.0	3.9

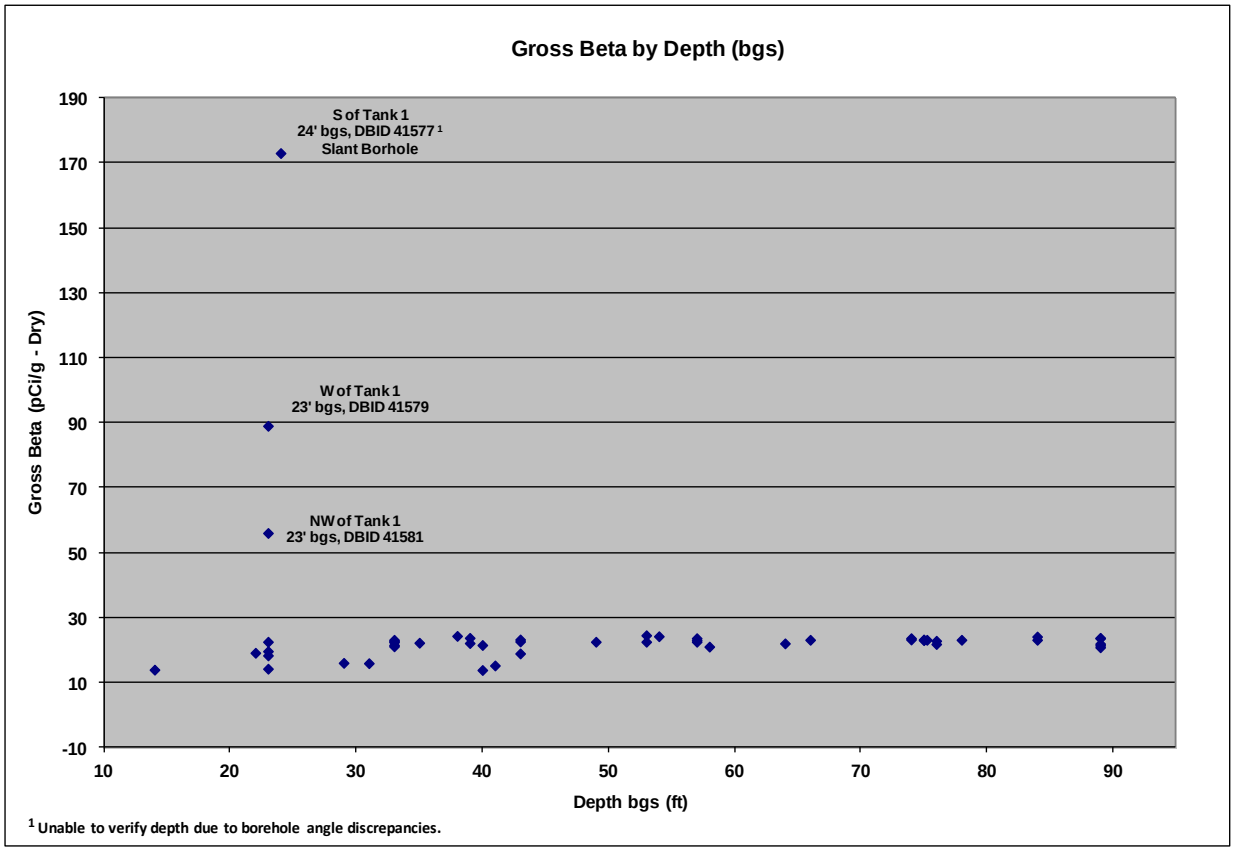
[1] **Unable to verify depth due to borehole angle discrepancies.**

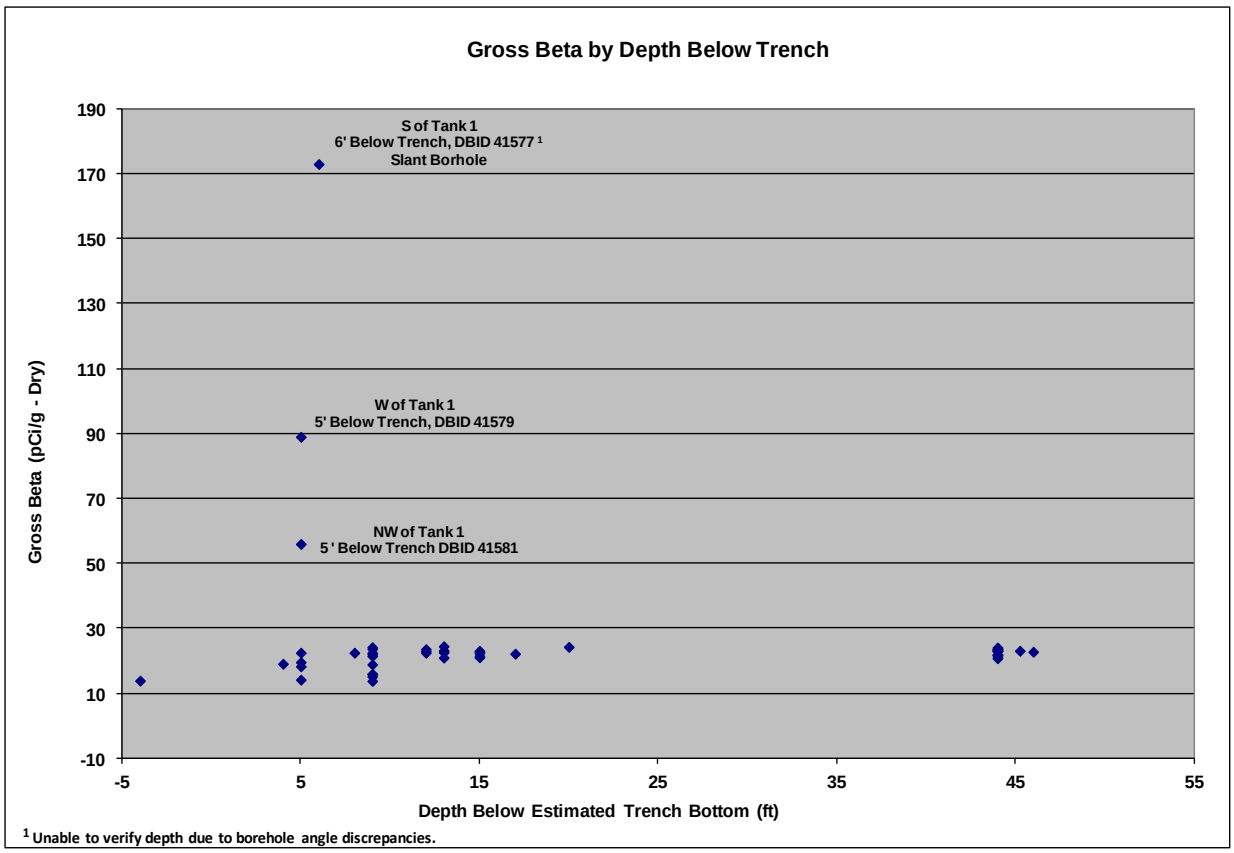
Three upper depth samples from the resin tank area were found to be above the gross beta screening level, as shown in Table 5. The remaining resin tank samples and the upper and lower depth trench area samples were all below the screening level, see Table 6.

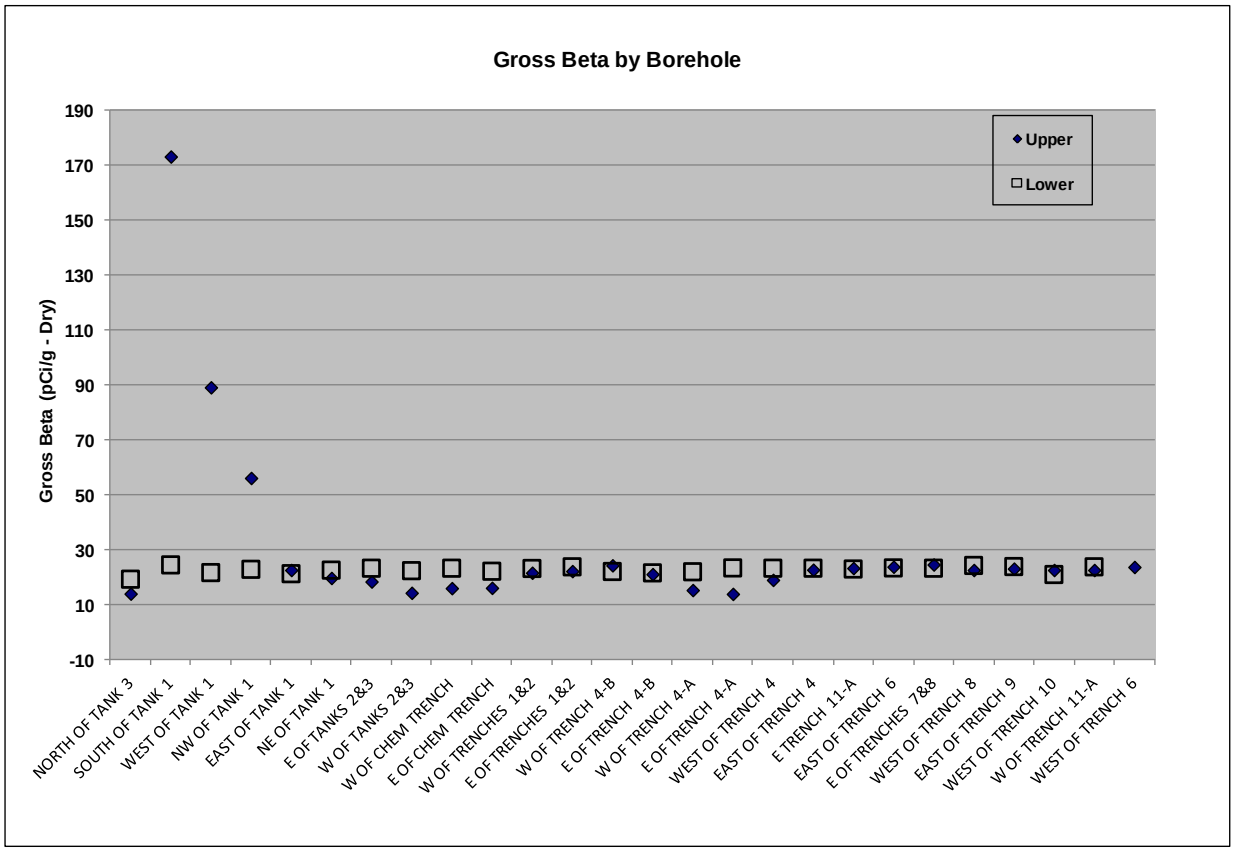
Table 6. Gross Beta Results (pCi/g - Dry)

	Number[1]	Min	Max	Mean	Median	Std Dev	Variance
Gross Beta	48	13.8	24.5	21.4	22.5	2.88	8.28

[1] **Table excludes Gross Beta results for DBID's 41577, 41579, and 41581.**




Gross Beta by Depth Below Trench
S of Tank 1
6' Below Trench, DBID 41577 [1]
Slant Borhole
W of Tank 1
5' Below Trench, DBID 41579
NW of Tank 1
5 ' Below Trench DBID 41581
Gross Beta (pCi/g - Dry)
Depth Below Estimated Trench Bottom (ft)
190
170
150
130
110
90
70
50
30
10
-10
-5
5
15
25
35
45
55
[1] Unable to verify depth due to borehole angle discrepancies.


Gross Beta by Borehole
Upper
Lower
Gross Beta (pCi/g - Dry)
190
170
150
130
110
90
70
50
30
10
-10
NORTH OF TANK 3
SOUTH OF TANK 1
WEST OF TANK 1
NW OF TANK 1
EAST OF TANK 1
NE OF TANK 1
E OF TANKS 2&3
W OF TANKS 2&3
W OF CHEM TRENCH
E OF CHEM TRENCH
W OF TRENCHES 1&2
E OF TRENCHES 1&2
W OF TRENCH 4-B
E OF TRENCH 4-B
W OF TRENCH 4-A
E OF TRENCH 4-A
WEST OF TRENCH 4
EAST OF TRENCH 4
E TRENCH 11-A
EAST OF TRENCH 6
E OF TRENCHES 7&8
WEST OF TRENCH 8
EAST OF TRENCH 9
EAST OF TRENCH 10
WEST OF TRENCH 11-A
W OF TRENCH 6
WEST OF TRENCH 6

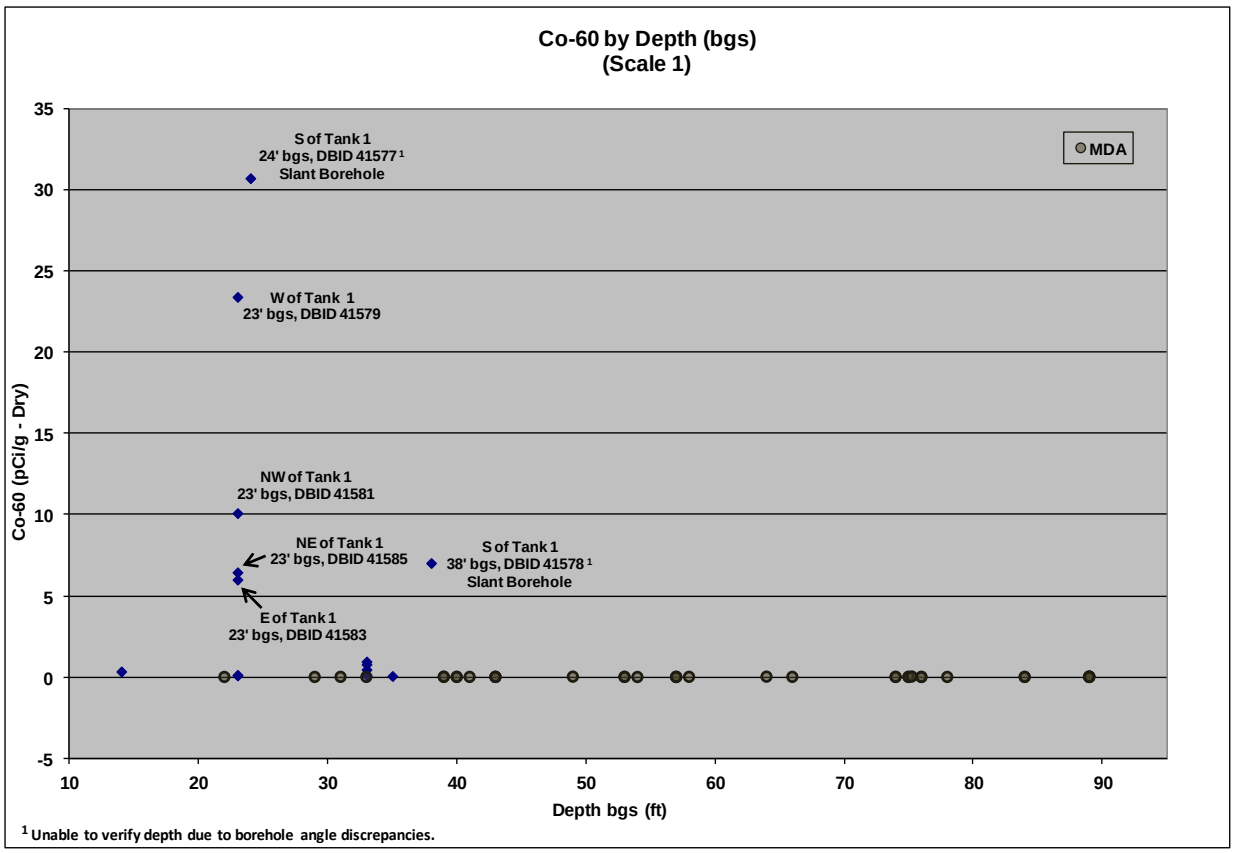
Co-60

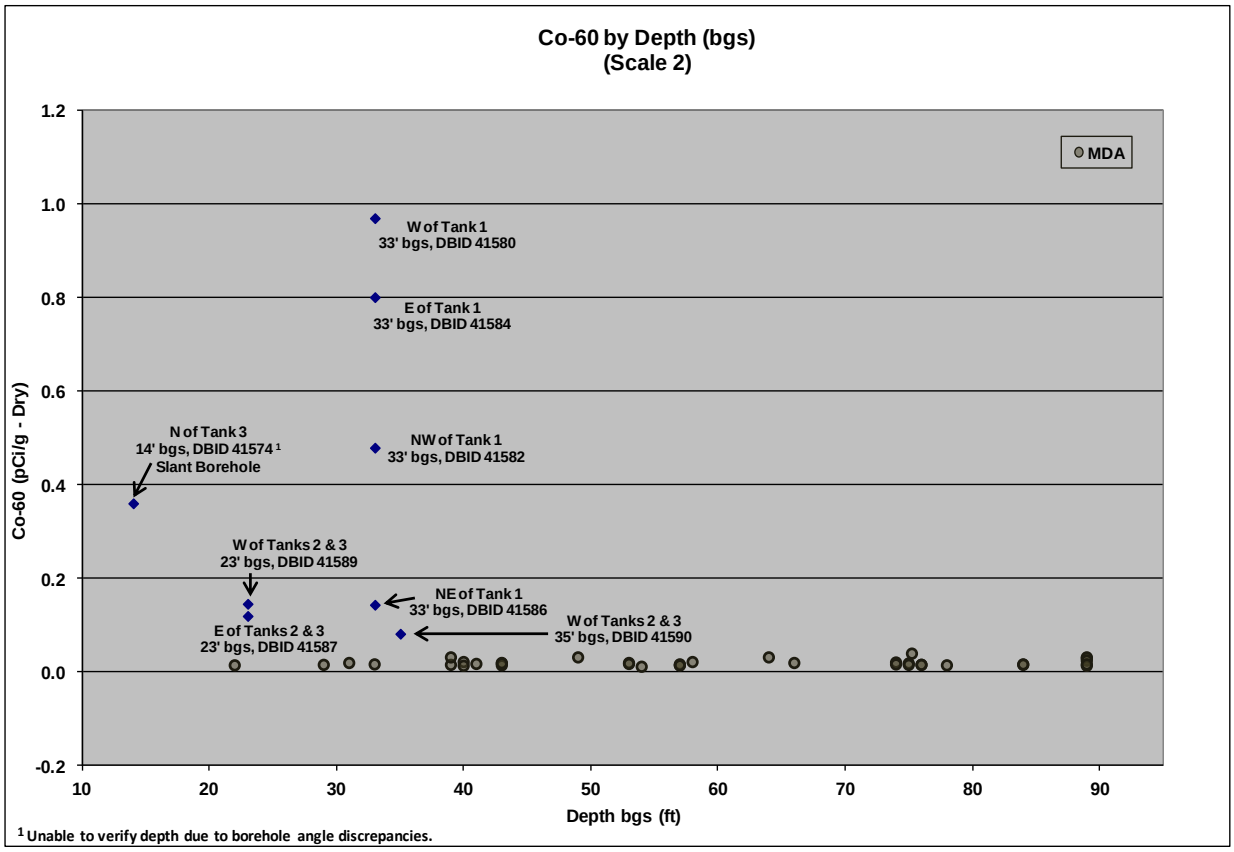
Cobalt-60 is not found naturally in background soils. Cobalt-60 was detected in numerous locations in the upper and lower sampling depths from the resin tank area as shown in Table 7. Cobalt-60 was not detected in the remaining resin tank samples or the upper or lower depth trench area samples. The maximum detection limit for the non-detect samples was 3.8E-02 pCi/g.

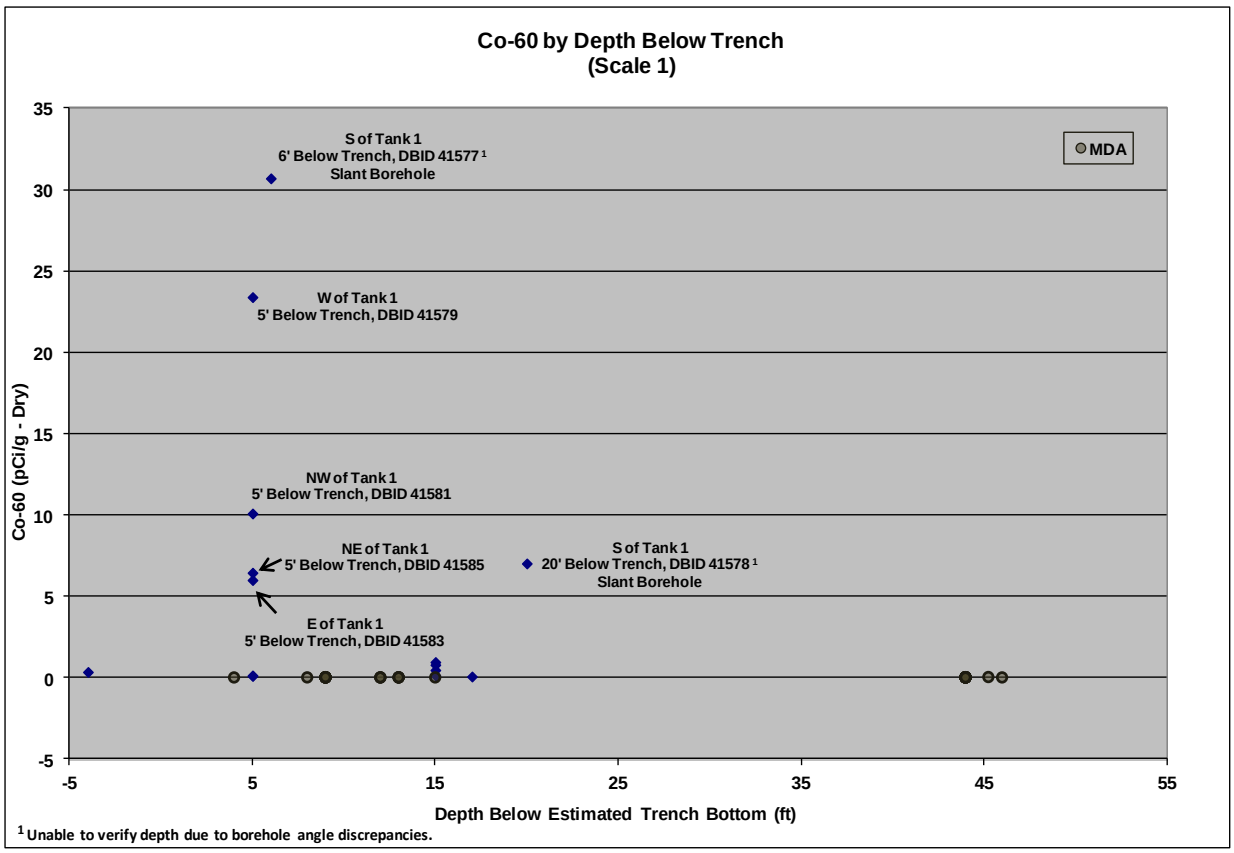
Table 7. Elevated Co-60 Results

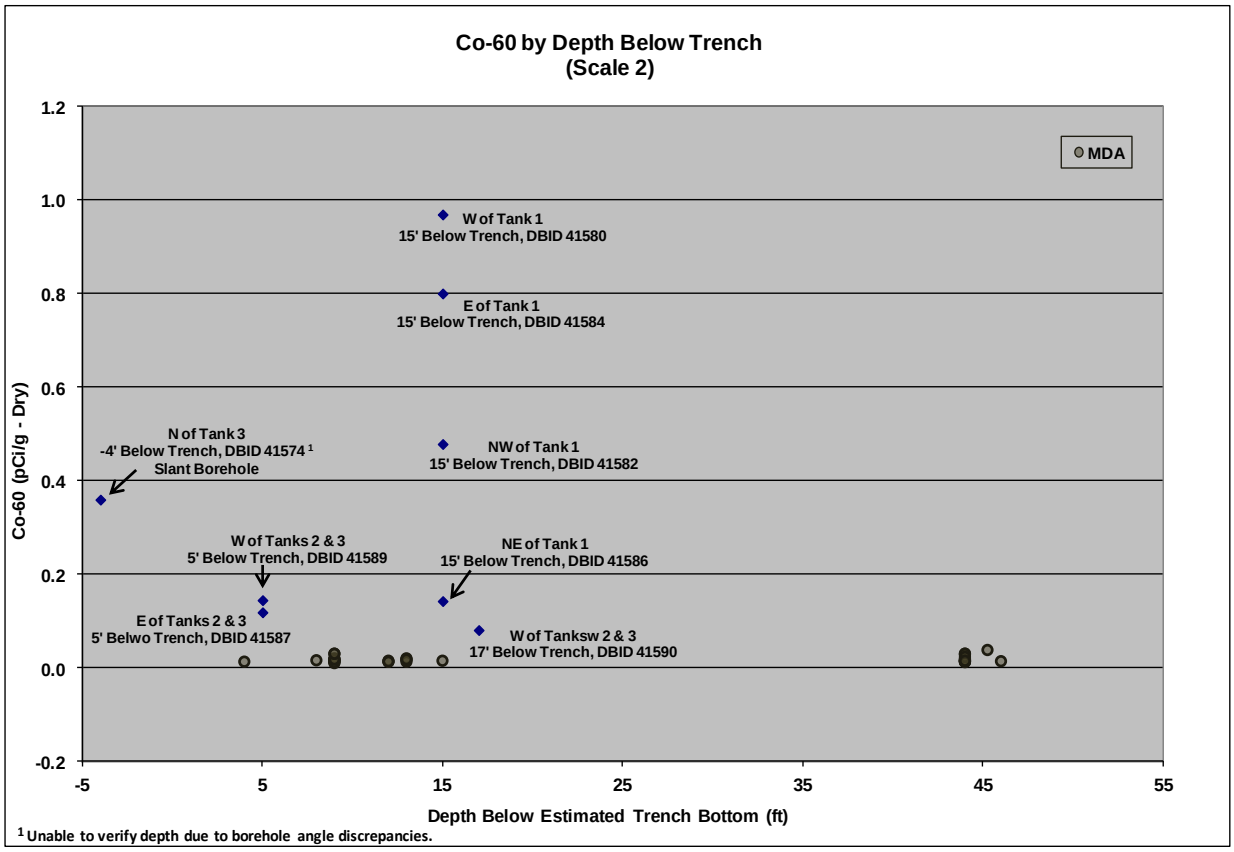
DBID	Depth (bgs-ft)	Depth Below Trench Bottom (ft)	Sample Location ID	Site	Result (pCi/g-Dry)	Error (pCi/g)
41574[1]	14	-4	B1A	N of Tank 3	3.60E-01	2.0E-02
41577[1]	24	6	B2A	S of Tank 1	3.07E+01	5.0E-01
41578[1]	38	20	B2B	S of Tank 1	7.03E+00	6.0E-02
41579	23	5	B3A	W of Tank 1	2.34E+01	2.0E-01
41580	33	15	B3B	W of Tank 1	9.70E-01	3.0E-02
41581	23	5	B4A	NW of Tank 1	1.01E+01	1.0E-01
41582	33	15	B4B	NW of Tank 1	4.79E-01	3.6E-02
41583	23	5	B5A	E of Tank 1	6.01E+00	6.4E-02
41584	33	15	B5B	E of Tank 1	8.01E-01	4.0E-02
41585	23	5	B6A	NE of Tank 1	6.46E+00	1.1E-01
41586	33	15	B6B	NE of Tank 1	1.43E-01	1.8E-02
41587	23	5	B7A	E of Tanks 2&3	1.19E-01	1.4E-02
41589	23	5	B8A	W of Tanks 2&3	1.45E-01	1.3E-02
41590	35	17	B8B	W of Tanks 2&3	8.1E-02	1.3E-02

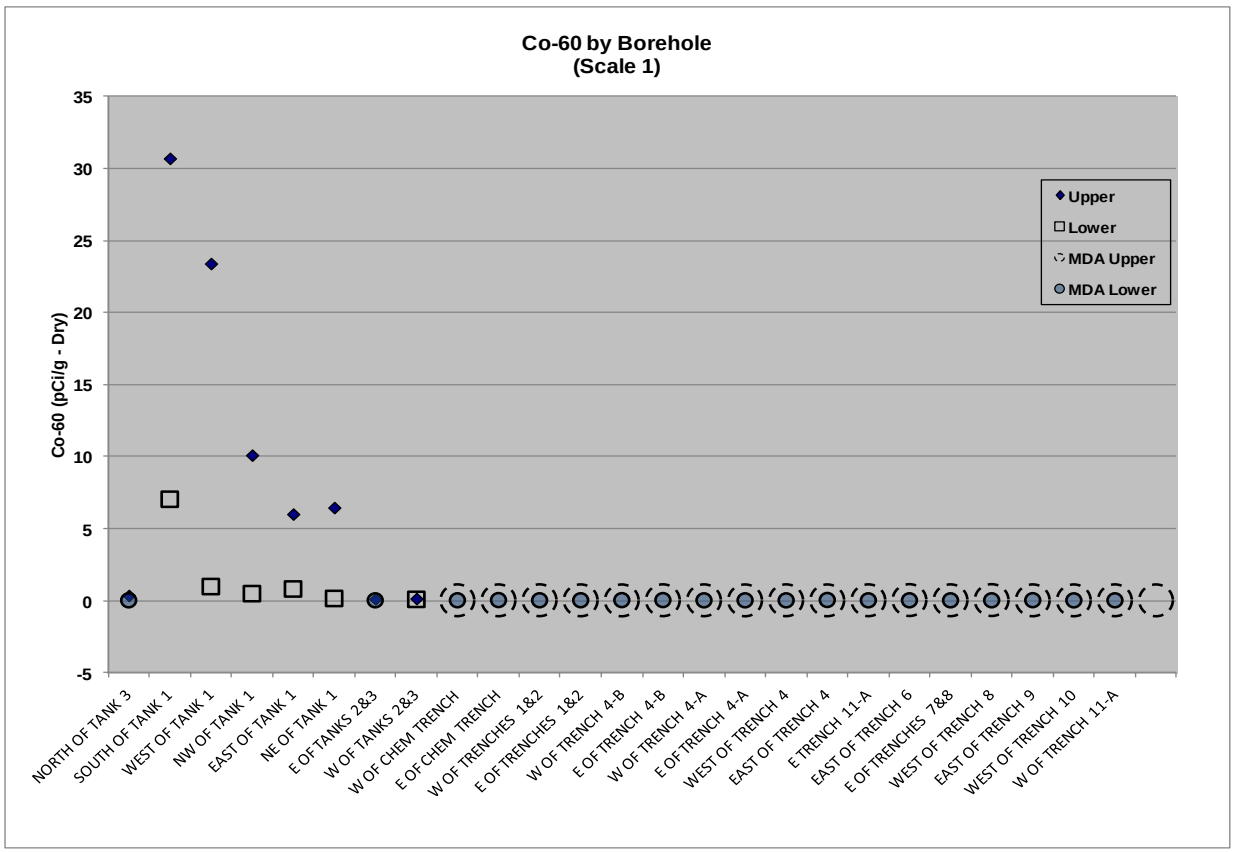
[1] Unable to verify depth due to borehole angle discrepancies.

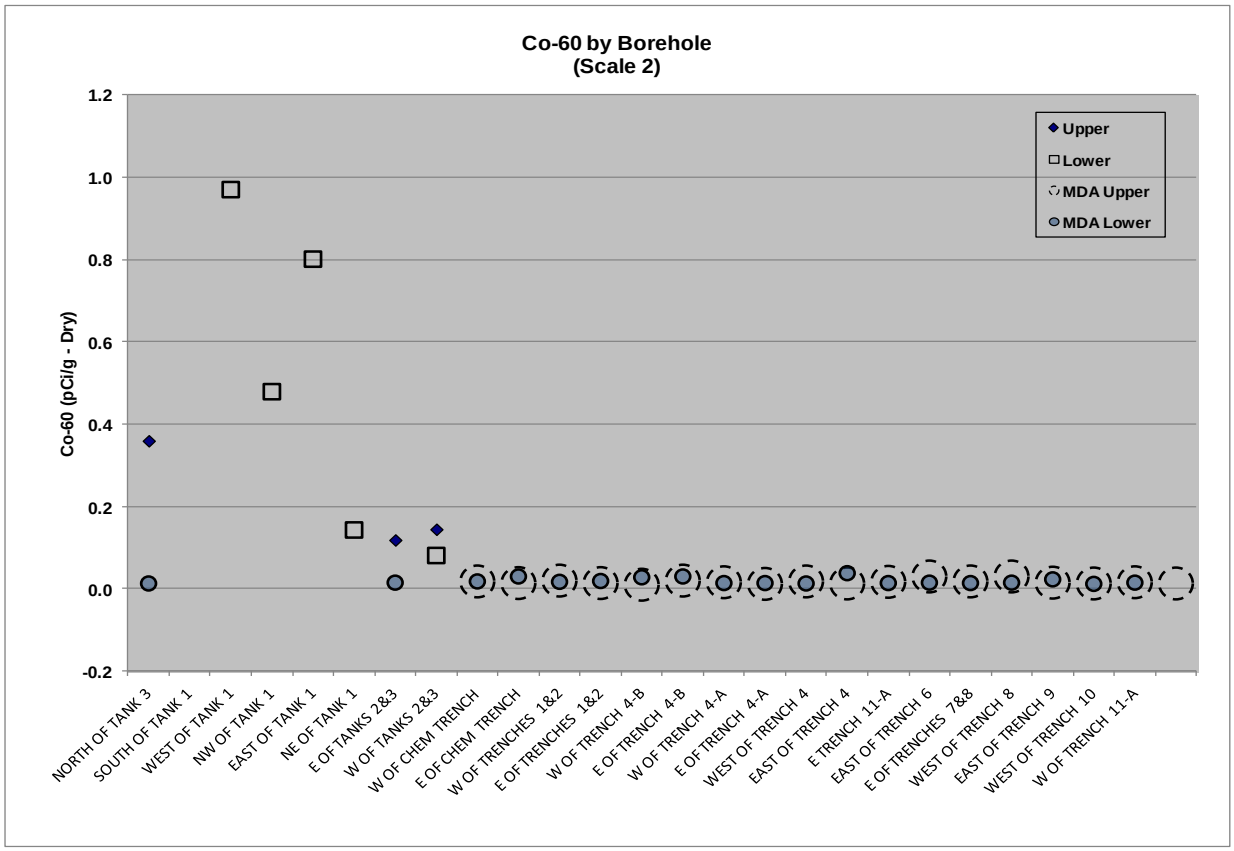

Co-60 by Depth (bgs)
(Scale 1)
MDA
S of Tank 1
24' bgs, DBID 41577 1
Slant Borehole
W of Tank 1
23' bgs, DBID 41579
NW of Tank 1
23' bgs, DBID 41581
NE of Tank 1
23' bgs, DBID 41585
S of Tank 1
38' bgs, DBID 41578 1
Slant Borehole
E of Tank 1
23' bgs, DBID 41583
Co-60 (pCi/g - Dry)
Depth bgs (ft)
1 Unable to verify depth due to borehole angle discrepancies.


Co-60 by Depth (bgs)
(Scale 2)
MDA
W of Tank 1
33' bgs, DBID 41580
E of Tank 1
33' bgs, DBID 41584
N of Tank 3
14' bgs, DBID 41574 1
Slant Borehole
NW of Tank 1
33' bgs, DBID 41582
W of Tanks 2 & 3
23' bgs, DBID 41589
NE of Tank 1
33' bgs, DBID 41586
W of Tanks 2 & 3
35' bgs, DBID 41590
E of Tanks 2 & 3
23' bgs, DBID 41587
Co-60 (pCi/g - Dry)
Depth bgs (ft)
1 Unable to verify depth due to borehole angle discrepancies.


Co-60 by Depth Below Trench
(Scale 1)
MDA
S of Tank 1
6' Below Trench, DBID 41577 1
Slant Borehole
W of Tank 1
5' Below Trench, DBID 41579
NW of Tank 1
5' Below Trench, DBID 41581
NE of Tank 1
5' Below Trench, DBID 41585
S of Tank 1
20' Below Trench, DBID 41578 1
Slant Borehole
E of Tank 1
5' Below Trench, DBID 41583
Co-60 (pCi/g - Dry)
Depth Below Estimated Trench Bottom (ft)
1 Unable to verify depth due to borehole angle discrepancies.


Co-60 by Depth Below Trench
(Scale 2)
MDA
W of Tank 1
15' Below Trench, DBID 41580
E of Tank 1
15' Below Trench, DBID 41584
N of Tank 3
-4' Below Trench, DBID 41574 1
Slant Borehole
NW of Tank 1
15' Below Trench, DBID 41582
W of Tanks 2 & 3
5' Below Trench, DBID 41589
NE of Tank 1
15' Below Trench, DBID 41586
E of Tanks 2 & 3
5' Belwo Trench, DBID 41587
W of Tanksw 2 & 3
17' Below Trench, DBID 41590
Co-60 (pCi/g - Dry)
Depth Below Estimated Trench Bottom (ft)
1 Unable to verify depth due to borehole angle discrepancies.


Co-60 by Borehole
(Scale 1)
Co-60 (pCi/g - Dry)
35
30
25
20
15
10
5
0
-5
Upper
Lower
MDA Upper
MDA Lower
NORTH OF TANK 3
SOUTH OF TANK 1
WEST OF TANK 1
NW OF TANK 1
EAST OF TANK 1
NE OF TANK 1
E OF TANKS 2&3
W OF TANKS 2&3
W OF CHEM TRENCH
E OF CHEM TRENCH
W OF TRENCHES 1&2
E OF TRENCHES 1&2
W OF TRENCH 4-B
E OF TRENCH 4-B
W OF TRENCH 4-A
E OF TRENCH 4-A
WEST OF TRENCH 4
EAST OF TRENCH 4
E TRENCH 11-A
EAST OF TRENCH 6
E OF TRENCHES 7&8
WEST OF TRENCH 8
EAST OF TRENCH 9
EAST OF TRENCH 10
WEST OF TRENCH 11-A
W OF TRENCH 11-A


Co-60 by Borehole
(Scale 2)
Co-60 (pCi/g - Dry)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Upper
Lower
MDA Upper
MDA Lower
NORTH OF TANK 3
SOUTH OF TANK 1
WEST OF TANK 1
NW OF TANK 1
EAST OF TANK 1
NE OF TANK 1
E OF TANKS 2&3
W OF TANKS 2&3
W OF CHEM TRENCH
E OF CHEM TRENCH
W OF TRENCHES 1&2
E OF TRENCHES 1&2
W OF TRENCH 4-B
E OF TRENCH 4-B
W OF TRENCH 4-A
E OF TRENCH 4-A
WEST OF TRENCH 4
EAST OF TRENCH 4
E TRENCH 11-A
EAST OF TRENCH 6
E OF TRENCHES 7&8
WEST OF TRENCH 8
EAST OF TRENCH 9
EAST OF TRENCH 10
WEST OF TRENCH 11-A
W OF TRENCH 11-A

Cs-137

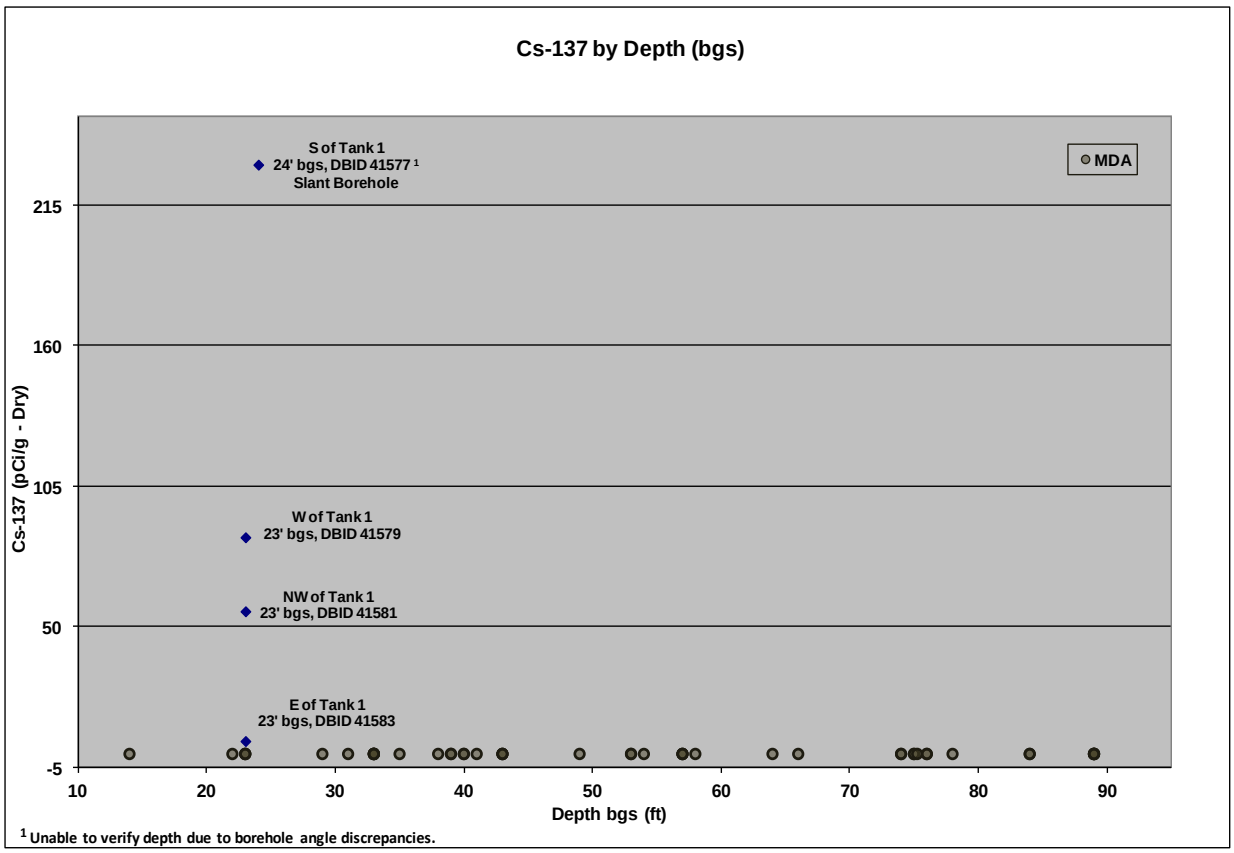
Cesium-137 is found naturally in upper level background soils as a result of fallout from past nuclear events and weapons testing. The investigation sample Cs-137 results were compared against a screening level based on a dataset of background values reported in the U.S. DOE *Hanford Site Background: Part 2* document, Reference 2. The Cs-137 screening level was set at 1.05 pCi/g, based on the 90th percentile of the Hanford background set.

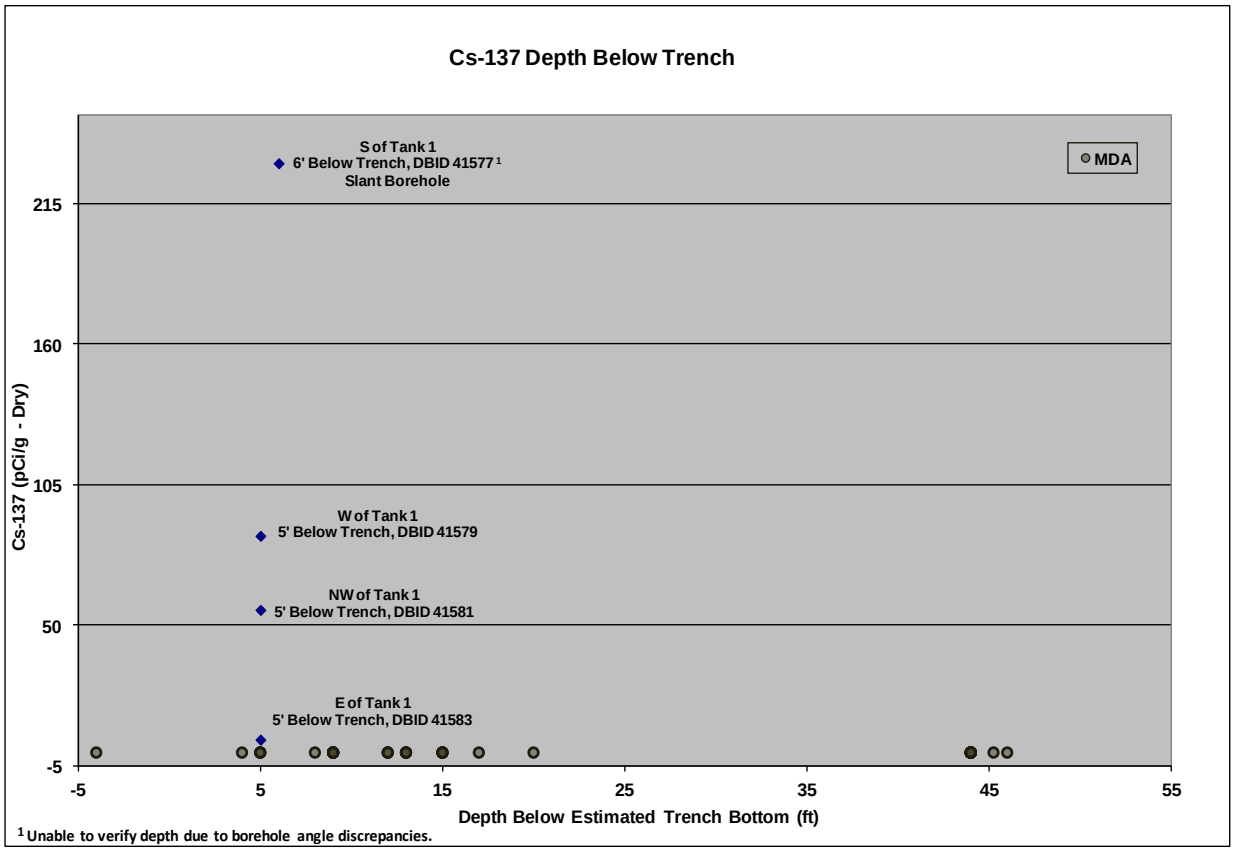
Four upper depth samples from the resin tank area were found to be above both the detection limit and the Cs-137 screening level, as shown in Table 8. Cesium-137 was not detected in the remaining resin tank samples or the upper or lower depth trench area samples. The maximum detection limit for non-detect samples was 3.2E0-2 pCi/g.

Table 8. Elevated Cs-137 Results

DBID	Depth (bgs-ft)	Depth Below Trench Bottom (ft)	Sample Location ID	Site	Result (pCi/g-Dry)	Error (pCi/g)
41577[1]	24	6	B2A	S of Tank 1	231	3.0
41579	23	5	B3A	W of Tank 1	85.0	1.0
41581	23	5	B4A	NW of Tank 1	56.0	0.80
41583	23	5	B5A	E of Tank 1	5.15	0.09

[1] **Unable to verify depth due to borehole angle discrepancies.**


Cs-137 by Depth (bgs)
S of Tank 1
24' bgs, DBID 41577 1
Slant Borehole
MDA
W of Tank 1
23' bgs, DBID 41579
NW of Tank 1
23' bgs, DBID 41581
E of Tank 1
23' bgs, DBID 41583
Cs-137 (pCi/g - Dry)
215
160
105
50
-5
10
20
30
40
50
60
70
80
90
Depth bgs (ft)
1 Unable to verify depth due to borehole angle discrepancies.


Cs-137 Depth Below Trench
S of Tank 1
6' Below Trench, DBID 41577 1
Slant Borehole
MDA
W of Tank 1
5' Below Trench, DBID 41579
NW of Tank 1
5' Below Trench, DBID 41581
E of Tank 1
5' Below Trench, DBID 41583
Cs-137 (pCi/g - Dry)
215
160
105
50
-5
-5
5
15
25
35
45
55
Depth Below Estimated Trench Bottom (ft)
1 Unable to verify depth due to borehole angle discrepancies.

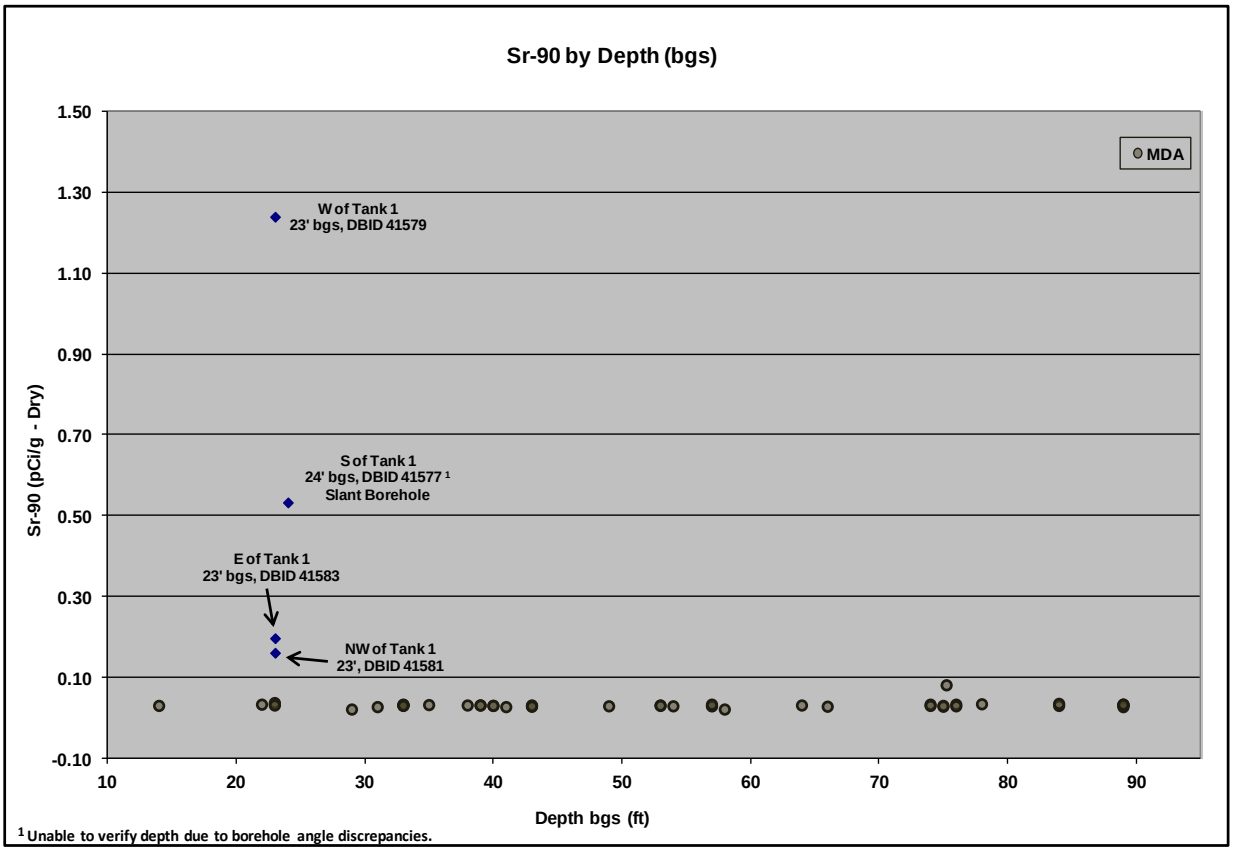
Sr-90

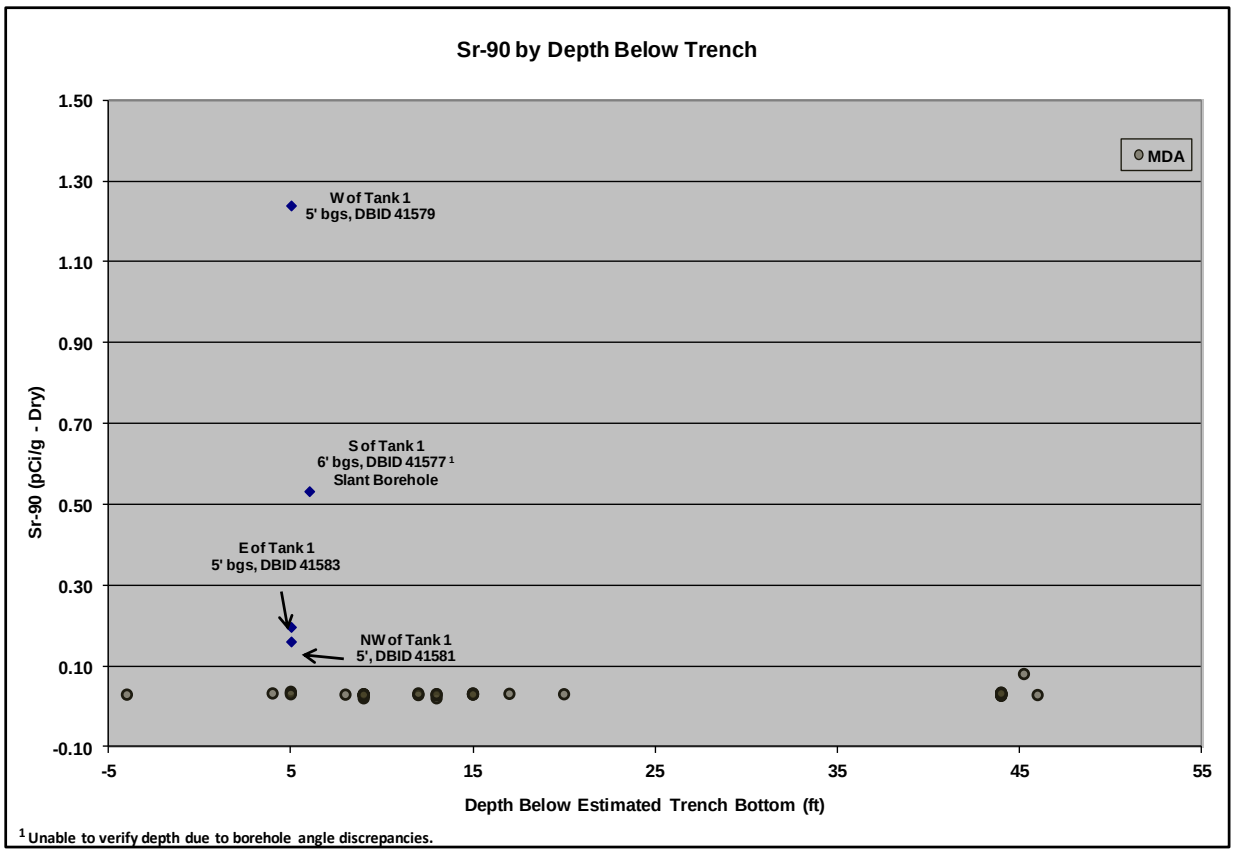
Strontium-90 is not found naturally in background soils. Strontium-90 was detected in four upper depth samples from the resin tank area, as shown in Table 9. Strontium-90 was not detected in the remaining resin tank samples or the upper or lower depth trench area samples. The maximum detection limit for non-detect samples was 8.0E0-2 pCi/g.

Table 9. Elevated Sr-90 Results

DBID	Depth (bgs-ft)	Depth Below Trench Bottom (ft)	Sample Location ID	Site	Result (pCi/g-Dry)	Error (pCi/g)
41577[1]	24	6	B2A	S of Tank 1	5.33E-01	4.3E-02
41579	23	5	B3A	W of Tank 1	1.24E+00	6.0E-02
41581	23	5	B4A	NW of Tank 1	1.61E-01	2.9E-02
41583	23	5	B5A	E of Tank 1	1.97E-01	2.9E-02

[1] **Unable to verify depth due to borehole angle discrepancies.**



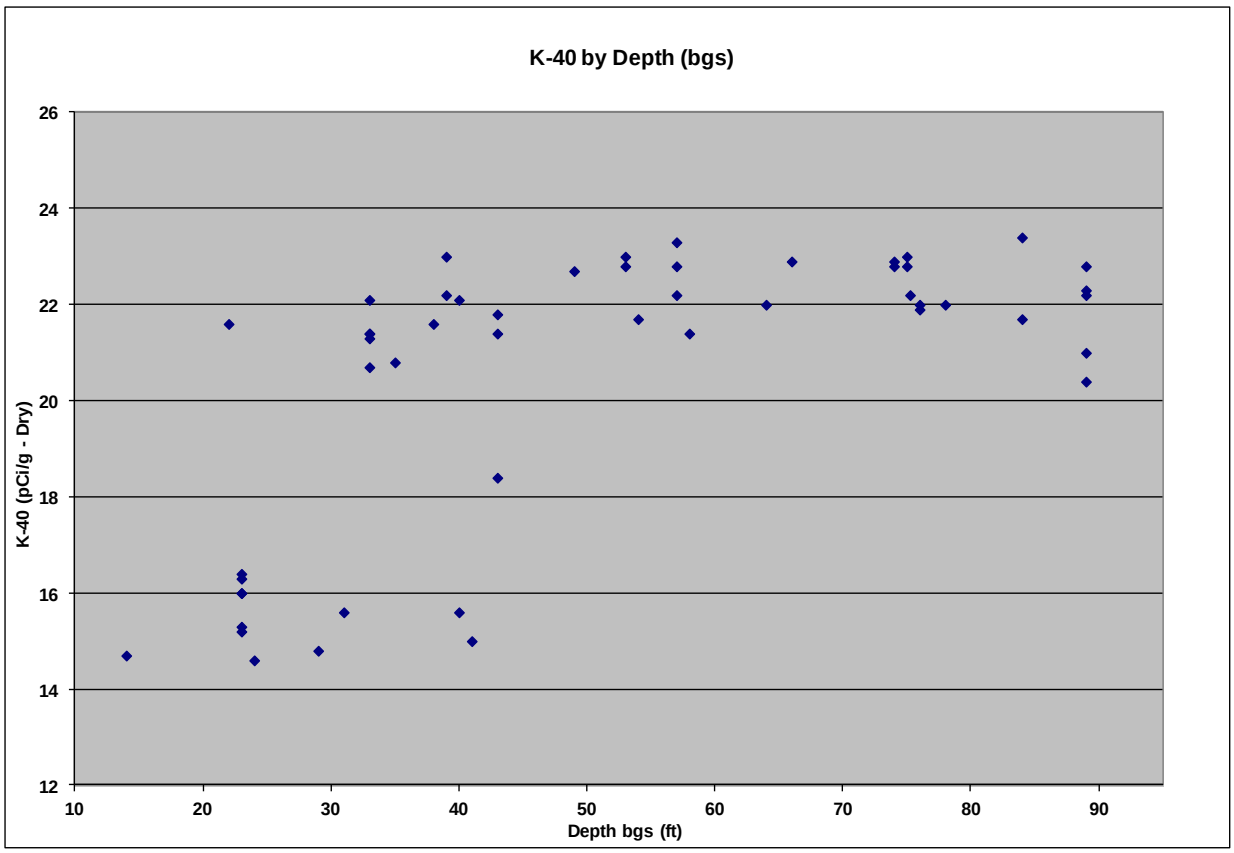


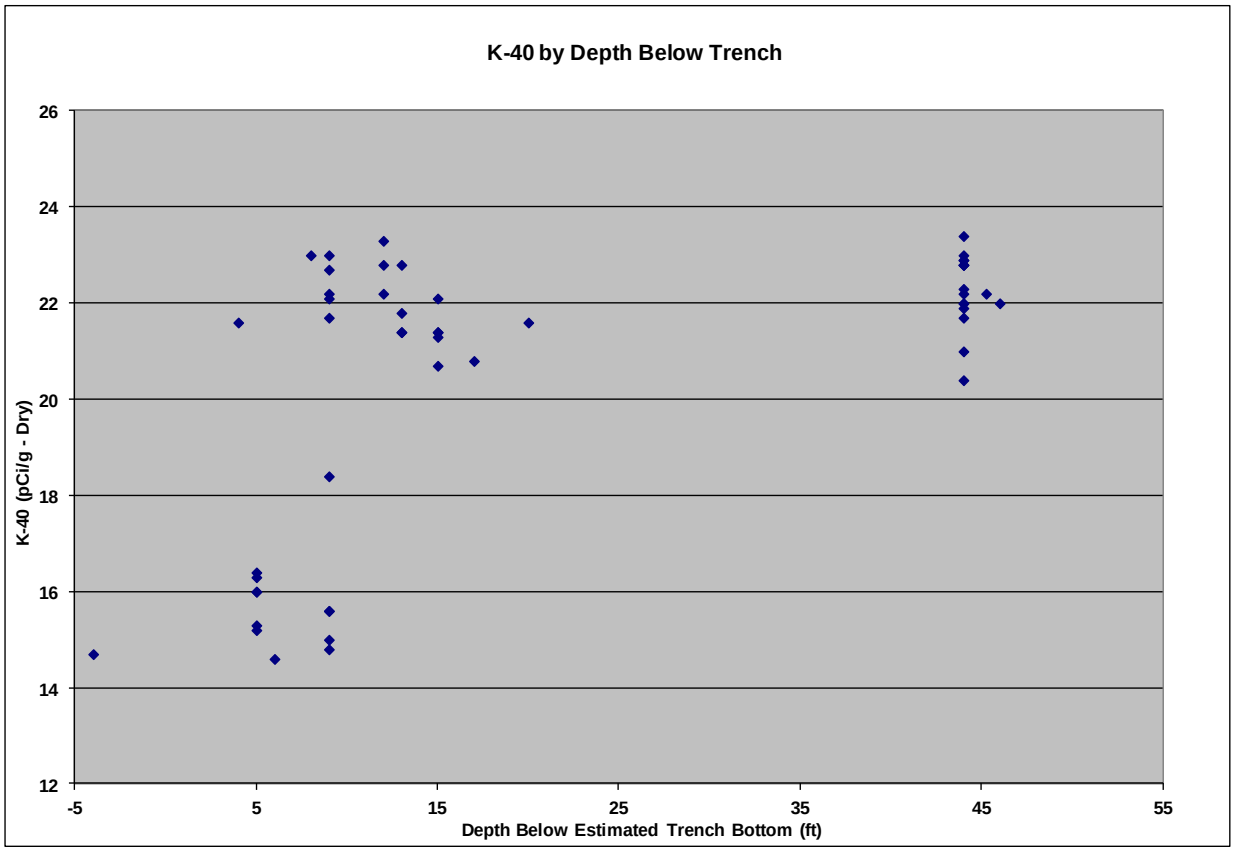
K-40

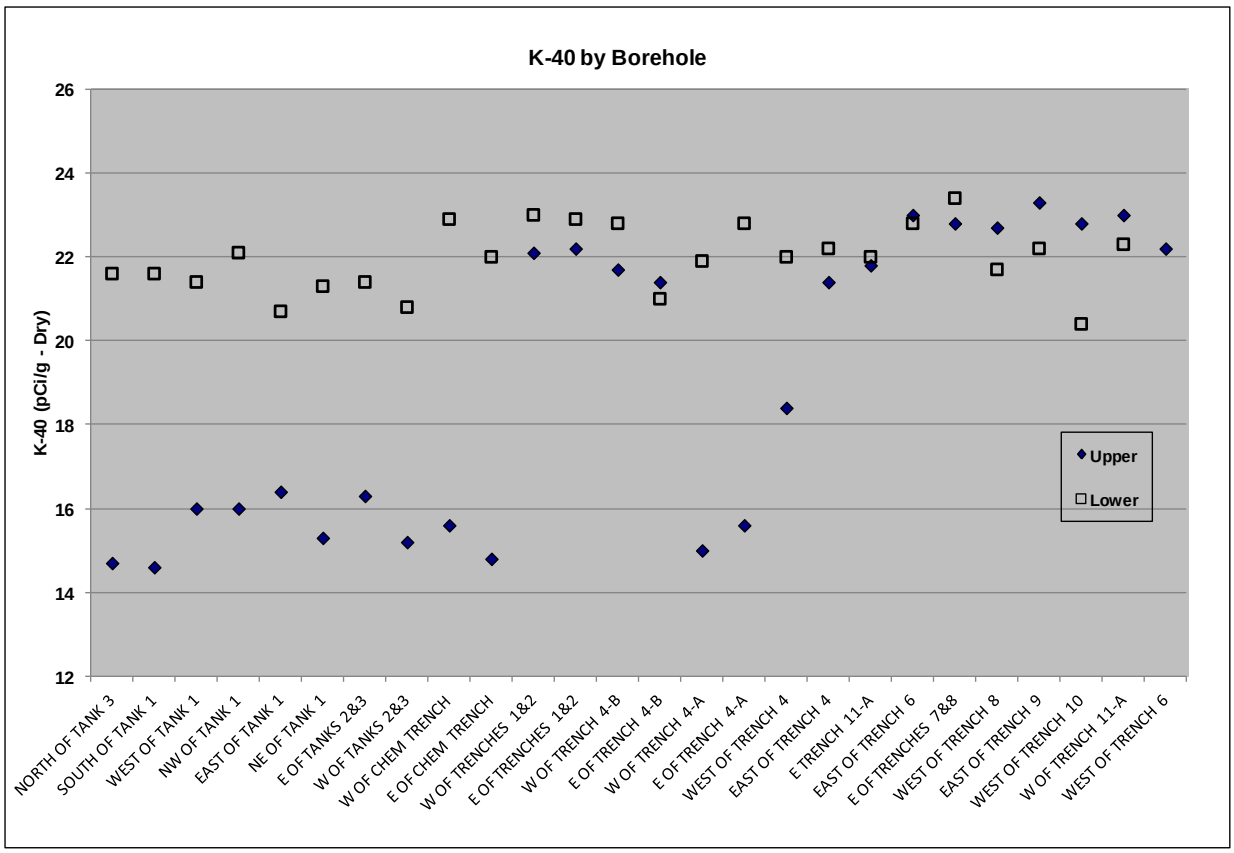
Potassium-40 is a found naturally in the environmental and reported for informational purposes only, as shown in Table 10.

Table 10. K-40 Results (pCi/g – Dry)

	Number	Min	Max	Mean	Median	Std Dev	Variance
K-40	51	14.6	23.4	20.5	21.7	2.9	8.6


K-40 by Depth (bgs)
K-40 (pCi/g - Dry)
26
24
22
20
18
16
14
12
10
20
30
40
50
60
70
80
90
Depth bgs (ft)


K-40 by Depth Below Trench
K-40 (pCi/g - Dry)
26
24
22
20
18
16
14
12
-5
5
15
25
35
45
55
Depth Below Estimated Trench Bottom (ft)



H-3

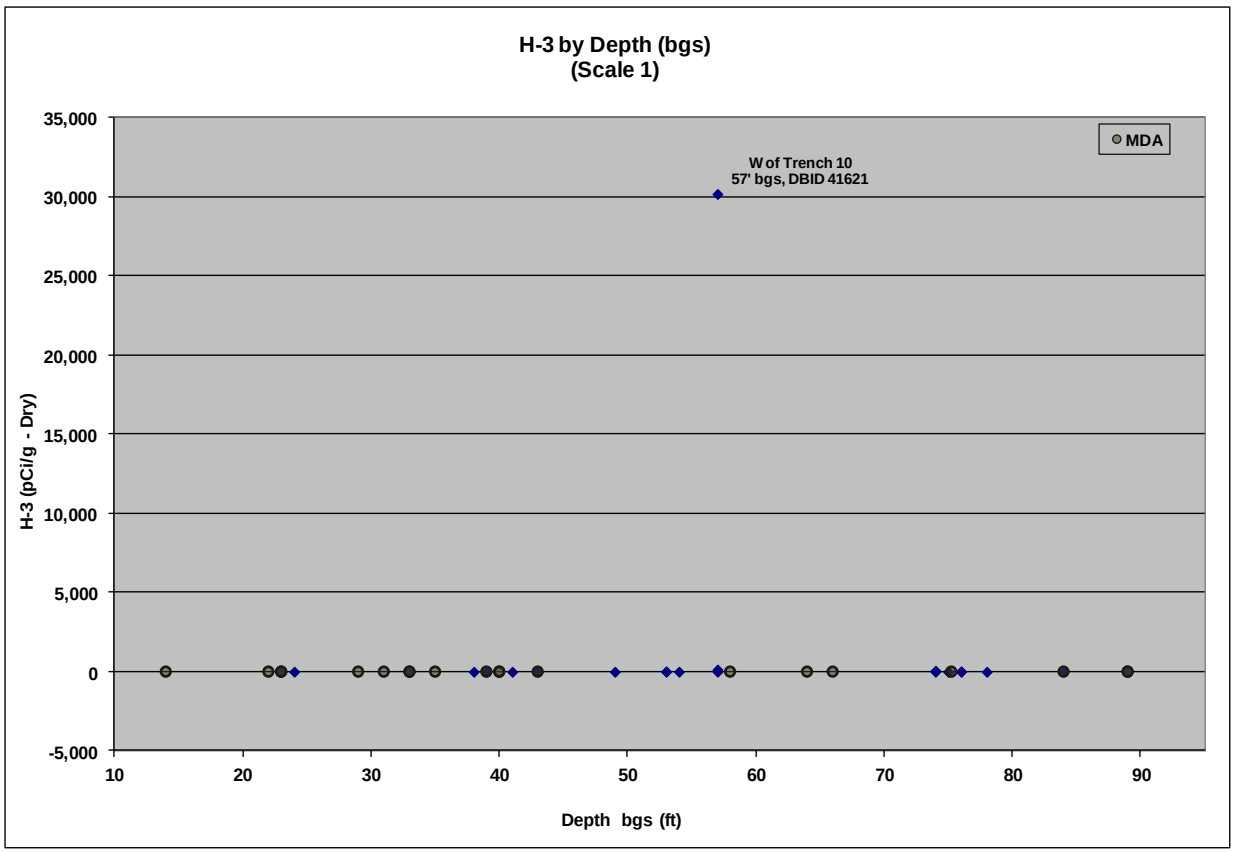
Tritium in soils has not been previously investigated. Tritium was detected in numerous locations in the upper and lower sampling depths in both the resin tank and trench areas, as shown in Table 11. Tritium was not detected in the remaining resin tank samples or the upper or lower depth trench area samples. The maximum detection limit for the non-detect samples was 6.4E-01 pCi/g.

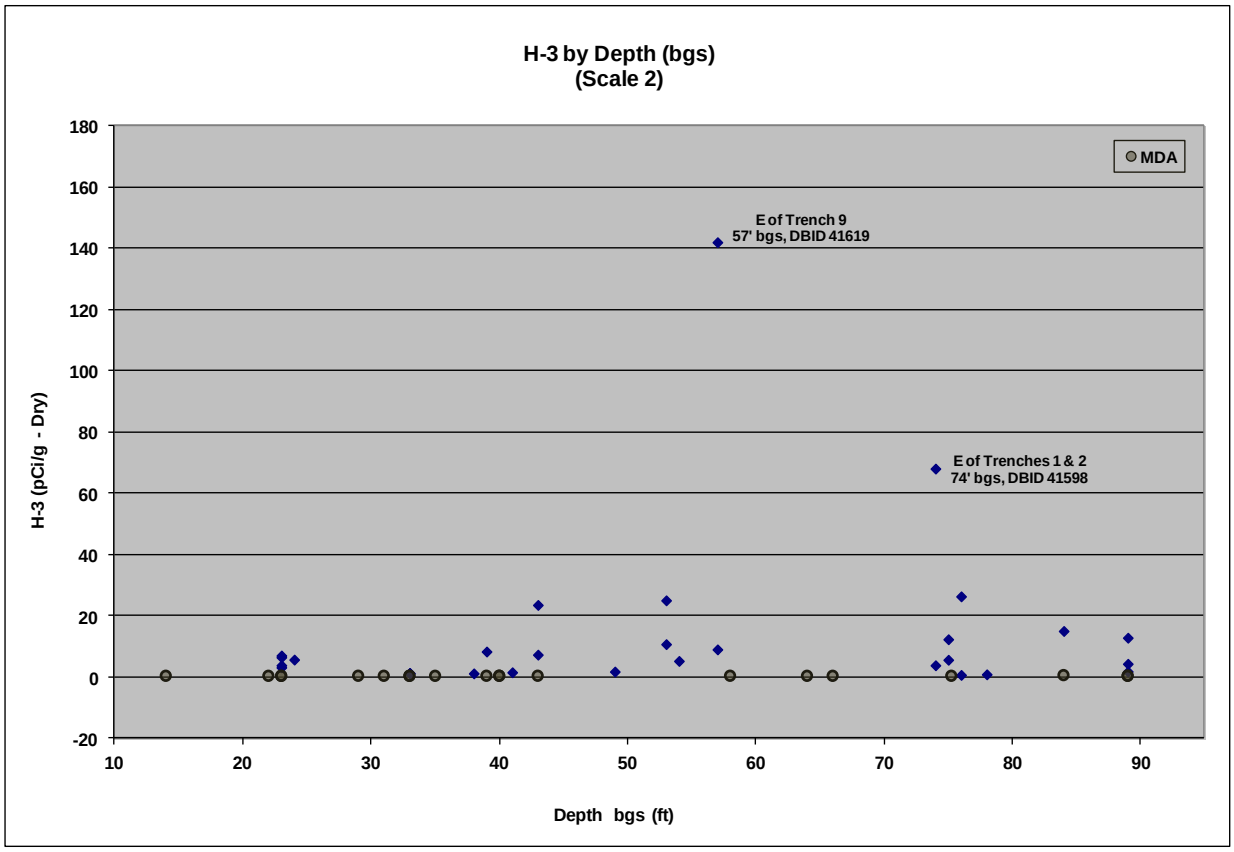
Table 11. Elevated H-3 Results

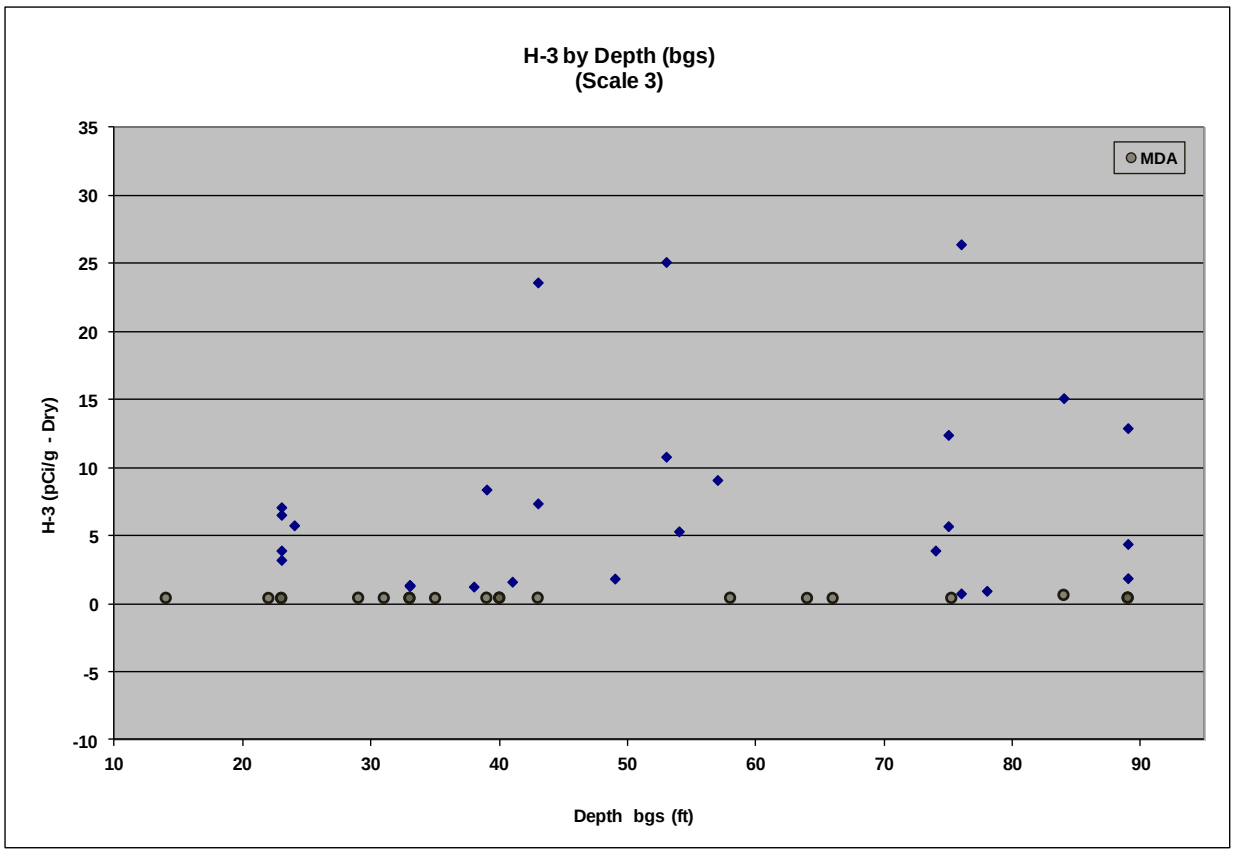
DBID	Depth (bgs-ft)	Depth Below Trench Bottom (ft)	Sample Location ID	Site	Result (pCi/g-Dry)	Error (pCi/g)
41577[1]	24	6	B2A	S of Tank 1	5.76	0.41
41578[1]	38	20	B2B	S of Tank 1	1.26	2.9E-01
41579	23	5	B3A	W of Tank 1	7.09	0.44
41581	23	5	B4A	NW of Tank 1	6.53	0.67
41582	33	15	B4B	NW of Tank 1	1.35	0.48
41583	23	5	B5A	E of Tank 1	3.91	0.58
41584	33	15	B5B	E of Tank 1	1.30	0.47

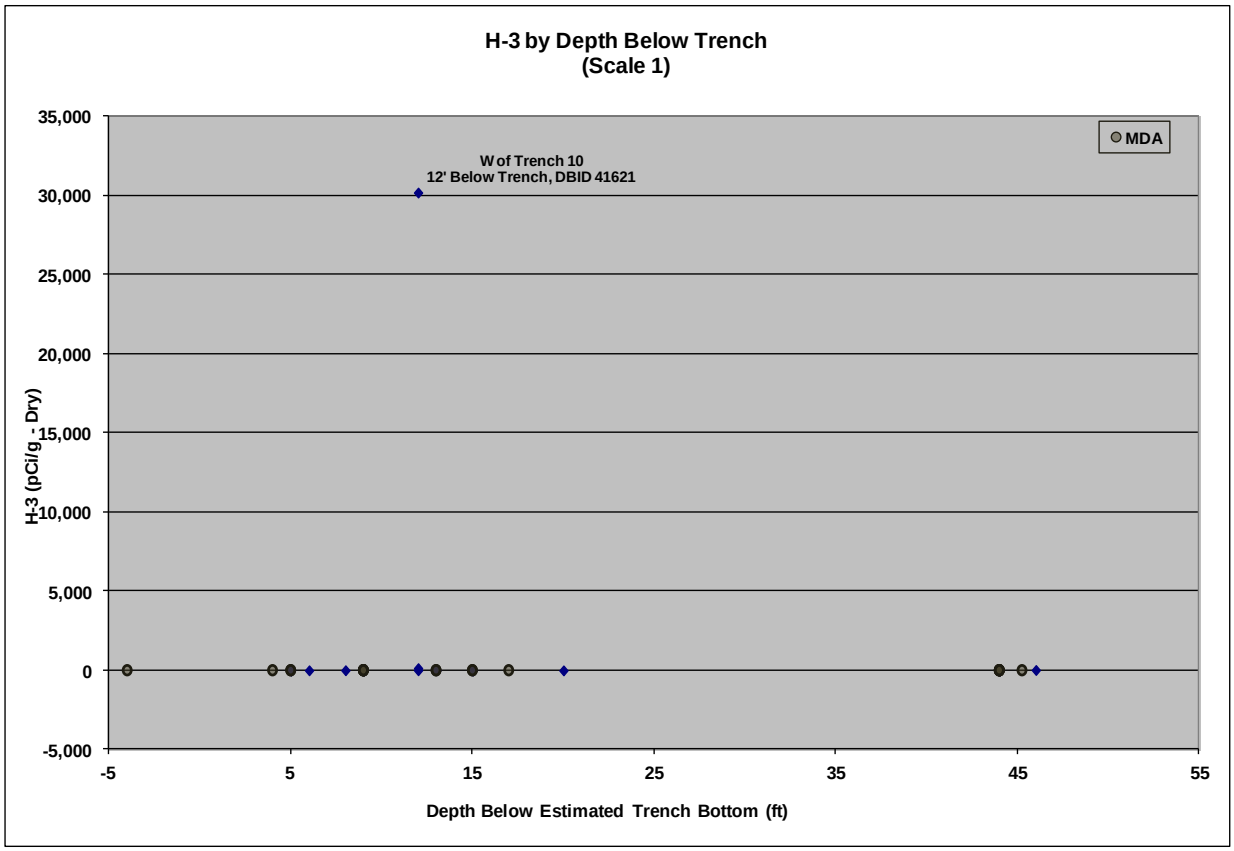
DBID	Depth (bgs-ft)	Depth Below Trench Bottom (ft)	Sample Location ID	Site	Result (pCi/g-Dry)	Error (pCi/g)
41585	23	5	B6A	NE of Tank 1	3.22	0.55
41586	33	15	B6B	NE of Tank 1	1.38	0.49
41596	75	44	B12B	W of Trenches 1&2	12.4	0.60
41598	74	44	B13B	E of Trenches 1&2	68.1	1.1
41599	54	9	B14A	W of Trench 4-B	5.32	0.41
41603	41	9	B16A	W of Trench 4-A	1.62	0.31
41604	76	44	B16B	W of Trench 4-A	0.76	0.28
41606	75	44	B17B	E of Trench 4-A	5.70	0.41
41607	43	9	B18A	W of Trench 4	23.6	0.70
41608	78	44	B18B	W of Trench 4	0.95	0.29
41611	43	13	B20A	E of Trench 11-A	7.37	0.54
41612	76	46	B20B	E of Trench 11-A	26.4	0.80
41613	39	9	B21A	E of Trench 6	8.39	0.56
41614	74	44	B21B	E of Trench 6	3.91	0.47
41615	53	13	B22A	E of Trenches 7&8	25.1	0.80
41616	84	44	B22B	E of Trenches 7&8	15.1	0.70
41617	49	9	B23A	W of Trench 8	1.85	0.43
41619	57	12	B24A	E of Trench 9	142	2.0
41620	89	44	B24B	E of Trench 9	12.9	0.60
41621	57	12	B25A	W of Trench 10	3.02E+04	20
41622[2]	89	44	B25B	W of Trench 10	1.88	0.41
41623	53	8	B26A	W of Trench 11-A	10.8	0.60
41624	89	44	B26B	W of Trench 11-A	4.39	0.48
41625	57	12	B27A	W of Trench 6	9.09	0.57

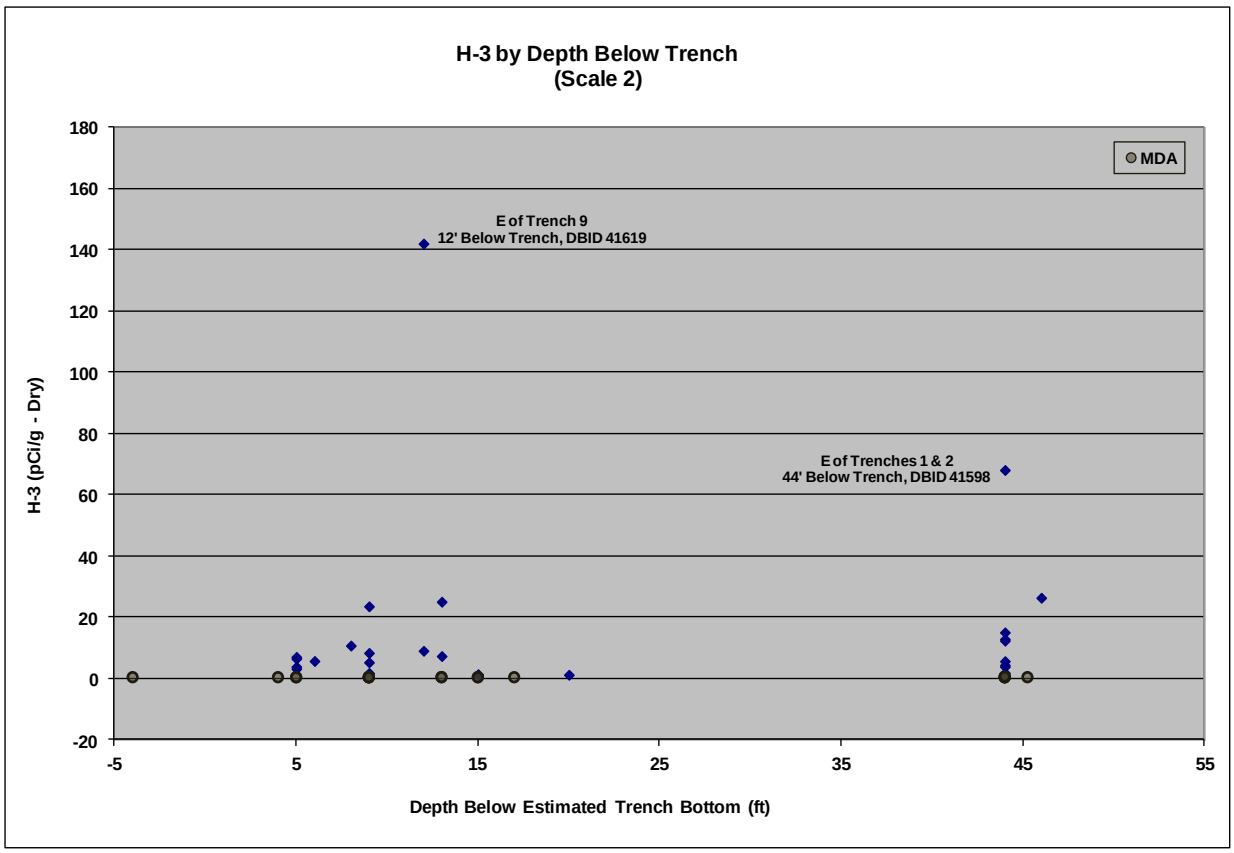
[1] Unable to verify depth due to borehole angle discrepancies.
[2] Result biased low due to moisture loss from storage.

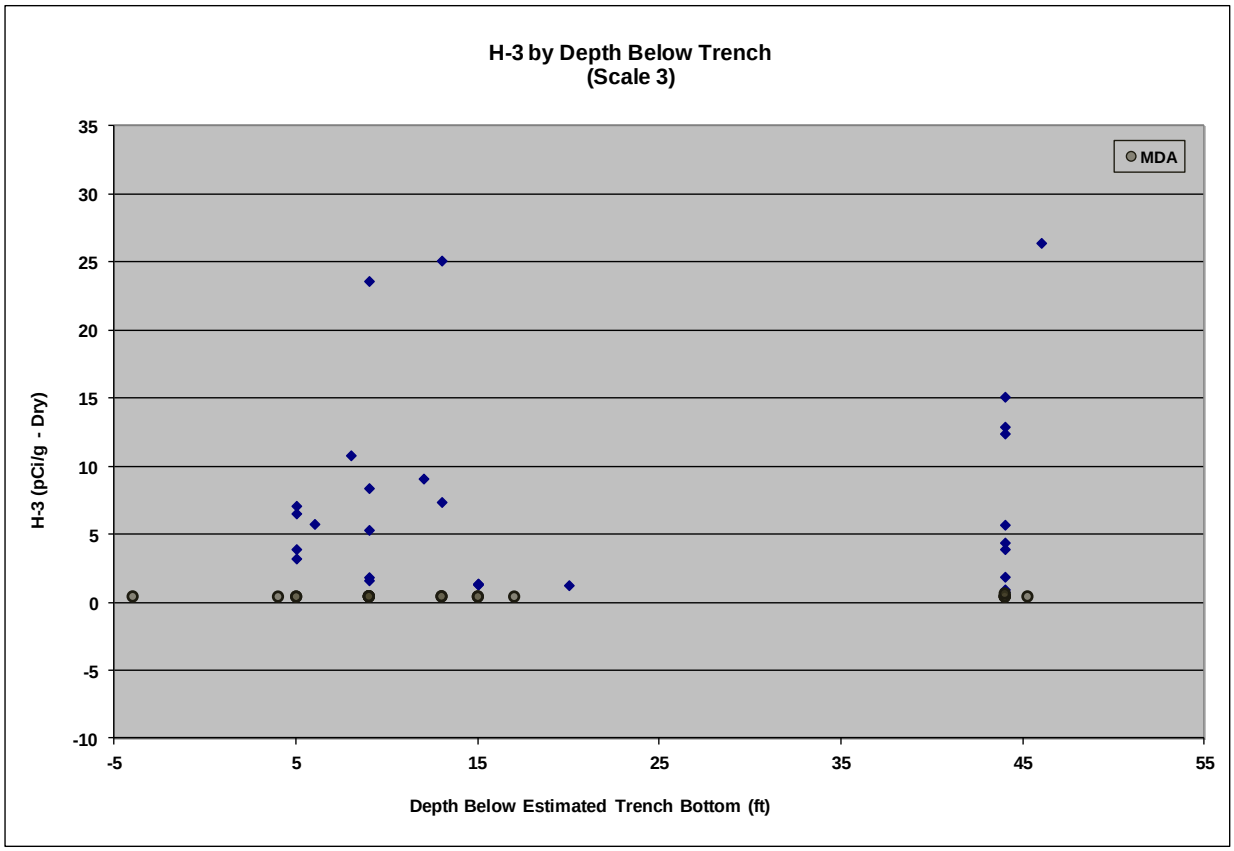

H-3 by Depth (bgs)
(Scale 1)
MDA
W of Trench 10
57' bgs, DBID 41621
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
-5,000
H-3 (pCi/g - Dry)
10
20
30
40
50
60
70
80
90
Depth bgs (ft)

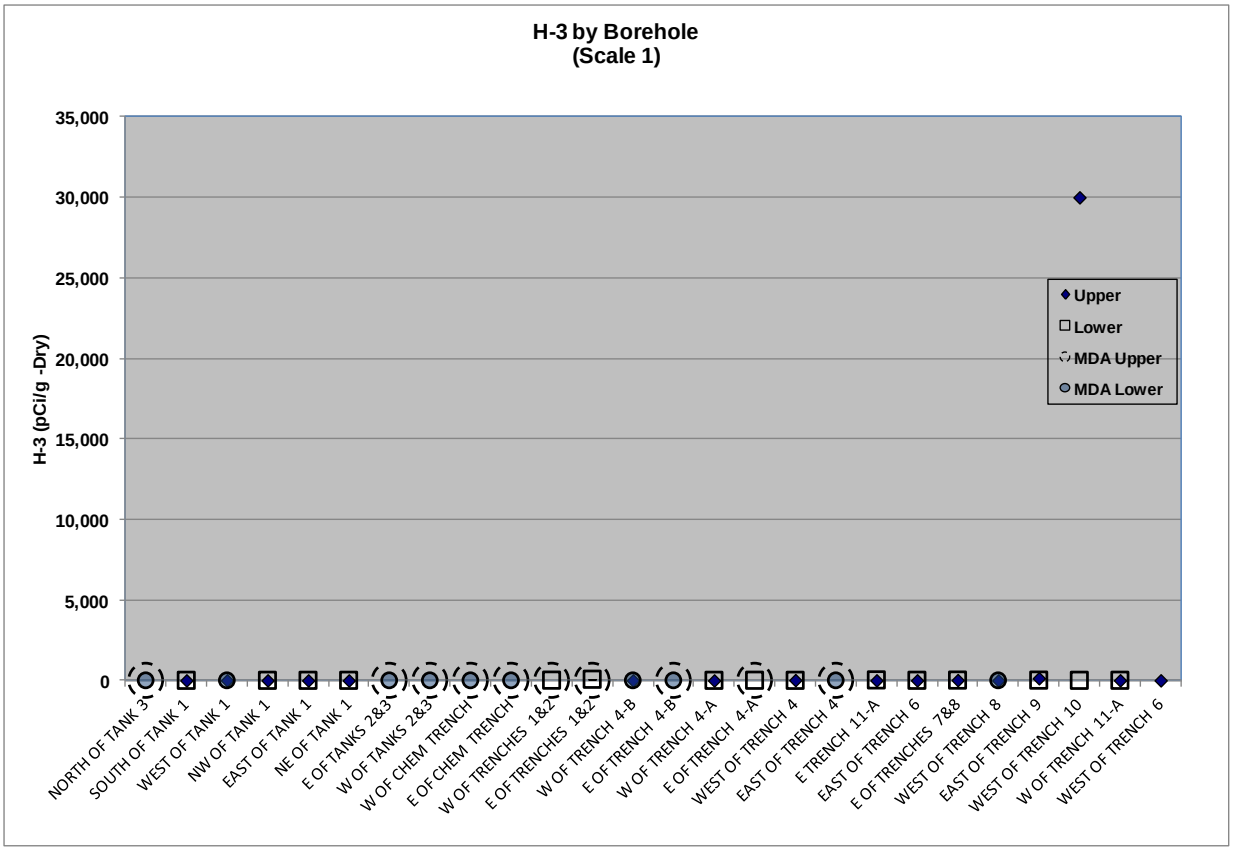

H-3 by Depth (bgs)
(Scale 2)
MDA
E of Trench 9
57' bgs, DBID 41619
E of Trenches 1 & 2
74' bgs, DBID 41598
180
160
140
120
100
80
60
40
20
0
-20
H-3 (pCi/g - Dry)
10
20
30
40
50
60
70
80
90
Depth bgs (ft)

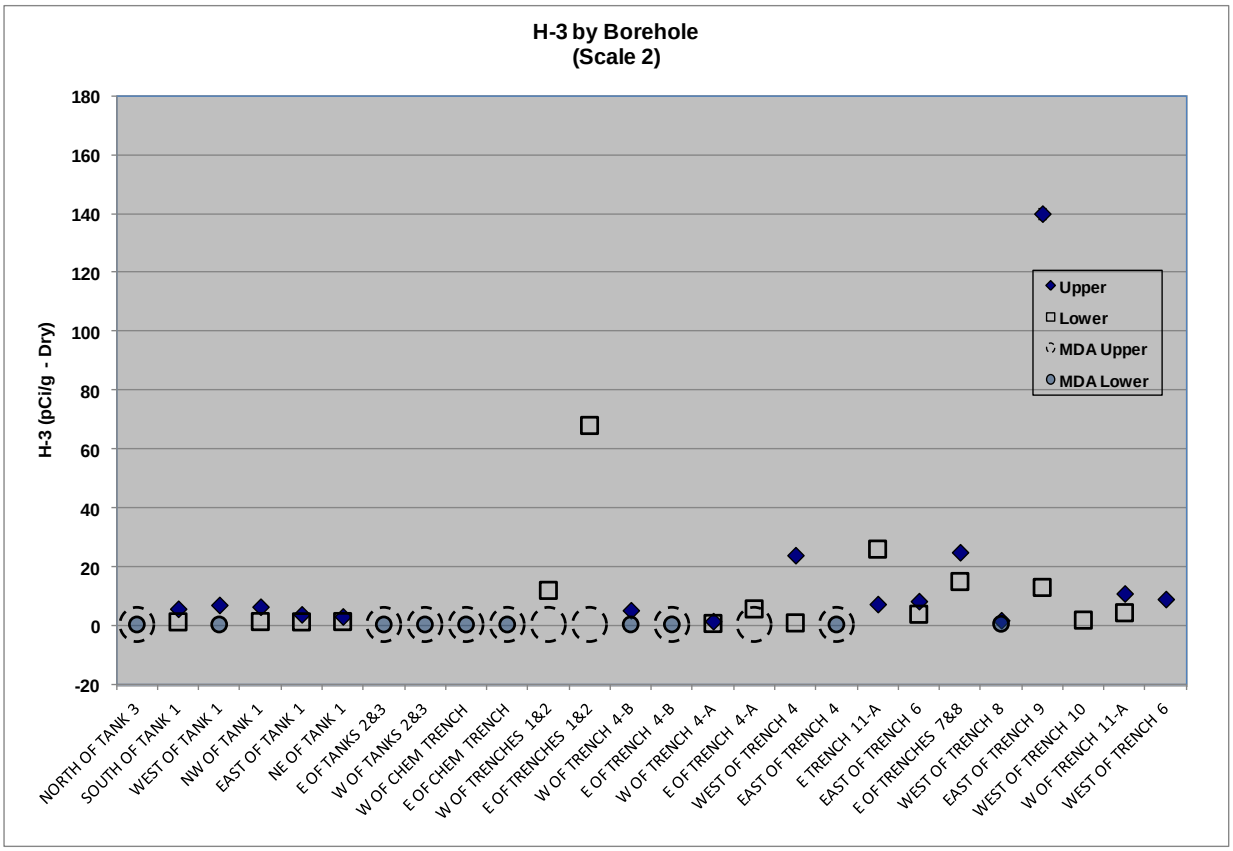

H-3 by Depth (bgs)
(Scale 3)
MDA
H-3 (pCi/g - Dry)
35
30
25
20
15
10
5
0
-5
-10
10
20
30
40
50
60
70
80
90
Depth bgs (ft)

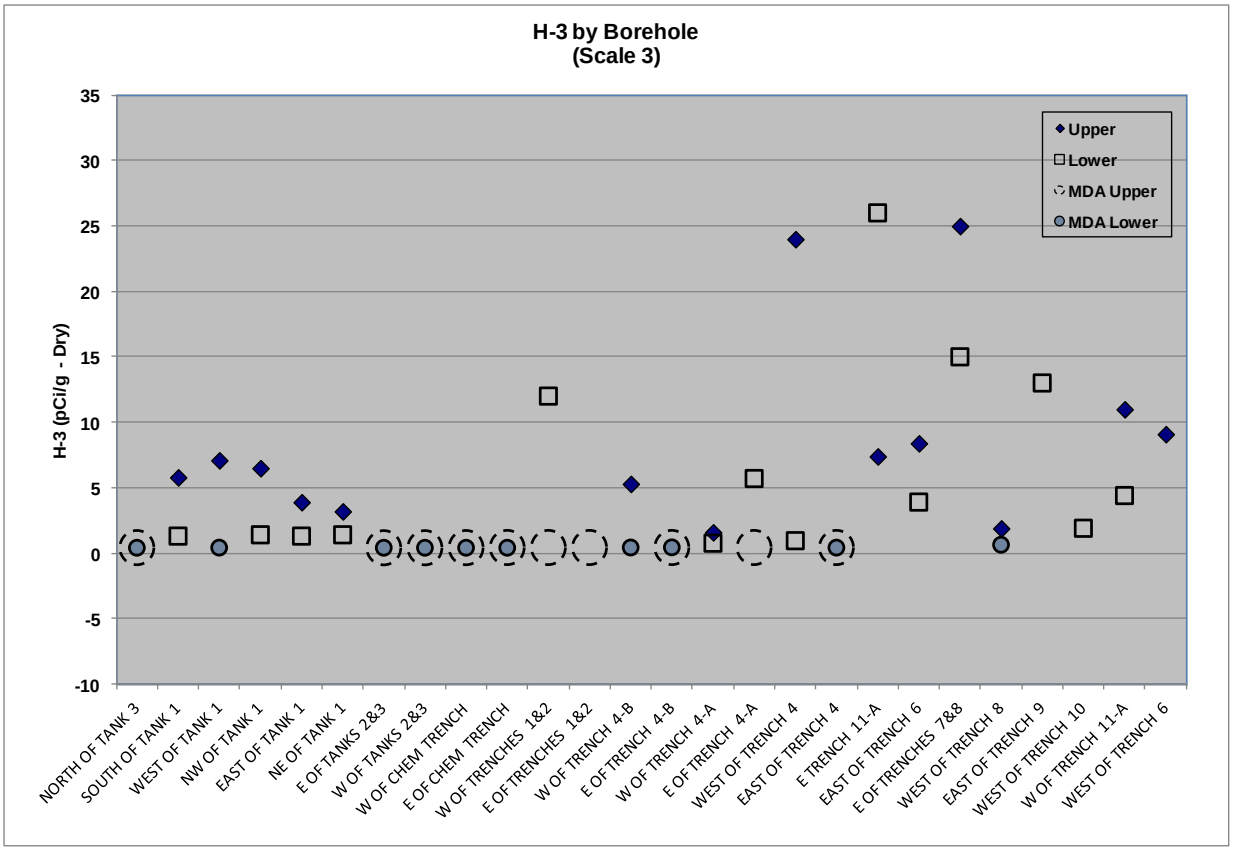

H-3 by Depth Below Trench
(Scale 1)
MDA
W of Trench 10
12' Below Trench, DBID 41621
H-3 (pCi/g - Dry)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
-5,000
-5
5
15
25
35
45
55
Depth Below Estimated Trench Bottom (ft)


H-3 by Depth Below Trench
(Scale 2)
MDA
E of Trench 9
12' Below Trench, DBID 41619
E of Trenches 1 & 2
44' Below Trench, DBID 41598
H-3 (pCi/g - Dry)
Depth Below Estimated Trench Bottom (ft)
180
160
140
120
100
80
60
40
20
0
-20
-5
5
15
25
35
45
55


H-3 by Depth Below Trench
(Scale 3)
MDA
H-3 (pCi/g - Dry)
Depth Below Estimated Trench Bottom (ft)
35
30
25
20
15
10
5
0
-5
-10
-5
5
15
25
35
45
55


H-3 by Borehole
(Scale 1)
H-3 (pCi/g -Dry)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Upper
Lower
MDA Upper
MDA Lower
NORTH OF TANK 3
SOUTH OF TANK 1
WEST OF TANK 1
NW OF TANK 1
EAST OF TANK 1
NE OF TANK 1
E OF TANKS 2&3
W OF TANKS 2&3
W OF CHEM TRENCH
E OF CHEM TRENCH
W OF TRENCHES 1&2
E OF TRENCHES 1&2
W OF TRENCH 4-B
E OF TRENCH 4-B
W OF TRENCH 4-A
E OF TRENCH 4-A
WEST OF TRENCH 4
EAST OF TRENCH 4
E TRENCH 11-A
EAST OF TRENCH 6
E OF TRENCHES 7&8
WEST OF TRENCH 8
EAST OF TRENCH 9
WEST OF TRENCH 10
W OF TRENCH 11-A
WEST OF TRENCH 6


H-3 by Borehole
(Scale 2)
H-3 (pCi/g - Dry)
180
160
140
120
100
80
60
40
20
0
-20
Upper
Lower
MDA Upper
MDA Lower
NORTH OF TANK 3
SOUTH OF TANK 1
WEST OF TANK 1
NW OF TANK 1
EAST OF TANK 1
NE OF TANK 1
E OF TANKS 2&3
W OF TANKS 2&3
W OF CHEM TRENCH
E OF CHEM TRENCH
W OF TRENCHES 1&2
E OF TRENCHES 1&2
W OF TRENCH 4-B
E OF TRENCH 4-B
W OF TRENCH 4-A
E OF TRENCH 4-A
WEST OF TRENCH 4
EAST OF TRENCH 4
E TRENCH 11-A
EAST OF TRENCH 6
E OF TRENCHES 7&8
WEST OF TRENCH 8
EAST OF TRENCH 9
WEST OF TRENCH 10
W OF TRENCH 11-A
WEST OF TRENCH 6

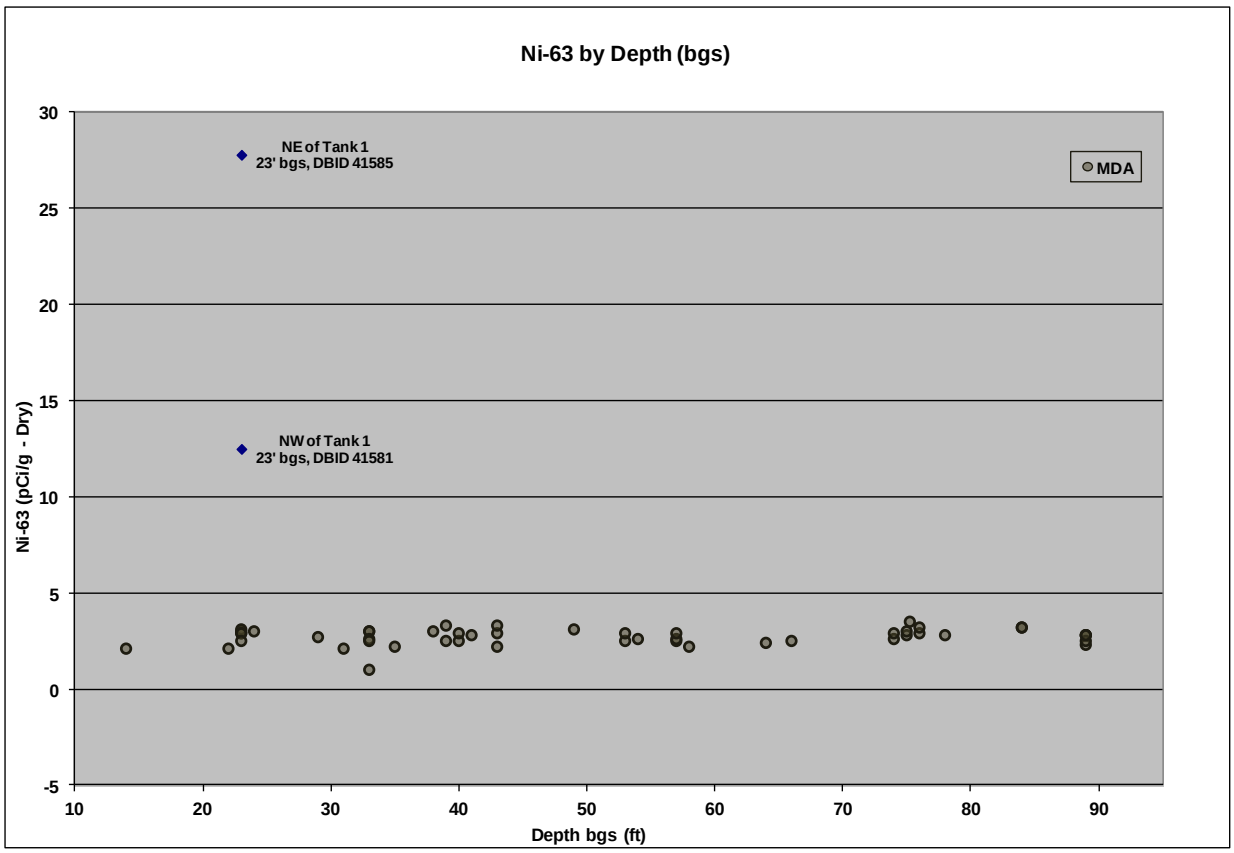


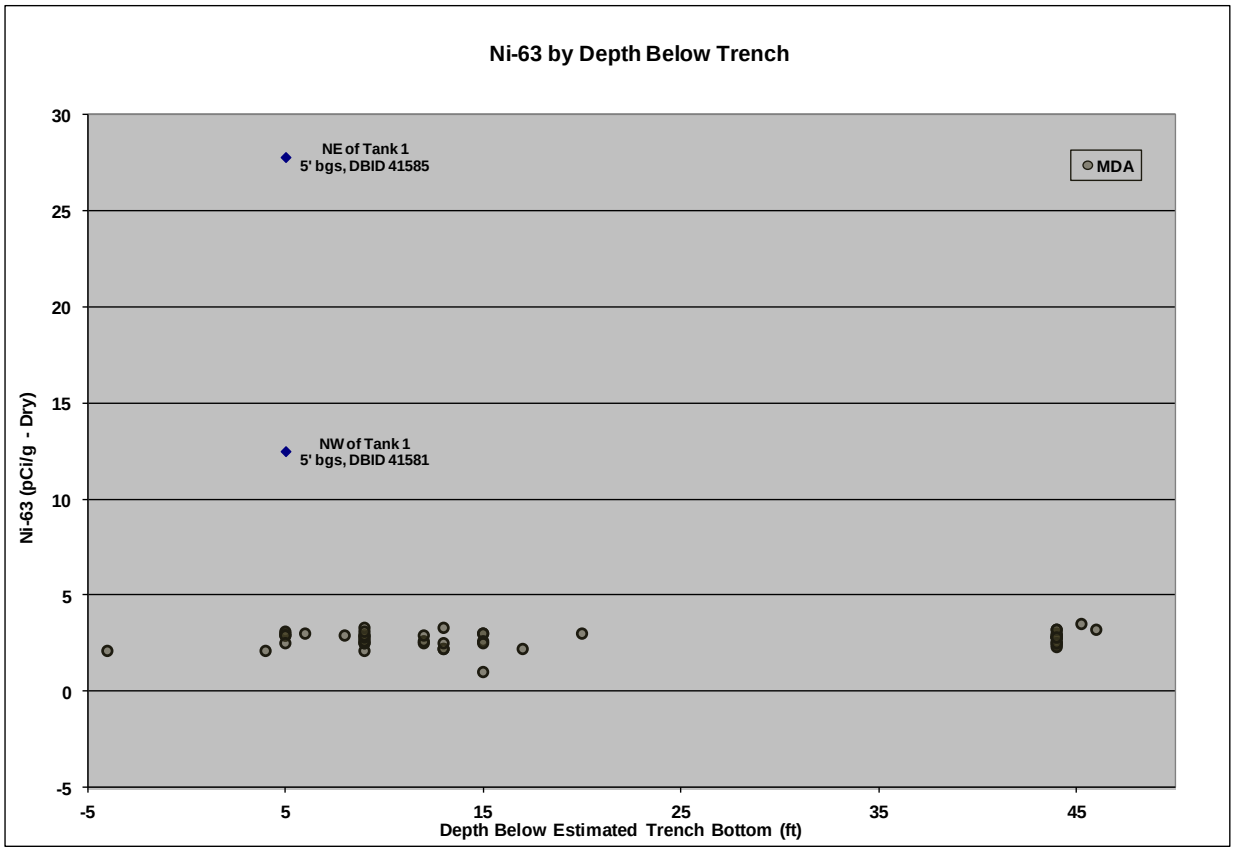
Ni-63

Nickel-63 is not found naturally in background soils. Nickel-63 was detected in two upper depth samples from the resin tank area, as shown in Table 12. Nickel-63 was not detected in the remaining resin tank samples or the upper or lower depth trench area samples. The maximum detection limit for the non-detect samples was 3.5 pCi/g.

Table 12. Elevated Ni-63 Results

DBID	Depth (bgs-ft)	Depth Below Trench Bottom (ft)	Sample Location ID	Site	Result (pCi/g-Wet)	Error (pCi/g)
41581	23	5	B4A	NW of Tank 1	12.5	2.1
41585	23	5	B6A	NE of Tank 1	27.8	2.9


Ni-63 by Depth (bgs)
NE of Tank 1
23' bgs, DBID 41585
NW of Tank 1
23' bgs, DBID 41581
MDA
Ni-63 (pCi/g - Dry)
Depth bgs (ft)
30
25
20
15
10
5
0
-5
10
20
30
40
50
60
70
80
90


Ni-63 by Depth Below Trench
NE of Tank 1
5' bgs, DBID 41585
NW of Tank 1
5' bgs, DBID 41581
MDA
Ni-63 (pCi/g - Dry)
Depth Below Estimated Trench Bottom (ft)
30
25
20
15
10
5
0
-5
-5
5
15
25
35
45

Tc-99

Technetium-99 is not found naturally in background soils. Technetium-99 was not detected in any upper or lower depth samples from the resin tank or trench areas. The maximum detection limit for non-detect samples was 2.9E-01 pCi/g.

I-129

Iodine-129 is not found naturally in background soils. Iodine-129 was not detected in any upper or lower depth samples from the resin tank or trench areas. The maximum detection limit was 15 pCi/g.

Ra-226

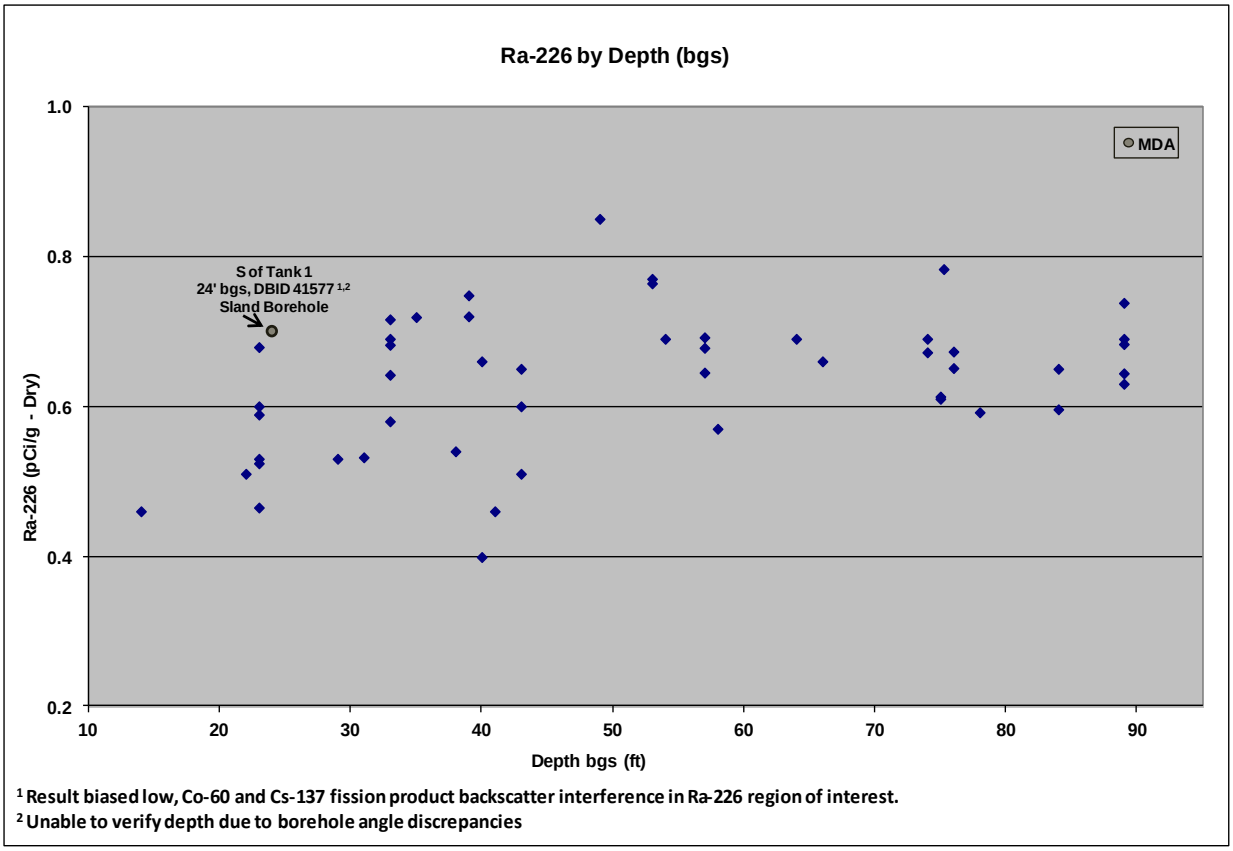
Radium-226 is found in natural background soils. The investigation sample Ra-226 results were compared against a screening level based on a dataset of background values reported in the U.S. DOE *Hanford Site Background: Part 2* document, Reference 2. The Ra-226 screening level was set at 0.815 pCi/g, based on the 90th percentile of the Hanford background set.

Radium-226 was not detected, at a 95% confidence level above the screening level, in any upper or lower depth samples from the resin tank or trench areas, as shown in Table 13.

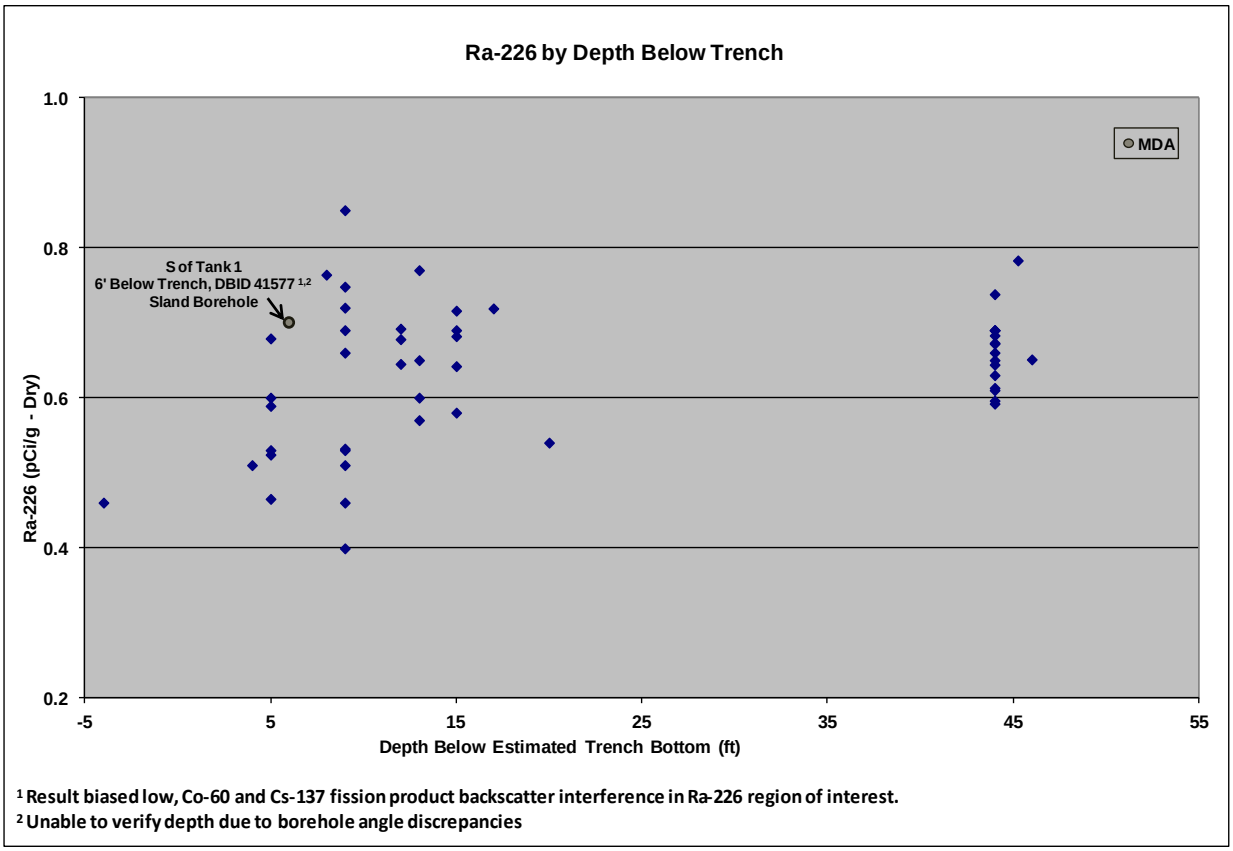
Table 13. Ra-226 Results (pCi/g - Dry)

	Number[1]	Min	Max	Mean	Median	Std Dev	Variance
Ra-226	50	0.40	0.85	0.63	0.65	0.09	0.01

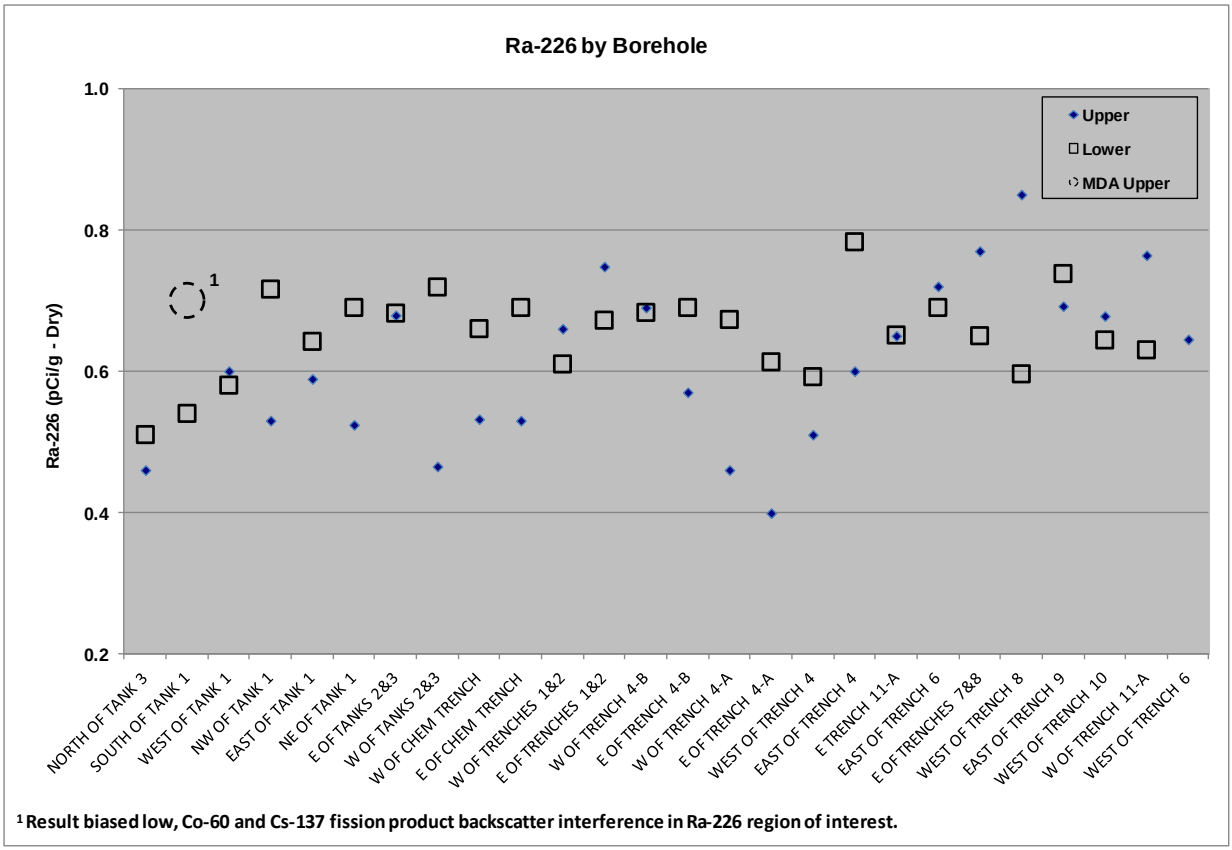
[1] Table excludes Ra-226 result for DBID 41577 due to result biased low, Co-60 and Cs-137 fission product backscatter interference in Ra-226 region of interest.



[1] Result biased low, Co-60 and Cs-137 fission product backscatter interference in Ra-226 region of interest.
[2] Unable to verify depth due to borehole angle discrepancies



[1] Result biased low, Co-60 and Cs-137 fission product backscatter interference in Ra-226 region of interest.
[2] Unable to verify depth due to borehole angle discrepancies



[1] Result biased low, Co-60 and Cs-137 fission product backscatter interference in Ra-226 region of interest.

Pu-238

Plutonium-238 is not found naturally in background soils. Plutonium-238 was not detected in any upper or lower depth samples from the resin tank or trench areas. The maximum detection limit for non-detect samples was 3.4E-02 pCi/g.

Pu-239/240

Plutonium-239/240 is not found naturally in background soils. Plutonium-239/240 was not detected in any upper or lower depth samples from the resin tank or trench areas. The maximum detection limit for non-detect samples was 2.3E-02 pCi/g.

U-234

Uranium-234 is found in natural background soils. The investigation sample U-234 results were compared against a screening level based on a dataset of background values reported in the U.S. DOE *Hanford Site Background: Part 2* document, Reference 2. The U-234 screening level was set at 1.10 pCi/g, based on the 90th percentile of the Hanford background set.

One upper depth sample from the resin tank area was found to be above the U-234 screening level, as shown in Table 14. The remaining resin tank samples and the upper and lower depth trench area samples were all below the screening level, as shown in Table 15.

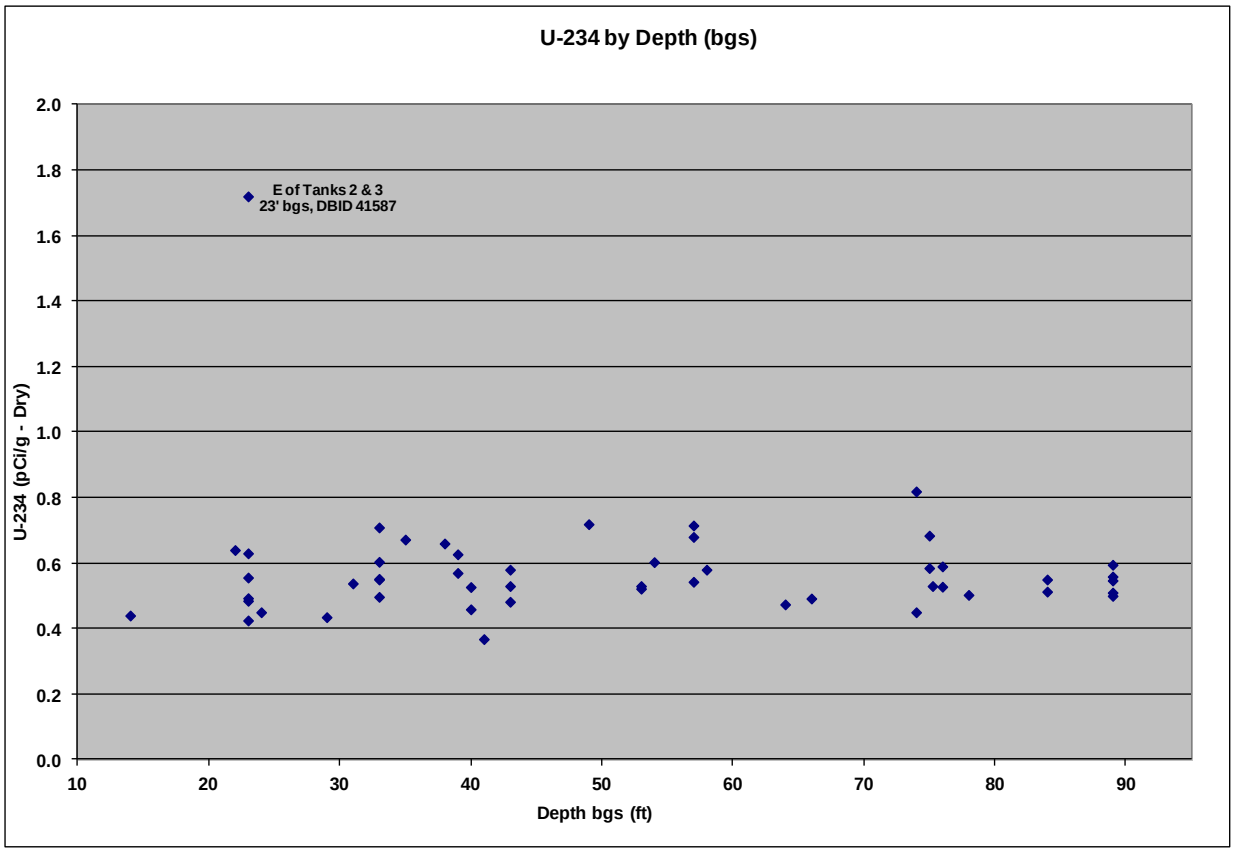
Table 14. Elevated U-234 Results

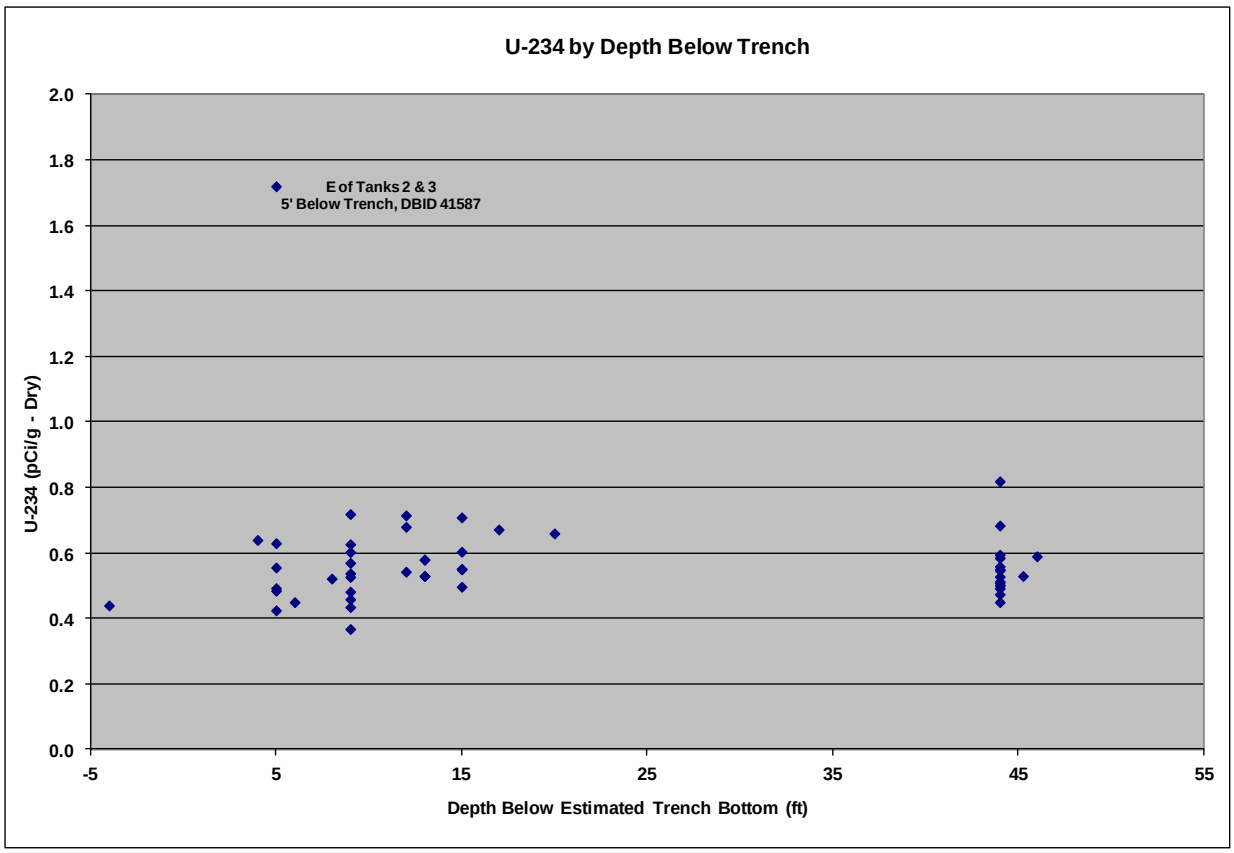
DBID	Depth (bgs-ft)	Depth Below Trench Bottom (ft)	Sample Location ID	Site	Result (pCi/g-Dry)	Error (pCi/g)
41587	23	5	B7A	E of Tanks 2&3	1.72	0.13

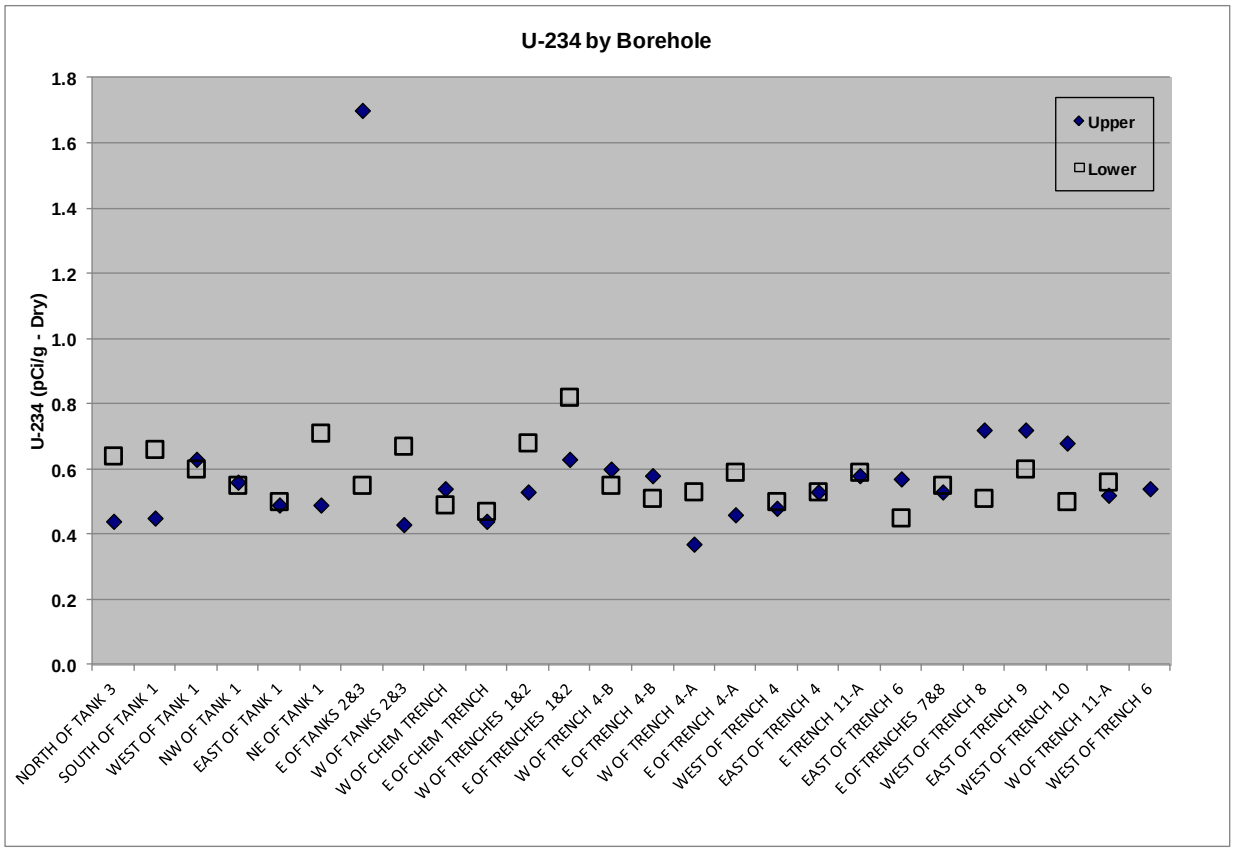
Table 15. U-234 Results (pCi/g - Dry)

	Number[1]	Min	Max	Mean	Median	Std Dev	Variance
U-234	50	0.37	0.82	0.56	0.55	0.09	0.01

[1] **Table excludes U-234 result for DBID 41587.**




U-234 by Depth Below Trench
E of Tanks 2 & 3
5' Below Trench, DBID 41587
U-234 (pCi/g - Dry)
Depth Below Estimated Trench Bottom (ft)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-5
5
15
25
35
45
55


U-234 by Borehole
Upper
Lower
U-234 (pCi/g - Dry)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
NORTH OF TANK 3
SOUTH OF TANK 1
WEST OF TANK 1
NW OF TANK 1
EAST OF TANK 1
NE OF TANK 1
E OF TANKS 2&3
W OF TANKS 2&3
W OF CHEM TRENCH
E OF CHEM TRENCH
W OF TRENCHES 1&2
E OF TRENCHES 1&2
W OF TRENCH 4-B
E OF TRENCH 4-B
W OF TRENCH 4-A
E OF TRENCH 4-A
WEST OF TRENCH 4
EAST OF TRENCH 4
E TRENCH 11-A
EAST OF TRENCH 6
E OF TRENCHES 7&8
WEST OF TRENCH 8
EAST OF TRENCH 9
WEST OF TRENCH 10
W OF TRENCH 11-A
WEST OF TRENCH 6

U-235

Uranium-235 is found in natural background soils. The investigation sample U-235 results were compared against a screening level based on a dataset of background values reported in the U.S. DOE *Hanford Site Background: Part 2* document, Reference 2. The U-235 screening level was set at 0.11 pCi/g, based on the 90th percentile of the Hanford background set.

One lower depth sample from the trench area was found to be above the U-235 screening level, as shown in Table 16, though this results was less than the 95th percentile of the Hanford background set, 0.153 pCi/g, at the 95% confidence level. Uranium-235 was not detected, at a 95% confidence level above the screening level in the remaining samples from the resin tank or trench areas, as shown in Table 17. Numerous samples were not detected above the detection limit. The maximum detection limit for non-detect samples was 3.0E-02 pCi/g.

Table 16. Elevated U-235 Results

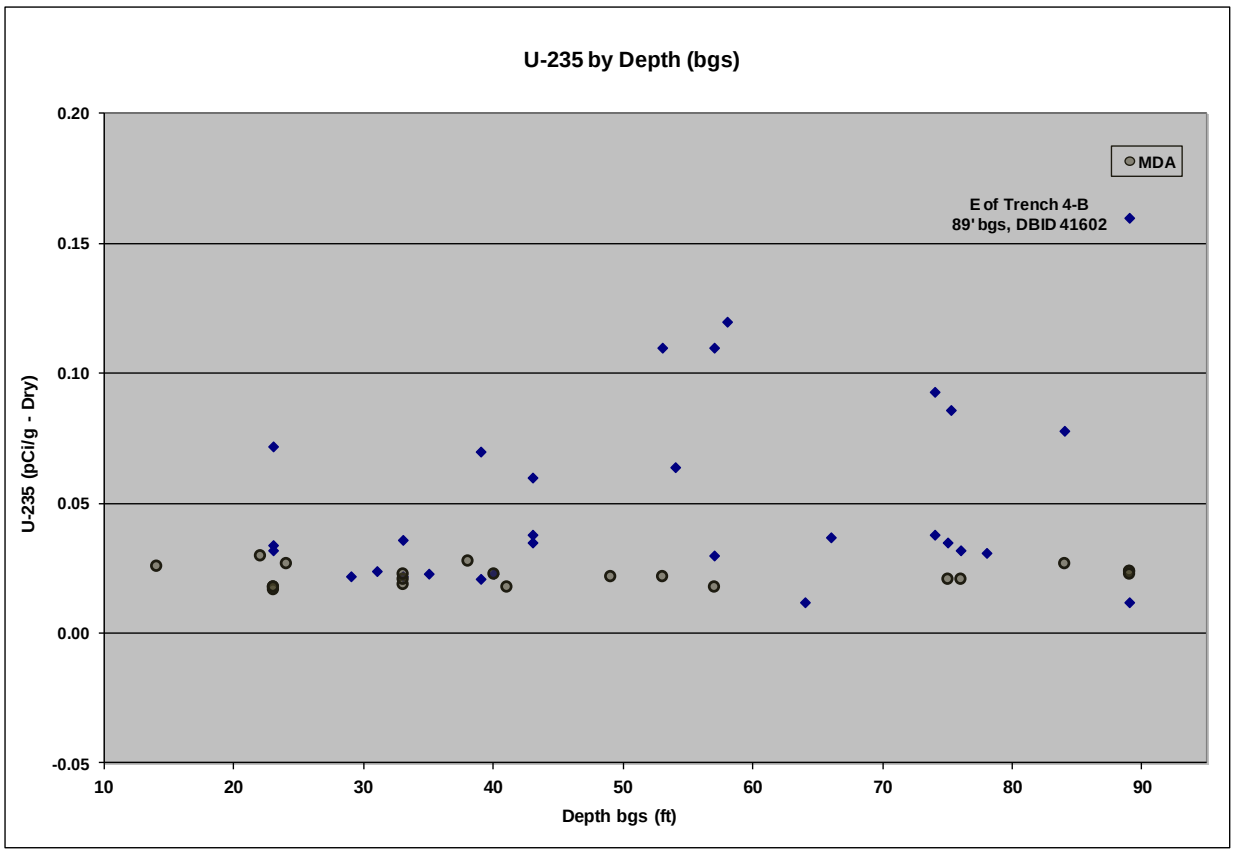
DBID	Depth (bgs-ft)	Depth Below Trench Bottom (ft)	Sample Location ID	Site	Result (pCi/g-Dry)	Error (pCi/g)
41602[1]	89	44	B15B	E of Trench 4-B	0.16	0.05

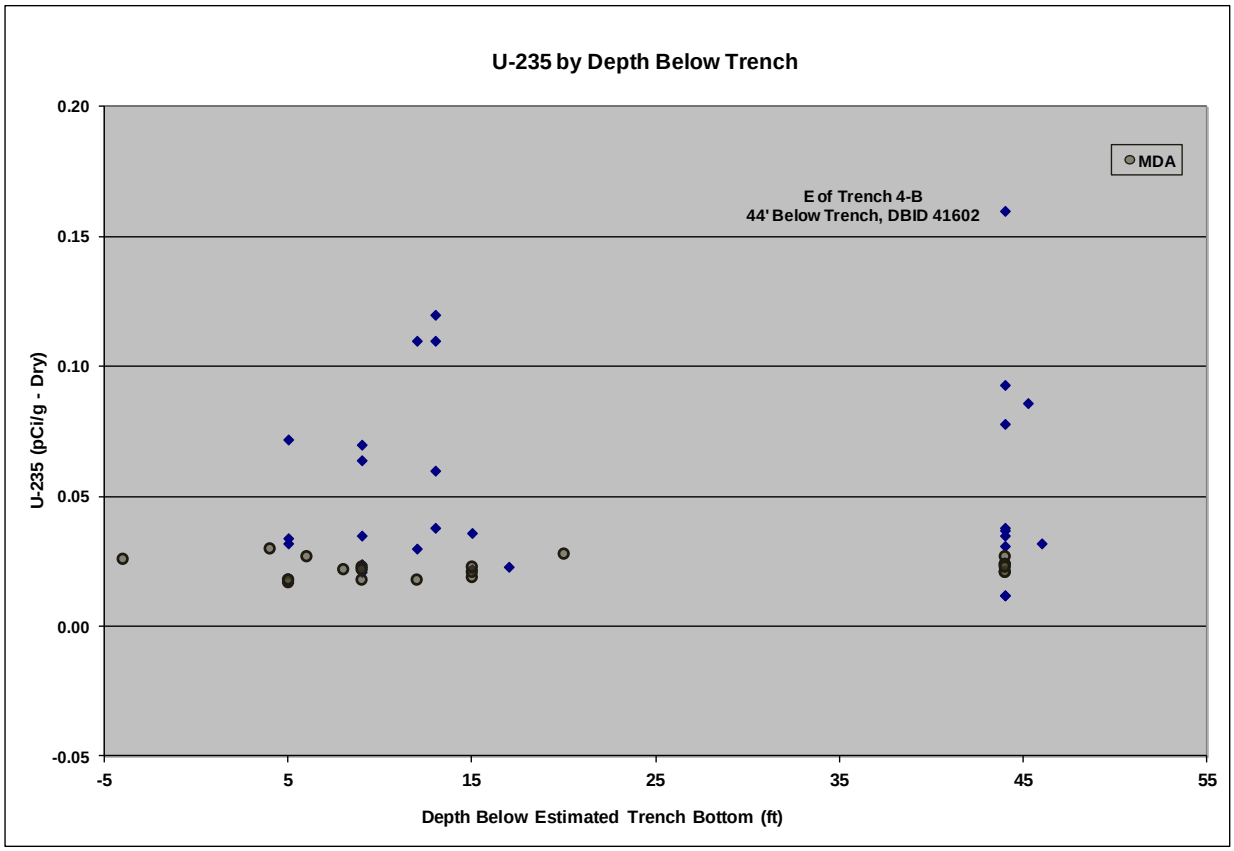
[1] **Result less than the 95th percentile of the Hanford background set, 0.153 pCi/g, at the 95% confidence level.**

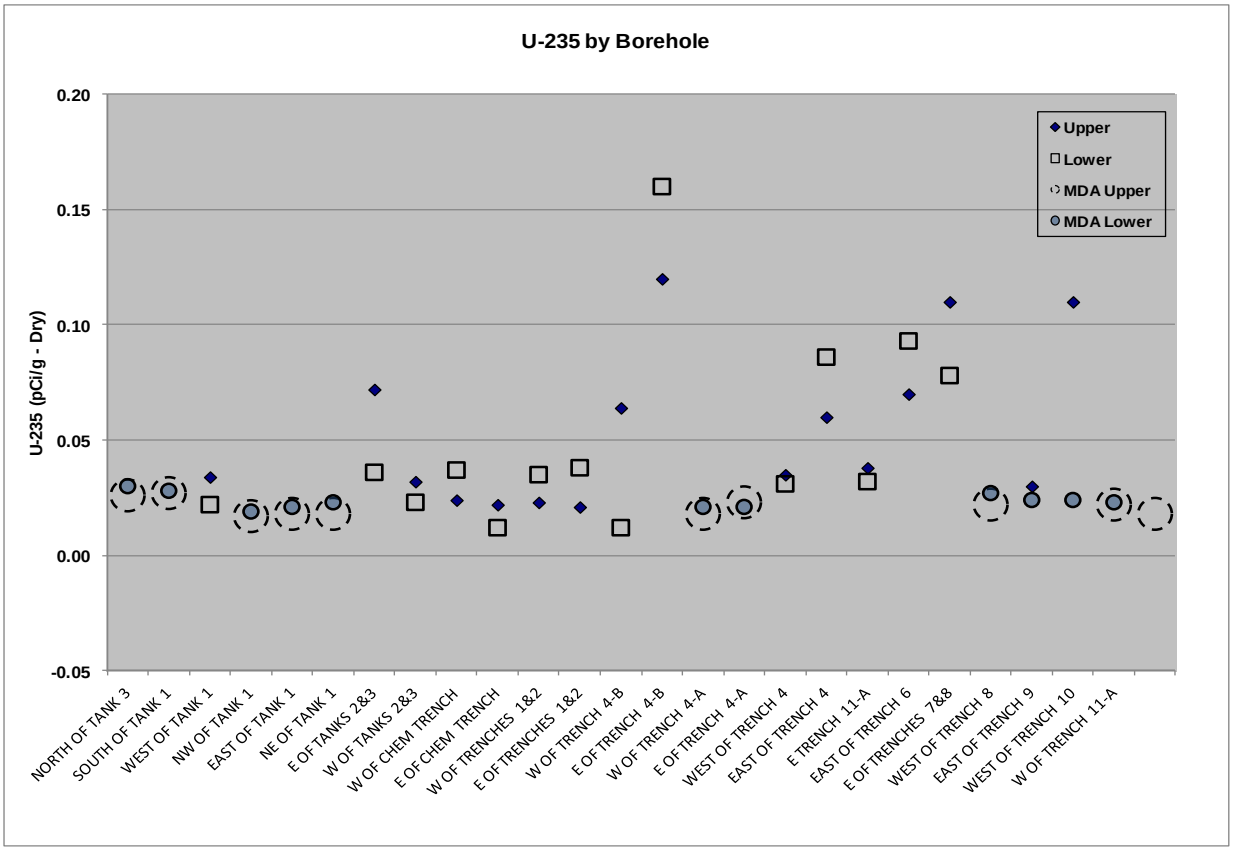
Table 17. U-235 Results (pCi/g - Dry)

	Number[1]	Min	Max	Mean	Median	Std Dev	Variance
U-235	50	0.00	0.12	0.04	0.03	0.03	0.00

[1] **Table excludes U-235 result for DBID 41602.**


U-235 by Depth (bgs)
MDA
E of Trench 4-B
89' bgs, DBID 41602
U-235 (pCi/g - Dry)
Depth bgs (ft)
0.20
0.15
0.10
0.05
0.00
-0.05
10
20
30
40
50
60
70
80
90


U-235 by Depth Below Trench
MDA
E of Trench 4-B
44' Below Trench, DBID 41602
U-235 (pCi/g - Dry)
Depth Below Estimated Trench Bottom (ft)
0.20
0.15
0.10
0.05
0.00
-0.05
-5
5
15
25
35
45
55



U-238

Uranium-238 is found in natural background soils. The investigation sample U-238 results were compared against a screening level based on a dataset of background values reported in the U.S. DOE *Hanford Site Background: Part 2* document, Reference 2. The U-238 screening level was set at 1.06 pCi/g, based on the 90th percentile of the Hanford background set.

One upper depth sample from the resin tank area was found to be above the U-238 screening level, as shown in Table 18. The remaining resin tank samples and the upper and lower depth trench area samples were all below the screening level, as shown in Table 19.

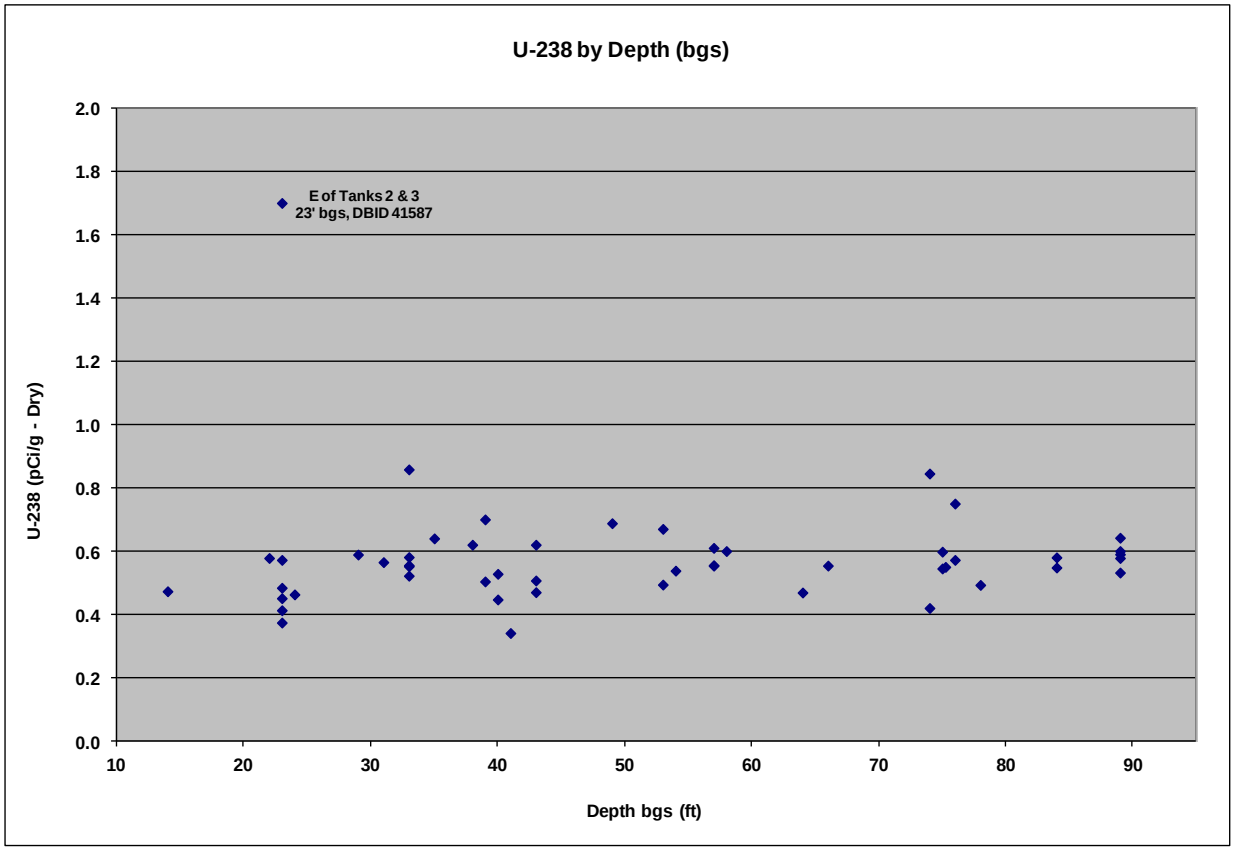
Table 18. Elevated U-238 Results

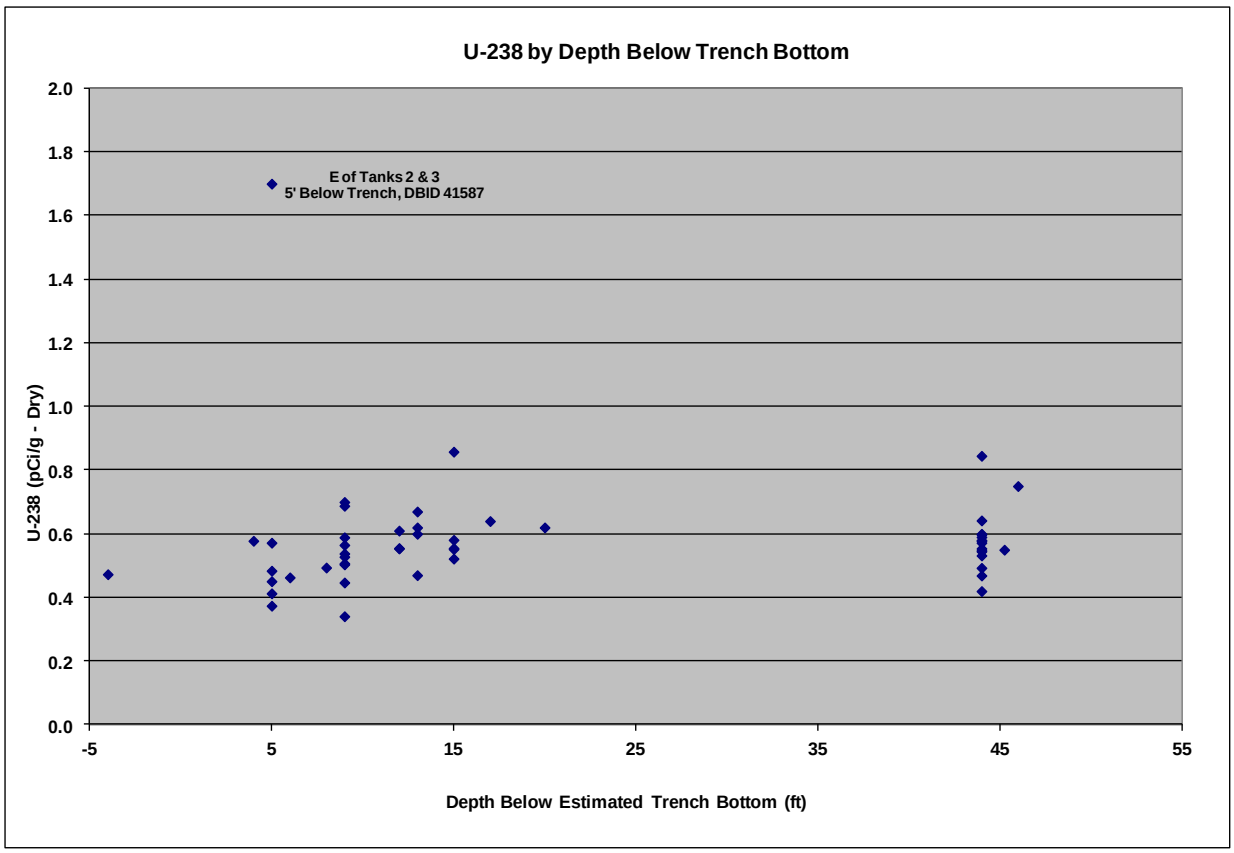
DBID	Depth (bgs-ft)	Depth Below Trench Bottom (ft)	Sample Location ID	Site	Result (pCi/g-Dry)	Error (pCi/g)
41587	23	5	B7A	E of Tanks 2&3	1.70	0.13

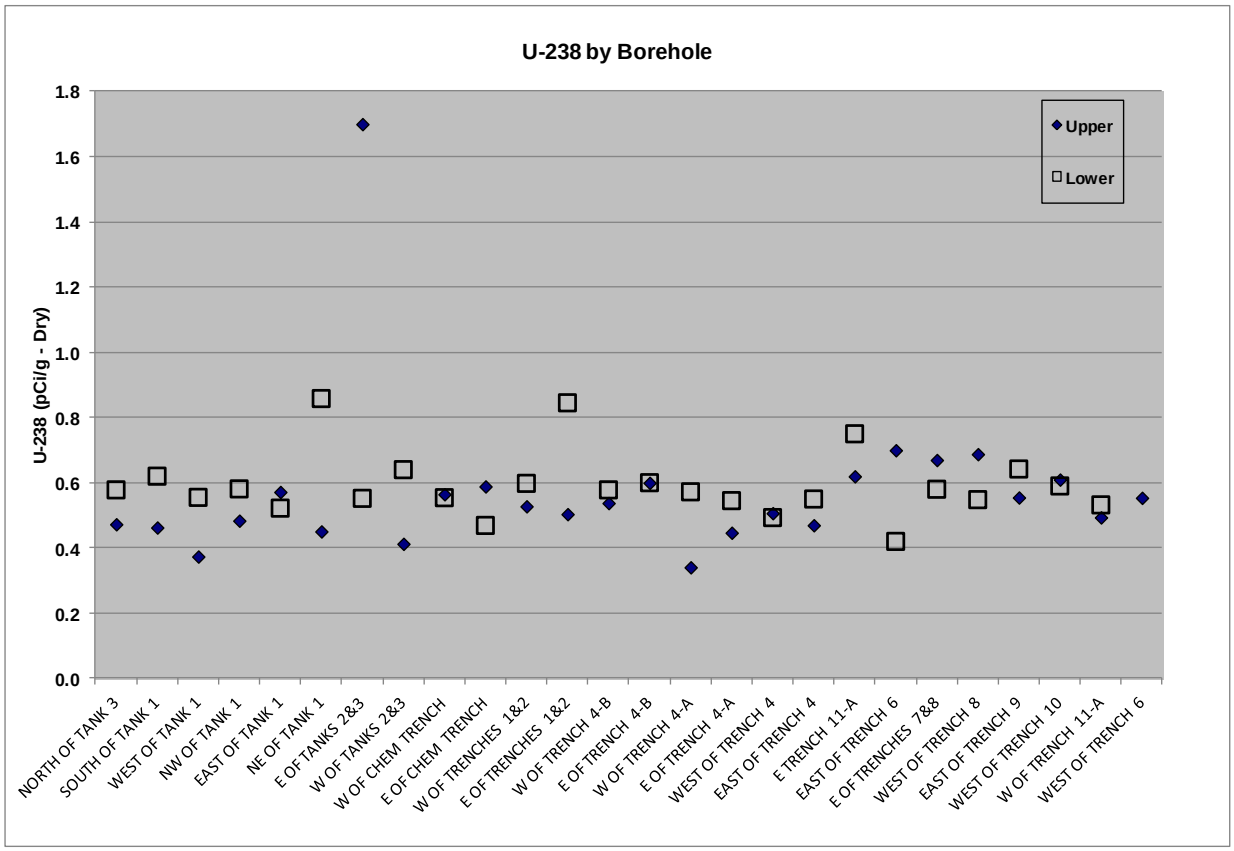
Table 19. U-238 Results (pCi/g - Dry)

	Number[1]	Min	Max	Mean	Median	Std Dev	Variance
U-234	50	0.34	0.86	0.56	0.55	0.10	0.01

[1] **Table excludes U-238 result for DBID 41587.**




U-238 by Depth Below Trench Bottom
E of Tanks 2 & 3
5' Below Trench, DBID 41587
U-238 (pCi/g - Dry)
Depth Below Estimated Trench Bottom (ft)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-5
5
15
25
35
45
55


U-238 by Borehole
Upper
Lower
U-238 (pCi/g - Dry)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
NORTH OF TANK 3
SOUTH OF TANK 1
WEST OF TANK 1
NW OF TANK 1
EAST OF TANK 1
NE OF TANK 1
E OF TANKS 2&3
W OF TANKS 2&3
W OF CHEM TRENCH
E OF CHEM TRENCH
W OF TRENCHES 1&2
E OF TRENCHES 1&2
W OF TRENCH 4-B
E OF TRENCH 4-B
W OF TRENCH 4-A
E OF TRENCH 4-A
WEST OF TRENCH 4
EAST OF TRENCH 4
E TRENCH 11-A
EAST OF TRENCH 6
E OF TRENCHES 7&8
WEST OF TRENCH 8
EAST OF TRENCH 9
WEST OF TRENCH 10
W OF TRENCH 11-A
WEST OF TRENCH 6

Discussion

Resin Tank Area

The data from this study show certain radiological contaminants detected in both the upper and lower sampling depths in the resin tank area. The radiological contaminants detected at a greater than 95% confidence level, or above the 90th percentile of the Hanford background dataset are shown in Table 20. Gross beta, Cs-137, and Sr-90 were detected in the upper depth in numerous samples; Ni-63 was detected in 2 upper depth samples; Co-60 and H-3 were detected in both the upper and lower depth in numerous samples; U-234 and U-238 were detected in one upper depth sample.

The 1998 MTCA site investigation collected 17 samples, from 2 slant boreholes under the chemical trench in the resin tank area. Table 21 identifies the radiological contaminates that were detected, at a greater than 95% confidence level, in the resin tank area. Naturally occurring radionuclides were not found above expected background levels.

The current study does not support the presence of Pu-238 or Pu-239/240 in the resin tank area soils, though it does support the presence of Sr-90 and Ni-63 in the resin tank area soils.

In 1985 a weather incident caused an excess of surface water that resulted in the loss of liquid from the resin tanks. The soils surrounding the resin tanks were remediated, though the soils below the tanks were not fully remediated. The radiological contaminants detected in this study are consistent with those expected as a result of the 1985 weather incident. Appendix G provides more information on the 1985 weather incident and resulting impacts on the resin tanks.

Table 20. Resin Tank Area Elevated Results (pCi/g – Dry)

DBID	Depth (bgs-ft)	Depth Below Trench Bottom (ft)	Sample Location ID	Site	Gross Beta	Co-60	Cs-137	Sr-90	H-3	Ni-63	Tc-99	I-129	Ra-226	U-234	U-235	U-238	Pu-238	Pu-239/ 240
41574[1]	14	-4	B1A	North of Tank 3		**0.36**												
41576[1]	22	4	B1B	North of Tank 3														
41577[1]	24	6	B2A	South of Tank 1	**173**	**30.7**	**231**	**0.533**	**5.76**				**2**					
41578[1]	38	20	B2B	South of Tank 1		**7.03**			**1.26**									
41579	23	5	B3A	West of Tank 1	**89.0**	**23.4**	**85.0**	**1.24**	**7.09**									
41580	33	15	B3B	West of Tank 1		**0.97**												
41581	23	5	B4A	NW of Tank 1	**56.0**	**10.1**	**56.0**	**0.161**	**6.53**	**12.5**								
41582	33	15	B4B	NW of Tank 1		**0.479**			**1.35**									
41583	23	5	B5A	East of Tank 1		**6.01**	**5.15**	**0.197**	**3.91**									
41584	33	15	B5B	East of Tank 1		**0.801**			**1.30**									
41585	23	5	B6A	NE of Tank 1		**6.46**			**3.22**	**27.8**								
41586	33	15	B6B	NE of Tank 1		**0.143**			**1.38**									
41587	23	5	B7A	E of Tanks 2&3		**0.119**								**1.72**		**1.70**		
41589	23	5	B8A	W of Tanks 2&3		**0.145**												
41590	35	17	B8B	W of Tanks 2&3		**0.081**												

[1] Unable to verify depth due to borehole angle discrepancies.
[2] Result biased low due to Co-60 and Cs-137 fission product backscatter interference in Ra-226 region of interest.

Table 21. 1998 Resin Tank Area Elevated Results (pCi/g)

Nuclide	# Detected	Maximum Result	MDA Range
Sr-90	17	1.13	0.012 - 0.100
Ni-63	16	6.14	0.492
Pu-238	1	0.037	0.017 - 0.025
Pu-239/240	4	0.036	0.015 - 0.021
Am-241	1	0.176[1]	0.089 - 1.08

[1] Sample result determined to be anomalous [Albin, 2000].

Trench Area

The data from this study show only H-3 was detected in both the upper and lower sampling depths in the trench area. However, results showed one lower depth sample with U-235 detected above the 90th percentile of the Hanford background set; this sample was less than the 95th percentile of the Hanford background set, 0.153 pCi/g, at the 95% confidence level. The radiological contaminants detected at a greater than 95% confidence level, or above the 90th percentile of the Hanford background dataset are shown in Table 22.

The 1998 MTCA site investigation collected 18 samples, from 2 slant boreholes under Trench 5. Table 23 identifies the radiological contaminates that were detected, at a greater than 95% confidence level, in the trench area. Naturally occurring radionuclides were not found above expected background levels.

The current study does not support the presence of Sr-90 or Ni-63 in the trench area soils.

Table 23. 1998 Resin Tank Area Elevated Results (pCi/g)

Nuclide	# Detected	Maximum Result	MDA Range
Sr-90	10	0.319	0.018 - 0.179
Ni-63	18	10.4	0.469 - 0.492

Table 22. Trench Area Elevated Results

DBID	Depth (bgs-ft)	Depth Below Trench Bottom (ft)	Sample Location ID	Site	Gross Beta	Co-60	Cs-137	Sr-90	H-3	Ni-63	Tc-99	I-129	Ra-226	U-234	U-235	U-238	Pu-238	Pu-239/ 240
41596	75	44	B12B	W of Trenches 1&2					**12.4**									
41598	74	44	B13B	E of Trenches 1&2					**68.1**									
41599	54	9	B14A	W of Trench 4-B					**5.32**									
41602	89	44	B15B	E of Trench 4-B											**0.16[2]**			
41603	41	9	B16A	W of Trench 4-A					**1.62**									
41604	76	44	B16B	W of Trench 4-A					**0.76**									
41606	75	44	B17B	E of Trench 4-A					**5.70**									
41607	43	9	B18A	West of Trench 4					**23.6**									
41608	78	44	B18B	West of Trench 4					**0.95**									
41611	43	13	B20A	E of Trench 11-A					**7.37**									
41612	76	46	B20B	E of Trench 11-A					**26.4**									
41613	39	9	B21A	East of Trench 6					**8.39**									
41614	74	44	B21B	East of Trench 6					**3.91**									
41615	53	13	B22A	E of Trenches 7&8					**25.1**									
41616	84	44	B22B	E of Trenches 7&8					**15.1**									
41617	49	9	B23A	West of Trench 8					**1.85**									
41619	57	12	B24A	East of Trench 9					**142**									
41620	89	44	B24B	East of Trench 9					**12.9**									
41621	57	12	B25A	West of Trench 10					**3.02E+04**									
41622	89	44	B25B	West of Trench 10					**1.88[1]**									
41623	53	8	B26A	W of Trench 11-A					**10.8**									
41624	89	44	B26B	W of Trench 11-A					**4.39**									
41625	57	12	B27A	West of Trench 6					**9.09**									

[1] Result biased low due to moisture loss from storage.
[2] Result less than the 95th percentile of the Hanford background set, 0.153 pCi/g, at the 95% confidence level.

Conclusion

In 2008 the Department of Health, Office of Radiation Protection, Waste Management Section performed an investigation of the vadose zone soils at the US Ecology commercial low-level radioactive waste disposal facility. The study area focused on the trenches and tanks that were active until 1985, when the facility was banned from receiving and disposing of RCRA waste. The intent of the study was both to determine if the migration of radionuclides from certain trenches and tanks had occurred, and as a follow up to the 1998 Model Toxics Control Act (MTCA) site investigation that detected radionuclides in the vadose zone soils.

The study consisted of collecting 51 vadose zone soil samples from 26 sample locations. Two samples were obtained per location, one at an “upper depth” and one at a “lower depth”. Upper depth samples from the trench area were taken at the perimeter of the trenches, approximately 10 feet below the bottom of the trench, while the lower depth samples were taken at the perimeter of the trenches near the lowest sampling depth, approximately 45 feet below the bottom of the trench. Likewise, the vertical resin tank area upper depth samples were taken at the perimeter of the tanks, approximately 5 feet below the bottom of the tanks, and the lower depth samples were taken at the perimeter of the tanks near the lowest sampling depth, which was approximately 15 feet below the bottom of the tanks. Two slant boreholes were drilled. The actual collection depths could not be confirmed due to inconsistencies in the reported boring angle.

The results from the current study did not support the presence of Pu-238 or Pu-239/240 in the resin tank area soils, as detected in the 1998 MTCA study. The current study did support the presence of Sr-90 and Ni-63 in the resin tank area soils, as detected in 1998. The current study, found gross beta, Cs-137, Co-60, Sr-90, Ni-63, and H-3 in the upper depth resin tank area samples, and Co-60 and H-3 in the lower depth resin tank area samples. Elevated levels of U-234 and U-238 were detected in one upper depth resin tank area sample. The radiological contaminants detected at a greater than 95% confidence level, or above the 90th percentile of the Hanford background dataset are shown in Figure 7. These contaminants are as expected due to the 1985 weather incident that resulted in a loss of liquid from the resin tanks.

The results from the current study do not support the presence of Sr-90 or Ni-63 in the trench area soils, as detected in the 1998 MTCA study. The current study, found the presence of H-3 in both the upper and lower depth trench area samples. The current study shows one lower depth trench area sample with U-235 detected above the 90th percentile of the Hanford background set, however this sample was less than the 95th percentile of the Hanford background set, 0.153 pCi/g, at the 95% confidence level. The radiological contaminants detected at a greater than 95% confidence level, or above the 90th percentile of the Hanford background dataset are shown in Figure 8.

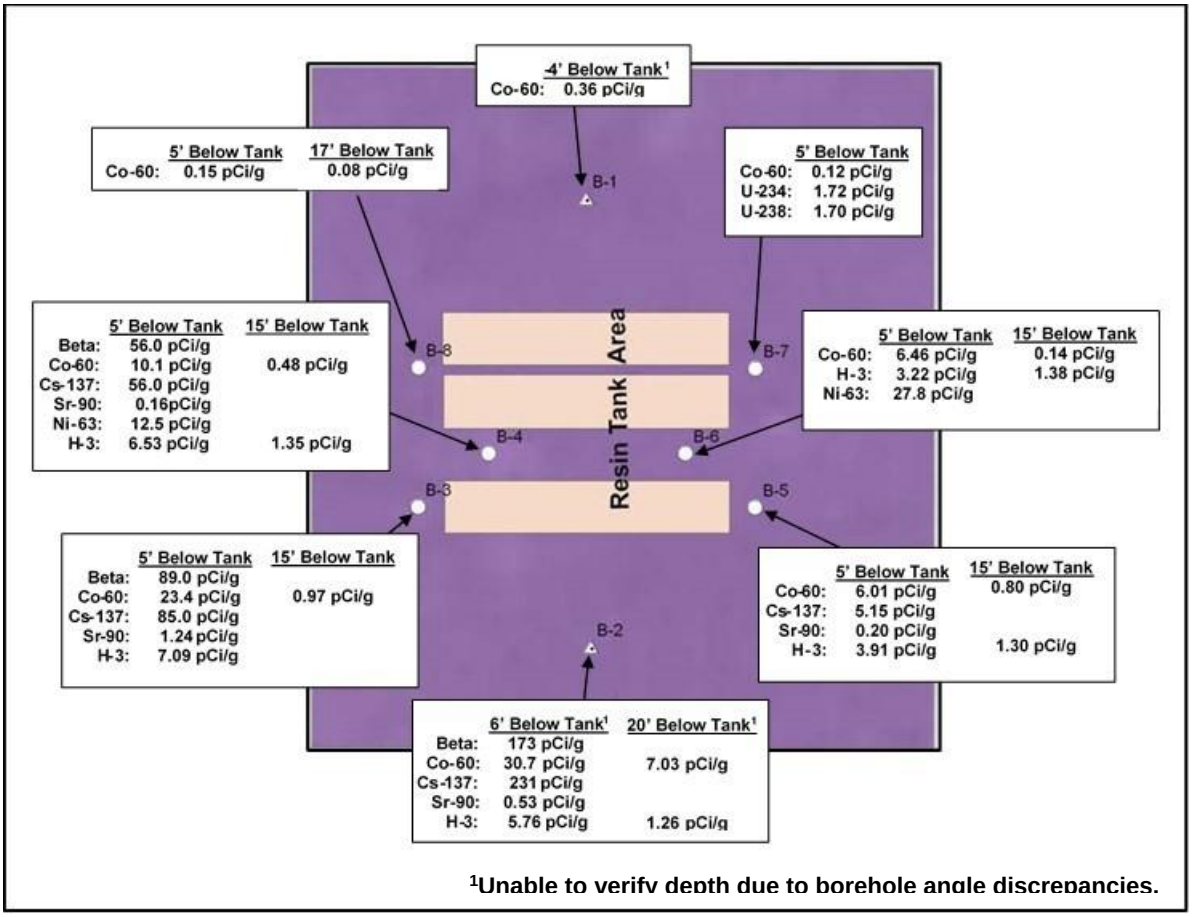


Figure 7. Resin Tank Area Sample Results

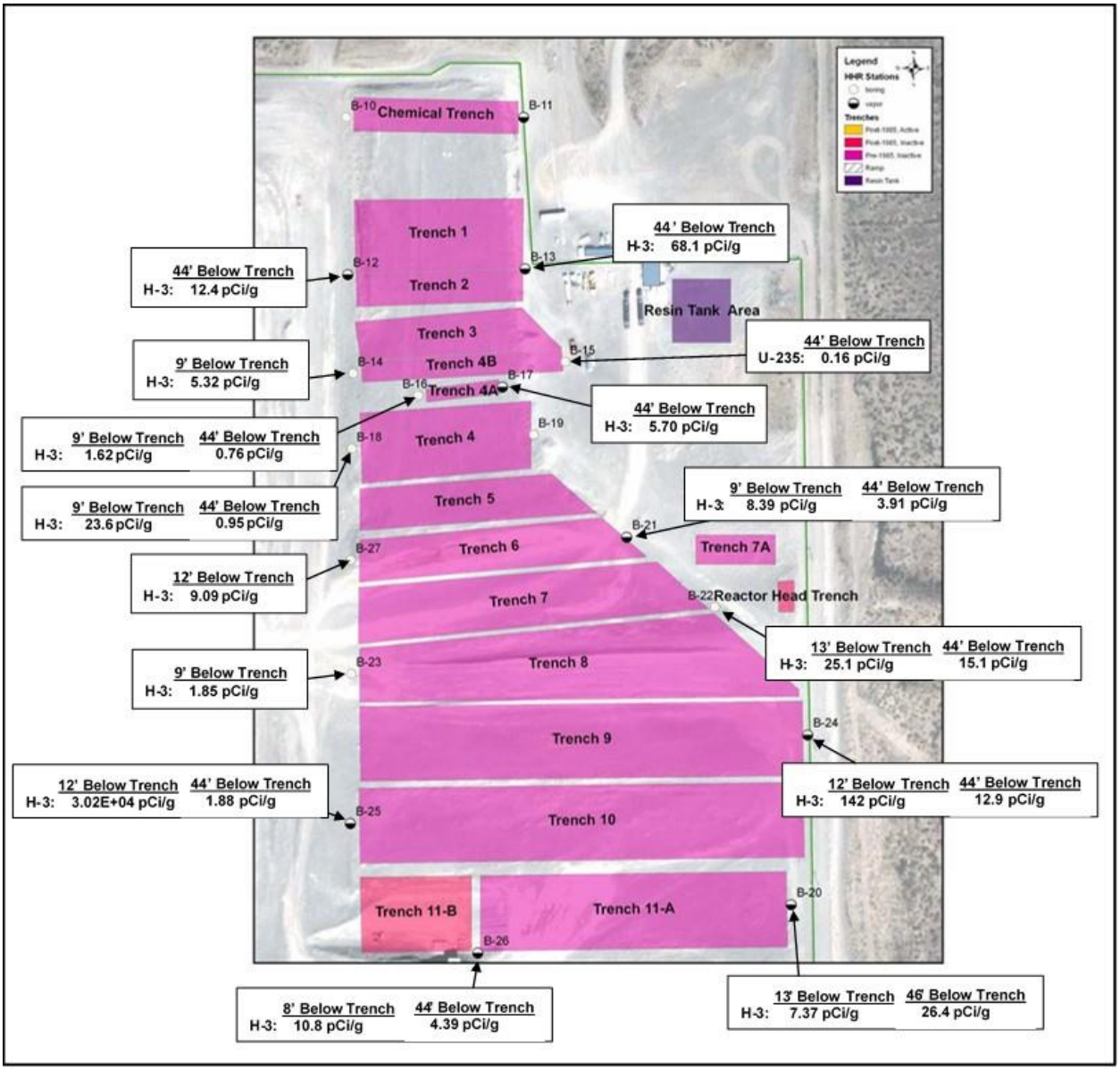


Figure 8. Trench Area Sample Results

References

1. Albin, Lynn, Evaluation of Data of the “Comprehensive Facility Investigation: Richland LLRW Disposal Facility Richland, Washington Phase 1 and 2 Report”, December 15, 2000.

2. United States Department of Energy, Hanford Site Background: Part 2, Soil Background for Radionuclides, DOE/RL-96-12, Rev. 0, September 1996.

3. US Ecology, Inc., Comprehensive Facility Investigation: Richland LLRW Disposal Facility Richland, Washington Phase 1 and 2 Report, August 16, 1999.

4. Vista Engineering Technologies, LLC, Final Remedial Investigation Report, VET-1405-RPT-001, July 14, 2010.