

# TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

## ANALYTICAL REPORT

TestAmerica Laboratories, Inc.  
TestAmerica St. Louis  
13715 Rider Trail North  
Earth City, MO 63045  
Tel: (314)298-8566

TestAmerica Job ID: 160-11590-2  
Client Project/Site: HDP

For:  
Perma-Fix Environmental Services Inc.  
2800 Solway Road  
Knoxville, Tennessee 37931

Attn: Brian Miller



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Authorized for release by:  
5/28/2015 2:54:00 PM

Ivan Vania, Project Manager II  
(314)298-8566  
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### LINKS

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results through  
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[www.testamericainc.com](http://www.testamericainc.com)

*This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.*

*Results relate only to the items tested and the sample(s) as received by the laboratory.*

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# Case Narrative

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11590-2

**Job ID: 160-11590-2**

**Laboratory: TestAmerica St. Louis**

**Narrative**

## CASE NARRATIVE

**Client: Perma-Fix Environmental Services Inc.**

**Project: HDP**

**Report Number: 160-11590-2**

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

TestAmerica St. Louis attests to the validity of the laboratory data generated by TestAmerica facilities reported herein. All analyses performed by TestAmerica facilities were done using established laboratory SOPs that incorporate QA/QC procedures described in the application methods. TestAmerica's operations groups have reviewed the data for compliance with the laboratory QA/QC plan, and data have been found to be compliant with laboratory protocols unless otherwise noted below.

The test results in this report meet all NELAP requirements for parameters for which accreditation is required or available. Any exceptions to NELAP requirements are noted in this report. Pursuant to NELAP, this report may not be reproduced, except in full, without the written approval of the laboratory.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

All solid sample results for Chemistry analyses are reported on an "as received" basis unless otherwise indicated by the presence of a % solids value in the method header. All soil/sediment sample results for radiochemistry analyses are based upon sample as dried and disaggregated with the exception of tritium, carbon-14, and iodine-129 by gamma spectroscopy unless requested as wet weight by the client."

This laboratory report is confidential and is intended for the sole use of TestAmerica and its client.

### **RECEIPT**

The samples were received on 04/30/2015; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the coolers at receipt was 18.0 C.

### **RADIUM-226 BY GAMMA SPEC (21 DAY INGROWTH)**

Samples L10-14-10-B-E-B-00 (160-11590-1), L10-14-11-B-E-B-00 (160-11590-2), L10-14-12-B-E-B-00 (160-11590-3) and L10-03-14-B-E-I-01 (160-11590-4) were analyzed for Radium-226 by gamma spec (21 day ingrowth) in accordance with EPA GA\_01\_R. The samples were leached on 04/30/2015, prepared on 05/04/2015 and analyzed on 05/25/2015.

Batch 189205:

The sample duplicate precision for the following sample associated with 189205 was outside control limits: L10-14-10-B-E-B-00 (160-11590-1) and (160-11590-A-1-A DU). The associated Laboratory Control Sample / Laboratory Control Sample Duplicate (LCS/LCSD) precision met acceptance criteria for Pa-231. Both results were below the MDC, the data is reported with this narrative.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

**TestAmerica St. Louis**

13715 Rider Trail North

Earth City, MO 63045  
phone 314.298.8566 fax

**Chain of Custody Record**

**TestAmerica**

THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Laboratories, Inc.

Regulatory Program:  DW  NPDES  RCRA  Other:

<b>Client Contact</b> Perma-Fix Environmental Services 2800 Solway Road Knoxville, TN 37931 (865) 690-0501 Phone (865) 539-9868 FAX		<b>Project Manager: Brian Miller</b> Tel/Fax: (314) 810-3333		<b>Site Contact: Ellen Jakub</b> Lab Contact: Ivan Vanya		<b>Date: 04/30/2015</b> Carrier: Courier		<b>COC No: 043015-FSS1</b> 1 of 1 COCs			
<b>Analysis Turnaround Time</b> <input checked="" type="checkbox"/> CALENDAR DAYS <input type="checkbox"/> WORKING DAYS TAT if different from Below _____ <input type="checkbox"/> 2 weeks <input checked="" type="checkbox"/> 1 week <input type="checkbox"/> 2 days <input type="checkbox"/> 1 day								<b>Sampler:</b> <b>For Lab Use Only:</b> Walk-in Client: Lab Sampling:			
<b>Project Name: Hematite Decommissioning Project</b> <b>Site: Westinghouse Hematite, MO</b> <b>P O # 832953</b>								<b>Job / SDG No.:</b>			
<b>Sample Identification</b>	<b>Sample Date</b>	<b>Sample Time</b>	<b>Sample Type (C=Comp, G=Grab)</b>	<b>Matrix</b>	<b># of Cont.</b>	<b>Filtered Sample (Y/N)</b>	<b>Perform MS / MSD (Y/N)</b>	<b>Gamma Spec Westinghouse Hematite Library</b>	<b>Alpha Spec</b>	<b>ICP/MS (Tc-99) Gamma Spec (With post-21 day ingrowth)</b>	<b>Sample Specific Notes:</b>
L10-14-10-B-E-B-00	4/28/15	1114	G	Soil	1	N		X	X	X	Matt Cushman
L10-14-11-B-E-B-00	4/29/15	1020	G	Soil	1	N		X	X	X	Jahmal Williams
L10-14-12-B-E-B-00	4/28/15	1119	G	Soil	1	N		X	X	X	Matt Cushman
<del>N / A</del>											
<b>Preservation Used:</b> 1=Ice, 2=HCl, 3=H2SO4, 4=HNO3, 5=NaOH, 6= Other None											
<b>Possible Hazard Identification:</b> Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample. <input checked="" type="checkbox"/> Non-Hazard <input type="checkbox"/> Flammable <input type="checkbox"/> Skin Irritant <input type="checkbox"/> Poison B <input type="checkbox"/> Unknown						<b>Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)</b> <input checked="" type="checkbox"/> Return to Client <input type="checkbox"/> Disposal by Lab <input type="checkbox"/> Archive for _____ Months					
<b>Special Instructions/QC Requirements &amp; Comments: Potential for Radiological Contamination</b>											
<b>Custody Seals Intact:</b> <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		<b>Custody Seal No.:</b>		<b>Cooler Temp. (°C):</b> Obs'd: _____		<b>Corr'd:</b> _____		<b>Therm ID No.:</b> _____			
Relinquished by: <i>[Signature]</i>		Company: <i>PermaFix</i>		Date/Time: 10:30		Received by: <i>[Signature]</i>		Company: <i>449 Crossroads</i>		Date/Time: 4/30/15 10:30	
Relinquished by: <i>[Signature]</i>		Company: <i>Crossroads 449</i>		Date/Time: 4/30/15		Received by: <i>[Signature]</i>		Company: <i>[Signature]</i>		Date/Time: 4/30/15 10:55	
Relinquished by:		Company:		Date/Time:		Received in Laboratory by:		Company:		Date/Time:	

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160-11590 Chain of Custody



Hematite Decommissioning Project

Permafix (for Westinghouse) Non-Proprietary Class 3

Procedure: HDP-PR-QA-006, Chain of Custody

Revision: 3



**TestAmerica St. Louis**

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**Chain of Custody Record**

**TestAmerica**

THE LEADER IN ENVIRONMENTAL TESTING

**TestAmerica Laboratories, Inc.**

Regulatory Program:  DW  NPDES  RCRA  Other:

<b>Client Contact</b> Perma-Fix Environmental Services 2800 Solway Road Knoxville, TN 37931 (865) 690-0501 Phone (865) 539-9868 FAX Project Name: Hematite Decommissioning Project Site: Westinghouse Hematite, MO P O # 832953		<b>Project Manager: Brian Miller</b> Tel/Fax: (314) 810-3333		<b>Site Contact: Ellen Jakub</b> Lab Contact: Ivan Vanya		<b>Date: 04/16/2015</b> Carrier: Courier		<b>COC No: 041615-FSS1</b> 1 of 1 COCs					
<b>Analysis Turnaround Time</b> <input checked="" type="checkbox"/> CALENDAR DAYS <input type="checkbox"/> WORKING DAYS TAT if different from Below _____ <input type="checkbox"/> 2 weeks <input checked="" type="checkbox"/> 1 week <input type="checkbox"/> 2 days <input type="checkbox"/> 1 day								<b>Sampler:</b> <b>For Lab Use Only:</b> Walk-in Client: Lab Sampling:  Job / SDG No.:					
<b>Sample Identification</b>		<b>Sample Date</b>	<b>Sample Time</b>	<b>Sample Type (C=Comp, G=Grab)</b>	<b>Matrix</b>	<b># of Cont.</b>	<b>Filtered Sample (Y/N)</b>	<b>Perform MS / MSD (Y/N)</b>	<b>Gamma Spec (Ra-226, Th-232, U-235, U-238)</b>	<b>Alpha Spec</b>	<b>ICP/MS (Tc-99)</b>	<b>Gamma Spec (Ra-226: post-21 day ingrowth)</b>	<b>Sample Specific Notes:</b>
L10-03-14-B-E-I-01  N/A		4/15/15	1634	G	Soil	1	N	X		X	X		Sampler Matt Cushman
<b>Preservation Used:</b> 1=Ice, 2=HCl, 3=H2SO4, 4=HNO3, 5=NaOH, 6=Other, None													
<b>Possible Hazard Identification:</b> Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample. <input checked="" type="checkbox"/> Non-Hazard <input type="checkbox"/> Flammable <input type="checkbox"/> Skin Irritant <input type="checkbox"/> Poison B <input type="checkbox"/> Unknown												<b>Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)</b> <input checked="" type="checkbox"/> Return to Client <input type="checkbox"/> Disposal by Lab <input type="checkbox"/> Archive for _____ Months	
<b>Special Instructions/QC Requirements &amp; Comments:</b> Potential for Radiological Contamination													
<b>Custody Seals Intact:</b> <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		<b>Custody Seal No.:</b>		<b>Cooler Temp. (°C):</b> Obs'd: _____		<b>Corr'd:</b> _____		<b>Therm ID No.:</b> _____					
Relinquished by: <i>[Signature]</i>		Company: PermaFix		Date/Time: 1030		Received by: <i>[Signature]</i>		Company: Crossroads		Date/Time: 4/15/15 10:50			
Relinquished by: <i>[Signature]</i>		Company: Crossroads		Date/Time: 4/15/15 10:55		Received by: <i>[Signature]</i>		Company: <i>[Signature]</i>		Date/Time: 4-30-15 10:55			
Relinquished by:		Company:		Date/Time:		Received in Laboratory by:		Company:		Date/Time:			

Hematite Decommissioning Project

Permafix (for Westinghouse) Non-Proprietary Class 3

Procedure: HDP-PR-QA-006, Chain of Custody

Revision: 3

# Login Sample Receipt Checklist

Client: Perma-Fix Environmental Services Inc.

Job Number: 160-11590-2

**Login Number: 11590**

**List Number: 1**

**Creator: Clarke, Jill C**

**List Source: TestAmerica St. Louis**

Question	Answer	Comment
Radioactivity wasn't checked or is $\leq$ background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	N/A	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is $<6\text{mm}$ (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	



# Definitions/Glossary

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11590-2

## Qualifiers

### Rad

Qualifier	Qualifier Description
U	Result is less than the sample detection limit.

## Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
▫	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

# Method Summary

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11590-2

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Method	Method Description	Protocol	Laboratory
GA-01-R	Radium-226 & Other Gamma Emitters (GS)	DOE	TAL SL

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**Protocol References:**

DOE = U.S. Department of Energy

**Laboratory References:**

TAL SL = TestAmerica St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566





# Sample Summary

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11590-2

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
160-11590-1	L10-14-10-B-E-B-00	Solid	04/28/15 11:14	04/30/15 10:55
160-11590-2	L10-14-11-B-E-B-00	Solid	04/29/15 10:20	04/30/15 10:55
160-11590-3	L10-14-12-B-E-B-00	Solid	04/28/15 11:19	04/30/15 10:55
160-11590-4	L10-03-14-B-E-I-01	Solid	04/15/15 16:34	04/30/15 10:55

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# Client Sample Results

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11590-2

**Client Sample ID: L10-14-10-B-E-B-00**

**Lab Sample ID: 160-11590-1**

Date Collected: 04/28/15 11:14

Matrix: Solid

Date Received: 04/30/15 10:55

**Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)**

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	1.05		0.125	0.165		0.0860	pCi/g	05/04/15 12:17	05/25/15 20:44	1
Bismuth 212	1.15		0.403	0.421		0.402	pCi/g	05/04/15 12:17	05/25/15 20:44	1
Bismuth 214	1.25		0.112	0.172		0.0727	pCi/g	05/04/15 12:17	05/25/15 20:44	1
Lead 212	1.13		0.0733	0.164		0.0566	pCi/g	05/04/15 12:17	05/25/15 20:44	1
Lead 214	1.31		0.0912	0.164		0.0746	pCi/g	05/04/15 12:17	05/25/15 20:44	1
Potassium 40	18.5		1.14	2.21		0.326	pCi/g	05/04/15 12:17	05/25/15 20:44	1
Protactinium 231	0.500	U	0.287	0.292		1.18	pCi/g	05/04/15 12:17	05/25/15 20:44	1
Radium 226	1.25		0.112	0.172	1.00	0.0727	pCi/g	05/04/15 12:17	05/25/15 20:44	1
Thorium 232	1.05		0.125	0.165		0.0860	pCi/g	05/04/15 12:17	05/25/15 20:44	1
Thorium 234	1.20		0.505	0.521		0.801	pCi/g	05/04/15 12:17	05/25/15 20:44	1
Uranium 235	1.47		0.242	0.285		0.290	pCi/g	05/04/15 12:17	05/25/15 20:44	1
Americium 241	-0.0242	U	0.0660	0.0660		0.110	pCi/g	05/04/15 12:17	05/25/15 20:44	1
Protactinium 234m	6.49		2.90	2.97		5.14	pCi/g	05/04/15 12:17	05/25/15 20:44	1
<b>Other Detected Radionuclides</b>			<b>Count Uncert. (2σ+/-)</b>	<b>Total Uncert. (2σ+/-)</b>	<b>RL</b>	<b>MDC</b>	<b>Unit</b>	<b>Prepared</b>	<b>Analyzed</b>	<b>Dil Fac</b>
Pb-210	1.36		0.623	0.643		0.835	pCi/g	05/04/15 12:17	05/25/15 20:44	1
Tl-208	0.313		0.0416	0.0528		0.0306	pCi/g	05/04/15 12:17	05/25/15 20:44	1

**Client Sample ID: L10-14-11-B-E-B-00**

**Lab Sample ID: 160-11590-2**

Date Collected: 04/29/15 10:20

Matrix: Solid

Date Received: 04/30/15 10:55

**Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)**

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	1.09		0.153	0.190		0.133	pCi/g	05/04/15 12:17	05/25/15 21:16	1
Bismuth 212	1.64		0.600	0.623		0.520	pCi/g	05/04/15 12:17	05/25/15 21:16	1
Bismuth 214	1.02		0.129	0.167		0.0909	pCi/g	05/04/15 12:17	05/25/15 21:16	1
Lead 212	1.06		0.0866	0.163		0.0823	pCi/g	05/04/15 12:17	05/25/15 21:16	1
Lead 214	1.21		0.113	0.169		0.0769	pCi/g	05/04/15 12:17	05/25/15 21:16	1
Potassium 40	19.2		1.39	2.41		0.253	pCi/g	05/04/15 12:17	05/25/15 21:16	1
Protactinium 231	0.558	U	0.304	0.310		1.36	pCi/g	05/04/15 12:17	05/25/15 21:16	1
Radium 226	1.02		0.129	0.167	1.00	0.0909	pCi/g	05/04/15 12:17	05/25/15 21:16	1
Thorium 232	1.09		0.153	0.190		0.133	pCi/g	05/04/15 12:17	05/25/15 21:16	1
Thorium 234	0.843	U	0.348	0.359		1.22	pCi/g	05/04/15 12:17	05/25/15 21:16	1
Uranium 235	0.0973	U	0.155	0.155		0.286	pCi/g	05/04/15 12:17	05/25/15 21:16	1
Americium 241	-0.0189	U	0.0759	0.0760		0.127	pCi/g	05/04/15 12:17	05/25/15 21:16	1
Protactinium 234m	0.853	U	3.86	3.86		6.80	pCi/g	05/04/15 12:17	05/25/15 21:16	1
<b>Other Detected Radionuclides</b>			<b>Count Uncert. (2σ+/-)</b>	<b>Total Uncert. (2σ+/-)</b>	<b>RL</b>	<b>MDC</b>	<b>Unit</b>	<b>Prepared</b>	<b>Analyzed</b>	<b>Dil Fac</b>
Tl-208	0.359		0.0609	0.0713		0.0458	pCi/g	05/04/15 12:17	05/25/15 21:16	1

TestAmerica St. Louis

# Client Sample Results

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11590-2

**Client Sample ID: L10-14-12-B-E-B-00**

**Lab Sample ID: 160-11590-3**

Date Collected: 04/28/15 11:19

Matrix: Solid

Date Received: 04/30/15 10:55

**Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)**

Analyte	Result	Qualifier	Count	Total	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
			Uncert.	Uncert.						
			(2σ+/-)	(2σ+/-)						
Actinium 228	1.16		0.123	0.171		0.126	pCi/g	05/04/15 12:17	05/25/15 21:17	1
Bismuth 212	1.26		0.421	0.441		0.401	pCi/g	05/04/15 12:17	05/25/15 21:17	1
Bismuth 214	1.39		0.102	0.177		0.0583	pCi/g	05/04/15 12:17	05/25/15 21:17	1
Lead 212	1.25		0.0708	0.177		0.0566	pCi/g	05/04/15 12:17	05/25/15 21:17	1
Lead 214	1.51		0.103	0.188		0.0745	pCi/g	05/04/15 12:17	05/25/15 21:17	1
Potassium 40	17.7		0.999	2.07		0.257	pCi/g	05/04/15 12:17	05/25/15 21:17	1
Protactinium 231	0.519	U	0.225	0.232		1.05	pCi/g	05/04/15 12:17	05/25/15 21:17	1
Radium 226	1.39		0.102	0.177	1.00	0.0583	pCi/g	05/04/15 12:17	05/25/15 21:17	1
Thorium 232	1.16		0.123	0.171		0.126	pCi/g	05/04/15 12:17	05/25/15 21:17	1
Thorium 234	0.892		0.505	0.514		0.819	pCi/g	05/04/15 12:17	05/25/15 21:17	1
Uranium 235	0.0797	U	0.133	0.133		0.228	pCi/g	05/04/15 12:17	05/25/15 21:17	1
Americium 241	-0.000155	U	0.0600	0.0600		0.101	pCi/g	05/04/15 12:17	05/25/15 21:17	1
Protactinium 234m	2.71	U	2.80	2.81		4.58	pCi/g	05/04/15 12:17	05/25/15 21:17	1
<b>Other Detected</b>			<b>Count</b>	<b>Total</b>						
<b>Radionuclides</b>			<b>Uncert.</b>	<b>Uncert.</b>	<b>RL</b>	<b>MDC</b>	<b>Unit</b>	<b>Prepared</b>	<b>Analyzed</b>	<b>Dil Fac</b>
<i>Tl-208</i>			<i>0.0420</i>	<i>0.0592</i>		<i>0.0284</i>	<i>pCi/g</i>	<i>05/04/15 12:17</i>	<i>05/25/15 21:17</i>	<i>1</i>

**Client Sample ID: L10-03-14-B-E-I-01**

**Lab Sample ID: 160-11590-4**

Date Collected: 04/15/15 16:34

Matrix: Solid

Date Received: 04/30/15 10:55

**Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)**

Analyte	Result	Qualifier	Count	Total	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
			Uncert.	Uncert.						
			(2σ+/-)	(2σ+/-)						
Actinium 228	1.19		0.129	0.177		0.107	pCi/g	05/04/15 12:17	05/25/15 22:03	1
Bismuth 212	1.45		0.433	0.458		0.379	pCi/g	05/04/15 12:17	05/25/15 22:03	1
Bismuth 214	1.18		0.124	0.174		0.0898	pCi/g	05/04/15 12:17	05/25/15 22:03	1
Lead 212	0.917		0.108	0.161		0.106	pCi/g	05/04/15 12:17	05/25/15 22:03	1
Lead 214	1.23		0.108	0.167		0.0850	pCi/g	05/04/15 12:17	05/25/15 22:03	1
Potassium 40	18.3		1.12	2.18		0.317	pCi/g	05/04/15 12:17	05/25/15 22:03	1
Protactinium 231	0.341	U	0.525	0.526		0.873	pCi/g	05/04/15 12:17	05/25/15 22:03	1
Radium 226	1.18		0.124	0.174	1.00	0.0898	pCi/g	05/04/15 12:17	05/25/15 22:03	1
Thorium 232	1.19		0.129	0.177		0.107	pCi/g	05/04/15 12:17	05/25/15 22:03	1
Thorium 234	1.22		0.801	0.811		0.999	pCi/g	05/04/15 12:17	05/25/15 22:03	1
Uranium 235	0.330		0.192	0.194		0.228	pCi/g	05/04/15 12:17	05/25/15 22:03	1
Americium 241	0.00784	U	0.0699	0.0699		0.117	pCi/g	05/04/15 12:17	05/25/15 22:03	1
Protactinium 234m	1.26	U	2.94	2.94		5.08	pCi/g	05/04/15 12:17	05/25/15 22:03	1
<b>Other Detected</b>			<b>Count</b>	<b>Total</b>						
<b>Radionuclides</b>			<b>Uncert.</b>	<b>Uncert.</b>	<b>RL</b>	<b>MDC</b>	<b>Unit</b>	<b>Prepared</b>	<b>Analyzed</b>	<b>Dil Fac</b>
<i>Tl-208</i>			<i>0.0478</i>	<i>0.0614</i>		<i>0.0366</i>	<i>pCi/g</i>	<i>05/04/15 12:17</i>	<i>05/25/15 22:03</i>	<i>1</i>

TestAmerica St. Louis

# QC Sample Results

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11590-2

## Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

**Lab Sample ID: MB 160-189205/1-A**

**Matrix: Solid**

**Analysis Batch: 192159**

**Client Sample ID: Method Blank**

**Prep Type: Total/NA**

**Prep Batch: 189205**

Analyte	MB MB		Count	Total	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
	Result	Qualifier	Uncert. (2σ+/-)	Uncert. (2σ+/-)						
Actinium 228	-0.001688	U	0.0257	0.0257		0.0504	pCi/g	05/04/15 12:17	05/25/15 21:15	1
Bismuth 212	-0.03610	U	0.118	0.118		0.211	pCi/g	05/04/15 12:17	05/25/15 21:15	1
Bismuth 214	0.007265	U	0.00690	0.00694		0.0392	pCi/g	05/04/15 12:17	05/25/15 21:15	1
Lead 212	-0.007202	U	0.0622	0.0622		0.0232	pCi/g	05/04/15 12:17	05/25/15 21:15	1
Lead 214	-0.006770	U	0.0372	0.0372		0.0315	pCi/g	05/04/15 12:17	05/25/15 21:15	1
Potassium 40	0.0000	U	0.0917	0.0917		0.0975	pCi/g	05/04/15 12:17	05/25/15 21:15	1
Protactinium 231	0.04723	U	0.161	0.161		0.289	pCi/g	05/04/15 12:17	05/25/15 21:15	1
Radium 226	0.007265	U	0.00690	0.00694	1.00	0.0392	pCi/g	05/04/15 12:17	05/25/15 21:15	1
Thorium 232	-0.001688	U	0.0257	0.0257		0.0504	pCi/g	05/04/15 12:17	05/25/15 21:15	1
Thorium 234	-0.06163	U	0.329	0.330		0.257	pCi/g	05/04/15 12:17	05/25/15 21:15	1
Uranium 235	0.008159	U	0.0165	0.0165		0.0666	pCi/g	05/04/15 12:17	05/25/15 21:15	1
Americium 241	-0.004918	U	0.0127	0.0127		0.0220	pCi/g	05/04/15 12:17	05/25/15 21:15	1
Protactinium 234m	-0.5558	U	4.51	4.51		2.35	pCi/g	05/04/15 12:17	05/25/15 21:15	1

Other Detected Radionuclides	MB MB		Count	Total	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
	Result	Qualifier	Uncert. (2σ+/-)	Uncert. (2σ+/-)						
Other Detected Radionuclide	None						pCi/g	05/04/15 12:17	05/25/15 21:15	1

**Lab Sample ID: LCS 160-189205/2-A**

**Matrix: Solid**

**Analysis Batch: 192155**

**Client Sample ID: Lab Control Sample**

**Prep Type: Total/NA**

**Prep Batch: 189205**

Analyte	Spike Added	LCS Result	LCS Qual	Total	RL	MDC	Unit	%Rec	%Rec.
				Uncert. (2σ+/-)					Limits
Americium 241	101	102.6		10.7		0.563	pCi/g	102	87 - 116
Cesium 137	34.8	36.91		3.82		0.153	pCi/g	106	87 - 120
Cobalt 60	35.5	36.80		3.65		0.129	pCi/g	104	87 - 115

**Lab Sample ID: 160-11590-1 DU**

**Matrix: Solid**

**Analysis Batch: 192155**

**Client Sample ID: L10-14-10-B-E-B-00**

**Prep Type: Total/NA**

**Prep Batch: 189205**

Analyte	Sample Result	Sample Qual	DU Result	DU Qual	Total	RL	MDC	Unit	RER	RER
					Uncert. (2σ+/-)					Limit
Actinium 228	1.05		1.203		0.182		0.148	pCi/g	0.45	1
Bismuth 212	1.15		1.390		0.490		0.438	pCi/g	0.26	1
Bismuth 214	1.25		1.224		0.167		0.0727	pCi/g	0.08	1
Lead 212	1.13		1.147		0.169		0.0796	pCi/g	0.04	1
Lead 214	1.31		1.356		0.182		0.0843	pCi/g	0.12	1
Potassium 40	18.5		23.74		2.70		0.260	pCi/g	1.07	1
Protactinium 231	0.500	U	-0.6367	U	0.787		1.29	pCi/g	1.05	1
Radium 226	1.25		1.224		0.167	1.00	0.0727	pCi/g	0.08	1
Thorium 232	1.05		1.203		0.182		0.148	pCi/g	0.45	1
Thorium 234	1.20		1.397		0.635		0.988	pCi/g	0.17	1
Uranium 235	1.47		1.640		0.275		0.265	pCi/g	0.31	1
Americium 241	-0.0242	U	0.01721	U	0.0709		0.119	pCi/g	0.30	1

TestAmerica St. Louis

# QC Sample Results

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11590-2

## Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS) (Continued)

**Lab Sample ID: 160-11590-1 DU**  
**Matrix: Solid**  
**Analysis Batch: 192155**

**Client Sample ID: L10-14-10-B-E-B-00**  
**Prep Type: Total/NA**  
**Prep Batch: 189205**

Analyte	Sample Result	Sample Qual	DU Result	DU Qual	Total	RL	MDC	Unit	RER	RER
					Uncert. (2σ+/-)					Limit
Protactinium 234m	6.49		8.213		3.73		3.12	pCi/g	0.26	1
<i>Total</i>										
<i>Other Detected Radionuclides</i>	<i>Sample Result</i>	<i>Sample Qual</i>	<i>DU Result</i>	<i>DU Qual</i>	<i>Uncert. (2σ+/-)</i>	<i>RL</i>	<i>MDC</i>	<i>Unit</i>	<i>RER</i>	<i>Limit</i>
<i>Pb-210</i>	<i>1.36</i>		<i>1.542</i>		<i>0.851</i>		<i>1.00</i>	<i>pCi/g</i>	<i>0.12</i>	<i>1</i>
<i>Tl-208</i>	<i>0.313</i>		<i>0.4379</i>		<i>0.0742</i>		<i>0.0427</i>	<i>pCi/g</i>	<i>0.98</i>	<i>1</i>



# QC Association Summary

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11590-2

## Rad

### Leach Batch: 188779

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-11590-1	L10-14-10-B-E-B-00	Total/NA	Solid	Dry and Grind	
160-11590-1 DU	L10-14-10-B-E-B-00	Total/NA	Solid	Dry and Grind	
160-11590-2	L10-14-11-B-E-B-00	Total/NA	Solid	Dry and Grind	
160-11590-3	L10-14-12-B-E-B-00	Total/NA	Solid	Dry and Grind	
160-11590-4	L10-03-14-B-E-I-01	Total/NA	Solid	Dry and Grind	

### Prep Batch: 189205

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-11590-1	L10-14-10-B-E-B-00	Total/NA	Solid	Fill_Geo-21	188779
160-11590-1 DU	L10-14-10-B-E-B-00	Total/NA	Solid	Fill_Geo-21	188779
160-11590-2	L10-14-11-B-E-B-00	Total/NA	Solid	Fill_Geo-21	188779
160-11590-3	L10-14-12-B-E-B-00	Total/NA	Solid	Fill_Geo-21	188779
160-11590-4	L10-03-14-B-E-I-01	Total/NA	Solid	Fill_Geo-21	188779
LCS 160-189205/2-A	Lab Control Sample	Total/NA	Solid	Fill_Geo-21	
MB 160-189205/1-A	Method Blank	Total/NA	Solid	Fill_Geo-21	