

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: 160-10296-2

Client Project/Site: HDP

For:

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

Attn: Brian Miller



Authorized for release by:
2/26/2015 4:32:02 PM

Ivan Vania, Project Manager II
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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: 160-10296-2

Job ID: 160-10296-2

Laboratory: TestAmerica St. Louis

Narrative

CASE NARRATIVE

Client: Perma-Fix Environmental Services Inc.

Project: HDP

Report Number: 160-10296-2

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 01/28/2015; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the coolers at receipt was 20.0 C.

RADIUM-226 BY GAMMA SPEC (21 DAY INGROWTH)

Samples L10-03-10-B-E-B-00 (160-10296-1), L10-03-11-B-E-B-00 (160-10296-2) and L10-03-12-B-E-B-00 (160-10296-3) were analyzed for Radium-226 by gamma spec (21 day ingrowth) in accordance with EPA GA_01_R. The samples were leached on 01/28/2015, prepared on 01/30/2015 and analyzed on 02/24/2015.

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

Chain of Custody Record

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☒ Other:

Project Manager: Brian Miller
Tel/Fax: (314) 810-3333

Site Contact: Ellen Jakub
Lab Contact: Ivan Vania

Date: 1/28/15
Carrier: Courier

COC No: 012815-FSS1
Page 1 of 1

Client Contact
Perma-Fix Environmental Services
2800 Solway Road
Knoxville, TN 37931
(865) 690-0501
(865) 539-9868
PHONE
FAX
Project Name: Hematite Decommissioning Project
Site: Westinghouse Hematite, MO
P O # 832953

Analysis Turnaround Time
☒ CALENDAR DAYS ☐ WORKING DAYS
TAT if different from Below
☐ 2 weeks
☒ 1 week
☐ 2 days
☐ 1 day

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y/N)	Perform MS/MSD (Y/N)	Gamma Spec (Ra-226, Th-232, U-238)	ICP/MS (Tc-99)	Gamma Spec (Ra-226; post-21 day ingrowth)
L10-03-10-B-E-B-00	1/27/15	10:40	G	Soil	1	N		X	X	X
L10-03-11-B-E-B-00	1/27/15	10:45	G	Soil	1	N		X	X	X
L10-03-12-B-E-B-00	1/27/15	10:50	G	Soil	1	N		X	X	X



160-10296 Chain of Custody

Preservation Used: 1= Ice, 2= HCl, 3= H2SO4, 4= HNO3, 5= NaOH, 6= Other None
Possible Hazard Identification:
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.

☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Special Instructions/QC Requirements & Comments: Dry and homogenize samples prior to analyses; potential for radiological contamination

Custody Seals Intact: ☐ Yes ☐ No
Relinquished by: *Don Ansell*
Relinquished by: *Mark Schuffin 904*
Relinquished by: *Mark Schuffin 904*

Custody Seal No.:
Company: Perma-Fix
Company: *Perma-Fix*
Company: *Perma-Fix*

Received by: *Mark Schuffin 904*
Received by: *Mark Schuffin 904*
Received in Laboratory by: *Mark Schuffin 904*

Company: TestAmerica
Company: *TA SR*
Company: *TA SR*

Date/Time: 1/28/15 12:10
Date/Time: 1/28/15 12:10
Date/Time: 1/28/15 13:38

Therm ID No.:
Cooler Temp. (°C): Obs'd: Corrd:
Procedure: HDP-PR-QA-006, Chain of Custody

Revision: 3

Login Sample Receipt Checklist

Client: Perma-Fix Environmental Services Inc.

Job Number: 160-10296-2

Login Number: 10296

List Source: TestAmerica St. Louis

List Number: 1

Creator: Clarke, Jill C

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?	False	
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: 160-10296-2

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.
α	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: 160-10296-2

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

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: 160-10296-2

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
160-10296-1	L10-03-10-B-E-B-00	Solid	01/27/15 10:40	01/28/15 13:38
160-10296-2	L10-03-11-B-E-B-00	Solid	01/27/15 10:45	01/28/15 13:38
160-10296-3	L10-03-12-B-E-B-00	Solid	01/27/15 10:50	01/28/15 13:38

Client Sample Results

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

TestAmerica Job ID: 160-10296-2

Client Sample ID: L10-03-10-B-E-B-00

Lab Sample ID: 160-10296-1

Date Collected: 01/27/15 10:40

Matrix: Solid

Date Received: 01/28/15 13:38

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	1.34		0.199	0.241		0.223	pCi/g	01/30/15 08:56	02/24/15 08:16	1
Bismuth 212	1.18		0.561	0.575		0.810	pCi/g	01/30/15 08:56	02/24/15 08:16	1
Bismuth 214	1.63		0.175	0.244		0.111	pCi/g	01/30/15 08:56	02/24/15 08:16	1
Lead 212	1.25		0.114	0.198		0.124	pCi/g	01/30/15 08:56	02/24/15 08:16	1
Lead 214	1.91		0.164	0.257		0.129	pCi/g	01/30/15 08:56	02/24/15 08:16	1
Potassium 40	19.6		1.57	2.55		0.344	pCi/g	01/30/15 08:56	02/24/15 08:16	1
Protactinium 231	0.699	U	0.446	0.453		1.88	pCi/g	01/30/15 08:56	02/24/15 08:16	1
Radium 226	1.63		0.175	0.244	1.00	0.111	pCi/g	01/30/15 08:56	02/24/15 08:16	1
Thorium 232	1.34		0.199	0.241		0.223	pCi/g	01/30/15 08:56	02/24/15 08:16	1
Thorium 234	3.72		1.33	1.39		1.55	pCi/g	01/30/15 08:56	02/24/15 08:16	1
Uranium 235	0.610		0.275	0.282		0.332	pCi/g	01/30/15 08:56	02/24/15 08:16	1
Americium 241	0.00379	U	0.0972	0.0972		0.164	pCi/g	01/30/15 08:56	02/24/15 08:16	1
Protactinium 234m	7.98	U	5.12	5.18		9.13	pCi/g	01/30/15 08:56	02/24/15 08:16	1
Other Detected										
Radionuclides	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tl-208	0.546		0.0740	0.0932		0.0462	pCi/g	01/30/15 08:56	02/24/15 08:16	1

Client Sample ID: L10-03-11-B-E-B-00

Lab Sample ID: 160-10296-2

Date Collected: 01/27/15 10:45

Matrix: Solid

Date Received: 01/28/15 13:38

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	1.55		0.144	0.214		0.141	pCi/g	01/30/15 08:56	02/24/15 09:01	1
Bismuth 212	1.62		0.685	0.705		0.633	pCi/g	01/30/15 08:56	02/24/15 09:01	1
Bismuth 214	1.80		0.156	0.243		0.0981	pCi/g	01/30/15 08:56	02/24/15 09:01	1
Lead 212	1.32		0.0906	0.193		0.0779	pCi/g	01/30/15 08:56	02/24/15 09:01	1
Lead 214	1.97		0.118	0.237		0.0905	pCi/g	01/30/15 08:56	02/24/15 09:01	1
Potassium 40	19.0		1.36	2.37		0.468	pCi/g	01/30/15 08:56	02/24/15 09:01	1
Protactinium 231	0.641	U	0.287	0.296		1.40	pCi/g	01/30/15 08:56	02/24/15 09:01	1
Radium 226	1.80		0.156	0.243	1.00	0.0981	pCi/g	01/30/15 08:56	02/24/15 09:01	1
Thorium 232	1.55		0.144	0.214		0.141	pCi/g	01/30/15 08:56	02/24/15 09:01	1
Thorium 234	2.89		0.713	0.775		1.07	pCi/g	01/30/15 08:56	02/24/15 09:01	1
Uranium 235	0.612		0.175	0.186		0.234	pCi/g	01/30/15 08:56	02/24/15 09:01	1
Americium 241	-0.0248	U	0.0763	0.0764		0.128	pCi/g	01/30/15 08:56	02/24/15 09:01	1
Protactinium 234m	2.98	U	3.59	3.61		5.89	pCi/g	01/30/15 08:56	02/24/15 09:01	1
Other Detected										
Radionuclides	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tl-208	0.449		0.0597	0.0758		0.0460	pCi/g	01/30/15 08:56	02/24/15 09:01	1

TestAmerica St. Louis

Client Sample Results

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

TestAmerica Job ID: 160-10296-2

Client Sample ID: L10-03-12-B-E-B-00

Lab Sample ID: 160-10296-3

Date Collected: 01/27/15 10:50

Matrix: Solid

Date Received: 01/28/15 13:38

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	1.39		0.164	0.217		0.101	pCi/g	01/30/15 08:56	02/24/15 09:05	1
Bismuth 212	1.51		0.480	0.505		0.454	pCi/g	01/30/15 08:56	02/24/15 09:05	1
Bismuth 214	1.41		0.110	0.183		0.0846	pCi/g	01/30/15 08:56	02/24/15 09:05	1
Lead 212	1.33		0.0835	0.192		0.0770	pCi/g	01/30/15 08:56	02/24/15 09:05	1
Lead 214	1.65		0.110	0.204		0.0772	pCi/g	01/30/15 08:56	02/24/15 09:05	1
Potassium 40	17.6		1.17	2.15		0.482	pCi/g	01/30/15 08:56	02/24/15 09:05	1
Protactinium 231	0.274	U	0.460	0.461		0.770	pCi/g	01/30/15 08:56	02/24/15 09:05	1
Radium 226	1.41		0.110	0.183	1.00	0.0846	pCi/g	01/30/15 08:56	02/24/15 09:05	1
Thorium 232	1.39		0.164	0.217		0.101	pCi/g	01/30/15 08:56	02/24/15 09:05	1
Thorium 234	1.08		0.552	0.564		0.886	pCi/g	01/30/15 08:56	02/24/15 09:05	1
Uranium 235	0.103	U	0.143	0.144		0.282	pCi/g	01/30/15 08:56	02/24/15 09:05	1
Americium 241	0.0178	U	0.0688	0.0689		0.115	pCi/g	01/30/15 08:56	02/24/15 09:05	1
Protactinium 234m	-0.284	U	331	331		5.84	pCi/g	01/30/15 08:56	02/24/15 09:05	1
Other Detected			Count	Total						
Radionuclides			Uncert.	Uncert.						
TI-208	0.436		(2σ+/-)	(2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
			0.0539	0.0703		0.0411	pCi/g	01/30/15 08:56	02/24/15 09:05	1

QC Sample Results

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

TestAmerica Job ID: 160-10296-2

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

Lab Sample ID: MB 160-171648/1-A

Matrix: Solid

Analysis Batch: 175640

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 171648

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	0.008060	U	0.0178	0.0178		0.0322	pCi/g	01/30/15 08:56	02/24/15 08:10	1
Bismuth 212	0.001416	U	0.136	0.136		0.260	pCi/g	01/30/15 08:56	02/24/15 08:10	1
Bismuth 214	0.005069	U	0.0162	0.0162		0.0359	pCi/g	01/30/15 08:56	02/24/15 08:10	1
Lead 212	-0.001398	U	0.0173	0.0173		0.0270	pCi/g	01/30/15 08:56	02/24/15 08:10	1
Lead 214	0.006060	U	0.00966	0.00968		0.0363	pCi/g	01/30/15 08:56	02/24/15 08:10	1
Potassium 40	0.002485	U	0.134	0.134		0.298	pCi/g	01/30/15 08:56	02/24/15 08:10	1
Protactinium 231	0.02604	U	0.130	0.130		0.246	pCi/g	01/30/15 08:56	02/24/15 08:10	1
Radium 226	0.005069	U	0.0162	0.0162	1.00	0.0359	pCi/g	01/30/15 08:56	02/24/15 08:10	1
Thorium 232	0.008060	U	0.0178	0.0178		0.0322	pCi/g	01/30/15 08:56	02/24/15 08:10	1
Thorium 234	0.02388	U	0.127	0.127		0.254	pCi/g	01/30/15 08:56	02/24/15 08:10	1
Uranium 235	0.01961	U	0.0269	0.0269		0.0706	pCi/g	01/30/15 08:56	02/24/15 08:10	1
Americium 241	0.003038	U	0.0132	0.0132		0.0235	pCi/g	01/30/15 08:56	02/24/15 08:10	1
Protactinium 234m	0.002753	U	0.876	0.876		1.89	pCi/g	01/30/15 08:56	02/24/15 08:10	1

Other Detected Radionuclides	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Other Detected Radionuclide	None						pCi/g	01/30/15 08:56	02/24/15 08:10	1

Lab Sample ID: LCS 160-171648/2-A

Matrix: Solid

Analysis Batch: 175638

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 171648

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits
Americium 241	101	101.3		10.5		0.513	pCi/g	100	87 - 116
Cesium 137	35.0	34.81		3.64		0.164	pCi/g	100	87 - 120
Cobalt 60	36.7	35.83		3.61		0.124	pCi/g	98	87 - 115

Lab Sample ID: 160-10296-3 DU

Matrix: Solid

Analysis Batch: 175640

Client Sample ID: L10-03-12-B-E-B-00

Prep Type: Total/NA

Prep Batch: 171648

Analyte	Sample Result	Sample Qual	DU Result	DU Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	RER	RER Limit
Actinium 228	1.39		1.399		0.226		0.128	pCi/g	0.01	1
Bismuth 212	1.51		1.759		0.608		0.543	pCi/g	0.22	1
Bismuth 214	1.41		1.400		0.196		0.0815	pCi/g	0.03	1
Lead 212	1.33		1.408		0.203		0.0652	pCi/g	0.19	1
Lead 214	1.65		1.654		0.217		0.0888	pCi/g	0.01	1
Potassium 40	17.6		17.08		2.13		0.255	pCi/g	0.13	1
Protactinium 231	0.274	U	0.5843	U	0.269		1.44	pCi/g	0.43	1
Radium 226	1.41		1.400		0.196	1.00	0.0815	pCi/g	0.03	1
Thorium 232	1.39		1.399		0.226		0.128	pCi/g	0.01	1
Thorium 234	1.08		0.8238	U	0.334		0.923	pCi/g	0.29	1
Uranium 235	0.103	U	0.1802	U	0.145		0.206	pCi/g	0.27	1
Americium 241	0.0178	U	0.009082	U	0.0684		0.115	pCi/g	0.06	1

TestAmerica St. Louis

QC Sample Results

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

TestAmerica Job ID: 160-10296-2

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

Lab Sample ID: 160-10296-3 DU

Matrix: Solid

Analysis Batch: 175640

Client Sample ID: L10-03-12-B-E-B-00

Prep Type: Total/NA

Prep Batch: 171648

Analyte	Sample Result	Sample Qual	DU Result	DU Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	RER	RER Limit
Protactinium 234m	-0.284	U	2.346	U	3.56		5.94	pCi/g	0.01	1
<hr/>										
Other Detected Radionuclides	Sample Result	Sample Qual	DU Result	DU Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	RER	RER Limit
Tl-208	0.436		0.4972		0.0796		0.0402	pCi/g	0.41	1

QC Association Summary

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

TestAmerica Job ID: 160-10296-2

Rad

Leach Batch: 170938

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-10296-1	L10-03-10-B-E-B-00	Total/NA	Solid	Dry and Grind	
160-10296-2	L10-03-11-B-E-B-00	Total/NA	Solid	Dry and Grind	
160-10296-3	L10-03-12-B-E-B-00	Total/NA	Solid	Dry and Grind	
160-10296-3 DU	L10-03-12-B-E-B-00	Total/NA	Solid	Dry and Grind	

Prep Batch: 171648

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-10296-1	L10-03-10-B-E-B-00	Total/NA	Solid	Fill_Geo-21	170938
160-10296-2	L10-03-11-B-E-B-00	Total/NA	Solid	Fill_Geo-21	170938
160-10296-3	L10-03-12-B-E-B-00	Total/NA	Solid	Fill_Geo-21	170938
160-10296-3 DU	L10-03-12-B-E-B-00	Total/NA	Solid	Fill_Geo-21	170938
LCS 160-171648/2-A	Lab Control Sample	Total/NA	Solid	Fill_Geo-21	
MB 160-171648/1-A	Method Blank	Total/NA	Solid	Fill_Geo-21	