OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
Managed by ORAU for DOE

October 12, 2016

Ms. Rachel Browder
U.S. Nuclear Regulatory Commission
Region IV
1600 East Lamar Boulevard
Arlington, TX 76011

SUBJECT: **ORISE CONTRACT NO. DE-SC0014664**
LETTER REPORT FOR ANALYTICAL RESULTS FOR SEVEN SOIL SAMPLES ASSOCIATED WITH THE HILL AIR FORCE BASE, LITTLE MOUNTAIN TEST ANNEX WR111 SITE, UTAH
[TAC NO. 030-28641/2016-001] [DOCKET NO. 30-28641](RFTA NO. 16-001)
DCN: 5298-LR-01-0

Dear Ms. Browder:

Oak Ridge Institute for Science and Education (ORISE) received seven soil samples on August 25, 2016 from the Little Mountain Test Annex WR111 site Hill AFB, Utah. ORISE is managed by Oak Ridge Associated Universities (ORAU) under DOE contract number DE-SC0014664. The samples were received in good condition. Per the NRC Form 303 that was sent with the samples, the samples were analyzed for thorium and radium by gamma spectrometry. At your request, one sample was analyzed for thorium-230 by alpha spectrometry to confirm the gamma results. The analytical data, along with the procedure references, are presented in the attached reports. A case narrative is included to provide information regarding the analytical data.

Quality Control (QC) requirements were met for these analyses. The QC files are available for your review upon request.

Please feel free to contact me at 865.576.9184 or Forrest Smith at 865.574.9802 with any questions or comments.

Sincerely,

For Wade Ivey

Wade Ivey, Manager Laboratory
ORAU

WPI:WFS:km:lw

Enclosures

Electronic distribution: T. Carter, NRC; S. Roberts, ORAU; T. Vitkus, ORAU; E. Bailey, ORAU; D. Hagemeyer, ORAU
File code: 5298; Lab code: 11791

Distribution approval and concurrence:	Initials
Quality Review	
Technical Review	

CASE NARRATIVE FOR ANALYTICAL RESULTS FOR SEVEN SOIL SAMPLES FROM THE HILL AIR FORCE BASE, LITTLE MOUNTAIN TEST ANNEX WR111 SITE, UTAH

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
Managed by ORAU for DOE

Prepared for the
U.S. Nuclear Regulatory Commission

Issued October 2016

This document was prepared for the U.S. Nuclear Regulatory Commission (NRC) by the Oak Ridge Institute for Science and Education (ORISE) through an interagency agreement (NRC FIN No. F-1244) between the NRC and the U.S. Department of Energy (DOE). ORISE is managed by Oak Ridge Associated Universities under DOE contract number DE-SC0014664.

CASE NARRATIVE FOR ANALYTICAL RESULTS FOR SEVEN SOIL SAMPLES FROM THE HILL AIR FORCE BASE, LITTLE MOUNTAIN TEST ANNEX WR111 SITE, UTAH

PROJECT NAME:	Hill AFB
PROJECT #:	201211791
DCN:	5298-LR-01-0
SDG #:	201211791-1

1. GENERAL

The Radiological and Environmental Analytical Laboratory (REAL) at Oak Ridge Institute for Science and Education (ORISE) received seven soil samples on August 25, 2016 from the Little Mountain Test Annex WR111 site Hill AFB, Utah. All samples were received in good condition. As requested, all samples were analyzed for thorium-232, thorium-230, and radium-226 by gamma spectrometry. In addition, one sample was analyzed for thorium-230 by alpha spectrometry.

The quality control (QC) samples were evaluated against ORISE's acceptance criteria as defined by the *ORAU Radiological and Environmental Analytical Laboratory Procedures Manual* and the *ORAU Environmental Services and Radiation Training Quality Program Manual* (ORAU 2016a and 2016b), which are at least as stringent as those set forth in the U.S. Department of Defense/U.S. Department of Energy (DoD/DOE) Quality Systems Manual (QSM). Any deviations from the approved REAL procedures are documented in the project file and described in the sections below.

2. SAMPLE IDENTIFICATION AND RECEIPT/CHAIN OF CUSTODY

2.1 SAMPLE IDENTIFICATION

This data package contains analytical data for seven soil samples for gamma spectrometry and one soil sample for alpha spectrometry. The sample labels on the samples matched the sample identifications (IDs) on the chain of custody (COC). REAL sample IDs are cross-referenced with the client sample IDs below, along with the sample receipt date and requested analysis.

Client Sample ID	Lab Sample ID	LAB Receipt Date	Requested Analysis
Hill-S-01	11791S0001	08/25/2016	Gamma Spec
Hill-S-02	11791S0002	08/25/2016	Gamma Spec
Hill-S-03	11791S0003	08/25/2016	Gamma Spec
Hill-S-04	11791S0004	08/25/2016	Gamma Spec
Hill-S-05	11791S0005	08/25/2016	Gamma Spec
Hill-S-06	11791S0006	08/25/2016	Gamma Spec
Hill-S-07	11791S0007	08/25/2016	Gamma Spec and Alpha Spec

2.2 SAMPLE RECEIPT/CHAIN OF CUSTODY

The seven soil samples arrived on August 25, 2016 in a cooler, and all samples were received in good condition. The Form 303 supplied with the samples was complete and legible.

3. SAMPLE PREPARATION

The soil samples were prepared for analysis using REAL procedure SP3, revision 9. The samples were dried to constant weight, homogenized, and passed through a 0.25-inch sieve. The homogenized samples were placed in appropriately sized containers for gamma spectrometry. An aliquot of the homogenized sample (Hill-S-07) that had been counted for gamma spectroscopy was used for the alpha spectrometry analysis. There were no deviations from SP3, revision 9 for the soil samples.

4. GAMMA SPECTROMETRY

REAL analyzed for radium-226, thorium-230, and thorium-232, (Ra-226, Th-230, and Th-232) by gamma spectrometry using REAL procedure CP1, revision 19, which is a modified version of EPA method 901.1, DOE EMM HASL 300 Ga-010R, and Standards Methods 7120B. A summary of these standardized methods may be found in the EPA document titled "Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events, Revision 5.0" (EPA/600/R-04/126E September 29, 2009).
http://nepis.epa.gov/Exe/ZyPDF.cgi/P1005B4P.PDF?Dockey=P1005B4P.PDF.

REAL used the direct Th-230 gamma emission and the progeny of Ra-226 and Th-232 for quantification. The requested gamma-emitting radionuclide, the progeny radionuclide, and the approximate peak energy of the progeny used for quantification are presented below. The site-specific derived concentration guideline levels (DCGLs) were specified via the Form 303 for thorium-232, thorium-230, and radium-226 as 1.9, 4.3, and 1.6 pCi/g, respectively. Six of the seven soil samples had gamma spec values for Th-232 (by Ac-228 progeny) above the site specific DCGL of 1.9 pCi/g.

Client sample ID (Hill-S-07) showed an elevated thorium-230 value and did not meet the DCGL for thorium-230 by gamma spectroscopy. At the customer's request, this sample was analyzed by alpha spectroscopy to verify the results and to satisfy the required minimum detection concentration.

Requested Isotope	Progeny Isotope	Peak Energy, KeV
Ra-226	Pb-214	351.9
Th-230	NA	67.7
Th-232	Ac-228	911.2

The method blank (BLK) and laboratory control sample (LCS) quality control samples were all within acceptable limits.

5. ALPHA SPECTROMETRY

REAL analyzed the client sample ID (Hill-S-07) for thorium-230 by alpha spectrometry using REAL procedures AP11, revision 8 and CP2, revision 19, which are modified versions of DOE EML HASL 300 U-02-RC and DOE RESL CHEM-TP-A.1. The DUP, BLK, and LCS quality control samples were all within acceptable limits.

6. DATA ANALYSIS AND INTERPRETATION

All calculations—including the concentration, total propagated uncertainties (TPUs), and minimum detectable concentrations (MDCs)—were performed using Canberra's Gamma Apex and Canberra's Alpha Apex software. Units are picocuries per gram (pCi/g).

All QC samples were within acceptable limits for the analytical batch. The BLK was an empty Marinelli beaker for the gamma spectrometry analysis. For the alpha spectrometry analysis, the BLK was processed through the entire analytical process. The results of the BLK were all below the MDCs. The LCS was a 250 mL Marinelli with Standard Reference Material having known concentrations of Am-241, Cs-137, and Co-60 for the gamma spectrometry analysis. For the alpha spectrometry, the LCS was a sample of Mixed-Nuclide Reference Material with a known amount of Th-230 and was processed through the entire analytical process. The LCS percent recovery was between 80-120%. The sample duplicate (DUP) was performed by analyzing a separate fraction of the sample in the same way the sample was analyzed. The duplicate error ratio (DER) for the DUP was less than 3 for all analytes. A DER value of less than 3 indicates that the duplicate analysis was statistically equal to the sample at the 99% confidence interval.

The DER equation is:

$$DER = \frac{|S - D|}{\sqrt{{U_D}^2 + {U_S}^2}}$$

Where:

S = sample result
D = duplicate result
U_S = sample one sigma uncertainty
U_D = duplicate one sigma uncertainty

7. REFERENCES

ORAU 2016a. *ORAU Radiological and Environmental Analytical Laboratory Procedures Manual.* Oak Ridge, Tennessee. September 8.

ORAU 2016b. *ORAU Environmental Services and Radiation Training Quality Program Manual.* Oak Ridge, Tennessee. September 8.

Gamma Spectrometry Summary Results By Analyte

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Report Date: October 07, 2016

Analyte:	Ra-226 by Pb-214	SOP (Rev. #)	CP1 (19)
Project Name:	Hill AFB	Energy Signature:	351.93 (KeV)
Project # :	201211791	SDG # :	201211791-1

Client Sample ID:	Lab Sample ID:	Result	TPU (2s)	MDC	Units	Qualifier Flag	Batch #
Hill-S-01	11791S0001	0.767	0.049	0.039	pCi/g		GS0334
Hill-S-02	11791S0002	0.686	0.026	0.030	pCi/g		GS0334
Hill-S-03	11791S0003	0.787	0.048	0.035	pCi/g		GS0334
Hill-S-04	11791S0004	1.159	0.068	0.040	pCi/g		GS0334
Hill-S-05	11791S0005	0.992	0.056	0.032	pCi/g		GS0334
Hill-S-06	11791S0006	1.132	0.065	0.036	pCi/g		GS0334
Hill-S-07	11791S0007	1.398	0.082	0.052	pCi/g		GS0334

Electronically Validated By:
John Cox- 10/3/2016 07:43

Electronically Approved By:

William Smith 10/4/2016 12:45

Qualifier Flags:
U = Analyte not detected (< MDC)

TPU = Total Propagated Uncertainty
MDC = Minimum Detectable Concentration

Gamma Spectrometry Summary Results By Analyte

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Report Date: November 03, 2016

Analyte:	Th-228 by Pb-212	SOP (Rev. #)	CP1 (19)
Project Name:	Hill AFB	Energy Signature:	238.63 (KeV)
Project # :	201211791	SDG # :	201211791-1

Client Sample ID:	Lab Sample ID:	Result	TPU (2s)	MDC	Units	Qualifier Flag	Batch #
Hill-S-01	11791S0001	2.35	0.14	0.04	pCi/g		GS0334
Hill-S-02	11791S0002	2.203	0.072	0.035	pCi/g		GS0334
Hill-S-03	11791S0003	2.42	0.14	0.03	pCi/g		GS0334
Hill-S-04	11791S0004	2.01	0.12	0.04	pCi/g		GS0334
Hill-S-05	11791S0005	2.50	0.14	0.04	pCi/g		GS0334
Hill-S-06	11791S0006	1.674	0.099	0.031	pCi/g		GS0334
Hill-S-07	11791S0007	3.83	0.22	0.05	pCi/g		GS0334

Electronically Validated By:
John Cox- 10/3/2016 07:43

Electronically Approved By:

William Smith 10/4/2016 12:45

Qualifier Flags:
U = Analyte not detected (< MDC)

TPU = Total Propagated Uncertainty
MDC = Minimum Detectable Concentration

Gamma Spectrometry Summary Results By Analyte

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Report Date: October 07, 2016

Analyte:	Th-232 by Ac-228	SOP (Rev. #)	CP1 (19)
Project Name:	Hill AFB	Energy Signature:	911.20 (KeV)
Project # :	201211791	SDG # :	201211791-1

Client Sample ID:	Lab Sample ID:	Result	TPU (2s)	MDC	Units	Qualifier Flag	Batch #
Hill-S-01	11791S0001	2.58	0.18	0.09	pCi/g		GS0334
Hill-S-02	11791S0002	2.53	0.20	0.06	pCi/g		GS0334
Hill-S-03	11791S0003	2.69	0.19	0.06	pCi/g		GS0334
Hill-S-04	11791S0004	2.31	0.17	0.08	pCi/g		GS0334
Hill-S-05	11791S0005	2.77	0.20	0.07	pCi/g		GS0334
Hill-S-06	11791S0006	1.87	0.14	0.06	pCi/g		GS0334
Hill-S-07	11791S0007	4.34	0.29	0.10	pCi/g		GS0334

Electronically Validated By:
John Cox- 10/3/2016 07:43

Electronically Approved By:

William Smith 10/4/2016 12:45

Qualifier Flags:
U = Analyte not detected (< MDC)

TPU = Total Propagated Uncertainty
MDC = Minimum Detectable Concentration

Gamma Spectrometry Summary Results By Analyte

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Report Date: October 07, 2016

Analyte:	Th-230	SOP (Rev. #)	CP1 (19)
Project Name:	Hill AFB	Energy Signature:	67.67 (KeV)
Project # :	201211791	SDG # :	201211791-1

Client Sample ID:	Lab Sample ID:	Result	TPU (2s)	MDC	Units	Qualifier Flag	Batch #
Hill-S-01	11791S0001	2.1	1.5	3.5	pCi/g	U	GS0334
Hill-S-02	11791S0002	1.4	1.8	4.3	pCi/g	U	GS0334
Hill-S-03	11791S0003	1.1	1.5	3.5	pCi/g	U	GS0334
Hill-S-04	11791S0004	1.8	1.5	3.4	pCi/g	U	GS0334
Hill-S-05	11791S0005	3.3	1.4	2.9	pCi/g		GS0334
Hill-S-06	11791S0006	0.5	1.4	3.3	pCi/g	U	GS0334
Hill-S-07	11791S0007	19.5	3.8	4.5	pCi/g		GS0334

Electronically Validated By:
John Cox- 10/3/2016 07:43

Electronically Approved By:

William Smith 10/4/2016 12:45

Qualifier Flags:
U = Analyte not detected (< MDC)

TPU = Total Propagated Uncertainty
MDC = Minimum Detectable Concentration

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Alpha Spectrometry Summary Sheet

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Report Date: October 07, 2016

Project Name: Hill AFB
Project # : 201211791
COC # : 1608-009
SDG #: 201211791-1
Analyst: nagler

Batch # : AS0349
Receipt Date: 8/25/2016
Collection Date: 8/24/2016
Count Date: 9/29/2016
SOP (Rev. #): AP11 (8)

Client Sample ID	Lab Sample ID	Analyte	Result	TPU (2s)	MDC	Units	Yield	Qualifier
Hill-S-07	11791S0007	TH-228	3.99	0.46	0.07	pCi/g	0.8276	
Hill-S-07	11791S0007	TH-230	13.2	1.4	0.0	pCi/g	0.8276	
Hill-S-07	11791S0007	TH-232	3.88	0.45	0.03	pCi/g	0.8276	
	11791S0007Dup	TH-228	4.63	0.54	0.07	pCi/g	0.7758	
	11791S0007Dup	TH-230	16.8	1.9	0.0	pCi/g	0.7758	
	11791S0007Dup	TH-232	4.60	0.54	0.01	pCi/g	0.7758	
	BLK0349S	TH-228	0.004	0.043	0.113	pCi/g	0.8746	U
	BLK0349S	TH-230	0.015	0.024	0.056	pCi/g	0.8746	U
	BLK0349S	TH-232	0.004	0.013	0.037	pCi/g	0.8746	U
	LCS0349S	TH-228	4.92	0.56	0.06	pCi/sample	0.8309	
	LCS0349S	TH-230	6.92	0.77	0.03	pCi/sample	0.8309	
	LCS0349S	TH-232	4.90	0.56	0.02	pCi/sample	0.8309	

SampleCode	Isotope	Known Activity (pCi)	Known Uncertainty (1 s)	Meas./Known Activity Ratio
LCS0349S	TH-230	6.68	0.27	1.04

SampleCode	Isotope	Duplicate Error Ratio
11791S0007Dup	TH-228	1.77
11791S0007Dup	TH-230	2.99
11791S0007Dup	TH-232	2.03

Qualifier Flags:
U = Analyte not detected (< MDC)

TPU = Total Propagated Uncertainty
MDC = Minimum Detectable Concentration

Report Date: October 07, 2016

AS Electronically Reviewed By:
Roxanne Nagle- 9/30/2016 10:05

Electronically Validated By:
Wade Ivey- 9/30/2016 11:06

Electronically Approved By:

William Smith 10/4/2016 12:45

Qualifier Flags:
U = Analyte not detected (< MDC)

TPU = Total Propagated Uncertainty
MDC = Minimum Detectable Concentration

NRC FORM 303 (4-2004) — U.S. NUCLEAR REGULATORY COMMISSION

REQUEST FOR ANALYSIS AND CHAIN OF CUSTODY

LABORATORY -- ORISE

LABORATORY USE ONLY

CONTROL NUMBER: RFTA-16-001

SAMPLE LOCATION (LICENSEE): Hill AFB - Little Mountain Test Annex WR111 site

LICENSE NO.: 42-23539-01AF

DOCKET NO.: 30-28641

SAMPLE SUBMITTED

# TOTAL	TYPE	VOLUME	WEIGHT
7	Soil Samples		

DATE SAMPLES SUBMITTED: 8/24/16

PRIORITY: ☒ ROUTINE ☐ URGENT

SAMPLE COLLECTION INTERVAL

	MONTH	DAY	YEAR	TIME
START	8	24	16	11:00
STOP	8	24	16	11:30

INSPECTOR RESPONSIBLE: Rachel Browder

TELEPHONE NUMBER: 817-200-1452

ANALYSIS TO BE PERFORMED	LIST DESIRED LLD (Optional)	OTHER TYPE OF ANALYSIS (Specify)	LIST DESIRED LLD (Optional)
☐ GROSS ALPHA (GA)		☐	
☐ GROSS BETA (GB)		☐	
☒ GAMMA SPEC (GS)		☐	
☐ TRITIUM (H3)		☐	
☐ CARBON-14 (C14)		☐	
☐ IODINE-125 (I125)		☐	

RELINQUISHED BY	RECEIVED BY	DATE	TIME	REASON FOR CHANGE OF CUSTODY
Rachel Browder	Fed Ex	8-24-16		Ship to ORAU Lab
Fed Ex	ORAU Fount Smith	8/25/16	1100	Analysis

FEE RECOVERABLE: ☐ NO ☒ YES — IF YES TAC NUMBER: 030-28641/2016-001

REMARKS

Return samples to: AFCEC/CZOM
7290 Weiner St., Building 383
Hill AFB, UT 84056-5003
Attn: Mark Roginske, Room 210

Radionuclides of concern: Th-232; Th-230; Ra-226

Action levels - Site Specific DCGLs: Th-232 - 1.9 pCi/g; Th-230 - 4.3 pCi/g; Ra-226 - 1.6 pCi/g

NRC Inspection Report Number: 03028641/2016-001

NOTE: SAMPLES WILL BE DISCARDED AFTER ANALYSIS UNLESS REASONS ARE NOTED IN REMARKS ABOVE.

NRC FORM 303 (4-2004)

U.S. NUCLEAR REGULATORY COMMISSION

SAMPLE RECORD -- (Continued)
LABORATORY -- ORISE

LABORATORY USE ONLY

CONTROL NUMBER

RFTA-16-001

SAMPLE NUMBER	SAMPLE NAME AND DESCRIPTION	COLLECTION DATE/TIME	REMARKS, PRESERVATIVE ANALYSIS REQUESTED, ETC.
Hill-S-01	Hill - WRIII - 01	8-24-16 11:00 a	γ-Spec ; α for Th-230 as necessary
Hill-S-02	Hill - WRIII - 02	8-24-16 11:05a	γ-Spec ; "
Hill-S-03	Hill - WRIII - 03	8-24-16 11:10a	γ-Spec ; "
Hill-S-04	Hill-WRIII-04	8-24-16 11:15a	γ-Spec ; "
Hill-S-05	Hill - WRIII - 05	8-24-16 11:20a	γ-Spec ; "
Hill-S-06	Hill - WRIII - 06	8-24-16 11:25a	γ-Spec ; "
Hill-S-07	Hill - WRIII - 07	8-24-16 11:30 a	γ-Spec ; "

Page 1 of 1

Project #: 201211791

Project Name: Hill AFB

ORAU/ORISE Chain of Custody and Analytical Request

COC # : 1608-009

ORAU/ORISE
1299 Bethel Valley Road, Bldg SC-200
Oak Ridge, TN 37831
Phone: (865) 576-9184
Fax: (865) 241-3248

Client Name: IEAV - Lab **Phone # :** 865-576-9184 **Fax # :**

Address: **Email :** Wade.Ivey@orau.org

Collected By: Rachel Browder **Send Results To:** IveyWade

Client Sample ID	Date Collected (mm-dd-yy)	Time Collected (military)	Sample Matrix (1)	Field Filtered (2)	ORAU/ORISE Lab Sample ID (Lab Use Only)	Total # of containers	Sample Analysis Requested (3)	Comments
Hill-S-01	08/24/16	11:00	S	No	11791S0001	1	GAMMA SPEC	
Hill-S-02	08/24/16	11:05	S	No	11791S0002	1	GAMMA SPEC	
Hill-S-03	08/24/16	11:10	S	No	11791S0003	1	GAMMA SPEC	
Hill-S-04	08/24/16	11:15	S	No	11791S0004	1	GAMMA SPEC	
Hill-S-05	08/24/16	11:20	S	No	11791S0005	1	GAMMA SPEC	
Hill-S-06	08/24/16	11:25	S	No	11791S0006	1	GAMMA SPEC	
Hill-S-07	08/24/16	11:30	S	No	11791S0007	1	GAMMA SPEC, ALPHA SPEC	

Gamma Isotopes: AC228, AC228, BI212, BI214, BI214, BI214, K40, PA234, PB212, PB214, PB214, RA226, TH230, TH234, TH234, U235, U235, U235

Alpha Isotopes: Th,

LSA:

TAT Requested: 28 **Rush:** ***Fax Results*** **Fax # :**

Chain of Custody Signatures

Relinquished By (Signed)	Date	Time	Received By (Signed)	Date	Time
Fed Ex	8/25/2016	11:00:00AM	Forrest Smith	8/25/2016	11:00:00AM

Sample Shipping and Delivery Details

ORAU/ORISE PM: IveyWade Phone # : 865-576-9184

Method of Shipment: Date Shipped:

EDD Required: **Report Type:** 3 **Received in Good Condition:** Yes

PEMS Project ID : Hill AFB **PEMS SOW ID:** Hill AFB

Airbill # :

Airbill # :

1) Matrix Codes: **S**=Soil, **W**=Water, **M**=Miscellaneous, **A**=Air Filter, **R**=Smear/Wipe

2) Field Filtered: For liquid matrices, indicate **-Y-** for yes the sample was field filtered or **-N-** for sample was not field filtered.

3) If the integrity of the samples and/or sample packaging are in question, provide details in the CoC comment field.

COC Comments:

DGCLS: Th-232 - 1.9 pCi/g
Th-230 - 4.3 pCi/g
Ra-226 - 1.6 pCi/g