



**Staff Report**

City Council Study Session Meeting  
February 1, 2021



*Visionary Leadership, Effective Governance and Proactive Regional Collaboration*



*Vibrant, Inclusive and Engaged Community*



*Beautiful, Desirable, Safe and Environmentally Responsible City*

**Subject:** Presentation on Federal Land Access Program Grant and the Rocky Mountain Greenway Regional Project

**Prepared By:** Jason Genck, Parks, Recreation and Libraries Director  
Rod Larsen, Open Space Manager  
Joe Reale, Open Space Superintendent

**Recommended City Council Action:**

Receive the presentation on the Federal Lands Access Program grant, ask Staff questions, and provide feedback regarding the program and partnership to extend the Rocky Mountain Greenway regional project.

**Summary Statement:**

- In 2016, the City joined with five neighboring open space partners including Jefferson County, Boulder County, City and County of Broomfield, the City of Boulder, and the City of Arvada to submit a grant to extend the Rocky Mountain Greenway (RMG) regional project.
- As part of the RMG project, City Council requested a sampling analysis plan (SAP) that was requested in part to support for the Federal Lands Access Program (FLAP) grant.
- The FLAP grant partners entered in a cost sharing agreement to fund the SAP and awarded the soil analysis contract to Engineering Analytics, Inc. (EA). Jason Andrews, P.E. from EA, will be in attendance to present the findings of the SAP and will be available for questions.
- In 2019, soil samples were collected at both proposed crossing locations by EA and analyzed at an independent laboratory.
- The findings of the SAP reflect radionuclide activity levels that are consistent with the standards used by the Environmental Protection Agency (EPA) and Colorado Department of Public Health and Environment (CDPHE) to demonstrate that the Rocky Flats National Wildlife Refuge (NWR) is safe for public use.
- It is the intent of the FLAP grant partners to have all intergovernmental agreements (IGA) in place for project design by Federal Highways Administration (FHWA) to start in the spring/summer 2021, facilitating construction in summer/fall 2021.
- Representatives from Jefferson County Open Space and Rocky Flats National Wildlife Refuge (David Lucas) will also be available for questions.

**Fiscal Impact:**

\$0 in expenditures.

**Source of Funds:**

Not applicable.

**Policy Issue(s):**

- Does City Council want to receive this presentation with an update on the FLAP grant, the results of requested testing, and the status of the RMG regional project?
- Does City Council want to continue to be involved with the FLAP grant and the RMG regional project?

**Alternative(s):**

- City Council could choose to not receive the presentation to learn more about the FLAP grant and the RMG regional project. Staff recommends hearing the presentation, which allows City Council the opportunity to ask questions they might have related to this program moving forward.
- City Council could choose not to continue the partnership with our neighboring open space partners to extend the Rocky Mountain Greenway (RMG) regional project and discuss this trail crossing. Staff does not recommend this alternative as this crossing is an important component to achieve the regional vision of a trail system to connect Denver International Airport to the Rocky Mountains. This crossing will serve as a natural gateway to the Rocky Mountains from Westminster to provide nature-based mobility and exploration for the community and visitors, which otherwise would not exist.

**Background Information:**

The City has historically placed a high priority on the planning and development of regional trails. There are approximately 150 miles of trails in the City, most of which wind through open space and provide access to magnificent vistas, wildlife corridors, and natural beauty. Over one million people used the City's trail system in 2020, with trail segments experiencing as much as a 400% increase in users compared to previous years. The events of 2020 and the COVID-19 pandemic definitely contributed to this increase and further strengthened the need for open space and trail systems. Residents truly rely on these trails to recreate and connect with nature through open space lands.

Enhancing the trail systems is a high priority of the community as evidenced in the recent community survey. In July 2020, a community survey of residents strongly indicated that beautiful parks and open space describe Westminster. In addition, a majority of respondents agreed that trails and parks were important to the quality of life facilitated by the City. These results coincide with the mission of the Parks, Recreation and Libraries (PRL) Department to create exceptional opportunities for a vibrant community and a commitment to nature, wellness, and literacy. Staff has actively pursued unique opportunities locally and regionally to further this commitment and build upon what has already been accomplished. Attachment A is the Resolution that the PRL Open Space Advisory Board (PRLOSAB) presented to City Council on May 12, 2016, during the public comment in support for this particular project.

The RMG is one of the several regional trail projects that is currently active. In 2012, then Governor Hickenlooper and former United States Secretary of Interior Ken Salazar, proposed the RMG to link the Rocky Mountain NWR, Two Ponds NWR, Rocky Flats NWR, and Rocky Mountain National Park using local and regional trails and transit opportunities. As part of the federal government's America's Great Outdoors initiative, the approximately 80-mile RMG has a focus on providing the community and visitors access to public lands. In 2015, then Governor Hickenlooper announced the Colorado the Beautiful initiative that included the identification of 16 trail gaps, missing trail segments and underdeveloped trails by 2016. The RMG was one of these "16 in 16." The goal of these initiatives has been to support locally driven projects and strengthen economies and communities by providing greater access to open space and outdoor recreation.

Jefferson County Open Space (JCOS) staff identified the availability of the FHWA grant that could support community access into the Rocky Flats NWR. In 2015, Jefferson County contacted the City about supporting a FLAP grant that would fund over 83% of the costs of the RMG connections to the Rocky Flats NWR. On July 11, 2016, City Council adopted Resolution No. 24 to conditionally support JCOS's request to pursue a FLAP grant and to provide up to \$220,000 in matching funds for the construction of a pedestrian overpass crossing Indiana Street and a pedestrian underpass at Highway 128 (Attachment B). At the time the resolution was adopted, the other members of the partnership were Jefferson County, Boulder County, City and County of Broomfield, and the cities of Boulder and Arvada. In October 2020, the City and County of Broomfield withdrew from the partnership.

Currently, the 27-mile RMG originates at the Rocky Mountain Arsenal NWR in northeast Denver at the east end, heads west as it passes through Two Ponds NWR in Arvada, and dead-ends in Westminster Hills Open Space on the east side of Indiana Street. The FLAP grant will provide funding for crossings at this location on the east side of Rocky Flats NWR as well as on Highway 128 on the north end of Rocky Flats NWR. Attachment C illustrates a map from Jefferson County with an overview of this area.

In September 2018, Rocky Flats NWR was opened to the public. Since that time, it has seen increasing visitation to the 5,237 acres of mixed and tall grass prairies. Visitors have utilized the 10.3 miles of multi-use trails for year-round hiking, bicycling, cross country skiing, snowshoeing, and horseback riding.



As of this presentation, staff from the FLAP partners are working with their respective City Councils/Commissioners to outline and approve a new IGA that would allow for the planning and construction of the RMG crossings into Rocky Flats NWR. On December 15, 2020, the Jefferson County Board of Commissioners approved a resolution accepting a draft IGA with the partners. The City of Boulder addressed their City Council with information on January 5, 2021, and the City of Arvada is scheduled to do the same on February 8, 2021. The overall intent is to have the IGA signed by all partners during the first quarter of 2021, with the intent of having all agreements in place so that project design by FHWA can start spring/summer of 2021, leading to construction in summer/fall 2021.

JCOS has maintained a complete project website with links to all the project documents and links to historical information, and it can be accessed here. This website includes a summary of all public engagement about this project. Jefferson County Open Space serves as the central contact and tracking for public engagement and the City has supported and directed public input in this regard.

The support for this project application and the construction of connections was contingent on the development of a soil SAP (Attachment D) in addition to the results of the SAP demonstrating levels below applicable federal and state human health standards.

#### Soil SAP

In December 2017, the partners entered into a cost sharing agreement to fund a soil SAP to measure the activity of radionuclides at the crossing locations. Soil conditions at the trail crossing locations need to be consistent with public health standards for recreation activity. Construction of the crossings will occur only if the confirmatory testing results are consistent with the standards that show the site is safe for public use.

After a competitive bid process, the contract was awarded to Engineering Analytics, Inc. (EA). The partner agencies worked with EA in June 2018 to develop a draft SAP. In early July 2019, samples were collected at eight locations in the vicinity of the Highway 128 crossing and 17 locations at the Indiana Street crossing. Samples were analyzed at an independent laboratory and a final report was completed in February 2020. The report was then evaluated by member open space entities and one partner open space entity completed a separate independent analysis since the report was completed. A summary of the SAP findings is below with a more detailed report included in Attachment E.

The findings of the SAP reflect radionuclide activity levels that are consistent with the standards used by the EPA and CDPHE to demonstrate that the Rocky Flats NWR is safe for public use. The mean activity values of surface soil radionuclide samples from both the Highway 128 underpass location and the Indiana Street bridge and overpass location were without exception (lower than the historic values for the relevant exposure units). The levels are consistent with the extremely conservative benchmarks established.

Staff recognizes that Attachment E is substantial in length and therefore has made arrangements for Jason Andrews, P.E., from EA to be in attendance to present the findings of the SAP and answer questions. As a quick reference, the Summary and Conclusions is included in the attachment under Section 5, pages 39-46, of the report.

#### Next Steps

After this presentation and receiving feedback, Staff anticipates bringing the IGA before City Council for consideration at the February 8, 2021, City Council Meeting. The new IGA addresses cost sharing, operations and maintenance of an underpass at Highway 128 and overpass at Indiana Street as well as other associated trail connections. Attachment F is the proposed new IGA. A total of \$220,000 was budgeted in 2016 by the City and is available for this project. The proposed IGA outlines a total of \$188,654.44 as the City's share of the cost; the City is responsible for reimbursing testing costs incurred as part of the SAP that will utilize some of the remaining funds previously budgeted.

An additional IGA will be negotiated in the future to address the ongoing maintenance, operation, and ownership of the Trail Crossings between the partner open space entities.

This project supports the City's Strategic Plan goals of Visionary Leadership, Effective Governance and Proactive Regional Collaboration; Vibrant, Inclusive and Engaged Community; and Beautiful, Desirable, Safe and Environmentally Responsible City by initiating a wide community outreach process seeking to protect natural resources in a thoughtful placemaking effort, collaborating to reach shared goals with regional partners, and proactively leading a planning process to enhance the trail and open space system.

Respectfully submitted,

*Donald M. Tripp*

Donald M. Tripp

City Manager

**ATTACHMENTS:**

Description	Upload Date	Type
Attachment A: PRLOSB RMG Trail Resolution (dated May 5, 2016)	1/19/2021	Attachment
Attachment B: COW Resolution 24 in Support of & Authorization of Matching Funds for Jefferson County's Federal Land Access Program Grant Application (dated July 11, 2016)	1/19/2021	Attachment
Attachment C: Rocky Mountain Greenway Trail Map (dated Feb 24, 2017)	1/20/2021	Map
Attachment D: Sampling and Analysis Plan for Rocky Mountain Greenway Trail Crossings (dated March 2019)	1/20/2021	Attachment
Attachment E: Soil Sampling Results Report (dated Feb 5, 2020)	1/20/2021	Attachment
Attachment F: Proposed New Intergovernmental Agreement	1/20/2021	Attachment

## **Resolution**

Whereas the Rocky Mountain Greenway Trail is an important addition to recreational opportunities in and near the city of Westminster; and

Whereas contributions from local governments are required in order to gain Federal Land Access Project funds; and

Whereas The United States Fish and Wildlife Service has agreed to continued soil sampling during the completion of the project;

**Now therefore be it resolved,**

That the Citizens Advisory Board for Parks, Recreation, Libraries, and Open Space urges the Westminster City Council to approve a contribution of up to \$250,000 to the Rocky Mountain Greenway Trail Project.

Janet C. Bruchmann, Chair

May 12, 2016



## Agenda Memorandum

City Council Meeting  
July 11, 2016



*Visionary Leadership, Effective Governance and Proactive Regional Collaboration*



*Beautiful, Desirable, Safe and Environmentally Responsible City*



*Ease of Mobility*

**Subject:** Resolution No. 24 in Support of and Authorization of Matching Funds for Jefferson County's Federal Lands Access Program Grant Application

**Prepared By:** Jason Genck, Parks, Recreation & Libraries Director  
Max Kirschbaum, Public Works & Utilities Director  
Rod Larsen, Open Space Manager  
Heather Cronenberg, Open Space Superintendent

### Recommended City Council Action:

Adopt Resolution No. 24 to conditionally support Jefferson County's request to pursue a Federal Lands Access Program (FLAP) grant and to provide up to \$220,000 in matching funds to construct trail connections to the Rocky Flats Wildlife Refuge and the Westminster Hills Open Space.

### Summary Statement:

On April 11, 2016, Staff brought forward a resolution to City Council to support the Jefferson County application for a Federal Lands Access Program (FLAP) grant and to provide up to \$220,000 in matching funds for the construction of a pedestrian overpass crossing Indiana Street and a pedestrian underpass at Highway 128. Members of the public raised concerns regarding the development of the Greenway Trail through the Rocky Flats Wildlife Refuge during that City Council meeting. City Council tabled the item and directed Staff to bring it back to a Study Session for further discussion.

A presentation was delivered at the June 6, 2016, Study Session. The following experts and interested parties were present during the meeting to provide information and answer questions from City Council:

- David Lucas, U.S. Fish and Wildlife Service (USFWS);
- Scott Surovchak, Department of Energy (DOE);
- Carl Spreng, Colorado Department of Public Health and Environment (CDPHE);
- Vera Moritz, Environmental Protection Agency (EPA); and
- Janet Bruchmann, Chair of the City's Parks, Recreation, Libraries and Open Space Advisory Board.

Additionally, Ron Hellbush, former Director of the City of Westminster's Public Works & Utilities Department, submitted a letter supporting the grant.

At City Council's direction, Staff is returning to seek conditional approval of the Jefferson County request.

### Fiscal Impact:

Matching Funds for FLAP grant up to \$220,000

### Source of Funds:

2017 General Capital Improvement Fund

**Policy Issue(s):**

Should the City support Jefferson County's FLAP grant to construct an overpass over Indiana Street and an underpass under State Highway 128 and commit to provide matching funds for the project conditioned upon entering into an IGA with the partner agencies on funding and additional testing and upon receiving satisfactory results from additional soil sampling, prior to City funds expenditure?

**Alternative(s):**

- City Council could choose not to support Jefferson County's grant request or to provide matching funds.
- City Council could seek other sources of funds for these connections or could choose not to partner with Jefferson County and surrounding communities to seek funds to construct these improvements. Staff does not recommend these alternatives because providing this connection from the Greenway Trail over Indiana Street is extremely important and will serve as a gateway to our community. Seeking other funding sources to construct this project would be difficult due to the large expense associated with the two crossings; partnering with Jefferson County and the surrounding communities provides an opportunity to advance regionalism and share costs associated with this project.
- City Council could direct Staff to bring a resolution to City Council for consideration that includes different language or stipulations.

**Background Information:**

Rocky Mountain Greenway Trail - The Rocky Mountain Greenway Trail (Greenway Trail) is a regional trail planned across the northern part of the Denver metropolitan area to connect the Rocky Mountain Arsenal National Wildlife Refuge in Commerce City to the Rocky Flats National Wildlife Refuge directly abutting Westminster's western boundary at Indiana Street. This project is part of President Obama's America's Great Outdoors initiative introduced in 2011 by former U.S. Secretary of the Interior Ken Salazar and Colorado Governor John Hickenlooper. The goal is an uninterrupted network of regional trails and transportation systems connecting three urban wildlife refuges with the Rocky Mountain National Park. The City is collaborating with the Federal Highway Administration (FHWA) to construct the latest segment of the trail connecting Two Ponds Wildlife Refuge to Arvada, Westminster, and Broomfield. The FHWA received a grant of \$1.735M through the U.S. Fish and Wildlife Service (USFWS) to construct the trail.

A portion of the Greenway Trail segment utilizes the already existing Little Dry Creek trail. The remainder of the trail consists of new construction in Westminster starting with a pedestrian underpass under 86th Parkway and moves along the east side of Standley Lake utilizing an existing maintenance road to a signalized pedestrian crossing at 100th Avenue. After the trail crosses 100th Avenue, a new section of soft trail will continue through Westminster Hills Open Space in a northwesterly direction utilizing an old railroad bed. Currently, it ends just over the Broomfield City/County line on the east side of Indiana Street. This segment of the Greenway Trail connecting Two Ponds Wildlife Refuge to just east of Indiana Street is almost complete. City Council reviewed the draft Greenway Trail feasibility study on March 18, 2013, and the final study on November 25, 2013. On February 23, 2015, City Council supported a resolution to submit a grant request with the City of Arvada to Great Outdoors Colorado to help fund portions of the project. A ribbon cutting for this portion of the Greenway Trail was held on June 4, 2016, just south of Standley Lake. Local officials along with the Governor, former Secretary of the Interior Ken Salazar, and the Director of the USFWS attended the event.

Collaborative Application to the Federal Lands Access Program (FLAP) - Open Space surrounding the 5,000-acre Rocky Flats National Wildlife Refuge (RFNWR) totals more than 10,000 acres within many counties and municipalities, including Westminster, Arvada, Broomfield, Superior, Jefferson County, Boulder County, and the City of Boulder. These communities would like to tie their trail systems together. This has been a goal for the City of Westminster for many years.

The FLAP program seeks to "improve state and local transportation facilities that provide access to and through federal lands for visitors, recreationists and resource users." The FLAP grant is a 5-year grant for planning, design, and construction in linking other lands to federal lands. Jefferson County is applying for a FLAP grant to pursue connections over Indiana Street and under State Highway 128 to connect these trail systems to the Rocky Flats Wildlife Refuge. The grant requires a 17.21% minimum local match. Jefferson County has asked municipalities in Jefferson County along with the City of Boulder, Superior, Boulder County, and the City and County of Broomfield to participate in the match requirement by pledging to provide up to \$243,000 in 2017 towards the project. The communities are being asked to contribute as follows:

Entity	Amount Requested	Council/Board Approval
Jefferson County	\$220,000	May 10
Arvada	\$243,000	May 16, Conditional
Westminster	\$220,000	Scheduled for July 11 consideration
City of Boulder	Up to \$218,318	May 3, Conditional
Boulder County	Up to \$218,318	May 10, Conditional
City and County of Broomfield	\$105,000	May 10, Conditional

The Town of Superior declined to participate in the match or support the grant proposal. The City of Boulder and Boulder County agreed to absorb

Superior’s contribution amount so the total amount asked from Westminster is \$218,318 or rounded up to \$220,000. The communities that voted to support the FLAP grant and to provide matching funds approved resolutions that included language requiring soil sampling and selecting preferred alternatives based on sampling results. All participating communities will enter into an IGA to address these sampling requirements and any other conditions of participation in the grant.

Due to public concerns raised over the proposal to cross Indiana Street and build out the trail network in the refuge, the USFWS has provided written documentation guaranteeing that a new round of soil sampling will be completed with the FLAP projects to ensure the areas being opened to the public are safe. This will include an inventory and analysis of existing conditions, impacts analysis including soil sampling for radionuclides within the project area, development of alternative locations and alignments, and a robust public engagement process. Flexibility exists in the feasibility and alignment study regarding the locations of the connections over Indiana Street and the trail network within Rocky Flats Wildlife Refuge. Jefferson County and the USFWS are committed to looking at alternative crossing locations along Indiana Street depending on the sampling outcomes. FLAP grant funds can be used for soil and additional testing at access points.

The USFWS recently received federal funding to construct the trail network and a visitor center within RFNWR. They are planning an 18 to 24 month public outreach process related to these improvements. If the FLAP grant funds are awarded, design of the trail network within Rocky Flats National Wildlife Refuge will move forward in conjunction with the design and locations of the trail crossings into the refuge.

The City of Westminster’s Parks, Recreation, Libraries and Open Space Advisory Board discussed the FLAP grant opportunity and voted to support the project due to the importance of the Rocky Mountain Greenway Trail and the fact that the USFWS has agreed to soil sampling for the project.

Staff supports the request to provide matching funds because of the importance of the Greenway Trail as a gateway to our City. These bridges will also connect Westminster’s trail system into the City of Boulder, Boulder County, and Jefferson County trail systems. Staff believes that participating in the match for the FLAP grant will give Westminster a “seat at the table” and the ability to influence requirements such as soil sampling and alternative locations for the crossings.

At its June 6, 2016, Study Session, City Council asked Staff to bring forward the attached resolution supporting the Jefferson County FLAP grant request and pledging to provide up to \$220,000 in matching funds from the 2017 General Capital Improvement Fund conditioned upon a requirement to enter into an IGA with the participating communities supporting the FLAP grant. That agreement will address funding participation, required additional soil testing, and on-going maintenance requirements. The proposed resolution, based on Boulder County’s at the request of Westminster City Council, includes language requiring a soil Sampling and Analysis Plan. The soil sampling must include testing of radionuclides known to be at Rocky Flats as well as any other agreed upon contaminants identified during the development of the soil analysis plan with the grant partners. Soil sampling is to be conducted according to the Sampling and Analysis Plan. In addition, the resolution provides that Westminster’s funding commitment is contingent on the results of the soil sampling demonstrating that contamination levels are at or below the applicable federal and state human health standards.

The construction of the Rocky Mountain Greenway Trail and participation in the Federal Lands Access Program supports the City’s Strategic Plan Goals of Visionary Leadership, Effective Governance and Proactive Regional Collaboration; Beautiful, Desirable, Safe and Environmentally Responsible City; and, Ease of Mobility by providing recreational opportunities, increasing regional trail connectivity, and partnering and collaborating with surrounding communities

Respectfully submitted,

Donald M. Tripp  
City Manager

**ATTACHMENTS:**

Description	Upload Date	Type
Resolution No. 24 re FLAP Grant Support with Conditions	7/5/2016	Resolution

## RESOLUTION

RESOLUTION NO. **24**

INTRODUCED BY COUNCILLORS

SERIES OF 2016

**A RESOLUTION****TO CONDITIONALLY SUPPORT JEFFERSON COUNTY'S REQUEST TO PURSUE A  
FEDERAL LANDS ACCESS PROGRAM (FLAP) GRANT AND TO PROVIDE UP TO  
\$220,000.00 IN MATCHING FUNDS TO CONSTRUCT TRAIL CONNECTIONS TO THE  
ROCKY FLATS WILDLIFE REFUGE**

WHEREAS, the City of Westminster recognizes the health and conservation benefits of connecting residents and visitors to natural environments, and supports projects that uphold those benefits;

WHEREAS, the City of Westminster recognizes the value in trail linkages providing connections between local communities for recreation, transportation, and environmental purposes;

WHEREAS, the City of Westminster recognizes the value of proactive regional collaboration with transparent decision making;

WHEREAS, Jefferson County is submitting a grant proposal for Federal Lands Access Program (FLAP) funding to support a pedestrian overpass and underpass between the Rocky Mountain Greenway Trail (Greenway Trail) and Rocky Flats National Wildlife Refuge (Rocky Flats NWR);

WHEREAS, Jefferson County has requested financial assistance from the cities of Arvada, Boulder and Westminster, Boulder County, the City and County of Broomfield, and the Town of Superior to support planning, design and construction of the trail connections. These contributions would help satisfy the 17.21 percent local match required by FLAP if federal grant funds are awarded;

WHEREAS, Arvada, Boulder, Boulder County and the City and County of Broomfield have conditionally approved supporting Jefferson County's request;

WHEREAS, the City of Westminster recognizes the value of partnership with federal, state, and local entities, and participation in this project is contingent on the joint participation of other local municipalities and Boulder and Jefferson counties;

WHEREAS, these connections would be a part of the Rocky Mountain Greenway Trail, which has been established to create a regional network comprised of trails and transportation systems that connect the Rocky Mountain Arsenal National Wildlife Refuge (Arsenal NWR), Two Ponds National Wildlife Refuge (Two Ponds NWR), Rocky Flats NWR and eventually Rocky Mountain National Park;

WHEREAS, the City of Westminster recognizes that the lands interior to the Rocky Flats NWR were used as a nuclear weapons plant, which raises concerns regarding the health and safety of accessing the Refuge;

WHEREAS, there has been extensive testing and soil sampling conducted on the Rocky Flats NWR resulting in the Environmental Protection Agency (EPA) and Colorado Department of Public Health and Environment (CDPHE) certifying the refuge land for unlimited use;

WHEREAS, there remain public concerns regarding the safety of human access to the lands located inside and outside the Rocky Flats NWR;

WHEREAS, the City of Westminster believes a soil Sampling and Analysis Plan (SAP) is appropriate in areas where public access will be allowed in order to understand the risks associated with accessing, and recreating on, the Rocky Flats NWR;

WHEREAS, additional soil sampling for radionuclides and other contaminants known to be found at Rocky Flats NWR is appropriate in areas on the refuge where new trails and a visitor center will be constructed;

WHEREAS, if soil sampling in those trail areas included in the FLAP grant proposal indicate that contamination levels are above the applicable federal and state standards for human health safety, the City of Westminster will not participate or contribute funds to the project; and

WHEREAS, the City of Westminster would also like to support opportunities for trail connections with adjacent communities and Westminster trails, and complete the Rocky Mountain Greenway Trail, with an alternate option that does not necessarily require trail users to enter upon the Rocky Flats NWR.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF WESTMINSTER:

1. That the Westminster City Council hereby pledges its support for Jefferson County's FLAP grant application and agrees to commit up to \$220,000 in matching funds to support future planning, design and construction of trails connect Rocky Flats NWR with Westminster lands to the east, subject to the following conditions:

a. If the FLAP grant is awarded, and before Jefferson County signs a grant agreement with the Federal Highway Administration, the City of Westminster shall enter into an IGA between Jefferson County and the participating local governments that addresses:

- (1) The funding obligations of each of the local governments, the timing of the same, and the adequacy of the funding to meet the required local match;
- (2) Any ongoing maintenance requirements for the improvements supported through the FLAP grant;
- (3) A sampling plan as described below and any other conditions that each local government partner may impose for the EPA analysis or any other conditions which may affect the project;
- (4) How the grant and project will proceed if the conditions of each local government are not met through the environmental analysis of the project.

b. The pledge of support and funding commitment, beyond that required to support the costs of soil sampling and analysis, is contingent on soil sampling occurring on areas allowing public access and construction, as follows.

- (1) A Sampling and Analysis Plan (SAP) shall be developed in conjunction with and approved by the City of Westminster. The sampling plan shall include, at a minimum, data quality objectives and sampling methodology (what is sampled, how deep samples are taken, how locations are identified for sampling, controls for sampling, timelines for



data, etc.). The SAP discussions should also include periodic sampling and sampling after significant events such as earthquakes, floods, fires, and tornadic storms.

(2) The initial sampling must be completed prior to construction commencing.

(3) At a minimum, soil sampling shall include the full panel of testing for radionuclides known to contaminate the site and any other contaminants recommended for testing during the SAP development with partner agencies.

(4) At a minimum, soil sampling shall be conducted within each of the site areas included in the FLAP grant proposal and should be analyzed in accordance with EPA recommended methodology.

(5) The SAP must provide for soil sampling results being publically available.

2. That this pledge of support and funding commitment are contingent on the results of the soil sampling demonstrating that contamination levels are below the applicable federal and state human-health standards.

PASSED AND ADOPTED this 11th day of July, 2016.

\_\_\_\_\_  
Mayor

ATTEST:

APPROVED AS TO LEGAL FORM:

\_\_\_\_\_  
City Clerk




\_\_\_\_\_  
City Attorney



# FLAP Crossing Locations and Conceptual Trail Circulation Plan

This map illustrates the proposed greenway routes through the Rocky Flats National Wildlife Refuge and the Rocky Flats Department of Energy site. The map includes the following features:

- Proposed Greenway Routes:**
  - Route D:** A green line starting from the west, passing through the High Plains area, and ending near the Boulder County line.
  - Route E:** A green line starting from the west, passing through the Rocky Flats Department of Energy site, and ending near the Arvada area.
- Geographic Features:**
  - Rocky Flats National Wildlife Refuge:** Shaded in light green.
  - Rocky Flats Department of Energy:** Shaded in light pink.
  - Great Western Reservoir:** A large blue body of water in the northwest.
  - Rocky Flats Lake:** A smaller blue body of water in the southeast.
  - Standley Lake Regional Park:** Located in the northeast.
  - Whisper Creek Park:** Located in the northeast.
  - Coal Creek Canyon Park:** Located in the southwest.
- Infrastructure and Landmarks:**
  - Highways:** 128, 128A, 93A, and 93.
  - Local Partners:** City of Westminster, City of Arvada, City of Golden, and City of Jefferson.
  - Other Landmarks:** US Fish and Wildlife Service, Colorado State Land Board, and Denver Water Board.
- Annotations:**
  - Local partners request USFWS prohibits public access in this area:** A callout pointing to a specific area within the refuge.
  - OSMP:** Open Space Management Plan.
- Inset Map:** A small map of Colorado in the bottom right corner, with a star indicating the location of the main map area.

 Conceptual Rocky Mountain Greenway Alignment  
 Conceptual Colorado Front Range Trail Alignment  
 Rocky Flats Conceptual Trails (FWS)

**X** FLAP Crossing Locations



Jeffco Open Space

Boulder OSMP



Disclaimer: This information/map is the property of the Jefferson County Open Space Program (JCOS). Jefferson County, Colorado and is copyrighted material. Reproduction, manipulation or distribution of this product is prohibited without the prior written consent of JCOS staff. Jefferson County does not warrant the completeness, accuracy, or correctness of this product, its use for any purpose, and shall not be liable for damages of any kind arising from use of the product or for any errors or inaccuracies.

A scale bar labeled "Miles" with markings at 0, 0.375, and 0.75.

Scale is 1:40,000 when printed at 8"x11"

**Last Revised 2/24/17**

# **Sampling and Analysis Plan**

## **Rocky Mountain Greenway Trail Crossings**

*Prepared for:*

**Jefferson County**  
**100 Jefferson County Parkway, Suite 4500**  
**Golden Colorado, 80419**

**And**

**City of Boulder**  
**Boulder County**  
**City and County of Broomfield**  
**City of Arvada**  
**City of Westminster**

*Prepared by:*



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Project No. 110836

March 2019  
Rev 4.0

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<b>Acronym</b>	<b>Explanation</b>
AD	Absolute Difference
AEU	Aquatic Exposure Unit
ALS	ALS Global Laboratories
CAD/ROD	Corrective Action Decision/Record of Decision
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CO-128	Colorado Highway 128
COC	Contaminants Of Concern
DOE	Department of Energy.
DQI	Data Quality Indicator
DQO	Data Quality Objective
EA	Engineering Analytics, Inc.
EDD	Electronic Data Delivery
EPA	United States Environmental Protection Agency
EPC	Exposure Point Concentration.
ERB	Equipment Rinsate Blank
EU	Exposure Unit
FHWA	Federal Highway Administration.
FLAP	Federal Land Access Program.
FSP	Field Sampling Plan
HHRA	Human Health Risk Assessment
IDW	Investigation Derived Wastes
LBGR	Lower Bounds Gray Region
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management System
LM	Legacy Management
M2SD	Background Mean Plus Two Standard Deviations
MARSSIM,	Multi-Agency Radiation Survey and Site Investigation Manual
MARLAP	Multi-Agency Radiological Laboratory Analytical Protocols
MB	Matrix Blanks
MDC	Minimum Detectable Concentrations
MQO	Method Quality Objective
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
OU	Operable Unit
pCi/g	Picocuries per gram.
PCOC	Potential Contaminants Of Concern
PNNL	Pacific Northwest National Laboratory
PRG	Preliminary Remediation Goals
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act.

<b>Acronym</b>	<b>Explanation</b>
RESRAD	Residual Radioactivity Computer Program
RFP	Request for Proposals
RI/FS	Remedial Investigation/Feasibility Study
RMG	Rocky Mountain Greenway
RPD	Relative Percent Difference
RSAL	Radionuclide Soil Action Levels
SAP	Sampling and Analysis Plan
SCM	Site Conceptual Model
SOP	Standard Operating Procedure
TPU	Total Propagated Uncertainty
UBGR	Upper Bounds Gray Region
UCL	Upper Confidence Limit
USDOE	United States Department of Energy
USFWS	United States Fish and Wildlife Service
VSP	Visual Sampling Plan
WRV	Wildlife Refuge Visitor
WRW	Wildlife Refuge Worker
WRW-PRGs	Wildlife Refuge Worker - Preliminary Remediation Goals



## **1.0 INTRODUCTION**

In May 2016, Jefferson County Open Space, the City and County of Broomfield, City of Arvada, City of Westminster, Boulder County, and the City of Boulder (collectively referred to as the “Partner Group”) submitted an application to the Federal Lands Access Program (FLAP), a funding source administered by the Federal Highway Administration (FHWA), to construct two trail crossings that will link planned trail improvements at the Rocky Flats National Wildlife Refuge (Refuge) with existing Partner Group trail infrastructure adjacent to the Refuge (Figure 1-1). This project is part of the broader Rocky Mountain Greenway (RMG) Trail initiative, a regional trails project to connect Front Range federal lands (Rocky Mountain Arsenal National Wildlife Refuge, Two Ponds National Wildlife Refuge, Rocky Flats National Wildlife Refuge, and Rocky Mountain National Park) via a multiuse path. Information on the RMG Trail initiative is available at <https://rockymtngreenway.org>.

In August of 2016, FHWA notified the Partner Group of shortlist funding status and requested that the required soil sampling and testing be completed before project scoping, design and construction begin. In fall 2017, the Partner Group issued a Request for Proposal (RFP) to perform the confirmatory soil sampling and analysis (the “Project”). Engineering Analytics, Inc. (EA) of Fort Collins, Colorado was awarded the Project by the Partner Group. Phase I of the Project is to develop a Sampling and Analysis Plan (SAP) that will document the procedural and analytical requirements of this one-time collection of soil samples to confirm the activity of radionuclides in the areas where Project-related construction will be performed. This document fulfills the requirements of Phase I.

### **1.1 Purpose and Goal**

The purpose of this SAP is to define the procedures for the collection and analysis of soil samples obtained at the two proposed crossings that will connect existing trail systems of the Partner Group to a trail system operated by the U.S. Fish and Wildlife Service (USFWS) on the Refuge (Figure 1-1). This document is a stand-alone SAP, meaning that it contains elements common to a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP).

The goal of this SAP is to promote the generation of soil radionuclide data that meet standard environmental data quality requirements and are comparable to the risk assessment values used at the site. By accomplishing this goal, the soil data from this Project can be compared to the data, findings, and conclusions of historic Rocky Flats soil sampling risks assessments such as the Comprehensive Risk Assessments of Appendix A of the Kaiser-Hill Company 2006 Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study-Feasibility Study Report (RI/FS). Linking the current data to the 2006 studies, the potential risks to visitors near the two proposed crossings can be established.

### **1.2 Scope**

The scope of this SAP is limited to collection and analysis of radionuclide data in soil samples in and near the two proposed crossing locations. The proposed crossings are illustrated on Figure 1-1 and are described below:



- Crossing Location D (“Bridge Crossing”): A proposed bridge over Indiana Street near the abandoned railroad grade just north of the former Rocky Flats East Entrance. This location lies adjacent to the *Wind Blown Area Exposure Unit* (EU) described in the 2006 RI/FS.
- Crossing Location E (“Underpass Crossing”): A proposed box culvert underpass below State Highway 128 (CO-128) just east of the Coalton/High Plains Trail access parking area. This location lies adjacent to the *Rock Creek Drainage Exposure Unit* described in the 2006 RI/FS.

This is a planned one-time sampling event with soil sample locations limited to the footprints of the crossing structures, the footprints of the new trails connecting the crossings to existing Partner Group trail systems east of Indiana Street (Bridge Crossing) and north of CO-128 (Underpass Crossing), and the footprints of the new trails connecting both crossings to planned USFWS trails (stopping at the Rocky Flats boundary).

### 1.3 Project Organization

The roles of the senior professionals on the EA Project team are provided in Table 1-1.

**Table 1-1 Senior EA Project Staff and Roles**

<b>Key Staff</b>	<b>Project Role</b>
Dan Overton, M.S., P.E.	Senior Reviewer
Jason Andrews, M.E., P.E.	Project Manager
Bruce Marshall, M.S., P.G.	Principal Geochemist
Dr. Craig Little, Ph.D.	Health Physicist and Radiation Protection

EA’s point of contact with the Partner Group is Mr. Andrew Valdez of Jefferson County, Open Space.

## 2.0 BACKGROUND

A comprehensive discussion of the Rocky Flats operational history and remediation is beyond the scope of this document. Both proposed crossings are located outside the boundary of the current Department of Energy (DOE) Legacy Management Site on property immediately adjacent to the Refuge. Consequently, EA's document review primarily focused on reports pertaining to the large portion of the Rocky Flats site outside the industrial area (i.e., in the Peripheral Operable Unit). Even with this narrowed focus, the number of documents available for review pertaining to the site characterization and environmental remediation is voluminous. Documents which EA reviewed to develop this SAP are summarized in Table 2-1.

**Table 2-1 Select Documents Reviewed for Development of the SAP**

<b>Published by</b>	<b>Document Title</b>
Applicable standards from the United States Nuclear Regulatory Commission (NRC)	(NRC Title 10 Part 20) and Environmental Protection Agency Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).
Central Federal Lands, Federal Highway Administration.	Rocky Mountain Greenway Feasibility Study. 2016.
Chem-Risk (Phase I) & Radiological Assessment Corporation (Phase II).	Rocky Flats Historical Public Exposures Studies prepared for the Colorado Department of Public Health and Environment. 1990-1999.
Colorado Department of Public Health and Environment	Colorado Code of Regulations, Radiation Control – Standards for Protection Against Radiation (6 CCR 1007-1 Part 04), Adopted June 17, 2015
Colorado Department of Health and Public Environment,	Public Testimony by State Project Manager. 2016.
CTL Thompson Inc.	Limited Surface Screening for Radiation Levels Candelas Development, Arvada. Colorado August 24, 2011.
CTL Thompson Inc.	Limited Surface Screening for Radiation levels Candelas Development, Filing 3, Arvada, Colorado March 8, 2013.
Hydros Consulting	Offsite Human Health Risk Assessment Findings from Rocky Flats. June 3, 2014.
Institute for Energy and Environmental Research	Setting Cleanup Standards to Protect Future Generations: The Scientific Basis of the Subsistence Farmer Scenario and Its Application to the Estimation of Radionuclide Soil Action Levels (RSALs) for Rocky Flats. December 2001.

<b>Published by</b>	<b>Document Title</b>
Jefferson and Boulder Counties, Colorado	Corrective Action Decision/Record of Decision for Rocky Flats Plant (USDOE) Peripheral Operable Unit and Central Operable Unit. September 2006.
Kaiser-Hill Company	RCRA Facility Investigation - Remedial Investigation/Corrective Measures Study – Feasibility Study Report for the Rocky Flats Environmental Technology Site. June 2006.
Kaiser-Hill Company	Industrial Area and Buffer Zone Sampling and Analysis Plan Modification 1. May 2004.
Risk Assessment Corporation	RAC Report No. 5-RSALOP-RSAL-1999-Final “Final Report Task 6: Sampling Protocols, Radionuclide Soil Action Level Oversight Panel.” December 1999.
US Fish and Wildlife Service.	Modified Level III Pre-acquisition Environmental Contaminants Survey for Rocky Flats Environmental Technology Site. 2006.
Boston Chemical Data Corp.	Field investigation and laboratory report: LeRoy Moore Ph.D. Rocky Mountain Peace & Justice Center. Report on the 2011 Rocky Flats sampling and analysis campaign. January 20, 2012.
Colorado State University Department of Radiological Health Sciences	Soil Sampling Site Characterization Near the Rocky Flats Plant. November 21, 1994.
Colorado State University Department of Radiological Health Science.	The Spatial Distribution of Plutonium in Soil Near Rocky Flats Plant. November 21, 1994.
Margulies, T.D., Schonbeck, N.D., Morin-Voillequé, N.C., James K.A., and Lavelle, J.M.	A comparative study of <sup>239,240</sup> Pu in soil near the former Rocky Flats Nuclear Weapons Facility, Golden, CO. 2004.

## 2.1 Rocky Flats History

EA primarily relied on the DOE’s Rocky Flats, Colorado Fact Sheet (DOE, 2017) as the source of information for the history of the site. Much of the information provided below is taken directly from the DOE (2017) document.

The Rocky Flats site is situated on a plateau at the eastern edge of the Front Range of the Rocky Mountains, at an elevation close to 6,000 feet. Most of the approximately 6,500 acres of the property was used as a security buffer surrounding the site’s 385-acre industrial area. The Rocky Flats Plant was part of the nationwide nuclear weapons complex that manufactured weapons components under the jurisdiction and control of the DOE and its predecessor agencies. From 1952 to 1994, the plant’s primary mission was producing nuclear and nonnuclear weapons components for America’s arsenal. The key component produced at Rocky Flats was the plutonium pit, or

“trigger,” for nuclear weapons. Operational problems, including fires, during the plant’s history and standard practices used at the time resulted in contamination from plutonium, beryllium, and other hazardous substances both within and outside the industrial area.

After nuclear weapons components production ended, the facility’s mission changed to cleanup and closure, and it was renamed the Rocky Flats Environmental Technology Site. In October 2005, DOE and its contractor completed an accelerated 10-year, \$7 billion cleanup of chemical and radiological contamination in production buildings and limited areas across the site. The DOE Office of Legacy Management (LM) assumed site operation and maintenance responsibility in 2005 and received final jurisdiction in 2008. After cleanup, two operable units (OUs) defined the Rocky Flats site within the boundaries of the property. The OUs are shown in Figure 2-1:

- OU 1. Central OU
- OU 2. Peripheral OU

The Peripheral OU includes most of the site and generally encompasses the portions of Rocky Flats surrounding the Central OU. The boundaries of the EU’s described in the 2006 RI/FS are also shown on Figure 2-1

The final remedy for OUs 1 and 2 was selected in the September 29, 2006 Corrective Action Decision/Record of Decision (CAD/ROD) (Jefferson and Boulder Counties, Colorado, 2006). The CAD/ROD was based on the results of the July 2006 RI/FS (Kaiser-Hill Company 2006) and Comprehensive Human Health and Ecological Risk, Assessment. The 2006 CAD/ROD determined that no action was required for the Peripheral OU.

The Peripheral OU, which served as the security buffer zone during the operational period of the site, was subsequently transferred to the U.S. Department of the Interior in July 2007, to be managed by the USFWS as the Rocky Flats National Wildlife Refuge. Additional DOE-administered lands (745 acres) associated with private mineral rights on the site’s west side transferred to the Refuge in 2014.

## **2.2 Review of Select Rocky Flats Environmental Documents**

The goal of this SAP is to promote the generation of soil radionuclide data that meet standard quality requirements and are comparable to the risk assessment values used at the site. To that end, EA reviewed select historic documents to ascertain how soil samples had previously been collected. The objective of this review was to establish (a) a method(s) to collect soil samples, and (b) a depth(s) at which to collect the soil samples that would result in radionuclide data for the crossing samples that is comparable to historic data. An additional objective of the review was to identify standard operating procedures (SOPs) relevant to the Project (e.g., equipment decontamination, investigation derived waste, sample handling) that could be adopted for use in this SAP. EA also reviewed select risk assessments to evaluate if the methodology and results can be extrapolated to visitors of the crossings and associated connector paths.

### **2.2.1 Previous Sampling Methodology**

EA primarily relied upon information in the following two documents to assess previous soil sampling protocol:

- Kaiser-Hill Company, 2014, Industrial Area and Buffer Zone Sampling and Analysis Plan Modification 1, May.
- Risk Assessment Corporation, 1999, Task 6: Sampling Protocols, Final Report submitted to the Radionuclide Soil Action Level Oversight Panel, December.

In general, previous investigators appear to have used four main methods to collect soil samples at Rocky Flats. The methods are:

- Colorado Department of Public Health and Environment (CDPHE) Method
- Rocky Flats Method
- Grab Sampling Method
- Vertical Soil Profile Method

The CDPHE method used a sampling device to obtain a soil sample from the upper ¼-inch of the soil from an area 2-inches wide by 2-3/8 inches long. Vegetation and other non-soil material are removed prior to collection. A specific number of samples, defined in the sampling plan, are collected from an area and then composited. The objective of the method is to characterize the radionuclides in the soil that could potentially be resuspended into the air and inhaled.

In the Rocky Flats Method, 10 individual samples are collected from 10-cm by 10-cm (4-inch x 4-inch) squares to a depth of 5-cm (2 inches). Samples are screened through a 10-mesh (2 mm) sieve to remove large particles and then combined to represent a sample volume of approximately 5 liters, from which a representative sample is collected for laboratory analysis. The objective of the method is to characterize the radionuclides in the soil that have accumulated in the near surface.

Grab sampling was practiced at Rocky Flats by employing a tool to collect soil samples for radionuclide analyses. The vegetation and other undesired surficial material were first removed from the area to be sampled. The soil sample is then collected to the desired depth using a stainless-steel spoon or scoop. The total number of samples and sampling interval was defined in the sampling plan. The objective of the method is to characterize the radionuclides in the soil that have accumulated at a specific depth interval.

Vertical soil profile sampling at Rocky Flats was used to define the distribution of radionuclides in the top 6 inches of soil to verify the results of radiation surveys. This sampling included the collection of discrete soil samples at 2-inch intervals corresponding to depths from 0–2 inches, 2–4 inches, and 4–6 inches. Four procedures were employed to obtain the vertical samples: (1) collection from the surface downward, (2) collection from the side wall of a small excavation, (3) collection by coring, and (4) collection from beneath concrete and asphalt pavement. The total number of samples collected, and their locations were specified in site-specific field sampling plans. A sample of approximately 500 grams was obtained for each soil profile interval.

### **2.2.2 Nature and Extent of Contamination**

As defined in the RFP, the contaminants of concern for the Project are select isotopes of americium, plutonium, and uranium. Historic maps illustrating the distribution of americium, plutonium and uranium in surface soils on and near the Refuge are produced in Figures 2-1 through 2-5. These figures provide the relative distribution of the activities of the radionuclides at Rocky

Flats, as the data are expressed in terms Wildlife Refuge Worker Preliminary Remediation Goals (WRW-PRGs). As illustrated on Figures 2-1 and 2-2, the activity of the americium-241 and plutonium 239/240 near the Underpass Crossing, which is located north of the former industrial area along CO-128, are lower than the activities near the Bridge Crossing, which is east and downwind of the former industrial area on Indiana Street. This is consistent with the distribution of plutonium described in Margulies, et al. (2004). The activities of the uranium isotopes are similar at both locations.

Summary statistics for americium, plutonium and uranium from surface soil samples collected in the Rock Creek Drainage Exposure Unit (see Volume 4 of Appendix A of the 2006 RI/FS) ([https://www.lm.doe.gov/Rocky\\_Flats/Regulations.aspx](https://www.lm.doe.gov/Rocky_Flats/Regulations.aspx)) are provided in Table 2-2. The proposed box culvert underpass below CO-128 is located adjacent to this area.

**Table 2-2 Summary Statistics for Select Radionuclides in the Rock Creek Drainage Exposure Unit (Underpass Crossing Location along CO-128)**

Radionuclide	Number of Results	Minimum Value (pCi/g) <sup>(1)</sup>	Maximum Value (pCi/g)	Arithmetic Mean Value (pCi/g)	Standard Deviation (pCi/g)
Am-241	37	-0.00738	0.950	0.0613	0.160
Pu-239/240	50	-0.00602	7.25	0.222	1.02
U-233/234	39	0.343	2.17	1.07	0.362
U-235	39	-0.109	0.466	0.0641	0.113
U-238	39	0.417	1.83	1.11	0.311

Source: Table 1.4, Volume 4 of 15, Appendix A, Kaiser-Hill Company (2006)

(1)- Radioactive decay is a probabilistic process with a Poisson distribution. When a sample has very little radioactivity in it, the result may be lower than the blank sample relied upon by the analytical laboratory. In such a situation, the reported radionuclide results would be reported as a negative number.

Review of the radionuclide data for soil samples collected within the Rock Creek Drainage EU in the CDPHE database indicates that samples were collected from depths of 0 to 2 inches to 0 to 6 inches. Approximately 60 percent of the data from samples in the Rock Creek Drainage EU were collected from the 0 to 2-inch depth interval.

Summary statistics for americium, plutonium and uranium from surface soil samples collected in the *Wind Blown Area Exposure Unit* (see Volume 9 of Appendix A of the 2006 RI/FS) are provided in Table 2-3. The proposed bridge over Indiana Street is located adjacent to this area. It is important to note that the boundaries of the *Wind Blown Area Exposure Unit* extend from the shared boundary with the Industrial Area EU eastward to Indiana Street. As illustrated in Figures 2-1 through 2-3, the general trend is for radionuclide activities to decrease eastward (away) from the Industrial Area EU towards the Bridge Crossing location.

**Table 2-3 Summary Statistics for Select Radionuclides in the Wind Blown Area Exposure Unit (Bridge Crossing Location along Indiana Street)**

Radionuclide	Number of Results	Minimum Value (pCi/g) <sup>(1)</sup>	Maximum Value (pCi/g)	Arithmetic Mean Value (pCi/g)	Standard Deviation (pCi/g)
Am-241	279	0	15.6	1.86	2.44
Pu-238	9	0.102	1.53	0.447	0.454
Pu-239/240	307	-0.00292	49	9.44	12.1
U-233/234	193	0.119	7.96	1.12	0.799
U-235	192	-0.0431	0.680	0.0827	0.0922
U-238	193	0.351	3.78	1.12	0.454

Source: Table 1.5, Volume 9 of 15, Appendix A, Kaiser-Hill Company (2006)

(1)- Radioactive decay is a probabilistic process with a Poisson distribution. When a sample has very little radioactivity in it, the result may be lower than the blank sample relied upon by the analytical laboratory. In such a situation, the reported radionuclide results would be reported as a negative number.

Review of the radionuclide data for soil samples collected within the Wind Blown Area EU in the CDPHE database indicates that samples were collected from the surface to depths ranging from 0 to 1 inch to 0 to 6 inches. Approximately 40 percent of the data were from samples collected from the 0 to 2-inch depth interval, with the next largest group being from the surface (approximately 28 percent).

### 2.2.3 Summary of Risk Assessments

The Comprehensive Risk Assessment (see Appendix A of the 2006 RI/FS) presented a Site Conceptual Model (SCM) that provided an overview of potential human exposures at Rocky Flats. The following discussion is taken primarily from that document.

Rocky Flats was divided into 12 Exposure Units (EUs) (Figure 2-1) to assess potential risks for human and terrestrial ecological receptors and 7 Aquatic EUs (AEUs) for assessing potential risks for aquatic ecological receptors. As described above, the EUs germane to the project are:

- The Wind Blown Area Exposure Unit, representing Crossing Location D (proposed bridge over Indiana Street).
- The Rock Creek Drainage Exposure Unit, representing Crossing Location E (proposed box culvert underpass below CO-128).

The EUs were designated based on known sources and potential contaminant release patterns to collectively assess areas with similar types of potential contamination. Other criteria used in distinguishing the EUs included separate watersheds, similar topography and vegetation, and expected land use.

The SCM assumed that the future land use for Rocky Flats would be as a wildlife refuge and, as such, human populations who may be present included a wildlife refuge worker (WRW) and a wildlife refuge visitor (WRV). Workers may staff a visitor center, monitor and maintain the trail

system, and track the on-site wildlife populations. Visitors may hike, bike, bird watch, etc. on the Refuge. WRW receptors were assumed to be adults, while WRV receptors were assumed to include both adults and children.

Both workers and visitors were assumed to theoretically contact contaminants in surface soil, subsurface soil, sediment, surface water, and groundwater. All exposure pathways included in the SCM were identified as complete (meaning that exposure through the pathway is at least theoretically possible). In addition, the pathways were identified as either significant or insignificant. Insignificant pathways were those that are associated with such low exposure that there would be negligible risk even if exposure occurred. The significant pathways were evaluated on an EU basis and risk calculations were only performed for significant pathways in the individual EUs. However, pathways considered to be insignificant were evaluated to ensure that the pathways are appropriately identified as such.

The following exposure pathways were identified as potentially complete and significant in the 2006 RI/FS SCM:

- Surface Soil/Sediment:
  - Incidental ingestion of surface soil/surface sediment.
  - Inhalation of dust released from surface soil/surface sediment.
  - Dermal exposure to surface soil/surface sediment.
  - External irradiation exposure from surface soil/surface sediment.
- Subsurface Soil/Sediment:
  - Incidental ingestion of subsurface soil/subsurface sediment.
  - Inhalation of particulates released from subsurface soil/subsurface sediment.
  - Dermal exposure to subsurface soil/subsurface sediment.
  - External irradiation exposure from subsurface soil/subsurface sediment.

In the first step of the human health risk assessment (HHRA), the levels of potential contaminants of concern (PCOCs) in each EU were evaluated to assess whether a quantitative assessment of risks needed to be conducted. Only those parameters that were retained for the risk assessment were called contaminants of concern (COCs). The above pathways were quantitatively characterized for an individual EU if a COC(s) was identified.

As described in the HHRA, COCs were identified for surface soil/surface sediment in the Wind Blown Area EU (Plutonium 239/240 was the only radionuclide identified as a COC). However, COCs were not identified for surface soil/surface sediment in the Rock Creek Drainage EU. Consequently, a quantitative risk characterization for subsurface soil/subsurface sediment was not performed for the Rock Creek Drainage EU. In addition, COCs were not identified for subsurface soil/subsurface sediment in any EU. Therefore, quantitative risk characterization for subsurface soil/subsurface sediment was not performed.



The HHRA presented two exposure point concentrations (EPCs) estimates, Tier 1 and Tier 2, for the COCs at Rocky Flats. Briefly, EPCs are an estimate of COC concentrations to which people may be exposed. For the Rocky Flats HHRA, the Tier 1 concentration was calculated as the 95<sup>th</sup> percent upper confidence limit (UCL) on the average (mean) concentration within an EU. The 95<sup>th</sup> percent UCL is defined as the value that equals or exceeds the true mean with 95 percent confidence. As described in the HHRA, if most of the data for an EU have been collected in areas associated with historic releases, and few data points are available for the nonimpacted areas, the Tier 1 EPC is likely to overestimate the concentration for the EU as a whole. Therefore, Tier 2 EPCs were calculated in a manner that equally weighs the data for different subareas of an EU. In this approach, averages are first calculated for 30-acre subareas of an EU. These averages are then combined to calculate an EU-wide average. In areas where the data are evenly spaced throughout an EU, there are only minor differences between the Tier 1 and Tier 2 EPCs.

As stated above, Plutonium 239/240 was the only radionuclide identified as a COC. Radiological dose estimates were developed for the HHRA using the RESRAD software which was used to evaluate all applicable exposure pathways at a site (Kaiser-Hill Company, 2006). The dose estimate for plutonium for the WRW is 0.3 mrem/yr and for the WRV child it is 0.2 mrem/yr. These dose estimates are well below the acceptable annual radiation dose of 25 mrem specified in the Colorado Standards for Protection Against Radiation (CDPHE, 2005). A summary of cancer risks and dose estimates for WRW and WRV receptors in the Wind Blown Area EU is presented in Table 2-4.

**Table 2-4 Summary of Human Health Risk Estimates from Plutonium 239/240 in the Wind Blown Area Exposure Unit (Bridge Crossing Location along Indiana Street)**

Wildlife Refuge Worker (WRW)				Wildlife Refuge Visitor (WRV)			
Excess Lifetime Cancer Risk		Annual Dose Rate (mrem)		Excess Lifetime Cancer Risk		Annual Dose Rate (mrem)	
Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2
$2 \times 10^{-6}$	$9 \times 10^{-7}$	0.3	0.2	$1 \times 10^{-6}$	$6 \times 10^{-7}$	0.2 (child) 0.07 (adult)	0.1 (child) 0.04 (adult)

Source: Table ES8, Volume 1 of 15, Appendix A, Kaiser-Hill (2006)

The cancer risk estimates were at the lower end of EPA's risk range of  $1 \times 10^{-6}$  (one in a million) to  $1 \times 10^{-4}$  (one in ten thousand).

### 3.0 SAMPLING RATIONALE

EA used Visual Sample Plan (VSP), developed by Pacific Northwest National Laboratory (PNNL), to develop the sampling design. VSP is a software tool that supports the development of a defensible sampling plan based on statistical sampling theory and the statistical analysis of sample results to support confident decision making. VSP incorporates a variety of sampling designs, including those described in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), in its programming. Based on the project-specific sampling goals, VSP calculates the number of samples to be collected and identifies random locations for the samples to be collected. Information on the VSP software is available at <https://vsp.pnnl.gov/>. As indicated on the PNNL website, VSP's development was supported by a variety of federal departments, agencies and commissions, including the DOE and the EPA.

#### 3.1 Conceptual Physical Model

The Indiana Street Bridge Crossing and CO-128 Underpass Crossing are located within two different exposure units (EUs), as described in the HHRA (Kaiser-Hill Company, 2006). As illustrated on Figure 2-1, the Indiana Street Crossing is located downwind of the former industrial area. In the HHRA (*ibid.*), the area near the Indiana Street Crossing is adjacent to the Wind Blown Area EU. The CO-128 Underpass Crossing is located north of the former industrial area along CO-128 and is adjacent to the Rock Creek Drainage EU.

There are no known primary Rocky Flats related contaminant source(s) located near either crossing location. Consequently, the source of non-native radionuclides located in both areas is atmospheric fall-out and windblown contamination from the Rocky Flats Industrial Area. Therefore, radionuclide contamination at both crossings will be limited to the near surface soils which is consistent with the model verified in Margulies et al. (2004). The near surface soil data from the CDPHE database, as summarized in Table 2-2 (Rock Creek Drainage EU) and Table 2-3 (Wind Blown Area EU), should be representative of the radionuclide activities in the near surface soils at the Indiana Street and CO-128 crossings.

#### 3.2 Sampling Design

EA will collect soil samples from the proposed disturbance areas at the two locations, the Bridge Crossing and the Underpass Crossing, following the procedures described in Section 5 of this report. No sampling/testing will be done unless prior landowner authorization is given. EA will sample and analyze soils from individual sample locations within the potential areas of disturbance of the crossing structures and the footprint of the new paths associated with each crossing, as illustrated in Figure 1-1.

EA used VSP to separately estimate the number of samples to be collected at each location. The null hypothesis is that the average radionuclide activity at a crossing exceeds the average in its associated EU. To reject the null hypothesis, VSP calculates the number of samples to statistically prove the opposite (i.e., that the average radionuclide activity at a crossing is no different than that in its associated EU). For each VSP analysis, EA assumed a Type I error ( $\alpha$ ) of 5 percent and a Type II error ( $\beta$ ) of 10 percent<sup>1</sup>. EA used the historic Plutonium 239/240 data from the two EUs

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<sup>1</sup> Type I errors occur when the null hypothesis is rejected, incorrectly. For this Project, a Type I error would occur if the radionuclide activities at a crossing are incorrectly classified as being similar to that in the associated EU (null hypothesis rejected) when, in fact, they are higher than those in the associated EU (as stated in the null

to develop the number of samples; however, all samples will be analyzed for americium, plutonium and uranium.

### **3.2.1 Bridge Crossing (Indiana Street)**

The disturbed area associated with the Indiana Street bridge (Crossing D) is approximately 192,707 ft<sup>2</sup>, or approximately 4.4 acres. The Plutonium-239/240 data for the 307 historic surface soil samples from the Wind Blown Area EU (Table 2-3) were used in VSP, along with the Type I and Type II error information described above. The VSP software calculated that 17 samples would be required to reject the null hypothesis at the Bridge Crossing location. The planned sample density within the Bridge Crossing disturbed area (one sample per 0.3 acres) will be approximately 8 times greater than that within the 715 acre Wind Blown Area EU (one sample per 2.33 acres).

Based on the relative sizes of the disturbed areas on either side of Indiana Street (Figure 1-1), EA will collect three of the samples from the area on the west side of Indiana Street and 14 samples from the area on the east side of Indiana Street. One sample location in each disturbed area will be located near the terminus of the bridge. The other samples will be randomly distributed throughout the footprint of the disturbed areas and selected using the random sampling function in VSP.

### **3.2.2 Underpass Crossing (CO-128)**

The disturbed area associated with the CO-128 underpass (Crossing E) is approximately 116,502 ft<sup>2</sup>, or approximately 2.7 acres. The Plutonium-239/240 data for 50 surface soil samples from the Rock Creek Drainage EU (Table 2-2) were used in VSP, along with the Type I and Type II error information described above. The VSP software calculated that eight samples would be required to reject the null hypothesis at the Underpass Crossing location. The planned sample density within the Underpass Crossing disturbed area (one sample per 0.3 acres) will be approximately 50 times greater than that within the 735 acre Rock Creek Drainage EU (one sample per 14.7 acres).

Based on the relative sizes of the disturbed areas on either side of CO-128 (Figure 1-1), EA will collect two of the samples from the area on the south side of CO-128 and six samples from the area on the north side of CO-128. One sample location in each disturbed area will be located on the CO-128 embankment near the proposed tunnel openings. The other samples will be randomly distributed throughout the areas and selected using the random sampling function in VSP.

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hypothesis). Type II errors occur when the null hypothesis is accepted, incorrectly. For this Project, a Type II error would occur if the radionuclide activities at a crossing are incorrectly classified as being higher to that in the associated EU (null hypothesis accepted) when, in fact, they are no different or lower than those in the associated EU. From a risk perspective, Type I errors are more serious than Type II errors, which is why a more conservative Type I error was selected in VSP for the Project.

## **4.0 PROJECT DATA QUALITY OBJECTIVES**

The data quality objectives DQOs and criteria for measurement data are defined below using the seven-step process described in EPA *Guidance for the Data Quality Objectives Process* (EPA 2006). This seven-step process clarifies the objectives, inputs, and decisions for the current project and helps define the data quality requirements. Below is a brief description of the outputs of each for the seven steps.

### **Step 1. Define the problem**

Samples of soil are needed to confirm that the activity of americium, plutonium, and uranium at the crossing locations are consistent with the risk assessment values used at the site.

### **Step 2. Identify the goal(s) of the study**

The goal of this study is to obtain data to confirm that the risk to visitors at the crossings and associated connector paths from americium, plutonium, and uranium are consistent with historic risk assessment findings.

### **Step 3. Identify Information Needed for the Decision**

The inputs needed to collect representative and comparable soil data to assess visitor risk are:

- Conceptual design plans to define the spatial boundaries of the sampling activities.
- Previous sampling procedures and protocol to ensure that current soil samples are collected as similarly to historic samples as practicable.
- Historic americium, plutonium, and uranium data so statistical analyses can be performed on the population. The summary statistics will be used to define the sampling density in the larger areas to be sampled.
- Previous human health risk assessments.

### **Step 4. Define the Boundaries of the Study**

*Spatial Boundaries:* Sampling locations are outside the Rocky Flats Refuge boundary and on properties owned by the members of the Partner Group, Colorado Department of Transportation (CO-128), and Jefferson County Road and Bridge Division (Indiana Street).

*Temporal Boundaries:* The half-lives of the americium, plutonium, and uranium are long, measured in tens of years to millions of years. The sampling event will take place over the course of days.

### **Step 5. Develop a Decision Rule**

The soil data will be used in conjunction with previously completed human health risk assessments to evaluate risk to visitors of the crossings and associated connector paths.

**Step 6. Specify Acceptable Limits on Decision Error**

The potential for decision errors exists because all analytical measurements inherently contain sampling and measurement errors. Sampling design error occurs when the data collection scheme does not adequately address the inherent variability of the matrix being sampled.

Measurement error occurs from inherent variability in the collection, preparation, and analysis of an environmental sample. These errors will be minimized by following the procedures outlined in this SAP, collection of field quality control samples, and by following established laboratory protocols.

The distribution of the americium, plutonium, and uranium in the Project soil samples will be compared to the historic data to determine if the populations are equivalent.

**Step 7. Optimize the Design**

Ensure that samples are analyzed with methods that are sufficiently reliable and sensitive to detect americium, plutonium, and uranium in soils if activities approach or exceed reporting limits.

No resource restraints are anticipated on this project.

## **5.0 FIELD METHODS AND PROCEDURES**

Soil samples will be collected in a manner to make the data consistent with the historic data, to the extent practicable. A site specific health and safety plan will be developed prior to field work.

### **5.1 Soil Sampling**

The soil samples will be collected from the 0 to 2-inch (5 cm) depth interval, as this interval is consistent with the majority of radionuclide data in the CDPHE database ( see Section 2.2.2). EA will visually describe the texture and grain size distribution of the soil samples following the Unified Soil Classification System (USCS). The sample color will be classified using the Munsell soil color charts or similar system, and the moisture content of the sample will be visually estimated. This information will be recorded in a field logbook.

At each sample location, EA staff will remove vegetation and large material (such as rocks) from an approximate 4 x 4-inch area. To the extent practical, soil attached to plant roots will be removed from the roots and retained for analysis. The soil will be collected with clean, stainless steel tools from the surface to a depth of 2 inches. The soil will be sieved through a Number 10 (2 mm) stainless steel sieve to remove coarse grained material. The soil will be thoroughly mixed in a stainless-steel bowl, trisected and a sub-sample of approximately 200 to 300 grams will be collected and placed in an appropriate container for laboratory analysis. A separate aliquot of approximately the same size will be placed in the same type of container and archived. One field duplicate sample will be generated at each crossing location (two total). The distribution of the field sample aliquots is summarized in Figure 5-1.

As described in Section 3.2, 17 discrete samples will be collected from within the footprint of the Bridge Crossing disturbed area and 8 discrete samples will be collected from within the smaller footprint of the Underpass Crossing disturbed area. Two samples in each disturbed area will be collected at a biased location, collected near each terminus of the crossing structure. The remaining samples will be collected at random grid locations throughout the footprint of the disturbed area.

### **5.2 Sample Documentation**

Soil samples will be labeled using their location, identification number, sample type [grab (G)] and date of collection. The location nomenclature is:

- Within the Underpass Crossing (Location D) disturbed area (CO-128) = D
- Within the Bridge Crossing (Location E) disturbed area (Indiana Street) = E

The date will be recorded in six-digit format (MMDDYY). For example, the fourth soil sample collected within the footprint of Crossing E on August 24, 2018 would be identified as E4G-082418 on the sample label. A field duplicate at this location would be identified as E4G-082418Dup on the sample label. An equipment rinsate blank (ERB) sample at this location would be identified as E4G-082418ERB on the sample label. (Generation of rinsate is described in Section 5.3). The archived sample from this location would identified as E4G-082418Arch.

Field notes and observations will be recorded in project specific water- resistant logbooks. Pages in the logbooks will be sequentially numbered. Logbook entries will be scanned upon return from the field and saved as portable document format (pdf) formatted files. Soil sample collection will information will be described in the logbook and will document the following information:

- Soil description (color, texture, moisture).
- Sample ID as recorded on the sample label and chain-of-custody form.
- Sample depth.
- Date, time, and a description weather/field conditions.
- Sample coordinates.
- Name(s) of sampler.

Documentation of field activities may be supplemented using photographs. The date, time, location, and view direction or perspective of photographs will be recorded in field log-books.

Sample coordinates will be obtained using a Wide Area Augmentation System (WAAS) enabled consumer grade GPS unit. Sample locations coordinates will be based on the Colorado Central State Plane Coordinates in NAD 27 State plane Colorado Central.

### **5.3 Decontamination**

Reusable sampling equipment will be cleaned prior to and between each sampling location with Liquinox (or Alconox) solution, and then rinsed with deionized or distilled water. Cleaned equipment will be stored in clean plastic bags if not immediately used.

EA will generate one equipment rinsate blank (ERB) sample at each crossing location (two total) to document decontamination effectiveness. Approximately three liters of water will be required for the laboratory to perform the analyses. The aqueous sample will be preserved with nitric acid but will not require chilling.

### **5.4 Investigation Derived Waste**

Investigation derived wastes (IDW) will be generated during the soil sampling program. IDW will be temporarily contained and/or disposed in accordance with the procedures outlined below. The types of IDW anticipated to be generated from the sampling activity include:

- Excess soil generated during excavation.
- Decontamination water.
- Personal protective equipment (PPE).

Handling/disposal of IDW will be completed as follows:

- Excess soil generated during excavation – Excess soil generated during sample collection will be returned to the excavation. The excavation will be hand compacted. Additional soil from adjacent locations will be added to the excavation, as needed, to return the elevation to its approximate pre-sample level.

- Decontamination Water – The quantity of water derived during the decontamination of soil and sediment sampling equipment will be minimal (less than one gallon) and will be disposed on the land surface away from drainage areas and allowed to infiltrate.
- Disposable Personal Protective Equipment (PPE) – Disposable PPE will be limited to nitrile gloves. The PPE will be placed in plastic bags along with other solid waste (e.g., paper towels) and disposed as solid waste at an off-site location.



## **6.0 SAMPLE CONTAINERS, PRESERVATION, PACKAGING AND SHIPPING**

The soil samples will be placed in new and certified clean wide-mouth glass (WMG) jars supplied by the laboratory or a third-party vendor. No preservation for the soil samples is required. Sample containers will be stored upright in an ice chest or other large container for security. The containers will be wrapped in bubble-wrap to inhibit breakage.

All samples will be transmitted to ALS Global Laboratories (ALS) in Fort Collins, Colorado. The samples will be accompanied by a completed and signed Chain-of-Custody record. One copy of the Chain-of-Custody will accompany the samples and a copy of the Chain-of-Custody will be retained by the sampling personnel. EA personnel will hand deliver the samples to ALS.

## 7.0 LABORATORY TESTING

ALS Global Laboratories (ALS) will provide analytical services for the project. ALS is a publicly traded company based in Brisbane, Australia. ALS serves multiple industries globally from 300 plus locations in over 65 countries. The Project samples will be analyzed for americium-241, isotopic plutonium and isotopic uranium by ALS in their Fort Collins, Colorado facility. ALS Fort Collins, formerly Paragon Analytics, provides radiochemistry and environmental testing services to Federal and State agencies, environmental and engineering consulting firms, and private industry. ALS Fort Collins is familiar with Rocky Flats soil matrices, having served as the analytical laboratory for numerous Rocky Flats Environmental Technology Site related projects for more than 20 years. A copy of the current Quality Assurance Manual for the ALS Fort Collins laboratory is provided in Appendix A.

Upon transfer of custody of the Project samples from EA to ALS, ALS will log the samples into their Laboratory Information Management System (LIMS), prepare and process the samples for analysis, and then analyze the samples for americium-241, isotopic plutonium, and isotopic uranium via alpha spectroscopy. Information on the analytical methods that ALS will use to test the soils is summarized in Table 7-1.

**Table 7-1 Radionuclide Analytical Testing Information**

<b>Radionuclide</b>	<b>Method<sup>1</sup></b>	<b>Minimum Detectable Concentration<sup>2</sup> (MDC) (pCi/g)</b>
Am-241	alpha spectroscopy	0.1
Pu-238	alpha spectroscopy	0.15
Pu-239/240	alpha spectroscopy	0.1
U-234	alpha spectroscopy	0.1
U-235	alpha spectroscopy	0.1
U-238	alpha spectroscopy	0.1

1. ALS SOP 714, Revision 14, *Analysis of Alpha Emitting Radionuclides by Alpha Spectroscopy*.
2. MDCs may vary from sample-to-sample.

ALS processes samples using proprietary Standard Operation Procedure (SOPs) or in-house procedures described in Quality Assurance Summary Sheets (QASSs). The SOPs and QASSs that ALS will apply to the Project soil samples are summarized in Table 7-2. As discussed above, ALS has served as the analytical laboratory for numerous Rocky Flats Environmental Technology Site related projects for more than 20 years and, as such, has utilized these SOPs to produce radionuclide data for a variety of researchers.

The ALS soil sample preparation sequence for the Project soils is described below and summarized in Figure 7-1. ALS will digest Project soil sample aliquots via two separate methods: (1) acid dissolution, and (2) fusion. The resultant solutions will be processed, purified, and mounted on planchets for analysis via the method described in Table 7-1. Therefore, ALS will provide EA with two sets of analytical results for each Project soil sample. In addition, following the initial processing step (drying and milling), splits will be created of each sample and packaged for third-

party analysis<sup>2</sup> and archival purposes. Consequently, multiple analyses will be available from separate laboratories for each soil sample collected by EA.

**Table 7-2 Summary of ALS Soil Sample Preparation Methods**

Document Number	Document Title	Revision Number
SOP 736	Representative Laboratory Subsampling – Radiochemistry	1
SOP 773	Total Dissolution of Solids for the Radiochemical Determination of Actinides and other Non-Volatile Radionuclides	12
QASS	Carbonate Fusion	N/A
SOP 778	Uranium, Plutonium and Americium/Curium (Partial) Sequential Separation by Ion Exchange	14
SOP 751	Actinides – Americium/Curium Separation – Purification by TRU™ and TEVA™ Spec Column	6

ALS will initially process the field samples per ALS SOP 736, *Representative Laboratory Subsampling – Radiochemistry*, which will include drying and milling<sup>3</sup>. The samples will be dried at 105±5°C for a minimum of 16 hours and then milled. Two approximately 60-gram aliquots of the dried sample will be machine shaken in separate half-pint steel cannisters each containing 5 half-inch steel ball bearings for 15 minutes. This milling process produces a 200-mesh powder (silt and clay size) to facilitate dissolution of the sample matrices in the subsequent steps. The powdered soil from both containers will be combined and thoroughly mixed to produce aliquots for subsequent processing and analysis. Splits of Project samples for third-party analyses and archival purposes will also be generated following this step (Figure 7-1).

The milled samples will be digested via two methods: (1) acid dissolution, and (2) fusion. Aliquots dissolved using acids will be digested via a multi-step process using ALS SOP 773, *Total Dissolution of Solids for the Radiochemical Determination of Actinides and other Non-Volatile Radionuclides*. Tracers are added to the sample at the beginning of the process and the digestion of approximately 1- to 2-gram aliquots will be accomplished using nitric, hydrochloric, and hydrofluoric acids. Because of the potential presence of recalcitrant material (minerals, glass, refractory oxides) hosting some of the radionuclides in the Project soil samples, ALS will also perform a separate fusion dissolution on a split of the original sample utilizing sodium carbonate and potassium carbonate (Figure 7-1). A ferric hydroxide co-precipitation step will then be separately performed on the solutions from both soil digestion methods to preconcentrate actinides and to remove constituents that do not form hydroxides. The hydroxide precipitate will then be re-dissolved and further purification performed to prepare the samples for analysis (see below).

Americium, plutonium, and uranium will be separated and purified from the digested/fused samples via ALS SOP # 778, *Actinides – Uranium, Plutonium and Americium/Curium (Partial) Sequential Separation by Ion Exchange*. This step will be followed by ALS SOP # 751, *Actinides*

<sup>2</sup> Quality Assurance/Quality Control of Project samples is the responsibility of other entities following relinquishment of sample custody by ALS/EA.

<sup>3</sup> ALS SOP 736 includes a #4 (4.75 mm) sieving step between the drying and milling steps. The ALS sieving step will be omitted as EA will field sieve the samples using a smaller-sized (#10 or 2 mm) sieve.

– *Americium/Curium Separation – Purification by TRU<sup>TM</sup> and TEVA<sup>TM</sup> Spec Column*, specifically for Am-241. The final step of these processes involves the purified isotope(s) being co-precipitated with lanthanum fluoride, the precipitate being retained on a filter membrane, and the membrane being mounted on a planchet for quantification by alpha spectroscopy via ALS SOP 714, *Analysis of Alpha Emitting Radionuclides by Alpha Spectroscopy*.

The aqueous equipment rinsate blank ERBs samples will also be analyzed for radionuclides via ALS SOP 714, *Analysis of Alpha Emitting Radionuclides by Alpha Spectroscopy*. As discussed in Section 5.3, approximately three liters of water will be required for the laboratory to perform the analyses.

The standard turn-around-time for americium, plutonium and uranium processing and analyses is 45 days but may take up to 8 weeks depending on laboratory volume. ALS will provide the test results as both an electronic data deliverable (EDD) format (MS Excel spreadsheet) and a printable PDF laboratory report. The laboratory report will provide a Level II quality control (QC) package which will contain: Case Narrative, Receipt Documentation and Chain-of Custody, Individual Sample Results, and laboratory QC sample results for Blanks, Duplicates, and Laboratory Control Samples.

## **8.0 DATA REVIEW AND USABILITY**

EA will review the field records and laboratory analytical reports. The laboratory analytical data will also be reviewed for data quality indicators (precision, accuracy, representativeness, comparability, and completeness). As indicated in Section 7, ALS will provide Level II QC reporting of their radiochemistry results.

### **8.1 Data Review, Verification and Validation**

After the field sampling activities are completed EA staff will review the field records to assess compliance with the items listed below:

- Samples correctly identified.
- Field logbooks and documentation are complete.
- Laboratory receipt of sample documented.
- Required field data collected and acceptable.
- Required sampling procedures were followed and, if not, deviations are documented.
- Required field QC samples were collected.
- Custody records are complete.

EA staff will also review the laboratory records to assess if the laboratory reporting is accurate and complete, and to assess compliance with the items listed below:

- Samples are correctly identified.
- Custody records are complete and traceable.
- Samples were appropriately containerized, and the proper amount received to perform the requested analyses.
- All sample analyses are correctly identified and complete.
- All analytical methods are pursuant to this SAP.
- All applicable performance criteria are addressed.
- Required QC samples are present and results within performance criteria.

EA will compare the original sample information entered on the chain of custody to the information in the laboratory reports and EDD. EA will verify information for fields in the EDD such as laboratory ID, batch numbers, method numbers, minimum detectable concentration, field sample numbers, sample dates, preparation dates, analysis dates, flag codes, etc.

### **8.2 Data Quality Indicators/Measurement Quality Objectives**

Performance criteria for radiochemical analytical data will be based on the evaluation of Measurement Quality Objectives (MQO). MQOs are quantitative statistics and qualitative descriptors used to interpret the degree of acceptability of data. Failure to meet performance criteria will not necessarily result in rejection of the data. Professional judgment, combined with the MQO evaluation, will be used to determine data usability. These acceptance criteria were developed in consideration of Appendix C “Measurement Quality Objectives for Method Uncertainty and Detection and Quantification Capability” of the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP [EPA, 2004]).

Objective measurements of analytical data quality are required for laboratory analysis of environmental samples. The principal Data Quality Indicators (DQIs) of analytical data quality are precision, accuracy, sensitivity, representativeness, comparability, and completeness, as identified in EPA QA/G-5 (EPA, 2002b). For this SAP, an additional MQO has been added for uncertainty as recommended by MARLAP. The quality of laboratory analytical results is assessed using specific laboratory QC samples, which are compared to specific performance criteria (control limits) for each DQI. Laboratory QC samples are discussed below. These discussions include the decision rule for assessing laboratory performance with respect to the relevant DQI presented.

### **8.2.1      *Total Uncertainty***

The primary laboratory measurement of uncertainty for a reported radiometric value is the combined standard uncertainty, also referred to as the total propagated uncertainty (TPU). The TPU is the standard deviation of all the components of error that may be associated with a sample result. Acceptable levels of uncertainty pursuant to MARLAP are based on the region defined as the difference between the upper bound gray region (UBGR) and lower bound gray region (LBGR) of the concentrations of interest and the defined decision error probabilities. In this case, the UBGR is considered to be the average concentration of the radionuclides in the applicable EU.

### **8.2.2      *Precision***

The primary laboratory QC samples assessing precision are duplicate samples. Laboratory QC duplicates may include other QC samples, such as matrix spike (MS) and matrix spike duplicate (MSD) samples.

Laboratory duplicate results are evaluated by comparing the results from the primary and duplicate sample with respect to each other using either the relative percent difference (RPD) or the absolute difference (AD) of the two measurements. The following DQI are applied to laboratory analytical results to assess precision for Project samples.

The total variance of the data, ( $\sigma^2$ ) is the sum of two components:

$$\sigma^2 = \sigma^2_M \text{ and } \sigma^2_S$$

Where

$\sigma^2_M$  = variance of the analytical measurement, and

$\sigma^2_S$  = variance of the contaminant concentration in the sampled population.

The sampling standard deviation,  $\sigma_s$ , may be affected by the spatial distribution of the analyte, the survey unit extent, physical sample sizes, and sampling procedures. The analytical standard deviation,  $\sigma_m$ , is affected by laboratory sample preparation, aliquot selection, and analysis procedures.

### **Relative Percent Difference (RPD)**

When the average of the analytical results (the duplicate pairs) is greater than or equal to the UBGR, (e.g.,  $\bar{x} \geq 9.44$  for Pu-239/240 in the Wind Blown Area EU) the RPD is calculated as follows:

$$RPD = \frac{|D1-D2|}{\text{avg}(D1+D2)} \times 100$$

Where:

D1 = First or primary sample value

D2 = Second or duplicate sample value

Warning limit for RPD is 75% and control limit is 113% (MARLAP, Appendix C.4.2.2)

### **Absolute Difference (AD)**

When the average of the analytical results (the duplicate pairs) is less than the UBGR (e.g.,  $\bar{x} < 9.44$  for Pu-239/240 in the Wind Blown Area EU), the AD is used instead of the RPD and is calculated as follows:

$$AD = |D1 - D2|$$

This is keeping with Section C.4.2.2 of Appendix C to MARLAP (EPA, 2004).

### **8.2.3 Accuracy and Bias**

The primary laboratory QC samples assessing accuracy and bias include those listed below:

- Blanks
- Matrix blanks (MB)
- Laboratory control samples (LCS)

The following DQI are applied to laboratory analytical results to assess accuracy and bias.

#### **Matrix Blanks (MB)**

For radionuclides in MB, the results should be zero. However, due to the nature of radiochemistry measurement performance indicator is the allowable TPU of 0.1 pCi/g. This TPU is used for the MB since this sample should be near or close to zero.

The warning limit for measured concentrations are  $\pm 0.2$  pCi/g and the control limit is  $\pm 0.3$  pCi/g (MARLAP, Appendix C.4.2.3 [EPA, 2004]).

#### **Laboratory Control Samples (LCS)**

The LCS consist of a National Institute of Standards and Technology (NIST) traceable reference material with known concentrations of target analytes. The LCS is used to document laboratory performance by checking the accuracy of the analytical procedure. The LCS are obtained by the analytical laboratory from an outside vendor and consist of the same type of matrix (e.g., solid, aqueous) as the batch samples.

For LCS, the DQI assessing the method is the percent deviation (%D), which is compared to control limits. For LCS, the %D is calculated as follows:

$$\% D = \frac{SSR - SA}{SA} \times 100$$

Where:

SSR = The measured result

SA = The known concentration

It is assumed that the uncertainty of SA is negligible so the maximum allowable relative standard deviation of %D is the same as the SSR.

#### **8.2.4 Sensitivity**

ALS is obligated to meet the MDCs for the radionuclides provided in Table 7-1. These MDCs are compared to the Preliminary Remediation Goals (PRGs) developed for the RI/FS (Kaiser-Hill Company, 2006) and then revised in June 2017 (USDOE, 2017) in Table 8-1.

**Table 8-1 Radionuclide Analytical Testing Sensitivity**

Radionuclide	Minimum Detectable Concentration (MDC) (pCi/g)	Wildlife Refuge Worker PRG (pCi/g)
Am-241	0.1	11.5
Pu-238	0.15	22.9
Pu-239/240	0.1	9.3
U-234	0.1	20.0
U-235	0.1	4.5
U-238	0.1	22.9

Note: The Am, U and Pu-239/240 PRGs were revised in June 2017 based on updated toxicological data as shown in Table 7 of the “*Fourth Five-Year Review Report for the Rocky Flats Site*” (DOE, 2017). This report is available at [https://www.lm.doe.gov/Rocky\\_Flats/Regulations.aspx](https://www.lm.doe.gov/Rocky_Flats/Regulations.aspx)

The MDCs proposed by ALS are less than the PRGs. If achieved, the MDCs will be sensitive for each parameter.

#### **8.2.5 Representativeness**

Quality program assessments (e.g., field oversight and audits) will be used to verify that the methods described in this SAP are followed. No MQO is developed for this DQI.

#### **8.2.6 Completeness**

Completeness is assessed by the ratio of fully usable data points to the total number of data points. The MQO for analytical laboratory data completeness is 95%, though failure to achieve this goal does not necessarily indicate required re-sampling and/or re-analysis. For the assessment of this



performance criteria, “Complete Data” does not exclude data that is flagged (qualified) as near or less than the MDC or data flagged with a non-quality control qualifier (not quality control related).

### **8.2.7      *Comparability***

Comparability is a qualitative term that expresses the confidence that one data set can be compared to another and can be combined for the decision(s) to be made. Comparability is assessed by comparing sample collection and handling methods, sample preparation and analytical procedures, holding times, stability issues, and QA protocols. Comparability is also assessed through laboratory performance evaluations. Data are considered comparable when acquired through means resulting in comparable quality (precision, bias, accuracy, sensitivity, etc.).

## **8.3      *Data Usability***

The data usability process is the final assessment that will be performed to ensure that the implementation of the sampling and analysis program described in this SAP provides results that can be used to meet the DQOs and data quality requirements. Components of the data review process include evaluating the data against the data quality indicators of precision, accuracy/bias, representativeness, completeness, and comparability; review of field and laboratory QC results; data verification and validation results; and evaluating the data for suitability based on the intended use. Deficiencies identified during this assessment will be reported to the Project Manager along with an indication of how the assessment will impact the use of the data. Limitations on the data will be communicated to the data users and, as appropriate, through the use of data qualifiers.

## 9.0 REFERENCES

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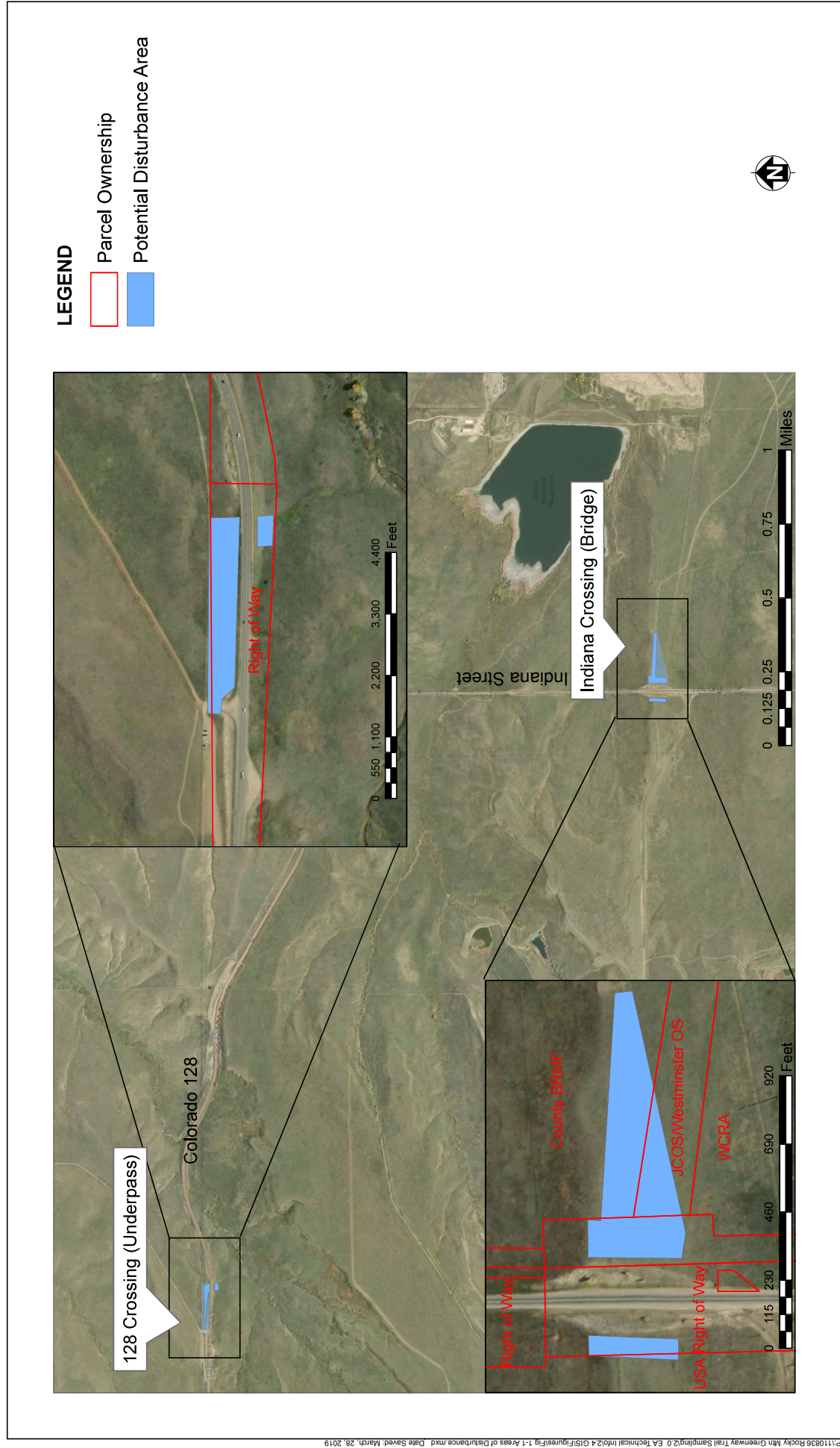
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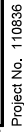
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## **FIGURES**



Project No. 110836

March 2019  
Rev. 4.0

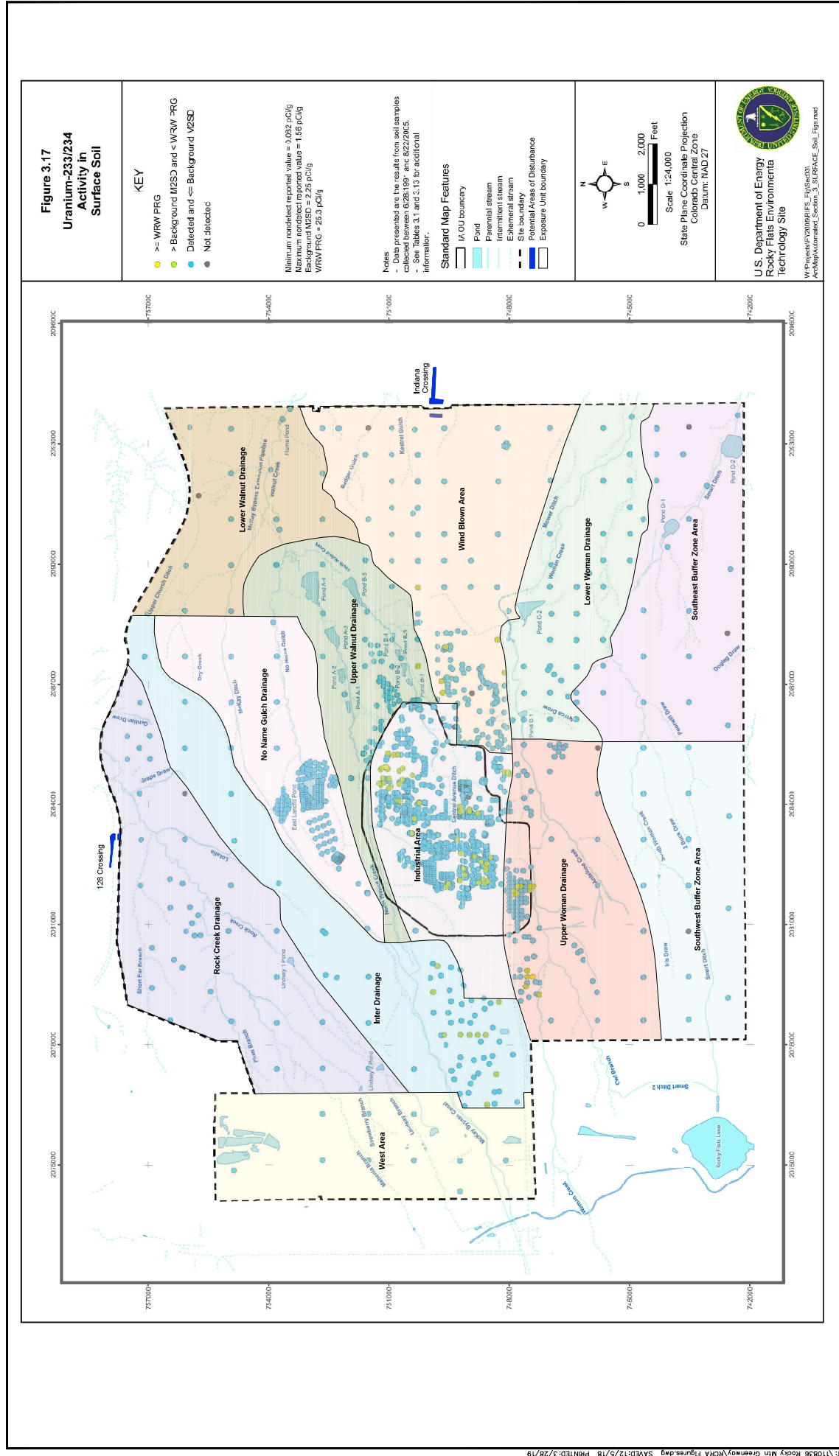


March 2019  
Rev 4.0

FIGURE 2-1  
AMERICIUM-241 ACTIVITY IN SURFACE SOIL  
ROCKY MOUNTAIN GREENWAY







March 2019  
Rev 4.0

**FIGURE 2-3**  
**URANIUM-233/234 ACTIVITY IN SURFACE SOIL**  
**ROCKY MOUNTAIN GREENWAY**

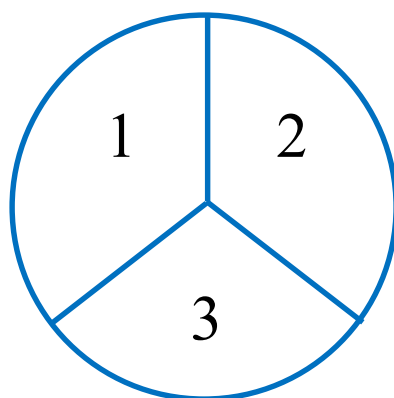
**NOTE:**  
FIGURE 3.17 FROM RCRA FACILITY INVESTIGATION -  
REMEDIAL INVESTIGATION/CORRECTIVE MEASURES  
STUDY - FEASIBILITY STUDY REPORT FOR THE ROCKY  
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Project No. 110836





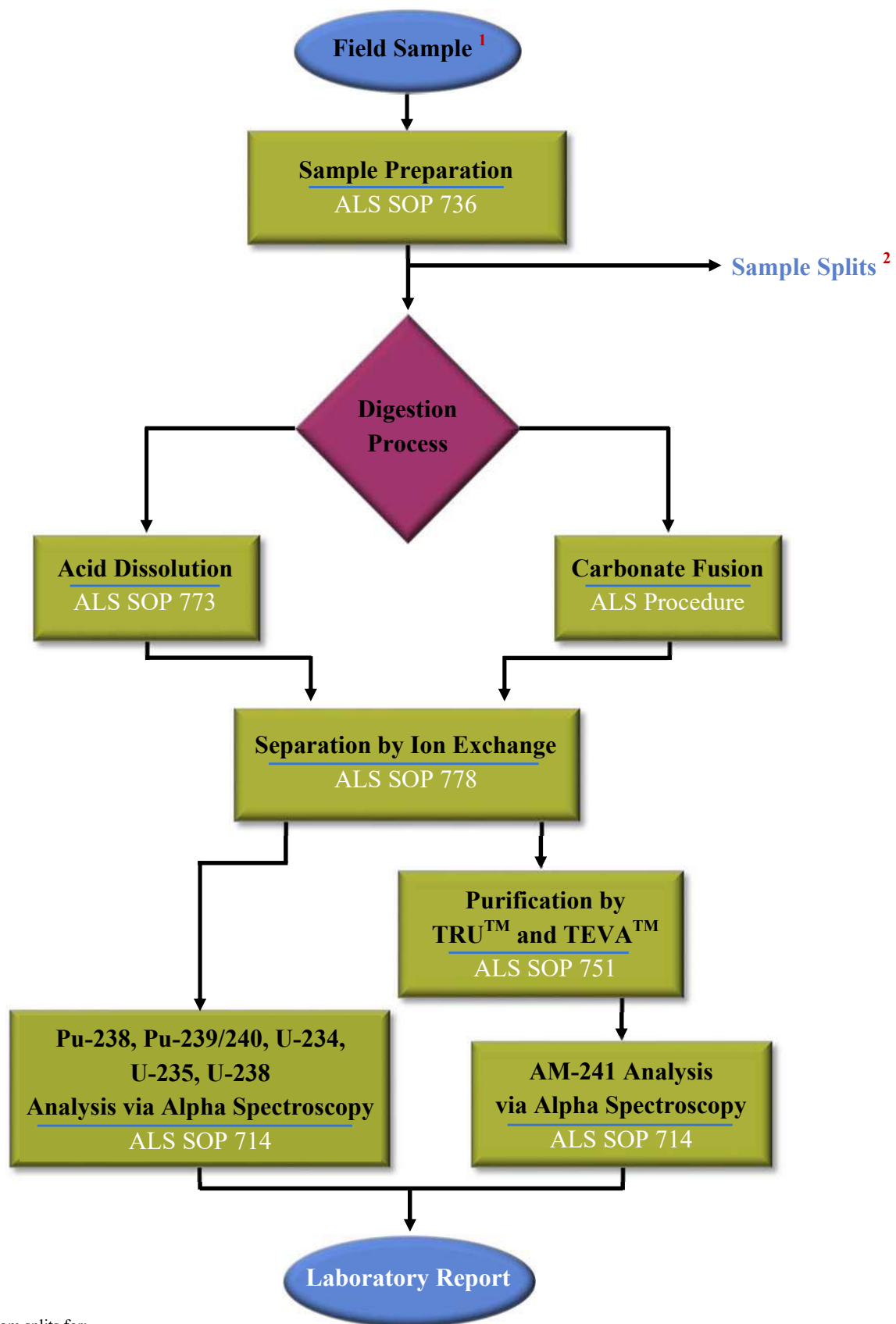




Aliquot	Description
1	Primary field sample delivered to laboratory <sup>1</sup>
2	Duplicate field sample delivered to laboratory <sup>1</sup> or discarded, as appropriate <sup>2</sup>
3	Archived sample

<sup>1</sup> See Figure 7-1

<sup>2</sup> One field duplicate sample will be generated at each crossing location



<sup>1</sup> See Figure 5-1

<sup>2</sup> Approximate 30 gram splits for:

- \* City and County of Broomfield for acid digestion and analysis via alpha spectroscopy
- \* Third party for fusion and analysis via ICP-MS
- \* Archived

**FIGURE 7-1**  
**LABORATORY SAMPLE PREPARATION**  
**AND ANALYSIS FLOWCHART**  
**ROCKY MOUNTAIN GREENWAY**

**APPENDIX A  
ALS FORT COLLINS  
QUALITY ASSURANCE MANUAL**



## QUALITY ASSURANCE MANUAL

ALS Environmental  
225 Commerce Drive  
Fort Collins, CO 80524  
(970) 490-1511  
[www.alsglobal.com](http://www.alsglobal.com)



## QUALITY ASSURANCE MANUAL

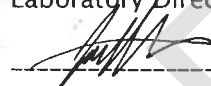
DocID: ALS QAM      Rev. Number: 22      Effective Date: 05/14/2018

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**APPENDIX I – LABORATORY ACCREDITATIONS**

**APPENDIX J – CALIBRATION AND METHOD QC REQUIREMENTS**

**APPENDIX K – CHAIN OF CUSTODY**

**APPENDIX L – LIST OF SERVICES**





## QA MANUAL CROSS REFERENCE TABLE

QAM	ISO/IEC 17025
1	4.1
2	4.2
3	4.1
4	4.3
5	4.4
6	4.5
7	4.6
8	4.7
9	4.8
10	5.3 and 5.5
11	5.8
12	5.4
13	5.6
14	5.9
15	4.9
16	4.10, 4.11, 4.12
17	4.13 and 5.4
18	4.14
19	4.15
20	5.2
21	5.10
22	NA
Appendix A	NA
Appendix B	NA
Appendix C	NA
Appendix D	5.3 and 5.6
Appendix E	5.5
Appendix F	NA
Appendix G	5.4
Appendix H	5.9
Appendix I	4.3
Appendix J	NA
Appendix K	5.9
Appendix L	NA



## 1 INTRODUCTION AND SCOPE

### 1.1 PURPOSE

This Quality Assurance Manual (QAM) describes the policies, procedures and accountabilities established by the Laboratory of ALS Environmental (ALS) to ensure that the test results reported from analysis of air, water, soil, waste, and other matrices are reliable and of known and documented quality. This document describes the quality assurance and quality control procedures followed to generate reliable analytical data.

This QAM is designed to be an overview of ALS operations. Detailed methodologies and practices are written in ALS Standard Operating Procedures (ALS SOPs). Where appropriate, ALS SOPs are referenced in this document to direct the reader to more complete information. A list of current ALS SOPs is found in Appendix G

ALS maintains certifications pertaining to various commercial and government entities; these are listed in Appendix I. Each certification requires that the laboratory continue to perform at levels specified by the programs issuing certification. Program requirements can be rigorous; they include performance evaluations as well as annual audits of the laboratory to verify compliance.

ALS is a full service environmental and radiochemistry laboratory, performing analyses for organic, inorganic, and radiological constituents in a variety of matrices. ALS specializes in serving the Department of Energy (DOE), Department of Defense (DoD), and architect-engineering firms. ALS routinely provides hardcopy data packages and electronic data deliverables that are easily validated by external validators.

The management team at ALS applies an integrated approach to quality assurance, client service, and efficient operations that enables ALS to produce compliant data that meet or exceed all technical and service requirements as prescribed by our clients. This Quality Assurance Manual (QAM) defines ALS's quality assurance (QA) program, and communicates ALS's goals, values and policies regarding quality, ethical conduct, data integrity, and optimized operations. ALS management is committed to continual improvement by implementing the management systems set forth in this QAM and the following documents: ISO 17025;2005, TNI 2009, AIHA LAP Policies, and DoD/DOE QSM.

Documents and forms used in the laboratory may still have previous ownership names like ATI, PAI, Paragon Analytical, DataChem or DCL. These former names can be used until revisions to specific documents are needed

ALS policy is to perform work for clients in the most efficient manner possible, avoiding waste of resources and undue pressure on employees. It is the role of



both ALS management and employees to ensure that work for clients is performed most efficiently and effectively by properly utilizing ALS purchased materials, equipment, and the time and ability of personnel.

## 1.2 MISSION STATEMENT

To help our customers make informed decisions by providing testing and technical services.

## 1.3 VISION STATEMENT

To be recognized as a global market leader.

## 1.4 STATEMENT ON WASTE, ABUSE AND FRAUD

ALS is committed to achieving our goals in the most efficient and effective manner possible, thus avoiding wasteful use of resources. This is accomplished by assuring the proper utilization of ALS's purchased materials and equipment, and time and ability of our personnel. *Any ALS employee, who has any suggestion or concern regarding ALS's practices, is encouraged to discuss his/her idea or question with the Laboratory Director, the Quality Assurance Manager, and supervisor.* A means of confidentially reporting concerns anonymously is also available. Grievances and allegations of unethical conduct will be fully investigated, and appropriate actions taken.

Training regarding ALS's Waste, Abuse and Fraud policies is provided to every new staff member, and to all employees lab-wide as an annual refresher. ALS's policies regarding waste, abuse and fraud are included in ALS SOP 143 and CE-GEN-001.

### 1.4.1 Code of Ethics and Data Integrity Statements

ALS is responsible for creating a work environment that enables all employees to perform their duties in an ethical manner. *It is ALS's expectation that all employees exhibit professionalism and respect for clients and each other in all interactions and tasks.* ALS requires that each employee abide by the following guidelines:

- Every ALS employee is responsible for the propriety and consequences of his or her actions. Each employee shall conduct him or herself in a professional manner towards all clients, regulators, auditors, vendors, and other employees. Professional conduct relates to honesty, integrity, respect, and tolerance for cultural diversity.
- Every ALS employee shall perform all assigned duties in accordance with ALS's established quality assurance policies and quality control



procedures that have been developed to ensure conformance with contractual and regulatory requirements.

- ALS expects all employees to use professional judgment and to document all situations thoroughly. It is the responsibility of each ALS employee to consult the Laboratory Director or Quality Assurance Manager when atypical or unusual situations occur and to disclose and document the decision-making process. Every employee must disclose any instance of noncompliance. ALS reports all noncompliance issues affecting data to the client.
- It is the responsibility of each ALS employee to report any suspicion of unethical conduct to the Quality Assurance Manager or the Laboratory Director.
- Procedures addressing Ethics and Data Integrity provide assurance that a highly ethical approach to testing is a key component of all laboratory planning, training and implementation of methods. See ALS SOPs 143 and CE-GEN-001.
- *Strict adherence to ALS's Code of Ethics and Data Integrity is essential to the reputation and continued health of our business. All ALS employees are required to acknowledge their responsibility and intent to behave in an ethical manner by attesting to the requirements described in procedures and annual refresher training is conducted.*

## 2 ORGANIZATION

The Laboratory is organized around the functions described in the following sections. Appendix B of this Quality Assurance Manual contains a detailed organization chart for this laboratory. The laboratory is part of ALS USA Corp and the Laboratory Director reports to the Director of Operations, USA. There are other support functions such as human resources, accounting, safety oversight and computer systems that are provided to the laboratory by corporate entities but none of which is responsible for managing laboratory activities. The support functions of this laboratory involved with testing and services are under the direction of the laboratory director.

The ALS laboratory employs sufficient personnel to complete required chemical analyses and support activities. Support activities include personnel recruiting and management, sample receiving and logging, computer programming and data processing, analytical report preparation, equipment procurement, and method development.



### 3 MANAGEMENT

This section provides an overview of ALS organization and defines key personnel, their responsibilities, and the lines of communication between these employees. An organization chart that illustrates reporting relationships is provided in Appendix B

#### 3.1 KEY PERSONNEL

Education, experience and skill requirements for these positions are addressed in job descriptions (Title). Functional responsibilities are further discussed below.

In the event of a temporary absence, key personnel must notify other key staff of their absence and reassign their duties to another employee (deputy) who will perform the assigned duties. For example, a PM may assign another PM to cover his or her duties; Group Leader may assign a senior chemist to cover his or her duties; and the Laboratory Director may assign a qualified employee to cover his or her duties

##### 3.1.1 Laboratory Director

The Laboratory Director (Laboratory Director) is responsible for:

- All laboratory operations, including: business functions such as marketing, sales and financial issues. Providing input and support to proposal processes, including interacting with the Sales, Technical and Quality Assurance staff, to ensure that the laboratory is capable of complying with client and regulatory requirements;
- Supervising all personnel through Management staff, who ensure that QA/QC procedures are being performed and that any non-conformances or discrepancies are documented and remedied properly and promptly;
- Ensuring that corrective actions relating to Findings from internal and external audits are completed in a timely fashion;
- Ensuring that the laboratory has the appropriate resources and facilities to perform analytical services;
- Ensuring that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory;
- Defining the minimum level of education, experience, and skills necessary for all positions in the laboratory;
- Ensuring that only those vendors and supplies that are of adequate quality are used; and



- Directing the performance of the annual Managerial Review
- Providing technical education and training to personnel, authorizing personnel with appropriate educational and/or technical background perform all tests for which the laboratory is accredited, and providing documentation of employee capability and training, and ensuring that training and documentation are up to date;
- Reviewing RFPs and assisting in the preparation and submission of proposals; and
- Interacting with all phases of laboratory operations, including Quality Assurance, Information Systems, and Health and Safety,
- Ensure that the laboratory is capable of complying with client and regulatory requirements.

### 3.1.2 Quality Assurance Manager

The Quality Assurance Manager reports to the Laboratory Director and is independent of daily operation and production requirements. Therefore, the Quality Assurance Department is able to evaluate data objectively and perform assessments without production influence. *This position has authority to stop work if systems are sufficiently out of control to compromise the integrity of the data generated.*

The Quality Assurance Manager shall have documented training and/or experience in QA/QC procedures; knowledge of quality systems as defined by TNI and other management systems standards; and a general knowledge of the analytical test methods for which data review is performed.

The Quality Assurance Manager (and/or designee) is responsible for:

- Defining and implementing the quality system;
- Developing and maintaining a pro-active program for prevention and detection of improper, unethical, or illegal practices (e.g., single- or double-blind proficiency testing studies, electronic data audits, maintaining documents that identify appropriate and inappropriate laboratory and data manipulation practices);
- Ensuring continuous improvement of laboratory procedures via training, control charts, proficiency testing studies, internal audits, and external audits;
- Coordinating the laboratory's participation in state and Federal certification programs;



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- Scheduling the review and distribution and maintaining distribution records of controlled documents, including plans (e.g., Quality Assurance Manuals, etc.) and SOPs;
- Reviewing, when requested, Requests For Proposal (RFPs) to ensure ALS compliance with required QA/QC practices;
- Facilitating external audits;
- Overseeing or conducting internal audits of the entire operation annually (technical, management system, data, electronic);
- Coordinating, preparing and approving external and internal audit responses and corrective actions;
- Managing the laboratory's participation in proficiency testing (PT/PAT) studies;
- Reviewing non-conformances and approving corrective actions;
- Reviewing QC limits per established procedures;
- Ensuring that Detection Limit studies are performed and documented per requirements;
- Managing the reference standards used in the calibration and/or verification of support equipment (e.g., weights, thermometers, balances);
- Revising the Quality Assurance Manual annually in accordance with industry standards;
- Maintaining an archival system for quality records; and
- Maintaining technical and quality assurance training records, including employee authorizations and competency to perform testing.
- Ensure implementation of quality policy and applicable standards.
- Understand, monitor and evaluate the quality assurance (QA) and quality control (QC) activities described in this QAM and its references, reporting deficiencies and identifying resource requirements to the Laboratory Director.
- Conduct reviews or update laboratory Standard Operating Procedures (SOPs).
- Arrange for the analysis performance evaluation (PE/PAT) samples.
- Maintain a record of ongoing personnel training for QAM-related activities, reporting training deficiencies to the Laboratory Director.
- Maintain the laboratory records of nonconformance, corrective action, preventive action and improvement.



### 3.1.3 The Radiation Safety Officer (RSO) Responsibilities and Health and Safety Responsibilities for assigned personnel.

This position reports directly to the Laboratory Director. The person assigned is responsible for establishing and monitoring adequate systems, procedures and training to ensure that the laboratory staff, facilities and operational activities conducted, function in a manner that minimizes employee risk of illness and injury, is compliant with all applicable regulations pertaining to matters of safety and health, and that limits the financial liability of the corporation as it relates to these matters. The RSO/HSO is also responsible for discharging the duties and requirements prescribed by ALS's Radioactive Materials License.

Key responsibilities for Health & Safety include:

- Ensuring that all employees have sufficient training to perform their job without unnecessary risk of illness or injury, providing health and safety training for new employees, and maintaining health and safety-related training records;
- Providing CPR and other similar training to make certain trained staff is on site to respond to emergency situations.
- Procuring necessary Personal Protective Equipment (PPE) to safeguard laboratory personnel.
- Providing procedural guidance in the form of the Chemical Hygiene Plan (CHP), Radiation Protection Plan (RPP), Respiratory Protection Plan (ResPP), Emergency and Contingency Plan (ECP) and Health and Safety SOPs, and ensuring that these guidances are reviewed by laboratory staff;
- Ensuring that the laboratory facilities are maintained and operated in a safe manner, including:
  - Reviewing routine safety inspections of all operational areas;
  - Performing personal monitoring, as indicated, for chemical and other exposures.
  - Conducting monthly Safety Committee meetings, including discussion and resolution of safety concerns
  - Verifying building security

Key responsibilities for RSO include:





- Ensuring that all employees have sufficient training to perform their job without unnecessary risk of illness or injury, providing radiation safety, training for new employees, and maintaining training records;
- Ensuring that the laboratory facilities are maintained and operated in a safe manner, including:
  - Performing routine radiation surveys and managing the radiation dosimetry program; and
  - Performing personal monitoring, as indicated, for chemical and other exposures.
- Maintaining the laboratory's Colorado Radioactive Materials License and ensuring compliance with the terms of the license. Included in this responsibility are:
  - Procuring and managing radioactive sources and standards;
  - Maintaining the laboratory's radioactive materials inventory, which also includes directing prescreen analyses that provide initial characterization of potential sample radioactivity;
  - Overseeing permitted low level radioactive materials releases to the sanitary sewer; and
  - Ensuring that radioactive materials waste is transported in accordance with all Federal and state regulations, and is transferred only to facilities that possess a radioactive materials license.

#### 3.1.4 Laboratory Information Management Systems Manager

The Information Systems (IS) Manager (Manager) reports to the Laboratory Director. This Manager is responsible for administering the network, maintaining data recovery systems, and for managing personal computing (PC) equipment and peripherals, thus supporting instrumentation and LIMS. The IS Manager (and/or designee) is responsible for:

- Managing and maintaining the laboratory computer system. This function includes determining and purchasing appropriate hardware and verifying that its function meets intended objectives, establishing network server structure, and developing and implementing proper maintenance and backup procedures;
- Procuring, configuring and maintaining all printers and copiers;



- Serving as a technical resource on computer-related issues;
- Documenting related operating procedures through SOPs, manuals or other proprietary documentation;
- Supervising recovery of all systems in the event of a disaster;
- Analyzing information flow in the laboratory and suggesting the most effective hardware, applications software, and/or programming changes as solutions to meet long-term customer requirements; also, implementing those changes in data acquisition and management by purchasing hardware or software, where software is not developed internally; and
- Maintaining and implementing existing and future communications systems, including all internet and telephone systems.
- Developing, maintaining, enhancing the Laboratory Information Management System (LIMS), and other data base programs to facilitate and streamline Laboratory operations

### 3.1.5 Project Manager

Project Managers report to the Laboratory Director. *The Project Manager serves as the primary point of contact between clients and ALS.* Client communication procedures and documentation requirements are listed in the ALS SOP 997. Each PM (and/or designee) is responsible for:

- Managing and coordinating the laboratory's performance after contract award, by defining technical and service requirements for personnel via LIMS, and interacting with clients and laboratory personnel to ensure that technical criteria and client service needs are met, including monitoring holding times (if appropriate) and deliverable deadlines, for all project sample analyses;
- Reviewing and approving any non-conformances reported by the laboratory and notifying the client, if appropriate, and communicating with clients pro-actively to ensure that all client service and technical concerns are resolved promptly;
- Reviewing all final reports for completeness, compliance with project requirements, clerical accuracy, and reasonableness;
- Generating, as directed by prompts provided in ALS's EDD generator, and transmitting EDDs to their clients as required;
- Ensure communications with the clients are in compliance with ALS SOP 997 "Client Communication"; and



- Communicating to the Laboratory Director any potential need for new or improved capabilities based on clients' feedback.
- Ensure implementation of quality policy and applicable standards.
- Complete and distribute project related information for each project before the laboratory starts work on the project.
- Immediately communicate to the laboratory changes made to projects in progress and document these changes as appropriate.
- Respond to client requests for information and coordinate responses to client audits.
- Perform an initial review of results for large projects to verify that data reports submitted to the client meet all project requirements

### 3.1.6 Group Leader

- Technical functions such as sample control, preparation, analysis, data management; and quality assurance;
- Monitoring QA/QC standards of performance, including ensuring that corrective actions are developed, documented, and implemented for all external and internal audit Findings, PT study failures, and other corrective actions;
- Monitoring the validity of the analyses performed and data generated in the laboratory to ensure the production of compliant data, including, contributing to and/or overseeing data review processes;
- Ensure that SOPs are compliant with promulgated methodologies and reflect current practice;
- Providing input to the Laboratory Director regarding methodologies, personnel resources, software, and instrumentation; and assisting in the evaluation and/or development of new methods and technologies that improve ALS's ability to meet clients' needs;
- Reviewing RFPs and assisting in the preparation and submission of proposals; and
- Interacting with Quality Assurance, Information Systems, and Health and Safety to ensure that the laboratory is capable of complying with client and regulatory requirements.
- Coordinating and approving the purchase of reagents, standards, glassware, and equipment that meet requirements



- Maintaining current, compliant RVS QC samples for all methods, matrices, analytes, columns, and instruments
- Develop training plans and assigning job tasks and prioritizing analyses;
- Authorize technical staff to perform analyses, including assigning technical SOPs, and providing the QA department with Initial Demonstration of Competency documentation.
- Developing and implementing a preventive maintenance program for instrumentation in their laboratory, and ensuring that all equipment is maintained, serviced, and properly calibrated;

### 3.2 GENERAL TECHNICAL PERSONNEL

A Chemist (Analyst) or technician reports to the Group Leader or Lab Manager. This employee performs work in accordance with ALS's controlled documents (e.g., SOPs, QAM, etc.) and project-specific requirements as defined by the applicable LIMS specification. *ALS believes that quality begins at the bench.* Accordingly, these employees are key contributors to ALS's success.

A chemist or technician is responsible for:

- Demonstrating proficiency in the analyses for which they are responsible and documenting this demonstration of proficiency in accordance with ALS Standard Operating Procedure 150;
- Performing analyses, recording all data accurately, directly, and promptly, and interpreting and reviewing data according to established procedures;
- Read and understand all assigned SOPs and plan documents;
- Follow Quality Assurance requirements as outlined in the QAM and SOPs. Follow appropriate channels regarding modification of existing SOPs.
- Complying with all QA/QC requirements that pertain to their job function;
- Complying with all health, safety, and waste disposal requirements, as applicable;
- Maintaining and repairing instrumentation;
- Demonstrating good house-keeping practices;
- Follow appropriate protocols when the results for QC samples and/or check standards do not meet acceptance criteria. Disclosing all instances of non-conformances promptly and in writing using the NCR process (ALS SOP 928);
- Participating in training sessions.



- Be familiar with current quality systems and policies as established by management. To comply with these requirements, analysts are responsible but not limited to the following;
  - Follow project requirements as delineated by project managers to ensure analyses are performed as requested.
  - Develop knowledge and understanding of the QAM requirements under which samples are analyzed.
  - Notify managers and Quality Assurance personnel when QA problems arise.
  - Ensure that applicable data are included in each data package in accordance with applicable SOPs.
  - Apply integrity and professional judgment when dealing with analytical processes and laboratory operations.

#### 4 DOCUMENT CONTROL

Current copies of pertinent quality assurance guidance documents, such as ALS's QAM, the TNI Standards, ISO 17025:2005, , the US DoD Quality Systems Manual (QSM), AIHA and others, are posted to the ALS intranet so that they are accessible to every employee. Laboratory Standard Operating Procedures (SOPs) and other method references are also posted to the intranet for lab-wide employee access. Project-specific requirements are disseminated to the laboratory via Laboratory Information Management Systems (LIMS) program specifications.

An overview explaining document hierarchy is in ALS SOP 143. ALS SOP 926 provides detailed guidance on the review, revision, and distribution of laboratory-generated controlled documents.

New and revised documents are posted to the intranet to share with all employees. The LIMS notifies personnel of all revised documents. It is the responsibility of all employees to read and update reading records for all assigned controlled documents. Archival records of all document iterations are maintained by the Quality Assurance Department.

This process of revision, approval and distribution is established in the ALS SOP 926. A list of current SOPs is provided in Appendix G. The Quality Assurance Department manages the review, revision and controlled distribution of documents and maintains associated records.

##### 4.1 LABORATORY QUALITY ASSURANCE PLAN



The QAM is an encompassing controlled-document that describes the ALS quality assurance programs and policies. All systems, policies, and procedures have been developed and implemented in accordance with applicable USEPA requirements, regulations, and guidance from current TNI Standard, ISO/IEC 17025:2005, AIHA LAP Policies, DoD QSM and DOE QSAS documents.

This document has been prepared in accordance with these referenced documents, as well as others, cited in the attached Bibliography. The QAM is intended to provide a 'quality requirements framework', including quality control (QC) procedures to be followed in the absence of reference method and project-specific requirements.

The Quality Assurance Manager bears primary responsibility for ensuring that the QAM meets industry standards. Proposed revisions to the QAM are approved by key laboratory personnel.

#### 4.2 STANDARD OPERATING PROCEDURES

The second kind of controlled-document in the hierarchy of quality assurance guidance is the Standard Operating Procedures (SOPs). An SOP defines the QA/QC requirements for each method and describes in detail how personnel perform procedures and evaluate data. SOPs pertaining to general practices, administrative procedures and health & safety requirements are also maintained by ALS QA Department. It is ALS's intent that the information contained in our SOPs is both method-compliant, and accurately reflect actual practice.

#### 4.3 LABORATORY MANAGEMENT INFORMATION SYSTEMS (LIMS) PROGRAM SPECIFICATION

The last and most specific controlled-document in this hierarchy is the LIMS program specification. The LIMS program specification is a distillation of client Quality Assurance Project Plan (QAPjP) or contractual requirements, prepared electronically by the ALS Project Manager (PM), in collaboration with the Quality Assurance Manager and applicable operations management. This custom program specification, along with the associated LIMS test code nicknames, contains directives and controls that govern testing and reporting data. The program specification is often limited in scope and addresses only those QA/QC criteria required for a specific project. When the client's requirements differ from those stated in the SOPs and/or QAM, the project-specific LIMS program specification requirements supersede the others.

### 5 REVIEW OF REQUESTS, TENDERS AND CONTRACTS



Project Managers are responsible for maintaining, archiving, and retrieving all contracts, project requirements and QAPPs provided to ALS by clients and related to projects completed by ALS.. Specific procedures for client communication and required documentation are listed in the ALS SOP 997, "Client Communication."

## **6 SUBCONTRACTING OF TESTS**

ALS strives to identify the need to subcontract specific analytical procedures during the bid response process. Analyses may also need to be subcontracted, however, in cases of emergency where the ability to meet sample holding time criteria is endangered. In these instances, ALS compiles a list of qualified subcontract laboratories that are suitable to perform the needed analyses.

ALS's Project Manager must receive permission from the client, in writing, before the subcontract laboratory can be procured and samples forwarded to the laboratory. See ALS SOP 103 for guidance on evaluating a subcontract laboratory's qualifications. Detailed procedures pertaining to submitting samples to a subcontract laboratory are provided in ALS SOP 103.

Procedures and documentation for using sub-contract laboratories are listed in the ALS SOP 997 "Client Communication." All results provided to ALS by a subcontract laboratory are identified clearly in the analytical report to the ALS client. Under no circumstances will ALS PT samples be sent to a subcontract laboratory.

## **7 PURCHASING SERVICES AND SUPPLIES**

ALS uses vendors which supply the level of quality required to perform testing activities. ALS maintains a relationship with multiple vendors and looks for vendors with comparable certifications or accreditations. The laboratory monitors compressed gases used through system performance (e.g. background, blanks, calibrations criteria, detection limits). Any out of specification compressed gases are documented as nonconformance. Procedures designed to ensure that materials and services purchased meet the quality specifications of ALS delineated in ALS SOP 127.

## **8 SERVICE TO THE CLIENT**

At ALS, improvement of the quality systems and preventative action is effected through an ongoing systems review by management using input for all staff.

ALS actively seeks employee and client input for improvements through surveys and questionnaires. Internally, ALS maintains a process improvement website for employees to provide suggestions for improvements. For clients, ALS surveys and gains feedback on services provided. This input to management is managed at a corporate level.





Project managers are especially involved in the production and assurance of quality results. Client Communication Procedures and documentation requirements are listed in ALS SOP 997.

## 9 COMPLAINTS

The focal point of contact with the client is the ALS Project Manager. If a complaint or any circumstance raises doubt concerning ALS's compliance with its policies or procedures, or with the requirement of a method or quality system, it is the Project Manager who initiates a client inquiry or nonconformance through the ALS LIMS NCR system following the ALS SOP 928. ALS will respond to all complaints in a timely fashion.

## 10 FACILITIES AND EQUIPMENT

**Appendix D** contains a diagram of the ALS laboratory facility. ALS maintains constant and consistent test conditions throughout the facility (e.g., temperature, air purification, and lighting). All entrances and exits are wired to a laboratory-wide security system that is monitored continuously. Access to the laboratory area from the front offices is restricted by means of keypad locks requiring numeric security code entry. Visitors must sign in at the front desk and must be escorted at all times (some vendors are allowed access without continuous escort, in order to facilitate repairs or deliveries). Further details pertaining to building security are provided in **ALS SOP 132**.

The following sections highlight areas of the laboratory that are involved with sample receipt, handling, preparation, and analysis of samples.

### 10.1 SAMPLE RECEIPT AREAS

ALS's sample receiving area consists of a large dedicated room of more than 500 ft<sup>2</sup>. It contains fume extraction and radiation survey equipment to safely handle incoming radioactive and mixed waste samples. There is an outside access door to facilitate sample delivery and shipping of sample kits. Adjacent to the sample receiving area is the bottle storage room and the radioactivity prescreening lab.

### 10.2 SAMPLE STORAGE AREAS

ALS's sample receiving area has a walk-in cooler and a freezer that are used for temporary storage of samples that require thermal preservation. In addition, there are several designated sample storage locations throughout the laboratory that are used to store samples scheduled for specific analyses (see section 11 for further details). An alarm system in the walk-in coolers notifies the Laboratory Manager of any temperature excursions. See ALS SOP 326.





### 10.3 SAMPLE PREPARATION AREAS

The laboratory has seven dedicated sample preparation/extraction/digestion areas: six radiochemistry preparation laboratories, one organics extraction laboratory. Additionally, there are extractions/digestion areas within some analytical labs, including Metals, Wet Chemistry, Fuels, and VOAs. The total floor space of these areas is approximately 4500 ft<sup>2</sup>.

Laboratory preparation procedures are segregated as much as possible to minimize the potential for contamination, maximize processing efficiency, and maintain analytical integrity. Rigorous cleaning of glassware and apparatus ensures that cross-contamination is minimized. Each laboratory area has a dedicated or locally shared HVAC system that continuously exchanges the laboratory air with filtered and conditioned outside air. There are 44 (including Niederman arms) laboratory hoods in the six sample preparation areas, and each sample preparation area has at least one hood. See HSE Hood for specific details related to fume hood monitoring.

### 10.4 STANDARDS PREPARATION AREAS

A dedicated radiochemical standards preparations room and an organics standards preparation area are maintained. Other standards are stored in their respective laboratory areas in refrigeration units, separate from sample storage.

### 10.5 ANALYTICAL LABORATORIES

The ALS facility houses a volatile organics analysis (VOAs) laboratory that is on an upper level of the building, away from all other laboratory operations. The ALS facility also houses one general chemistry (WetChem) laboratory, two radiochemical counting rooms, a total organic carbon (TOC) laboratory area, two gas chromatograph (GC) laboratory area, a semivolatile organic compounds (SVOCs) laboratory, and a metals laboratory that contains separate inductively coupled plasma (ICP), mercury, and inductively coupled plasma/mass spectrometry (ICP/MS) rooms.

### 10.6 OTHER LABORATORY AREAS

Other areas of the ALS facility include a tank room for compressed gasses, several waste management areas, telephone and computer storage rooms, staff offices, Reporting Group and Reports Management data processing rooms, and various scanning/reproduction and supply storage areas.

### 10.7 DEIONIZED WATER SYSTEM

Within the laboratory, there are two main deionized (DI) water distribution systems available for glassware cleaning, bulk reagent preparation, and



general use. One system is located in the janitor's area and serves the radiochemistry side of the facility (ASTM Type II water generated). The other system is located adjacent to the metals laboratory area and serves the stable chemistry side of the facility (ASTM Type I water generated).

ALS SOP 319 provides detailed information pertaining to ALS's DI water systems, including independent testing to verify that electronic readouts of water quality are accurate, maintenance by a vendor contractor, and corrective measures to be taken should water quality degrade to below acceptable limits.

## 10.8 ANALYTICAL EQUIPMENT

ALS maintains an organized maintenance program that is broader than the particular instruments or devices a specific employee may operate or is familiar with. The objective of ALS's equipment maintenance program is to provide a structure of care that prevents quality control failures and minimizes lost productivity that results from equipment malfunction or failure. Within this program are provisions for corrective actions, maintaining spare parts, and a contingency plan in the event of catastrophic failure (e.g., loss of power for a significant period of time).

See Appendix E for a comprehensive list of ALS's equipment.

## 10.9 PREVENTIVE MAINTENANCE

ALS's maintenance program is based on equipment manufacturer's recommendations, operator training guidance, and other considerations.

Provisions for documenting all routine and non-routine instrument equipment maintenance and repairs are also established within the maintenance program.

Responsibilities for applying ALS's maintenance program rests with the department that utilizes the equipment, the Quality Assurance Department bears responsibility for certain support equipment such as balances, weights and temperature measurement devices. Only authorized personnel are permitted to perform maintenance.

In general, ALS performs maintenance as needed (including preventive considerations). Certain aspects of routine maintenance are considered to be 'operational', and are performed each time the instrument is run. Other maintenance is performed 'periodically'. Each instrument operator is responsible for the performance of their own instrument, and may perform maintenance duties at their discretion.



ALS maintains service contracts for most major analytical equipment. Preventive maintenance is included in most of these service contracts.

#### 10.10 EQUIPMENT DOCUMENTATION REQUIREMENTS

Analysts are responsible for maintaining calibration/verification and maintenance records of all instruments and equipment involved in the creation of the analytical data they generate.

Although the manner of record keeping varies, maintenance records provide a clear and complete history of repairs and maintenance associated with the instrument.

Details regarding equipment documentation are also provided in ALS SOP 303. Maintenance Logbooks are reviewed during internal audits.

#### 10.11 SPARE PARTS

An adequate inventory of spare parts is required to minimize equipment downtime. This inventory should include those parts and supplies that:

- are subject to frequent failure;
- have limited useful lifetimes, or
- cannot be obtained in a timely manner should failure occur.

Departments are responsible for maintaining an adequate inventory of necessary spare parts for all major instruments and equipment items. Examples of spare parts maintained for major instrumentation include: septa, inserts, columns, tube fittings, filaments, source parts, and traps.

#### 10.12 SUPPORT EQUIPMENT

ALS defines support equipment as all those devices which are not the primary determinative instrument defined by the analytical method, which support laboratory operations and would contribute to the testing uncertainty. Support equipment includes balances, temperature measurement devices, and mechanical (e.g., Eppendorf™ pipets) volumetric measurement. Support equipment affecting the uncertainty of testing results is verified periodically in accordance with applicable procedures. All verification is directly or indirectly traceable to certified reference standards. The results of the calibration/verification are documented.



Because automatic dispensing devices used to deliver solvents or reagents (e.g., for sample preservation and extractions) are not used to deliver critical volumes, these devices are exempt from daily verification.

Additionally, ALS has procedures for the following support equipment:

- Deionized (DI) water systems ALS SOP 319
- Health physics equipment ALS SOPs 012, 016 and 029
- Mechanical Pipettes, ALS SOP 321.

A statement of Accuracy is acquired from the manufacturer for all glass microliter syringes.

The following ALS SOPs provide additional information about calibration and verification of support equipment:

- ALS SOP 305 -- balance calibration and verification
- ALS SOP 320 -- monitoring and recording of oven temperatures
- ALS SOP 326 -- monitoring refrigerator and freezer temperatures

## 11 SAMPLE MANAGEMENT

### 11.1 SAMPLE CONTAINERS, PRESERVATION, HANDLING, HOLDING TIMES

Although the laboratory is not responsible for sample collection, it is responsible for maintaining the integrity of the sample after receipt. After the sample has been collected, the constituents of the sample must remain as close as possible to the field condition (i.e., degradation must be prevented). The length of time that these constituents will remain stable is related to their character and the preservation method used. Preservation is accomplished by the addition of chemical preservatives and/or storage at a controlled temperature, and by the strict observation of prescribed maximum holding time allowances. Appendix F lists sample container types, preservation requirements, and holding times.

### 11.2 FIELD SUPPORT

ALS provides shipping containers, custody documents, custody seals, clean sample bottles, labels, applicable high-purity chemical preservatives for water samples, and trip blanks to support field-sampling events. Hard-sided, insulated, "picnic" coolers are typically used to transport samples from the field to the laboratory. These coolers meet or exceed all protocol



requirements (i.e., USDOT, USEPA, ASTM) for shipping. ALS SOP 205 provides further information on sample kits.

### 11.3 SAMPLE CONTAINERS

ALS provides certified clean sample bottles for sample collection. Used sample bottles are never used by the laboratory. Containers are stored in clean areas, away from laboratory processes, to prevent exposure to fuels, solvents, and other contaminants.

### 11.4 SAMPLE PRESERVATION AND HOLDING TIMES

ALS provides the required chemical preservatives for water samples. ALS uses high quality reagent grade chemical preservatives (i.e., acids, solutions, etc.) are added to individual sample bottles, as appropriate per method and US Department of Transportation (DOT) requirements. Holding times begin with the collection of samples and continue until analysis is complete. See Appendix F for a summary of container, preservation and holding time requirements specific to various analyses and matrices.

### 11.5 SAMPLE RECEIPT SCHEDULE

ALS receives samples six days of the week, Monday through Saturday. ALS requests that clients ship samples for delivery within one day of collection, and give advance notice to the laboratory regarding shipment of RUSH samples or samples with short hold time requirements. Shipping containers received at the laboratory on holidays or after business hours are placed in a walk-in refrigerator and opened on the next business day, unless other arrangements are made in advance.

### 11.6 CHAIN-OF-CUSTODY

Chain-of-custody (COC) documentation begins with field sampling and continues through laboratory analysis and disposal. A chain-of-custody record that identifies all individuals who handle the sample is used to establish an intact, continuous record of the physical possession, storage, and disposal of collected samples, including their aliquots, extracts or digestates.

To ensure that sample custody objectives of traceability are achieved for every project, the chain-of-custody initiated in the field is continued and maintained internally throughout the laboratory per the requirements specified in ALS SOP 318. Internal chain-of-custody begins with sample acceptance and login. ALS SOP 202 is followed as samples are distributed for use throughout the laboratory and concludes with final sample disposition



ALS applies a unique barcode to each sample bottle received, and maintains several scanners and PCs throughout the laboratory to document and assist with sample, aliquot, extract and digestate movement throughout the facility. This electronic process is accomplished through LIMS, which retains records of all sample and fraction transactions made.

## 11.7 SAMPLE ACCEPTANCE POLICY

ALS' sample acceptance policy requires that a sample meet the following conditions:

- The sample shall be completely documented (sample identification, location, date and time of collection, collector's name, preservation type, sample type, any special remarks concerning the sample);
- The sample shall be identified by a unique identifier using durable labels completed in indelible ink;
- The sample shall be collected in adequate volume;
- The sample shall be collected in an appropriate container;
- The sample shall be delivered to the laboratory with at least one-half the holding time remaining;
- The sample shall not exceed allowed radioactivity levels; and
- The sample shall not show signs of contamination, breakage, or leakage.

Sample receipt discrepancies are documented by Sample Receiving Department personnel on the Condition of Sample Upon Receipt, Form 201 (ALS SOP 008), which is forwarded to the Project Manager as part of the workorder folder. Where samples do not meet the criteria stated above, the Project Manager requests information from the client before proceeding. If the client can provide the information and, in cases of compromised sample integrity, directs the laboratory to proceed, then data acquired from the sample(s) analysis is reported and the problems noted during sample receipt are disclosed in the narrative of the final data report.

In support of the protection of employee health and of ALS's radioactive materials license, ALS observes prescreening protocols that designate or determine samples with radioactive content. Detailed procedures for conducting radiological survey of incoming sample packages are given in ALS SOP 008, further details regarding prescreening protocols are given in ALS SOP 703.

## 11.8 SAMPLE RECEIPT PROTOCOLS



Upon receipt of the field samples at the laboratory, personnel ensure that ALS SOP 202 is followed.

Following sample arrival and initial screen for USDOT compliance and removable radioactivity, sample receiving personnel inspect the sample and record any discrepancies using Form 201 from ALS SOP 008.

Sample temperature is verified upon receipt by measuring the temperature of the temperature blank or by measuring the temperature of a representative sample(s) with an infrared (IR) temperature device. See ALS SOP 210 for instructions and procedures related to IR temperature guns. Samples that require thermal preservation are considered acceptable if the temperature upon arrival is between just above freezing to 6°C. Samples that require thermal preservation but are hand-delivered to the laboratory immediately after collection, may not meet the temperature requirement. If the hand-delivered sample is packed in ice, then Sample Receiving personnel record its temperature and note that the chilling process was initiated.

#### 11.9 SAMPLE STORAGE

Samples requiring thermal preservation are stored in designated refrigerated storage areas that are maintained just above freezing to 6°C. Freezer storage areas are maintained below freezing. The temperature of refrigeration units is monitored continuously using electronic min/max thermometers and recorded each business day, near to the beginning of the work shift. If the temperature exceeds the prescribed range, then corrective action is taken and documented immediately, and the client notified, if appropriate; see ALS SOP 326 for further details. Directives for corrective action pertaining to catastrophic failure of cooling units (as well as laboratory ovens, etc.) are included in ALS's Emergency and Contingency Plan (ECP).

Samples are stored away from all standards, reagents, food and other sources of contamination. Samples are stored in such a manner as to prevent cross-contamination. For example, pure product or potentially contaminated samples are tagged as "hazardous" and stored within a secured area, separate from other samples. ALS provides designated sample storage areas according to the following parameter groups: metals, inorganics (WetChem), semivolatile organics, volatile organics, fuels, and radiochemical analyses.

Samples having suspected radioactive activity and scheduled also for stable chemical analyses are refrigerated. Samples to receive tritium analyses are refrigerated. Samples designated for radiochemistry analyses only, with the exception of tritium, are segregated and maintained at ambient temperature.





To effectively monitor the storage and potential contamination of volatile organic samples, ALS observes a refrigerator blank program as detailed in ALS SOPs 511, 512.

To provide for the safe containment of sample material that could be released as a result of sample container failure, all samples are stored in secondary containment bins. These secondary containment bins are of a sturdy and inert nature, and are sufficient in size to fully contain the sample(s) in the event of a spill, leak or breakage. The bin(s) may be uniquely identified (labeled) to assist in locating samples via the chain-of-custody system. The bins are thoroughly cleaned between uses.

#### 11.10 SAMPLE ACCESS

*It is ALS's policy that neither samples nor data may be released to unauthorized personnel.* In order to ensure that this policy is maintained, the laboratory facilities are maintained under controlled access and are restricted to authorized personnel only (see ALS SOP 132 for further details pertaining to building security).

#### 11.11 SAMPLE HOMOGENIZATION AND SUBSAMPLING

*Obtaining a representative aliquot of sample for testing is critical to the representativeness of the analytical results obtained.* Proper subsampling techniques, particularly for solid matrices, are a component of each bench employee's technical instruction. Sample homogenization procedures prior to radiochemical analysis are prescribed in ALS SOP 736. Representative subsampling procedures for stable chemistry analyses is prescribed in ALS SOP 336. Client and method specified procedures for homogenization or aliquotting may also be defined in the applicable LIMS program specification.

#### 11.12 SAMPLE DISPOSAL

After completion of sample analysis and submission of the project report, unused portions of samples are retained by the laboratory for a minimum of 30 days or as designated by client and contract requirements from date of invoice. Samples are disposed or returned to the client according to the nature of the samples and the client's specifications. ALS documents and retains all conditions of disposal and correspondence between all parties concerning the final disposition of the sample.

Samples, digestates, leachates, extracts, and process waste that are characterized as hazardous, radioactive, or mixed waste are disposed in accordance with Federal and state laws and regulations. ALS maintains records to demonstrate that all disposal efforts were conducted in compliance with these laws and regulations. This documentation includes the unique sample identity, date of disposal, nature of disposal (e.g., sample





depleted, sample disposed in hazardous waste facility, sample disposed in mixed waste facility, sample returned to client); and name of the individual responsible for disposal.

## 12 ANALYTICAL PROCEDURES

ALS is capable of analyzing various matrices, including surface and groundwater, drinking water, soil, sediment, vegetation, tissue, filter and aqueous and solid wastes. Analytical procedures are conducted in strict adherence with SOPs that describe the preparation, analysis, review and reporting of samples. In some cases, these SOPs may also describe proprietary methods developed by ALS and used per the client's request. A list of ALS's analytical capabilities is presented in Appendix F. References for analytical procedures used are presented in the attached Bibliography. ALS also, upon request, develops and validates procedures that are more applicable to a specific client objective.

### 12.1 ANALYTICAL METHODS

Selection of the appropriate method is dependent upon data usage and regulatory requirements. ALS may modify existing methods in order to:

- achieve project-specific objectives;
- incorporate modifications or improvements in analytical technology;
- address unusual matrices not covered in available methods; and
- provide analytical capabilities for an analyte for which there are no promulgated methodologies.

*ALS discloses method modifications to our clients by providing the appropriate SOP for review.*

### 12.2 METHOD COMPLIANCE

Compliance is the proper execution of recognized, documented procedures that are either approved or required. Strict adherence to these procedures is necessary to provide data acceptable to a regulatory body of competent jurisdiction in a specific regulatory context. To ensure method compliance ALS personnel follows SOPs as written and internal audits review methods for regulatory compliance.

### 12.3 NON-STANDARD METHOD VALIDATION



When a non-promulgated method (i.e., methods other than EPA, ASTM, etc.) is required for specific projects or analytes of interest, or when the laboratory develops a procedure, the laboratory must establish the validity of the method prior to extracting or analyzing a client's samples. *Validity is established by meeting criteria for precision and accuracy. See ALS SOP 999 for method validation protocols.*

## 13 MEASUREMENT AND TRACEABILITY

### 13.1 DATA INTEGRITY AND TRACEABILITY

Data Integrity is the extent to which results can be substantiated by hard-copy documentation, electronic or computer-generated data calculations, computer software, and data generation.

Traceability links final numerical results to authoritative measurement standards (reference materials and reference standards) and that which explicitly describes the processing of each sample from receipt to analysis.

### 13.2 SENSITIVITY

The term sensitivity is used in a broad sense to describe the various limits that enable a laboratory to meet project-specific data quality objectives (DQOs). These limit types include: instrument detection limit (IDL), method detection limit (MDL), method quantitation limit (MQL) or method reporting limit (RL), contract-required detection limit (CRDL), and contract-required quantitation limit (CRQL).

### 13.3 LOD (Can be called MDL)

The LOD is a minimum value that addresses the detection capability for the sample preparation procedures and the instrument. Hence, ALS performs ongoing analyses for each preparatory and determinative method combination, matrix, instrument, and analytical column. These analyses of Reporting Limits Verification Samples (RVS) are ongoing in each batch of samples tested. RVS analyses are also required for method validation, and whenever the basic chemistry of a procedure changes.

LOD is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. LODs are determined using ALS SOP 329.

An LOD study is not performed for radiological analyses, or any components for which spiking solutions are not available or relevant (e.g., pH, ignitability, etc.). Reporting limits for these kinds of parameters, where applicable, are established based on the laboratory's knowledge of extraction efficiency, instrument sensitivity, and experience with the procedure.



### 13.4 LOQ (can be called RL)

ALS defines LOQ as the analyte concentration at or above the lowest standard used for calibration and can be routinely demonstrated and achieved.

The LOQ is the lowest level that can be reliably measured by a laboratory with defined limits of precision and bias. The precision and bias at the LOQ is associated with Reporting Limits verification (RVS) samples analyzed.

The LOQ is verified using reporting limit verification samples (RVS) on either a batch basis or periodically scheduled. This RVS is a clean matrix spiked at the LOQ.

### 13.5 MINIMUM DETECTABLE CONCENTRATION (RADIOCHEMISTRY)

The minimum detectable concentration (MDC) is used for radiochemical procedures and is defined as the concentration at which there is a 95% confidence that an analyte signal will be distinguishable from an analyte-free sample.

The general formula for calculating the MDC is based on calculations derived by Curie (Curie, L.A., "Limits for Qualitative Detection and Quantitative Determination," Analytical Chemistry 40(3); pp. 586-693; 1968) and is calculated as follows:

$$MDC = \frac{(4.65 \times \sigma_b) + 2.71}{T * K}$$

where:

MDC = Minimum Detectable Concentration

$\sigma_b$  = Standard deviation of the measurement background

T = Sample count time

K = Factor for incorporating efficiency, abundance, aliquot yield, ingrowth and decay, and activity conversion factors

### 13.6 MEASUREMENT UNCERTAINTY

#### 13.6.1 Analytical Uncertainty

Uncertainty is associated with most of the results obtained in the laboratory testing conducted by ALS. It is meaningful to estimate the extent of the uncertainty associated with each result generated by the laboratory.

It is also useful to recognize that this measurement uncertainty is likely to be much less than that associated with sample collection activities. In practice, the uncertainty of a result may arise from



many possible sources. ALS has considered the relative contribution of major sources of error. The approach adopted by the laboratory to estimate uncertainty resulted in the conclusion that many sources of error are insignificant compared to the processes of sample preparation, calibration, and instrumental measurement. The uncertainty associated with these processes can be estimated from quality control data. Accordingly, ALS estimates uncertainty from data derived from quality control samples carried through the entire analytical process. Each estimate of uncertainty is associated with a specific combination of analytical method and sample matrix.

The ALS Standard Operating Procedure 998 gives details of how uncertainty in the analytical process is estimated, calculated and reported if required.

#### 13.6.2 Total Propagated Uncertainty For Radiochemisry

Total propagated uncertainty (TPU), is a summation of the various uncertainties present in a measurement process, and is an integral part of every reported radiochemical value. TPU, reported as  $\pm$ TPU, is the expressed estimated measure of the total uncertainty inherent in that reported radiochemical result.

The components of the TPU are classified as either random or systematic.

Random uncertainties, also called counting uncertainties (CU), derive from the statistically random (normally distributed) nature of radioactive decay, and are estimated as the square root of the total number of counts acquired during analysis. In cases where the chemical yield is determined by the analysis of a radioactive tracer, the yield uncertainty (YU) is also a random uncertainty, and is estimated as the square root of the total number of tracer counts acquired. CU and YU are calculated in activity units to afford comparability to the sample result.

Systematic uncertainties are attributable to actual errors in the measurement of a physical quantity. For example, if a balance has an accuracy of  $\pm 0.1\%$ , the results of those gravimetric measurements are not normally distributed, but rather are assumed to be biased by that amount. Estimates of systematic uncertainties in laboratory processes are somewhat subjective, but should be supported by empirical data whenever possible. Systematic uncertainties associated with the preparation of a sample are called preparation uncertainties (PU), and are defined based on the number of volumetric and gravimetric measurements, quantitative transfers,



etc. Systematic uncertainties associated with the analysis, called instrument uncertainties (IU), include biases associated with sample positioning, standard values, calibration coefficients, etc. PU and IU are typically provided as a percentage of the final result. To afford comparability to sample results, PU and IU are expressed in activity units by multiplying the percentage by the sample activity (A).

**ALS SOP 708** provides more information about the calculation and use of TPU.

## 14 ASSURING THE QUALITY OF RESULTS

### 14.1 QUALITY ASSURANCE INDICATORS AND OTHER MEASUREMENT PARAMETERS

ALS' objective is the development and implementation of policies and procedures that provide results of known, documented, and appropriate quality. This QAM defines general policies for the analysis, documentation, evaluation, validation, and reporting of data. Specific, detailed procedures for chain-of-custody, calibration of instruments, analysis, reporting, quality control, audits, preventative maintenance, and corrective actions, are provided in SOPs as listed in Appendix G.

The hierarchy of quality control requirements begins with:

- Client Requirements (Program Specifications (LIMS))
- Reference Method and/or SOP requirements
- Guidance from QAM and other general SOPs

*In order to produce data of known, documented, and appropriate quality, ALS:*

- maintains an effective quality assurance program that measures and verifies laboratory performance. This program includes the regular analysis of proficiency testing samples for procedures and methods throughout the laboratory, in adherence with TNI Standard EL-V1M1-2016-Rev.2.1 and Dod/DOE QSM v5.1.1 V1M1.
- evaluates technical and service requirements of all analytical services requests before accepting samples from a client/project. This evaluation includes a review of facilities, instrumentation, staffing, turnaround times, and any project-specific quality control or reporting requirements;
- provides sufficient flexibility to allow controlled changes in routine methodology in order to achieve client-specific data requirements as prescribed in client documents and contracts;



- performs all analyses according to promulgated methods or methods developed and validated by ALS and documented in SOPs;
- recognizes as soon as possible and discloses and corrects any factors that adversely affect data quality; and
- maintains complete records of sample submittal, raw data, laboratory performance, and completed analyses to support reported data.

## 14.2 DATA QUALITY INDICATORS

Data Quality Indicators (DQIs) are qualitative and quantitative statements developed by data users that specify the quality of data from field and laboratory data collection activities in order to support specific decisions or regulatory actions. The DQIs describe *what* data are needed, *why* the data are needed, and *how* the data will be used to address the problem being investigated. DQIs also establish qualitative and quantitative goals that allow the data user to determine whether the data are of sufficient quality for the intended application.

The principal DQIs are **precision, accuracy and bias, representativeness, completeness, and comparability** (i.e., the PARCC parameters). The following sections define and describe the application of these parameters. The QA/QC protocols used for the majority of analyses are adopted from SW-846 and 40 CFR methodologies, the USEPA Organics and Inorganics CLP SOWs, and various radiochemistry guidances, which contain detailed descriptions of the quality control measures routinely employed.

## 14.3 PRECISION

Precision is an expression of the reproducibility or degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions.

Analytical precision is a measurement of the variability associated with duplicate or replicate analyses of the same sample in the laboratory. Analytical precision is determined by the analysis of matrix spike/matrix spike duplicates (MS/MSD), laboratory control sample pairs (LCS/LCSD), or by unspiked duplicate samples (DUPS). Total precision is a measurement of the variability associated with the entire sampling and analysis process, and is determined by analysis of duplicate or replicate *field* samples, thus incorporating the variability introduced by both the field and laboratory operations.

Precision is independent of bias or accuracy, and reflects only the degree to which the measurements agree *with one another*, not the degree to which they agree with the true or accepted value of the parameter measured. Precision for



chemistry analyses is typically expressed as relative percent difference (RPD), as defined below:

$$RPD(\%) = \frac{X_1 - X_2}{(X_1 + X_2)/2} (100)$$

where:

RPD = Relative Percent Difference

X<sub>1</sub>, X<sub>2</sub> = analyte value of sample 1 and sample 2

Precision, for radiochemical analyses, is typically measured in terms of Duplicate Error Ratio (DER), calculated as follows:

$$DER = \frac{|S - D|}{2 * \sqrt{\sigma^2_S + \sigma^2_D}}$$

where:

DER = Duplicate Error Ratio

S, D = analyte values of (S)ample and (D)uplicate

σ = One Sigma error value associated with sample result

RPDs or DERs are compared to the control limits established for the analysis method, or other quality control criteria as prescribed in the applicable LIMS program specification. Precision objectives vary per analytical method. Sample homogeneity/non-homogeneity is an important factor that influences the precision of duplicate sample results.

#### 14.4 ACCURACY and BIAS

Accuracy is agreement between the measured and true (known or accepted reference) value.

Bias describes the systematic error of a measurement process that causes errors in one direction from the true value. Sources of bias include are usually systematic and maybe limitations of the method, matrix or analytical technology. *Bias is **not** equivalent to accuracy.*

Accuracy is typically measured by determining the bias (percent recovery) of known target analytes that are spiked into a field sample or reagent water or simulated solid matrix (laboratory control sample). Surrogate recovery is reported and is used to assess method performance for each sample analyzed for volatile and semivolatile organic compounds. For organic and inorganic parameters, the stated accuracy objectives apply to spiking levels at or near the midpoint of the calibration curve. For radiochemical analyses, the spiking





levels for the control spikes may vary from five to fifty times the method reporting limit.

Percent recovery is calculated as:

$$R(\%) = \frac{(C_1 - C_2)(100)}{C_3}$$

where:

R% = Spike amount recovered

C<sub>1</sub> = Concentration of analyte in spiked sample

C<sub>2</sub> = Concentration of analyte in unspiked sample

C<sub>3</sub> = Concentration of spike added

Acceptance limits are usually based upon established laboratory control samples from similar matrices. Other quality control criteria may be prescribed in the applicable LIMS program specification. Recoveries outside the established limits may indicate some assignable cause other than normal measurement error, and the need for corrective action.

Both bias and precision are calculated for each batch and the associated sample results must be interpreted by considering these specific measures. The quality assurance objectives for precision and bias are to achieve the quality control acceptance criteria specified in the appropriate analytical procedure.

For organic analyses, precision and accuracy are determined by using matrix spike and matrix spike duplicate samples and/or surrogate spike compounds and laboratory control samples. For inorganic analyses, precision and accuracy are determined by using duplicate samples or matrix spike duplicate samples (precision) and matrix spike and laboratory control samples (accuracy). For radiological analyses, precision and accuracy are determined from the results of duplicate samples or matrix spike duplicate samples (precision), laboratory control sample duplicates (precision) and laboratory control samples (accuracy).

QC limits for accuracy and precision are to be developed from intra-laboratory historical data, adopted from prescribed limits required by the client or from the reference method. If quality control acceptance criteria do not exist for a given method, then the laboratory may establish advisory control limits derived from a minimum of four data points. Until verified by a statistically significant data population, the control limits will be considered as advisory limits only, and the laboratory will not automatically initiate reanalysis if these limits are not achieved. See Section 16.2 for further discussion of control limits and control charts.

#### 14.5 REPRESENTATIVENESS





Representativeness is a qualitative element. It expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary.

Sample handling protocols (e.g., holding times, storage, preservation and transportation) have been developed to preserve the representativeness of the samples. Proper documentation establishes that quality control protocols have been followed, and sample identification and integrity are ensured. SUB-sampling is addressed in ALS SOPs 336 and 736.

#### 14.6 COMPARABILITY

Comparability is a qualitative expression of the confidence with which one data set can be compared to another. Comparability is achieved by:

- following established, standardized, and approved sample collection techniques and analytical methods;
- achieving holding times;
- reporting results in common units;
- using consistent detection levels; and
- Reporting data according to consistent rules.

#### 14.7 COMPLETENESS

Completeness is an expression of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. Completeness is the percentage of measurements that are judged to be usable (i.e., that meet project-specific requirements). Completeness goals are defined in the site sampling and analysis plan, QAPjP or contract, and vary with the size and complexity of the project. Completeness goals of 80-95% are traditionally accepted as realistic. ALS's objective is 100% completeness for samples unaffected by matrix interferences.

#### 14.8 QUALITY ASSURANCE PROCEDURES

ALS' quality control program provides a systematic process that enables the laboratory to evaluate and control the validity of analytical results, by measuring and monitoring accuracy and precision by method and matrix; by



developing control limits and using these limits to detect errors or out-of-control events; and by requiring corrective actions to prevent or minimize the recurrence of these events. ALS observes QC procedures to ensure that sample data meet laboratory and client quality objectives.

The purpose of preparing and analyzing QC samples is to demonstrate accuracy and precision of the sample data and performance of the method for the target analytes being investigated. Acceptance criteria may be dictated by reference methods or by project requirements.

For all analyses performed by ALS, the QC concepts and samples described in the following sections are mandatory. Determinative SOPs contain a Table that summarizes the types and frequency of QC samples, acceptance criteria, and corrective actions required.

#### 14.9 DEFINITIONS OF BATCH and BATCH QC SAMPLES

##### 14.9.1 Preparation Batch

A preparation batch consists of as many as 20 field samples of the same or similar matrix that are prepared together by the same analyst(s) within a limited or continuous time period, following the same method, and using the same kind of equipment and same lots of reagents. Additional samples may be added to a batch if the appropriate number and kind of method control samples (e.g., MB, LCS) and matrix-specific QC samples (e.g., MS/MSD, DUP). Cleanup procedures may be included as part of the preparation batch. All field and QC samples in the batch shall be subjected to the same preparation and cleanup procedures. For industrial hygiene samples a Reagent Blank, Method Blank, RVS and duplicate Laboratory Control Samples (LCS/LCSD) are used in each preparation batch.

##### 14.9.2 Analysis Batch

The analysis batch (or sequence) consists of samples, may be multiple preparation batches that are analyzed together within the same or continuous time period, on the same instrument, and processed using the same calibration. Each analysis sequence must contain the appropriate number and kind of standards and samples as defined by the method.

Where no sample pre-treatment (such as extraction or digestion) is required prior to analysis (e.g., analysis of volatile organic compounds, anions analysis by ion chromatography, etc.), the preparation batch and analysis sequence are equivalent.



#### 14.9.3 Preparation Batch QC Samples and Standards – Definition and Use

The results of quality control samples provide an estimate of accuracy and precision for the preparation and analysis steps of sample handling. The following sections describe the QC information provided by each of these analytical measurements.

#### 14.9.4 Method Blank

A method blank (MB) consists of an aliquot of well-characterized, controlled, or certified matrix (e.g., reagent water, Ottawa sand, solid reference material, boiling chips) that is processed through the entire sample preparation, cleanup, and analysis procedure. For radiochemical analyses, a suitable blank solid matrix has not been identified; therefore, reagent water is routinely used for the blank for most solid matrices. The volume or weight of the blank must be approximately equal to the sample volume or weight processed for sample analyses.

The purpose of the MB is to demonstrate that interferences caused by contaminants in solvents, reagents, glassware, and other sample processing hardware, are known and minimized. A method blank should not contain target analytes at or above the reporting limit, unless otherwise permitted in the method. Other maximum blank contamination control criteria may apply, as indicated in the associated LIMS program specification.

While some methods may require background correction, sample results are typically not corrected for blank contamination.

#### 14.9.5 Laboratory Control Sample

A Laboratory Control Sample (LCS) consists of an aliquot of well-characterized, controlled, certified matrix (e.g., reagent water, sand, solid reference material, Teflon™ chips) that is spiked with analytes of interest and processed through the sample preparation, cleanup, and analysis procedure. For industrial hygiene testing the appropriate media is added.

The purpose of the LCS is to provide an estimate of bias based on recovery of the compounds from the clean, controlled matrix, and to demonstrate that the laboratory is performing the method within accepted guidelines without potential non-matrix interferences.

Where sample pretreatment is not required, such as with ion chromatography or gamma spectroscopy analysis, or the analysis of



volatile organic compounds, the ICV standard or other appropriate control standard may be employed as the LCS.

An LCS for methods with extensive lists of analytes that may interfere with one another may include a limited number of analytes, but the analytes included must be representative of as many analytes as is practical.

Other client-specific QC requirements may be prescribed in the applicable LIMS program specification.

#### 14.9.6 Matrix Spike/Matrix Spike Duplicate

A matrix spike (MS) or matrix spike duplicate (MSD) is a field sample to which known concentrations of target analytes are added before the sample is processed. The purpose of MS/MSD samples is to assess the performance of the method for a particular matrix and to provide information about the sample's homogeneity. Results of the MS/MSD samples are evaluated in relation to the method QC samples to determine the effect of the matrix in regards to accuracy and precision. Sample results are not corrected for MS/MSD excursions.

For some analyses, changing the composition of the sample in any way invalidates the analysis to be performed (e.g., hardness, alkalinity, pH). Therefore, an MS/MSD pair cannot be generated for these analyses. Normally, duplicate sample aliquots are analyzed in order to generate an estimate of the method's precision.

Other client-specific quality control requirements may be prescribed in the applicable LIMS program specification. The requirements set forth in the LIMS program specification supersede those stated in the method, SOP or Quality Assurance Manual.

Not applicable for industrial hygiene and ambient air testing.

#### 14.9.7 Sample Duplicate

A sample duplicate (DUP) is a second representative portion of sample that is carried through the preparation, cleanup and analysis process. Results for the duplicate sample are compared to the initial sample analysis results as a means of evaluating precision. For organic analyses, the MS/MSDs fulfill this function. The degree of sample homogeneity directly impacts the integrity of the sample duplicate analysis.



Not applicable for industrial hygiene and ambient air testing.

Precision criteria for sample duplicate analyses are those prescribed in the reference method and/or SOP, unless otherwise superseded by client-specific requirements contained in the applicable LIMS program specification.

#### 14.9.8 Surrogates

Surrogates are organic compounds that are similar to the target analytes, but are unlikely to be present in actual field samples. They are introduced into all field and QC samples in a batch prior to sample preparation, and provide an estimate of bias based on recovery of similar compounds, for a given extraction technique and analysis method combination. Sample results are not corrected for surrogate recoveries.

Acceptance criteria for surrogates are those prescribed in the reference method and/or SOP, unless otherwise superseded by client-specific requirements contained in the applicable LIMS program specification.

#### 14.9.9 Chemical Yield Monitors or Isotopic Tracers

Chemical yield monitors are used in radiochemical analyses and provide information similar to the surrogate spikes discussed above. The primary difference between a chemical yield monitor and a surrogate is that sample results are corrected for chemical yield recoveries and not corrected for surrogate recoveries. A chemical yield monitor is a substance that has similar chemical characteristics as the parameter being measured. It is introduced into all field and QC samples in a batch during the preparation procedure. Chemical yield monitors provide information regarding the performance of a method on a sample-by-sample basis.

Chemical yield monitors are evaluated against established laboratory control limits. These ALS default control limits may be superseded by other quality control criteria specified in the applicable LIMS program specification.

### 14.10 CONTROL LIMITS

#### 14.10.1 Control Limits

Control limits for each controlled analyte are calculated, and can be updated, using ALS's LIMS. The recovery values from all data processed within a specified date range are used to calculate the control limits and compile the control chart if needed.



The upper and lower control limits of the control chart are designated as the value equal to the average recovery plus or minus three times the standard deviation (i.e., 99% confidence interval). The upper and lower warning limits for the control chart are designated as the value equal to the average recovery plus or minus two times the standard deviation (i.e., 95% confidence interval).

Control limits are updated as needed (e.g., acquisition of a sufficient number of data points to establish meaningful control limits for a newly implemented method; if deemed appropriate as a result of a corrective action investigation; etc.).

Control Limits are reviewed quarterly for trends only and on an annual basis to determine changes to control limits, if any. NO changes are made to current control limits if no changes are detected in the following process.

Current recoveries are compared to current mean and standard deviation of the current control limits. Any changes greater than 10% of the mean and 25% of the standard deviation are evaluated by operations as candidates for updating control limits. The decision rests with operations as instructions on how to proceed are given to QA personnel.

The update requires the review by operations to determine why changes are warranted. The review is needed to assess why a method/analyte combination is experiencing change. This operational review has options but is not limited to the following:

- Operations can request an update of control limits for the method/analyte combination based on evaluation that process changes have improved to steady state.
- Operations can request that control limits not be updated in order to review the current procedure to determine what procedural changes have taken place.
- Operations can request an update based on a specific set of data that is known to be valid based on the procedure.
- Operations can request control limits be reset to method limits based on evaluation that a steady state has not been reached.
- Operations can request no changes because current limits adequately reflect the current uncertainties in method performance



All data for processing and decisions on updating are maintained by the QA department.

#### 14.10.2 Outlier Rejection

For the generation of quality control data that monitor the laboratory's performance, it is essential to prevent spurious or erroneous data from being incorporated. It may be necessary to reject data as an outlier to prevent an adverse effect on the values being calculated.

#### 14.10.3 Trend Evaluation

In addition to evaluating individual batch QC results against control limits, QC results from successive batches can also be evaluated for possible trends. See section 16.2.

### 14.11 SECOND COLUMN OR SECOND DETECTOR CONFIRMATION

Second column or detector confirmation is performed for several GC methods. Whenever two dissimilar chromatography columns or two detectors of a different nature are available for a given method, the laboratory performs second column or second detector confirmation analysis to confirm the identity of target analytes in field samples. When second column analysis is performed for any chromatography technique, the following policies apply:

- Every attempt will be made to calibrate the second (confirmatory) column in the same manner as the quantitative (primary) column. The same initial and continuing calibration standards will be analyzed on the confirmation column in the same manner as the quantitation column. The purpose of this dual calibration requirement is to allow the possibility of reporting quantitative results from the confirmation column if interferences on the primary column prevent accurate target analyte quantitation.
- For chromatographic techniques, the determination of target analytes in a sample depends solely on peak retention times observed in both primary and secondary column chromatograms. If target analyte peaks are present at the proper retention times in both confirmation and quantitation column chromatograms at levels above the LOD, then ALS considers this analyte to be confirmed.
- In general, ALS reports a single value from the two columns based on client requirements. In the absence of client requirements ALS reports the higher value of the two columns.





If no interferences are present, and an analyte's value from either the primary or secondary column is greater than the reporting limit but between the MDL and the reporting limit on the other column, then ALS reports the higher value that is greater than the reporting limit for that analyte.

#### 14.12 MANUAL RE-INTEGRATION POLICIES AND PROCEDURES

Many data collection systems allow the analyst to reprocess data, thereby allowing for the manual re-integration of analyte peaks. ALS makes every attempt to optimize peak integration parameters; however, manual reprocessing of data must be performed to correct a data system's integration errors (e.g., incorrect or missed peak assignment, over- or under-integration of area). Manual re-integrations may not be performed solely to meet initial or continuing calibration criteria or any QC criteria (e.g., tuning, or surrogate or spiking compound recovery). Whenever a manual integration is performed, the analyst must follow manual integration procedures given in ALS SOP 939.

### 15 CONTROL OF NON-CONFORMING ENVIRONMENTAL TESTING WORK

#### 15.1 ALS NONCONFORMANCE AND CORRECTIVE ACTION PROCESS

Non-conformances are reported (documented) electronically through a LIMS interface that is available to all staff. The individual who discovered the problem or deviation is responsible for initiating the next sequential NCR in LIMS. Note that in addition to documenting laboratory sample or test issues, NCRs are also used to address client inquiries (where appropriate) and complaints.

As described in ALS SOP 928, the processing of the NCR flows from the initiator, to their Group Leader and the relevant Project Manager(s), and finally to the Quality Assurance Manager. In this manner, an evaluation of significance and a decision on data recall, stop work and client contact can be made.

The Project Manager records any problem- related contact with clients in the NCR system.

The review of NCRs by the Quality Assurance Manager that are determined as a reoccurring systemic event or significantly against ALS policy or procedure will be addressed as a corrective action.

### 16 CORRECTIVE ACTION, PREVENTIVE ACTION, AND IMPROVEMENT





## 16.1 CORRECTIVE ACTION

Corrective actions are required for external audit findings, internal audit findings and when NCR requires corrective action as stated above.

### 16.1.1 Corrective Action Definition

A corrective action used to eliminate systematic and reoccurring events. Corrective actions include a determination of cause, selection of appropriate corrective actions, and monitoring to ensure effectiveness. Corrective actions are required for nonconforming events discovered during internal and external audits or when NCR is reoccurring or against ALS Policies and Procedure.

### 16.1.2 Root Cause

Root cause is a process to determine the cause of an error. Proper root cause analysis is the key to a successful process and sometimes the most difficult part in the corrective action procedure. Often the root cause is not obvious and thus a careful analysis of all potential causes of the problem is required. The root cause process followed must reflect the severity of the problem identified.

### 16.1.3 Documentation

All corrective actions require written documentation of events, root cause, immediate and permanent corrective actions. When corrective actions are applied there must be monitoring for effectiveness. Quality Assurance keeps maintains a database of all corrective actions.

## 16.2 PREVENTIVE ACTIONS

ALS defines preventive actions as any event that will eliminate real and potential nonconformance.

ALS maintains service contracts (preventive maintenance, repair) for most major analytical equipment. ALS performs preventive maintenance on current equipment on an ongoing basis and these events are recorded in maintenance logs.

Preventive Action using instrument performance and/or control charts is encouraged by analysts to help prevent noncompliant QC situations from occurring.



While a trend is not necessarily an out-of-control situation in itself, its detection can provide an early warning of a condition that might later cause the system to go out of control. Trending can be used to monitor calibrations, equipment, reagents, and various other routine processes in the laboratory. ALS analytical SOPs describe in detail the assessment of batch and sample QC data in the laboratory.

The following conditions are trends or conditions that can initiate action and/or monitoring.

- A series of seven successive points on the same side of the mean
- A series of five successive points going in the same direction
- A cyclical pattern of QC sample results
- Two successive points between warning limits and control limits

ALS relies on analytical staff to identify trends in analytical systems and processes. Quality Assurance and laboratory personnel can produce control charts as needed to help assess trends but this activity in itself is not preventive and is only used to verify trends exist. The occurrence of a trend does not invalidate data that are otherwise in control. However, trends do require attention to determine whether a cause can be assigned to the trend so that appropriate preventive action can be undertaken before the system goes out of control.

Long term trends in control limits are evaluated yearly by Quality Assurance as per section 14.10 and technical operations as described below on an ongoing basis.

#### 16.2.1 Process for identification of trends in QC data

Control limits are guides used for data evaluation. Verifying that QC sample values are not trending ensures that the method may continue to be used for the analysis of field samples. If a trend appears in the analytical QC data, field sample data for samples analyzed with the QC samples might also be trending in the same manner.

A trend in method QC data might be indicated if one or more of the following situations exist:

- A series of seven successive points on the same side of the mean
- A series of five successive points trending in the same direction
- Two consecutive points outside of warning limits

To identify a trend in surrogate, tracer and carrier recovery data, all values for a preparation batch must be evaluated collectively as a



single event, since the values were generated during the same preparation event. Trends should be evaluated between preparation batches and not on any single sample.

LIMS can provide control charts for review. It is the responsibility of the analyst to review data for trends.

#### 16.2.2 Evaluation of Significance

After a trend has been identified, the significance of the trend must be evaluated. An individual trend in data might, or might not, be a cause for action, particularly in the case of a single analyte in a multi-analyte method.

Examples:

- 1) Seven points (values of 97% – 100%) on the same side of the chart mean (value of 96%), with a warning limit at 104% and a control limit at 109%.  
Evaluation: Consistent data, less than one standard deviation from the chart mean. No action required.
- 2) Five successive points (values of 88% – 96%) moving in the same direction, with a chart mean of 94% and an upper control limit of 109%.  
Evaluation: Data moving across the chart mean, within one standard deviation from the chart mean, data are in the middle of the performance range of the method. No action required, but continue to monitor
- 3) Five successive points (values of 94% – 107%) moving in the same direction, with a chart mean of 94% and an upper control limit of 109%.  
Evaluation: Data moving away from the chart mean, nearing the control limit. Action should be implemented to keep the procedure from going out-of-control.

If data exhibit a sufficiently significant trend to require action, the cause of the trend should be investigated and determined.

Questions to be considered in the evaluation of a data trend and the determination of the cause of the trend might include (but are not limited to) the following:

- Is this trend representative of the entire method?



- Is this trend limited to a single analyte in a multi-analyte method?
- Is this trend exhibited in the data of several analytes in a multi-analyte method, and is the same general trend observed for each analyte?
- What is the time period of the trend (i.e., a week, several weeks, several months)?
- What changes in the analytical system have occurred during the time period to which the trend applies?
- Are new personnel involved?
- Is different instrumentation involved?
- Were new or different standard solutions introduced?
- Was there a change in the analytical protocol or method?
- Has instrument sensitivity or response changed dramatically?
- Has instrument maintenance been performed recently?
- Have there been any changes in method reagents (i.e. brand, lot)?
- Have there been any matrix effects carried over from difficult samples?

#### 16.2.3 Assignment of Significance

Following the identification of a data trend (as indicated above) and the evaluation of the trend for significance, a decision should be made that the level of significance does or does not require action.

At the time of quality control sample data evaluation, the evaluator should make a decision based upon personal judgment. Criteria can determine whether a trend exists, but judgment should be used in the determination of the significance of that trend.

If the data trend is determined to not pose a threat to the quality of immediate and future analytical data, or does not reasonably indicate that the analytical method might begin to produce data that could be anomalous, the level of significance is INSIGNIFICANT.

If the data trend is determined to not pose a threat to the quality of immediate analytical data such that no action is required, but does possibly indicate that the analytical method may begin to produce data that could be anomalous, the level of significance should be MONITORED by technical personnel.

If the data trend is determined to possibly or reasonably pose a threat to the quality of future analytical data, and reasonably indicates that the analytical method may begin to produce data that could be anomalous, the level of significance is SIGNIFICANT, and actions must be initiated to prevent out of control events.



### 16.2.4 Resolution Procedure

Following identification of a trend and an assignment of a level of significance, future action regarding the trend must be determined. If a data trend is evaluated as significant, laboratory personnel responsible for data trend evaluation must promptly inform all analysts involved in work related to the significant trend that the trend exists and that action must be initiated to prevent its reoccurrence and correct it.

All activities related to a significant trend will be documented in normal analysis records.

Laboratory personnel are required to initiate action to correct a significant data trend related to their work.

The trending guidelines used by ALS are in the following table. In many instances experienced chemists will identify trends and take action upon reviewing analytical data (i.e. control charts may not be necessary).

GUIDELINE	DESCRIPTION
Above Warning Limits	Two of three data points above warning limits
Below Warning Limits	Two of three data points below warning limits.
Above Mean	Seven consecutive data points above the mean
Below Mean	Seven consecutive data points below the mean
Ascending Data	Seven consecutive data points in ascending direction
Descending Data	Seven consecutive data points in descending direction

16.2.5 Procedure for producing Control Charts to verify trends are present  
 This procedure is available if verification of trends is needed.

- LIMS Main Menu
- From Quality Assurance Menu



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- Select Compile Control Limits



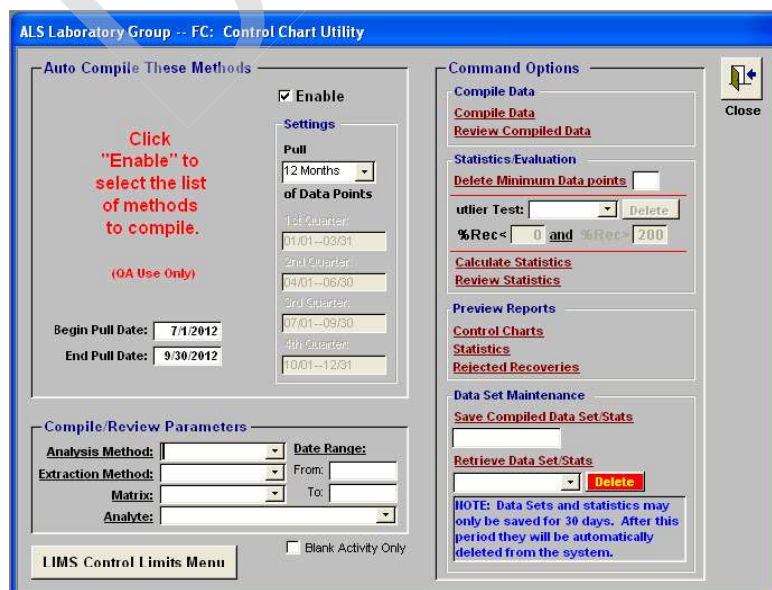
### Compile Control Utility Menu

In the Compile/Review Parameters Box:

Select Analysis Method, Extraction Method, Matrix, Analyte and Date Range (Use no more than the last 12 months)

In the Command Option Box (In Sequence)

Compile Data  
Calculate Statistics  
Control Charts





**Compile/Review Parameters**

<b>Analysis Method:</b>	SW8081	<b>Date Range:</b>	
<b>Extraction Method:</b>	SW3520	From:	01/01/2012
<b>Matrix:</b>	LIQUID	To:	07/25/2012
<b>Analyte:</b>	4,4'-DDE		

**Command Options**

**Compile Data**

[Compile Data](#)

[Review Compiled Data](#)

**Statistics/Evaluation**

[Delete Minimum Data points:](#) ☐

**Outlier Test:**  [Delete](#)

**%Rec <**  **and %Rec >**

[Calculate Statistics](#)

[Review Statistics](#)

**Preview Reports**

[Control Charts](#)

[Statistics](#)

[Rejected Recoveries](#)

### 16.3 IMPROVEMENT

At ALS, improvement of the quality systems is effected through an ongoing systems review by management using input from all staff.

ALS actively seeks employee and client input for improvements through surveys and questionnaires.

Internally ALS maintains a process improvement website and database for employees to provide suggestions for improvements and to record actions by managements.

For clients, ALS surveys and gains feedback on services provided. This input to management is managed at a corporate level.

### 16.4 MANAGEMENT OF CHANGE

The Management of Change, SOP 995, is a process designed to minimize risks from significant change to laboratory management, facilities, process and testing scope. The potential risks are minimized through pre-planning and preventive measures. The type of changes covered under this process includes:

- Facility Changes (Major construction or renovation)





- Management Changes (Key personnel)
- Testing Scope (New technologies)
- Management Requirements and Systems (New management standard changes)
- LIMS changes (Structure, format and software)

## 17 CONTROL OF RECORDS

### 17.1 RECORDS AND DATA STORAGE

Records provide the direct evidence and support for the necessary technical interpretations, judgments, and discussion concerning laboratory results. These records, particularly those that are anticipated to be used as evidentiary data, provide the historical evidence needed for later review and evaluation. Records must be legible, identifiable, and retrievable. They must be protected against damage, deterioration, fire, theft, vermin, and loss. Though only 5-year retention is required by TNI, ALS retains all records for a minimum of seven (7) years, or as otherwise specified per the client's contract.

Laboratory records include the following kinds of documentation:

- personnel qualifications, experience, and training;
- correspondence between ALS and clients;
- quality assurance records (e.g., retired SOPs and Quality Assurance Manuals, PT study results, internal and external audit reports and responses);
- contents of laboratory logbooks;
- equipment maintenance records;
- traceability of standards, solvents and reagents;
- instrument checks and calibrations;
- raw data;
- final data reports; and
- sample management records (e.g., sample login, field and internal chain-of-custody, storage, disposal).

### 17.2 ELECTRONIC RECORDS

ALS employs a multi-level system that addresses both the frequent backup of sample results (in LIMS) and the periodic backup of raw data (from both networked and non-networked instruments). Additionally, the software that ALS uses for these backups, contains a disaster recovery module that allows





for the complete recovery of the backup database, in its entirety. See ALS SOPs 1403 and 1401 for additional information.

### 17.3 TRANSFER OF RECORDS

In the event that the laboratory changes ownership, the responsibility for the retention of records in accordance with the guidelines established in this Quality Assurance Manual, is conferred to the new owner. Should ALS go out of business, ALS will inform our clients in writing of this business decision, and that the transfer of records to the client must be in compliance with state, regulatory and legal records retention times.

### 17.4 TRAINING RECORDS

Technical and quality assurance training records are maintained on network servers by the Quality Assurance Department. Health & Safety training records are also maintained on network servers. Training records are designated for storage using the ALS SOP 150.

## 18 AUDITS

All non-conformances from internal and external audits require corrective action as per section 16.1.

### 18.1 INTERNAL AUDITS

Internal audits include both technical and systems audits, and are performed periodically per an annual schedule developed and maintained by the Quality Assurance Department.

All internal audits are conducted by QA staff or designees who, by experience, are deemed to be knowledgeable in the area assessed. Reports of nonconformance and opportunities for improvement are completed monthly by the Quality Assurance Manager.

See **ALS SOP 937** for additional information pertaining to internal audit procedures.

### 18.2 EXTERNAL AUDITS

External audits may be performed by a state or Federal agency or a client as part of an ongoing certification or client process. Items evaluated by external assessors may include, but are not limited to, reviews of the following: analytical capabilities and procedures; COC procedures; document control; quality systems; and QC procedures.

## 19 MANAGEMENT REVIEW



A Managerial Review is performed annually. The Managerial Review assesses operational effectiveness in terms of meeting ALS's business goals. It is a tool used to document and facilitate the consideration and introduction of needed operational changes and improvements.

The Managerial Review is performed the laboratory director. The contents of the annual Managerial Review are considered to be confidential.

Inputs to the Managerial Review may include, but are not limited to the following:

- suitability of policies and procedures;
- reports from managerial and supervisory personnel;
- outcome of recent internal audits;
- corrective and preventive actions;
- assessments by external bodies;
- results of interlaboratory comparisons or proficiency tests;
- changes in the volume and type of the work;
- customer feedback;
- complaints;
- recommendations for improvement;
- other relevant factors, such as quality control activities, resources and staff training.

The laboratory director is responsible for action plans that are documented in an annual summary report of all item listed in above. This summary report will include the actions initiated from management review and outcomes or effectiveness of previous actions.

## 20 PERSONNEL

The selection of well-qualified personnel is a factor that contributes to ALS's success. Therefore, qualifications of personnel are based upon education and experience. In order to maintain qualified staff, provide personnel advancement within the laboratory, and to provide for personnel's ongoing awareness of potential hazards and protective measures, ALS follows a program of orientation and training. Records of all training are maintained by the Quality Assurance Department in accordance with ALS SOP 150.

### 20.1 ORIENTATION

New employees receive a four-part orientation as described below:

- Human resources -- involves matters of immediate personal concern, such as benefits and company policies



- Quality assurance -- addresses topics related to ethical conduct, good laboratory practices and ongoing documentation of employee capability demonstrations. Required readings (SOPs, Quality Assurance Manual) are assigned at this time. See ALS SOP 143.
- Health & safety -- provides for a review of ALS's various safety program documents (Chemical Hygiene Plan, CHP; Radiation Protection Plan, RPP; Emergency and Contingency Plan, ECP; Respiratory Protection Plan, ResPP; Waste Management Plan, WMP); as well as other safety and security training such as the Alstar/Induction training.
- Department functional orientation -- focuses on the new employee's basic understanding of their role within the overall role of Operations within the structure of ALS. The department training expands upon the employee's scientific background and work experience to provide the employee with a level of competence that enables the individual to successfully function within the defined responsibilities of his/her position.

Temporary employees receive the same orientation as regular staff, with the exception of the human resources orientation.

## 20.2 TECHNICAL TRAINING

Chemists (analysts) and technicians are qualified to perform specific analytical procedures and methods. Technical management and quality management authorize employees to perform testing activities. The qualification process is detailed in the ALS SOP 329.

## 21 REPORTING OF RESULTS

### 21.1 DATA REDUCTION, VALIDATION AND REPORTING

Data transfer and reduction are essential functions in summarizing information to support conclusions. It is essential that these processes are performed accurately and are followed by multiple reviews before data are submitted to the client. All analytical data generated by ALS are extensively reviewed for accuracy and completeness. The data validation process consists of data generation, reduction, and multiple levels of review, as described below.

### 21.2 DOCUMENTATION OF RAW DATA

Where possible, raw data are captured and processed electronically using verified software programs (see ALS SOPs 709 and 1400 for further information regarding software verification).



To facilitate manual documentation of raw data (where suitable LIMS benchsheet interfaces do not yet exist), ALS creates custom logbooks as per ALS SOP 303.

The manually recorded raw data are entered into the laboratory logbook directly, promptly, and legibly in indelible ink. All raw data entries must be in compliance with ALS SOP 303.

Raw data not only includes instrument outputs, but sample preparation, standard materials documentation, and equipment maintenance information as well. Raw data is archived electronically.

### 21.3 CORRECTION OF ERRORS IN DOCUMENTS

During the course of processing and reviewing sample preparations and analysis results, it may be necessary to correct documentation errors. Detailed requirements for the correction of manual documentation errors are prescribed in **ALS SOP 303**

### 21.4 DATA REDUCTION

ALS analysts perform data reduction. This process consists of interpreting instrument results and verifying calculated concentrations in samples from the raw data. The complexity of the data reduction is dependent on the specific analytical method and the number of discrete operations involved in obtaining a measurement (e.g., digestions, dilutions, cleanups, concentrations). The analyst calculates the final reportable values from raw data or enters all necessary raw data into the LIMS so that the LIMS can calculate the final reportable values.

Data are reduced according to protocols described in SOPs and method-specific review checklists. Computer software used for data reduction is validated before use and verified regularly by manual calculations.

Copies of all raw data and the calculations used to generate the final results, as recorded in hardbound laboratory notebooks, spreadsheets, electronic data files and LIMS record files, are retained in the project file to allow reconstruction of the data reduction process.

### 21.5 REPORTING OF SAMPLE RESULTS

Sample results are reported either on an “as-received” basis, or in units of dry-weight measure. The number of significant figures reported is consistent with the limits of uncertainty inherent to the analytical method. In most cases, results are reported to no more than two or three significant figures. Analytical problems, and/or any modifications of referenced methods are noted in the data package case narrative.



## 21.6 DATA REVIEW

ALS employs multiple levels of data review. All data generated and reduced follow review protocols specified in laboratory ALS SOPs 052 and 715, method-specific checklists and the applicable SOPs.

Each step of the review process involves evaluation of data quality based on both the results of the QC data and the professional judgment of those conducting the analysis and/or review. This application of technical knowledge and experience to the evaluation of the data is essential in ensuring that data produced are consistently of known, documented, and appropriate quality.

## 21.7 PROCEDURES FOR HANDLING UNACCEPTABLE DATA

When an analysis of a QC sample (e.g., MB, LCS, CCV, etc.), indicates that the associated samples do not meet requirements, the analyst must immediately initiate a NCR as per ALS SOP 928.

If the non-compliant data cannot be corrected, then the affected results must be flagged as discussed below, and the discrepancy disclosed in the data package case narrative.

## 21.8 DATA REPORTING

Data reports contain final sample results, the methods of analysis used and limits of detection, and QC data. The extent of supportive data included (e.g., benchsheets, run logs, calibration data, instrument raw data printouts, etc.), is contingent upon the type of report contracted by the client. Results of subcontracted data are clearly indicated as subcontract laboratory results when incorporated into the final data package report. Data reporting is specified by project managers in the corresponding program specification in LIMS.

### 21.8.1 Facsimile or Imaged Reports

For projects that require rapid turnaround of sample analysis results, the laboratory may provide a facsimile or imaged e-mail attachment to the client, followed by the full data report at a later date. If the analysis results provided by facsimile or imaged e-mail attachment have undergone the same review processes followed for final data packages, then this forwarded report indicates that the sample analysis results are final. However, if the accelerated turnaround time requirements preclude a full review/validation of the sample data, then the report is marked as "PRELIMINARY" to indicate that results may change as the review process is completed.



## 21.8.2 Hardcopy Data Packages

The format and content of a data report is dependent upon project specifications, and it is beyond the scope of this document to describe project-specific report requirements. In the absence of client-specified data package deliverables, the following sections describe the items that must be included in all data reports.

### 21.8.2.1 Cover Letter

Items contained in the cover letter include:

- the client's name and address;
- ALS's name and address, name of contact and telephone number;
- a tabular presentation of field/client sample ID, ALS Sample ID, date received, matrix, and date collected. This item is typically presented as an attachment, the Sample Cross Reference Table;
- a list of each analysis performed and total number of pages for each analytical report;
- identification of all test data provided by a subcontract laboratory;
- a discussion of previously submitted or partial reports that pertain to the samples discussed in the current report; and
- the signature of ALS's Project Manager or designee.

### 21.8.2.2 Report Format

Analysis reports are presented in tabular format, and consistent significant figures and units of measurement are used. The following information is included in each report:

- laboratory name, client name, project name and/or number;
- client/field sample ID and ALS sample ID;
- date of sample receipt, date and time of sample collection, and date/time of sample preparation and/or analysis;
- sample matrix;
- reporting units and identification of whether the sample results are reported on an "as-received" or dry weight basis;
- method reference for the parameter analyzed and method reporting limits;



- identification of numerical results with values below the method reporting limit;
- case narrative that identifies test methods, describes any deviation from the method or contractual requirements, additions or exceptions to the SOP, and discloses any conditions that may affect the quality of the results;
- identification of sample results that did not meet sample acceptance criteria;
- footnotes or qualifiers referenced to specific data (as applicable) and explanations or keys to flags and abbreviations used;
- surrogate and tracer recoveries, where applicable;
- where applicable, a statement of the estimated uncertainty of the test result; and
- a signature and title, or equivalent electronic identification, of the personnel who accepts responsibility for the content of the report, and the date of issue.

Results calculated between the MDL and the LOQ (RL) contains significant amounts of error. Therefore, values reported between the LOD and LOQ(RL) are qualified as estimated – 'J' flagged for organic parameters, 'B' flagged for inorganic parameters. Also, LOD values are based on an interference-free matrix, and cannot evaluate the effects of sample matrix. Therefore, established LODs may not be achievable in some environmental matrices.

If a report is reissued, the amendments must clearly state that the report is reissued. The cover letter and case narrative must describe why the report has been reissued and which sample results have been reissued.

#### 21.8.2.3 QC Reports

Each final report may include QC reports that summarize results from the associated LCS, MB, and matrix QC samples. Additional QC samples may be prepared and reported to comply with project-specific requirements.

#### 21.8.2.4 Data Qualifiers – Flagging Codes





Whenever the data quality objectives of the Quality Assurance Manual are not met, the associated sample results must be flagged with the appropriate flagging codes.

Other flagging practices may be observed if so dictated by the applicable LIMS program specification.

#### 21.8.3 Electronic Data Deliverables (EDDs)

The electronic data deliverables generated by the laboratory are project-specific and are produced in a format specified by the client.

*Information presented in corresponding fields of the hardcopy report and EDD are identical as both are generated from LIMS.* Before submitting the EDD file, the Project Manager or designee verifies that the EDD is complete and meets the client's format requirements. All EDDs are submitted to the client on computer disks or are transmitted electronically.

#### 21.9 CONFIDENTIALITY

All laboratory results and associated raw data are confidential and may not be released to or discussed with any party other than the client who requested the analytical services.

ALS requires that auditors honor our clients' and ALS's confidentiality requirements, and will not discuss any results, documents, or records viewed during the course of an audit.

Confidentiality is included as a component of ALS's ethics training, which is provided to each person as they join the ALS staff, and annually, as a refresher training, thereafter.

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Appendices are available upon request. All current documents are available on ALS On-Line. The documents listed in this section are dynamic; accordingly they can change without notice or revision to this QAM.

APPENDIX A – GLOSSARY, ACRONYMS AND SYMBOLS GLOSSARY

APPENDIX B – Organization Charts and Key Personnel Qualifications

APPENDIX C – Ethics and Data Integrity Policy

APPENDIX D – Laboratory Floor Plan

APPENDIX E – Analytical and Support Equipment

APPENDIX F – Containers, Preservation and Holding Times

APPENDIX G – Master List of Controlled Documents

APPENDIX H – Data Qualifiers

APPENDIX I – Laboratory Accreditations

APPENDIX J – Calibration and Method QC Requirements

APPENDIX K – Chain of Custody

APPENDIX L – List of Services

## Attachment E

# Rocky Mountain Greenway Trail Crossings Soil Sampling Results Report

*Prepared for:*

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**and**

**City of Boulder**

**Boulder County**

**City and County of Broomfield**

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Project No. 110836

February 5, 2020

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## **1.0 INTRODUCTION**

In May 2016, Jefferson County Open Space, the City and County of Broomfield, City of Arvada, City of Westminster, Boulder County, and the City of Boulder (collectively referred to as the “Partner Group”) submitted an application to the Federal Lands Access Program (FLAP), a funding source administered by the Federal Highway Administration (FHWA), to construct two trail crossings. The trail crossings will link planned trail improvements at the Rocky Flats National Wildlife Refuge (Refuge) with existing Partner Group trail infrastructure adjacent to the Refuge (Figure 1-1). The locations of the proposed trail crossings under Colorado Highway 128 (CO-128) and over Indiana Street are shown in Figures 1-2a and 1-2b. This project is part of the broader Rocky Mountain Greenway (RMG) Trail initiative, a regional trails project to connect Front Range federal lands (Rocky Mountain Arsenal National Wildlife Refuge, Two Ponds National Wildlife Refuge, Rocky Flats National Wildlife Refuge, and Rocky Mountain National Park) via a multiuse path. Information on the RMG Trail initiative is available at <https://rockymtngreenway.org>.

In August of 2016, FHWA notified the Partner Group of shortlist funding status and requested that the soil sampling and testing be completed before project scoping, design and construction begin. In fall 2017, the Partner Group issued a Request for Proposal (RFP) to perform the confirmatory soil sampling and analysis (the “Project”). Engineering Analytics, Inc. (EA) of Fort Collins, Colorado was awarded the Project by the Partner Group. Phase I of the Project was to develop a Sampling and Analysis Plan (SAP) to document the procedural and analytical requirements of this onetime collection of soil samples. The SAP is provided in Appendix A.

The goal of this Project is to collect radionuclide data for soils along the proposed trail crossings that can be compared to the data, findings, and conclusions of the Comprehensive Risk Assessments published in Appendix A of the Resource Conservation and Recovery Act (RCRA) Facility Investigation – Remedial Investigation/Corrective Measures Study – Feasibility Study Report (the “RI/FS Report”) (Kaiser-Hill Company, 2006). The potential risks to recreational visitors using the Refuge trail crossings can be estimated by linking the Project results to the results of the 2006 studies.

### **1.1 Background**

A comprehensive discussion of the Rocky Flats Plant operational history and its subsequent remediation is beyond the scope of this document. The following provides a brief summary of the recent history of the site. More information on the history of Rocky Flats can be found in the SAP in Appendix A. Detailed information on the site, including documents describing the site characterization and remediation, are available at [https://www.lm.doe.gov/rocky\\_flats/sites.aspx](https://www.lm.doe.gov/rocky_flats/sites.aspx).

After nuclear weapons components production ended, the Rocky Flat Plant’s mission changed to cleanup and closure, and it was renamed the Rocky Flats Environmental Technology Site. During the characterization process, the site was divided into 12 physical exposure units (EUs) based on geography and proximity to sources (Figure 1-3). In October 2005, the United States Department of Energy (DOE) and its contractor, Kaiser-Hill, completed an accelerated 10-year,

\$7 billion cleanup of chemical and radiological contamination in production buildings and limited areas across the site.

The DOE Office of Legacy Management (LM) assumed operations and maintenance responsibility of the site in 2005 and received final jurisdiction in 2008. Following cleanup, two operable units (OUs) defined the site within the boundaries of the property:

- OU 1. Central OU
- OU 2. Peripheral OU

OU 1 is roughly equivalent to the Industrial Area EU (Figure 1-3), although OU 1 extends slightly into the Upper Walnut Drainage EU to the north and the Upper Woman Drainage EU to the south. The Peripheral OU includes most of the site and generally encompasses the portions of Rocky Flats surrounding the Central OU.

The final remedy for OUs 1 and 2 was selected in the September 29, 2006 Corrective Action Decision/Record of Decision (CAD/ROD) (USEPA, 2006). The CAD/ROD determination(s) was based on the results of the July 2006 RI/FS and Comprehensive Human Health and Ecological Risk Assessment (Kaiser-Hill Company, 2006). The 2006 CAD/ROD determined that no action was required for the Peripheral OU given its intended future use.

The Peripheral OU was transferred to the U.S. Department of the Interior in July 2007 to be managed by the United States Fish and Wildlife Service (USFWS) as the Rocky Flats National Wildlife Refuge. Additional DOE administered lands (745 acres) on the site's west side were transferred to the Refuge in 2014. The existing approximately 11-mile long trail system within the Refuge opened to the public in September 2018. The USFWS plans to construct additional trails on the Refuge that will connect to the Rocky Mountain Greenway via the two highway crossings that are the subject of this Project (Figures 1-2a and 1-2b).

## **1.2 Previous Soil Characterization**

The radionuclides of interest for the Project are select isotopes of americium (Am-241), plutonium (Pu-238 and Pu-239/240), and uranium (U-234, U-235, and U-238). Note that laboratory analyses in previous studies may have reported some of these isotopes differently (e.g., U-233/234, U235/236). The activity of the radionuclides of interest were characterized in each exposure unit in the RI/FS Report Appendix A (Kaiser-Hill Company, 2006). Summary statistics for the americium, plutonium, and uranium isotopes from surface soil samples in the two exposure units (Rock Creek Drainage EU and Wind Blown Area EU) intersected by the proposed trail crossings that are the subject of this Project are reproduced from the RI/FS Report in Tables 1-1 and 1-2.

Review of the radionuclide data for surficial soil samples collected within the Rock Creek Drainage EU in the 2006 RI/FS database indicates that samples were collected from depths of 0 to 2 inches to 0 to 6 inches. Approximately 60 percent of the data from samples in the Rock Creek Drainage EU were collected from the 0 to 2-inch depth interval.

Review of the radionuclide data for surficial soil samples collected within the Wind Blown Area EU in the 2006 RI/FS database indicates that samples were collected from the surface to depths

ranging from 0 to 1 inch to 0 to 6 inches. Approximately 40 percent of the data were from samples collected from the 0 to 2-inch depth interval, with the next largest group being from the surface (approximately 28 percent).

Within these two exposure units, the RI/FS Report indicated that the highest levels of the radionuclides were found in the Wind Blown Area EU (Table 1-2). The Wind Blown Area EU is located east, or generally downwind of, the Industrial Area EU (Figure 1-3). The proposed bridge over Indiana Street is located adjacent to the Wind Blown Area EU. It is important to note that the boundaries of the Wind Blown Area EU extend from the shared boundary with the Industrial Area EU eastward to Indiana Street and that the general trend is for radionuclide activities to decrease eastward (away) from the Industrial Area EU towards the Bridge Crossing location. For the two exposure units investigated for this project, historic Pu-238 data were only published in the RI/FS Report for the Wind Blown Area (Table 1-2).

**Table 1-1 Summary Statistics for Surface Soil Samples in the Rock Creek Drainage Exposure Unit (Underpass Crossing Location along CO-128)**

Summary Statistic	Am-241	Pu-238	Pu-239/240	U-233/234	U-235	U-238
Total Number of Results	37	-	50	39	39	39
Minimum Activity	-0.00738	-	-0.00602	0.343	-0.109	0.417
Maximum Activity	0.95	-	7.25	2.17	0.466	1.83
Arithmetic Mean Activity	0.0613	-	0.222	1.07	0.0641	1.11
Standard Deviation	0.16	-	1.02	0.362	0.113	0.311

Notes:

1. Activity in pCi/g.
2. All values were considered "detected."
3. Blank cells indicate that data were not published in the 2006 RI/FS.
4. Source: Kaiser-Hill (2006), Appendix A, Volume 4 of 15, Table 1.4.
5. Surface soils defined in Kaiser-Hill (2006), Appendix A, Volume 1 of 15 as soils present from 0 to 0.5 feet.

**Table 1-2 Summary Statistics for Surface Soil Samples in the Wind Blown Area Exposure Unit (Bridge Crossing Location along Indiana Street)**

Summary Statistic	Am-241	Pu-238	Pu-239/240	U-233/234	U-235	U-238
Total Number of Results	279	9	307	193	192	193
Minimum Activity	0	0.102	-0.00292	0.119	-0.0431	0.351
Maximum Activity	15.6	1.53	49	7.96	0.68	3.78
Arithmetic Mean Activity	1.86	0.447	9.44	1.12	0.0827	1.12
Standard Deviation	2.44	0.454	12.1	0.799	0.0922	0.454

Notes:

1. Activity in pCi/g.
2. All values were considered "detected."
3. Source: Kaiser-Hill (2006), Appendix A, Volume 9 of 15, Table 1.5.
4. Surface soils defined in Kaiser-Hill (2006), Appendix A, Volume 1 of 15 as soils present from 0 to 0.5 feet.

The RI/FS report also provided estimates for background levels of radionuclides in surface soils at the site. These background levels were calculated based on the mean plus two standard deviation (M2SD) and were presented in the RI/FS Report (Kaiser-Hill Company, 2006). Background values for the americium, plutonium, and uranium isotopes from the RI/FS Report are reproduced in Table 1-3.

**Table 1-3 Sitewide Surface Soil Background Radionuclide Activities**

<b>Am-241 (pCi/g)</b>	<b>Pu-239/240 (pCi/g)</b>	<b>U-233/234 (pCi/g)</b>	<b>U-235 (pCi/g)</b>	<b>U-238 (pCi/g)</b>
0.022	0.066	2.25	0.095	2.00

Source: RI/FS Report Table 3.9 (Kaiser-Hill Company, 2006).

A background level for Pu-238 was not included in the referenced RI/FS Report table.

### 1.3 Summary of Risk Assessment

The two crossings are located primarily on lands just outside the Peripheral OU (Figures 1-2a and 1-2b). For the purposes of this Project the radiological characterization of the exposure unit from Kaiser-Hill (2006) abutting the proposed crossing location is considered applicable to the soils within the footprint of the proposed crossings (Tables 1-1 and 1-2).

The RI/FS report presented a Site Conceptual Model (SCM) that provided an overview of potential human exposures at Rocky Flats (Kaiser-Hill, 2006). The following discussion is taken primarily from that document.

Rocky Flats was divided into 12 Exposure Units (EUs) (Figure 1-3) to assess potential risks for human and terrestrial ecological receptors and 7 Aquatic EUs (AEUs) for assessing potential risks for aquatic ecological receptors. As described in Section 1.2, the EUs germane to the project are:

- The Wind Blown Area Exposure Unit, representing Crossing Location E (proposed bridge over Indiana Street).
- The Rock Creek Drainage Exposure Unit, representing Crossing Location D (proposed box culvert underpass below CO-128).

The EUs were designated based on known sources and potential contaminant release patterns to collectively assess areas with similar types of potential contamination. Other criteria used in distinguishing the EUs included watershed boundaries, similar topography and vegetation, and expected land use.

The SCM assumed that the future land use for Rocky Flats would be as a wildlife refuge and, as such, human populations who may be present included a wildlife refuge worker (WRW) and a wildlife refuge visitor (WRV). Workers may staff a visitor center, monitor and maintain the trail system, and track the on-site wildlife populations. Visitors may hike, bike, bird watch, etc. on the Refuge. WRW receptors were assumed to be adults, while WRV receptors were assumed to include both adults and children.

Both workers and visitors were assumed to theoretically contact contaminants present in surface soil, subsurface soil, sediment, surface water, and groundwater. All exposure pathways included in the SCM were identified as complete (meaning that exposure through the pathway is at least theoretically possible). In addition, the pathways were identified as either significant or insignificant. Insignificant pathways were those that are associated with such low exposure that there would be negligible risk even if exposure occurred. The significant pathways were evaluated on an EU basis and risk calculations were only performed for significant pathways in the individual EUs. However, pathways considered to be insignificant were evaluated to ensure that the pathways are appropriately identified as such.

The following exposure pathways were identified as potentially complete and significant in the 2006 RI/FS SCM:

- Surface Soil/Sediment:
  - Incidental ingestion of surface soil/surface sediment.
  - Inhalation of dust released from surface soil/surface sediment.
  - Dermal exposure to surface soil/surface sediment.
  - External irradiation exposure from surface soil/surface sediment.
- Subsurface Soil/Sediment:
  - Incidental ingestion of subsurface soil/subsurface sediment.
  - Inhalation of particulates released from subsurface soil/subsurface sediment.
  - Dermal exposure to subsurface soil/subsurface sediment.
  - External irradiation exposure from subsurface soil/subsurface sediment.

In the first step of the human health risk assessment (HHRA), the levels of potential contaminants of concern (PCOCs) in each EU were evaluated to assess whether a quantitative assessment of risks needed to be conducted. Only those parameters that were retained for the risk assessment were identified as contaminants of concern (COCs). The above pathways were quantitatively characterized for an individual EU if a COC(s) was identified.

As described in the HHRA, COCs were identified for surface soil/surface sediment in the Wind Blown Area EU (Plutonium 239/240 was the only radionuclide identified as a COC). However, no COCs were identified for surface soil/surface sediment in the Rock Creek Drainage EU. Consequently, a quantitative risk characterization for subsurface soil/subsurface sediment was not performed for the Rock Creek Drainage EU. In addition, COCs were not identified for subsurface soil/subsurface sediment in any EU. Therefore, quantitative risk characterization for subsurface soil/subsurface sediment was not performed.

The HHRA presented two exposure point concentrations (EPCs) estimates, Tier 1 and Tier 2, for the COCs at Rocky Flats. Briefly, EPCs are an estimate of COC concentrations to which people may be exposed. For the Rocky Flats HHRA, the Tier 1 concentration was calculated as the 95<sup>th</sup>



percent upper confidence limit (UCL) on the average (mean) concentration within an EU. The 95<sup>th</sup> percent UCL is defined as the value that equals or exceeds the true mean with 95 percent confidence. As described in the HHRA, if most of the data for an EU have been collected in areas associated with historic releases, and few data points are available for the non-impacted areas, the Tier 1 EPC is likely to overestimate the concentration for the EU as a whole. Therefore, Tier 2 EPCs were calculated in a manner that equally weighs the data for different subareas of an EU. In this approach, averages are first calculated for 30-acre subareas of an EU. These averages are then combined to calculate an EU-wide average. In areas where the data are evenly spaced throughout an EU, there are only minor differences between the Tier 1 and Tier 2 EPCs.

As stated above, Plutonium 239/240 was the only radionuclide identified as a COC. Radiological dose estimates were developed for the HHRA using the RESRAD software which was used to evaluate all applicable exposure pathways at a site (Kaiser-Hill Company, 2006). The Tier I plutonium dose estimate for the WRW is 0.3 mrem/yr and for the WRV child it is 0.2 mrem/yr. These dose estimates are well below the acceptable annual radiation dose of 25 mrem specified in the Colorado Standards for Protection Against Radiation (CDPHE, 2005). A summary of cancer risks and dose estimates for WRW and WRV receptors in the Wind Blown Area EU is presented in Table 1-4.

**Table 1-4 Summary of Human Health Risk Estimates from Plutonium 239/240 in the Wind Blown Area Exposure Unit (Bridge Crossing Location along Indiana Street)**

Wildlife Refuge Worker (WRW)				Wildlife Refuge Visitor (WRV)			
Excess Lifetime Cancer Risk		Annual Dose Rate (mrem)		Excess Lifetime Cancer Risk		Annual Dose Rate (mrem)	
Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2
$2 \times 10^{-6}$	$9 \times 10^{-7}$	0.3	0.2	$1 \times 10^{-6}$	$6 \times 10^{-7}$	0.2 (child) 0.07 (adult)	0.1 (child) 0.04 (adult)

Source: Table ES8, Volume 1 of 15, Appendix A, Kaiser-Hill (2006)

The cancer risk estimates were at the lower end of EPA's risk range of  $1 \times 10^{-6}$  (one in a million) to  $1 \times 10^{-4}$  (one in ten thousand). The Department of Energy (DOE, 2017) Five Year Review Report for Rocky Flats Site report provides a summary of the plutonium concentrations associated with the risk ranges. A summary of these results is provided in Table 1-5.

**Table 1-5 Summary of Pu-239/240 PRG Comparison for Wildlife Refuge Worker (DOE, 2017)**

Wildlife Refuge Worker (WRW)			
Risk Level	$1 \times 10^{-4}$	$1 \times 10^{-5}$	$1 \times 10^{-6}$
Isotope			
Pu-239	929.0 (pCi/g)	92.9 (pCi/g)	9.3 (pCi/g)
Pu-240	931.0 (pCi/g)	93.1 (pCi/g)	9.3 (pCi/g)

## **1.4 Report Organization**

This report is organized in the following manner:

- Section 2 provides a description of the soil collection and analytical processes
- Section 3 provides a summary of the Project results
- Section 4 provides an evaluation of the Project results by comparing them to historic data
- Section 5 presents a summary of the Project and provides EA's conclusions

References cited in the report are provided in Section 6. Copies of the laboratory analytical reports are provided in Appendix B. Electronic Data Deliverables (EDDs) provided by the laboratory in Microsoft Excel file format were transmitted to the Partner Group with this report.

## 2.0 DATA COLLECTION

The sample design, sample collection, and laboratory analyses processes are described in this section.

### 2.1 Sample Design

EA used the software Visual Sample Plan (VSP) developed by the Pacific Northwest National Laboratory to estimate the number of samples at each crossing location. Information on VSP can be obtained at <http://vsp.pnl.gov>.

#### 2.1.1 Bridge Crossing (Indiana Street)

The disturbed area associated with the Indiana Street bridge (Crossing E) is approximately 312,533.5 ft<sup>2</sup>, or approximately 7.17 acres. EA input the Plutonium-239/240 summary statistics for the 307 historic surface soil samples from the Wind Blown Area EU (Table 1-2) into VSP to assess the number of samples to characterize the Bridge Crossing location. The VSP software calculated that 17 samples would be required at the Bridge Crossing location (one sample per 0.42 acres). The sample density within the Bridge Crossing disturbed area is much greater than that within the 715 acre Wind Blown Area EU (one sample per 2.33 acres).

Based on the relative sizes of the disturbed areas on either side of Indiana Street, EA collected three of the samples from the area on the west side of Indiana Street and 14 samples from the area on the east side of Indiana Street. One sample location in each disturbed area was located near the anticipated terminus of the bridge (i.e., samples E1 and E4). The remaining sample locations were distributed throughout the footprint of the disturbed areas and selected using the random number function in Excel. The sample locations are shown on Figure 1-2a.

#### 2.1.2 Underpass Crossing (CO-128)

The disturbed area associated with the CO-128 underpass (Crossing D) is approximately 192,359 ft<sup>2</sup>, or approximately 4.4 acres. EA input the Plutonium-239/240 summary statistics for 50 surface soil samples from the Rock Creek Drainage EU (Table 1-1) into VSP to assess the number of samples to characterize the Underpass Crossing location. The VSP software calculated that eight samples would be required at the Underpass Crossing location (one sample per 0.55 acres). The sample density within the Underpass Crossing disturbed area is much greater than that within the 735 acre Rock Creek Drainage EU (one sample per 14.7 acres).

Based on the relative sizes of the disturbed areas on either side of CO-128 (Figure 1-2b), EA collected two of the samples from the area on the south side of CO-128 and six samples from the area on the north side of CO-128. One sample location in each disturbed area was located on the CO-128 embankment near the proposed tunnel openings (i.e., D2 and D3). The remaining sample locations were distributed throughout the disturbed areas and selected using the random number function in Excel.

## **2.2 Sample Collection**

EA personnel collected 25 (plus 2 duplicate) soil samples over three consecutive days (July 1-3, 2019). Per the SAP (Appendix A), EA obtained soil samples from an approximate 4-inch by 4-inch area. Prior to collecting the sample, EA personnel removed vegetation from the surface taking care to strip soil clinging to plant roots, to the extent practical, letting the soil fall back onto the area to be sampled. Using a stainless-steel trowel, EA personnel then excavated the soil from within the cleared 4-inch by 4-inch area to a depth of 2 inches (5 cm), placing the excavated material in a stainless-steel bowl. EA personnel then mixed the soil in the bowl, while removing larger rocks and organic fragments. EA personnel then placed aliquots of the soil into two clean, glass jars. The glass jars were supplied by ALS Global Laboratories (ALS), the environmental laboratory chosen to conduct the analyses. One jar was for the primary sample ("01" sample suffix) and the second jar was for an archive sample ("99" sample suffix). EA also collected one duplicate soil sample ("DUP" sample suffix) per crossing location. One deviation from the SAP (Appendix A) is that EA personnel did not field sieve the samples. The field sieving step was omitted because the abundant precipitation in the spring and early summer 2019 resulted in damp soils which made field sieving impractical. Consequently, sample sieving was performed in the laboratory by ALS (Section 2.3).

EA decontaminated reusable sampling equipment between locations using an initial Liquinox (soap) solution wash followed by a deionized water rinse. EA personnel generated one equipment rinsate blank (ERB) sample ("03" sample suffix) per crossing location to document the decontamination process. Three liters of water from the final deionized water rinse were collected for each ERB and placed in clean bottles provided by ALS. The deionized water for the ERB was provided by ALS. The sample bottles were pre-charged by ALS with nitric acid as a preservative.

EA personnel hand-delivered all samples to the ALS Fort Collins, Colorado facility following chain-of-custody protocol. A summary of the primary, duplicate, and ERB samples collected by EA and logged into the ALS laboratory information management system (LIMS) is provided in Table 2-1.

**Table 2-1 Sample Summary**

Sample Location	Lab Sample ID	Field Sample ID	Date and Time Collected		Matrix	Sample Type
CO-128 (Underpass) Crossing Samples						
D1	1907016-15	D1G-070119-0-2-01	07/01/2019	11:25	SOIL	Primary
D2	1907016-13	D2G-070119-0-2-01	07/01/2019	11:15	SOIL	Primary
D3	1907016-11	D3G-070119-0-2-01	07/01/2019	10:40	SOIL	Primary
D4	1907016-5	D4G-070119-0-2-01	07/01/2019	09:45	SOIL	Primary
D4	1907016-19	D4G-070119-0-2-DUP	07/01/2019	09:45	SOIL	Duplicate
D5	1907016-1	D5G-070119-0-2-01	07/01/2019	08:50	SOIL	Primary
D6	1907016-3	D6G-070119-0-2-01	07/01/2019	09:05	SOIL	Primary
D6	1907016-20	D6G-070119-ERB	07/01/2019	09:30	WATER	Rinsate
D7	1907016-9	D7G-070119-0-2-01	07/01/2019	10:20	SOIL	Primary
D8	1907016-7	D8G-070119-0-2-01	07/01/2019	10:05	SOIL	Primary
Indiana Street (Bridge) Crossing Samples						
E1	1907083-3	E1G-070219-0-2-01	07/02/2019	09:15	SOIL	Primary
E2	1907083-1	E2G-070219-0-2-01	07/02/2019	08:45	SOIL	Primary
E3	1907016-17	E3G-070119-0-2-01	07/01/2019	13:40	SOIL	Primary
E4	1907103-25	E4G-070319-0-2-01	07/03/2019	11:25	SOIL	Primary
E5	1907583-9	E5G-070319-0-2-01	07/03/2019	15:30	SOIL	Primary
E6	1907083-5	E6G-070219-0-2-01	07/02/2019	11:20	SOIL	Primary
E7	1907103-11	E7G-070319-0-2-01	07/03/2019	15:40	SOIL	Primary
E8	1907103-7	E8G-070319-0-2-01	07/03/2019	14:15	SOIL	Primary
E9	1907083-9	E9G-070219-0-2-01	07/02/2019	12:00	SOIL	Primary
E10	1907083-7	E10G-070219-0-2-01	07/02/2019	11:30	SOIL	Primary
E10	1907083-11	E10G-070219-0-2-ERB	07/02/2019	11:45	WATER	Rinsate
E11	1907103-5	E11G-070319-0-2-01	07/03/2019	14:00	SOIL	Primary
E12	1907103-13	E12G-070319-0-2-01	07/03/2019	09:20	SOIL	Primary
E13	1907103-1	E13G-070319-0-2-01	07/03/2019	08:40	SOIL	Primary
E14	1907103-3	E14G-070319-0-2-01	07/03/2019	09:00	SOIL	Primary
E15	1907083-17	E15G-070219-0-2-01	07/02/2019	15:55	SOIL	Primary
E16	1907083-14	E16G-070219-0-2-01	07/02/2019	14:20	SOIL	Primary
E16	1907083-16	E16G-070219-0-2-DUP	07/02/2019	14:20	SOIL	Duplicate
E17	1907083-12	E17G-070219-0-2-01	07/02/2019	13:50	SOIL	Primary

Note:

1. An archive soil sample (Field Sample ID with a "99" suffix) was collected by EA at each sample location and provided to the laboratory for storage.

The 25 Project sample locations are illustrated on Figure 1-2a and Figure 1-2b. Coordinates for each sample location are provided in Table 2-2. Table 2-2 also indicates the exposure unit from the 2006 RI/FS Report that the Project sample locations are associated with.

**Table 2-2 Soil Sample Breakdown by Exposure Unit**

Soil Sample Location	Longitude	Latitude	Associated RI/FS Exposure Unit	Direction from Highway
<b>CO-128 (Underpass) Locations</b>				
D1	-105.2035513	39.91340039	Rock Creek Drainage	South of CO-128
D2	-105.2033968	39.91349648	North of Rock Creek Drainage	South of CO-128
D3	-105.2033341	39.9138168	North of Rock Creek Drainage	North of CO-128
D4	-105.2049252	39.91388086	North of Rock Creek Drainage	North of CO-128
D5	-105.2058481	39.91388726	North of Rock Creek Drainage	North of CO-128
D6	-105.2052343	39.91401539	North of Rock Creek Drainage	North of CO-128
D7	-105.2036515	39.91407625	North of Rock Creek Drainage	North of CO-128
D8	-105.2043072	39.91407945	North of Rock Creek Drainage	North of CO-128
<b>Indiana Street (Bridge) Crossing Locations</b>				
E1	-105.1660554	39.89186207	Wind Blown Area	West of Indiana St
E2	-105.1662455	39.89152196	Wind Blown Area	West of Indiana St
E3	-105.1661718	39.89135237	Wind Blown Area	West of Indiana St
E4	-105.1649799	39.89180645	East of Wind Blown Area	East of Indiana St
E5	-105.1649846	39.89157849	East of Wind Blown Area	East of Indiana St
E6	-105.1648141	39.89120155	East of Wind Blown Area	East of Indiana St
E7	-105.1645021	39.89192863	East of Wind Blown Area	East of Indiana St
E8	-105.1644498	39.89165235	East of Wind Blown Area	East of Indiana St
E9	-105.1644552	39.89142713	East of Wind Blown Area	East of Indiana St
E10	-105.1644576	39.89127486	East of Wind Blown Area	East of Indiana St
E11	-105.1640957	39.89157667	East of Wind Blown Area	East of Indiana St
E12	-105.1635562	39.89180043	East of Wind Blown Area	East of Indiana St
E13	-105.1632038	39.89149826	East of Wind Blown Area	East of Indiana St
E14	-105.1630232	39.89172384	East of Wind Blown Area	East of Indiana St
E15	-105.1629031	39.89185113	East of Wind Blown Area	East of Indiana St
E16	-105.1624905	39.89164706	East of Wind Blown Area	East of Indiana St
E17	-105.1623089	39.89179733	East of Wind Blown Area	East of Indiana St

Notes:

1. Latitude and Longitude approximate. Coordinate system is GCS North America (1984).

## 2.3 Laboratory Analysis

ALS Global Laboratories (ALS) performed the radionuclide analyses in their Fort Collins, Colorado facility. ALS processed the samples using proprietary Standard Operating Procedures (SOPs). The SOPs that ALS applied to the Project samples are summarized in Table 2-3.

**Table 2-3 Summary of ALS Soil Sample Preparation Methods**

Document Number	Document Title	Revision Number
<b>Soil Samples</b>		
SOP 736	Representative Laboratory Subsampling – Radiochemistry	1
SOP 751	Actinides – Americium/Curium Separation – Purification by TRU <sup>TM</sup> and TEVA <sup>TM</sup> Spec Column	6
SOP 768	Rapid Method for Sodium Carbonate Fusion - Uranium, Plutonium and Americium	0
SOP 773	Total Dissolution of Solids for the Radiochemical Determination of Actinides and other Non-Volatile Radionuclides	12
SOP 777	Actinides – Thorium, Americium and Plutonium Sequential Separation by Ion Exchange	13
SOP 778	Actinides - Uranium, Plutonium and Americium/Curium (Partial) Sequential Separation by Ion Exchange	14
<b>Water (Equipment Rinsate Blank) Samples</b>		
SOP 776	Preparation of Water Samples for Actinides	14

ALS has served as the analytical laboratory for numerous Rocky Flats related projects for more than 20 years and, as such, has utilized the SOPs shown in Table 2-3 to produce radionuclide data for a variety of researchers. The ALS soil sample preparation sequence for the Project samples is described below and summarized in Figure 2-1.

Upon receipt, ALS processed the raw soil samples per ALS SOP 736, *Representative Laboratory Subsampling – Radiochemistry*. In brief, the samples were dried at 105±5°C for a minimum of 16 hours, sieved through a #4 (4.75 mm) sieve, and then milled. During milling, an approximate 60-gram aliquot of the dried and sieved soil sample was machine shaken in a half-pint steel canister containing 5 half-inch steel ball bearings for 15 minutes. This milling process produces an approximate 200-mesh powder (silt and clay size) that facilitates dissolution of the sample matrices in the subsequent steps (ALS SOPs 768 or 773). Following the milling process, ALS split the samples into thirds – one for EA analysis, one for archive, and one for third party analysis.

For carbonate fusion, ALS digested the soil samples per ALS SOP 768, *Rapid Method for Sodium Carbonate Fusion - Uranium, Plutonium and Americium*. Tracers (e.g., Am-243, Pu-242, and U-232) are added to the sample at the beginning of the process and the digestion of approximately 1-gram aliquots is performed in a 100 ml platinum crucible. The sample is initially treated with concentrated HF acid and evaporated to dryness. A dry flux mixture of potassium carbonate, boric acid and sodium carbonate is subsequently added to the dry sample and the mixture is heated using compressed air until melted. The mixture is cooled and then re-dissolved in concentrated nitric acid. A subsequent ferric hydroxide step is performed to co-precipitate the actinides with iron hydroxide (ALS SOP 777).

For the acid digestion, the milled samples are digested via a multi-step process using ALS SOP 773, *Total Dissolution of Solids for the Radiochemical Determination of Actinides and other Non-Volatile Radionuclides*. Tracers (e.g., Am-243, Pu-242, and U-232) are added to the sample at the beginning of the process and the digestion of approximately 1- to 2-gram aliquots is accomplished using alternating nitric, hydrochloric, and hydrofluoric acids. A subsequent ferric hydroxide co-precipitation is performed to pre-concentrate plutonium and to remove constituents that do not form hydroxides (ALS SOP 777).

Americium, plutonium, and uranium were separated and purified from the digested/fused samples via ALS SOP 778, *Actinides – Uranium, Plutonium and Americium/Curium (Partial) Sequential Separation by Ion Exchange*. For Am-241 only, this step was followed by ALS SOP 751, *Actinides – Americium/Curium Separation – Purification by TRU<sup>TM</sup> and TEVA<sup>TM</sup> Spec Column*. The final step of these processes involves the purified isotope(s) being co-precipitated with lanthanum fluoride, the precipitate being retained on a filter membrane, and the membrane being mounted on a planchet for quantification by alpha spectroscopy via ALS SOP 714, *Analysis of Alpha Emitting Radionuclides by Alpha Spectroscopy*.

EA set minimum detectable concentration (MDC) goals for ALS to meet in their alpha spectroscopy analysis of the soil samples (Table 2-4). EA set these MDCs one to two orders of magnitude below the Preliminary Remediation Goals (PRGs) developed for wildlife refuge workers (WRWs) originally in the RI/FS (Kaiser-Hill Company, 2006) and then revised in June 2017 (DOE, 2017). ALS achieved the MDC goals for the radionuclides, with individual sample MDCs typically being well below the levels provided in Table 2-4.

**Table 2-4 Radionuclide Analytical Testing Sensitivity for Soil Samples**

<b>Radionuclide</b>	<b>Minimum Detectable Concentration (MDC) Goal (pCi/g)</b>	<b>Wildlife Refuge Worker PRG (pCi/g)</b>
Am-241	0.1	11.5
Pu-238	0.15	22.9
Pu-239/240	0.1	9.3
U-234	0.1	20.0
U-235	0.1	4.5
U-238	0.1	22.9

Note: The Am, U, and Pu-239/240 PRGs were revised in June 2017 based on updated toxicological data as shown in Table 7 of the “*Fourth Five-year Review Report for the Rocky Flats Site*” (DOE, 2017).

ALS processed the aqueous equipment rinsate blank (ERB) samples per ALS SOP 776, *Preparation of Water Samples for Actinides*. This step replaces the initial preparation steps shown for soils (SOPs 736 and 773/768) on Figure 2-1. As discussed in Section 2.2, approximately three liters of water was required for ALS to perform the radionuclide analyses on the ERB samples.



### 3.0 RESULTS

This section provides a summary of the laboratory analytical results for the samples collected at the CO-128 and Indiana Street crossings. The data quality is summarized in Section 3.1 and Appendix B.1. The radionuclide results are summarized in Section 3.2 and the laboratory reports are provided in Appendices B.2 through B.7. Section 4 provides a detailed description of the radionuclide results at each crossing location.

#### 3.1 Data Quality

The Project soil samples were digested via two methods:

1. Acid (HCl-HNO<sub>3</sub>-HF)
2. Carbonate fusion

The quality control information associated with the acid digestion laboratory reports is discussed in Section 3.1.1. The quality control information associated with the carbonate fusion laboratory reports is discussed in Section 3.1.2.

##### 3.1.1 Acid Digestion Data Quality

ALS reported the Project results for the soils digested using acid in work order numbers 1907016, 1907083 and 1907103:

- Work order number 1907016 (Appendix B.2) provides the results of the eight CO-128 crossing samples and one Indiana Street crossing sample collected on July 1, 2019; the results of a field duplicate sample and an equipment rinsate blank (ERB) sample are also included in this work order.
- Work order number 1907083 (Appendix B.3) provides the results of nine Indiana Street crossing samples collected on July 2, 2019; the results of a field duplicate sample and an ERB sample are also included in this work order.
- Work order number 1907103 (Appendix B.4) provides the results of eight Indiana Street crossing samples collected on July 3, 2019.

EA reviewed the documentation and quality control sample results associated with each laboratory report. The results of these reviews are provided in Appendix B.1 and summarized below.

The following provides a brief review of the quality control information contained in the three laboratory data packages.

- The soil samples were prepared in three preparation batches: AS190723-3, -4 and -5. Each preparation batch included one method blank (MB), a laboratory control sample (LCS), and a laboratory duplicate sample.
  - The MB results were within ALS control limits.
  - The results of the LCS were all within ALS control limits.

- The results of the laboratory duplicate samples were all within ALS control limits.
- The recovery of tracers (Am-243, Pu-242 and U-232) added by ALS to each soil sample were all within ALS control limits.
- The americium isotope was counted for 600 to 1,000 minutes. Plutonium isotopes were counted for 360 to 480 minutes. Uranium isotopes were counted for 360 to 420 minutes.
- The specified MDCs (Table 2-4) were achieved in all samples.

The following provides a review of the water quality control information (for two ERB samples) contained in ALS work order numbers 1907016 and 1907083.

- The two ERB samples were prepared in preparation batch, AS190717-1. The preparation batch included one method blank (MB) and one laboratory control sample (LCS). In lieu of a duplicate sample, ALS included a laboratory control duplicate sample (LCDS) in the preparation batch.
  - The results of the MB were all within ALS control limits.
  - The LCS and LCSD results were within ALS control limits.
  - The LCS to LCSD results (duplicate evaluation) were all within ALS control limits.
- The americium isotope was counted for 1,000 minutes. Plutonium and uranium isotopes were counted for 420 minutes.

As described in Section 2.2, EA personnel collected one field duplicate and one equipment rinsate blank at each crossing location. The following provides a review of the field quality control sample results.

- The results for the two ERB samples (D6G-070119-ERB and E16G-070219-ERB) were all reported as below the MDC.
- The results from the two field duplicate sample pairs were evaluated using the relative percent difference (RPD) method. The results of this evaluation are summarized in Table 3-1. A “U” in Table 3-1 indicates that one or both values were reported below the MDC, which precludes the calculation of the RPD.

**Table 3-1 Summary of Field Duplicate Sample RPD Results, Acid Digestion**

<b>Radionuclide</b>	<b>CO-128 Crossing</b>	<b>Indiana St Crossing</b>
	<b>D4G-0701-0-4-01/DUP</b>	<b>D16G-0701-0-4-01/DUP</b>
Am-241	U	66%
Pu-238	U	62%
Pu-239/240	U	82%
U-234	30%	8%
U-235	U	52%
U-238	13%	31%

A control limit of 35% is recommended for laboratory duplicate soil analyses. Field replicates may offer more variability due to sample inhomogeneity.

The field duplicate sample results provided in Table 3-1 suggest small-scale variability in the radionuclide activity in the soils at the Indiana Street crossing location.

Based on a review of the laboratory and field quality control sample results, EA judges the data quality to meet the Project goals (Appendix A). No qualifiers, other than those given by ALS, are recommended for the Project sample results. However, the field duplicate sample results suggest a high level of variability in radionuclide activity in the soils at the Indiana Street crossing location; this location is immediately east of the Rocky Flats Wind Blown Area Exposure Unit.

### 3.1.2 Carbonate Fusion Data Quality

ALS reported the Project results for soil samples digestion using carbonate fusion in work order numbers 1907579, 1907581 and 1907583:

- Work order number 1907579 (Appendix B.5) provides the results of the eight CO-128 crossing samples and one Indiana Street crossing sample collected on July 1, 2019.
- Work order number 1907581 (Appendix B.6) provides the results of nine Indiana Street crossing samples collected on July 2, 2019.
- Work order number 1907583 (Appendix B-7) provides the results of eight Indiana Street crossing samples collected on July 3, 2019.

EA reviewed the documentation and quality control sample results associated with each laboratory report. The results of these reviews are provided in Appendix B.1 and summarized below.

The following provides a brief review of the soil quality control information contained in the three laboratory data packages.

- The samples were prepared in three preparation batches: AS191002-1 and AS191004-1 and AS191004-2. One sample was re-digested for americium analysis in preparation batch AS19004-4. Each preparation batch included one method blank (MB), a laboratory control sample (LCS), and a laboratory duplicate sample. The laboratory duplicate sample results were not included in the work order numbers 1907579 and 1907581 reports. The laboratory duplicate results were published in another work order and the results are included in Appendix B.
  - The MB results were within ALS control limits with the following exceptions:
    - U-238 was detected in the AS191004-2MB at a level of 0.018 pCi/g (versus a sample MDC of 0.011 pCi/g), a value that is 18% of the Project required MDC of 0.1 pCi/g.
    - Pu-239/240 and U-238 were detected in the AS191002-1MB. Pu-239/240 was detected in the MB at a level of 0.020 pCi/g (versus a sample MDC of 0.009 pCi/g), a value that is 20% of the Project required MDC of 0.1 pCi/g. U-238 was detected in the MB at a level of 0.0073 pCi/g (versus a sample MDC of 0.0066 pCi/g), a value that is 7.3% of the Project required MDC of 0.1 pCi/g.

U-234 and U-235 were detected in the AS191004-1MB. U-234 was detected at a level of 0.031 pCi/g (versus a sample MDC of 0.021 pCi/g) while U-235 was detected at a level of 0.012 pCi/g (versus a sample MDC of 0.008 pCi/g). These values are 31% and 12%, respectively, of the Project required MDCs of 0.1 pCi/g.

ALS flagged the MB results called out above as “B3<sup>1</sup>” but did not qualify any sample results associated with them.

- The results of the LCS were all within ALS control limits.
- The results of the laboratory duplicate samples were all within ALS control limits.
- The recovery of tracers (Am-243, Pu-242 and U-232) added by ALS to each soil sample were all within ALS control limits.
- The americium isotope was counted for 360 to 1,000 minutes. Plutonium isotopes were counted for 360 to 420 minutes. Uranium isotopes were counted for 370 to 420 minutes.
- The specified MDCs (Table 2-4) were achieved in all samples.

As described in Section 2.2, EA personnel collected one each field duplicate and equipment rinsate blank at each crossing location. The ERB results were all reported as below the MDC and are discussed in Section 3.1.1. The results from the two field duplicate sample pairs were evaluated using the relative percent difference (RPD) method. The results of this evaluation are summarized in Table 3-2. A “U” in Table 3-2 indicates that one or both values were reported below the MDC, which precludes the calculation of the RPD.

**Table 3-2 Summary of Field Duplicate Sample RPD Results, Carbonate Fusion**

Radionuclide	CO-128 Crossing	Indiana St Crossing
	D4G-0701-0-4-01/DUP	D16G-0701-0-4-01/DUP
Am-241	U	32%
Pu-238	U	U
Pu-239/240	U	25%
U-234	13%	14%
U-235	38%	21%
U-238	16%	7%

A control limit of 35% is recommended for laboratory duplicate soil analyses. Field replicates may offer more variability due to sample inhomogeneity.

The carbonate fusion results provided in Table 3-2 suggest less variability in the radionuclide activity in the soils at the Indiana Street crossing location than is present in the acid digestion results (Table 3-1).

Based on a review of the laboratory and field quality control sample results, EA judges the data quality to meet the Project goals (Appendix A). Select laboratory matrix blank results may

<sup>1</sup> ALS comment on MB report reads “B3 = Analyte concentration greater than MDC but less than requested MDC.” See the case narratives in Appendix B for more information.

suggest a slight high bias, but the activities detected in the MBs were well below the Project MDCs. No qualifiers, other than those given by ALS, are recommended for the Project sample results. The level of variability in the Indiana Street crossing carbonate fusion duplicate sample aliquots (Table 3-2) was lower than that observed in the aliquots selected for acid digestion (Table 3-1).

### 3.2 Radionuclide Data Summary

This section describes the activities of americium, plutonium, and uranium found in the Project soil samples. The levels of the radionuclides in the Project soils are compared to background levels (Table 1-3) and Wildlife Refuge Worker PRG levels (Table 2-4), where applicable. As described in DOE (2017) and summarized in Table 1-4, the calculated risk to a wildlife refuge visitor (WRV) is less than the calculated risk to a wildlife refuge worker (WRW), primarily due to the difference in exposure frequency. In the Comprehensive Risk Assessments published in Appendix A of the RI/FS Report (Kaiser-Hill Company, 2006), the WRW scenario exposure frequency was 230 days/year; whereas, the WRV scenario exposure frequency for an adult is 250 hours/year. To be conservative, the lower WRW PRG levels are referenced in this report.

Copies of the ALS laboratory reports are provided in Appendices B.2 through B.7. Each appendix contains a separate report for americium, plutonium, and uranium. Sample locations are illustrated on Figure 1-2a and Figure 1-2b. For purposes of the discussions below, reference to a sample's "maximum value" means the greater of the two analytical results (acid digestion and carbonate fusion) for that individual soil sample.

#### 3.2.1 Americium

The Project americium soil sample (and ERB) results are summarized in Table 3-2a and Table 3-2b. The maximum value observed at each crossing location is bolded in the tables.

**Table 3-2a Americium 241 Results CO-128 crossing at Rock Creek Drainage EU**

Soil Sample ID	Acid Digestion			Carbonate Fusion			Maximum Value
	Activity	2sTPU	Q	Activity	2sTPU	Q	
D1G-070119-0-2-01	-0.002	0.013	U	-0.011	0.017	U	-0.002
D2G-070119-0-2-01	-0.012	0.013	U	0.002	0.022	U	0.002
D3G-070119-0-2-01	0.004	0.016	U	-0.008	0.019	U	0.004
D4G-070119-0-2-01	0	0.016	U	0.001	0.022	U	0.001
D4G-070119-0-2-DUP	-0.001	0.012	U	0.004	0.023	U	0.004
D5G-070119-0-2-01	-0.011	0.012	U	-0.009	0.019	U	-0.009
<b>D6G-070119-0-2-01</b>	<b>0.02</b>	0.021	U	<b>0.004</b>	0.023	U	<b>0.02</b>
D7G-070119-0-2-01	0.01	0.016	U	-0.002	0.021	U	0.01
D8G-070119-0-2-01	-0.001	0.017	U	-0.004	0.02	U	-0.001
D6G-070119-ERB	0.008	0.014	U	NA	NA		0.008

Notes:

1. Activity is in pCi/g except for the equipment rinsate blank (ERB suffix) sample, which is in pCi/L.
2. "Q" is sample qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. TPU = Total Propagated Uncertainty.
4. NA – Carbonate fusion data was not verified in the ERB.

All soil samples at the CO-128 crossing (Table 3-2a) possessed an Am-241 activity below the sample MDC (“U” qualifier). The maximum Am-241 sample MDC at the CO-128 crossing, 0.02 U pCi/g at location D6, is below the background level (Table 1-3) and well below the Wildlife Refuge Worker PRG of 11.5 pCi/g (Table 2-4).

**Table 3-2b Americium 241 Results Indiana Street crossing at Wind Blown Area EU**

Soil Sample ID	Acid Digestion			Carbonate Fusion			Maximum Value
	Activity	2sTPU	Q	Activity	2sTPU	Q	
E1G-070219-0-2-01	1.22	0.25		1.08	0.23		1.22
E2G-070219-0-2-01	0.379	0.092		0.62	0.15		0.62
E3G-070119-0-2-01	0.117	0.043		0.116	0.049		0.117
E4G-070319-0-2-01	0.86	0.15		0.455	0.092		0.86
E5G-070319-0-2-01	0.46	0.092		0.49	0.12		0.49
E6G-070219-0-2-01	0.65	0.14		0.81	0.18		0.81
E7G-070319-0-2-01	0.5	0.11		0.51	0.13		0.51
E8G-070319-0-2-01	0.419	0.085		0.32	0.092		0.419
E9G-070219-0-2-01	1.23	0.23		1.11	0.24		1.23
E10G-070219-0-2-01	0.391	0.094		0.339	0.098		0.391
E11G-070319-0-2-01	0.439	0.088		0.41	0.1		0.439
E12G-070319-0-2-01	0.316	0.067		0.43	0.11		0.43
E13G-070319-0-2-01	0.57	0.11		0.61	0.14		0.61
E14G-070319-0-2-01	0.88	0.17		0.96	.020		0.88
<b>E15G-070219-0-2-01</b>	<b>1.63</b>	<b>0.3</b>		<b>1.74</b>	<b>0.34</b>		<b>1.74</b>
E16G-070219-0-2-01	0.53	0.12		0.5	0.13		0.53
E16G-070219-0-2-DUP	1.05	0.21		0.69	0.16		1.05
E17G-070219-0-2-01	0.332	0.087		0.38	0.11		0.38
E10G-070219-0-2-ERB	-0.007	0.011	Y1,U	NA	NA		-0.007

Notes:

1. Activity is in pCi/g except for the equipment rinsate blank (ERB suffix) sample, which is in pCi/L.
2. “Q” is sample qualifier assigned by lab. A “U” indicates that the result was below the MDC.
3. TPU = Total Propagated Uncertainty.
4. NA – Carbonate fusion data was not verified in the ERB.
5. Y1 is a tracer yield; chemical control yield of 100-110%.

The Am-241 activities in the soil samples from the Indiana Street crossing (Table 3-2b) are all above the background level of 0.022 pCi/g (Table 1-3). The maximum Am-241 activity detected in an Indiana Street Crossing sample (1.74 pCi/g in E15) is an order of magnitude lower than the Wildlife Refuge Worker PRG of 11.5 pCi/g (Table 2-4).

**3.2.2 Plutonium**

The Project Pu-238 soil sample results are summarized in Tables 3-3a and 3-3b. The maximum value of each radionuclide is bolded in each table.

**Table 3-3a Plutonium 238 Results CO-128 crossing at Rock Creek Drainage EU**

Soil Sample ID	Acid Digestion			Carbonate Fusion			Maximum Value
	Activity	2sTPU	Q	Activity	2sTPU	Q	
D1G-070119-0-2-01	-0.01	0.02	U	0.006	0.02	U	0.006
D2G-070119-0-2-01	0.002	0.02	U	-0.005	0.023	U	0.002
D3G-070119-0-2-01	<b>0.021</b>	0.024	U	0.008	0.02	U	0.021
D4G-070119-0-2-01	0.001	0.018	U	0.013	0.023	U	0.013
D4G-070119-0-2-DUP	0.003	0.016	U	0.012	0.02	U	0.012
D5G-070119-0-2-01	0.013	0.019	U	0.019	0.026	U	0.019
<b>D6G-070119-0-2-01</b>	0.008	0.018	U	<b>0.034</b>	0.031	U	<b>0.034</b>
D7G-070119-0-2-01	0.01	0.016	U	-0.001	0.019	U	0.01
D8G-070119-0-2-01	-0.006	0.019	U	0.004	0.019	U	0.004
D6G-070119-ERB	0.008	0.027	U	NA	NA		0.008

Notes:

1. Activity is in pCi/g except for the equipment rinsate blank (ERB suffix) sample, which is in pCi/L.
2. "Q" is sample qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. TPU = Total Propagated Uncertainty.
4. NA – Carbonate fusion data was not verified in the ERB.

All soil samples at the CO-128 crossing possessed a Pu-238 activity below the MDC (Table 3-3a). The maximum Pu-238 MDC in a CO-128 crossing sample, 0.034 pCi/g in sample D6, is three orders of magnitude lower than Wildlife Refuge Worker PRG of 22.9 pCi/g (Table 2-4). As discussed in Section 1.2, a background level for Pu-238 was not included in the RI/FS Report.

**Table 3-3b Plutonium 238 Results Indiana Street crossing at Windblown Area EU**

Soil Sample ID	Acid Digestion			Carbonate Fusion			Maximum Value
	Activity	2sTPU	Q	Activity	2sTPU	Q	
E1G-070219-0-2-01	0.077	0.044		0.087	0.052		0.087
E2G-070219-0-2-01	0.019	0.019		0.081	0.042		0.081
E3G-070119-0-2-01	0.018	0.021	U	0.007	0.022	U	0.018
E4G-070319-0-2-01	0.106	0.044		0.093	0.056		0.106
E5G-070319-0-2-01	0.033	0.026		0.007	0.023	U	0.033
E6G-070219-0-2-01	0.043	0.032		0.069	0.039		0.069
E7G-070319-0-2-01	0.032	0.029	U	0.023	0.029	U	0.032
E8G-070319-0-2-01	0.026	0.02		0.023	0.026	U	0.026
E9G-070219-0-2-01	0.096	0.049		0.095	0.048		0.096
E10G-070219-0-2-01	0.032	0.028	U	0.022	0.023	U	0.032
E11G-070319-0-2-01	0.056	0.037		-0.001	0.027		0.056
E12G-070319-0-2-01	0.058	0.035		0.047	0.045	U	0.058
E13G-070319-0-2-01	0.066	0.037		0.071	0.05		0.071
E14G-070319-0-2-01	0.069	0.035		0.091	0.058		0.091
<b>E15G-070219-0-2-01</b>	<b>0.146</b>	0.058		<b>0.2</b>	0.068		<b>0.2</b>
E16G-070219-0-2-01	0.063	0.038		0.017	0.02	U	0.063
E16G-070219-0-2-DUP	0.12	0.055		0.049	0.032		0.12
E17G-070219-0-2-01	0.013	0.021	U	0.045	0.032		0.045
E10G-070219-0-2-ERB	0.008	0.02	U	NA	NA		0.008

Notes:

1. Activity is in pCi/g except for the equipment rinsate blank (ERB suffix) sample, which is in pCi/L.
2. "Q" is sample qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. TPU = Total Propagated Uncertainty.
4. NA – Carbonate fusion data was not verified in the ERB.

At the Indiana Street crossing, the Pu-238 activity in most soil samples was above the sample MDC (Table 3-3b). The maximum Pu-238 activity detected in an Indiana Street crossing sample, 0.2 pCi/g sample E15 is two orders of magnitude below the Wildlife Refuge Worker PRG of 22.9 pCi/g (Table 2-4).



The Project Pu-239/240 results are summarized in Tables 3-3c and 3-3d. The maximum value of each radionuclide is bolded in each table.

**Table 3-3c Plutonium 239/240 Results CO-128 crossing at Rock Creek Drainage EU**

Soil Sample ID	Acid Digestion			Carbonate Fusion			Maximum Value
	Activity	2sTPU	Q	Activity	2sTPU	Q	
D1G-070119-0-2-01	0.026	0.024		0.001	0.02	U	0.026
D2G-070119-0-2-01	0	0.02	U	0.024	0.025		0.024
<b>D3G-070119-0-2-01</b>	<b>0.044</b>	0.034		<b>0.045</b>	0.032		<b>0.045</b>
D4G-070119-0-2-01	0.018	0.02	U	0.024	0.024		0.024
D4G-070119-0-2-DUP	0.017	0.021	U	0.03	0.027	U	0.03
D5G-070119-0-2-01	0.003	0.017	U	0.032	0.034	U	0.032
D6G-070119-0-2-01	0.04	0.03		0.032	0.034	U	0.04
D7G-070119-0-2-01	0.027	0.024	U	0.026	0.025	U	0.027
D8G-070119-0-2-01	0.031	0.025		0.002	0.019	U	0.031
D6G-070119-ERB	0.001	0.026	U	NA	NA		0.001

Notes:

1. Activity is in pCi/g except for the equipment rinsate blank (ERB suffix) sample, which is in pCi/L.
2. "Q" is sample qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. TPU = Total Propagated Uncertainty.
4. NA – Carbonate fusion data was not verified in the ERB.

At the CO-128 crossing, the Pu-239/240 activity in approximately half the samples was below the MDC (Table 3-3c). The maximum Pu-239/240 activity detected in a CO-128 sample, 0.045 pCi/g in sample D3, is below the background level of 0.066 pCi/g (Table 1-3) and two orders of magnitude below the Wildlife Refuge Worker PRG of 9.3 pCi/g (Table 2-4).

**Table 3-3d Plutonium 239/240 Results Indiana Street crossing at Windblown Area EU**

Soil Sample ID	Acid Digestion			Carbonate Fusion			Maximum Value
	Activity	2sTPU	Q	Activity	2sTPU	Q	
E1G-070219-0-2-01	5.43	0.95		6.10	1.1		6.1
E2G-070219-0-2-01	2.47	0.46		2.74	0.5		2.74
E3G-070119-0-2-01	0.88	0.2		0.76	0.18		0.88
E4G-070319-0-2-01	5.98	0.99		3.21	0.63		5.98
E5G-070319-0-2-01	2.44	0.44		0.72	0.18		2.44
E6G-070219-0-2-01	3.31	0.59		4.61	0.81		4.61
E7G-070319-0-2-01	2.67	0.49		2.17	0.44		2.67
E8G-070319-0-2-01	1.73	0.32		1.79	0.37		1.79
E9G-070219-0-2-01	5.90	1.00		6.10	1.1		6.1
E10G-070219-0-2-01	1.82	0.36		2.44	0.45		2.44
E11G-070319-0-2-01	2.56	0.48		2.49	0.5		2.56
E12G-070319-0-2-01	2.00	0.37		2.73	0.57		2.73
E13G-070319-0-2-01	3.23	0.58		3.04	0.6		3.23
E14G-070319-0-2-01	4.1	0.70		6.80	1.2		6.8
<b>E15G-070219-0-2-01</b>	<b>14.0</b>	<b>2.30</b>		<b>19.4</b>	<b>3.2</b>		<b>19.4</b>
E16G-070219-0-2-01	2.55	0.47		2.56	0.47		2.56
E16G-070219-0-2-DUP	6.10	1.10		3.28	0.58		6.1
E17G-070219-0-2-01	1.47	0.30		1.87	0.35		1.87
E10G-070219-0-2-ERB	0.005	0.02	U	NA	NA		0.005

Notes:

1. Activity is in pCi/g except for the equipment rinsate blank (ERB suffix) sample, which is in pCi/L.
2. "Q" is sample qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. TPU = Total Propagated Uncertainty.
4. NA – Carbonate fusion data was not verified in the ERB.

At the Indiana crossing, the Pu-239/240 activity in all samples was above the MDC (Table 3-3d). The Pu-239/240 activity in all Indiana Street crossing soil samples was above background (Table 1-3). The Pu-239/240 activity in Indiana Street crossing sample E15, at 19.4 pCi/g, is more than twice the Wildlife Refuge Worker PRG of 9.3 pCi/g (Table 2-4). No other samples exceeded the WRW PRG.

**3.2.3 Uranium**

The Project U-234 soil sample results are summarized in Tables 3-4a and Table 3-4b. The maximum value of each radionuclide is bolded.

**Table 3-4a Uranium 234 Results CO-128 crossing at Rock Creek Drainage EU**

Soil Sample ID	Acid Digestion			Carbonate Fusion			Maximum Value
	Activity	2sTPU	Q	Activity	2sTPU	Q	
D1G-070119-0-2-01	0.62	0.15		0.86	0.19		0.86
D2G-070119-0-2-01	0.68	0.16		0.79	0.18		0.79
D3G-070119-0-2-01	0.56	0.14		0.86	0.18		0.86
D4G-070119-0-2-01	0.73	0.17		0.81	0.18		0.81
D4G-070119-0-2-DUP	0.54	0.13		0.92	0.2		0.92
D5G-070119-0-2-01	0.53	0.13		0.81	0.18		0.81
D6G-070119-0-2-01	0.71	0.17		1.04	0.22		1.04
D7G-070119-0-2-01	0.68	0.16		1	0.21		1
<b>D8G-070119-0-2-01</b>	<b>0.77</b>	0.18		<b>1.18</b>	0.24		<b>1.18</b>
D6G-070119-ERB	0.018	0.021	U	NA	NA		0.018

Notes:

1. Activity is in pCi/g except for the equipment rinsate blank (ERB suffix) sample, which is in pCi/L.
2. "Q" is sample qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. TPU = Total Propagated Uncertainty.
4. NA – Carbonate fusion data was not verified in the ERB.

**Table 3-4b Uranium 234 Results Indiana Street crossing at Windblown Area EU**

Soil Sample ID	Acid Digestion			Carbonate Fusion			Maximum Value
	Activity	2sTPU	Q	Activity	2sTPU	Q	
E1G-070219-0-2-01	0.68	0.15		1.15	0.25		1.15
E2G-070219-0-2-01	0.66	0.15		0.9	0.19		0.9
<b>E3G-070119-0-2-01</b>	0.81	0.19		<b>1.18</b>	0.24		<b>1.18</b>
E4G-070319-0-2-01	0.7	0.15		0.96	0.21		0.96
E5G-070319-0-2-01	0.69	0.15		0.94	0.22		0.94
E6G-070219-0-2-01	0.67	0.15		1.05	0.21		1.05
E7G-070319-0-2-01	0.73	0.16		0.89	0.2		0.89
E8G-070319-0-2-01	0.81	0.18		1.16	0.24		1.16
E9G-070219-0-2-01	0.81	0.17		1.11	0.23		1.11
E10G-070219-0-2-01	0.7	0.15		1.06	0.22		1.06
E11G-070319-0-2-01	0.76	0.18		0.94	0.21		0.94
E12G-070319-0-2-01	0.9	0.19		1.01	0.21		1.01
E13G-070319-0-2-01	0.91	0.19		1.09	0.23		1.09
E14G-070319-0-2-01	<b>0.93</b>	0.2		1.16	0.24		1.16
E15G-070219-0-2-01	0.73	0.17		1.15	0.23		1.15
E16G-070219-0-2-01	0.87	0.19		0.97	0.2		0.97
E16G-070219-0-2-DUP	0.8	0.17		1.12	0.23		1.12
E17G-070219-0-2-01	0.82	0.18		1.17	0.23		1.17
E10G-070219-0-2-ERB	0.034	0.029	U	NA	NA		0.034

Notes:

1. Activity is in pCi/g except for the equipment rinsate blank (ERB suffix) sample, which is in pCi/L.
2. "Q" is sample qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. TPU = Total Propagated Uncertainty.
4. NA – Carbonate fusion data was not verified in the ERB.

The U-234 activity in all CO-128 and all Indiana Street crossing soil samples was above the sample MDC (Table 3-4a and Table 3-4b). However, the U-234 activity in all soil samples was less than the background level of 2.25 pCi/g (Table 1-3). The maximum U-234 activity detected in Project soils, 1.18 pCi/g in both samples D8 (CO-128) and E3 (Indiana Street), is an order of magnitude lower than Wildlife Refuge Worker PRG of 20.0 pCi/g (Table 2-4).

The Project U-235 soil sample results are summarized in Tables 3-4c and Table 3-4d. The maximum value of each radionuclide is bolded.

**Table 3-4c Uranium 235 Results CO-128 crossing at Rock Creek Drainage EU**

Soil Sample Location	Acid Digestion			Carbonate Fusion			Maximum Value
	Activity	2sTPU	Q	Activity	2sTPU	Q	
D1G-070119-0-2-01	0.03	0.027		0.04	0.031		0.04
D2G-070119-0-2-01	0.06	0.039		0.038	0.029		0.06
D3G-070119-0-2-01	0.028	0.026		0.068	0.04		0.068
D4G-070119-0-2-01	0.021	0.027	U	0.053	0.035		0.053
<b>D4G-070119-0-2-DUP</b>	0.019	0.022	U	<b>0.078</b>	0.042		<b>0.078</b>
D5G-070119-0-2-01	0.023	0.023	U	0.076	0.042		0.076
D6G-070119-0-2-01	0.037	0.031		0.059	0.042		0.059
D7G-070119-0-2-01	0.026	0.026	U	0.059	0.037		0.059
D8G-070119-0-2-01	<b>0.048</b>	0.036		0.026	0.026	U	0.048
D6G-070119-ERB	0	0.02	U	NA	NA		0

Notes:

1. Activity is in pCi/g except for the equipment rinsate blank (ERB suffix) sample, which is in pCi/L.
2. "Q" is sample qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. TPU = Total Propagated Uncertainty.
4. NA – Carbonate fusion data was not verified in the ERB.

At the CO-128 crossing, the U-235 activity in all soil samples was above the sample MDC (Table 3-4c). However, the U-235 activity detected in all CO-128 soil samples was below the background level of 0.095 pCi/g (Table 1-3). The maximum U-235 activity, 0.078 pCi/g in the DG sample duplicate, is two orders of magnitude lower than the Wildlife Refuge Worker PRG of 4.5 pCi/g (Table 2-4).

**Table 3-4d Uranium 235 Results Indiana Street crossing at Windblown Area EU**

Soil Sample Location	Acid Digestion			Carbonate Fusion			Maximum Value
	Activity	2sTPU	Q	Activity	2sTPU	Q	
E1G-070219-0-2-01	0.048	0.034		0.036	0.036	U	0.048
E2G-070219-0-2-01	0.02	0.023	U	0.016	0.021	U	0.02
E3G-070119-0-2-01	<b>0.06</b>	0.041		0.04	0.031		0.06
E4G-070319-0-2-01	0.033	0.026		0.047	0.034		0.047
E5G-070319-0-2-01	0.029	0.029		0.023	0.028		0.029
E6G-070219-0-2-01	0.026	0.024	U	0.064	0.036		0.064
E7G-070319-0-2-01	0.06	0.037		0.066	0.041		0.066
E8G-070319-0-2-01	0.048	0.034		0.075	0.044		0.075
E9G-070219-0-2-01	0.043	0.029		0.047	0.034		0.047
E10G-070219-0-2-01	0.03	0.025		0.033	0.027		0.033
E11G-070319-0-2-01	0.001	0.024	U	0.066	0.043		0.066
E12G-070319-0-2-01	0.039	0.028		0.061	0.038		0.061
E13G-070319-0-2-01	0.05	0.033		0.061	0.04		0.061
E14G-070319-0-2-01	0.036	0.03		0.049	0.033		0.049
E15G-070219-0-2-01	0.029	0.026	U	0.03	0.025		0.03
E16G-070219-0-2-01	0.058	0.038		0.064	0.037		0.064
<b>E16G-070219-0-2-DUP</b>	0.034	0.028		<b>0.079</b>	0.041		<b>0.079</b>
E17G-070219-0-2-01	0.039	0.03		0.06	0.035		0.06
E10G-070219-0-2-ERB	0.021	0.023	U	NA	NA		0.021

## Notes:

1. Activity is in pCi/g except for the equipment rinsate blank (ERB suffix) sample, which is in pCi/L.
2. "Q" is sample qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. TPU = Total Propagated Uncertainty.
4. NA – Carbonate fusion data was not verified in the ERB.

The U-235 activity in all but one soil sample at the Indiana Street crossing exceeded the sample MDC (Table 3-4d). However, the U-235 activity in all samples was below the background level of 0.095 pCi/g (Table 1-3). The maximum U-235 activity detected in an Indiana Street crossing soil sample, 0.079 pCi/g the E16 sample duplicate, is two orders of magnitude lower than the Wildlife Refuge Worker PRG of 4.5 pCi/g (Table 2-4).

The Project U-238 soil sample results are summarized in Tables 3-4e and Table 3-4f. The maximum value of each radionuclide is bolded.

**Table 3-4e Uranium 238 Results CO-128 crossing at Rock Creek Drainage EU**

Soil Sample ID	Acid Digestion			Carbonate Fusion			Maximum Value
	Activity	2sTPU	Q	Activity	2sTPU	Q	
D1G-070119-0-2-01	0.68	0.16		<b>1.08</b>	0.23		<b>1.08</b>
D2G-070119-0-2-01	0.74	0.17		0.84	0.18		0.84
D3G-070119-0-2-01	0.79	0.18		0.8	0.17		0.8
D4G-070119-0-2-01	0.75	0.18		0.97	0.21		0.97
D4G-070119-0-2-DUP	0.66	0.15		0.83	0.18		0.83
D5G-070119-0-2-01	0.54	0.13		0.87	0.19		0.87
D6G-070119-0-2-01	<b>0.84</b>	0.19		1.03	0.22		1.03
D7G-070119-0-2-01	0.56	0.14		0.89	0.19		0.89
D8G-070119-0-2-01	0.79	0.18		1.03	0.22		1.03
D6G-070119-ERB	0.012	0.019	U	NA	NA		0.012

Notes:

1. Activity is in pCi/g except for the equipment rinsate blank (ERB suffix) sample, which is in pCi/L.
2. "Q" is sample qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. TPU = Total Propagated Uncertainty.
4. NA – Carbonate fusion data was not verified in the ERB.

**Table 3-4f Uranium 238 Results Indiana Street crossing at Windblown Area EU**

Soil Sample ID	Acid Digestion			Carbonate Fusion			Maximum Value
	Activity	2sTPU	Q	Activity	2sTPU	Q	
E1G-070219-0-2-01	0.71	0.16		1.11	0.25		1.11
E2G-070219-0-2-01	0.66	0.15		0.88	0.19		0.88
E3G-070119-0-2-01	0.79	0.18		1.21	0.25		1.21
E4G-070319-0-2-01	0.69	0.15		1.11	0.23		1.11
E5G-070319-0-2-01	0.74	0.16		1.04	0.24		1.04
E6G-070219-0-2-01	0.61	0.14		1.13	0.23		1.13
E7G-070319-0-2-01	0.82	0.18		1.17	0.25		1.17
E8G-070319-0-2-01	0.81	0.17		1.19	0.25		1.19
E9G-070219-0-2-01	0.77	0.17		1.1	0.23		1.1
E10G-070219-0-2-01	0.71	0.16		<b>1.23</b>	0.25		<b>1.23</b>
E11G-070319-0-2-01	0.68	0.17		0.98	0.22		0.98
E12G-070319-0-2-01	0.83	0.18		1.07	0.22		1.07
E13G-070319-0-2-01	0.87	0.19		1.09	0.23		1.09
E14G-070319-0-2-01	0.92	0.2		1.15	0.24		1.15
E15G-070219-0-2-01	0.79	0.17		1.2	0.24		1.2
E16G-070219-0-2-01	<b>0.96</b>	0.2		1.1	0.22		1.1
E16G-070219-0-2-DUP	0.7	0.16		1.03	0.21		1.03
E17G-070219-0-2-01	0.78	0.17		1.05	0.21		1.05
E10G-070219-0-2-ERB	0.012	0.018	U	NA	NA		0.012

At the CO-128 and Indiana Street crossings, all samples possessed a U-238 activity above the sample MDC (Table 3-4e and Table 3-4f). However, the U-238 activity in all samples was less than the background level of 2.00 pCi/g (Table 1-3). The maximum U-238 activities detected in the Project soil samples (1.08 pCi/g in CO-128 crossing sample D1 and 1.23 pCi/g in Indiana Street crossing sample E10) are an order of magnitude lower than Wildlife Refuge Worker PRG of 22.9 pCi/g (Table 2-4).



## 4.0 EVALUATION

The americium, plutonium, and uranium results from the Project soils samples from each exposure unit are discussed in this section. The maximum sample value from the acid digestion and carbonate fusion results in the Project soils are compared to the mean levels determined for surface soils in each exposure area in the RI/FS Report (Tables 1-1 and 1-2), the sitewide surface soil background levels (Table 1-3), and the Wildlife Refuge Worker PRG levels (Table 2-4), where applicable. As described in Section 3.2, the calculated risk to a wildlife refuge visitor (WRV) is less than the calculated risk to a wildlife refuge worker (WRW); however, to be conservative, the lower WRW PRG levels are referenced in this report.

### 4.1 CO-128 Crossing/Rock Creek Drainage EU

CO-128 follows along the north side of Rocky flats near the Rock Creek Drainage EU (Figure 1-3). EA collected eight soil samples and one duplicate along the planned underpass in this exposure unit (Figure 1-2b).

#### 4.1.1 Americium

The Am-241 results from the eight soil samples collected within the CO-128 Crossing are summarized in Table 4-1.

**Table 4-1 Americium Summary Statistics for Soil Samples from CO-128 Crossing**

Soil Sample Location	Am-241	
	Activity	Qualifier
D1	-0.002	U
D2	0.002	U
D3	0.004	U
D4	0.001	U
D5	-0.009	U
D6	<b>0.02</b>	U
D7	0.01	U
D8	-0.001	U
<b>Summary Statistics</b>		
Total Number of Results	8	
Total Number of Results above MDC	0	
Detection Frequency	0%	
Minimum Activity	-0.009	
Maximum Activity	0.020	
Arithmetic Mean Activity	N.A.	
Standard Deviation	N.A.	

Notes:

1. Activity is in pCi/g
2. Qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. N.A. = Not applicable. All values below MDC.
4. Duplicates and ERBs removed for analysis.

All values were below their MDCs, with the sample MDCs all being below the background level of 0.022 pCi/g. The maximum Am-241 activity reported for a Project sample from this exposure unit (0.02 pCi/g in sample D6) is two orders of magnitude lower than the Wildlife Refuge Worker PRG of 11.5 pCi/g (Table 2-4). The Project mean was not calculated for this exposure unit as all samples were under the MDCs.

#### 4.1.2 Plutonium

The plutonium results from the eight soil samples collected within the area near CO-128 and the Rock Creek Drainage are summarized in Table 4-2.

**Table 4-2 Plutonium Summary Statistics for Soil Samples from CO-128 Crossing/Rock Creek Drainage EU**

Soil Sample Location	Pu-238		Pu-239/240	
	Activity	Qualifier	Activity	Qualifier
D1	0.006	U	0.026	U
D2	0.002	U	0.024	
D3	0.021	U	<b>0.045</b>	
D4	0.013	U	0.024	
D5	0.019	U	0.032	U
D6	<b>0.034</b>	U	0.04	U
D7	0.01	U	0.027	U
D8	0.004	U	0.031	U
<b>Summary Statistics</b>				
Total Number of Results	8		8	
Total Number of Results above MDC	0		3	
Detection Frequency	0%		38%	
Minimum Activity	0.002		0.024	
Maximum Activity	0.034		0.045	
Arithmetic Mean Activity	N.A.		0.031	
Standard Deviation	N.A.		0.012	

Notes:

1. Activity is in pCi/g
2. Qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. N.A. = Not applicable. All values below MDC.
4. Mean and standard deviation calculations based on values above MDC.
5. Duplicates and ERBs removed for calculations.

All Pu-238 values were below their MDCs and the maximum Pu-238 MDC reported for a soil sample from this exposure unit (0.034 pCi/g in sample D6) is three orders of magnitude lower than the Wildlife Refuge Worker PRG of 22.9 pCi/g (Table 2-4).

Three of the eight Pu-239/240 values were above their MDCs. All values were below the background level of 0.066 pCi/g. The maximum Pu-239/240 activity reported for a Project

sample from this exposure unit (0.045 pCi/g in sample D3) is two orders of magnitude lower than the Wildlife Refuge Worker PRG of 9.3 pCi/g (Table 2-4). The mean activity of the Project soil samples is also less than the mean Pu-239/240 activity (0.222 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-1).

#### 4.1.3 Uranium

The uranium results from the eight soil samples collected within the CO-128 area and Rock Creek Drainage EU are summarized in Table 4-3.

**Table 4-3 Uranium Summary Statistics for Soil Samples from CO-128 Crossing/Rock Creek Drainage EU**

Soil Sample Location	U-234		U-235		U-238	
	Activity	Qualifier	Activity	Qualifier	Activity	Qualifier
D1	0.86		0.04		<b>1.08</b>	
D2	0.79		0.06		0.84	
D3	0.86		0.068		0.80	
D4	0.81		0.053		0.97	
D5	0.81		<b>0.076</b>		0.87	
D6	1.04		0.059		1.03	
D7	1.00		0.059		0.89	
D8	<b>1.18</b>		0.048		1.03	
<b>Summary Statistics</b>						
Total Number of Results	8		8		8	
Total Number of Results above MDC	8		8		8	
Detection Frequency	100%		100%		100%	
Minimum Activity	0.79		0.040		0.80	
Maximum Activity	1.18		0.076		1.08	
Arithmetic Mean Activity	0.92		0.058		0.94	
Standard Deviation	0.14		0.013		0.10	

Notes:

1. Activity is in pCi/g
2. Qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. N.A. = Not applicable. All values below MDC.
4. Mean and standard deviation calculations based on values above MDC.
5. Duplicates and ERBs removed for calculations

All U-234 values were above their MDCs, but below the background level of 2.25 pCi/g (Table 1-3). The maximum U-234 activity reported in a Project sample from this exposure unit (1.18 pCi/g in sample D8) is an order of magnitude lower than Wildlife Refuge Worker PRG of 20 pCi/g (Table 2-4). The mean activity of the Project samples, 0.92 pCi/g, is less than the mean activity (1.07 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-1).

All U-235 values were above their MDCs, but below the background level of 0.095 pCi/g (Table 1-3). The maximum U-235 activity reported in a Project sample from this exposure unit (0.076 pCi/g in sample D5) is two orders of magnitude lower than the Wildlife Refuge Worker PRG of 4.5 pCi/g (Table 2-4). The mean activity of the Project samples, 0.0613 pCi/g, is below the mean U-235 activity (0.0641 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-1).

All U-238 values were above their MDCs, but below the background level of 2.00 pCi/g (Table 1-7). The maximum U-238 activity reported in a Project sample from this exposure unit (1.08 pCi/g in sample D1) is an order of magnitude lower than Wildlife Refuge Worker PRG of 22.9 pCi/g (Table 2-4). The mean activity of the Project samples, 0.94 pCi/g, is less than the mean U-238 activity (1.11 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-1).

## **4.2 Indiana Street Crossing/Wind Blown Area EU**

Indiana Street follows the eastern border of the Wind Blown Area EU in the east-central portion of the site. This exposure unit shares its western boundary with the Industrial Area EU (Figure 1-3). Surface soil samples collected from the Wind Blown Area EU historically have exhibited the highest americium and plutonium activities outside of the Industrial Area (Section 1.2). EA collected 17 soil samples (and 1 duplicate) along the planned Indiana Street bridge crossing in this exposure unit (Figure 1-2a). The field duplicate results suggest small-scale variability in radionuclide activities in soils in this area.

### **4.2.1 Americium**

The Am-241 results from the 17 (not including duplicates) soil samples collected within the Indiana Street crossing and Wind Blown Area EU are summarized in Table 4-4.

**Table 4-4 Americium Summary Statistics for Soil Samples from Indiana Street Crossing/Wind Blown Area EU**

Soil Sample Location	Am-241	
	Activity	Qualifier
E1	1.22	
E2	0.62	
E3	0.117	
E4	0.86	
E5	0.49	
E6	0.81	
E7	0.51	
E8	0.419	
E9	1.23	
E10	0.391	
E11	0.439	
E12	0.43	
E13	0.61	
E14	0.96	
E15	<b>1.74</b>	
E16	0.53	
E17	0.38	
<b>Summary Statistics</b>		
Total Number of Results	17	
Total Number of Results above MDC	17	
Detection Frequency	100%	
Minimum Activity	0.117	
Maximum Activity	1.74	
Arithmetic Mean Activity	0.692	
Standard Deviation	0.405	

## Notes:

1. Activity is in pCi/g
2. Qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. Mean and standard deviation calculations based on values above MDC.
4. Duplicates and ERBs removed for calculations

All values were above their MDCs and all sample activities were greater than the background level of 0.022 pCi/g (Table 1-3). However, the maximum Am-241 activity reported for a Project sample from this exposure unit (1.74 pCi/g in sample E15) is an order of magnitude lower than the Wildlife Refuge Worker PRG of 11.5 pCi/g (Table 2-4). The mean activity of Project samples, 0.692 pCi/g, is less than half of the mean Am-241 activity (1.86 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-2).

**4.2.2 Plutonium**

The plutonium results from the 17 soil samples collected within the Indiana Street crossing and Wind Blown Area EU are summarized in Table 4-5.

**Table 4-5 Plutonium Summary Statistics for Soil Samples from Indiana Street Crossing/Wind Blown Area EU**

Soil Sample Location	Pu-238		Pu-239/240	
	Activity	Qualifier	Activity	Qualifier
E1	0.087		6.1	
E2	0.081		2.74	
E3	0.018	U	0.88	
E4	0.106		5.98	
E5	0.033		2.44	
E6	0.069		4.61	
E7	0.032	U	2.67	
E8	0.026		1.79	
E9	0.096		6.1	
E10	0.032	U	2.44	
E11	0.056		2.56	
E12	0.058		2.73	
E13	0.071		3.23	
E14	0.091		6.8	
E15	<b>0.20</b>		<b>19.4</b>	
E16	0.063		2.56	
E17	0.045	U	1.87	
<b>Summary Statistics</b>				
Total Number of Results	17		17	
Total Number of Results above MDC	13		17	
Detection Frequency	76%		100%	
Minimum Activity	0.018		0.880	
Maximum Activity	0.200		19.40	
Arithmetic Mean Activity	0.080		4.406	
Standard Deviation	0.043		4.25	

Notes:

1. Activity is in pCi/g
2. Qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. Mean and standard deviation calculations based on values above MDC.
4. Duplicates and ERBs removed for calculations

Four of the 17 Pu-238 activities were below their MDCs. The maximum Pu-238 value reported for a Project sample from this exposure unit (0.20 pCi/g in sample E15) is two orders of magnitude lower than Wildlife Refuge Worker PRG of 22.9 pCi/g (Table 2-4). The mean Pu-

238 activity of the Project soil samples, 0.080 pCi/g, is also less than the mean Pu-238 activity (0.447 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-2).

The Pu-239/240 activity of all Project samples were above their sample MDC and greater than the background level of 0.066 pCi/g. The maximum Pu-239/240 activity reported for a Project sample from this exposure unit (19.4 pCi/g in sample E15) is above the Wildlife Refuge Worker PRG value of 9.3 pCi/g (Table 2-4) but less than half of the 50 pCi/g Pu239/240 clean-up standard for Rocky Flats. The mean Pu-239/240 activity of the Project soils, 4.406 pCi/g, is approximately half of the mean Pu-239/240 activity (9.44 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-2).

**4.2.3 Uranium**

The uranium results from the 17 soil samples and duplicates collected within the Indiana Street crossing and Wind Blown Area EU are summarized in Table 4-6.

**Table 4-6 Uranium Summary Statistics for Soil Samples from Indiana Street Crossing**

Soil Sample Location	U-234		U-235		U-238	
	Activity	Qualifier	Activity	Qualifier	Activity	Qualifier
E1	1.15		0.048		1.11	
E2	0.9		0.02	U	0.88	
E3	<b>1.18</b>		0.06		1.21	
E4	0.96		0.047		1.11	
E5	0.94		0.029		1.04	
E6	1.05		0.064	U	1.13	
E7	0.89		0.066		1.17	
E8	1.16		<b>0.075</b>		1.19	
E9	1.11		0.047		1.1	
E10	1.06		0.033		<b>1.23</b>	
E11	0.94		0.066	U	0.98	
E12	1.01		0.061		1.07	
E13	1.09		0.061		1.09	
E14	1.16		0.049		1.15	
E15	1.15		0.03	U	1.2	
E16	0.97		0.064		1.1	
E17	1.17		0.06		1.05	
<b>Summary Statistics</b>						
Total Number of Results	17		17		17	
Total Number of Results above MDC	17		13		17	
Detection Frequency	100%		76%		100%	
Minimum Activity	0.89		0.02		0.88	
Maximum Activity	1.18		0.075		1.23	
Arithmetic Mean Activity	1.05		0.054		1.11	
Standard Deviation	0.10		0.02		0.09	

Notes:

1. Activity is in pCi/g
2. Qualifier assigned by lab. A "U" indicates that the result was below the MDC.
3. Mean and standard deviation calculations based on values above MDC.
4. Duplicates and ERBs removed for calculations

The U-234 activities were all above their MDCs, but less than the background level of 2.25 pCi/g (Table 1-3). The maximum U-234 activity reported in a Project sample from this exposure unit (1.18 pCi/g in sample E3) is an order of magnitude lower than Wildlife Refuge Worker PRG of



20 pCi/g (Table 2-4). The mean U-234 activity of the Project soil samples, 1.05 pCi/g, is less than the mean U-234 activity (1.12 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-2).

The U-235 activity in 13 of the 17 Project soil samples were above their MDCs. All U-235 values were less than the background level of 0.095 pCi/g (Table 1-3). The maximum U-235 activity reported in a Project sample from this exposure unit (0.075 pCi/g in sample E8) is two orders of magnitude lower than the Wildlife Refuge Worker PRG of 4.5 pCi/g (Table 2-4). The mean U-235 activity of the Project soil samples, 0.054 pCi/g, is lower than the mean U-235 activity (0.0827 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-2).

The U-238 activity in all Project soils samples was above their MDCs, but less than the background level of 2.00 pCi/g (Table 1-3). The maximum U-238 activity reported in a Project sample from this exposure unit (1.23 pCi/g in sample E10) is an order of magnitude lower than the Wildlife Refuge Worker PRG of 22.9 pCi/g (Table 2-4). The mean U-238 activity of the Project soil samples, 1.11 pCi/g, is slightly lower than the mean U-238 activity (1.12 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-2).

## **5.0 SUMMARY AND CONCLUSIONS**

This section provides a summary of the americium, plutonium, and uranium results from the Project soil samples.

### **5.1 Summary**

EA personnel collected 25 (plus 2 duplicate) surface soil samples along planned trail crossing locations on the Rocky Flats Refuge and land to the east and north of the refuge on July 1-3, 2019 (Figures 1-2a and 1-2b). ALS analyzed the soil samples for Am-241, Pu-238, Pu-239/240, U-234, U-235, and U-238.

#### **5.1.1 Americium**

The following discussion provides a summary of how the Project Am-241 activities compare to background levels (Table 1-3), Wildlife Refuge Worker PRGs (Table 2-4), and the mean values calculated for the two exposure units in the RI/FS Report (Tables 1-1 and 1-2).

All samples collected from the CO-128 crossing location (Rock Creek Drainage EU) possessed Am-241 activities below the sample MDC. In contrast, the Am-241 activity in all samples collected from the Indiana Street crossing location (Wind Blown Area EU) were above their MDC, ranging from 0.117 pCi/g to 1.740 pCi/g.

#### Background

The MDCs for the “non-detect” samples collected from the CO-128 crossing location (Rock Creek Drainage EU) are all less than the background level of 0.022 pCi/g (Table 1-3).

The Am-241 activity in all samples collected from the Indiana Street crossing location (Wind Blown Area EU) were above the background level of 0.022 pCi/g (Table 1-3).

#### Wildlife Refuge Worker PRG

The WRW PRG for Am-241 activity is 11.5 pCi/g (Table 2-4). This PRG is over one order of magnitude greater than the maximum Am-241 activity detected in a Project sample (1.74 pCi/g on the east side of Indiana Street, east of the Wind Blown Area EU in sample E15).

#### RI/FS Report Mean Activity

The mean Am-241 activities calculated for the various exposure units in the RI/FS Report are summarized in Tables 1-1 and 1-2. The mean Am-241 activities at both the CO-128 crossing location (Rock Creek Drainage EU) and the Indiana Street crossing location (Wind Blown Area EU) are less than the mean value calculated in the RI/FS Report the corresponding exposure units.

#### **5.1.2 Plutonium**

The following discussion provides a summary of how the Project plutonium isotope activities compare to background levels (Table 1-3), Wildlife Refuge Worker PRGs (Table 2-4), and the mean values calculated for the two exposure units in the RI/FS Report (Tables 1-1 and 1-2).

### 5.1.2.1 Pu-238

All samples collected from the CO-128 crossing location (Rock Creek Drainage EU) possessed Pu-238 activities below the sample MDC. In contrast, the Pu-238 activity in most samples collected from the Indiana Street crossing location (Wind Blown Area EU) were above their MDC, ranging from 0.018 pCi/g to 0.2 pCi/g.

#### Background

A background level for Pu-238 was not included in the RI/FS Report table used as the reference for Table 1-3.

#### Wildlife Refuge Worker PRG

The WRW PRG for Pu-238 is 22.9 pCi/g (Table 2-4). This PRG is over two orders of magnitude greater than the maximum Pu-238 activity detected in a Project sample (0.2 pCi/g in Wind Blown Area EU sample E15).

#### RI/FS Report Mean Activity

Summary statistics for Pu-238 activities were only calculated for the Wind Blown Area EU in the RI/FS Report (Tables 1-1 through 1-2). The mean Pu-238 activity of the Indiana Street crossing soil samples, 0.08 pCi/g, is less than the mean Pu-238 activity (0.447 pCi/g) calculated for the Wind Blown Area EU in the RI/FS Report.

### 5.1.2.2 Pu-239/240

At the CO-128 crossing (Rock Creek Drainage EU), the Pu-239/240 activity in five of eight samples were below the MDC. At the Indiana Street crossing (Wind Blown Area EU), the Pu-239/240 activity in all samples was above the MDC.

#### Background

The Pu-239/240 activities, including the MDCs for the “non-detect” results, in soil samples collected from the CO-128 crossing location (Rock Creek Drainage EU) are all less than the background level of 0.066 pCi/g (Table 1-3).

The Pu-239/240 activity in all samples collected from the Indiana Street crossing location (Wind Blown Area EU) were above the background level of 0.066 pCi/g (Table 1-3).

#### Wildlife Refuge Worker PRG

The WRW PRG for Pu-239/240 is 9.3 pCi/g (Table 2-4). The Pu-239/240 activity in all soil samples collected from the CO-128 crossing location (Rock Creek Drainage EU) are two orders of magnitude below the WRW PRG. However, the Pu-239/240 activity in one sample taken at the Indiana Street crossing location exceeded the PRG for Pu-239/240 (19.4 pCi/g east of the Wind Blown Area EU in sample E15) but was less than half of the approved 50 pCi/g Pu-239/240 clean-up (USEPA, 2006) standard for Rocky Flats. The clean-up standard of 50 pCi/g was based on a risk level of  $5 \times 10^{-6}$ , which is in the approved EPA risk range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  (Table 1-5).

### RI/FS Report Mean Activity

The mean Pu-239/240 activities calculated for the two exposure units in the RI/FS Report are summarized in Tables 1-1 and 1-2.

The mean Pu-239/240 activity in the CO-128 crossing location soil samples, 0.031 pCi/g, was less than the mean value of 0.222 pCi/g calculated in the RI/FS Report for the Rock Creek Drainage EU surficial soils (Table 1-1).

The mean Pu-239/240 activity in the Indiana Street crossing location soil samples, 4.406 pCi/g, was less than the mean value of 9.44 pCi/g calculated in the RI/FS Report for the Wind Blown Area EU (Table 1-2).

### **5.1.3 Uranium**

The following discussion provides a summary of how the Project uranium isotope activities compare to background levels (Table 1-3), Wildlife Refuge Worker PRGs (Table 2-4), and the mean values calculated for both exposure units in the RI/FS Report (Tables 1-1 through 1-2).

#### **5.1.3.1 U-234**

U-234 activities were reported above the sample MDC in all Project soil samples.

#### Background

The U-234 activity in all soil samples collected at both crossing locations is less than the background level of 2.25 pCi/g.

#### Wildlife Refuge Worker PRG

The WRW PRG for U-234 is 20.0 pCi/g (Table 2-4). This PRG is an order of magnitude greater than the maximum U-234 activity detected in Project soil samples of 1.18 pCi/g in sample D8 at the CO-128 crossing location and sample E3 at the Indiana Street crossing.

### RI/FS Report Mean Activity

The mean U-234 activities calculated for both exposure units in the RI/FS Report are summarized in Tables 1-1 and 1-2.

The mean activity of the soil samples from the CO-128 crossing location, 0.92 pCi/g, is less than the mean U-234 activity (1.07 pCi/g) calculated for the Rock Creek Drainage EU in the RI/FS Report (Table 1-1).

The mean U-234 activity of the soil samples from the Indiana Street crossing location, 1.05 pCi/g, is less than the mean U-234 activity (1.12 pCi/g) calculated for the Wind Blown Area EU in the RI/FS Report (Table 1-2).

#### **5.1.3.2 U-235**

The U-235 activities in all soil samples collected from the CO-128 crossing location were above the sample MDC. The U-235 activities in most soil samples collected from the Indiana crossing location were above the sample MDC.

### Background

The U-235 activity in all Project samples is less than the background level of 0.095 pCi/g.

### Wildlife Refuge Worker PRG

The WRW PRG for U-235 is 4.5 pCi/g (Table 2-4). This PRG is two orders of magnitude greater than the maximum U-235 activity detected in a Project soil sample (0.075 pCi/g east of the Wind Blown Area EU in sample E8).

### RI/FS Report Mean Activity

The mean U-235 activities calculated for the various exposure units in the RI/FS Report are summarized in Tables 1-1 through 1-2.

The mean activity of the CO-128 crossing location soil samples, 0.058 pCi/g, is slightly below the mean U-235 activity (0.0641 pCi/g) calculated for the Rock Creek Drainage EU in the RI/FS Report (Table 1-1).

The mean U-235 activity of the Indiana Street crossing location soil samples, 0.052 pCi/g, is lower than the mean U-235 activity (0.0827 pCi/g) calculated for the Wind Blown Area EU in the RI/FS Report (Table 1-2).

## **5.1.3.3 U-238**

U-238 activities were reported above the sample MDC in all Project soil samples.

### Background

The U-238 activity in all Project soil samples is less than the background level of 2.00 pCi/g.

### Wildlife Refuge Worker PRG

The WRW PRG for U-238 activity is 22.9 pCi/g (Table 2-4). This PRG is over one order of magnitude greater than the maximum U-238 activity detected in a Project sample (1.23 pCi/g in the Wind Blown Area sample E10).

### RI/FS Report Mean Activity

The mean U-238 activities calculated for the both exposure units in the RI/FS Report are summarized in Tables 1-1 through 1-2.

The mean activity of the CO-128 crossing location soil samples, 0.94 pCi/g, is less than the mean U-238 activity (1.11 pCi/g) calculated for the Rock Creek Drainage EU in the RI/FS Report (Table 1-1).

The mean U-238 activity of the Indiana Street crossing location soil samples, 1.11 pCi/g, is slightly lower than the mean U-238 activity (1.12 pCi/g) calculated for the Wind Blown Area EU in the RI/FS Report (Table 1-2).

## **5.2 Conclusions**

The goal of this Project is to generate radionuclide data for soils along the proposed trail crossings that can be compared to the data used to perform the Comprehensive Risk Assessments

published in Appendix A of the RI/FS Report (Kaiser-Hill Company, 2006). The potential risks to recreational visitors using the new Refuge trails can be estimated by linking the Project results to the results of the 2006 studies.

Throughout this report, the americium, plutonium, and uranium activities were compared to background levels (Table 1-3), Wildlife Refuge Worker PRGs (Table 2-4), and the mean values calculated for the various exposure units in the RI/FS Report (Tables 1-1 through 1-2). In most cases, the levels of the radionuclides in Project samples were below these RI/FS benchmark values as summarized in Tables 5-1 through 5-6.

**Table 5-1 Comparison of Project Am-241 Results to RI/FS Benchmarks**

Sampled Area	Associated Exposure Unit	Project Samples Less Than Background	Project Samples Less Than WRW PRG	Project Sample Mean Less Than RI/FS Mean
CO-128 Crossing	Rock Creek Drainage	✓	✓	✓
Indiana Street Crossing	Wind Blown Area		✓	✓

Note: A check indicates that the Project result was less than the RI/FS benchmark value.

The Am-241 values in the soil samples from the Indiana Street crossing were above background levels. However, the Am-241 activity in all Project samples was below the Wildlife Refuge Worker PRG and less than the mean values calculated for both exposure units in the RI/FS Report.

**Table 5-2 Comparison of Project Pu-238 Results to RI/FS Benchmarks**

Sampled Area	Associated Exposure Unit	Project Samples Less Than Background	Project Samples Less Than WRW PRG	Project Sample Mean Less Than RI/FS Mean
CO-128 Crossing	Rock Creek Drainage	N.A.	✓	N.A.
Indiana Street Crossing	Wind Blown Area	N.A.	✓	✓

Notes:

1. A check indicates that the Project result was less than the RI/FS benchmark value.
2. N.A. = Not applicable (values not published in the RI/FS Report).

The Pu-238 activity in Project soil samples were below the RI/FS Benchmark values where available for comparison.

**Table 5-3 Comparison of Project Pu-239/240 Results to RI/FS Benchmarks**

Sampled Area	Associated Exposure Unit	Project Samples Less Than Background	Project Samples Less Than WRW PRG	Project Sample Mean Less Than RI/FS Mean
CO-128 Crossing	Rock Creek Drainage	✓	✓	✓
Indiana Street Crossing	Wind Blown Area			✓

Note: A check indicates that the Project result was less than the RI/FS benchmark value.

The Pu-239/240 values in the soil samples from the Indiana Street crossing location were above background levels. One project sample from the Indiana Street crossing location exceeded the Wildlife Refuge Worker PRG but was less than half the 50 pCi/g Pu239/240 clean-up standard for Rocky Flats. The mean Pu-239/240 activity at both crossing locations was less than the applicable RI/FS mean activity.

**Table 5-4 Comparison of Project U-234 Results to RI/FS Benchmarks**

Sampled Area	Associated Exposure Unit	Project Samples Less Than Background	Project Samples Less Than WRW PRG	Project Sample Mean Less Than RI/FS Mean
CO-128 Crossing	Rock Creek Drainage	✓	✓	✓
Indiana Street Crossing	Wind Blown Area	✓	✓	✓

Note: A check indicates that the Project result was less than the RI/FS benchmark value.

The U-234 activities in soil samples from both crossing locations were below the applicable background levels and below the Wildlife Refuge Worker PRG. The Project sample means at both crossing locations were less than the applicable RI/FS mean activities.

**Table 5-5 Comparison of Project U-235 Results to RI/FS Benchmarks**

Sampled Area	Associated Exposure Unit	Project Samples Less Than Background	Project Samples Less Than WRW PRG	Project Sample Mean Less Than RI/FS Mean
CO-128 Crossing	Rock Creek Drainage	✓	✓	✓
Indiana Street Crossing	Wind Blown Area	✓	✓	✓

Note: A check indicates that the Project result was less than the RI/FS benchmark value.

The U-235 activities in soil samples from both crossing locations were below the applicable background levels and below the Wildlife Refuge Worker PRG. The Project sample means at both crossing locations were less than the applicable RI/FS mean activities.

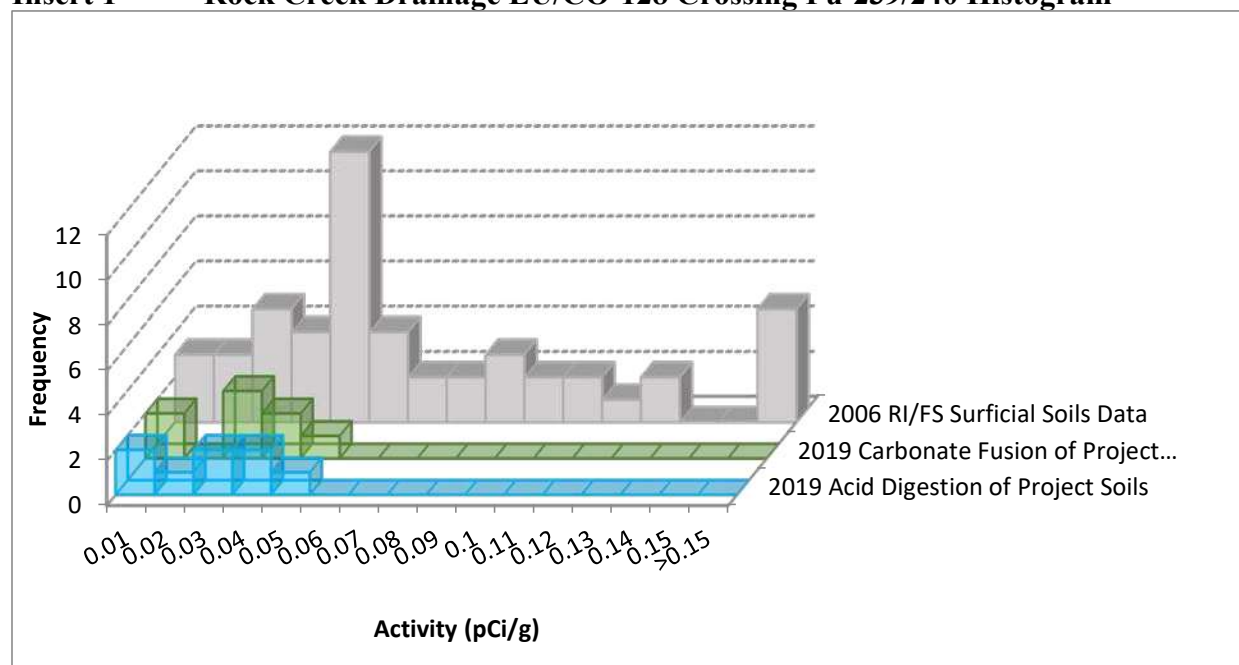
**Table 5-6 Comparison of Project U-238 Results to RI/FS Benchmarks**

Sampled Area	Associated Exposure Unit	Project Samples Less Than Background	Project Samples Less Than WRW PRG	Project Sample Mean Less Than RI/FS Mean
CO-128 Crossing	Rock Creek Drainage	✓	✓	✓
Indiana Street Crossing	Wind Blown Area	✓	✓	✓

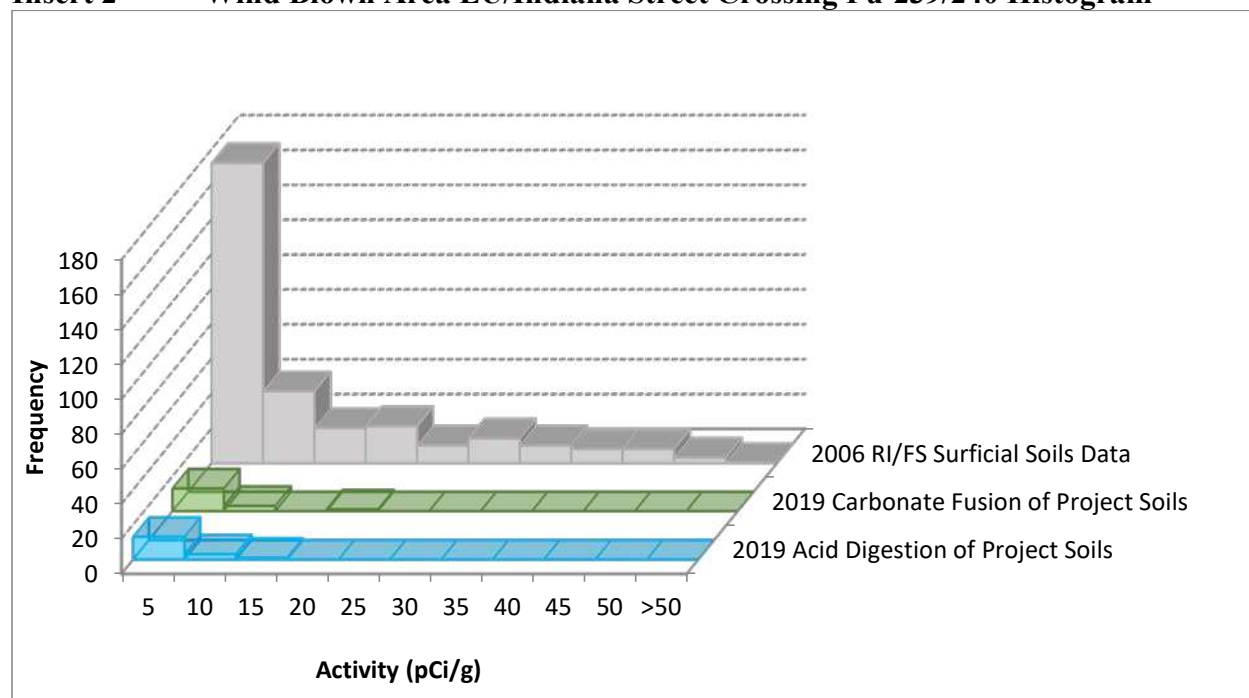
Note: A check indicates that the Project result was less than the RI/FS benchmark value.

The U-238 activities in soil samples from both crossing locations were below the applicable background levels and below the Wildlife Refuge Worker PRG. The Project sample mean at the Indiana Street crossing location was slightly less than the applicable RI/FS mean activities.

To assess the Project radionuclide data populations further, EA compared the distribution of the activity of each radionuclide in the soil samples from the crossing locations to the activity in surface soils in the corresponding exposure unit populations. The results of these comparisons are provided, in the form of histograms, in Appendix C. The results of this comparison for Pu-239/240 for the two crossing locations are reproduced in Inserts 1 and 2.

**Insert 1 Rock Creek Drainage EU/CO-128 Crossing Pu-239/240 Histogram**



**Insert 2 Wind Blown Area EU/Indiana Street Crossing Pu-239/240 Histogram**

Review of the histograms in Inserts 1 2 indicates that the Pu-239/240 activity in surficial soils (0 to 6 inches) along the proposed trail crossings are at the lower end of the activities observed within the two associated exposure units investigated as part of the 2006 RI/FS. As illustrated by the histograms in Appendix C, the distributions of the Am-241, Pu-238, U-234, U-235 and U-238 are similar to those exhibited by Pu-239/240.

The Project data summarized in Tables 5-1 through 5-6 and illustrated on Inserts 1 and 2 and Appendix C are consistent with, if not generally lower than, the radionuclide data used in the Comprehensive Risk Assessments published in Appendix A of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study-Feasibility Study Report (Kaiser-Hill Company, 2006). Consequently, it is EA's opinion that the findings and conclusions of the 2006 RI/FS, as updated in DOE (2017), are applicable to the Project sample populations, assuming the same exposure assumptions apply, and that the risk calculations are performed in the same manner. EA did not obtain any results from the soil samples collected and analyzed that indicate a higher risk level than presented in the 2006 Kaiser-Hill Company report and the DOE (2017) report, which allowed for public access to the Project area.

## **6.0 REFERENCES**

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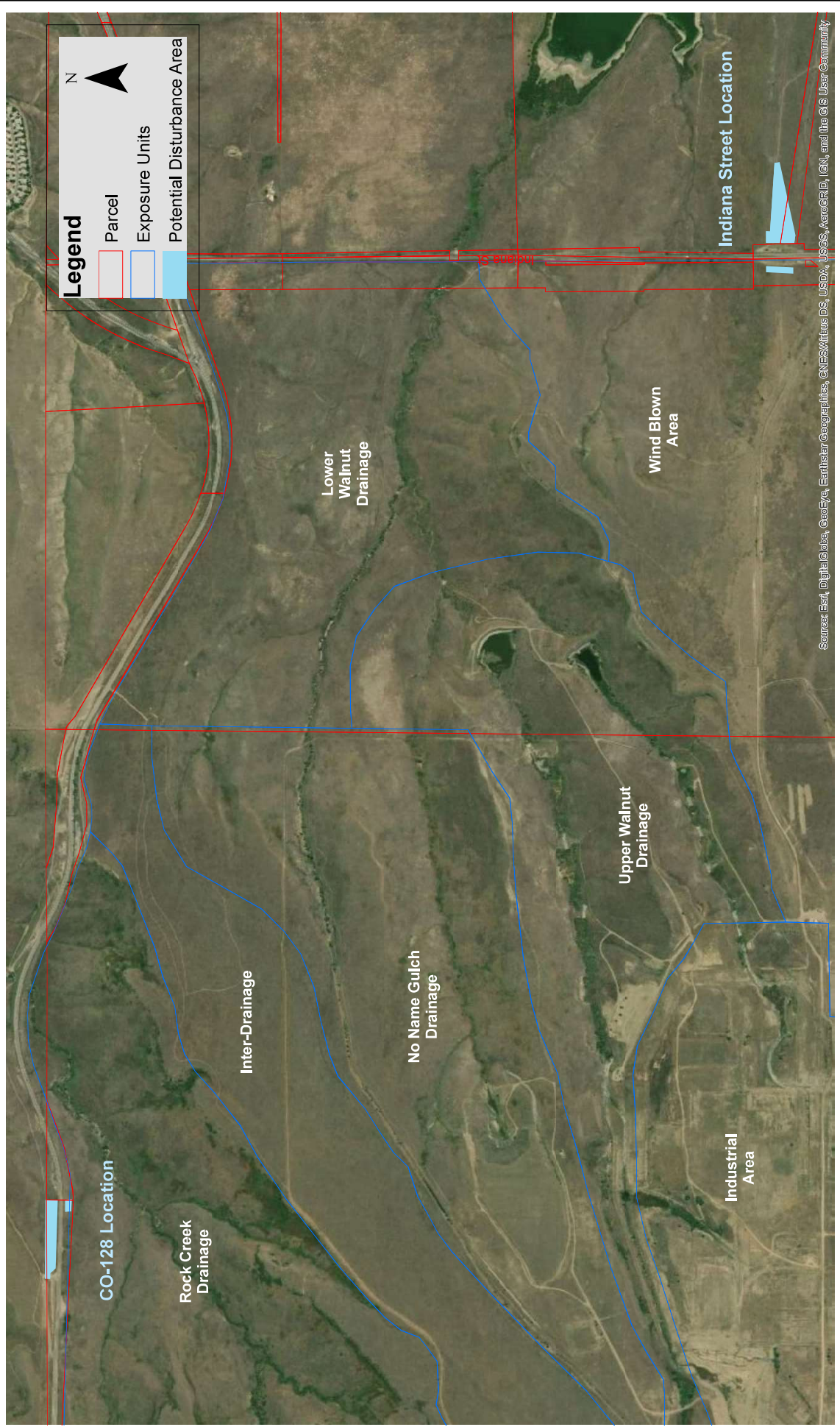
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Map Service Layer Credits: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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## **FIGURES**



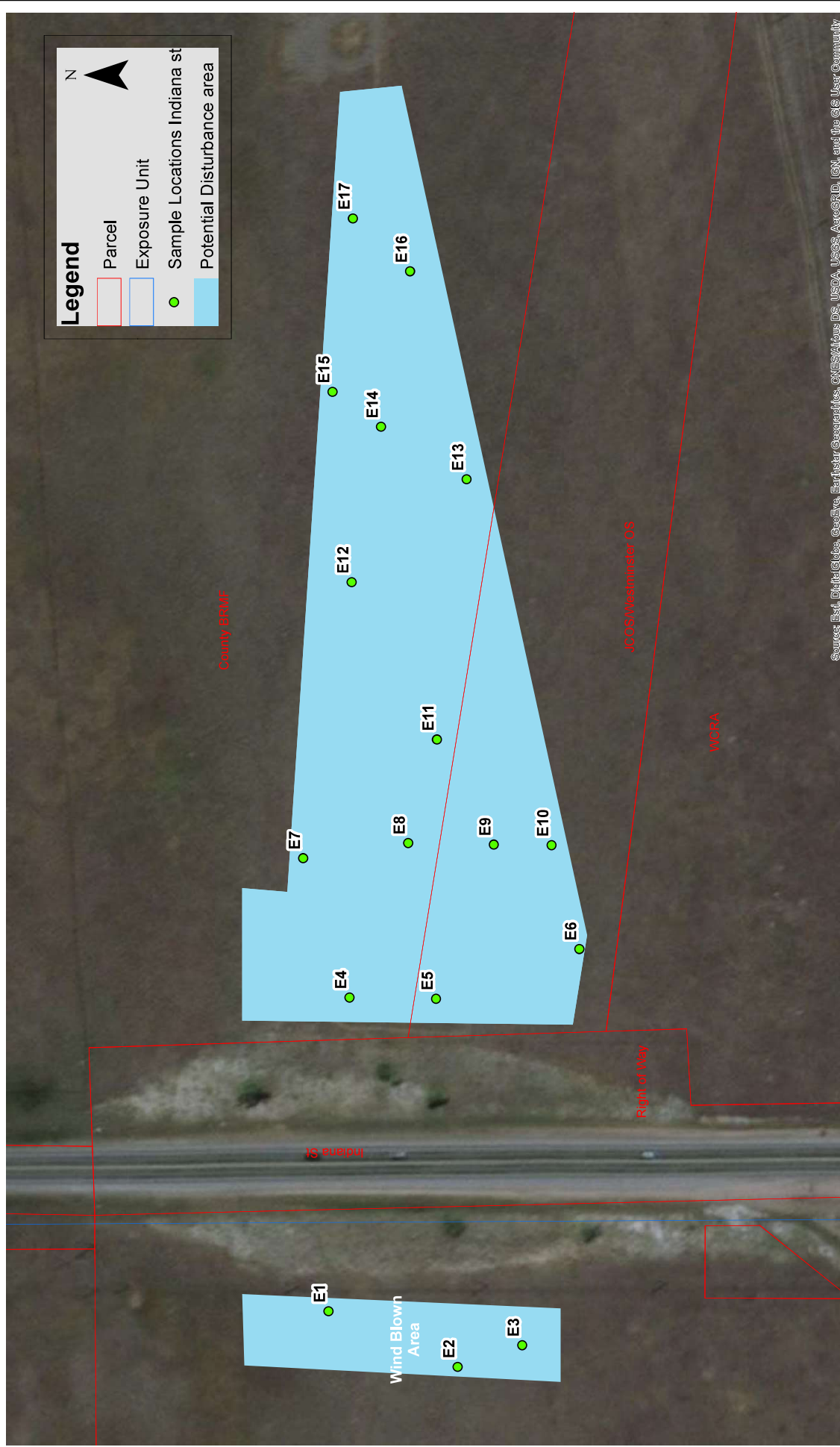
Project No. 110836



February 2020

**Figure 1-1 Site Location**  
**Rocky Mountain Greenway**





Project No. 110836



February 2020

**Figure 1-2a**  
Sample Location  
Indiana Street Crossing  
Rocky Mountain Greenway



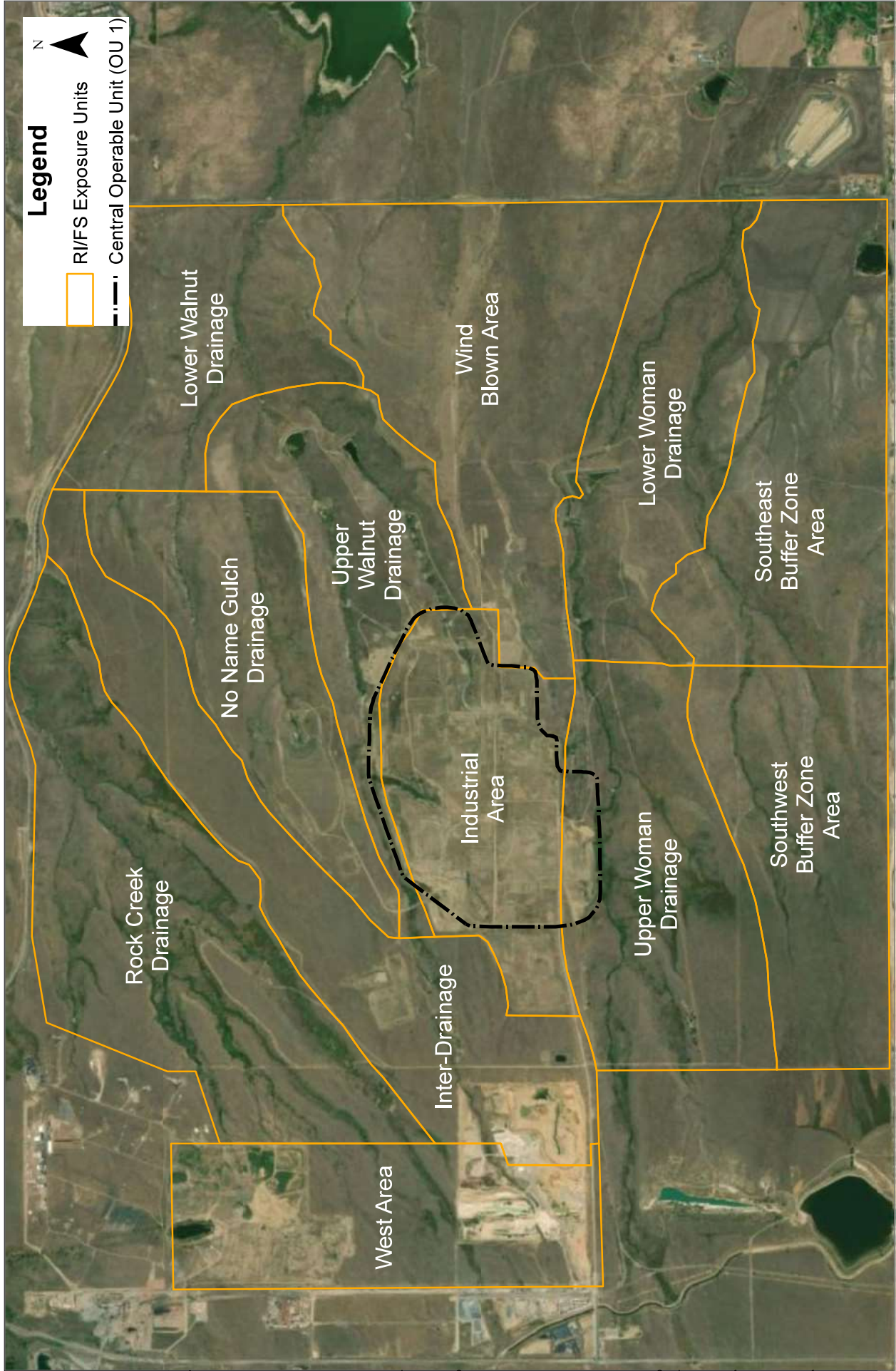
Project No. 110836



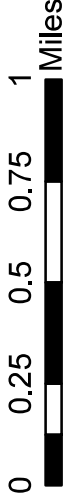
February 2020

**Figure 1-2b**  
**Map of Sample Locations on Potential Disturbance Area**  
**CO-128 Crossing**  
**Rocky Mountain Greenway**

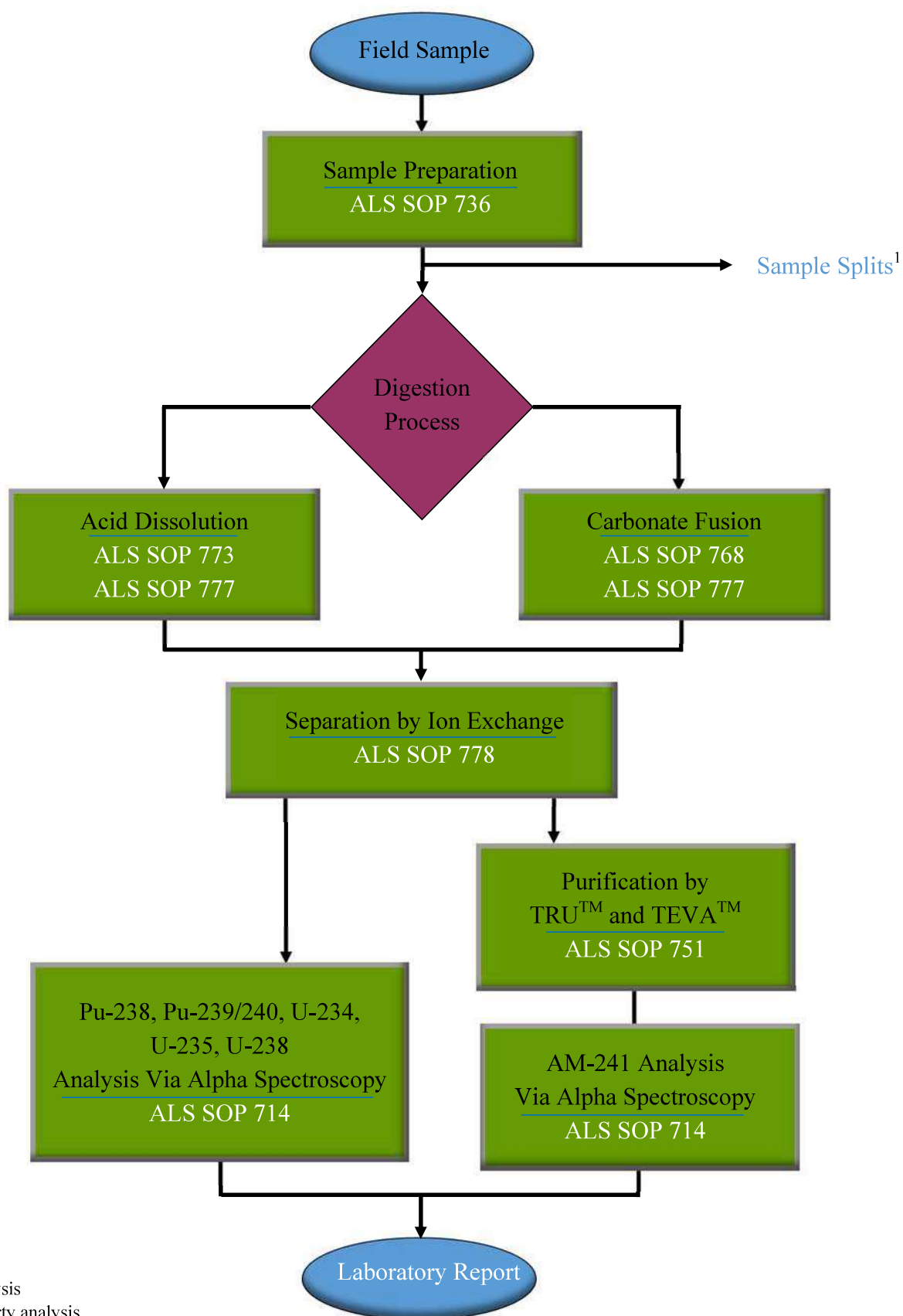




Project No. 110836



**FIGURE 1-3**  
**2006 RI/FS EXPOSURE UNIT LOCATIONS**  
**ROCKY MOUNTAIN GREENWAY**





## **APPENDICES**

## **APPENDIX A**

# **Sampling and Analysis Plan**

## **Rocky Mountain Greenway Trail Crossings**

*Prepared for:*

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**100 Jefferson County Parkway, Suite 4500**  
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**And**

**City of Boulder**  
**Boulder County**  
**City and County of Broomfield**  
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Project No. 110836

March 2019  
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Appendix A	ALS Fort Collins Quality Assurance Manual
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<b>Acronym</b>	<b>Explanation</b>
AD	Absolute Difference
AEU	Aquatic Exposure Unit
ALS	ALS Global Laboratories
CAD/ROD	Corrective Action Decision/Record of Decision
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CO-128	Colorado Highway 128
COC	Contaminants Of Concern
DOE	Department of Energy.
DQI	Data Quality Indicator
DQO	Data Quality Objective
EA	Engineering Analytics, Inc.
EDD	Electronic Data Delivery
EPA	United States Environmental Protection Agency
EPC	Exposure Point Concentration.
ERB	Equipment Rinsate Blank
EU	Exposure Unit
FHWA	Federal Highway Administration.
FLAP	Federal Land Access Program.
FSP	Field Sampling Plan
HHRA	Human Health Risk Assessment
IDW	Investigation Derived Wastes
LBGR	Lower Bounds Gray Region
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management System
LM	Legacy Management
M2SD	Background Mean Plus Two Standard Deviations
MARSSIM,	Multi-Agency Radiation Survey and Site Investigation Manual
MARLAP	Multi-Agency Radiological Laboratory Analytical Protocols
MB	Matrix Blanks
MDC	Minimum Detectable Concentrations
MQO	Method Quality Objective
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NIST	National Institute of Standards and Technology
NRG	Nuclear Regulatory Commission
OU	Operable Unit
pCi/g	Picocuries per gram.
PCOC	Potential Contaminants Of Concern
PNNL	Pacific Northwest National Laboratory
PRG	Preliminary Remediation Goals
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act.

<b>Acronym</b>	<b>Explanation</b>
RESRAD	Residual Radioactivity Computer Program
RFP	Request for Proposals
RI/FS	Remedial Investigation/Feasibility Study
RMG	Rocky Mountain Greenway
RPD	Relative Percent Difference
RSAL	Radionuclide Soil Action Levels
SAP	Sampling and Analysis Plan
SCM	Site Conceptual Model
SOP	Standard Operating Procedure
TPU	Total Propagated Uncertainty
UBGR	Upper Bounds Gray Region
UCL	Upper Confidence Limit
USDOE	United States Department of Energy
USFWS	United States Fish and Wildlife Service
VSP	Visual Sampling Plan
WRV	Wildlife Refuge Visitor
WRW	Wildlife Refuge Worker
WRW-PRGs	Wildlife Refuge Worker - Preliminary Remediation Goals

## **1.0 INTRODUCTION**

In May 2016, Jefferson County Open Space, the City and County of Broomfield, City of Arvada, City of Westminster, Boulder County, and the City of Boulder (collectively referred to as the “Partner Group”) submitted an application to the Federal Lands Access Program (FLAP), a funding source administered by the Federal Highway Administration (FHWA), to construct two trail crossings that will link planned trail improvements at the Rocky Flats National Wildlife Refuge (Refuge) with existing Partner Group trail infrastructure adjacent to the Refuge (Figure 1-1). This project is part of the broader Rocky Mountain Greenway (RMG) Trail initiative, a regional trails project to connect Front Range federal lands (Rocky Mountain Arsenal National Wildlife Refuge, Two Ponds National Wildlife Refuge, Rocky Flats National Wildlife Refuge, and Rocky Mountain National Park) via a multiuse path. Information on the RMG Trail initiative is available at <https://rockymtngreenway.org>.

In August of 2016, FHWA notified the Partner Group of shortlist funding status and requested that the required soil sampling and testing be completed before project scoping, design and construction begin. In fall 2017, the Partner Group issued a Request for Proposal (RFP) to perform the confirmatory soil sampling and analysis (the “Project”). Engineering Analytics, Inc. (EA) of Fort Collins, Colorado was awarded the Project by the Partner Group. Phase I of the Project is to develop a Sampling and Analysis Plan (SAP) that will document the procedural and analytical requirements of this one-time collection of soil samples to confirm the activity of radionuclides in the areas where Project-related construction will be performed. This document fulfills the requirements of Phase I.

### **1.1 Purpose and Goal**

The purpose of this SAP is to define the procedures for the collection and analysis of soil samples obtained at the two proposed crossings that will connect existing trail systems of the Partner Group to a trail system operated by the U.S. Fish and Wildlife Service (USFWS) on the Refuge (Figure 1-1). This document is a stand-alone SAP, meaning that it contains elements common to a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP).

The goal of this SAP is to promote the generation of soil radionuclide data that meet standard environmental data quality requirements and are comparable to the risk assessment values used at the site. By accomplishing this goal, the soil data from this Project can be compared to the data, findings, and conclusions of historic Rocky Flats soil sampling risks assessments such as the Comprehensive Risk Assessments of Appendix A of the Kaiser-Hill Company 2006 Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study-Feasibility Study Report (RI/FS). Linking the current data to the 2006 studies, the potential risks to visitors near the two proposed crossings can be established.

### **1.2 Scope**

The scope of this SAP is limited to collection and analysis of radionuclide data in soil samples in and near the two proposed crossing locations. The proposed crossings are illustrated on Figure 1-1 and are described below:



- Crossing Location D (“Bridge Crossing”): A proposed bridge over Indiana Street near the abandoned railroad grade just north of the former Rocky Flats East Entrance. This location lies adjacent to the *Wind Blown Area Exposure Unit* (EU) described in the 2006 RI/FS.
- Crossing Location E (“Underpass Crossing”): A proposed box culvert underpass below State Highway 128 (CO-128) just east of the Coalton/High Plains Trail access parking area. This location lies adjacent to the *Rock Creek Drainage Exposure Unit* described in the 2006 RI/FS.

This is a planned one-time sampling event with soil sample locations limited to the footprints of the crossing structures, the footprints of the new trails connecting the crossings to existing Partner Group trail systems east of Indiana Street (Bridge Crossing) and north of CO-128 (Underpass Crossing), and the footprints of the new trails connecting both crossings to planned USFWS trails (stopping at the Rocky Flats boundary).

### 1.3 Project Organization

The roles of the senior professionals on the EA Project team are provided in Table 1-1.

**Table 1-1 Senior EA Project Staff and Roles**

<b>Key Staff</b>	<b>Project Role</b>
Dan Overton, M.S., P.E.	Senior Reviewer
Jason Andrews, M.E., P.E.	Project Manager
Bruce Marshall, M.S., P.G.	Principal Geochemist
Dr. Craig Little, Ph.D.	Health Physicist and Radiation Protection

EA’s point of contact with the Partner Group is Mr. Andrew Valdez of Jefferson County, Open Space.

## 2.0 BACKGROUND

A comprehensive discussion of the Rocky Flats operational history and remediation is beyond the scope of this document. Both proposed crossings are located outside the boundary of the current Department of Energy (DOE) Legacy Management Site on property immediately adjacent to the Refuge. Consequently, EA's document review primarily focused on reports pertaining to the large portion of the Rocky Flats site outside the industrial area (i.e., in the Peripheral Operable Unit). Even with this narrowed focus, the number of documents available for review pertaining to the site characterization and environmental remediation is voluminous. Documents which EA reviewed to develop this SAP are summarized in Table 2-1.

**Table 2-1 Select Documents Reviewed for Development of the SAP**

<b>Published by</b>	<b>Document Title</b>
Applicable standards from the United States Nuclear Regulatory Commission (NRC)	(NRC Title 10 Part 20) and Environmental Protection Agency Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).
Central Federal Lands, Federal Highway Administration.	Rocky Mountain Greenway Feasibility Study. 2016.
Chem-Risk (Phase I) & Radiological Assessment Corporation (Phase II).	Rocky Flats Historical Public Exposures Studies prepared for the Colorado Department of Public Health and Environment. 1990-1999.
Colorado Department of Public Health and Environment	Colorado Code of Regulations, Radiation Control – Standards for Protection Against Radiation (6 CCR 1007-1 Part 04), Adopted June 17, 2015
Colorado Department of Health and Public Environment,	Public Testimony by State Project Manager. 2016.
CTL Thompson Inc.	Limited Surface Screening for Radiation Levels Candelas Development, Arvada. Colorado August 24, 2011.
CTL Thompson Inc.	Limited Surface Screening for Radiation levels Candelas Development, Filing 3, Arvada, Colorado March 8, 2013.
Hydros Consulting	Offsite Human Health Risk Assessment Findings from Rocky Flats. June 3, 2014.
Institute for Energy and Environmental Research	Setting Cleanup Standards to Protect Future Generations: The Scientific Basis of the Subsistence Farmer Scenario and Its Application to the Estimation of Radionuclide Soil Action Levels (RSALs) for Rocky Flats. December 2001.

<b>Published by</b>	<b>Document Title</b>
Jefferson and Boulder Counties, Colorado	Corrective Action Decision/Record of Decision for Rocky Flats Plant (USDOE) Peripheral Operable Unit and Central Operable Unit. September 2006.
Kaiser-Hill Company	RCRA Facility Investigation - Remedial Investigation/Corrective Measures Study – Feasibility Study Report for the Rocky Flats Environmental Technology Site. June 2006.
Kaiser-Hill Company	Industrial Area and Buffer Zone Sampling and Analysis Plan Modification 1. May 2004.
Risk Assessment Corporation	RAC Report No. 5-RSALOP-RSAL-1999-Final “Final Report Task 6: Sampling Protocols, Radionuclide Soil Action Level Oversight Panel.” December 1999.
US Fish and Wildlife Service.	Modified Level III Pre-acquisition Environmental Contaminants Survey for Rocky Flats Environmental Technology Site. 2006.
Boston Chemical Data Corp.	Field investigation and laboratory report: LeRoy Moore Ph.D. Rocky Mountain Peace & Justice Center. Report on the 2011 Rocky Flats sampling and analysis campaign. January 20, 2012.
Colorado State University Department of Radiological Health Sciences	Soil Sampling Site Characterization Near the Rocky Flats Plant. November 21, 1994.
Colorado State University Department of Radiological Health Science.	The Spatial Distribution of Plutonium in Soil Near Rocky Flats Plant. November 21, 1994.
Margulies, T.D., Schonbeck, N.D., Morin-Voillequé, N.C., James K.A., and Lavelle, J.M.	A comparative study of <sup>239,240</sup> Pu in soil near the former Rocky Flats Nuclear Weapons Facility, Golden, CO. 2004.

## 2.1 Rocky Flats History

EA primarily relied on the DOE’s Rocky Flats, Colorado Fact Sheet (DOE, 2017) as the source of information for the history of the site. Much of the information provided below is taken directly from the DOE (2017) document.

The Rocky Flats site is situated on a plateau at the eastern edge of the Front Range of the Rocky Mountains, at an elevation close to 6,000 feet. Most of the approximately 6,500 acres of the property was used as a security buffer surrounding the site’s 385-acre industrial area. The Rocky Flats Plant was part of the nationwide nuclear weapons complex that manufactured weapons components under the jurisdiction and control of the DOE and its predecessor agencies. From 1952 to 1994, the plant’s primary mission was producing nuclear and nonnuclear weapons components for America’s arsenal. The key component produced at Rocky Flats was the plutonium pit, or

“trigger,” for nuclear weapons. Operational problems, including fires, during the plant’s history and standard practices used at the time resulted in contamination from plutonium, beryllium, and other hazardous substances both within and outside the industrial area.

After nuclear weapons components production ended, the facility’s mission changed to cleanup and closure, and it was renamed the Rocky Flats Environmental Technology Site. In October 2005, DOE and its contractor completed an accelerated 10-year, \$7 billion cleanup of chemical and radiological contamination in production buildings and limited areas across the site. The DOE Office of Legacy Management (LM) assumed site operation and maintenance responsibility in 2005 and received final jurisdiction in 2008. After cleanup, two operable units (OUs) defined the Rocky Flats site within the boundaries of the property. The OUs are shown in Figure 2-1:

- OU 1. Central OU
- OU 2. Peripheral OU

The Peripheral OU includes most of the site and generally encompasses the portions of Rocky Flats surrounding the Central OU. The boundaries of the EU’s described in the 2006 RI/FS are also shown on Figure 2-1

The final remedy for OUs 1 and 2 was selected in the September 29, 2006 Corrective Action Decision/Record of Decision (CAD/ROD) (Jefferson and Boulder Counties, Colorado, 2006). The CAD/ROD was based on the results of the July 2006 RI/FS (Kaiser-Hill Company 2006) and Comprehensive Human Health and Ecological Risk, Assessment. The 2006 CAD/ROD determined that no action was required for the Peripheral OU.

The Peripheral OU, which served as the security buffer zone during the operational period of the site, was subsequently transferred to the U.S. Department of the Interior in July 2007, to be managed by the USFWS as the Rocky Flats National Wildlife Refuge. Additional DOE-administered lands (745 acres) associated with private mineral rights on the site’s west side transferred to the Refuge in 2014.

## **2.2 Review of Select Rocky Flats Environmental Documents**

The goal of this SAP is to promote the generation of soil radionuclide data that meet standard quality requirements and are comparable to the risk assessment values used at the site. To that end, EA reviewed select historic documents to ascertain how soil samples had previously been collected. The objective of this review was to establish (a) a method(s) to collect soil samples, and (b) a depth(s) at which to collect the soil samples that would result in radionuclide data for the crossing samples that is comparable to historic data. An additional objective of the review was to identify standard operating procedures (SOPs) relevant to the Project (e.g., equipment decontamination, investigation derived waste, sample handling) that could be adopted for use in this SAP. EA also reviewed select risk assessments to evaluate if the methodology and results can be extrapolated to visitors of the crossings and associated connector paths.

### **2.2.1 Previous Sampling Methodology**

EA primarily relied upon information in the following two documents to assess previous soil sampling protocol:

- Kaiser-Hill Company, 2014, Industrial Area and Buffer Zone Sampling and Analysis Plan Modification 1, May.
- Risk Assessment Corporation, 1999, Task 6: Sampling Protocols, Final Report submitted to the Radionuclide Soil Action Level Oversight Panel, December.

In general, previous investigators appear to have used four main methods to collect soil samples at Rocky Flats. The methods are:

- Colorado Department of Public Health and Environment (CDPHE) Method
- Rocky Flats Method
- Grab Sampling Method
- Vertical Soil Profile Method

The CDPHE method used a sampling device to obtain a soil sample from the upper ¼-inch of the soil from an area 2-inches wide by 2-3/8 inches long. Vegetation and other non-soil material are removed prior to collection. A specific number of samples, defined in the sampling plan, are collected from an area and then composited. The objective of the method is to characterize the radionuclides in the soil that could potentially be resuspended into the air and inhaled.

In the Rocky Flats Method, 10 individual samples are collected from 10-cm by 10-cm (4-inch x 4-inch) squares to a depth of 5-cm (2 inches). Samples are screened through a 10-mesh (2 mm) sieve to remove large particles and then combined to represent a sample volume of approximately 5 liters, from which a representative sample is collected for laboratory analysis. The objective of the method is to characterize the radionuclides in the soil that have accumulated in the near surface.

Grab sampling was practiced at Rocky Flats by employing a tool to collect soil samples for radionuclide analyses. The vegetation and other undesired surficial material were first removed from the area to be sampled. The soil sample is then collected to the desired depth using a stainless-steel spoon or scoop. The total number of samples and sampling interval was defined in the sampling plan. The objective of the method is to characterize the radionuclides in the soil that have accumulated at a specific depth interval.

Vertical soil profile sampling at Rocky Flats was used to define the distribution of radionuclides in the top 6 inches of soil to verify the results of radiation surveys. This sampling included the collection of discrete soil samples at 2-inch intervals corresponding to depths from 0–2 inches, 2–4 inches, and 4–6 inches. Four procedures were employed to obtain the vertical samples: (1) collection from the surface downward, (2) collection from the side wall of a small excavation, (3) collection by coring, and (4) collection from beneath concrete and asphalt pavement. The total number of samples collected, and their locations were specified in site-specific field sampling plans. A sample of approximately 500 grams was obtained for each soil profile interval.

### **2.2.2 Nature and Extent of Contamination**

As defined in the RFP, the contaminants of concern for the Project are select isotopes of americium, plutonium, and uranium. Historic maps illustrating the distribution of americium, plutonium and uranium in surface soils on and near the Refuge are produced in Figures 2-1 through 2-5. These figures provide the relative distribution of the activities of the radionuclides at Rocky

Flats, as the data are expressed in terms Wildlife Refuge Worker Preliminary Remediation Goals (WRW-PRGs). As illustrated on Figures 2-1 and 2-2, the activity of the americium-241 and plutonium 239/240 near the Underpass Crossing, which is located north of the former industrial area along CO-128, are lower than the activities near the Bridge Crossing, which is east and downwind of the former industrial area on Indiana Street. This is consistent with the distribution of plutonium described in Margulies, et al. (2004). The activities of the uranium isotopes are similar at both locations.

Summary statistics for americium, plutonium and uranium from surface soil samples collected in the Rock Creek Drainage Exposure Unit (see Volume 4 of Appendix A of the 2006 RI/FS) ([https://www.lm.doe.gov/Rocky\\_Flats/Regulations.aspx](https://www.lm.doe.gov/Rocky_Flats/Regulations.aspx)) are provided in Table 2-2. The proposed box culvert underpass below CO-128 is located adjacent to this area.

**Table 2-2 Summary Statistics for Select Radionuclides in the Rock Creek Drainage Exposure Unit (Underpass Crossing Location along CO-128)**

Radionuclide	Number of Results	Minimum Value (pCi/g) <sup>(1)</sup>	Maximum Value (pCi/g)	Arithmetic Mean Value (pCi/g)	Standard Deviation (pCi/g)
Am-241	37	-0.00738	0.950	0.0613	0.160
Pu-239/240	50	-0.00602	7.25	0.222	1.02
U-233/234	39	0.343	2.17	1.07	0.362
U-235	39	-0.109	0.466	0.0641	0.113
U-238	39	0.417	1.83	1.11	0.311

Source: Table 1.4, Volume 4 of 15, Appendix A, Kaiser-Hill Company (2006)

(1)- Radioactive decay is a probabilistic process with a Poisson distribution. When a sample has very little radioactivity in it, the result may be lower than the blank sample relied upon by the analytical laboratory. In such a situation, the reported radionuclide results would be reported as a negative number.

Review of the radionuclide data for soil samples collected within the Rock Creek Drainage EU in the CDPHE database indicates that samples were collected from depths of 0 to 2 inches to 0 to 6 inches. Approximately 60 percent of the data from samples in the Rock Creek Drainage EU were collected from the 0 to 2-inch depth interval.

Summary statistics for americium, plutonium and uranium from surface soil samples collected in the *Wind Blown Area Exposure Unit* (see Volume 9 of Appendix A of the 2006 RI/FS) are provided in Table 2-3. The proposed bridge over Indiana Street is located adjacent to this area. It is important to note that the boundaries of the *Wind Blown Area Exposure Unit* extend from the shared boundary with the Industrial Area EU eastward to Indiana Street. As illustrated in Figures 2-1 through 2-3, the general trend is for radionuclide activities to decrease eastward (away) from the Industrial Area EU towards the Bridge Crossing location.

**Table 2-3 Summary Statistics for Select Radionuclides in the Wind Blown Area Exposure Unit (Bridge Crossing Location along Indiana Street)**

Radionuclide	Number of Results	Minimum Value (pCi/g) <sup>(1)</sup>	Maximum Value (pCi/g)	Arithmetic Mean Value (pCi/g)	Standard Deviation (pCi/g)
Am-241	279	0	15.6	1.86	2.44
Pu-238	9	0.102	1.53	0.447	0.454
Pu-239/240	307	-0.00292	49	9.44	12.1
U-233/234	193	0.119	7.96	1.12	0.799
U-235	192	-0.0431	0.680	0.0827	0.0922
U-238	193	0.351	3.78	1.12	0.454

Source: Table 1.5, Volume 9 of 15, Appendix A, Kaiser-Hill Company (2006)

(1)- Radioactive decay is a probabilistic process with a Poisson distribution. When a sample has very little radioactivity in it, the result may be lower than the blank sample relied upon by the analytical laboratory. In such a situation, the reported radionuclide results would be reported as a negative number.

Review of the radionuclide data for soil samples collected within the Wind Blown Area EU in the CDPHE database indicates that samples were collected from the surface to depths ranging from 0 to 1 inch to 0 to 6 inches. Approximately 40 percent of the data were from samples collected from the 0 to 2-inch depth interval, with the next largest group being from the surface (approximately 28 percent).

### 2.2.3 Summary of Risk Assessments

The Comprehensive Risk Assessment (see Appendix A of the 2006 RI/FS) presented a Site Conceptual Model (SCM) that provided an overview of potential human exposures at Rocky Flats. The following discussion is taken primarily from that document.

Rocky Flats was divided into 12 Exposure Units (EUs) (Figure 2-1) to assess potential risks for human and terrestrial ecological receptors and 7 Aquatic EUs (AEUs) for assessing potential risks for aquatic ecological receptors. As described above, the EUs germane to the project are:

- The Wind Blown Area Exposure Unit, representing Crossing Location D (proposed bridge over Indiana Street).
- The Rock Creek Drainage Exposure Unit, representing Crossing Location E (proposed box culvert underpass below CO-128).

The EUs were designated based on known sources and potential contaminant release patterns to collectively assess areas with similar types of potential contamination. Other criteria used in distinguishing the EUs included separate watersheds, similar topography and vegetation, and expected land use.

The SCM assumed that the future land use for Rocky Flats would be as a wildlife refuge and, as such, human populations who may be present included a wildlife refuge worker (WRW) and a wildlife refuge visitor (WRV). Workers may staff a visitor center, monitor and maintain the trail

system, and track the on-site wildlife populations. Visitors may hike, bike, bird watch, etc. on the Refuge. WRW receptors were assumed to be adults, while WRV receptors were assumed to include both adults and children.

Both workers and visitors were assumed to theoretically contact contaminants in surface soil, subsurface soil, sediment, surface water, and groundwater. All exposure pathways included in the SCM were identified as complete (meaning that exposure through the pathway is at least theoretically possible). In addition, the pathways were identified as either significant or insignificant. Insignificant pathways were those that are associated with such low exposure that there would be negligible risk even if exposure occurred. The significant pathways were evaluated on an EU basis and risk calculations were only performed for significant pathways in the individual EUs. However, pathways considered to be insignificant were evaluated to ensure that the pathways are appropriately identified as such.

The following exposure pathways were identified as potentially complete and significant in the 2006 RI/FS SCM:

- Surface Soil/Sediment:
  - Incidental ingestion of surface soil/surface sediment.
  - Inhalation of dust released from surface soil/surface sediment.
  - Dermal exposure to surface soil/surface sediment.
  - External irradiation exposure from surface soil/surface sediment.
- Subsurface Soil/Sediment:
  - Incidental ingestion of subsurface soil/subsurface sediment.
  - Inhalation of particulates released from subsurface soil/subsurface sediment.
  - Dermal exposure to subsurface soil/subsurface sediment.
  - External irradiation exposure from subsurface soil/subsurface sediment.

In the first step of the human health risk assessment (HHRA), the levels of potential contaminants of concern (PCOCs) in each EU were evaluated to assess whether a quantitative assessment of risks needed to be conducted. Only those parameters that were retained for the risk assessment were called contaminants of concern (COCs). The above pathways were quantitatively characterized for an individual EU if a COC(s) was identified.

As described in the HHRA, COCs were identified for surface soil/surface sediment in the Wind Blown Area EU (Plutonium 239/240 was the only radionuclide identified as a COC). However, COCs were not identified for surface soil/surface sediment in the Rock Creek Drainage EU. Consequently, a quantitative risk characterization for subsurface soil/subsurface sediment was not performed for the Rock Creek Drainage EU. In addition, COCs were not identified for subsurface soil/subsurface sediment in any EU. Therefore, quantitative risk characterization for subsurface soil/subsurface sediment was not performed.



The HHRA presented two exposure point concentrations (EPCs) estimates, Tier 1 and Tier 2, for the COCs at Rocky Flats. Briefly, EPCs are an estimate of COC concentrations to which people may be exposed. For the Rocky Flats HHRA, the Tier 1 concentration was calculated as the 95<sup>th</sup> percent upper confidence limit (UCL) on the average (mean) concentration within an EU. The 95<sup>th</sup> percent UCL is defined as the value that equals or exceeds the true mean with 95 percent confidence. As described in the HHRA, if most of the data for an EU have been collected in areas associated with historic releases, and few data points are available for the nonimpacted areas, the Tier 1 EPC is likely to overestimate the concentration for the EU as a whole. Therefore, Tier 2 EPCs were calculated in a manner that equally weighs the data for different subareas of an EU. In this approach, averages are first calculated for 30-acre subareas of an EU. These averages are then combined to calculate an EU-wide average. In areas where the data are evenly spaced throughout an EU, there are only minor differences between the Tier 1 and Tier 2 EPCs.

As stated above, Plutonium 239/240 was the only radionuclide identified as a COC. Radiological dose estimates were developed for the HHRA using the RESRAD software which was used to evaluate all applicable exposure pathways at a site (Kaiser-Hill Company, 2006). The dose estimate for plutonium for the WRW is 0.3 mrem/yr and for the WRV child it is 0.2 mrem/yr. These dose estimates are well below the acceptable annual radiation dose of 25 mrem specified in the Colorado Standards for Protection Against Radiation (CDPHE, 2005). A summary of cancer risks and dose estimates for WRW and WRV receptors in the Wind Blown Area EU is presented in Table 2-4.

**Table 2-4 Summary of Human Health Risk Estimates from Plutonium 239/240 in the Wind Blown Area Exposure Unit (Bridge Crossing Location along Indiana Street)**

Wildlife Refuge Worker (WRW)				Wildlife Refuge Visitor (WRV)			
Excess Lifetime Cancer Risk		Annual Dose Rate (mrem)		Excess Lifetime Cancer Risk		Annual Dose Rate (mrem)	
Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2
$2 \times 10^{-6}$	$9 \times 10^{-7}$	0.3	0.2	$1 \times 10^{-6}$	$6 \times 10^{-7}$	0.2 (child) 0.07 (adult)	0.1 (child) 0.04 (adult)

Source: Table ES8, Volume 1 of 15, Appendix A, Kaiser-Hill (2006)

The cancer risk estimates were at the lower end of EPA's risk range of  $1 \times 10^{-6}$  (one in a million) to  $1 \times 10^{-4}$  (one in ten thousand).

### 3.0 SAMPLING RATIONALE

EA used Visual Sample Plan (VSP), developed by Pacific Northwest National Laboratory (PNNL), to develop the sampling design. VSP is a software tool that supports the development of a defensible sampling plan based on statistical sampling theory and the statistical analysis of sample results to support confident decision making. VSP incorporates a variety of sampling designs, including those described in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), in its programming. Based on the project-specific sampling goals, VSP calculates the number of samples to be collected and identifies random locations for the samples to be collected. Information on the VSP software is available at <https://vsp.pnnl.gov/>. As indicated on the PNNL website, VSP's development was supported by a variety of federal departments, agencies and commissions, including the DOE and the EPA.

#### 3.1 Conceptual Physical Model

The Indiana Street Bridge Crossing and CO-128 Underpass Crossing are located within two different exposure units (EUs), as described in the HHRA (Kaiser-Hill Company, 2006). As illustrated on Figure 2-1, the Indiana Street Crossing is located downwind of the former industrial area. In the HHRA (*ibid.*), the area near the Indiana Street Crossing is adjacent to the Wind Blown Area EU. The CO-128 Underpass Crossing is located north of the former industrial area along CO-128 and is adjacent to the Rock Creek Drainage EU.

There are no known primary Rocky Flats related contaminant source(s) located near either crossing location. Consequently, the source of non-native radionuclides located in both areas is atmospheric fall-out and windblown contamination from the Rocky Flats Industrial Area. Therefore, radionuclide contamination at both crossings will be limited to the near surface soils which is consistent with the model verified in Margulies et al. (2004). The near surface soil data from the CDPHE database, as summarized in Table 2-2 (Rock Creek Drainage EU) and Table 2-3 (Wind Blown Area EU), should be representative of the radionuclide activities in the near surface soils at the Indiana Street and CO-128 crossings.

#### 3.2 Sampling Design

EA will collect soil samples from the proposed disturbance areas at the two locations, the Bridge Crossing and the Underpass Crossing, following the procedures described in Section 5 of this report. No sampling/testing will be done unless prior landowner authorization is given. EA will sample and analyze soils from individual sample locations within the potential areas of disturbance of the crossing structures and the footprint of the new paths associated with each crossing, as illustrated in Figure 1-1.

EA used VSP to separately estimate the number of samples to be collected at each location. The null hypothesis is that the average radionuclide activity at a crossing exceeds the average in its associated EU. To reject the null hypothesis, VSP calculates the number of samples to statistically prove the opposite (i.e., that the average radionuclide activity at a crossing is no different than that in its associated EU). For each VSP analysis, EA assumed a Type I error ( $\alpha$ ) of 5 percent and a Type II error ( $\beta$ ) of 10 percent<sup>1</sup>. EA used the historic Plutonium 239/240 data from the two EUs

<sup>1</sup> Type I errors occur when the null hypothesis is rejected, incorrectly. For this Project, a Type I error would occur if the radionuclide activities at a crossing are incorrectly classified as being similar to that in the associated EU (null hypothesis rejected) when, in fact, they are higher than those in the associated EU (as stated in the null

to develop the number of samples; however, all samples will be analyzed for americium, plutonium and uranium.

### **3.2.1 Bridge Crossing (Indiana Street)**

The disturbed area associated with the Indiana Street bridge (Crossing D) is approximately 192,707 ft<sup>2</sup>, or approximately 4.4 acres. The Plutonium-239/240 data for the 307 historic surface soil samples from the Wind Blown Area EU (Table 2-3) were used in VSP, along with the Type I and Type II error information described above. The VSP software calculated that 17 samples would be required to reject the null hypothesis at the Bridge Crossing location. The planned sample density within the Bridge Crossing disturbed area (one sample per 0.3 acres) will be approximately 8 times greater than that within the 715 acre Wind Blown Area EU (one sample per 2.33 acres).

Based on the relative sizes of the disturbed areas on either side of Indiana Street (Figure 1-1), EA will collect three of the samples from the area on the west side of Indiana Street and 14 samples from the area on the east side of Indiana Street. One sample location in each disturbed area will be located near the terminus of the bridge. The other samples will be randomly distributed throughout the footprint of the disturbed areas and selected using the random sampling function in VSP.

### **3.2.2 Underpass Crossing (CO-128)**

The disturbed area associated with the CO-128 underpass (Crossing E) is approximately 116,502 ft<sup>2</sup>, or approximately 2.7 acres. The Plutonium-239/240 data for 50 surface soil samples from the Rock Creek Drainage EU (Table 2-2) were used in VSP, along with the Type I and Type II error information described above. The VSP software calculated that eight samples would be required to reject the null hypothesis at the Underpass Crossing location. The planned sample density within the Underpass Crossing disturbed area (one sample per 0.3 acres) will be approximately 50 times greater than that within the 735 acre Rock Creek Drainage EU (one sample per 14.7 acres).

Based on the relative sizes of the disturbed areas on either side of CO-128 (Figure 1-1), EA will collect two of the samples from the area on the south side of CO-128 and six samples from the area on the north side of CO-128. One sample location in each disturbed area will be located on the CO-128 embankment near the proposed tunnel openings. The other samples will be randomly distributed throughout the areas and selected using the random sampling function in VSP.

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hypothesis). Type II errors occur when the null hypothesis is accepted, incorrectly. For this Project, a Type II error would occur if the radionuclide activities at a crossing are incorrectly classified as being higher to that in the associated EU (null hypothesis accepted) when, in fact, they are no different or lower than those in the associated EU. From a risk perspective, Type I errors are more serious than Type II errors, which is why a more conservative Type I error was selected in VSP for the Project.

## **4.0 PROJECT DATA QUALITY OBJECTIVES**

The data quality objectives DQOs and criteria for measurement data are defined below using the seven-step process described in EPA *Guidance for the Data Quality Objectives Process* (EPA 2006). This seven-step process clarifies the objectives, inputs, and decisions for the current project and helps define the data quality requirements. Below is a brief description of the outputs of each for the seven steps.

### **Step 1. Define the problem**

Samples of soil are needed to confirm that the activity of americium, plutonium, and uranium at the crossing locations are consistent with the risk assessment values used at the site.

### **Step 2. Identify the goal(s) of the study**

The goal of this study is to obtain data to confirm that the risk to visitors at the crossings and associated connector paths from americium, plutonium, and uranium are consistent with historic risk assessment findings.

### **Step 3. Identify Information Needed for the Decision**

The inputs needed to collect representative and comparable soil data to assess visitor risk are:

- Conceptual design plans to define the spatial boundaries of the sampling activities.
- Previous sampling procedures and protocol to ensure that current soil samples are collected as similarly to historic samples as practicable.
- Historic americium, plutonium, and uranium data so statistical analyses can be performed on the population. The summary statistics will be used to define the sampling density in the larger areas to be sampled.
- Previous human health risk assessments.

### **Step 4. Define the Boundaries of the Study**

*Spatial Boundaries:* Sampling locations are outside the Rocky Flats Refuge boundary and on properties owned by the members of the Partner Group, Colorado Department of Transportation (CO-128), and Jefferson County Road and Bridge Division (Indiana Street).

*Temporal Boundaries:* The half-lives of the americium, plutonium, and uranium are long, measured in tens of years to millions of years. The sampling event will take place over the course of days.

### **Step 5. Develop a Decision Rule**

The soil data will be used in conjunction with previously completed human health risk assessments to evaluate risk to visitors of the crossings and associated connector paths.

**Step 6. Specify Acceptable Limits on Decision Error**

The potential for decision errors exists because all analytical measurements inherently contain sampling and measurement errors. Sampling design error occurs when the data collection scheme does not adequately address the inherent variability of the matrix being sampled.

Measurement error occurs from inherent variability in the collection, preparation, and analysis of an environmental sample. These errors will be minimized by following the procedures outlined in this SAP, collection of field quality control samples, and by following established laboratory protocols.

The distribution of the americium, plutonium, and uranium in the Project soil samples will be compared to the historic data to determine if the populations are equivalent.

**Step 7. Optimize the Design**

Ensure that samples are analyzed with methods that are sufficiently reliable and sensitive to detect americium, plutonium, and uranium in soils if activities approach or exceed reporting limits.

No resource restraints are anticipated on this project.

## **5.0 FIELD METHODS AND PROCEDURES**

Soil samples will be collected in a manner to make the data consistent with the historic data, to the extent practicable. A site specific health and safety plan will be developed prior to field work.

### **5.1 Soil Sampling**

The soil samples will be collected from the 0 to 2-inch (5 cm) depth interval, as this interval is consistent with the majority of radionuclide data in the CDPHE database ( see Section 2.2.2). EA will visually describe the texture and grain size distribution of the soil samples following the Unified Soil Classification System (USCS). The sample color will be classified using the Munsell soil color charts or similar system, and the moisture content of the sample will be visually estimated. This information will be recorded in a field logbook.

At each sample location, EA staff will remove vegetation and large material (such as rocks) from an approximate 4 x 4-inch area. To the extent practical, soil attached to plant roots will be removed from the roots and retained for analysis. The soil will be collected with clean, stainless steel tools from the surface to a depth of 2 inches. The soil will be sieved through a Number 10 (2 mm) stainless steel sieve to remove coarse grained material. The soil will be thoroughly mixed in a stainless-steel bowl, trisected and a sub-sample of approximately 200 to 300 grams will be collected and placed in an appropriate container for laboratory analysis. A separate aliquot of approximately the same size will be placed in the same type of container and archived. One field duplicate sample will be generated at each crossing location (two total). The distribution of the field sample aliquots is summarized in Figure 5-1.

As described in Section 3.2, 17 discrete samples will be collected from within the footprint of the Bridge Crossing disturbed area and 8 discrete samples will be collected from within the smaller footprint of the Underpass Crossing disturbed area. Two samples in each disturbed area will be collected at a biased location, collected near each terminus of the crossing structure. The remaining samples will be collected at random grid locations throughout the footprint of the disturbed area.

### **5.2 Sample Documentation**

Soil samples will be labeled using their location, identification number, sample type [grab (G)] and date of collection. The location nomenclature is:

- Within the Underpass Crossing (Location D) disturbed area (CO-128) = D
- Within the Bridge Crossing (Location E) disturbed area (Indiana Street) = E

The date will be recorded in six-digit format (MMDDYY). For example, the fourth soil sample collected within the footprint of Crossing E on August 24, 2018 would be identified as E4G-082418 on the sample label. A field duplicate at this location would be identified as E4G-082418Dup on the sample label. An equipment rinsate blank (ERB) sample at this location would be identified as E4G-082418ERB on the sample label. (Generation of rinsate is described in Section 5.3). The archived sample from this location would be identified as E4G-082418Arch.

Field notes and observations will be recorded in project specific water- resistant logbooks. Pages in the logbooks will be sequentially numbered. Logbook entries will be scanned upon return from the field and saved as portable document format (pdf) formatted files. Soil sample collection will information will be described in the logbook and will document the following information:

- Soil description (color, texture, moisture).
- Sample ID as recorded on the sample label and chain-of-custody form.
- Sample depth.
- Date, time, and a description weather/field conditions.
- Sample coordinates.
- Name(s) of sampler.

Documentation of field activities may be supplemented using photographs. The date, time, location, and view direction or perspective of photographs will be recorded in field log-books.

Sample coordinates will be obtained using a Wide Area Augmentation System (WAAS) enabled consumer grade GPS unit. Sample locations coordinates will be based on the Colorado Central State Plane Coordinates in NAD 27 State plane Colorado Central.

### **5.3 Decontamination**

Reusable sampling equipment will be cleaned prior to and between each sampling location with Liquinox (or Alconox) solution, and then rinsed with deionized or distilled water. Cleaned equipment will be stored in clean plastic bags if not immediately used.

EA will generate one equipment rinsate blank (ERB) sample at each crossing location (two total) to document decontamination effectiveness. Approximately three liters of water will be required for the laboratory to perform the analyses. The aqueous sample will be preserved with nitric acid but will not require chilling.

### **5.4 Investigation Derived Waste**

Investigation derived wastes (IDW) will be generated during the soil sampling program. IDW will be temporarily contained and/or disposed in accordance with the procedures outlined below. The types of IDW anticipated to be generated from the sampling activity include:

- Excess soil generated during excavation.
- Decontamination water.
- Personal protective equipment (PPE).

Handling/disposal of IDW will be completed as follows:

- Excess soil generated during excavation – Excess soil generated during sample collection will be returned to the excavation. The excavation will be hand compacted. Additional soil from adjacent locations will be added to the excavation, as needed, to return the elevation to its approximate pre-sample level.

- Decontamination Water – The quantity of water derived during the decontamination of soil and sediment sampling equipment will be minimal (less than one gallon) and will be disposed on the land surface away from drainage areas and allowed to infiltrate.
- Disposable Personal Protective Equipment (PPE) – Disposable PPE will be limited to nitrile gloves. The PPE will be placed in plastic bags along with other solid waste (e.g., paper towels) and disposed as solid waste at an off-site location.



## **6.0 SAMPLE CONTAINERS, PRESERVATION, PACKAGING AND SHIPPING**

The soil samples will be placed in new and certified clean wide-mouth glass (WMG) jars supplied by the laboratory or a third-party vendor. No preservation for the soil samples is required. Sample containers will be stored upright in an ice chest or other large container for security. The containers will be wrapped in bubble-wrap to inhibit breakage.

All samples will be transmitted to ALS Global Laboratories (ALS) in Fort Collins, Colorado. The samples will be accompanied by a completed and signed Chain-of-Custody record. One copy of the Chain-of-Custody will accompany the samples and a copy of the Chain-of-Custody will be retained by the sampling personnel. EA personnel will hand deliver the samples to ALS.

## 7.0 LABORATORY TESTING

ALS Global Laboratories (ALS) will provide analytical services for the project. ALS is a publicly traded company based in Brisbane, Australia. ALS serves multiple industries globally from 300 plus locations in over 65 countries. The Project samples will be analyzed for americium-241, isotopic plutonium and isotopic uranium by ALS in their Fort Collins, Colorado facility. ALS Fort Collins, formerly Paragon Analytics, provides radiochemistry and environmental testing services to Federal and State agencies, environmental and engineering consulting firms, and private industry. ALS Fort Collins is familiar with Rocky Flats soil matrices, having served as the analytical laboratory for numerous Rocky Flats Environmental Technology Site related projects for more than 20 years. A copy of the current Quality Assurance Manual for the ALS Fort Collins laboratory is provided in Appendix A.

Upon transfer of custody of the Project samples from EA to ALS, ALS will log the samples into their Laboratory Information Management System (LIMS), prepare and process the samples for analysis, and then analyze the samples for americium-241, isotopic plutonium, and isotopic uranium via alpha spectroscopy. Information on the analytical methods that ALS will use to test the soils is summarized in Table 7-1.

**Table 7-1 Radionuclide Analytical Testing Information**

<b>Radionuclide</b>	<b>Method<sup>1</sup></b>	<b>Minimum Detectable Concentration<sup>2</sup> (MDC) (pCi/g)</b>
Am-241	alpha spectroscopy	0.1
Pu-238	alpha spectroscopy	0.15
Pu-239/240	alpha spectroscopy	0.1
U-234	alpha spectroscopy	0.1
U-235	alpha spectroscopy	0.1
U-238	alpha spectroscopy	0.1

1. ALS SOP 714, Revision 14, *Analysis of Alpha Emitting Radionuclides by Alpha Spectroscopy*.
2. MDCs may vary from sample-to-sample.

ALS processes samples using proprietary Standard Operation Procedure (SOPs) or in-house procedures described in Quality Assurance Summary Sheets (QASSs). The SOPs and QASSs that ALS will apply to the Project soil samples are summarized in Table 7-2. As discussed above, ALS has served as the analytical laboratory for numerous Rocky Flats Environmental Technology Site related projects for more than 20 years and, as such, has utilized these SOPs to produce radionuclide data for a variety of researchers.

The ALS soil sample preparation sequence for the Project soils is described below and summarized in Figure 7-1. ALS will digest Project soil sample aliquots via two separate methods: (1) acid dissolution, and (2) fusion. The resultant solutions will be processed, purified, and mounted on planchets for analysis via the method described in Table 7-1. Therefore, ALS will provide EA with two sets of analytical results for each Project soil sample. In addition, following the initial processing step (drying and milling), splits will be created of each sample and packaged for third-

party analysis<sup>2</sup> and archival purposes. Consequently, multiple analyses will be available from separate laboratories for each soil sample collected by EA.

**Table 7-2 Summary of ALS Soil Sample Preparation Methods**

<b>Document Number</b>	<b>Document Title</b>	<b>Revision Number</b>
SOP 736	Representative Laboratory Subsampling – Radiochemistry	1
SOP 773	Total Dissolution of Solids for the Radiochemical Determination of Actinides and other Non-Volatile Radionuclides	12
QASS	Carbonate Fusion	N/A
SOP 778	Uranium, Plutonium and Americium/Curium (Partial) Sequential Separation by Ion Exchange	14
SOP 751	Actinides – Americium/Curium Separation – Purification by TRU™ and TEVA™ Spec Column	6

ALS will initially process the field samples per ALS SOP 736, *Representative Laboratory Subsampling – Radiochemistry*, which will include drying and milling<sup>3</sup>. The samples will be dried at 105±5°C for a minimum of 16 hours and then milled. Two approximately 60-gram aliquots of the dried sample will be machine shaken in separate half-pint steel cannisters each containing 5 half-inch steel ball bearings for 15 minutes. This milling process produces a 200-mesh powder (silt and clay size) to facilitate dissolution of the sample matrices in the subsequent steps. The powdered soil from both containers will be combined and thoroughly mixed to produce aliquots for subsequent processing and analysis. Splits of Project samples for third-party analyses and archival purposes will also be generated following this step (Figure 7-1).

The milled samples will be digested via two methods: (1) acid dissolution, and (2) fusion. Aliquots dissolved using acids will be digested via a multi-step process using ALS SOP 773, *Total Dissolution of Solids for the Radiochemical Determination of Actinides and other Non-Volatile Radionuclides*. Tracers are added to the sample at the beginning of the process and the digestion of approximately 1- to 2-gram aliquots will be accomplished using nitric, hydrochloric, and hydrofluoric acids. Because of the potential presence of recalcitrant material (minerals, glass, refractory oxides) hosting some of the radionuclides in the Project soil samples, ALS will also perform a separate fusion dissolution on a split of the original sample utilizing sodium carbonate and potassium carbonate (Figure 7-1). A ferric hydroxide co-precipitation step will then be separately performed on the solutions from both soil digestion methods to preconcentrate actinides and to remove constituents that do not form hydroxides. The hydroxide precipitate will then be re-dissolved and further purification performed to prepare the samples for analysis (see below).

Americium, plutonium, and uranium will be separated and purified from the digested/fused samples via ALS SOP # 778, *Actinides – Uranium, Plutonium and Americium/Curium (Partial) Sequential Separation by Ion Exchange*. This step will be followed by ALS SOP # 751, *Actinides*

<sup>2</sup> Quality Assurance/Quality Control of Project samples is the responsibility of other entities following relinquishment of sample custody by ALS/EA.

<sup>3</sup> ALS SOP 736 includes a #4 (4.75 mm) sieving step between the drying and milling steps. The ALS sieving step will be omitted as EA will field sieve the samples using a smaller-sized (#10 or 2 mm) sieve.

– *Americium/Curium Separation – Purification by TRU<sup>TM</sup> and TEVA<sup>TM</sup> Spec Column*, specifically for Am-241. The final step of these processes involves the purified isotope(s) being co-precipitated with lanthanum fluoride, the precipitate being retained on a filter membrane, and the membrane being mounted on a planchet for quantification by alpha spectroscopy via ALS SOP 714, *Analysis of Alpha Emitting Radionuclides by Alpha Spectroscopy*.

The aqueous equipment rinsate blank ERBs samples will also be analyzed for radionuclides via ALS SOP 714, *Analysis of Alpha Emitting Radionuclides by Alpha Spectroscopy*. As discussed in Section 5.3, approximately three liters of water will be required for the laboratory to perform the analyses.

The standard turn-around-time for americium, plutonium and uranium processing and analyses is 45 days but may take up to 8 weeks depending on laboratory volume. ALS will provide the test results as both an electronic data deliverable (EDD) format (MS Excel spreadsheet) and a printable PDF laboratory report. The laboratory report will provide a Level II quality control (QC) package which will contain: Case Narrative, Receipt Documentation and Chain-of Custody, Individual Sample Results, and laboratory QC sample results for Blanks, Duplicates, and Laboratory Control Samples.

## **8.0 DATA REVIEW AND USABILITY**

EA will review the field records and laboratory analytical reports. The laboratory analytical data will also be reviewed for data quality indicators (precision, accuracy, representativeness, comparability, and completeness). As indicated in Section 7, ALS will provide Level II QC reporting of their radiochemistry results.

### **8.1 Data Review, Verification and Validation**

After the field sampling activities are completed EA staff will review the field records to assess compliance with the items listed below:

- Samples correctly identified.
- Field logbooks and documentation are complete.
- Laboratory receipt of sample documented.
- Required field data collected and acceptable.
- Required sampling procedures were followed and, if not, deviations are documented.
- Required field QC samples were collected.
- Custody records are complete.

EA staff will also review the laboratory records to assess if the laboratory reporting is accurate and complete, and to assess compliance with the items listed below:

- Samples are correctly identified.
- Custody records are complete and traceable.
- Samples were appropriately containerized, and the proper amount received to perform the requested analyses.
- All sample analyses are correctly identified and complete.
- All analytical methods are pursuant to this SAP.
- All applicable performance criteria are addressed.
- Required QC samples are present and results within performance criteria.

EA will compare the original sample information entered on the chain of custody to the information in the laboratory reports and EDD. EA will verify information for fields in the EDD such as laboratory ID, batch numbers, method numbers, minimum detectable concentration, field sample numbers, sample dates, preparation dates, analysis dates, flag codes, etc.

### **8.2 Data Quality Indicators/Measurement Quality Objectives**

Performance criteria for radiochemical analytical data will be based on the evaluation of Measurement Quality Objectives (MQO). MQOs are quantitative statistics and qualitative descriptors used to interpret the degree of acceptability of data. Failure to meet performance criteria will not necessarily result in rejection of the data. Professional judgment, combined with the MQO evaluation, will be used to determine data usability. These acceptance criteria were developed in consideration of Appendix C “Measurement Quality Objectives for Method Uncertainty and Detection and Quantification Capability” of the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP [EPA, 2004]).

Objective measurements of analytical data quality are required for laboratory analysis of environmental samples. The principal Data Quality Indicators (DQIs) of analytical data quality are precision, accuracy, sensitivity, representativeness, comparability, and completeness, as identified in EPA QA/G-5 (EPA, 2002b). For this SAP, an additional MQO has been added for uncertainty as recommended by MARLAP. The quality of laboratory analytical results is assessed using specific laboratory QC samples, which are compared to specific performance criteria (control limits) for each DQI. Laboratory QC samples are discussed below. These discussions include the decision rule for assessing laboratory performance with respect to the relevant DQI presented.

### **8.2.1      *Total Uncertainty***

The primary laboratory measurement of uncertainty for a reported radiometric value is the combined standard uncertainty, also referred to as the total propagated uncertainty (TPU). The TPU is the standard deviation of all the components of error that may be associated with a sample result. Acceptable levels of uncertainty pursuant to MARLAP are based on the region defined as the difference between the upper bound gray region (UBGR) and lower bound gray region (LBGR) of the concentrations of interest and the defined decision error probabilities. In this case, the UBGR is considered to be the average concentration of the radionuclides in the applicable EU.

### **8.2.2      *Precision***

The primary laboratory QC samples assessing precision are duplicate samples. Laboratory QC duplicates may include other QC samples, such as matrix spike (MS) and matrix spike duplicate (MSD) samples.

Laboratory duplicate results are evaluated by comparing the results from the primary and duplicate sample with respect to each other using either the relative percent difference (RPD) or the absolute difference (AD) of the two measurements. The following DQI are applied to laboratory analytical results to assess precision for Project samples.

The total variance of the data, ( $\sigma^2$ ) is the sum of two components:

$$\sigma^2 = \sigma^2_M \text{ and } \sigma^2_S$$

Where

$\sigma^2_M$  = variance of the analytical measurement, and

$\sigma^2_S$  = variance of the contaminant concentration in the sampled population.

The sampling standard deviation,  $\sigma_s$ , may be affected by the spatial distribution of the analyte, the survey unit extent, physical sample sizes, and sampling procedures. The analytical standard deviation,  $\sigma_m$ , is affected by laboratory sample preparation, aliquot selection, and analysis procedures.

### **Relative Percent Difference (RPD)**

When the average of the analytical results (the duplicate pairs) is greater than or equal to the UBGR, (e.g.,  $\bar{x} \geq 9.44$  for Pu-239/240 in the Wind Blown Area EU) the RPD is calculated as follows:

$$RPD = \frac{|D1 - D2|}{\text{avg}(D1 + D2)} \times 100$$

Where:

D1 = First or primary sample value

D2 = Second or duplicate sample value

Warning limit for RPD is 75% and control limit is 113% (MARLAP, Appendix C.4.2.2)

### **Absolute Difference (AD)**

When the average of the analytical results (the duplicate pairs) is less than the UBGR (e.g.,  $\bar{x} < 9.44$  for Pu-239/240 in the Wind Blown Area EU), the AD is used instead of the RPD and is calculated as follows:

$$AD = |D1 - D2|$$

This is keeping with Section C.4.2.2 of Appendix C to MARLAP (EPA, 2004).

### **8.2.3 Accuracy and Bias**

The primary laboratory QC samples assessing accuracy and bias include those listed below:

- Blanks
- Matrix blanks (MB)
- Laboratory control samples (LCS)

The following DQI are applied to laboratory analytical results to assess accuracy and bias.

#### **Matrix Blanks (MB)**

For radionuclides in MB, the results should be zero. However, due to the nature of radiochemistry measurement performance indicator is the allowable TPU of 0.1 pCi/g. This TPU is used for the MB since this sample should be near or close to zero.

The warning limit for measured concentrations are  $\pm 0.2$  pCi/g and the control limit is  $\pm 0.3$  pCi/g (MARLAP, Appendix C.4.2.3 [EPA, 2004]).

#### **Laboratory Control Samples (LCS)**

The LCS consist of a National Institute of Standards and Technology (NIST) traceable reference material with known concentrations of target analytes. The LCS is used to document laboratory performance by checking the accuracy of the analytical procedure. The LCS are obtained by the analytical laboratory from an outside vendor and consist of the same type of matrix (e.g., solid, aqueous) as the batch samples.

For LCS, the DQI assessing the method is the percent deviation (%D), which is compared to control limits. For LCS, the %D is calculated as follows:

$$\% D = \frac{SSR-SA}{SA} \times 100$$

Where:

SSR = The measured result

SA = The known concentration

It is assumed that the uncertainty of SA is negligible so the maximum allowable relative standard deviation of %D is the same as the SSR.

#### 8.2.4 Sensitivity

ALS is obligated to meet the MDCs for the radionuclides provided in Table 7-1. These MDCs are compared to the Preliminary Remediation Goals (PRGs) developed for the RI/FS (Kaiser-Hill Company, 2006) and then revised in June 2017 (USDOE, 2017) in Table 8-1.

**Table 8-1 Radionuclide Analytical Testing Sensitivity**

Radionuclide	Minimum Detectable Concentration (MDC) (pCi/g)	Wildlife Refuge Worker PRG (pCi/g)
Am-241	0.1	11.5
Pu-238	0.15	22.9
Pu-239/240	0.1	9.3
U-234	0.1	20.0
U-235	0.1	4.5
U-238	0.1	22.9

Note: The Am, U and Pu-239/240 PRGs were revised in June 2017 based on updated toxicological data as shown in Table 7 of the “Fourth Five-Year Review Report for the Rocky Flats Site” (DOE, 2017). This report is available at [https://www.lm.doe.gov/Rocky\\_Flats/Regulations.aspx](https://www.lm.doe.gov/Rocky_Flats/Regulations.aspx)

The MDCs proposed by ALS are less than the PRGs. If achieved, the MDCs will be sensitive for each parameter.

#### 8.2.5 Representativeness

Quality program assessments (e.g., field oversight and audits) will be used to verify that the methods described in this SAP are followed. No MQO is developed for this DQI.

#### 8.2.6 Completeness

Completeness is assessed by the ratio of fully usable data points to the total number of data points. The MQO for analytical laboratory data completeness is 95%, though failure to achieve this goal does not necessarily indicate required re-sampling and/or re-analysis. For the assessment of this



performance criteria, “Complete Data” does not exclude data that is flagged (qualified) as near or less than the MDC or data flagged with a non-quality control qualifier (not quality control related).

### **8.2.7 Comparability**

Comparability is a qualitative term that expresses the confidence that one data set can be compared to another and can be combined for the decision(s) to be made. Comparability is assessed by comparing sample collection and handling methods, sample preparation and analytical procedures, holding times, stability issues, and QA protocols. Comparability is also assessed through laboratory performance evaluations. Data are considered comparable when acquired through means resulting in comparable quality (precision, bias, accuracy, sensitivity, etc.).

## **8.3 Data Usability**

The data usability process is the final assessment that will be performed to ensure that the implementation of the sampling and analysis program described in this SAP provides results that can be used to meet the DQOs and data quality requirements. Components of the data review process include evaluating the data against the data quality indicators of precision, accuracy/bias, representativeness, completeness, and comparability; review of field and laboratory QC results; data verification and validation results; and evaluating the data for suitability based on the intended use. Deficiencies identified during this assessment will be reported to the Project Manager along with an indication of how the assessment will impact the use of the data. Limitations on the data will be communicated to the data users and, as appropriate, through the use of data qualifiers.

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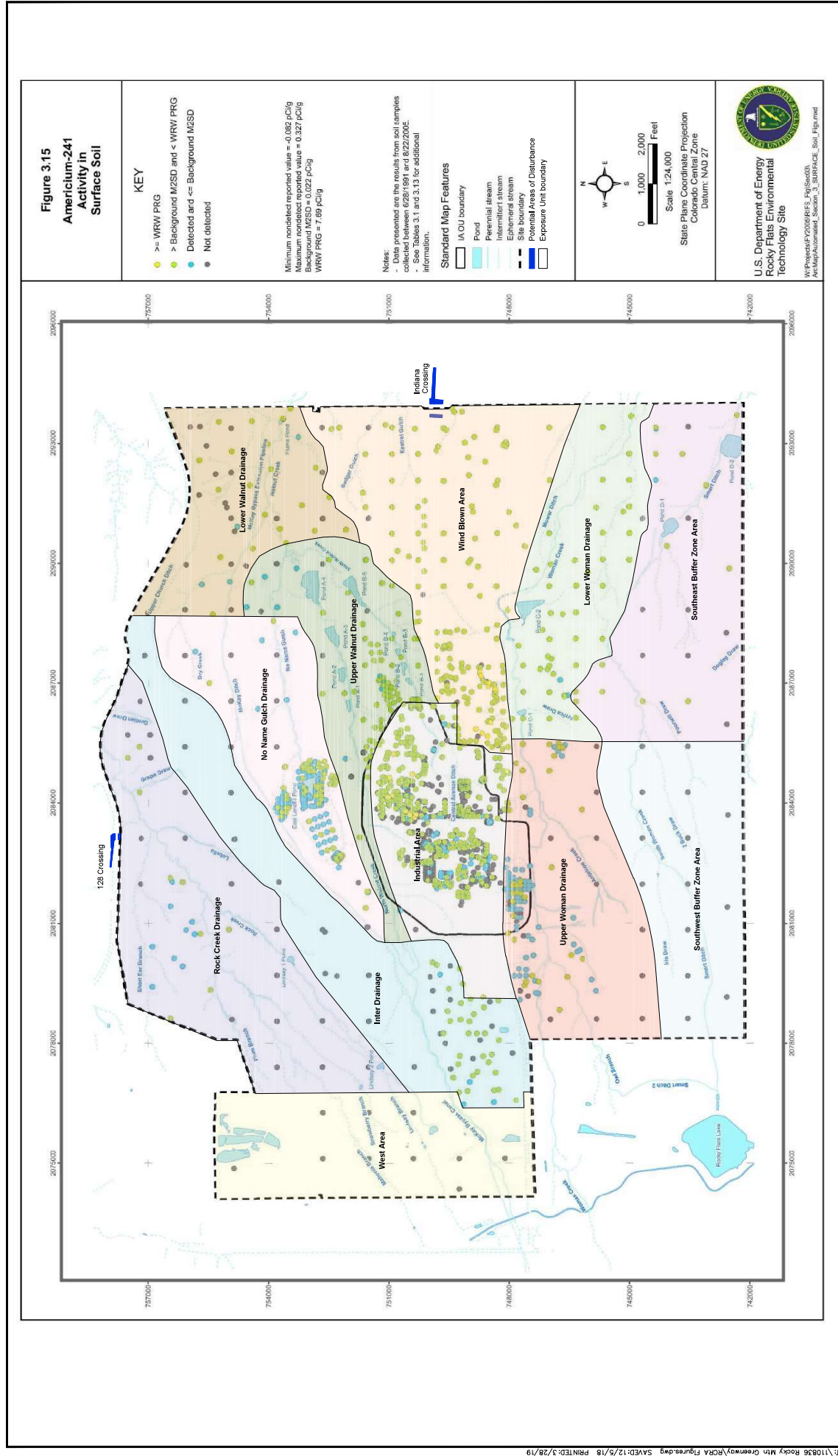
Risk Assessment Corporation. (1999) RAC Report No. 5-RSALOP-RSAL-1999-Final “Final Report Task 6: Sampling Protocols, Radionuclide Soil Action Level Oversight Panel.” December.

U.S. Department of Energy (USDOE) (2017). Fourth Five-Year Review Report for the Rocky Flats Site, Jefferson County, Colorado. Office of Legacy Management. LMS/RFS/S15528. June.

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## **FIGURES**





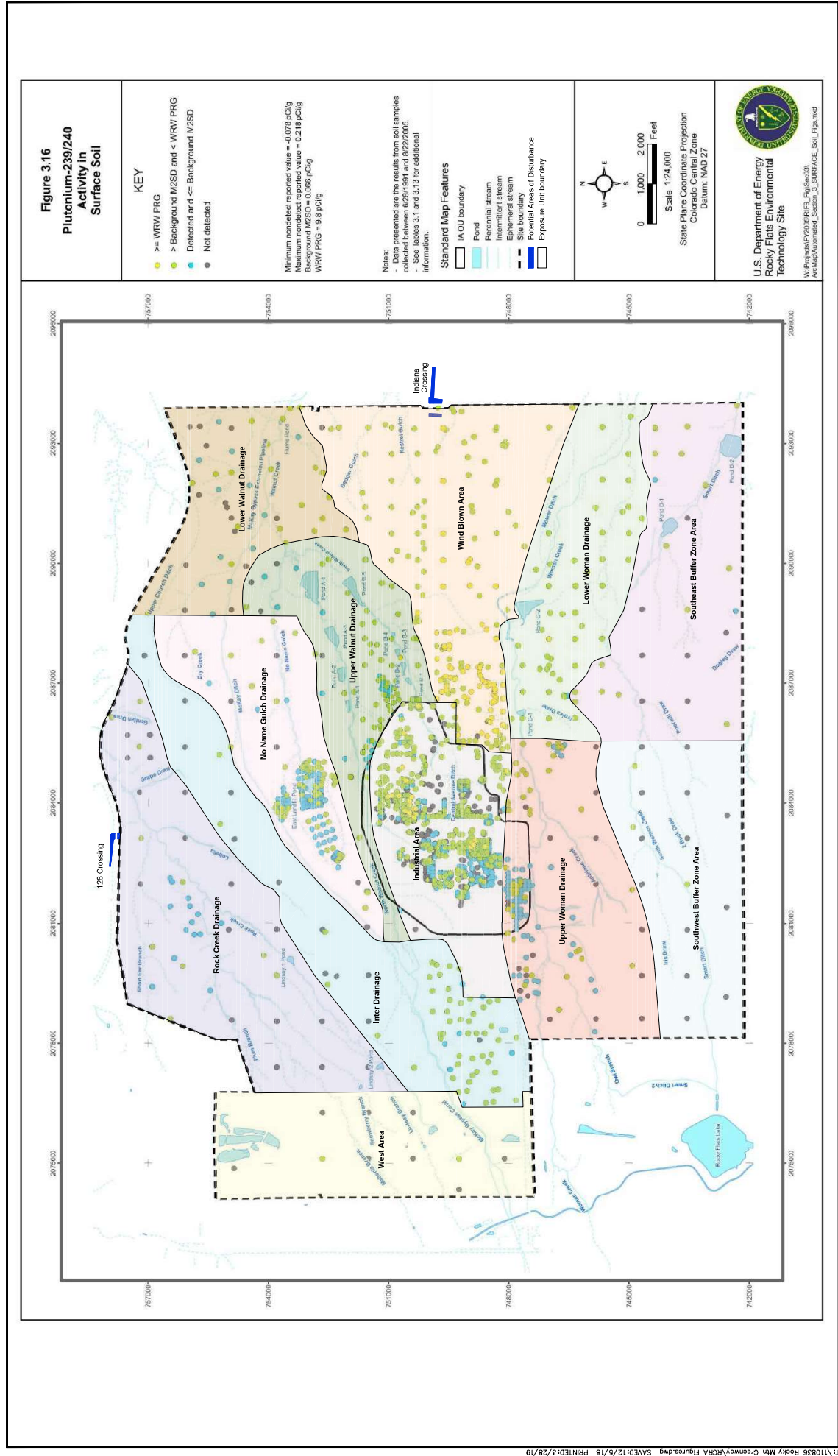
March 2019  
Rev 4.0

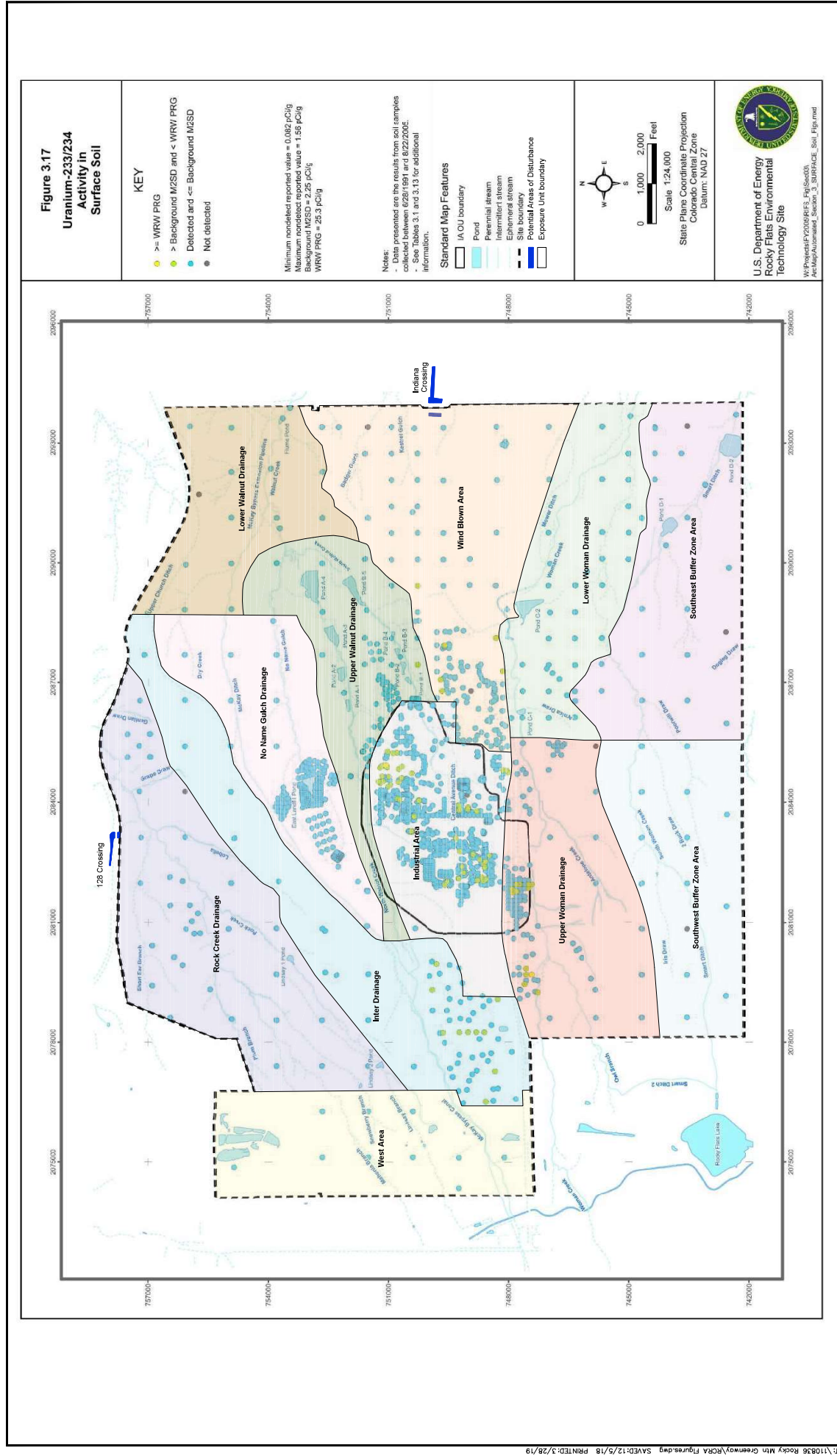
FIGURE 2-1  
AMERICIUM-241 ACTIVITY IN SURFACE SOIL  
ROCKY MOUNTAIN GREENWAY

NOTE:  
FIGURE 3.15 FROM RCRA FACILITY INVESTIGATION -  
REMEDIAL INVESTIGATION/CORRECTIVE MEASURES  
STUDY - FEASIBILITY STUDY REPORT FOR THE ROCKY  
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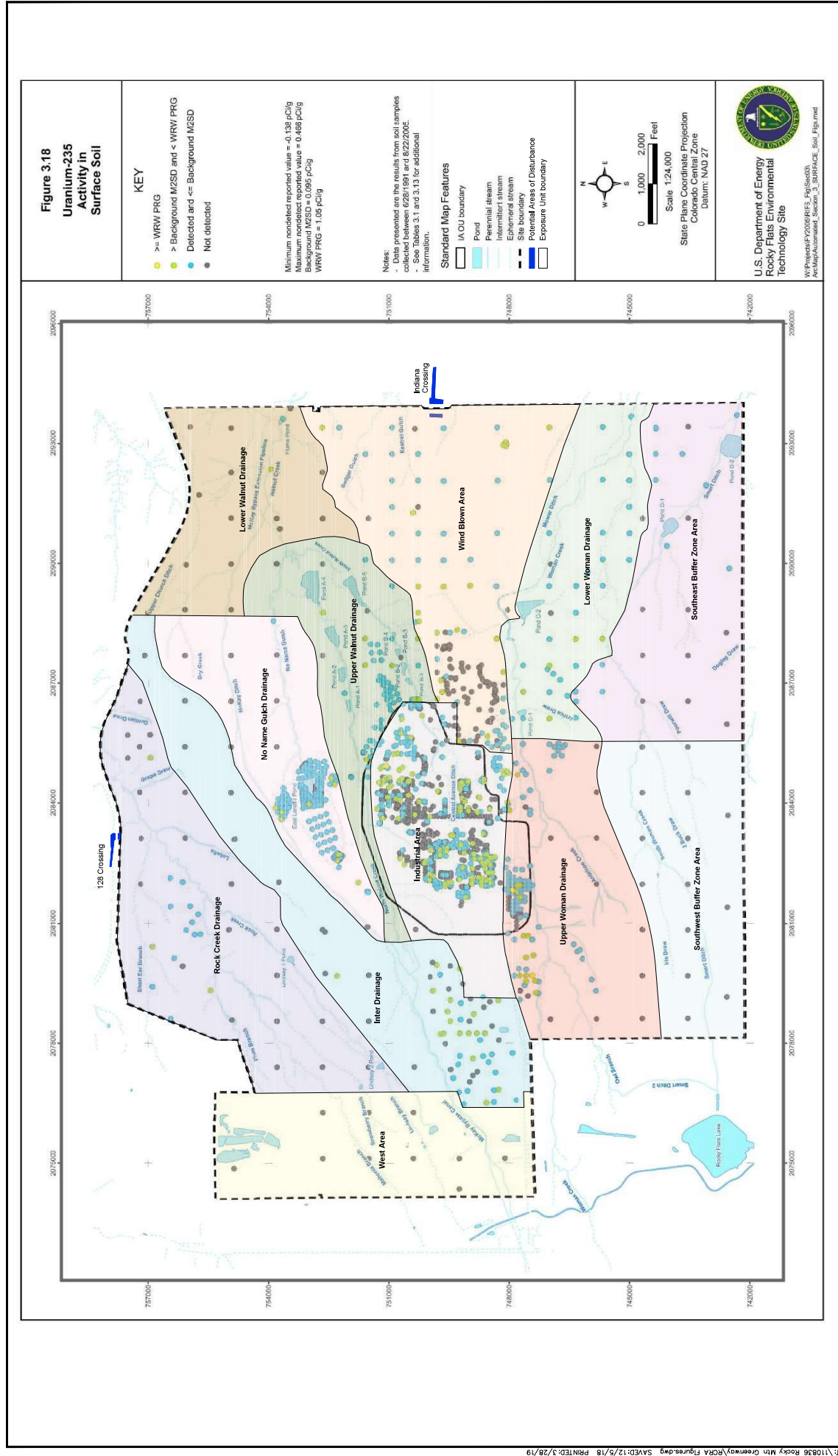
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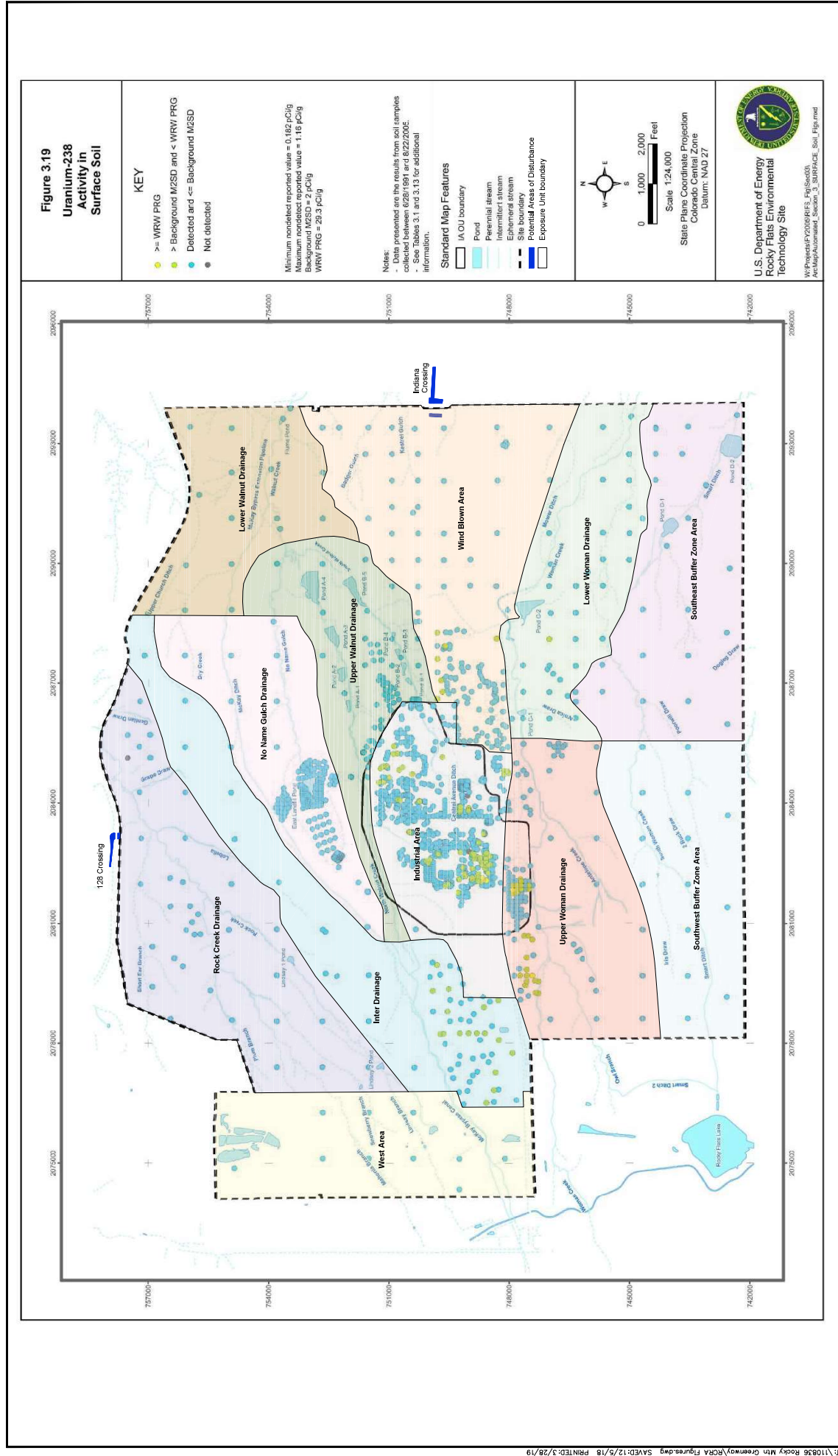


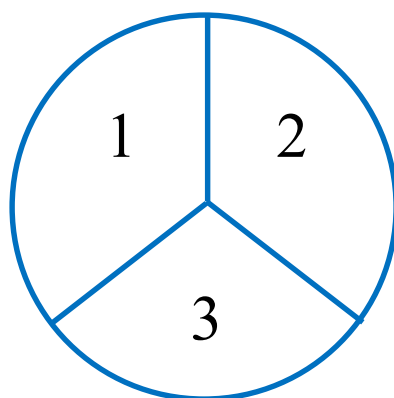
March 2019  
Rev 4.0

FIGURE 2-4  
URANIUM-235 ACTIVITY IN SURFACE SOIL  
ROCKY MOUNTAIN GREENWAY

NOTE:  
FIGURE 3.18 FROM RCRA FACILITY INVESTIGATION -  
REMEDIAL INVESTIGATION/CORRECTIVE MEASURES  
STUDY - FEASIBILITY STUDY REPORT FOR THE ROCKY  
FLATS ENVIRONMENTAL TECHNOLOGY SITE (JUNE 2006).

Project No. 110836

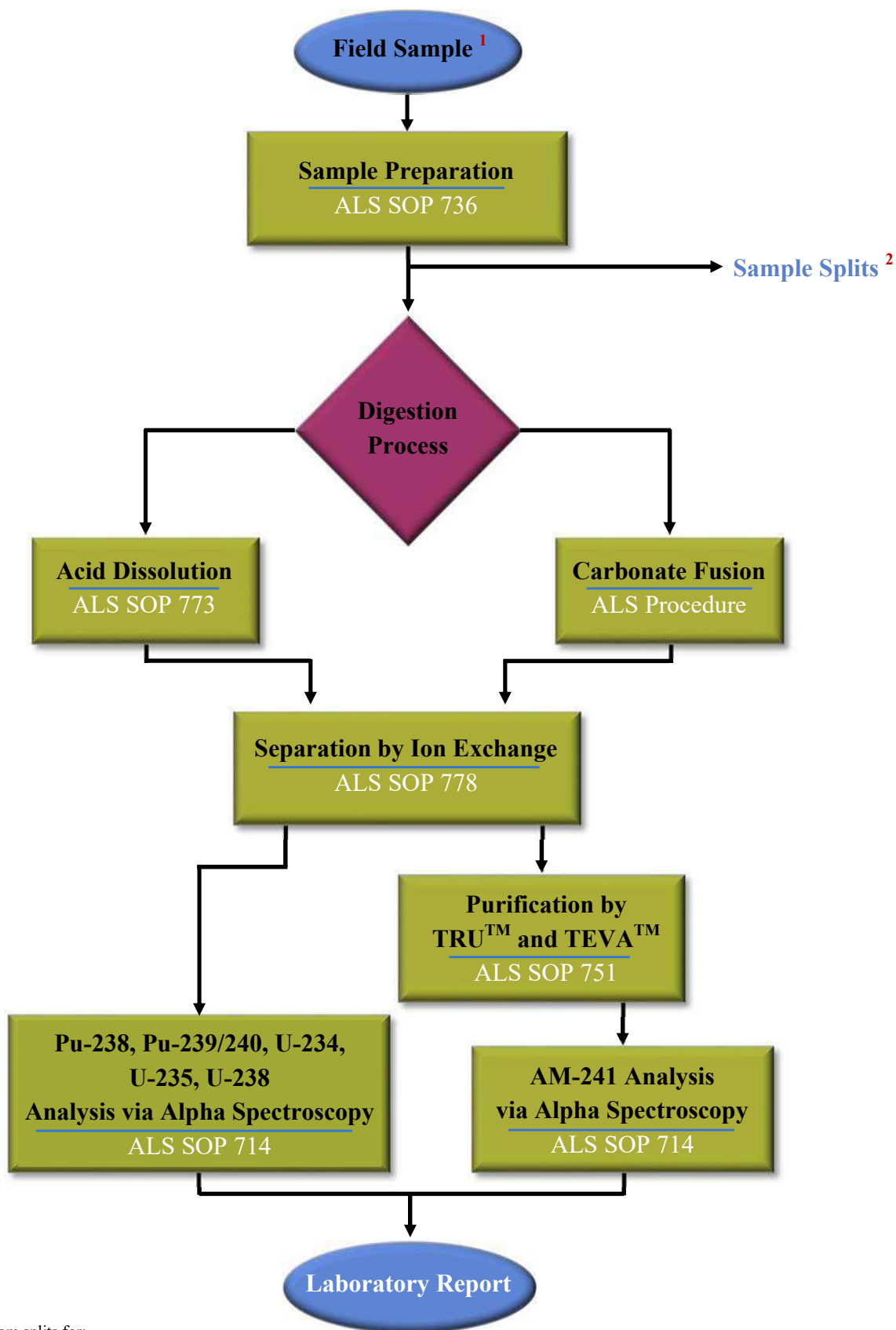




Aliquot	Description
1	Primary field sample delivered to laboratory <sup>1</sup>
2	Duplicate field sample delivered to laboratory <sup>1</sup> or discarded, as appropriate <sup>2</sup>
3	Archived sample

<sup>1</sup> See Figure 7-1

<sup>2</sup> One field duplicate sample will be generated at each crossing location



<sup>1</sup> See Figure 5-1

<sup>2</sup> Approximate 30 gram splits for:

- \* City and County of Broomfield for acid digestion and analysis via alpha spectroscopy
- \* Third party for fusion and analysis via ICP-MS
- \* Archived

**FIGURE 7-1**  
**LABORATORY SAMPLE PREPARATION**  
**AND ANALYSIS FLOWCHART**  
**ROCKY MOUNTAIN GREENWAY**

**APPENDIX A  
ALS FORT COLLINS  
QUALITY ASSURANCE MANUAL**



## QUALITY ASSURANCE MANUAL

ALS Environmental  
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[www.alsglobal.com](http://www.alsglobal.com)





## QUALITY ASSURANCE MANUAL

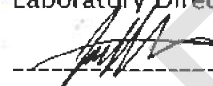
DocID:	ALS QAM	Rev. Number:	22	Effective Date:	05/14/2018
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QAM	ISO/IEC 17025
1	4.1
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4	4.3
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7	4.6
8	4.7
9	4.8
10	5.3 and 5.5
11	5.8
12	5.4
13	5.6
14	5.9
15	4.9
16	4.10, 4.11, 4.12
17	4.13 and 5.4
18	4.14
19	4.15
20	5.2
21	5.10
22	NA
Appendix A	NA
Appendix B	NA
Appendix C	NA
Appendix D	5.3 and 5.6
Appendix E	5.5
Appendix F	NA
Appendix G	5.4
Appendix H	5.9
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Appendix J	NA
Appendix K	5.9
Appendix L	NA



## 1 INTRODUCTION AND SCOPE

### 1.1 PURPOSE

This Quality Assurance Manual (QAM) describes the policies, procedures and accountabilities established by the Laboratory of ALS Environmental (ALS) to ensure that the test results reported from analysis of air, water, soil, waste, and other matrices are reliable and of known and documented quality. This document describes the quality assurance and quality control procedures followed to generate reliable analytical data.

This QAM is designed to be an overview of ALS operations. Detailed methodologies and practices are written in ALS Standard Operating Procedures (ALS SOPs). Where appropriate, ALS SOPs are referenced in this document to direct the reader to more complete information. A list of current ALS SOPs is found in Appendix G

ALS maintains certifications pertaining to various commercial and government entities; these are listed in Appendix I. Each certification requires that the laboratory continue to perform at levels specified by the programs issuing certification. Program requirements can be rigorous; they include performance evaluations as well as annual audits of the laboratory to verify compliance.

ALS is a full service environmental and radiochemistry laboratory, performing analyses for organic, inorganic, and radiological constituents in a variety of matrices. ALS specializes in serving the Department of Energy (DOE), Department of Defense (DoD), and architect-engineering firms. ALS routinely provides hardcopy data packages and electronic data deliverables that are easily validated by external validators.

The management team at ALS applies an integrated approach to quality assurance, client service, and efficient operations that enables ALS to produce compliant data that meet or exceed all technical and service requirements as prescribed by our clients. This Quality Assurance Manual (QAM) defines ALS's quality assurance (QA) program, and communicates ALS's goals, values and policies regarding quality, ethical conduct, data integrity, and optimized operations. ALS management is committed to continual improvement by implementing the management systems set forth in this QAM and the following documents: ISO 17025;2005, TNI 2009, AIHA LAP Policies, and DoD/DOE QSM.

Documents and forms used in the laboratory may still have previous ownership names like ATI, PAI, Paragon Analytical, DataChem or DCL. These former names can be used until revisions to specific documents are needed

ALS policy is to perform work for clients in the most efficient manner possible, avoiding waste of resources and undue pressure on employees. It is the role of



both ALS management and employees to ensure that work for clients is performed most efficiently and effectively by properly utilizing ALS purchased materials, equipment, and the time and ability of personnel.

## 1.2 MISSION STATEMENT

To help our customers make informed decisions by providing testing and technical services.

## 1.3 VISION STATEMENT

To be recognized as a global market leader.

## 1.4 STATEMENT ON WASTE, ABUSE AND FRAUD

ALS is committed to achieving our goals in the most efficient and effective manner possible, thus avoiding wasteful use of resources. This is accomplished by assuring the proper utilization of ALS's purchased materials and equipment, and time and ability of our personnel. *Any ALS employee, who has any suggestion or concern regarding ALS's practices, is encouraged to discuss his/her idea or question with the Laboratory Director, the Quality Assurance Manager, and supervisor.* A means of confidentially reporting concerns anonymously is also available. Grievances and allegations of unethical conduct will be fully investigated, and appropriate actions taken.

Training regarding ALS's Waste, Abuse and Fraud policies is provided to every new staff member, and to all employees lab-wide as an annual refresher. ALS's policies regarding waste, abuse and fraud are included in ALS SOP 143 and CE-GEN-001.

### 1.4.1 Code of Ethics and Data Integrity Statements

ALS is responsible for creating a work environment that enables all employees to perform their duties in an ethical manner. *It is ALS's expectation that all employees exhibit professionalism and respect for clients and each other in all interactions and tasks.* ALS requires that each employee abide by the following guidelines:

- Every ALS employee is responsible for the propriety and consequences of his or her actions. Each employee shall conduct him or herself in a professional manner towards all clients, regulators, auditors, vendors, and other employees. Professional conduct relates to honesty, integrity, respect, and tolerance for cultural diversity.
- Every ALS employee shall perform all assigned duties in accordance with ALS's established quality assurance policies and quality control



procedures that have been developed to ensure conformance with contractual and regulatory requirements.

- ALS expects all employees to use professional judgment and to document all situations thoroughly. It is the responsibility of each ALS employee to consult the Laboratory Director or Quality Assurance Manager when atypical or unusual situations occur and to disclose and document the decision-making process. Every employee must disclose any instance of noncompliance. ALS reports all noncompliance issues affecting data to the client.
- It is the responsibility of each ALS employee to report any suspicion of unethical conduct to the Quality Assurance Manager or the Laboratory Director.
- Procedures addressing Ethics and Data Integrity provide assurance that a highly ethical approach to testing is a key component of all laboratory planning, training and implementation of methods. See ALS SOPs 143 and CE-GEN-001.
- *Strict adherence to ALS's Code of Ethics and Data Integrity is essential to the reputation and continued health of our business. All ALS employees are required to acknowledge their responsibility and intent to behave in an ethical manner by attesting to the requirements described in procedures and annual refresher training is conducted.*

## 2 ORGANIZATION

The Laboratory is organized around the functions described in the following sections. Appendix B of this Quality Assurance Manual contains a detailed organization chart for this laboratory. The laboratory is part of ALS USA Corp and the Laboratory Director reports to the Director of Operations, USA. There are other support functions such as human resources, accounting, safety oversight and computer systems that are provided to the laboratory by corporate entities but none of which is responsible for managing laboratory activities. The support functions of this laboratory involved with testing and services are under the direction of the laboratory director.

The ALS laboratory employs sufficient personnel to complete required chemical analyses and support activities. Support activities include personnel recruiting and management, sample receiving and logging, computer programming and data processing, analytical report preparation, equipment procurement, and method development.



### 3 MANAGEMENT

This section provides an overview of ALS organization and defines key personnel, their responsibilities, and the lines of communication between these employees. An organization chart that illustrates reporting relationships is provided in Appendix B

#### 3.1 KEY PERSONNEL

Education, experience and skill requirements for these positions are addressed in job descriptions (Title). Functional responsibilities are further discussed below.

In the event of a temporary absence, key personnel must notify other key staff of their absence and reassign their duties to another employee (deputy) who will perform the assigned duties. For example, a PM may assign another PM to cover his or her duties; Group Leader may assign a senior chemist to cover his or her duties; and the Laboratory Director may assign a qualified employee to cover his or her duties

##### 3.1.1 Laboratory Director

The Laboratory Director (Laboratory Director) is responsible for:

- All laboratory operations, including: business functions such as marketing, sales and financial issues. Providing input and support to proposal processes, including interacting with the Sales, Technical and Quality Assurance staff, to ensure that the laboratory is capable of complying with client and regulatory requirements;
- Supervising all personnel through Management staff, who ensure that QA/QC procedures are being performed and that any non-conformances or discrepancies are documented and remedied properly and promptly;
- Ensuring that corrective actions relating to Findings from internal and external audits are completed in a timely fashion;
- Ensuring that the laboratory has the appropriate resources and facilities to perform analytical services;
- Ensuring that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory;
- Defining the minimum level of education, experience, and skills necessary for all positions in the laboratory;
- Ensuring that only those vendors and supplies that are of adequate quality are used; and



- Directing the performance of the annual Managerial Review
- Providing technical education and training to personnel, authorizing personnel with appropriate educational and/or technical background perform all tests for which the laboratory is accredited, and providing documentation of employee capability and training, and ensuring that training and documentation are up to date;
- Reviewing RFPs and assisting in the preparation and submission of proposals; and
- Interacting with all phases of laboratory operations, including Quality Assurance, Information Systems, and Health and Safety,
- Ensure that the laboratory is capable of complying with client and regulatory requirements.

### 3.1.2 Quality Assurance Manager

The Quality Assurance Manager reports to the Laboratory Director and is independent of daily operation and production requirements. Therefore, the Quality Assurance Department is able to evaluate data objectively and perform assessments without production influence. *This position has authority to stop work if systems are sufficiently out of control to compromise the integrity of the data generated.*

The Quality Assurance Manager shall have documented training and/or experience in QA/QC procedures; knowledge of quality systems as defined by TNI and other management systems standards; and a general knowledge of the analytical test methods for which data review is performed.

The Quality Assurance Manager (and/or designee) is responsible for:

- Defining and implementing the quality system;
- Developing and maintaining a pro-active program for prevention and detection of improper, unethical, or illegal practices (e.g., single- or double-blind proficiency testing studies, electronic data audits, maintaining documents that identify appropriate and inappropriate laboratory and data manipulation practices);
- Ensuring continuous improvement of laboratory procedures via training, control charts, proficiency testing studies, internal audits, and external audits;
- Coordinating the laboratory's participation in state and Federal certification programs;



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- Scheduling the review and distribution and maintaining distribution records of controlled documents, including plans (e.g., Quality Assurance Manuals, etc.) and SOPs;
- Reviewing, when requested, Requests For Proposal (RFPs) to ensure ALS compliance with required QA/QC practices;
- Facilitating external audits;
- Overseeing or conducting internal audits of the entire operation annually (technical, management system, data, electronic);
- Coordinating, preparing and approving external and internal audit responses and corrective actions;
- Managing the laboratory's participation in proficiency testing (PT/PAT) studies;
- Reviewing non-conformances and approving corrective actions;
- Reviewing QC limits per established procedures;
- Ensuring that Detection Limit studies are performed and documented per requirements;
- Managing the reference standards used in the calibration and/or verification of support equipment (e.g., weights, thermometers, balances);
- Revising the Quality Assurance Manual annually in accordance with industry standards;
- Maintaining an archival system for quality records; and
- Maintaining technical and quality assurance training records, including employee authorizations and competency to perform testing.
- Ensure implementation of quality policy and applicable standards.
- Understand, monitor and evaluate the quality assurance (QA) and quality control (QC) activities described in this QAM and its references, reporting deficiencies and identifying resource requirements to the Laboratory Director.
- Conduct reviews or update laboratory Standard Operating Procedures (SOPs).
- Arrange for the analysis performance evaluation (PE/PAT) samples.
- Maintain a record of ongoing personnel training for QAM-related activities, reporting training deficiencies to the Laboratory Director.
- Maintain the laboratory records of nonconformance, corrective action, preventive action and improvement.





### 3.1.3 The Radiation Safety Officer (RSO) Responsibilities and Health and Safety Responsibilities for assigned personnel.

This position reports directly to the Laboratory Director. The person assigned is responsible for establishing and monitoring adequate systems, procedures and training to ensure that the laboratory staff, facilities and operational activities conducted, function in a manner that minimizes employee risk of illness and injury, is compliant with all applicable regulations pertaining to matters of safety and health, and that limits the financial liability of the corporation as it relates to these matters. The RSO/HSO is also responsible for discharging the duties and requirements prescribed by ALS's Radioactive Materials License.

Key responsibilities for Health & Safety include:

- Ensuring that all employees have sufficient training to perform their job without unnecessary risk of illness or injury, providing health and safety training for new employees, and maintaining health and safety-related training records;
- Providing CPR and other similar training to make certain trained staff is on site to respond to emergency situations.
- Procuring necessary Personal Protective Equipment (PPE) to safeguard laboratory personnel.
- Providing procedural guidance in the form of the Chemical Hygiene Plan (CHP), Radiation Protection Plan (RPP), Respiratory Protection Plan (ResPP), Emergency and Contingency Plan (ECP) and Health and Safety SOPs, and ensuring that these guidances are reviewed by laboratory staff;
- Ensuring that the laboratory facilities are maintained and operated in a safe manner, including:
  - Reviewing routine safety inspections of all operational areas;
  - Performing personal monitoring, as indicated, for chemical and other exposures.
  - Conducting monthly Safety Committee meetings, including discussion and resolution of safety concerns
  - Verifying building security

Key responsibilities for RSO include:





- Ensuring that all employees have sufficient training to perform their job without unnecessary risk of illness or injury, providing radiation safety, training for new employees, and maintaining training records;
- Ensuring that the laboratory facilities are maintained and operated in a safe manner, including:
  - Performing routine radiation surveys and managing the radiation dosimetry program; and
  - Performing personal monitoring, as indicated, for chemical and other exposures.
- Maintaining the laboratory's Colorado Radioactive Materials License and ensuring compliance with the terms of the license. Included in this responsibility are:
  - Procuring and managing radioactive sources and standards;
  - Maintaining the laboratory's radioactive materials inventory, which also includes directing prescreen analyses that provide initial characterization of potential sample radioactivity;
  - Overseeing permitted low level radioactive materials releases to the sanitary sewer; and
  - Ensuring that radioactive materials waste is transported in accordance with all Federal and state regulations, and is transferred only to facilities that possess a radioactive materials license.

#### 3.1.4 Laboratory Information Management Systems Manager

The Information Systems (IS) Manager (Manager) reports to the Laboratory Director. This Manager is responsible for administering the network, maintaining data recovery systems, and for managing personal computing (PC) equipment and peripherals, thus supporting instrumentation and LIMS. The IS Manager (and/or designee) is responsible for:

- Managing and maintaining the laboratory computer system. This function includes determining and purchasing appropriate hardware and verifying that its function meets intended objectives, establishing network server structure, and developing and implementing proper maintenance and backup procedures;
- Procuring, configuring and maintaining all printers and copiers;



- Serving as a technical resource on computer-related issues;
- Documenting related operating procedures through SOPs, manuals or other proprietary documentation;
- Supervising recovery of all systems in the event of a disaster;
- Analyzing information flow in the laboratory and suggesting the most effective hardware, applications software, and/or programming changes as solutions to meet long-term customer requirements; also, implementing those changes in data acquisition and management by purchasing hardware or software, where software is not developed internally; and
- Maintaining and implementing existing and future communications systems, including all internet and telephone systems.
- Developing, maintaining, enhancing the Laboratory Information Management System (LIMS), and other data base programs to facilitate and streamline Laboratory operations

### 3.1.5 Project Manager

Project Managers report to the Laboratory Director. *The Project Manager serves as the primary point of contact between clients and ALS.* Client communication procedures and documentation requirements are listed in the ALS SOP 997. Each PM (and/or designee) is responsible for:

- Managing and coordinating the laboratory's performance after contract award, by defining technical and service requirements for personnel via LIMS, and interacting with clients and laboratory personnel to ensure that technical criteria and client service needs are met, including monitoring holding times (if appropriate) and deliverable deadlines, for all project sample analyses;
- Reviewing and approving any non-conformances reported by the laboratory and notifying the client, if appropriate, and communicating with clients pro-actively to ensure that all client service and technical concerns are resolved promptly;
- Reviewing all final reports for completeness, compliance with project requirements, clerical accuracy, and reasonableness;
- Generating, as directed by prompts provided in ALS's EDD generator, and transmitting EDDs to their clients as required;
- Ensure communications with the clients are in compliance with ALS SOP 997 "Client Communication"; and



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- Communicating to the Laboratory Director any potential need for new or improved capabilities based on clients' feedback.
- Ensure implementation of quality policy and applicable standards.
- Complete and distribute project related information for each project before the laboratory starts work on the project.
- Immediately communicate to the laboratory changes made to projects in progress and document these changes as appropriate.
- Respond to client requests for information and coordinate responses to client audits.
- Perform an initial review of results for large projects to verify that data reports submitted to the client meet all project requirements

### 3.1.6 Group Leader

- Technical functions such as sample control, preparation, analysis, data management; and quality assurance;
- Monitoring QA/QC standards of performance, including ensuring that corrective actions are developed, documented, and implemented for all external and internal audit Findings, PT study failures, and other corrective actions;
- Monitoring the validity of the analyses performed and data generated in the laboratory to ensure the production of compliant data, including, contributing to and/or overseeing data review processes;
- Ensure that SOPs are compliant with promulgated methodologies and reflect current practice;
- Providing input to the Laboratory Director regarding methodologies, personnel resources, software, and instrumentation; and assisting in the evaluation and/or development of new methods and technologies that improve ALS's ability to meet clients' needs;
- Reviewing RFPs and assisting in the preparation and submission of proposals; and
- Interacting with Quality Assurance, Information Systems, and Health and Safety to ensure that the laboratory is capable of complying with client and regulatory requirements.
- Coordinating and approving the purchase of reagents, standards, glassware, and equipment that meet requirements



- Maintaining current, compliant RVS QC samples for all methods, matrices, analytes, columns, and instruments
- Develop training plans and assigning job tasks and prioritizing analyses;
- Authorize technical staff to perform analyses, including assigning technical SOPs, and providing the QA department with Initial Demonstration of Competency documentation.
- Developing and implementing a preventive maintenance program for instrumentation in their laboratory, and ensuring that all equipment is maintained, serviced, and properly calibrated;

### 3.2 GENERAL TECHNICAL PERSONNEL

A Chemist (Analyst) or technician reports to the Group Leader or Lab Manager. This employee performs work in accordance with ALS's controlled documents (e.g., SOPs, QAM, etc.) and project-specific requirements as defined by the applicable LIMS specification. *ALS believes that quality begins at the bench.* Accordingly, these employees are key contributors to ALS's success.

A chemist or technician is responsible for:

- Demonstrating proficiency in the analyses for which they are responsible and documenting this demonstration of proficiency in accordance with ALS Standard Operating Procedure 150;
- Performing analyses, recording all data accurately, directly, and promptly, and interpreting and reviewing data according to established procedures;
- Read and understand all assigned SOPs and plan documents;
- Follow Quality Assurance requirements as outlined in the QAM and SOPs. Follow appropriate channels regarding modification of existing SOPs.
- Complying with all QA/QC requirements that pertain to their job function;
- Complying with all health, safety, and waste disposal requirements, as applicable;
- Maintaining and repairing instrumentation;
- Demonstrating good house-keeping practices;
- Follow appropriate protocols when the results for QC samples and/or check standards do not meet acceptance criteria. Disclosing all instances of non-conformances promptly and in writing using the NCR process (ALS SOP 928);
- Participating in training sessions.



- Be familiar with current quality systems and policies as established by management. To comply with these requirements, analysts are responsible but not limited to the following;
  - Follow project requirements as delineated by project managers to ensure analyses are performed as requested.
  - Develop knowledge and understanding of the QAM requirements under which samples are analyzed.
  - Notify managers and Quality Assurance personnel when QA problems arise.
  - Ensure that applicable data are included in each data package in accordance with applicable SOPs.
  - Apply integrity and professional judgment when dealing with analytical processes and laboratory operations.

#### 4 DOCUMENT CONTROL

Current copies of pertinent quality assurance guidance documents, such as ALS's QAM, the TNI Standards, ISO 17025:2005, , the US DoD Quality Systems Manual (QSM), AIHA and others, are posted to the ALS intranet so that they are accessible to every employee. Laboratory Standard Operating Procedures (SOPs) and other method references are also posted to the intranet for lab-wide employee access. Project-specific requirements are disseminated to the laboratory via Laboratory Information Management Systems (LIMS) program specifications.

An overview explaining document hierarchy is in ALS SOP 143. ALS SOP 926 provides detailed guidance on the review, revision, and distribution of laboratory-generated controlled documents.

New and revised documents are posted to the intranet to share with all employees. The LIMS notifies personnel of all revised documents. It is the responsibility of all employees to read and update reading records for all assigned controlled documents. Archival records of all document iterations are maintained by the Quality Assurance Department.

This process of revision, approval and distribution is established in the ALS SOP 926. A list of current SOPs is provided in Appendix G. The Quality Assurance Department manages the review, revision and controlled distribution of documents and maintains associated records.

##### 4.1 LABORATORY QUALITY ASSURANCE PLAN



The QAM is an encompassing controlled-document that describes the ALS quality assurance programs and policies. All systems, policies, and procedures have been developed and implemented in accordance with applicable USEPA requirements, regulations, and guidance from current TNI Standard, ISO/IEC 17025:2005, AIHA LAP Policies, DoD QSM and DOE QSAS documents.

This document has been prepared in accordance with these referenced documents, as well as others, cited in the attached Bibliography. The QAM is intended to provide a 'quality requirements framework', including quality control (QC) procedures to be followed in the absence of reference method and project-specific requirements.

The Quality Assurance Manager bears primary responsibility for ensuring that the QAM meets industry standards. Proposed revisions to the QAM are approved by key laboratory personnel.

#### 4.2 STANDARD OPERATING PROCEDURES

The second kind of controlled-document in the hierarchy of quality assurance guidance is the Standard Operating Procedures (SOPs). An SOP defines the QA/QC requirements for each method and describes in detail how personnel perform procedures and evaluate data. SOPs pertaining to general practices, administrative procedures and health & safety requirements are also maintained by ALS QA Department. It is ALS's intent that the information contained in our SOPs is both method-compliant, and accurately reflect actual practice.

#### 4.3 LABORATORY MANAGEMENT INFORMATION SYSTEMS (LIMS) PROGRAM SPECIFICATION

The last and most specific controlled-document in this hierarchy is the LIMS program specification. The LIMS program specification is a distillation of client Quality Assurance Project Plan (QAPjP) or contractual requirements, prepared electronically by the ALS Project Manager (PM), in collaboration with the Quality Assurance Manager and applicable operations management. This custom program specification, along with the associated LIMS test code nicknames, contains directives and controls that govern testing and reporting data. The program specification is often limited in scope and addresses only those QA/QC criteria required for a specific project. When the client's requirements differ from those stated in the SOPs and/or QAM, the project-specific LIMS program specification requirements supersede the others.

### 5 REVIEW OF REQUESTS, TENDERS AND CONTRACTS



Project Managers are responsible for maintaining, archiving, and retrieving all contracts, project requirements and QAPPs provided to ALS by clients and related to projects completed by ALS.. Specific procedures for client communication and required documentation are listed in the ALS SOP 997, "Client Communication."

## 6 SUBCONTRACTING OF TESTS

ALS strives to identify the need to subcontract specific analytical procedures during the bid response process. Analyses may also need to be subcontracted, however, in cases of emergency where the ability to meet sample holding time criteria is endangered. In these instances, ALS compiles a list of qualified subcontract laboratories that are suitable to perform the needed analyses.

ALS's Project Manager must receive permission from the client, in writing, before the subcontract laboratory can be procured and samples forwarded to the laboratory. See ALS SOP 103 for guidance on evaluating a subcontract laboratory's qualifications. Detailed procedures pertaining to submitting samples to a subcontract laboratory are provided in ALS SOP 103.

Procedures and documentation for using sub-contract laboratories are listed in the ALS SOP 997 "Client Communication." All results provided to ALS by a subcontract laboratory are identified clearly in the analytical report to the ALS client. Under no circumstances will ALS PT samples be sent to a subcontract laboratory.

## 7 PURCHASING SERVICES AND SUPPLIES

ALS uses vendors which supply the level of quality required to perform testing activities. ALS maintains a relationship with multiple vendors and looks for vendors with comparable certifications or accreditations. The laboratory monitors compressed gases used through system performance (e.g. background, blanks, calibrations criteria, detection limits). Any out of specification compressed gases are documented as nonconformance. Procedures designed to ensure that materials and services purchased meet the quality specifications of ALS delineated in ALS SOP 127.

## 8 SERVICE TO THE CLIENT

At ALS, improvement of the quality systems and preventative action is effected through an ongoing systems review by management using input for all staff.

ALS actively seeks employee and client input for improvements through surveys and questionnaires. Internally, ALS maintains a process improvement website for employees to provide suggestions for improvements. For clients, ALS surveys and gains feedback on services provided. This input to management is managed at a corporate level.





Project managers are especially involved in the production and assurance of quality results. Client Communication Procedures and documentation requirements are listed in ALS SOP 997.

## 9 COMPLAINTS

The focal point of contact with the client is the ALS Project Manager. If a complaint or any circumstance raises doubt concerning ALS's compliance with its policies or procedures, or with the requirement of a method or quality system, it is the Project Manager who initiates a client inquiry or nonconformance through the ALS LIMS NCR system following the ALS SOP 928. ALS will respond to all complaints in a timely fashion.

## 10 FACILITIES AND EQUIPMENT

**Appendix D** contains a diagram of the ALS laboratory facility. ALS maintains constant and consistent test conditions throughout the facility (e.g., temperature, air purification, and lighting). All entrances and exits are wired to a laboratory-wide security system that is monitored continuously. Access to the laboratory area from the front offices is restricted by means of keypad locks requiring numeric security code entry. Visitors must sign in at the front desk and must be escorted at all times (some vendors are allowed access without continuous escort, in order to facilitate repairs or deliveries). Further details pertaining to building security are provided in **ALS SOP 132**.

The following sections highlight areas of the laboratory that are involved with sample receipt, handling, preparation, and analysis of samples.

### 10.1 SAMPLE RECEIPT AREAS

ALS's sample receiving area consists of a large dedicated room of more than 500 ft<sup>2</sup>. It contains fume extraction and radiation survey equipment to safely handle incoming radioactive and mixed waste samples. There is an outside access door to facilitate sample delivery and shipping of sample kits. Adjacent to the sample receiving area is the bottle storage room and the radioactivity prescreening lab.

### 10.2 SAMPLE STORAGE AREAS

ALS's sample receiving area has a walk-in cooler and a freezer that are used for temporary storage of samples that require thermal preservation. In addition, there are several designated sample storage locations throughout the laboratory that are used to store samples scheduled for specific analyses (see section 11 for further details). An alarm system in the walk-in coolers notifies the Laboratory Manager of any temperature excursions. See ALS SOP 326.





### 10.3 SAMPLE PREPARATION AREAS

The laboratory has seven dedicated sample preparation/extraction/digestion areas: six radiochemistry preparation laboratories, one organics extraction laboratory. Additionally, there are extractions/digestion areas within some analytical labs, including Metals, Wet Chemistry, Fuels, and VOAs. The total floor space of these areas is approximately 4500 ft<sup>2</sup>.

Laboratory preparation procedures are segregated as much as possible to minimize the potential for contamination, maximize processing efficiency, and maintain analytical integrity. Rigorous cleaning of glassware and apparatus ensures that cross-contamination is minimized. Each laboratory area has a dedicated or locally shared HVAC system that continuously exchanges the laboratory air with filtered and conditioned outside air. There are 44 (including Niederman arms) laboratory hoods in the six sample preparation areas, and each sample preparation area has at least one hood. See HSE Hood for specific details related to fume hood monitoring.

### 10.4 STANDARDS PREPARATION AREAS

A dedicated radiochemical standards preparations room and an organics standards preparation area are maintained. Other standards are stored in their respective laboratory areas in refrigeration units, separate from sample storage.

### 10.5 ANALYTICAL LABORATORIES

The ALS facility houses a volatile organics analysis (VOAs) laboratory that is on an upper level of the building, away from all other laboratory operations. The ALS facility also houses one general chemistry (WetChem) laboratory, two radiochemical counting rooms, a total organic carbon (TOC) laboratory area, two gas chromatograph (GC) laboratory area, a semivolatile organic compounds (SVOCs) laboratory, and a metals laboratory that contains separate inductively coupled plasma (ICP), mercury, and inductively coupled plasma/mass spectrometry (ICP/MS) rooms.

### 10.6 OTHER LABORATORY AREAS

Other areas of the ALS facility include a tank room for compressed gasses, several waste management areas, telephone and computer storage rooms, staff offices, Reporting Group and Reports Management data processing rooms, and various scanning/reproduction and supply storage areas.

### 10.7 DEIONIZED WATER SYSTEM

Within the laboratory, there are two main deionized (DI) water distribution systems available for glassware cleaning, bulk reagent preparation, and



general use. One system is located in the janitor's area and serves the radiochemistry side of the facility (ASTM Type II water generated). The other system is located adjacent to the metals laboratory area and serves the stable chemistry side of the facility (ASTM Type I water generated).

ALS SOP 319 provides detailed information pertaining to ALS's DI water systems, including independent testing to verify that electronic readouts of water quality are accurate, maintenance by a vendor contractor, and corrective measures to be taken should water quality degrade to below acceptable limits.

## 10.8 ANALYTICAL EQUIPMENT

ALS maintains an organized maintenance program that is broader than the particular instruments or devices a specific employee may operate or is familiar with. The objective of ALS's equipment maintenance program is to provide a structure of care that prevents quality control failures and minimizes lost productivity that results from equipment malfunction or failure. Within this program are provisions for corrective actions, maintaining spare parts, and a contingency plan in the event of catastrophic failure (e.g., loss of power for a significant period of time).

See Appendix E for a comprehensive list of ALS's equipment.

## 10.9 PREVENTIVE MAINTENANCE

ALS's maintenance program is based on equipment manufacturer's recommendations, operator training guidance, and other considerations.

Provisions for documenting all routine and non-routine instrument equipment maintenance and repairs are also established within the maintenance program.

Responsibilities for applying ALS's maintenance program rests with the department that utilizes the equipment, the Quality Assurance Department bears responsibility for certain support equipment such as balances, weights and temperature measurement devices. Only authorized personnel are permitted to perform maintenance.

In general, ALS performs maintenance as needed (including preventive considerations). Certain aspects of routine maintenance are considered to be 'operational', and are performed each time the instrument is run. Other maintenance is performed 'periodically'. Each instrument operator is responsible for the performance of their own instrument, and may perform maintenance duties at their discretion.



ALS maintains service contracts for most major analytical equipment. Preventive maintenance is included in most of these service contracts.

#### 10.10 EQUIPMENT DOCUMENTATION REQUIREMENTS

Analysts are responsible for maintaining calibration/verification and maintenance records of all instruments and equipment involved in the creation of the analytical data they generate.

Although the manner of record keeping varies, maintenance records provide a clear and complete history of repairs and maintenance associated with the instrument.

Details regarding equipment documentation are also provided in ALS SOP 303. Maintenance Logbooks are reviewed during internal audits.

#### 10.11 SPARE PARTS

An adequate inventory of spare parts is required to minimize equipment downtime. This inventory should include those parts and supplies that:

- are subject to frequent failure;
- have limited useful lifetimes, or
- cannot be obtained in a timely manner should failure occur.

Departments are responsible for maintaining an adequate inventory of necessary spare parts for all major instruments and equipment items. Examples of spare parts maintained for major instrumentation include: septa, inserts, columns, tube fittings, filaments, source parts, and traps.

#### 10.12 SUPPORT EQUIPMENT

ALS defines support equipment as all those devices which are not the primary determinative instrument defined by the analytical method, which support laboratory operations and would contribute to the testing uncertainty. Support equipment includes balances, temperature measurement devices, and mechanical (e.g., Eppendorf™ pipets) volumetric measurement. Support equipment affecting the uncertainty of testing results is verified periodically in accordance with applicable procedures. All verification is directly or indirectly traceable to certified reference standards. The results of the calibration/verification are documented.



Because automatic dispensing devices used to deliver solvents or reagents (e.g., for sample preservation and extractions) are not used to deliver critical volumes, these devices are exempt from daily verification.

Additionally, ALS has procedures for the following support equipment:

- Deionized (DI) water systems ALS SOP 319
- Health physics equipment ALS SOPs 012, 016 and 029
- Mechanical Pipettes, ALS SOP 321.

A statement of Accuracy is acquired from the manufacturer for all glass microliter syringes.

The following ALS SOPs provide additional information about calibration and verification of support equipment:

- ALS SOP 305 -- balance calibration and verification
- ALS SOP 320 -- monitoring and recording of oven temperatures
- ALS SOP 326 -- monitoring refrigerator and freezer temperatures

## 11 SAMPLE MANAGEMENT

### 11.1 SAMPLE CONTAINERS, PRESERVATION, HANDLING, HOLDING TIMES

Although the laboratory is not responsible for sample collection, it is responsible for maintaining the integrity of the sample after receipt. After the sample has been collected, the constituents of the sample must remain as close as possible to the field condition (i.e., degradation must be prevented). The length of time that these constituents will remain stable is related to their character and the preservation method used. Preservation is accomplished by the addition of chemical preservatives and/or storage at a controlled temperature, and by the strict observation of prescribed maximum holding time allowances. Appendix F lists sample container types, preservation requirements, and holding times.

### 11.2 FIELD SUPPORT

ALS provides shipping containers, custody documents, custody seals, clean sample bottles, labels, applicable high-purity chemical preservatives for water samples, and trip blanks to support field-sampling events. Hard-sided, insulated, "picnic" coolers are typically used to transport samples from the field to the laboratory. These coolers meet or exceed all protocol



requirements (i.e., USDOT, USEPA, ASTM) for shipping. ALS SOP 205 provides further information on sample kits.

### 11.3 SAMPLE CONTAINERS

ALS provides certified clean sample bottles for sample collection. Used sample bottles are never used by the laboratory. Containers are stored in clean areas, away from laboratory processes, to prevent exposure to fuels, solvents, and other contaminants.

### 11.4 SAMPLE PRESERVATION AND HOLDING TIMES

ALS provides the required chemical preservatives for water samples. ALS uses high quality reagent grade chemical preservatives (i.e., acids, solutions, etc.) are added to individual sample bottles, as appropriate per method and US Department of Transportation (DOT) requirements. Holding times begin with the collection of samples and continue until analysis is complete. See Appendix F for a summary of container, preservation and holding time requirements specific to various analyses and matrices.

### 11.5 SAMPLE RECEIPT SCHEDULE

ALS receives samples six days of the week, Monday through Saturday. ALS requests that clients ship samples for delivery within one day of collection, and give advance notice to the laboratory regarding shipment of RUSH samples or samples with short hold time requirements. Shipping containers received at the laboratory on holidays or after business hours are placed in a walk-in refrigerator and opened on the next business day, unless other arrangements are made in advance.

### 11.6 CHAIN-OF-CUSTODY

Chain-of-custody (COC) documentation begins with field sampling and continues through laboratory analysis and disposal. A chain-of-custody record that identifies all individuals who handle the sample is used to establish an intact, continuous record of the physical possession, storage, and disposal of collected samples, including their aliquots, extracts or digestates.

To ensure that sample custody objectives of traceability are achieved for every project, the chain-of-custody initiated in the field is continued and maintained internally throughout the laboratory per the requirements specified in ALS SOP 318. Internal chain-of-custody begins with sample acceptance and login. ALS SOP 202 is followed as samples are distributed for use throughout the laboratory and concludes with final sample disposition



ALS applies a unique barcode to each sample bottle received, and maintains several scanners and PCs throughout the laboratory to document and assist with sample, aliquot, extract and digestate movement throughout the facility. This electronic process is accomplished through LIMS, which retains records of all sample and fraction transactions made.

## 11.7 SAMPLE ACCEPTANCE POLICY

ALS' sample acceptance policy requires that a sample meet the following conditions:

- The sample shall be completely documented (sample identification, location, date and time of collection, collector's name, preservation type, sample type, any special remarks concerning the sample);
- The sample shall be identified by a unique identifier using durable labels completed in indelible ink;
- The sample shall be collected in adequate volume;
- The sample shall be collected in an appropriate container;
- The sample shall be delivered to the laboratory with at least one-half the holding time remaining;
- The sample shall not exceed allowed radioactivity levels; and
- The sample shall not show signs of contamination, breakage, or leakage.

Sample receipt discrepancies are documented by Sample Receiving Department personnel on the Condition of Sample Upon Receipt, Form 201 (ALS SOP 008), which is forwarded to the Project Manager as part of the workorder folder. Where samples do not meet the criteria stated above, the Project Manager requests information from the client before proceeding. If the client can provide the information and, in cases of compromised sample integrity, directs the laboratory to proceed, then data acquired from the sample(s) analysis is reported and the problems noted during sample receipt are disclosed in the narrative of the final data report.

In support of the protection of employee health and of ALS's radioactive materials license, ALS observes prescreening protocols that designate or determine samples with radioactive content. Detailed procedures for conducting radiological survey of incoming sample packages are given in ALS SOP 008, further details regarding prescreening protocols are given in ALS SOP 703.

## 11.8 SAMPLE RECEIPT PROTOCOLS



Upon receipt of the field samples at the laboratory, personnel ensure that ALS SOP 202 is followed.

Following sample arrival and initial screen for USDOT compliance and removable radioactivity, sample receiving personnel inspect the sample and record any discrepancies using Form 201 from ALS SOP 008.

Sample temperature is verified upon receipt by measuring the temperature of the temperature blank or by measuring the temperature of a representative sample(s) with an infrared (IR) temperature device. See ALS SOP 210 for instructions and procedures related to IR temperature guns. Samples that require thermal preservation are considered acceptable if the temperature upon arrival is between just above freezing to 6°C. Samples that require thermal preservation but are hand-delivered to the laboratory immediately after collection, may not meet the temperature requirement. If the hand-delivered sample is packed in ice, then Sample Receiving personnel record its temperature and note that the chilling process was initiated.

#### 11.9 SAMPLE STORAGE

Samples requiring thermal preservation are stored in designated refrigerated storage areas that are maintained just above freezing to 6°C. Freezer storage areas are maintained below freezing. The temperature of refrigeration units is monitored continuously using electronic min/max thermometers and recorded each business day, near to the beginning of the work shift. If the temperature exceeds the prescribed range, then corrective action is taken and documented immediately, and the client notified, if appropriate; see ALS SOP 326 for further details. Directives for corrective action pertaining to catastrophic failure of cooling units (as well as laboratory ovens, etc.) are included in ALS's Emergency and Contingency Plan (ECP).

Samples are stored away from all standards, reagents, food and other sources of contamination. Samples are stored in such a manner as to prevent cross-contamination. For example, pure product or potentially contaminated samples are tagged as "hazardous" and stored within a secured area, separate from other samples. ALS provides designated sample storage areas according to the following parameter groups: metals, inorganics (WetChem), semivolatile organics, volatile organics, fuels, and radiochemical analyses.

Samples having suspected radioactive activity and scheduled also for stable chemical analyses are refrigerated. Samples to receive tritium analyses are refrigerated. Samples designated for radiochemistry analyses only, with the exception of tritium, are segregated and maintained at ambient temperature.





To effectively monitor the storage and potential contamination of volatile organic samples, ALS observes a refrigerator blank program as detailed in ALS SOPs 511, 512.

To provide for the safe containment of sample material that could be released as a result of sample container failure, all samples are stored in secondary containment bins. These secondary containment bins are of a sturdy and inert nature, and are sufficient in size to fully contain the sample(s) in the event of a spill, leak or breakage. The bin(s) may be uniquely identified (labeled) to assist in locating samples via the chain-of-custody system. The bins are thoroughly cleaned between uses.

#### 11.10 SAMPLE ACCESS

*It is ALS's policy that neither samples nor data may be released to unauthorized personnel.* In order to ensure that this policy is maintained, the laboratory facilities are maintained under controlled access and are restricted to authorized personnel only (see ALS SOP 132 for further details pertaining to building security).

#### 11.11 SAMPLE HOMOGENIZATION AND SUBSAMPLING

*Obtaining a representative aliquot of sample for testing is critical to the representativeness of the analytical results obtained.* Proper subsampling techniques, particularly for solid matrices, are a component of each bench employee's technical instruction. Sample homogenization procedures prior to radiochemical analysis are prescribed in ALS SOP 736. Representative subsampling procedures for stable chemistry analyses is prescribed in ALS SOP 336. Client and method specified procedures for homogenization or aliquotting may also be defined in the applicable LIMS program specification.

#### 11.12 SAMPLE DISPOSAL

After completion of sample analysis and submission of the project report, unused portions of samples are retained by the laboratory for a minimum of 30 days or as designated by client and contract requirements from date of invoice. Samples are disposed or returned to the client according to the nature of the samples and the client's specifications. ALS documents and retains all conditions of disposal and correspondence between all parties concerning the final disposition of the sample.

Samples, digestates, leachates, extracts, and process waste that are characterized as hazardous, radioactive, or mixed waste are disposed in accordance with Federal and state laws and regulations. ALS maintains records to demonstrate that all disposal efforts were conducted in compliance with these laws and regulations. This documentation includes the unique sample identity, date of disposal, nature of disposal (e.g., sample





depleted, sample disposed in hazardous waste facility, sample disposed in mixed waste facility, sample returned to client); and name of the individual responsible for disposal.

## 12 ANALYTICAL PROCEDURES

ALS is capable of analyzing various matrices, including surface and groundwater, drinking water, soil, sediment, vegetation, tissue, filter and aqueous and solid wastes. Analytical procedures are conducted in strict adherence with SOPs that describe the preparation, analysis, review and reporting of samples. In some cases, these SOPs may also describe proprietary methods developed by ALS and used per the client's request. A list of ALS's analytical capabilities is presented in Appendix F. References for analytical procedures used are presented in the attached Bibliography. ALS also, upon request, develops and validates procedures that are more applicable to a specific client objective.

### 12.1 ANALYTICAL METHODS

Selection of the appropriate method is dependent upon data usage and regulatory requirements. ALS may modify existing methods in order to:

- achieve project-specific objectives;
- incorporate modifications or improvements in analytical technology;
- address unusual matrices not covered in available methods; and
- provide analytical capabilities for an analyte for which there are no promulgated methodologies.

*ALS discloses method modifications to our clients by providing the appropriate SOP for review.*

### 12.2 METHOD COMPLIANCE

Compliance is the proper execution of recognized, documented procedures that are either approved or required. Strict adherence to these procedures is necessary to provide data acceptable to a regulatory body of competent jurisdiction in a specific regulatory context. To ensure method compliance ALS personnel follows SOPs as written and internal audits review methods for regulatory compliance.

### 12.3 NON-STANDARD METHOD VALIDATION



When a non-promulgated method (i.e., methods other than EPA, ASTM, etc.) is required for specific projects or analytes of interest, or when the laboratory develops a procedure, the laboratory must establish the validity of the method prior to extracting or analyzing a client's samples. *Validity is established by meeting criteria for precision and accuracy. See ALS SOP 999 for method validation protocols.*

## 13 MEASUREMENT AND TRACEABILITY

### 13.1 DATA INTEGRITY AND TRACEABILITY

Data Integrity is the extent to which results can be substantiated by hard-copy documentation, electronic or computer-generated data calculations, computer software, and data generation.

Traceability links final numerical results to authoritative measurement standards (reference materials and reference standards) and that which explicitly describes the processing of each sample from receipt to analysis.

### 13.2 SENSITIVITY

The term sensitivity is used in a broad sense to describe the various limits that enable a laboratory to meet project-specific data quality objectives (DQOs). These limit types include: instrument detection limit (IDL), method detection limit (MDL), method quantitation limit (MQL) or method reporting limit (RL), contract-required detection limit (CRDL), and contract-required quantitation limit (CRQL).

### 13.3 LOD (Can be called MDL)

The LOD is a minimum value that addresses the detection capability for the sample preparation procedures and the instrument. Hence, ALS performs ongoing analyses for each preparatory and determinative method combination, matrix, instrument, and analytical column. These analyses of Reporting Limits Verification Samples (RVS) are ongoing in each batch of samples tested. RVS analyses are also required for method validation, and whenever the basic chemistry of a procedure changes.

LOD is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. LODs are determined using ALS SOP 329.

An LOD study is not performed for radiological analyses, or any components for which spiking solutions are not available or relevant (e.g., pH, ignitability, etc.). Reporting limits for these kinds of parameters, where applicable, are established based on the laboratory's knowledge of extraction efficiency, instrument sensitivity, and experience with the procedure.



### 13.4 LOQ (can be called RL)

ALS defines LOQ as the analyte concentration at or above the lowest standard used for calibration and can be routinely demonstrated and achieved.

The LOQ is the lowest level that can be reliably measured by a laboratory with defined limits of precision and bias. The precision and bias at the LOQ is associated with Reporting Limits verification (RVS) samples analyzed.

The LOQ is verified using reporting limit verification samples (RVS) on either a batch basis or periodically scheduled. This RVS is a clean matrix spiked at the LOQ.

### 13.5 MINIMUM DETECTABLE CONCENTRATION (RADIOCHEMISTRY)

The minimum detectable concentration (MDC) is used for radiochemical procedures and is defined as the concentration at which there is a 95% confidence that an analyte signal will be distinguishable from an analyte-free sample.

The general formula for calculating the MDC is based on calculations derived by Curie (Curie, L.A., "Limits for Qualitative Detection and Quantitative Determination," Analytical Chemistry 40(3); pp. 586-693; 1968) and is calculated as follows:

$$MDC = \frac{(4.65 \times \sigma_b) + 2.71}{T * K}$$

where:

MDC = Minimum Detectable Concentration

$\sigma_b$  = Standard deviation of the measurement background

T = Sample count time

K = Factor for incorporating efficiency, abundance, aliquot yield, ingrowth and decay, and activity conversion factors

### 13.6 MEASUREMENT UNCERTAINTY

#### 13.6.1 Analytical Uncertainty

Uncertainty is associated with most of the results obtained in the laboratory testing conducted by ALS. It is meaningful to estimate the extent of the uncertainty associated with each result generated by the laboratory.

It is also useful to recognize that this measurement uncertainty is likely to be much less than that associated with sample collection activities. In practice, the uncertainty of a result may arise from



many possible sources. ALS has considered the relative contribution of major sources of error. The approach adopted by the laboratory to estimate uncertainty resulted in the conclusion that many sources of error are insignificant compared to the processes of sample preparation, calibration, and instrumental measurement. The uncertainty associated with these processes can be estimated from quality control data. Accordingly, ALS estimates uncertainty from data derived from quality control samples carried through the entire analytical process. Each estimate of uncertainty is associated with a specific combination of analytical method and sample matrix.

The ALS Standard Operating Procedure 998 gives details of how uncertainty in the analytical process is estimated, calculated and reported if required.

#### 13.6.2 Total Propagated Uncertainty For Radiochemisry

Total propagated uncertainty (TPU), is a summation of the various uncertainties present in a measurement process, and is an integral part of every reported radiochemical value. TPU, reported as  $\pm$ TPU, is the expressed estimated measure of the total uncertainty inherent in that reported radiochemical result.

The components of the TPU are classified as either random or systematic.

Random uncertainties, also called counting uncertainties (CU), derive from the statistically random (normally distributed) nature of radioactive decay, and are estimated as the square root of the total number of counts acquired during analysis. In cases where the chemical yield is determined by the analysis of a radioactive tracer, the yield uncertainty (YU) is also a random uncertainty, and is estimated as the square root of the total number of tracer counts acquired. CU and YU are calculated in activity units to afford comparability to the sample result.

Systematic uncertainties are attributable to actual errors in the measurement of a physical quantity. For example, if a balance has an accuracy of  $\pm 0.1\%$ , the results of those gravimetric measurements are not normally distributed, but rather are assumed to be biased by that amount. Estimates of systematic uncertainties in laboratory processes are somewhat subjective, but should be supported by empirical data whenever possible. Systematic uncertainties associated with the preparation of a sample are called preparation uncertainties (PU), and are defined based on the number of volumetric and gravimetric measurements, quantitative transfers,



etc. Systematic uncertainties associated with the analysis, called instrument uncertainties (IU), include biases associated with sample positioning, standard values, calibration coefficients, etc. PU and IU are typically provided as a percentage of the final result. To afford comparability to sample results, PU and IU are expressed in activity units by multiplying the percentage by the sample activity (A).

**ALS SOP 708** provides more information about the calculation and use of TPU.

## 14 ASSURING THE QUALITY OF RESULTS

### 14.1 QUALITY ASSURANCE INDICATORS AND OTHER MEASUREMENT PARAMETERS

ALS' objective is the development and implementation of policies and procedures that provide results of known, documented, and appropriate quality. This QAM defines general policies for the analysis, documentation, evaluation, validation, and reporting of data. Specific, detailed procedures for chain-of-custody, calibration of instruments, analysis, reporting, quality control, audits, preventative maintenance, and corrective actions, are provided in SOPs as listed in Appendix G.

The hierarchy of quality control requirements begins with:

- Client Requirements (Program Specifications (LIMS))
- Reference Method and/or SOP requirements
- Guidance from QAM and other general SOPs

*In order to produce data of known, documented, and appropriate quality, ALS:*

- maintains an effective quality assurance program that measures and verifies laboratory performance. This program includes the regular analysis of proficiency testing samples for procedures and methods throughout the laboratory, in adherence with TNI Standard EL-V1M1-2016-Rev.2.1 and Dod/DOE QSM v5.1.1 V1M1.
- evaluates technical and service requirements of all analytical services requests before accepting samples from a client/project. This evaluation includes a review of facilities, instrumentation, staffing, turnaround times, and any project-specific quality control or reporting requirements;
- provides sufficient flexibility to allow controlled changes in routine methodology in order to achieve client-specific data requirements as prescribed in client documents and contracts;



- performs all analyses according to promulgated methods or methods developed and validated by ALS and documented in SOPs;
- recognizes as soon as possible and discloses and corrects any factors that adversely affect data quality; and
- maintains complete records of sample submittal, raw data, laboratory performance, and completed analyses to support reported data.

## 14.2 DATA QUALITY INDICATORS

Data Quality Indicators (DQIs) are qualitative and quantitative statements developed by data users that specify the quality of data from field and laboratory data collection activities in order to support specific decisions or regulatory actions. The DQIs describe *what* data are needed, *why* the data are needed, and *how* the data will be used to address the problem being investigated. DQIs also establish qualitative and quantitative goals that allow the data user to determine whether the data are of sufficient quality for the intended application.

The principal DQIs are **precision, accuracy and bias, representativeness, completeness, and comparability** (i.e., the PARCC parameters). The following sections define and describe the application of these parameters. The QA/QC protocols used for the majority of analyses are adopted from SW-846 and 40 CFR methodologies, the USEPA Organics and Inorganics CLP SOWs, and various radiochemistry guidances, which contain detailed descriptions of the quality control measures routinely employed.

## 14.3 PRECISION

Precision is an expression of the reproducibility or degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions.

Analytical precision is a measurement of the variability associated with duplicate or replicate analyses of the same sample in the laboratory. Analytical precision is determined by the analysis of matrix spike/matrix spike duplicates (MS/MSD), laboratory control sample pairs (LCS/LCSD), or by unspiked duplicate samples (DUPS). Total precision is a measurement of the variability associated with the entire sampling and analysis process, and is determined by analysis of duplicate or replicate *field* samples, thus incorporating the variability introduced by both the field and laboratory operations.

Precision is independent of bias or accuracy, and reflects only the degree to which the measurements agree *with one another*, not the degree to which they agree with the true or accepted value of the parameter measured. Precision for



chemistry analyses is typically expressed as relative percent difference (RPD), as defined below:

$$RPD(\%) = \frac{X_1 - X_2}{(X_1 + X_2)/2} (100)$$

where:

RPD = Relative Percent Difference

$X_1, X_2$  = analyte value of sample 1 and sample 2

Precision, for radiochemical analyses, is typically measured in terms of Duplicate Error Ratio (DER), calculated as follows:

$$DER = \frac{|S - D|}{2 * \sqrt{\sigma^2_S + \sigma^2_D}}$$

where:

DER = Duplicate Error Ratio

S, D = analyte values of (S)ample and (D)uplicate

$\sigma$  = One Sigma error value associated with sample result

RPDs or DERs are compared to the control limits established for the analysis method, or other quality control criteria as prescribed in the applicable LIMS program specification. Precision objectives vary per analytical method. Sample homogeneity/non-homogeneity is an important factor that influences the precision of duplicate sample results.

#### 14.4 ACCURACY and BIAS

Accuracy is agreement between the measured and true (known or accepted reference) value.

Bias describes the systematic error of a measurement process that causes errors in one direction from the true value. Sources of bias include are usually systematic and maybe limitations of the method, matrix or analytical technology. *Bias is **not** equivalent to accuracy.*

Accuracy is typically measured by determining the bias (percent recovery) of known target analytes that are spiked into a field sample or reagent water or simulated solid matrix (laboratory control sample). Surrogate recovery is reported and is used to assess method performance for each sample analyzed for volatile and semivolatile organic compounds. For organic and inorganic parameters, the stated accuracy objectives apply to spiking levels at or near the midpoint of the calibration curve. For radiochemical analyses, the spiking





levels for the control spikes may vary from five to fifty times the method reporting limit.

Percent recovery is calculated as:

$$R(\%) = \frac{(C_1 - C_2)(100)}{C_3}$$

where:

R% = Spike amount recovered

C<sub>1</sub> = Concentration of analyte in spiked sample

C<sub>2</sub> = Concentration of analyte in unspiked sample

C<sub>3</sub> = Concentration of spike added

Acceptance limits are usually based upon established laboratory control samples from similar matrices. Other quality control criteria may be prescribed in the applicable LIMS program specification. Recoveries outside the established limits may indicate some assignable cause other than normal measurement error, and the need for corrective action.

Both bias and precision are calculated for each batch and the associated sample results must be interpreted by considering these specific measures. The quality assurance objectives for precision and bias are to achieve the quality control acceptance criteria specified in the appropriate analytical procedure.

For organic analyses, precision and accuracy are determined by using matrix spike and matrix spike duplicate samples and/or surrogate spike compounds and laboratory control samples. For inorganic analyses, precision and accuracy are determined by using duplicate samples or matrix spike duplicate samples (precision) and matrix spike and laboratory control samples (accuracy). For radiological analyses, precision and accuracy are determined from the results of duplicate samples or matrix spike duplicate samples (precision), laboratory control sample duplicates (precision) and laboratory control samples (accuracy).

QC limits for accuracy and precision are to be developed from intra-laboratory historical data, adopted from prescribed limits required by the client or from the reference method. If quality control acceptance criteria do not exist for a given method, then the laboratory may establish advisory control limits derived from a minimum of four data points. Until verified by a statistically significant data population, the control limits will be considered as advisory limits only, and the laboratory will not automatically initiate reanalysis if these limits are not achieved. See Section 16.2 for further discussion of control limits and control charts.

#### 14.5 REPRESENTATIVENESS





Representativeness is a qualitative element. It expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary.

Sample handling protocols (e.g., holding times, storage, preservation and transportation) have been developed to preserve the representativeness of the samples. Proper documentation establishes that quality control protocols have been followed, and sample identification and integrity are ensured. SUB-sampling is addressed in ALS SOPs 336 and 736.

#### 14.6 COMPARABILITY

Comparability is a qualitative expression of the confidence with which one data set can be compared to another. Comparability is achieved by:

- following established, standardized, and approved sample collection techniques and analytical methods;
- achieving holding times;
- reporting results in common units;
- using consistent detection levels; and
- Reporting data according to consistent rules.

#### 14.7 COMPLETENESS

Completeness is an expression of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. Completeness is the percentage of measurements that are judged to be usable (i.e., that meet project-specific requirements). Completeness goals are defined in the site sampling and analysis plan, QAPjP or contract, and vary with the size and complexity of the project. Completeness goals of 80-95% are traditionally accepted as realistic. ALS's objective is 100% completeness for samples unaffected by matrix interferences.

#### 14.8 QUALITY ASSURANCE PROCEDURES

ALS' quality control program provides a systematic process that enables the laboratory to evaluate and control the validity of analytical results, by measuring and monitoring accuracy and precision by method and matrix; by



developing control limits and using these limits to detect errors or out-of-control events; and by requiring corrective actions to prevent or minimize the recurrence of these events. ALS observes QC procedures to ensure that sample data meet laboratory and client quality objectives.

The purpose of preparing and analyzing QC samples is to demonstrate accuracy and precision of the sample data and performance of the method for the target analytes being investigated. Acceptance criteria may be dictated by reference methods or by project requirements.

For all analyses performed by ALS, the QC concepts and samples described in the following sections are mandatory. Determinative SOPs contain a Table that summarizes the types and frequency of QC samples, acceptance criteria, and corrective actions required.

#### 14.9 DEFINITIONS OF BATCH and BATCH QC SAMPLES

##### 14.9.1 Preparation Batch

A preparation batch consists of as many as 20 field samples of the same or similar matrix that are prepared together by the same analyst(s) within a limited or continuous time period, following the same method, and using the same kind of equipment and same lots of reagents. Additional samples may be added to a batch if the appropriate number and kind of method control samples (e.g., MB, LCS) and matrix-specific QC samples (e.g., MS/MSD, DUP). Cleanup procedures may be included as part of the preparation batch. All field and QC samples in the batch shall be subjected to the same preparation and cleanup procedures. For industrial hygiene samples a Reagent Blank, Method Blank, RVS and duplicate Laboratory Control Samples (LCS/LCSD) are used in each preparation batch.

##### 14.9.2 Analysis Batch

The analysis batch (or sequence) consists of samples, may be multiple preparation batches that are analyzed together within the same or continuous time period, on the same instrument, and processed using the same calibration. Each analysis sequence must contain the appropriate number and kind of standards and samples as defined by the method.

Where no sample pre-treatment (such as extraction or digestion) is required prior to analysis (e.g., analysis of volatile organic compounds, anions analysis by ion chromatography, etc.), the preparation batch and analysis sequence are equivalent.



#### 14.9.3 Preparation Batch QC Samples and Standards – Definition and Use

The results of quality control samples provide an estimate of accuracy and precision for the preparation and analysis steps of sample handling. The following sections describe the QC information provided by each of these analytical measurements.

#### 14.9.4 Method Blank

A method blank (MB) consists of an aliquot of well-characterized, controlled, or certified matrix (e.g., reagent water, Ottawa sand, solid reference material, boiling chips) that is processed through the entire sample preparation, cleanup, and analysis procedure. For radiochemical analyses, a suitable blank solid matrix has not been identified; therefore, reagent water is routinely used for the blank for most solid matrices. The volume or weight of the blank must be approximately equal to the sample volume or weight processed for sample analyses.

The purpose of the MB is to demonstrate that interferences caused by contaminants in solvents, reagents, glassware, and other sample processing hardware, are known and minimized. A method blank should not contain target analytes at or above the reporting limit, unless otherwise permitted in the method. Other maximum blank contamination control criteria may apply, as indicated in the associated LIMS program specification.

While some methods may require background correction, sample results are typically not corrected for blank contamination.

#### 14.9.5 Laboratory Control Sample

A Laboratory Control Sample (LCS) consists of an aliquot of well-characterized, controlled, certified matrix (e.g., reagent water, sand, solid reference material, Teflon™ chips) that is spiked with analytes of interest and processed through the sample preparation, cleanup, and analysis procedure. For industrial hygiene testing the appropriate media is added.

The purpose of the LCS is to provide an estimate of bias based on recovery of the compounds from the clean, controlled matrix, and to demonstrate that the laboratory is performing the method within accepted guidelines without potential non-matrix interferences.

Where sample pretreatment is not required, such as with ion chromatography or gamma spectroscopy analysis, or the analysis of



volatile organic compounds, the ICV standard or other appropriate control standard may be employed as the LCS.

An LCS for methods with extensive lists of analytes that may interfere with one another may include a limited number of analytes, but the analytes included must be representative of as many analytes as is practical.

Other client-specific QC requirements may be prescribed in the applicable LIMS program specification.

#### 14.9.6 Matrix Spike/Matrix Spike Duplicate

A matrix spike (MS) or matrix spike duplicate (MSD) is a field sample to which known concentrations of target analytes are added before the sample is processed. The purpose of MS/MSD samples is to assess the performance of the method for a particular matrix and to provide information about the sample's homogeneity. Results of the MS/MSD samples are evaluated in relation to the method QC samples to determine the effect of the matrix in regards to accuracy and precision. Sample results are not corrected for MS/MSD excursions.

For some analyses, changing the composition of the sample in any way invalidates the analysis to be performed (e.g., hardness, alkalinity, pH). Therefore, an MS/MSD pair cannot be generated for these analyses. Normally, duplicate sample aliquots are analyzed in order to generate an estimate of the method's precision.

Other client-specific quality control requirements may be prescribed in the applicable LIMS program specification. The requirements set forth in the LIMS program specification supersede those stated in the method, SOP or Quality Assurance Manual.

Not applicable for industrial hygiene and ambient air testing.

#### 14.9.7 Sample Duplicate

A sample duplicate (DUP) is a second representative portion of sample that is carried through the preparation, cleanup and analysis process. Results for the duplicate sample are compared to the initial sample analysis results as a means of evaluating precision. For organic analyses, the MS/MSDs fulfill this function. The degree of sample homogeneity directly impacts the integrity of the sample duplicate analysis.



Not applicable for industrial hygiene and ambient air testing.

Precision criteria for sample duplicate analyses are those prescribed in the reference method and/or SOP, unless otherwise superseded by client-specific requirements contained in the applicable LIMS program specification.

#### 14.9.8 Surrogates

Surrogates are organic compounds that are similar to the target analytes, but are unlikely to be present in actual field samples. They are introduced into all field and QC samples in a batch prior to sample preparation, and provide an estimate of bias based on recovery of similar compounds, for a given extraction technique and analysis method combination. Sample results are not corrected for surrogate recoveries.

Acceptance criteria for surrogates are those prescribed in the reference method and/or SOP, unless otherwise superseded by client-specific requirements contained in the applicable LIMS program specification.

#### 14.9.9 Chemical Yield Monitors or Isotopic Tracers

Chemical yield monitors are used in radiochemical analyses and provide information similar to the surrogate spikes discussed above. The primary difference between a chemical yield monitor and a surrogate is that sample results are corrected for chemical yield recoveries and not corrected for surrogate recoveries. A chemical yield monitor is a substance that has similar chemical characteristics as the parameter being measured. It is introduced into all field and QC samples in a batch during the preparation procedure. Chemical yield monitors provide information regarding the performance of a method on a sample-by-sample basis.

Chemical yield monitors are evaluated against established laboratory control limits. These ALS default control limits may be superseded by other quality control criteria specified in the applicable LIMS program specification.

### 14.10 CONTROL LIMITS

#### 14.10.1 Control Limits

Control limits for each controlled analyte are calculated, and can be updated, using ALS's LIMS. The recovery values from all data processed within a specified date range are used to calculate the control limits and compile the control chart if needed.



The upper and lower control limits of the control chart are designated as the value equal to the average recovery plus or minus three times the standard deviation (i.e., 99% confidence interval). The upper and lower warning limits for the control chart are designated as the value equal to the average recovery plus or minus two times the standard deviation (i.e., 95% confidence interval).

Control limits are updated as needed (e.g., acquisition of a sufficient number of data points to establish meaningful control limits for a newly implemented method; if deemed appropriate as a result of a corrective action investigation; etc.).

Control Limits are reviewed quarterly for trends only and on an annual basis to determine changes to control limits, if any. NO changes are made to current control limits if no changes are detected in the following process.

Current recoveries are compared to current mean and standard deviation of the current control limits. Any changes greater than 10% of the mean and 25% of the standard deviation are evaluated by operations as candidates for updating control limits. The decision rests with operations as instructions on how to proceed are given to QA personnel.

The update requires the review by operations to determine why changes are warranted. The review is needed to assess why a method/analyte combination is experiencing change. This operational review has options but is not limited to the following:

- Operations can request an update of control limits for the method/analyte combination based on evaluation that process changes have improved to steady state.
- Operations can request that control limits not be updated in order to review the current procedure to determine what procedural changes have taken place.
- Operations can request an update based on a specific set of data that is known to be valid based on the procedure.
- Operations can request control limits be reset to method limits based on evaluation that a steady state has not been reached.
- Operations can request no changes because current limits adequately reflect the current uncertainties in method performance



All data for processing and decisions on updating are maintained by the QA department.

#### 14.10.2 Outlier Rejection

For the generation of quality control data that monitor the laboratory's performance, it is essential to prevent spurious or erroneous data from being incorporated. It may be necessary to reject data as an outlier to prevent an adverse effect on the values being calculated.

#### 14.10.3 Trend Evaluation

In addition to evaluating individual batch QC results against control limits, QC results from successive batches can also be evaluated for possible trends. See section 16.2.

### 14.11 SECOND COLUMN OR SECOND DETECTOR CONFIRMATION

Second column or detector confirmation is performed for several GC methods. Whenever two dissimilar chromatography columns or two detectors of a different nature are available for a given method, the laboratory performs second column or second detector confirmation analysis to confirm the identity of target analytes in field samples. When second column analysis is performed for any chromatography technique, the following policies apply:

- Every attempt will be made to calibrate the second (confirmatory) column in the same manner as the quantitative (primary) column. The same initial and continuing calibration standards will be analyzed on the confirmation column in the same manner as the quantitation column. The purpose of this dual calibration requirement is to allow the possibility of reporting quantitative results from the confirmation column if interferences on the primary column prevent accurate target analyte quantitation.
- For chromatographic techniques, the determination of target analytes in a sample depends solely on peak retention times observed in both primary and secondary column chromatograms. If target analyte peaks are present at the proper retention times in both confirmation and quantitation column chromatograms at levels above the LOD, then ALS considers this analyte to be confirmed.
- In general, ALS reports a single value from the two columns based on client requirements. In the absence of client requirements ALS reports the higher value of the two columns.





If no interferences are present, and an analyte's value from either the primary or secondary column is greater than the reporting limit but between the MDL and the reporting limit on the other column, then ALS reports the higher value that is greater than the reporting limit for that analyte.

#### 14.12 MANUAL RE-INTEGRATION POLICIES AND PROCEDURES

Many data collection systems allow the analyst to reprocess data, thereby allowing for the manual re-integration of analyte peaks. ALS makes every attempt to optimize peak integration parameters; however, manual reprocessing of data must be performed to correct a data system's integration errors (e.g., incorrect or missed peak assignment, over- or under-integration of area). Manual re-integrations may not be performed solely to meet initial or continuing calibration criteria or any QC criteria (e.g., tuning, or surrogate or spiking compound recovery). Whenever a manual integration is performed, the analyst must follow manual integration procedures given in ALS SOP 939.

### 15 CONTROL OF NON-CONFORMING ENVIRONMENTAL TESTING WORK

#### 15.1 ALS NONCONFORMANCE AND CORRECTIVE ACTION PROCESS

Non-conformances are reported (documented) electronically through a LIMS interface that is available to all staff. The individual who discovered the problem or deviation is responsible for initiating the next sequential NCR in LIMS. Note that in addition to documenting laboratory sample or test issues, NCRs are also used to address client inquiries (where appropriate) and complaints.

As described in ALS SOP 928, the processing of the NCR flows from the initiator, to their Group Leader and the relevant Project Manager(s), and finally to the Quality Assurance Manager. In this manner, an evaluation of significance and a decision on data recall, stop work and client contact can be made.

The Project Manager records any problem- related contact with clients in the NCR system.

The review of NCRs by the Quality Assurance Manager that are determined as a reoccurring systemic event or significantly against ALS policy or procedure will be addressed as a corrective action.

### 16 CORRECTIVE ACTION, PREVENTIVE ACTION, AND IMPROVEMENT





## 16.1 CORRECTIVE ACTION

Corrective actions are required for external audit findings, internal audit findings and when NCR requires corrective action as stated above.

### 16.1.1 Corrective Action Definition

A corrective action used to eliminate systematic and reoccurring events. Corrective actions include a determination of cause, selection of appropriate corrective actions, and monitoring to ensure effectiveness. Corrective actions are required for nonconforming events discovered during internal and external audits or when NCR is reoccurring or against ALS Policies and Procedure.

### 16.1.2 Root Cause

Root cause is a process to determine the cause of an error. Proper root cause analysis is the key to a successful process and sometimes the most difficult part in the corrective action procedure. Often the root cause is not obvious and thus a careful analysis of all potential causes of the problem is required. The root cause process followed must reflect the severity of the problem identified.

### 16.1.3 Documentation

All corrective actions require written documentation of events, root cause, immediate and permanent corrective actions. When corrective actions are applied there must be monitoring for effectiveness. Quality Assurance keeps maintains a database of all corrective actions.

## 16.2 PREVENTIVE ACTIONS

ALS defines preventive actions as any event that will eliminate real and potential nonconformance.

ALS maintains service contracts (preventive maintenance, repair) for most major analytical equipment. ALS performs preventive maintenance on current equipment on an ongoing basis and these events are recorded in maintenance logs.

Preventive Action using instrument performance and/or control charts is encouraged by analysts to help prevent noncompliant QC situations from occurring.



While a trend is not necessarily an out-of-control situation in itself, its detection can provide an early warning of a condition that might later cause the system to go out of control. Trending can be used to monitor calibrations, equipment, reagents, and various other routine processes in the laboratory. ALS analytical SOPs describe in detail the assessment of batch and sample QC data in the laboratory.

The following conditions are trends or conditions that can initiate action and/or monitoring.

- A series of seven successive points on the same side of the mean
- A series of five successive points going in the same direction
- A cyclical pattern of QC sample results
- Two successive points between warning limits and control limits

ALS relies on analytical staff to identify trends in analytical systems and processes. Quality Assurance and laboratory personnel can produce control charts as needed to help assess trends but this activity in itself is not preventive and is only used to verify trends exist. The occurrence of a trend does not invalidate data that are otherwise in control. However, trends do require attention to determine whether a cause can be assigned to the trend so that appropriate preventive action can be undertaken before the system goes out of control.

Long term trends in control limits are evaluated yearly by Quality Assurance as per section 14.10 and technical operations as described below on an ongoing basis.

#### 16.2.1 Process for identification of trends in QC data

Control limits are guides used for data evaluation. Verifying that QC sample values are not trending ensures that the method may continue to be used for the analysis of field samples. If a trend appears in the analytical QC data, field sample data for samples analyzed with the QC samples might also be trending in the same manner.

A trend in method QC data might be indicated if one or more of the following situations exist:

- A series of seven successive points on the same side of the mean
- A series of five successive points trending in the same direction
- Two consecutive points outside of warning limits

To identify a trend in surrogate, tracer and carrier recovery data, all values for a preparation batch must be evaluated collectively as a



single event, since the values were generated during the same preparation event. Trends should be evaluated between preparation batches and not on any single sample.

LIMS can provide control charts for review. It is the responsibility of the analyst to review data for trends.

#### 16.2.2 Evaluation of Significance

After a trend has been identified, the significance of the trend must be evaluated. An individual trend in data might, or might not, be a cause for action, particularly in the case of a single analyte in a multi-analyte method.

Examples:

- 1) Seven points (values of 97% – 100%) on the same side of the chart mean (value of 96%), with a warning limit at 104% and a control limit at 109%.  
Evaluation: Consistent data, less than one standard deviation from the chart mean. No action required.
- 2) Five successive points (values of 88% – 96%) moving in the same direction, with a chart mean of 94% and an upper control limit of 109%.  
Evaluation: Data moving across the chart mean, within one standard deviation from the chart mean, data are in the middle of the performance range of the method. No action required, but continue to monitor
- 3) Five successive points (values of 94% – 107%) moving in the same direction, with a chart mean of 94% and an upper control limit of 109%.  
Evaluation: Data moving away from the chart mean, nearing the control limit. Action should be implemented to keep the procedure from going out-of-control.

If data exhibit a sufficiently significant trend to require action, the cause of the trend should be investigated and determined.

Questions to be considered in the evaluation of a data trend and the determination of the cause of the trend might include (but are not limited to) the following:

- Is this trend representative of the entire method?



- Is this trend limited to a single analyte in a multi-analyte method?
- Is this trend exhibited in the data of several analytes in a multi-analyte method, and is the same general trend observed for each analyte?
- What is the time period of the trend (i.e., a week, several weeks, several months)?
- What changes in the analytical system have occurred during the time period to which the trend applies?
- Are new personnel involved?
- Is different instrumentation involved?
- Were new or different standard solutions introduced?
- Was there a change in the analytical protocol or method?
- Has instrument sensitivity or response changed dramatically?
- Has instrument maintenance been performed recently?
- Have there been any changes in method reagents (i.e. brand, lot)?
- Have there been any matrix effects carried over from difficult samples?

#### 16.2.3 Assignment of Significance

Following the identification of a data trend (as indicated above) and the evaluation of the trend for significance, a decision should be made that the level of significance does or does not require action.

At the time of quality control sample data evaluation, the evaluator should make a decision based upon personal judgment. Criteria can determine whether a trend exists, but judgment should be used in the determination of the significance of that trend.

If the data trend is determined to not pose a threat to the quality of immediate and future analytical data, or does not reasonably indicate that the analytical method might begin to produce data that could be anomalous, the level of significance is INSIGNIFICANT.

If the data trend is determined to not pose a threat to the quality of immediate analytical data such that no action is required, but does possibly indicate that the analytical method may begin to produce data that could be anomalous, the level of significance should be MONITORED by technical personnel.

If the data trend is determined to possibly or reasonably pose a threat to the quality of future analytical data, and reasonably indicates that the analytical method may begin to produce data that could be anomalous, the level of significance is SIGNIFICANT, and actions must be initiated to prevent out of control events.



#### 16.2.4 Resolution Procedure

Following identification of a trend and an assignment of a level of significance, future action regarding the trend must be determined. If a data trend is evaluated as significant, laboratory personnel responsible for data trend evaluation must promptly inform all analysts involved in work related to the significant trend that the trend exists and that action must be initiated to prevent its reoccurrence and correct it.

All activities related to a significant trend will be documented in normal analysis records.

Laboratory personnel are required to initiate action to correct a significant data trend related to their work.

The trending guidelines used by ALS are in the following table. In many instances experienced chemists will identify trends and take action upon reviewing analytical data (i.e. control charts may not be necessary).

GUIDELINE	DESCRIPTION
Above Warning Limits	Two of three data points above warning limits
Below Warning Limits	Two of three data points below warning limits.
Above Mean	Seven consecutive data points above the mean
Below Mean	Seven consecutive data points below the mean
Ascending Data	Seven consecutive data points in ascending direction
Descending Data	Seven consecutive data points in descending direction

16.2.5 Procedure for producing Control Charts to verify trends are present  
 This procedure is available if verification of trends is needed.

- LIMS Main Menu
- From Quality Assurance Menu



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- Select Compile Control Limits



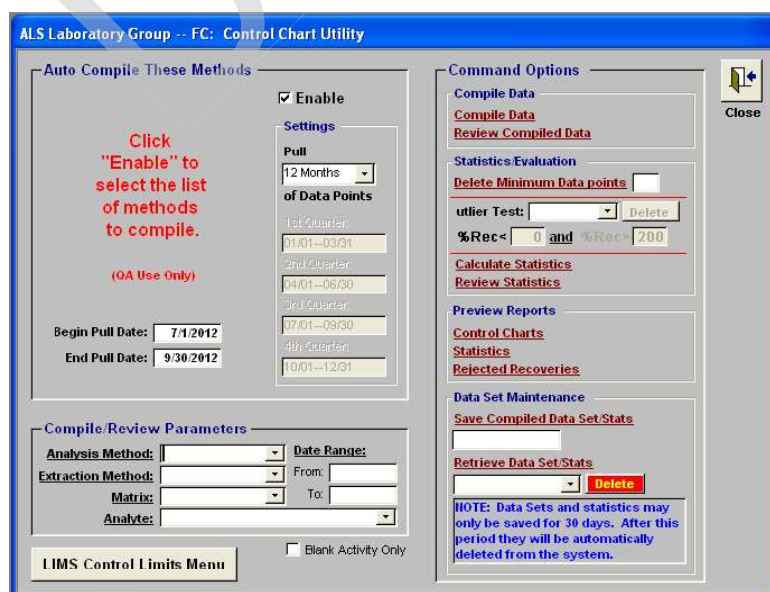
### Compile Control Utility Menu

In the Compile/Review Parameters Box:

Select Analysis Method, Extraction Method, Matrix, Analyte and Date Range (Use no more than the last 12 months)

In the Command Option Box (In Sequence)

Compile Data  
Calculate Statistics  
Control Charts





**Compile/Review Parameters**

<b>Analysis Method:</b>	SW8081	<b>Date Range:</b>	
<b>Extraction Method:</b>	SW3520	From:	01/01/2012
<b>Matrix:</b>	LIQUID	To:	07/25/2012
<b>Analyte:</b>	4,4'-DDE		

**Command Options**

**Compile Data**

[Compile Data](#)

[Review Compiled Data](#)

**Statistics/Evaluation**

**Delete Minimum Data points:** ☐

**Outlier Test:**

**%Rec < 0 and %Rec > 200**

[Calculate Statistics](#)

[Review Statistics](#)

**Preview Reports**

[Control Charts](#)

[Statistics](#)

[Rejected Recoveries](#)

### 16.3 IMPROVEMENT

At ALS, improvement of the quality systems is effected through an ongoing systems review by management using input from all staff.

ALS actively seeks employee and client input for improvements through surveys and questionnaires.

Internally ALS maintains a process improvement website and database for employees to provide suggestions for improvements and to record actions by managements.

For clients, ALS surveys and gains feedback on services provided. This input to management is managed at a corporate level.

### 16.4 MANAGEMENT OF CHANGE

The Management of Change, SOP 995, is a process designed to minimize risks from significant change to laboratory management, facilities, process and testing scope. The potential risks are minimized through pre-planning and preventive measures. The type of changes covered under this process includes:

- Facility Changes (Major construction or renovation)





- Management Changes (Key personnel)
- Testing Scope (New technologies)
- Management Requirements and Systems (New management standard changes)
- LIMS changes (Structure, format and software)

## 17 CONTROL OF RECORDS

### 17.1 RECORDS AND DATA STORAGE

Records provide the direct evidence and support for the necessary technical interpretations, judgments, and discussion concerning laboratory results. These records, particularly those that are anticipated to be used as evidentiary data, provide the historical evidence needed for later review and evaluation. Records must be legible, identifiable, and retrievable. They must be protected against damage, deterioration, fire, theft, vermin, and loss. Though only 5-year retention is required by TNI, ALS retains all records for a minimum of seven (7) years, or as otherwise specified per the client's contract.

Laboratory records include the following kinds of documentation:

- personnel qualifications, experience, and training;
- correspondence between ALS and clients;
- quality assurance records (e.g., retired SOPs and Quality Assurance Manuals, PT study results, internal and external audit reports and responses);
- contents of laboratory logbooks;
- equipment maintenance records;
- traceability of standards, solvents and reagents;
- instrument checks and calibrations;
- raw data;
- final data reports; and
- sample management records (e.g., sample login, field and internal chain-of-custody, storage, disposal).

### 17.2 ELECTRONIC RECORDS

ALS employs a multi-level system that addresses both the frequent backup of sample results (in LIMS) and the periodic backup of raw data (from both networked and non-networked instruments). Additionally, the software that ALS uses for these backups, contains a disaster recovery module that allows





for the complete recovery of the backup database, in its entirety. See ALS SOPs 1403 and 1401 for additional information.

### 17.3 TRANSFER OF RECORDS

In the event that the laboratory changes ownership, the responsibility for the retention of records in accordance with the guidelines established in this Quality Assurance Manual, is conferred to the new owner. Should ALS go out of business, ALS will inform our clients in writing of this business decision, and that the transfer of records to the client must be in compliance with state, regulatory and legal records retention times.

### 17.4 TRAINING RECORDS

Technical and quality assurance training records are maintained on network servers by the Quality Assurance Department. Health & Safety training records are also maintained on network servers. Training records are designated for storage using the ALS SOP 150.

## 18 AUDITS

All non-conformances from internal and external audits require corrective action as per section 16.1.

### 18.1 INTERNAL AUDITS

Internal audits include both technical and systems audits, and are performed periodically per an annual schedule developed and maintained by the Quality Assurance Department.

All internal audits are conducted by QA staff or designees who, by experience, are deemed to be knowledgeable in the area assessed. Reports of nonconformance and opportunities for improvement are completed monthly by the Quality Assurance Manager.

See **ALS SOP 937** for additional information pertaining to internal audit procedures.

### 18.2 EXTERNAL AUDITS

External audits may be performed by a state or Federal agency or a client as part of an ongoing certification or client process. Items evaluated by external assessors may include, but are not limited to, reviews of the following: analytical capabilities and procedures; COC procedures; document control; quality systems; and QC procedures.

## 19 MANAGEMENT REVIEW



A Managerial Review is performed annually. The Managerial Review assesses operational effectiveness in terms of meeting ALS's business goals. It is a tool used to document and facilitate the consideration and introduction of needed operational changes and improvements.

The Managerial Review is performed the laboratory director. The contents of the annual Managerial Review are considered to be confidential.

Inputs to the Managerial Review may include, but are not limited to the following:

- suitability of policies and procedures;
- reports from managerial and supervisory personnel;
- outcome of recent internal audits;
- corrective and preventive actions;
- assessments by external bodies;
- results of interlaboratory comparisons or proficiency tests;
- changes in the volume and type of the work;
- customer feedback;
- complaints;
- recommendations for improvement;
- other relevant factors, such as quality control activities, resources and staff training.

The laboratory director is responsible for action plans that are documented in an annual summary report of all item listed in above. This summary report will include the actions initiated from management review and outcomes or effectiveness of previous actions.

## 20 PERSONNEL

The selection of well-qualified personnel is a factor that contributes to ALS's success. Therefore, qualifications of personnel are based upon education and experience. In order to maintain qualified staff, provide personnel advancement within the laboratory, and to provide for personnel's ongoing awareness of potential hazards and protective measures, ALS follows a program of orientation and training. Records of all training are maintained by the Quality Assurance Department in accordance with ALS SOP 150.

### 20.1 ORIENTATION

New employees receive a four-part orientation as described below:

- Human resources -- involves matters of immediate personal concern, such as benefits and company policies



- Quality assurance -- addresses topics related to ethical conduct, good laboratory practices and ongoing documentation of employee capability demonstrations. Required readings (SOPs, Quality Assurance Manual) are assigned at this time. See ALS SOP 143.
- Health & safety -- provides for a review of ALS's various safety program documents (Chemical Hygiene Plan, CHP; Radiation Protection Plan, RPP; Emergency and Contingency Plan, ECP; Respiratory Protection Plan, ResPP; Waste Management Plan, WMP); as well as other safety and security training such as the Alstar/Induction training.
- Department functional orientation -- focuses on the new employee's basic understanding of their role within the overall role of Operations within the structure of ALS. The department training expands upon the employee's scientific background and work experience to provide the employee with a level of competence that enables the individual to successfully function within the defined responsibilities of his/her position.

Temporary employees receive the same orientation as regular staff, with the exception of the human resources orientation.

## 20.2 TECHNICAL TRAINING

Chemists (analysts) and technicians are qualified to perform specific analytical procedures and methods. Technical management and quality management authorize employees to perform testing activities. The qualification process is detailed in the ALS SOP 329.

## 21 REPORTING OF RESULTS

### 21.1 DATA REDUCTION, VALIDATION AND REPORTING

Data transfer and reduction are essential functions in summarizing information to support conclusions. It is essential that these processes are performed accurately and are followed by multiple reviews before data are submitted to the client. All analytical data generated by ALS are extensively reviewed for accuracy and completeness. The data validation process consists of data generation, reduction, and multiple levels of review, as described below.

### 21.2 DOCUMENTATION OF RAW DATA

Where possible, raw data are captured and processed electronically using verified software programs (see ALS SOPs 709 and 1400 for further information regarding software verification).



To facilitate manual documentation of raw data (where suitable LIMS benchsheet interfaces do not yet exist), ALS creates custom logbooks as per ALS SOP 303.

The manually recorded raw data are entered into the laboratory logbook directly, promptly, and legibly in indelible ink. All raw data entries must be in compliance with ALS SOP 303.

Raw data not only includes instrument outputs, but sample preparation, standard materials documentation, and equipment maintenance information as well. Raw data is archived electronically.

### 21.3 CORRECTION OF ERRORS IN DOCUMENTS

During the course of processing and reviewing sample preparations and analysis results, it may be necessary to correct documentation errors. Detailed requirements for the correction of manual documentation errors are prescribed in **ALS SOP 303**

### 21.4 DATA REDUCTION

ALS analysts perform data reduction. This process consists of interpreting instrument results and verifying calculated concentrations in samples from the raw data. The complexity of the data reduction is dependent on the specific analytical method and the number of discrete operations involved in obtaining a measurement (e.g., digestions, dilutions, cleanups, concentrations). The analyst calculates the final reportable values from raw data or enters all necessary raw data into the LIMS so that the LIMS can calculate the final reportable values.

Data are reduced according to protocols described in SOPs and method-specific review checklists. Computer software used for data reduction is validated before use and verified regularly by manual calculations.

Copies of all raw data and the calculations used to generate the final results, as recorded in hardbound laboratory notebooks, spreadsheets, electronic data files and LIMS record files, are retained in the project file to allow reconstruction of the data reduction process.

### 21.5 REPORTING OF SAMPLE RESULTS

Sample results are reported either on an “as-received” basis, or in units of dry-weight measure. The number of significant figures reported is consistent with the limits of uncertainty inherent to the analytical method. In most cases, results are reported to no more than two or three significant figures. Analytical problems, and/or any modifications of referenced methods are noted in the data package case narrative.



## 21.6 DATA REVIEW

ALS employs multiple levels of data review. All data generated and reduced follow review protocols specified in laboratory ALS SOPs 052 and 715, method-specific checklists and the applicable SOPs.

Each step of the review process involves evaluation of data quality based on both the results of the QC data and the professional judgment of those conducting the analysis and/or review. This application of technical knowledge and experience to the evaluation of the data is essential in ensuring that data produced are consistently of known, documented, and appropriate quality.

## 21.7 PROCEDURES FOR HANDLING UNACCEPTABLE DATA

When an analysis of a QC sample (e.g., MB, LCS, CCV, etc.), indicates that the associated samples do not meet requirements, the analyst must immediately initiate a NCR as per ALS SOP 928.

If the non-compliant data cannot be corrected, then the affected results must be flagged as discussed below, and the discrepancy disclosed in the data package case narrative.

## 21.8 DATA REPORTING

Data reports contain final sample results, the methods of analysis used and limits of detection, and QC data. The extent of supportive data included (e.g., benchsheets, run logs, calibration data, instrument raw data printouts, etc.), is contingent upon the type of report contracted by the client. Results of subcontracted data are clearly indicated as subcontract laboratory results when incorporated into the final data package report. Data reporting is specified by project managers in the corresponding program specification in LIMS.

### 21.8.1 Facsimile or Imaged Reports

For projects that require rapid turnaround of sample analysis results, the laboratory may provide a facsimile or imaged e-mail attachment to the client, followed by the full data report at a later date. If the analysis results provided by facsimile or imaged e-mail attachment have undergone the same review processes followed for final data packages, then this forwarded report indicates that the sample analysis results are final. However, if the accelerated turnaround time requirements preclude a full review/validation of the sample data, then the report is marked as "PRELIMINARY" to indicate that results may change as the review process is completed.



## 21.8.2 Hardcopy Data Packages

The format and content of a data report is dependent upon project specifications, and it is beyond the scope of this document to describe project-specific report requirements. In the absence of client-specified data package deliverables, the following sections describe the items that must be included in all data reports.

### 21.8.2.1 Cover Letter

Items contained in the cover letter include:

- the client's name and address;
- ALS's name and address, name of contact and telephone number;
- a tabular presentation of field/client sample ID, ALS Sample ID, date received, matrix, and date collected. This item is typically presented as an attachment, the Sample Cross Reference Table;
- a list of each analysis performed and total number of pages for each analytical report;
- identification of all test data provided by a subcontract laboratory;
- a discussion of previously submitted or partial reports that pertain to the samples discussed in the current report; and
- the signature of ALS's Project Manager or designee.

### 21.8.2.2 Report Format

Analysis reports are presented in tabular format, and consistent significant figures and units of measurement are used. The following information is included in each report:

- laboratory name, client name, project name and/or number;
- client/field sample ID and ALS sample ID;
- date of sample receipt, date and time of sample collection, and date/time of sample preparation and/or analysis;
- sample matrix;
- reporting units and identification of whether the sample results are reported on an "as-received" or dry weight basis;
- method reference for the parameter analyzed and method reporting limits;



- identification of numerical results with values below the method reporting limit;
- case narrative that identifies test methods, describes any deviation from the method or contractual requirements, additions or exceptions to the SOP, and discloses any conditions that may affect the quality of the results;
- identification of sample results that did not meet sample acceptance criteria;
- footnotes or qualifiers referenced to specific data (as applicable) and explanations or keys to flags and abbreviations used;
- surrogate and tracer recoveries, where applicable;
- where applicable, a statement of the estimated uncertainty of the test result; and
- a signature and title, or equivalent electronic identification, of the personnel who accepts responsibility for the content of the report, and the date of issue.

Results calculated between the MDL and the LOQ (RL) contains significant amounts of error. Therefore, values reported between the LOD and LOQ(RL) are qualified as estimated – 'J' flagged for organic parameters, 'B' flagged for inorganic parameters. Also, LOD values are based on an interference-free matrix, and cannot evaluate the effects of sample matrix. Therefore, established LODs may not be achievable in some environmental matrices.

If a report is reissued, the amendments must clearly state that the report is reissued. The cover letter and case narrative must describe why the report has been reissued and which sample results have been reissued.

#### 21.8.2.3 QC Reports

Each final report may include QC reports that summarize results from the associated LCS, MB, and matrix QC samples. Additional QC samples may be prepared and reported to comply with project-specific requirements.

#### 21.8.2.4 Data Qualifiers – Flagging Codes





Whenever the data quality objectives of the Quality Assurance Manual are not met, the associated sample results must be flagged with the appropriate flagging codes.

Other flagging practices may be observed if so dictated by the applicable LIMS program specification.

#### 21.8.3 Electronic Data Deliverables (EDDs)

The electronic data deliverables generated by the laboratory are project-specific and are produced in a format specified by the client.

*Information presented in corresponding fields of the hardcopy report and EDD are identical as both are generated from LIMS.* Before submitting the EDD file, the Project Manager or designee verifies that the EDD is complete and meets the client's format requirements. All EDDs are submitted to the client on computer disks or are transmitted electronically.

#### 21.9 CONFIDENTIALITY

All laboratory results and associated raw data are confidential and may not be released to or discussed with any party other than the client who requested the analytical services.

ALS requires that auditors honor our clients' and ALS's confidentiality requirements, and will not discuss any results, documents, or records viewed during the course of an audit.

Confidentiality is included as a component of ALS's ethics training, which is provided to each person as they join the ALS staff, and annually, as a refresher training, thereafter.

## 22 REFERENCE DOCUMENTS

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Appendices are available upon request. All current documents are available on ALS On-Line. The documents listed in this section are dynamic; accordingly they can change without notice or revision to this QAM.

APPENDIX A – GLOSSARY, ACRONYMS AND SYMBOLS GLOSSARY

APPENDIX B – Organization Charts and Key Personnel Qualifications

APPENDIX C – Ethics and Data Integrity Policy

APPENDIX D – Laboratory Floor Plan

APPENDIX E – Analytical and Support Equipment

APPENDIX F – Containers, Preservation and Holding Times

APPENDIX G – Master List of Controlled Documents

APPENDIX H – Data Qualifiers

APPENDIX I – Laboratory Accreditations

APPENDIX J – Calibration and Method QC Requirements

APPENDIX K – Chain of Custody

APPENDIX L – List of Services

## **APPENDIX B**

## **APPENDIX B.1 DATA QUALITY REVIEWS**



## ***Technical Memorandum***

<b>To:</b>	110836 File	<b>From:</b>	Bruce Marshall, P.G.
<b>Company:</b>	FLAP Partner Group	<b>Date:</b>	August 27, 2019
<b>EA No.:</b>	110836		
<b>Re:</b>	Rocky Mountain Greenway Trail Crossings ALS Work Order 1907016 Review		
<b>Cc:</b>	Jason Andrews, P.E.		

This review covers the ALS work order number **1907016**. ALS work order 1907016 provides the radionuclide results for 10 soil samples (9 primary samples with a **01** suffix on the sample ID and one field duplicate samples with a **DUP** suffix on the sample ID) and a field equipment rinsate blank (water) (**ERB** suffix on the sample ID) collected by EA on July 1, 2019. EA personnel also submitted archive samples (**99** suffix on sample IDs) for each soil sample to ALS marked “*Hold*” on the COC forms.

ALS transmitted laboratory results to EA in three laboratory reports titled:

- 1907016\_ISO-Am.pdf
- 1907016\_ISO-Pu.pdf
- 1907016\_ISO-U.pdf

ALS transmitted the data to EA in an Electronic Data Deliverable (EDD) titled:

- 1907016.xls

The soil samples were collected from depths of 0-2 inches and dissolved using an acid (HCl-HNO<sub>3</sub>-HF) digestion. The samples were analyzed for the isotopes of americium, plutonium and uranium via alpha spectroscopy. The carbonate fusion digestion results for these soil samples are presented in ALS work order 1907579.

Following provides a review of laboratory data package’s **soils** information.

- The Americium Case Narrative references ALS SOP 75 for the soil’s preparation. EA confirmed with Mr. Lance Steere of ALS that this is a typo and that the correct reference is ALS SOP 751.
- The ALS Sample Receipt Form noted no anomalies with the sample containers or documentation.

- Samples were prepared according to ALS SOPs. The soil samples were prepared in ALS Preparation Batch numbers AS190723-3 and AS190723-4.
- The preparation batch included one each method blank (MB) and laboratory control sample (LCS) for both preparation batches. A laboratory duplicate sample was not included in the report. However, a laboratory duplicate sample for ALS Preparation Batch number AS190723-4 was reported in associated ALS work order number 1907083 while a laboratory duplicate sample for ALS Preparation Batch number AS190723-3 was reported for ALS work order number 1906768 (soil samples EA collected for the USFWS on the RFNWR).
  - The MB results were all within ALS control limits.
  - The results of the LCS were all within ALS control limits.
  - As indicated above, laboratory duplicate samples for ALS Preparation Batch numbers AS190723-3 and AS190723-4 were reported in other ALS work orders; all results were within ALS control limits.
- The recovery of tracers (Am-243, Pu-242 and U-232) added by ALS to each soil sample were all within ALS control limits.
- The americium isotope was counted for 600 minutes. Plutonium isotopes were counted for 360 minutes. Uranium isotopes were counted for 360 to 420 minutes.
- The specified Minimum Detectable Concentrations (MDCs) were achieved in all samples.

Following provides a review of laboratory data package's **water** information.

- The Sample Receipt Form noted no anomalies with the sample container or documentation.
- The sample was prepared according to ALS SOPs. The sample was prepared in ALS Preparation Batch number AS190717-1.
- ALS Preparation Batch number AS190717-1 included one method blank (MB), one laboratory control sample (LCS) and one laboratory control duplicate sample (LCDS). A laboratory duplicate was not prepared due to insufficient sample volume, but the LCSD served as the duplicate for this batch.
  - The results of the MB were all within ALS control limits.
  - The LCS results were within ALS control limits. ALS noted that the Am-241 recovery (101%) was within control limits, but that they assume 100% recovery in their calculations. ALS flagged this result as "Y1<sup>1</sup>" but did not qualify any sample results.
  - The results of the LCSD were all within ALS control limits.
  - LCS-LCSD results compared using the Duplicate Sample Results (DER) method were all within ALS control limits.
- The americium isotope was counted for 1,000 minutes. Plutonium and uranium isotopes were counted for 420 minutes.

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<sup>1</sup> ALS comment on LCS report reads "Y1 = Chemical Yield is in control at 100-110%. Quantitative Yield is assumed." See Americium Case Narrative for more information.

**Field QC Sample Results.**

- The results for ERB sample D6G-070119-**ERB** from ALS work order number 1907016 were all reported as below the MDC.
- The results from one field replicate (D4G-070119-0-2-**01/DUP**) were compared using the relative percent difference (RPD) method. There were 6 analytical pairs for the acid digestion results. The RPD results are summarized below (a “U” indicates that one or both replicate values was reported below the MDC):

<b>Radionuclide</b>	<b>D4G-070119-0-2-01/DUP</b>
	<b>Acid Digestion</b>
Am-241	U
Pu-238	U
Pu-239/240	U
U-234	30%
U-235	U
U-238	13%

A control limit of 35% is recommended for laboratory duplicate soil analyses. Field replicates may offer more variability due to sample inhomogeneity.

## ***Technical Memorandum***

<b>To:</b>	110836 File	<b>From:</b>	Bruce Marshall, P.G.
<b>Company:</b>	FLAP Partner Group	<b>Date:</b>	August 27, 2019
<b>EA No.:</b>	110836		
<b>Re:</b>	Rocky Mountain Greenway Trail Crossings ALS Work Order 1907083 Review		
<b>Cc:</b>	Jason Andrews, P.E.		

This review covers the ALS work order number **1907083**. ALS work order 1907083 provides the radionuclide results for 9 soil samples (8 primary samples with a **01** suffix on the sample ID and one field duplicate samples with a **DUP** suffix on the sample ID) and a field equipment rinsate blank (water) (**ERB** suffix on the sample ID) collected by EA on July 2, 2019. EA personnel also submitted archive samples (**99** suffix on sample IDs) for each soil sample to ALS marked “*Hold*” on the COC forms.

ALS transmitted laboratory results to EA in three laboratory reports titled:

- 1907083\_ISO-Am.pdf
- 1907083\_ISO-Pu.pdf
- 1907083\_ISO-U.pdf

ALS transmitted the data to EA in an Electronic Data Deliverable (EDD) titled:

- 1907083.xls

The soil samples were collected from depths of 0-2 inches and dissolved using an acid (HCl-HNO<sub>3</sub>-HF) digestion. The samples were analyzed for the isotopes of americium, plutonium and uranium via alpha spectroscopy. The carbonated fusion digestion results for these soil samples are presented in ALS work order 1907581.

Following provides a review of laboratory data package’s **soils** information.

- The Americium Case Narrative references ALS SOP 75 for the soil’s preparation. EA confirmed with Mr. Lance Steere of ALS that this is a typo and that the correct reference is ALS SOP 751.
- The ALS Sample Receipt Form noted no anomalies with the sample containers or documentation.

- Samples were prepared according to ALS SOPs. The soil samples were prepared in ALS Preparation Batch number AS190723-4.
- The preparation batch included one each method blank (MB), a laboratory control sample and a laboratory duplicate sample.
  - The MB results were within ALS control limits.
  - The results of the LCS were within ALS control limits.
  - The laboratory duplicate sample results were within ALS control limits.
- The recovery of tracers (Am-243, Pu-242 and U-232) added by ALS to each soil sample were all within ALS control limits.
- The americium isotope was counted for 600 minutes. Plutonium isotopes were counted for 360 minutes. Uranium isotopes were counted for 420 minutes.
- The specified Minimum Detectable Concentrations (MDCs) were achieved in all samples.

Following provides a review of laboratory data package's **water** information.

- The Sample Receipt Form noted no anomalies with the sample container or documentation.
- The sample was prepared according to ALS SOPs. The sample was prepared in ALS Preparation Batch number AS190717-1.
- ALS Preparation Batch number AS190717-1 included one method blank (MB), one laboratory control sample (LCS) and one laboratory control duplicate sample (LCSD). A laboratory duplicate was not prepared due to insufficient sample volume, but the LCSD served as the duplicate for this batch.
  - The results of the MB were all within ALS control limits.
  - The LCS results were within ALS control limits. ALS noted that the Am-241 recovery (101%) was within control limits, but that they assume 100% recovery in their calculations. ALS flagged this result as "Y1<sup>1</sup>" but did not qualify any sample results.
  - The results of the LCSD were all within ALS control limits.
  - LCS-LCSD results compared using the Duplicate Sample Results (DER) method were all within ALS control limits.
- ALS noted that the Am-241 recovery for the ERB (103%) was within control limits, but that they assume 100% recovery in their calculations. ALS flagged this result as "Y1<sup>1</sup>" but did not qualify any sample results.
- The americium isotope was counted for 1,000 minutes. Plutonium and uranium isotopes were counted for 420 minutes.

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<sup>1</sup> ALS comment on LCS report reads "Y1 = Chemical Yield is in control at 100-110%. Quantitative Yield is assumed." See Americium Case Narrative for more information.

## Field QC Sample Results.

- The results for ERB sample E16G-070219-**ERB** from ALS work order number 1907083 were all reported as below the MDC.
- The results from one field replicate (E16G-070219-0-2-**01/DUP**) were compared using the relative percent difference (RPD) method. There were 6 analytical pairs for the acid digestion results. The RPD results are summarized below:

<b>Radionuclide</b>	<b>E16G-070219-0-2-01/DUP</b>
	<b>Acid Digestion</b>
Am-241	66%
Pu-238	62%
Pu-239/240	82%
U-234	8%
U-235	52%
U-238	31%

A control limit of 35% is recommended for laboratory duplicate soil analyses. Field replicates may offer more variability due to sample inhomogeneity.

## ***Technical Memorandum***

<b>To:</b>	110836a File	<b>From:</b>	Bruce Marshall, P.G.
<b>Company:</b>	City and County of Broomfield	<b>Date:</b>	September 4, 2019
<b>EA No.:</b>	110836a		
<b>Re:</b>	Rocky Mountain Greenway Trail Crossings ALS Work Order 1907084 Review		
<b>Cc:</b>	Jason Andrews, P.E.		

This review covers the ALS work order number **1907084**. ALS work order 1907084 provides the radionuclide results for 11 soil samples (10 primary samples with a **01** suffix on the sample ID and one field duplicate samples with a **DUP** suffix on the sample ID) and a field equipment rinsate blank (water) (**ERB** suffix on the sample ID) collected by EA on July 2, 2019. EA personnel also submitted archive samples (**99** suffix on sample IDs) for each soil sample to ALS marked “Hold” on the COC forms.

ALS transmitted laboratory results to EA in three laboratory reports titled:

- 1907084\_ISO-Am.pdf
- 1907084\_ISO-Pu.pdf
- 1907084\_ISO-U.pdf

ALS transmitted the data to EA in an Electronic Data Deliverable (EDD) titled:

- 1907084.xls

The soil samples were collected from depths of 2-4, 4-6, 6-8, 8-10 and 10-12 inches and dissolved using an acid (HCl-HNO<sub>3</sub>-HF) digestion. The samples were analyzed for the isotopes of americium, plutonium and uranium via alpha spectroscopy. The carbonate digestion results for these soil samples are presented in ALS work order 1907582.

Following provides a review of laboratory data package’s **soils** information.

- The Americium Case Narrative references ALS SOP 75 for the soil’s preparation. EA confirmed with Mr. Lance Steere of ALS that this is a typo and that the correct reference is ALS SOP 751.
- The ALS Sample Receipt Form noted no anomalies with the sample containers or documentation.

- Samples were prepared according to ALS SOPs. The soil samples were prepared in ALS Preparation Batch numbers AS190723-4 and AS190723-5.
- The laboratory report included one each method blank (MB) and one each laboratory control sample for each preparation batch. Laboratory duplicate sample results for neither preparation batch were included in the laboratory report; however, laboratory duplicate sample results were reported in other ALS work orders for both preparation blanks (see below).
  - The MB results were all within ALS control limits.
  - The results of the LCS were all within ALS control limits.
  - The laboratory duplicate sample results for Preparation Batches AS190723-4 and AS190723-5 are included in the ALS work order 1907083 (soil samples EA collected for the FLAP Partner Group) and the associated 1907103 reports, respectively; all results were within ALS control limits.
- The recovery of tracers (Am-243, Pu-242 and U-232) added by ALS to each soil sample were all within ALS control limits.
- The americium isotope was counted for 600 to 1,000 minutes. Plutonium isotopes were counted for 360 to 480 minutes. Uranium isotopes were counted for 420 minutes.
- The specified Minimum Detectable Concentrations (MDCs) were achieved in all samples.

Following provides a review of laboratory data package's **water** information.

- The Sample Receipt Form noted no anomalies with the sample container or documentation.
- The sample was prepared according to ALS SOPs. The sample was prepared in ALS Preparation Batch number AS190717-1.
- ALS Preparation Batch number AS190717-1 included one method blank (MB), one laboratory control sample (LCS) and one laboratory control duplicate sample (LCDS). A laboratory duplicate was not prepared due to insufficient sample volume, but the LCSD served as the duplicate for this batch.
  - The results of the MB were all within ALS control limits.
  - The LCS results were within ALS control limits. ALS noted that the Am-241 recovery (101%) was within control limits, but that they assume 100% recovery in their calculations. ALS flagged this result as "Y1<sup>1</sup>" but did not qualify any sample results.
  - The results of the LCSD were all within ALS control limits.
  - LCS-LCSD results compared using the Duplicate Sample Results (DER) method were all within ALS control limits.
- The americium isotope was counted for 1,000 minutes. Plutonium and uranium isotopes were counted for 420 minutes.

<sup>1</sup> ALS comment on LCS report reads "Y1 = Chemical Yield is in control at 100-100%. Quantitative Yield is assumed." See Americium Case Narrative for more information.



## Field QC Sample Results.

- The results for ERB sample E16G-070219-**ERB** from ALS work order number 1907084 were all reported as below the MDC.
- The results from one field replicate (E16G-070219-2-4-**01/DUP**) were compared using the relative percent difference (RPD) method. There were 6 analytical pairs for the acid digestion results. The RPD results are summarized below:

<b>Radionuclide</b>	<b>E16G-070219-2-4-01/DUP</b>
	<b>Acid Digestion</b>
Am-241	66%
Pu-238	81%
Pu-239/240	81%
U-234	16%
U-235	45%
U-238	20%

A control limit of 35% is recommended for laboratory duplicate soil analyses. Field replicates may offer more variability due to sample inhomogeneity.

## **Technical Memorandum**

<b>To:</b>	110836 and 110836a Files	<b>From:</b>	Bruce Marshall, P.G.
<b>Company:</b>	FLAP Partner Group/City and County of Broomfield	<b>Date:</b>	September 5, 2019
<b>EA No.:</b>	110836 and 110836a		
<b>Re:</b>	Rocky Mountain Greenway Trail Crossings ALS Work Order 1907103 Review		
<b>Cc:</b>	Jason Andrews, P.E.		

This review covers the ALS work order number **1907103**. ALS work order 1907103 provides the radionuclide results for 18 primary soil (samples with a **01** suffix on the sample ID) collected by EA on July 3, 2019. EA personnel also submitted archive samples (**99** suffix on sample IDs) for each soil sample to ALS marked “*Hold*” on the COC forms. Eight of the samples (those collected from depths of 0 to 2 inches) were collected for the FLAP Partner Group. The remaining 10 samples (those collected from depths of 2-4, 4-6, 6-8, 8-10 and 10-12 inches) were collected for the City and County of Broomfield.

ALS transmitted laboratory results to EA in three laboratory reports titled:

- 1907103\_ISO-Am.pdf
- 1907103\_ISO-Pu.pdf
- 1907103\_ISO-U.pdf

ALS transmitted the data to EA in an Electronic Data Deliverable (EDD) titled:

- 1907103.xls

The soil samples were dissolved using an acid (HCl-HNO<sub>3</sub>-HF) digestion. The samples were analyzed for the isotopes of americium, plutonium and uranium via alpha spectroscopy. The carbonate digestion results for these soil samples are presented in ALS work order 1907583.

Following provides a review of laboratory data package information.

- The Americium Case Narrative references ALS SOP 75 for the soil’s preparation. EA confirmed with Mr. Lance Steere of ALS that this is a typo and that the correct reference is ALS SOP 751.

- The ALS Sample Receipt Form noted no anomalies with the sample containers or documentation.
- Samples were prepared according to ALS SOPs. The soil samples were prepared in ALS Preparation Batch numbers AS190723-5 and AS190723-6.
- The laboratory report included one each method blank (MB), one each laboratory control sample (LCS) and one each laboratory duplicate sample for each preparation batch.
  - The americium and plutonium results in both MBs were all within ALS control limits as were the uranium results associated with the ALS Preparation Batch number AS190723-5 MB sample. With respect to the ALS Preparation Batch number AS190723-6 MB, the U-234 and U-235 MB results were within ALS control limits; however, U-235 was detected in this MB at a level of 0.0029 pCi/g (versus a sample MDC of 0.0026 pCi/g), which is less than 3% of the Project required MDC of 0.1 pCi/g. ALS flagged this result as “B3<sup>1</sup>” but did not qualify any sample results associated with this MB. *Note that all FLAP Partner Group (0-2-inch) soil samples were in ALS Preparation Batch number AS190723-5.*
  - The results of the LCS were all within ALS control limits.
  - The americium and uranium results in both laboratory duplicate samples were all within ALS control limits as were the plutonium results associated with the ALS Preparation Batch number AS190723-5 laboratory duplicate sample. With respect to the ALS Preparation Batch number AS190723-6 laboratory duplicate sample, the Pu-238 laboratory duplicate sample results were within ALS control limits; however, Pu-239/240 laboratory duplicate sample results exceeded the ALS control limits. ALS flagged the duplicate result as “D<sup>2</sup>” but did not qualify any of the other samples in this preparation batch, attributing the elevated DER to “sample inhomogeneity.” *Note that all FLAP Partner Group (0-2-inch) soil samples were in ALS Preparation Batch number AS190723-5.*
- The recovery of tracers (Am-243, Pu-242 and U-232) added by ALS to each soil sample were all within ALS control limits.
- The americium isotope was counted for 480 to 1,000 minutes. Plutonium isotopes were counted for 480 to 1,000 minutes. Uranium isotopes were counted for 420 to 480 minutes.
- The specified Minimum Detectable Concentrations (MDCs) were achieved in all samples.

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<sup>1</sup> ALS comment on MB report reads “B3 = Analyte concentration greater than MDC but less than requested MDC.” See Uranium Case Narrative for more information.

<sup>2</sup> ALS comment on laboratory duplicate sample report reads “D = [Duplicate Error Ratio] DER is greater than Control Limit of 2.13.” See Plutonium Case Narrative for more information.

## ***Technical Memorandum***

<b>To:</b>	110836 File	<b>From:</b>	Bruce Marshall, P.G.
<b>Company:</b>	FLAP Partner Group	<b>Date:</b>	November 22, 2019
<b>EA No.:</b>	110836		
<b>Re:</b>	Rocky Mountain Greenway Trail Crossings ALS Work Order 1907579 Review		
<b>Cc:</b>	Jason Andrews, P.E.		

This review covers the ALS work order number **1907579**. ALS work order 1907579 provides the radionuclide results for 10 soil samples (9 primary samples with a **01** suffix on the sample ID and one field duplicate samples with a **DUP** suffix on the sample ID) collected by EA on July 1, 2019.

ALS transmitted laboratory results to EA in three laboratory reports titled:

- 1907579\_ISO-Am\_Fusion Prep Procedure.pdf
- 1907579\_ISO-Pu\_Fusion Prep Procedure.pdf
- 1907579\_ISO-U\_Fusion Prep Procedure.pdf

ALS transmitted the data to EA in an Electronic Data Deliverable (EDD) titled:

- 1907579.xls

The soil samples were collected from depths of 0-2 inches and dissolved using a carbonate fusion digestion. The samples were analyzed for the isotopes of americium, plutonium and uranium via alpha spectroscopy. The acid (HCl-HNO<sub>3</sub>-HF) digestion results for these samples are presented in ALS work order 1907016.

Following provides a review of laboratory data package information.

- The Americium Case Narrative references ALS SOP 75 for the soil's preparation. EA confirmed with Mr. Lance Steere of ALS that this is a typo and that the correct reference is ALS SOP 751.
- The ALS Sample Receipt Form noted no anomalies with the sample containers or documentation.
- Samples were prepared according to ALS SOPs. The soil samples were prepared in ALS Preparation Batch number AS191004-2.

- The preparation batch included one method blank (MB) and one laboratory control sample (LCS). A laboratory duplicate sample was not included in the report; however, laboratory duplicate sample results for this preparation batch were reported in associated ALS work order number 1909129 (soil samples EA collected for the City and County of Broomfield).
  - The MB results were all within ALS control limits except for U-238. U-238 was detected in the MB at a level of 0.018 pCi/g (versus a sample MDC of 0.011 pCi/g), a value that is 18% of the Project required MDC of 0.1 pCi/g. ALS flagged the U-238 result as “B3<sup>1</sup>” but did not qualify any sample results associated with this MB.
  - The results of the LCS were all within ALS control limits.
  - The laboratory duplicate sample results were all within ALS control limits.
- The recovery of tracers (Am-243, Pu-242 and U-232) added by ALS to each soil sample were all within ALS control limits.
- The americium and plutonium isotopes were counted for 420 minutes. Uranium isotopes were counted for 370 minutes.
- The specified Minimum Detectable Concentrations (MDCs) were achieved in all samples.

#### Field QC Sample Results.

- The results for an associated Equipment Rinsate Blank (ERB) sample, D6G-070119-**ERB**, were reported in ALS work order number 1907016; all results were reported as below the MDC.
- The results from one field replicate (D4G-070119-0-2-**01/DUP**) were compared using the relative percent difference (RPD) method. There were 6 analytical pairs for the carbonate fusion results. The RPD results are summarized below (a “U” indicates that one or both replicate values was reported below the MDC):

Radionuclide	D4G-070119-0-2- <b>01/DUP</b>
	Carbonate Fusion
Am-241	U
Pu-238	U
Pu-239/240	U
U-234	13%
U-235	38%
U-238	16%

A control limit of 35% is recommended for laboratory duplicate soil analyses. Field replicates may offer more variability due to sample inhomogeneity.

<sup>1</sup> ALS comment on MB report reads “B3 = Analyte concentration greater than MDC but less than requested MDC.” See Uranium Case Narrative for more information.

## ***Technical Memorandum***

<b>To:</b>	110836 File	<b>From:</b>	Bruce Marshall, P.G.
<b>Company:</b>	FLAP Partner Group	<b>Date:</b>	November 23, 2019
<b>EA No.:</b>	110836		
<b>Re:</b>	Rocky Mountain Greenway Trail Crossings ALS Work Order 1907581 Review		
<b>Cc:</b>	Jason Andrews, P.E.		

This review covers the ALS work order number **1907581**. ALS work order 1907581 provides the radionuclide results for 9 soil samples (8 primary samples with a **01** suffix on the sample ID and one field duplicate samples with a **DUP** suffix on the sample ID) collected by EA on July 2, 2019.

ALS transmitted laboratory results to EA in three laboratory reports titled:

- 1907581\_ISO-Am\_Fusion Prep Procedure.pdf
- 1907581\_ISO-Pu\_Fusion Prep Procedure.pdf
- 1907581\_ISO-U\_Fusion Prep Procedure.pdf

ALS transmitted the data to EA in an Electronic Data Deliverable (EDD) titled:

- 1907581.xls

The soil samples were collected from depths of 0-2 inches and dissolved using a carbonate fusion digestion. The samples were analyzed for the isotopes of americium, plutonium and uranium via alpha spectroscopy. The acid (HCl-HNO<sub>3</sub>-HF) digestion results for these soil samples are presented in ALS work order 1907083.

Following provides a review of laboratory data package information.

- The Americium Case Narrative references ALS SOP 75 for the soil's preparation. EA confirmed with Mr. Lance Steere of ALS that this is a typo and that the correct reference is ALS SOP 751.
- The ALS Sample Receipt Form noted no anomalies with the sample containers or documentation.
- Samples were prepared according to ALS SOPs. The soil samples were prepared in ALS Preparation Batch number AS191002-1.

- The preparation batch included a method blank (MB) and a laboratory control sample. A laboratory duplicate sample was not included in the report; however, laboratory duplicate sample results for this preparation batch were reported in an ALS work order for soil samples EA collected for the Jefferson Parkway Public Highway Authority.
  - The MB results were all within ALS control limits except for Pu-239/240 and U-238. Pu-239/240 was detected in the MB at a level of 0.020 pCi/g (versus a sample MDC of 0.009 pCi/g), a value that is 20% of the Project required MDC of 0.1 pCi/g. U-238 was detected in the MB at a level of 0.0073 pCi/g (versus a sample MDC of 0.0066 pCi/g), a value that is 7.3% of the Project required MDC of 0.1 pCi/g. ALS flagged the Pu-239/240 and U-238 results as “B3<sup>1</sup>” but did not qualify any sample results associated with these MBs.
  - The results of the LCS were within ALS control limits.
  - The laboratory duplicate sample results were within ALS control limits.
- The recovery of tracers (Am-243, Pu-242 and U-232) added by ALS to each soil sample were all within ALS control limits.
- The americium isotope was counted for 360 minutes. Plutonium and uranium isotopes were counted for 420 minutes.
- The specified Minimum Detectable Concentrations (MDCs) were achieved in all samples.

#### Field QC Sample Results.

- The results for the Equipment Rinsate Blank (ERB) sample E16G-070219-**ERB**, reported in ALS work order number 1907083, were all reported as below the MDC.
- The results from one field replicate (E16G-070219-0-2-**01/DUP**) were compared using the relative percent difference (RPD) method. There were 6 analytical pairs for the carbonate fusion results. The RPD results are summarized below:

Radionuclide	E16G-070219-0-2- <b>01/DUP</b>
	Carbonate Fusion
Am-241	32%
Pu-238	U
Pu-239/240	25%
U-234	14%
U-235	21%
U-238	7%

A control limit of 35% is recommended for laboratory duplicate soil analyses. Field replicates may offer more variability due to sample inhomogeneity.

<sup>1</sup> ALS comment on MB report reads “B3 = Analyte concentration greater than MDC but less than requested MDC.” See the Plutonium and Uranium Case Narratives for more information.

## ***Technical Memorandum***

<b>To:</b>	110836 and 110836a Files	<b>From:</b>	Bruce Marshall, P.G.
<b>Company:</b>	FLAP Partner Group/City and County of Broomfield	<b>Date:</b>	November 20, 2019
<b>EA No.:</b>	110836 and 110836a		
<b>Re:</b>	Rocky Mountain Greenway Trail Crossings ALS Work Order 1907583 Review		
<b>Cc:</b>	Jason Andrews, P.E.		

This review covers the ALS work order number **1907583**. ALS work order 1907583 provides the radionuclide results for 18 primary soil (samples with a **01** suffix on the sample ID) collected by EA on July 3, 2019. Eight of the samples (those collected from depths of 0 to 2 inches) were collected for the FLAP Partner Group. The remaining 10 samples (those collected from depths of 2-4, 4-6, 6-8, 8-10 and 10-12 inches) were collected for the City and County of Broomfield.

ALS transmitted laboratory results to EA in three laboratory reports titled:

- 1907583\_ISO-Am\_Fusion Prep Procedure.pdf
- 1907583\_ISO-Pu\_Fusion Prep Procedure.pdf
- 1907583\_ISO-U\_Fusion Prep Procedure.pdf

ALS transmitted the data to EA in an Electronic Data Deliverable (EDD) titled:

- 1907583.xls

The soil samples were dissolved using carbonate fusion digestion. The samples were analyzed for the isotopes of americium, plutonium and uranium via alpha spectroscopy. The acid (HCl-HNO<sub>3</sub>-HF) digestion results for these soil samples are presented in ALS work order 1907103.

Following provides a review of laboratory data package information.

- The Americium Case Narrative references ALS SOP 75 for the soil's preparation. EA confirmed with Mr. Lance Steere of ALS that this is a typo and that the correct reference is ALS SOP 751.
- The ALS Sample Receipt Form noted no anomalies with the sample containers or documentation.



- Samples were prepared according to ALS SOPs. The soil samples were prepared in ALS Preparation Batch number AS191004-1. Sample 1907583-25 originally had a low Am-243 (tracer) recovery and was re-prepared in ALS Preparation Batch number AS191104-4.
- The laboratory report included one each method blank (MB), one each laboratory control sample (LCS) and one each laboratory duplicate sample for each preparation batch.
  - The americium and plutonium results in the ALS Preparation Batch number AS191004-1 MB sample were all within ALS control limits as was the U-238 results.
    - With respect to the ALS Preparation Batch number AS191004-1 MB, U-234 was detected at a level of 0.031 pCi/g (versus a sample MDC of 0.021 pCi/g) while U-235 was detected at a level of 0.012 pCi/g (versus a sample MDC of 0.008 pCi/g). These values are 31% and 12%, respectively, of the Project required MDCs of 0.1 pCi/g. ALS flagged both results as “B3<sup>1</sup>” but did not qualify any sample results associated with this MB.
    - With respect to the ALS Preparation Batch number AS191104-4 MB, the magnitude of the negative AM-241 activity is greater than 2 sigma TPU (i.e., result plus 2 sigma TPU < 0). ALS reported that data quality was not significantly impacted by this potential low bias and did not qualify the 1907583-25 data.
  - The results of the LCS were all within ALS control limits.
  - The results of the laboratory duplicate samples were all within ALS control limits.
- The recovery of tracers (Am-243, Pu-242 and U-232) added by ALS to each soil sample were all within ALS control limits.
- The americium isotope was counted for 420 to 1,000 minutes. Plutonium isotopes were counted for 360 to 420 minutes. Uranium isotopes were counted for 370 minutes.
- The specified Minimum Detectable Concentrations (MDCs) were achieved in all samples.

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<sup>1</sup> ALS comment on MB report reads “B3 = Analyte concentration greater than MDC but less than requested MDC.” See Uranium Case Narrative for more information.

**APPENDIX B.2**  
**ALS LABORATORY REPORT**  
**WORK ORDER NUMBER 1907016 ACID DIGESTION**



# Isotopic Americium Case Narrative

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## Engineering Analytics

Jeffco FLAP – 110836a

Work Order Number: 1907016

1. This report consists of the analytical results for ten soil samples and one water sample received by ALS on 07/01/2019.
2. The soil samples were prepared according to the current revisions of SOP 736, SOP 773, SOP 778, and SOP 75. The water sample was prepared according to the current revisions of SOP 776, SOP 778, and SOP 751. The soil samples in this report did not undergo the fusion procedure, SOP768.
3. The samples were analyzed for the presence of  $^{241}\text{Am}$  according to the current revision of SOP 714. The analyses were completed on 08/11/2019.
4. The analysis results for the soil samples are reported on a 'Dry Weight' basis in units of pCi/gram.
5. The analysis results for the water sample are reported in units of pCi/L. The water sample was not filtered prior to analysis.
6. Sample volume was insufficient to allow preparation of a duplicate. A laboratory control sample duplicate (LCSD) was prepared in lieu of a client sample duplicate for batch AS190717-1.
7. The tracer recovery of 101% for AS190717-1LCS is within the requested 30-110% limit. However, in such cases ALS assumes a 100% quantitative recovery in the calculations. While the 'Tracer Yield' on the report form shows the observed recovery (101%), a 'Y1' flag signifies this calculation convention. Results are submitted without further qualification.
8. No further anomalous situations were encountered during the preparation or analysis of these samples. All remaining quality control criteria were met.



The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Jean Anderson

Radiochemistry Primary Data Reviewer

8/13/19

Date

Radiochemistry Final Data Reviewer

8/14/19

Date

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

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**OrderNum:** 1907016

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**


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Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
D5G-070119-0-2-01	1907016-1		SOIL	01-Jul-19	8:50
D5G-070119-0-2-99	1907016-2		SOIL	01-Jul-19	8:50
D6G-070119-0-2-01	1907016-3		SOIL	01-Jul-19	9:05
D6G-070119-0-2-99	1907016-4		SOIL	01-Jul-19	9:05
D4G-070119-0-2-01	1907016-5		SOIL	01-Jul-19	9:45
D4G-070119-0-2-99	1907016-6		SOIL	01-Jul-19	9:45
D8G-070119-0-2-01	1907016-7		SOIL	01-Jul-19	10:05
D8G-070119-0-2-99	1907016-8		SOIL	01-Jul-19	10:05
D7G-070119-0-2-01	1907016-9		SOIL	01-Jul-19	10:20
D7G-070119-0-2-99	1907016-10		SOIL	01-Jul-19	10:20
D3G-070119-0-2-01	1907016-11		SOIL	01-Jul-19	10:40
D3G-070119-0-2-99	1907016-12		SOIL	01-Jul-19	10:40
D2G-070119-0-2-01	1907016-13		SOIL	01-Jul-19	11:15
D2G-070119-0-2-99	1907016-14		SOIL	01-Jul-19	11:15
D1G-070119-0-2-01	1907016-15		SOIL	01-Jul-19	11:25
D1G-070119-0-2-99	1907016-16		SOIL	01-Jul-19	11:25
E3G-070119-0-2-01	1907016-17		SOIL	01-Jul-19	13:40
E3G-070119-0-2-99	1907016-18		SOIL	01-Jul-19	13:40
D4G-070119-0-2-DUP	1907016-19		SOIL	01-Jul-19	9:45
D6G-070119-ERB	1907016-20		WATER	01-Jul-19	9:30



## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.

[illegible]



# ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
TF: (970) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

# Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

ALS WORKORDER #	
1907012	
PAGE	2 of 2
DISPOSAL	BY LAB or RETURN

PROJECT NAME	Jeffco ELAP	TURNAROUND TIME	Std	SAMPLER	NC, SK
PROJECT No.	110836a	SITE ID			
COMPANY NAME	Engineering Analytics	EDD FORMAT			
SEND REPORT TO	Susan Andrews	PURCHASE ORDER			
ADDRESS	1600 Specht Point Road	BILL TO COMPANY			
CITY/STATE/ZIP	Fort Collins, CO 80524	INVOICE ATTN TO			
PHONE	970 488 3411	ADDRESS			
FAX		CITY/STATE/ZIP			
E-MAIL	JAndrews@enganalytics.com	PHONE			
		FAX			
		E-MAIL			

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
13	DAG-070119-0-2-01	S	7/11/19	1115	1	None		X	X	X								
14	" " -99			1115														Hold
15	DIG-070119-0-2-01			1125				X	X	X								
16	" " -99			1125														Hold
17	E3G-070119-0-2-01			1340				X	X	X								
18	" " -99			1340														Hold
19	D4G-070119-0-2-DUP	✓	7/11/19	0945	✓	↓		X	X	X								
20	D6G-070119-ERB	W	7/11/19	0930	3	HNO3					X	X	X					

Time Zone (Circle): EST CST MST PST Metric: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter		Form 202a		SIGNATURE		PRINTED NAME		DATE		TIME	
RELINQUISHED BY		RECEIVED BY		RELINQUISHED BY		RECEIVED BY		RELINQUISHED BY		RECEIVED BY	
M. Carbo		J. Carbo		M. Carbo		J. Carbo		M. Carbo		J. Carbo	
No Carb fusion testing		Hold all - 99 samples for arch. r.		M. Carbo		M. Carbo		M. Carbo		M. Carbo	
of 25											
PRESERVATION KEY		1-HCI 2-HNO3 3-H2SO4 4-NH4OH 5-NH4OH/ZnAcetate 6-NH4OH 7-4°C 8-Other									



**ALS Environmental - Fort Collins**  
**CONDITION OF SAMPLE UPON RECEIPT FORM**

Client: Engineering AnalyticsWorkorder No: 1907016Project Manager: LRSInitials: EEDate: 7/1/19

1. Are airbills / shipping documents present and/or removable?	<input checked="" type="radio"/> YES	<input type="radio"/> NO
2. Are custody seals on <b>shipping</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
3. Are custody seals on <b>sample</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
4. Is there a COC (chain-of-custody) present?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
6. Are short-hold samples present?	<input type="radio"/> YES	<input checked="" type="radio"/> NO
7. Are all samples within holding times for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
8. Were all sample containers received intact? (not broken or leaking)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
9. Is there sufficient sample for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
10. Are all samples in the proper containers for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)	<input type="radio"/> N/A	<input checked="" type="radio"/> YES
12. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	<input checked="" type="radio"/> YES	<input type="radio"/> NO
14. Were the samples shipped on ice?	<input type="radio"/> YES	<input checked="" type="radio"/> NO
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #1 #3 #4	RAD ONLY
Cooler #: <u>1</u>		
Temperature (°C): <u>AMB</u>		
No. of custody seals on cooler: <u>0</u>		
External µR/hr reading: <u>N/A</u>		
Background µR/hr reading: <u>10</u>		
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO <u>NA</u> (If no, see Form 008.)		

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

All client bottle ID's vs ALS lab ID's double-checked by: EE

If applicable, was the client contacted? YES / NO / N/A

Contact:

Date/Time:

Project Manager Signature / Date:

7/1/19



# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1MB

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1AM

Count Time: 1000 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.005 +/- 0.013	0.024	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.271	2.07	pCi/l	91.2	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** AM1907016-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-3MB

Sample Matrix: SOIL

Prep Batch: AS190723-3

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS190723-3-1

Result Units: pCi/g

Date Collected: 23-Jul-19

Run ID: AS190723-3AM

File Name: Spectrum #1

Date Prepared: 23-Jul-19

Count Time: 600 minutes

Date Analyzed: 10-Aug-19

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	-0.0017 +/- 0.0062	0.0161	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	1.135	1.00	pCi/g	88.0	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

Data Package ID: AM1907016-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-4MB

Sample Matrix: SOIL

Prep Batch: AS190723-4

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS190723-4-1

Result Units: pCi/g

Date Collected: 23-Jul-19

Run ID: AS190723-4AM

File Name: Spectrum #1

Date Prepared: 23-Jul-19

Count Time: 600 minutes

Date Analyzed: 11-Aug-19

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	-0.0043 +/- 0.0077	0.0202	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	1.135	1.01	pCi/g	88.6	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** AM1907016-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1LCS

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1AM

Count Time: 1000 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14596-10-2	Am-241	4.52 +/- 0.73	0.02	4.935	91.7	79 - 118	P,Y1

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.271	2.30	pCi/l	101	30 - 110 %	Y1

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: AM1907016-1

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# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1LCSD

Sample Matrix: WATER

Prep Batch: AS190717-1

Final Aliquot: 1000 ml

Prep SOP: PAI 778 Rev 16

QCBatchID: AS190717-1-1

Result Units: pCi/l

Date Collected: 17-Jul-19

Run ID: AS190717-1AM

File Name: Spectrum #1

Date Prepared: 17-Jul-19

Count Time: 1000 minutes

Date Analyzed: 23-Jul-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14596-10-2	Am-241	4.53 +/- 0.73	0.02	4.935	91.9	79 - 118	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.271	2.19	pCi/l	96.7	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: AM1907016-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-3LCS

Sample Matrix: SOIL

Prep Batch: AS190723-3

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS190723-3-1

Result Units: pCi/g

Date Collected: 23-Jul-19

Run ID: AS190723-3AM

File Name: Spectrum #1

Date Prepared: 23-Jul-19

Count Time: 600 minutes

Date Analyzed: 09-Aug-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14596-10-2	Am-241	2.39 +/- 0.41	0.02	2.467	96.7	67 - 111	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	1.135	1.00	pCi/g	88.2	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

**Data Package ID: AM1907016-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-4LCS

Sample Matrix: SOIL

Prep Batch: AS190723-4

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS190723-4-1

Result Units: pCi/g

Date Collected: 23-Jul-19

Run ID: AS190723-4AM

File Name: Spectrum #1

Date Prepared: 23-Jul-19

Count Time: 600 minutes

Date Analyzed: 11-Aug-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14596-10-2	Am-241	2.43 +/- 0.41	0.02	2.467	98.4	67 - 111	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	1.135	0.96	pCi/g	84.6	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: AM1907016-1

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# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID:	
Lab ID:	AS190717-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1AM

Count Time: 1000 minutes

Final Aliquot: 1000 ml

Prep Basis: Unfiltered

Moisture(%): NA

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
14596-10-2	Am-241	4.52 +/-	0.73	0.02	P,Y1	4.53 +/-	0.73	0.02	P	0.011	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID:** AM1907016-1



# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D5G-070119-0-2-01

Lab ID: 1907016-1

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 11-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3AM

Count Time: 600 minutes

Report Basis: Dry Weight

Final Aliquot: 1.07 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	-0.011 +/- 0.012	0.038	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.125	1.70	pCi/g	80.1	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID:** AM1907016-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D6G-070119-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-3	Final Aliquot: 1.01 g
Lab ID: 1907016-3	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-3-1	Prep Basis: Dry Weight
	Date Collected: 01-Jul-19	Run ID: AS190723-3AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 09-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.020 +/- 0.021	0.034	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.247	1.91	pCi/g	85.0	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID:** AM1907016-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D4G-070119-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-3	Final Aliquot: 1.04 g
Lab ID: 1907016-5	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-3-1	Prep Basis: Dry Weight
	Date Collected: 01-Jul-19	Run ID: AS190723-3AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 09-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0 +/- 0.016	0.037	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.191	1.82	pCi/g	83.0	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907016-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D8G-070119-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-3	Final Aliquot: 1.05 g
Lab ID: 1907016-7	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-3-1	Prep Basis: Dry Weight
	Date Collected: 01-Jul-19	Run ID: AS190723-3AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 10-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	-0.001 +/- 0.017	0.039	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.170	1.72	pCi/g	79.2	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID:** AM1907016-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D7G-070119-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-3	Final Aliquot: 1.06 g
Lab ID: 1907016-9	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-3-1	Prep Basis: Dry Weight
	Date Collected: 01-Jul-19	Run ID: AS190723-3AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 09-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.010 +/- 0.016	0.031	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.139	1.90	pCi/g	88.7	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID:** AM1907016-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D3G-070119-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-3	Final Aliquot: 1.03 g
Lab ID: 1907016-11	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-3-1	Prep Basis: Dry Weight
	Date Collected: 01-Jul-19	Run ID: AS190723-3AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 09-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.004 +/- 0.016	0.035	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.205	1.80	pCi/g	81.5	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907016-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D2G-070119-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-3	Final Aliquot: 1.02 g
Lab ID: 1907016-13	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-3-1	Prep Basis: Dry Weight
	Date Collected: 01-Jul-19	Run ID: AS190723-3AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 09-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	-0.012 +/- 0.013	0.039	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.225	1.91	pCi/g	85.8	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907016-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D1G-070119-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-3	Final Aliquot: 1.07 g
Lab ID: 1907016-15	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-3-1	Prep Basis: Dry Weight
	Date Collected: 01-Jul-19	Run ID: AS190723-3AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 09-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	-0.002 +/- 0.013	0.032	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.129	1.95	pCi/g	91.6	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907016-1**



# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E3G-070119-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-3	Final Aliquot: 1.01 g
Lab ID: 1907016-17	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-3-1	Prep Basis: Dry Weight
	Date Collected: 01-Jul-19	Run ID: AS190723-3AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 09-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.117 +/- 0.043	0.033	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.243	1.94	pCi/g	86.6	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID:** AM1907016-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D4G-070119-0-2-DUP	Sample Matrix: SOIL	Prep Batch: AS190723-4	Final Aliquot: 1.08 g
Lab ID: 1907016-19	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-4-1	Prep Basis: Dry Weight
	Date Collected: 01-Jul-19	Run ID: AS190723-4AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 10-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	-0.001 +/- 0.012	0.029	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.109	1.70	pCi/g	80.7	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907016-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D6G-070119-ERB	Sample Matrix: WATER	Prep Batch: AS190717-1	Final Aliquot: 1000 ml
Lab ID: 1907016-20	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190717-1-1	Prep Basis: Unfiltered
	Date Collected: 01-Jul-19	Run ID: AS190717-1AM	Moisture(%): NA
	Date Prepared: 17-Jul-19	Count Time: 1000 minutes	Result Units: pCi/l
	Date Analyzed: 23-Jul-19	Report Basis: Unfiltered	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.008 +/- 0.014	0.024	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.271	2.06	pCi/l	90.9	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907016-1



# Isotopic Plutonium Case Narrative

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## Engineering Analytics

Jeffco FLAP – 110836a

Work Order Number: 1907016

1. This report consists of the analytical results for ten soil samples and one water sample received by ALS on 07/01/2019.
2. The soil samples were prepared according to the current revisions of SOP 736, SOP 773, SOP 777, and SOP 778. The water sample was prepared according to the current revisions of SOP 776, SOP 777, and SOP 778. The soil samples in this report did not undergo the fusion procedure, SOP768.
3. The samples were analyzed for the presence of isotopic plutonium according to the current revision of SOP 714. The analyses were completed on 08/08/2019.
4. The analysis results for the soil samples are reported on a 'Dry Weight' basis in units of pCi/gram.
5. The analysis results for the water sample are reported in units of pCi/L. The water sample was not filtered prior to analysis.
6. Plutonium-240 is indistinguishable from Plutonium-239. In this report, any plutonium in this region of interest will be reported as Pu-239/240.
7. Sample volume was insufficient to allow preparation of a duplicate. A laboratory control sample duplicate (LCSD) was prepared in lieu of a client sample duplicate for batch AS190717-1.
8. No anomalous situations were encountered during the preparation or analysis of these samples. All quality control criteria were met.



The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Jean Anderson

Jean Anderson

Radiochemistry Primary Data Reviewer

8/12/19

Date

June Hen

Radiochemistry Final Data Reviewer

8/14/19

Date

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

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**OrderNum:** 1907016

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**


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Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
D5G-070119-0-2-01	1907016-1		SOIL	01-Jul-19	8:50
D5G-070119-0-2-99	1907016-2		SOIL	01-Jul-19	8:50
D6G-070119-0-2-01	1907016-3		SOIL	01-Jul-19	9:05
D6G-070119-0-2-99	1907016-4		SOIL	01-Jul-19	9:05
D4G-070119-0-2-01	1907016-5		SOIL	01-Jul-19	9:45
D4G-070119-0-2-99	1907016-6		SOIL	01-Jul-19	9:45
D8G-070119-0-2-01	1907016-7		SOIL	01-Jul-19	10:05
D8G-070119-0-2-99	1907016-8		SOIL	01-Jul-19	10:05
D7G-070119-0-2-01	1907016-9		SOIL	01-Jul-19	10:20
D7G-070119-0-2-99	1907016-10		SOIL	01-Jul-19	10:20
D3G-070119-0-2-01	1907016-11		SOIL	01-Jul-19	10:40
D3G-070119-0-2-99	1907016-12		SOIL	01-Jul-19	10:40
D2G-070119-0-2-01	1907016-13		SOIL	01-Jul-19	11:15
D2G-070119-0-2-99	1907016-14		SOIL	01-Jul-19	11:15
D1G-070119-0-2-01	1907016-15		SOIL	01-Jul-19	11:25
D1G-070119-0-2-99	1907016-16		SOIL	01-Jul-19	11:25
E3G-070119-0-2-01	1907016-17		SOIL	01-Jul-19	13:40
E3G-070119-0-2-99	1907016-18		SOIL	01-Jul-19	13:40
D4G-070119-0-2-DUP	1907016-19		SOIL	01-Jul-19	9:45
D6G-070119-ERB	1907016-20		WATER	01-Jul-19	9:30



# ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
TF: (800) 443-1511 FAX: (970) 490-1522

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

PROJECT NAME Jeffco FLAP		TURNAROUND TIME Std		SAMPLER MC, SK		PAGE 1 of 2		ALS WORKORDER # 1907016																													
PROJECT NO. 1108360		SITE ID		EDD FORMAT		PARAMETER/METHOD REQUEST FOR ANALYSIS		DISPOSAL BY LAB or RETURN																													
COMPANY NAME Engineering Analytics		PURCHASE ORDER		BILL TO COMPANY		A		AS 80714																													
SEND REPORT TO Jason Andrews		INVOICE ATTN TO		Jeffco		B		238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000		C		U - 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CITY / STATE / ZIP Fort Collins, CO 80524		ADDRESS		Same		E																															
PHONE 9704883111		CITY / STATE / ZIP				F																															
FAX		PHONE				G																															
E-MAIL J.Andrews@enganalytics.com		E-MAIL				H																															
						I																															
						J																															
LAB #		FIELD ID		MATRIX		SAMPLE DATE		SAMPLE TIME		# OF BOTTLES		PRESERVATIVE		OC		A		B		C		D		E		F		G		H		I		J		SEE NOTES SECTION	
1		DSG-070119-0-2-01		S		7/1/19		0550		1		None				✓		✓		✓																Hold	
2		DSG-070119-0-2-99		L				0550		1						✓		✓		✓																Hold	
3		P65-070119-0-2-01		L				0905		1						✓		✓		✓																Hold	
4		P65-070119-0-2-99		L				0905		1						✓		✓		✓																Hold	
5		P45-070119-0-2-01		L				0905		1						✓		✓		✓																Hold	
6		P45-070119-0-2-99		L				0905		1						✓		✓		✓																Hold	
7		P85-070119-0-2-01		L				1005		1						✓		✓		✓																Hold	
8		P85-070119-0-2-99		L				1005		1						✓		✓		✓																Hold	
9		P75-070119-0-2-01		L				1020		1						X		X		X																Hold	
10		P75-070119-0-2-99		L				1020		1						X		X		X																Hold	
11		P35-070119-0-2-01		L				1040		1						X		X		X																Hold	
12		P35-070119-0-2-99		L				1040		1						X		X		X																Hold	

Time Zone (Circle): EST CST MST PST Metric: 0 = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filler

REPORT LEVEL / OC REQUIRED

Summary (Standard OC)	LEVEL II (Standard OC)	LEVEL III (Std OC + fumes)	LEVEL IV (Std OC + fumes + raw)

Hold all 99 samples for archiving

No carbonate fusion testing

of 25

PRESERVATION KEY 1-HCl 2-HNO3 3-H2SO4 4-NH4OH 5-NaOH/ZnAcetate 6-NH4SCN 7-4°C 8-Other







**ALS Environmental - Fort Collins**  
**CONDITION OF SAMPLE UPON RECEIPT FORM**

Client: Engineering AnalyticsWorkorder No: 1907016Project Manager: LRSInitials: EEDate: 7/1/19

1. Are airbills / shipping documents present and/or removable?	<input checked="" type="radio"/> YES	<input type="radio"/> NO
2. Are custody seals on <b>shipping</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
3. Are custody seals on <b>sample</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
4. Is there a COC (chain-of-custody) present?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
6. Are short-hold samples present?	<input type="radio"/> YES	<input checked="" type="radio"/> NO
7. Are all samples within holding times for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
8. Were all sample containers received intact? (not broken or leaking)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
9. Is there sufficient sample for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
10. Are all samples in the proper containers for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)	<input type="radio"/> N/A	<input checked="" type="radio"/> YES
12. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	<input checked="" type="radio"/> YES	<input type="radio"/> NO
14. Were the samples shipped on ice?	<input type="radio"/> YES	<input checked="" type="radio"/> NO
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #1 #3 #4	RAD ONLY
Cooler #: <u>1</u>		
Temperature (°C): <u>AMB</u>		
No. of custody seals on cooler: <u>0</u>		
External µR/hr reading: <u>N/A</u>		
Background µR/hr reading: <u>10</u>		
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO <u>NA</u> (If no, see Form 008.)		

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

All client bottle ID's vs ALS lab ID's double-checked by: EE

If applicable, was the client contacted? YES / NO / N/A Contact: \_\_\_\_\_

Date/Time: \_\_\_\_\_

Project Manager Signature / Date: [Signature] 7/1/19

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1MB

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 22-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1PU

Count Time: 420 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	-0.013 +/- 0.023	0.059	0.15	NA	U
10-12-8	Pu-239/240	-0.003 +/- 0.023	0.036	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.133	2.10	pCi/l	50.8	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** PU1907016-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-3MB

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3PU

Count Time: 360 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.004 +/- 0.010	0.022	0.15	NA	U
10-12-8	Pu-239/240	0 +/- 0.0086	0.0063	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	2.304	1.94	pCi/g	84.2	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** PU1907016-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-4MB

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4PU

Count Time: 360 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	-0.005 +/- 0.010	0.025	0.15	NA	U
10-12-8	Pu-239/240	-0.001 +/- 0.010	0.023	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	2.304	1.52	pCi/g	65.8	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** PU1907016-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1LCS

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 22-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1PU

Count Time: 420 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
10-12-8	Pu-239/240	4.74 +/- 0.83	0.03	4.553	104	82 - 118	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.133	2.71	pCi/l	65.5	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

**Data Package ID:** PU1907016-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 22-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1PU

Count Time: 420 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
10-12-8	Pu-239/240	5.32 +/- 0.94	0.02	4.553	117	82 - 118	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.133	2.47	pCi/l	59.7	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

**Data Package ID:** PU1907016-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-3LCS

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3PU

Count Time: 360 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
10-12-8	Pu-239/240	2.43 +/- 0.43	0.02	2.277	107	82 - 118	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	2.304	1.67	pCi/g	72.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: PU1907016-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-4LCS

Sample Matrix: SOIL

Prep Batch: AS190723-4

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS190723-4-1

Result Units: pCi/g

Date Collected: 23-Jul-19

Run ID: AS190723-4PU

File Name: Spectrum #1

Date Prepared: 23-Jul-19

Count Time: 360 minutes

Date Analyzed: 08-Aug-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
10-12-8	Pu-239/240	2.21 +/- 0.39	0.01	2.277	97.1	82 - 118	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	2.304	1.84	pCi/g	79.9	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

**Data Package ID: PU1907016-1**

Date Printed: Monday, August 12, 2019

ALS -- Fort Collins

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# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID:	
Lab ID:	AS190717-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 22-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1PU

Count Time: 420 minutes

Final Aliquot: 1000 ml

Prep Basis: Unfiltered

Moisture(%): NA

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
10-12-8	Pu-239/240	4.74 +/- 0.83		0.03	P	5.32 +/- 0.94		0.02	P	0.454	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID:** PU1907016-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D5G-070119-0-2-01

Lab ID: 1907016-1

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.07 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.013 +/- 0.019	0.035	0.15	NA	U
10-12-8	Pu-239/240	0.003 +/- 0.017	0.025	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.314	3.55	pCi/g	82.3	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907016-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D6G-070119-0-2-01

Lab ID: 1907016-3

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.01 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.008 +/- 0.018	0.027	0.15	NA	U
10-12-8	Pu-239/240	0.040 +/- 0.030	0.032	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.561	3.71	pCi/g	81.3	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907016-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D4G-070119-0-2-01

Lab ID: 1907016-5

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.04 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.001 +/- 0.018	0.033	0.15	NA	U
10-12-8	Pu-239/240	0.018 +/- 0.020	0.027	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.447	3.35	pCi/g	75.4	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907016-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D8G-070119-0-2-01

Lab ID: 1907016-7

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	-0.006 +/- 0.019	0.049	0.15	NA	U
10-12-8	Pu-239/240	0.031 +/- 0.025	0.014	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.405	3.27	pCi/g	74.1	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907016-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D7G-070119-0-2-01

Lab ID: 1907016-9

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.06 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.010 +/- 0.016	0.029	0.15	NA	U
10-12-8	Pu-239/240	0.027 +/- 0.024	0.029	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.341	3.81	pCi/g	87.7	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: PU1907016-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D3G-070119-0-2-01

Lab ID: 1907016-11

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.021 +/- 0.024	0.032	0.15	NA	U
10-12-8	Pu-239/240	0.044 +/- 0.034	0.032	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.475	3.03	pCi/g	67.7	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: PU1907016-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D2G-070119-0-2-01

Lab ID: 1907016-13

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.02 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.002 +/- 0.020	0.036	0.15	NA	U
10-12-8	Pu-239/240	0 +/- 0.020	0.040	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.517	3.37	pCi/g	74.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907016-1*



# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D1G-070119-0-2-01

Lab ID: 1907016-15

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.07 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	-0.010 +/- 0.020	0.047	0.15	NA	U
10-12-8	Pu-239/240	0.026 +/- 0.024	0.014	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.322	3.16	pCi/g	73.1	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907016-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E3G-070119-0-2-01

Lab ID: 1907016-17

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.01 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.018 +/- 0.021	0.028	0.15	NA	U
10-12-8	Pu-239/240	0.88 +/- 0.20	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.553	3.34	pCi/g	73.3	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907016-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D4G-070119-0-2-DUP

Lab ID: 1907016-19

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.08 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.003 +/- 0.016	0.024	0.15	NA	U
10-12-8	Pu-239/240	0.017 +/- 0.021	0.033	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.282	3.31	pCi/g	77.3	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907016-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D6G-070119-ERB

Lab ID: 1907016-20

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 22-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1PU

Count Time: 420 minutes

Report Basis: Unfiltered

Final Aliquot: 1000 ml

Prep Basis: Unfiltered

Moisture(%): NA

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.008 +/- 0.027	0.049	0.15	NA	U
10-12-8	Pu-239/240	0.001 +/- 0.026	0.049	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.133	1.97	pCi/l	47.7	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907016-1*



# Isotopic Uranium Case Narrative

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## Engineering Analytics

Jeffco FLAP – 110836a

Work Order Number: 1907016

1. This report consists of the analytical results for ten soil samples and one water sample received by ALS on 07/01/2019.
2. The soil samples were prepared according to the current revisions of SOP 736, SOP 773, and SOP 778. The water sample was prepared according to the current revisions of SOP 776 and SOP 778. The soil samples in this report did not undergo the fusion procedure, SOP768.
3. The samples were analyzed for the presence of isotopic uranium according to the current revision of SOP 714. The analyses were completed on 08/08/2019.
4. The analysis results for the soil samples are reported on a 'Dry Weight' basis in units of pCi/gram.
5. The analysis results for the water sample are reported in units of pCi/L. The water sample was not filtered prior to analysis.
6. Sample volume was insufficient to allow preparation of a duplicate. A laboratory control sample duplicate (LCSD) was prepared in lieu of a client sample duplicate for batch AS190717-1.
7. This analytical method quantifies U-235 alpha activity in a specific region of interest corresponding to emission energies between those of U-234 and U-238. A potential limitation of this method is that measurable amounts of U-234 in the sample may cause a small amount of characteristic activity in the U-235 region of interest due to poorly resolved alpha activity at the boundary between the two regions. To minimize the potential for a high bias in the U-235 analytical results, the U-235 region of interest has been narrowed and limited to a lower energy region. An 85.1% abundance correction has been made to the final U-235 results.
8. No anomalous situations were encountered during the preparation or analysis of these samples. All quality control criteria were met.



The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Jean Anderson  
Jean Anderson  
Radiochemistry Primary Data Reviewer

8/13/19  
Date

Jonie Steen  
Radiochemistry Final Data Reviewer

8/14/19  
Date

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

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**OrderNum:** 1907016

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**


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Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
D5G-070119-0-2-01	1907016-1		SOIL	01-Jul-19	8:50
D5G-070119-0-2-99	1907016-2		SOIL	01-Jul-19	8:50
D6G-070119-0-2-01	1907016-3		SOIL	01-Jul-19	9:05
D6G-070119-0-2-99	1907016-4		SOIL	01-Jul-19	9:05
D4G-070119-0-2-01	1907016-5		SOIL	01-Jul-19	9:45
D4G-070119-0-2-99	1907016-6		SOIL	01-Jul-19	9:45
D8G-070119-0-2-01	1907016-7		SOIL	01-Jul-19	10:05
D8G-070119-0-2-99	1907016-8		SOIL	01-Jul-19	10:05
D7G-070119-0-2-01	1907016-9		SOIL	01-Jul-19	10:20
D7G-070119-0-2-99	1907016-10		SOIL	01-Jul-19	10:20
D3G-070119-0-2-01	1907016-11		SOIL	01-Jul-19	10:40
D3G-070119-0-2-99	1907016-12		SOIL	01-Jul-19	10:40
D2G-070119-0-2-01	1907016-13		SOIL	01-Jul-19	11:15
D2G-070119-0-2-99	1907016-14		SOIL	01-Jul-19	11:15
D1G-070119-0-2-01	1907016-15		SOIL	01-Jul-19	11:25
D1G-070119-0-2-99	1907016-16		SOIL	01-Jul-19	11:25
E3G-070119-0-2-01	1907016-17		SOIL	01-Jul-19	13:40
E3G-070119-0-2-99	1907016-18		SOIL	01-Jul-19	13:40
D4G-070119-0-2-DUP	1907016-19		SOIL	01-Jul-19	9:45
D6G-070119-ERB	1907016-20		WATER	01-Jul-19	9:30



# ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
TF: (800) 443-1511 FAX: (970) 490-1522

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

PROJECT NAME Jeffco FLAP		TURNAROUND TIME Std		SAMPLER MC,SK		PAGE 1 of 2		ALS WORKORDER # 1907016																													
PROJECT NO. 1108360		SITE ID		EDD FORMAT		PARAMETER/METHOD REQUEST FOR ANALYSIS		DISPOSAL BY LAB or RETURN																													
COMPANY NAME Engineering Analytics		PURCHASE ORDER		BILL TO COMPANY		A		AS 80714																													
SEND REPORT TO Jason Andrews		INVOICE ATTN TO		ADDRESS		B		238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000		C		U - 235, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000		D		AS 80714																					
CITY / STATE / ZIP		ADDRESS		CITY / STATE / ZIP		E																															
PHONE		PHONE		PHONE		F																															
FAX		FAX		FAX		G																															
E-MAIL		E-MAIL		E-MAIL		H																															
						I																															
						J																															
LAB #		FIELD ID		MATRIX		SAMPLE DATE		SAMPLE TIME		# OF BOTTLES		PRESERVATIVE		OC		A		B		C		D		E		F		G		H		I		J		SEE NOTES SECTION	
1		DSG-070119-0-2-01		S		7/11/19		0550		1		None				✓		✓		✓																Hold	
2		DSG-070119-0-2-99		L				0550		1						✓		✓		✓																Hold	
3		P65-070119-0-2-01		L				0905		1						✓		✓		✓																Hold	
4		P65-070119-0-2-99		L				0905		1						✓		✓		✓																Hold	
5		P45-070119-0-2-01		L				0905		1						✓		✓		✓																Hold	
6		P45-070119-0-2-99		L				0905		1						✓		✓		✓																Hold	
7		P85-070119-0-2-01		L				1005		1						✓		✓		✓																Hold	
8		P85-070119-0-2-99		L				1005		1						✓		✓		✓																Hold	
9		P75-070119-0-2-01		L				1020		1						X		X		X																Hold	
10		P75-070119-0-2-99		L				1020		1						X		X		X																Hold	
11		P35-070119-0-2-01		L				1040		1						X		X		X																Hold	
12		P35-070119-0-2-99		L				1040		1						X		X		X																Hold	

Time Zone (Circle): EST CST MST PST Metric: 0 = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filler

REPORT LEVEL / OC REQUIRED

Summary (Standard OC)	LEVEL II (Standard OC)	LEVEL III (Std OC + fumes)	LEVEL IV (Std OC + fumes + raw)

Hold all 99 samples for archiving

No carbonate fusion testing

of 25

PRESERVATION KEY 1-HCl 2-HNO3 3-H2SO4 4-NH4OH 5-NaOH/ZnAcetate 6-NH4SCN 7-4°C 8-Other





# ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
TF: (970) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

# Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

ALS WORKORDER #	1907012
PAGE	2 of 2
DISPOSAL	
BY LAB	
OR RETURN	

PROJECT NAME	Jeffco ELAP	TURNAROUND TIME	Std	SAMPLER	NC, SK
PROJECT No.	110836a	SITE ID			
COMPANY NAME	Engineering Analytics	EDD FORMAT			
SEND REPORT TO	Susan Andrews	PURCHASE ORDER			
ADDRESS	1600 Specht Point Road	BILL TO COMPANY			
CITY/STATE/ZIP	Fort Collins, CO 80524	INVOICE ATTN TO			
PHONE	970 488 3411	ADDRESS			
FAX		CITY/STATE/ZIP			
E-MAIL	JAndrews@enganalytics.com	PHONE			
		FAX			
		E-MAIL			

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
13	DAG-070119-0-2-01	S	7/11/19	1115	1	None		X	X	X								
14	" " -99			1115				X	X	X								Hold
15	DIG-070119-0-2-01			1125				X	X	X								
16	" " -99			1125				X	X	X								Hold
17	E3G-070119-0-2-01			1340				X	X	X								
18	" " -99			1340				X	X	X								Hold
19	D4G-070119-0-2-DUP	✓	✓	0945	✓	↓		X	X	X								
20	D6G-070119-ERB	W	7/11/19	0930	3	HNO3					X	X	X					

\*Time Zone (Circle): EST CST MST PST Metric: O = oil S = soil NS = non-sol solid W = water L = liquid E = extract F = filter

PRESERVATION KEY	1-HCI 2-HNO3 3-H2SO4 4-NH4OH 5-NH4OH/ZnAcetate 6-NH4OH 7-4°C 8-Other					
	REPORT LEVEL / QC REQUIRED	SUMMARY (Standard QC)	LEVEL I (Standard QC)	LEVEL II (Std QC + form)	LEVEL III (Std QC + form)	LEVEL IV (Std QC + form + raw)
	No Carb fusion testing	Hold all -99 samples for arch. r.				
	of 25					

RELINQUISHED BY	RELINQUISHED BY	RELINQUISHED BY	RELINQUISHED BY	RELINQUISHED BY
Signature	Signature	Signature	Signature	Signature
DATE	DATE	DATE	DATE	DATE
7/11/19	7/11/19	7/11/19	7/11/19	7/11/19
1550p	1550p	1550p	1550p	1550p



**ALS Environmental - Fort Collins**  
**CONDITION OF SAMPLE UPON RECEIPT FORM**

Client: Engineering AnalyticsWorkorder No: 1907016Project Manager: LRSInitials: EEDate: 7/1/19

1. Are airbills / shipping documents present and/or removable?	<input checked="" type="radio"/> YES	<input type="radio"/> NO
2. Are custody seals on <b>shipping</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
3. Are custody seals on <b>sample</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
4. Is there a COC (chain-of-custody) present?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
6. Are short-hold samples present?	<input type="radio"/> YES	<input checked="" type="radio"/> NO
7. Are all samples within holding times for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
8. Were all sample containers received intact? (not broken or leaking)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
9. Is there sufficient sample for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
10. Are all samples in the proper containers for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)	<input type="radio"/> N/A	<input checked="" type="radio"/> YES
12. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	<input checked="" type="radio"/> YES	<input type="radio"/> NO
14. Were the samples shipped on ice?	<input type="radio"/> YES	<input checked="" type="radio"/> NO
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #1 #3 #4	RAD ONLY
Cooler #: <u>1</u>		
Temperature (°C): <u>AMB</u>		
No. of custody seals on cooler: <u>0</u>		
External µR/hr reading: <u>N/A</u>		
Background µR/hr reading: <u>10</u>		
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO <u>NA</u> (If no, see Form 008.)		

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

All client bottle ID's vs ALS lab ID's double-checked by: EE

If applicable, was the client contacted? YES / NO / N/A Contact: \_\_\_\_\_

Date/Time: \_\_\_\_\_

Project Manager Signature / Date: \_\_\_\_\_

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1MB

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1UD

Count Time: 420 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.009 +/- 0.018	0.035	0.2	NA	U
15117-96-1	U-235	-0.002 +/- 0.018	0.027	0.2	NA	U
7440-61-1	U-238	-0.002 +/- 0.015	0.023	0.2	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.429	3.48	pCi/l	78.6	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** UR1907016-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-3MB

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3UD

Count Time: 420 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.0075 +/- 0.0087	0.0121	0.1	NA	U
15117-96-1	U-235	0.0025 +/- 0.0093	0.0067	0.1	NA	U
7440-61-1	U-238	0.0042 +/- 0.0079	0.0057	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	2.287	1.73	pCi/g	75.6	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** UR1907016-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-4MB

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4UDA

Count Time: 420 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.010 +/- 0.011	0.016	0.1	NA	U
15117-96-1	U-235	0 +/- 0.010	0.007	0.1	NA	U
7440-61-1	U-238	-0.0010 +/- 0.0087	0.0133	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	2.214	1.65	pCi/g	74.6	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

Data Package ID: UR1907016-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1LCS

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1UD

Count Time: 420 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
13966-29-5	U-234	4.86 +/- 0.82	0.04	4.220	115	82 - 122	P
7440-61-1	U-238	5.08 +/- 0.86	0.03	4.382	116	78 - 126	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.429	3.56	pCi/l	80.4	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: UR1907016-1

Date Printed: Monday, August 12, 2019

ALS -- Fort Collins

LIMS Version: 6.906

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# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1UD

Count Time: 420 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
13966-29-5	U-234	4.43 +/- 0.75	0.03	4.220	105	82 - 122	P
7440-61-1	U-238	4.67 +/- 0.79	0.02	4.382	107	78 - 126	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.429	4.02	pCi/l	90.8	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: UR1907016-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-3LCS

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3UD

Count Time: 360 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
13966-29-5	U-234	2.15 +/- 0.38	0.02	2.110	102	82 - 122	P
7440-61-1	U-238	2.26 +/- 0.40	0.02	2.191	103	82 - 122	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	2.287	1.72	pCi/g	75.1	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: UR1907016-1

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# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-4LCS

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4UDA

Count Time: 420 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
13966-29-5	U-234	2.06 +/- 0.37	0.02	2.110	97.5	82 - 122	P
7440-61-1	U-238	2.30 +/- 0.41	0.03	2.191	105	82 - 122	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	2.214	1.40	pCi/g	63.3	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: UR1907016-1

Date Printed: Monday, August 12, 2019

ALS -- Fort Collins

LIMS Version: 6.906

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# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID:	
Lab ID:	AS190717-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1UD

Count Time: 420 minutes

Final Aliquot: 1000 ml

Prep Basis: Unfiltered

Moisture(%): NA

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13966-29-5	U-234	4.86 +/- 0.82		0.04	P	4.43 +/- 0.75		0.03	P	0.389	2.13
7440-61-1	U-238	5.08 +/- 0.86		0.03	P	4.67 +/- 0.79		0.02	P	0.354	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID:** UR1907016-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D5G-070119-0-2-01

Lab ID: 1907016-1

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3UD

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.07 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.53 +/- 0.13	0.02	0.1	NA	
15117-96-1	U-235	0.023 +/- 0.023	0.029	0.1	NA	U
7440-61-1	U-238	0.54 +/- 0.13	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.282	3.16	pCi/g	73.8	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907016-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D6G-070119-0-2-01

Lab ID: 1907016-3

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3UD

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.01 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.71 +/- 0.17	0.04	0.1	NA	
15117-96-1	U-235	0.037 +/- 0.031	0.017	0.1	NA	
7440-61-1	U-238	0.84 +/- 0.19	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.527	3.18	pCi/g	70.2	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907016-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D4G-070119-0-2-01

Lab ID: 1907016-5

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3UD

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.04 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.73 +/- 0.17	0.04	0.1	NA	
15117-96-1	U-235	0.021 +/- 0.027	0.043	0.1	NA	U
7440-61-1	U-238	0.75 +/- 0.18	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.414	2.89	pCi/g	65.5	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907016-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D8G-070119-0-2-01

Lab ID: 1907016-7

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3UD

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.77 +/- 0.18	0.04	0.1	NA	
15117-96-1	U-235	0.048 +/- 0.036	0.039	0.1	NA	
7440-61-1	U-238	0.79 +/- 0.18	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.372	3.18	pCi/g	72.8	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907016-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D7G-070119-0-2-01

Lab ID: 1907016-9

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3UD

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.06 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.68 +/- 0.16	0.04	0.1	NA	
15117-96-1	U-235	0.026 +/- 0.026	0.031	0.1	NA	U
7440-61-1	U-238	0.56 +/- 0.14	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.309	3.23	pCi/g	75.1	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907016-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D3G-070119-0-2-01

Lab ID: 1907016-11

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3UD

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.56 +/- 0.14	0.04	0.1	NA	
15117-96-1	U-235	0.028 +/- 0.026	0.015	0.1	NA	
7440-61-1	U-238	0.79 +/- 0.18	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.442	3.36	pCi/g	75.8	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID:** UR1907016-1



# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D2G-070119-0-2-01

Lab ID: 1907016-13

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3UD

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.02 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.68 +/- 0.16	0.04	0.1	NA	
15117-96-1	U-235	0.060 +/- 0.039	0.016	0.1	NA	
7440-61-1	U-238	0.74 +/- 0.17	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.483	3.21	pCi/g	71.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907016-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D1G-070119-0-2-01

Lab ID: 1907016-15

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3UD

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.07 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.62 +/- 0.15	0.04	0.1	NA	
15117-96-1	U-235	0.030 +/- 0.027	0.030	0.1	NA	
7440-61-1	U-238	0.68 +/- 0.16	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.290	3.28	pCi/g	76.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907016-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E3G-070119-0-2-01

Lab ID: 1907016-17

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-3

QCBatchID: AS190723-3-1

Run ID: AS190723-3UD

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.01 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.81 +/- 0.19	0.04	0.1	NA	
15117-96-1	U-235	0.060 +/- 0.041	0.034	0.1	NA	
7440-61-1	U-238	0.79 +/- 0.18	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.519	3.16	pCi/g	70.0	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907016-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D4G-070119-0-2-DUP

Lab ID: 1907016-19

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4UDA

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.08 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.54 +/- 0.13	0.04	0.1	NA	
15117-96-1	U-235	0.019 +/- 0.022	0.031	0.1	NA	U
7440-61-1	U-238	0.66 +/- 0.15	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.113	2.67	pCi/g	64.8	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907016-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907016

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: D6G-070119-ERB

Lab ID: 1907016-20

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 01-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1UD

Count Time: 420 minutes

Report Basis: Unfiltered

Final Aliquot: 1000 ml

Prep Basis: Unfiltered

Moisture(%): NA

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.018 +/- 0.021	0.031	0.2	NA	U
15117-96-1	U-235	0 +/- 0.020	0.014	0.2	NA	U
7440-61-1	U-238	0.012 +/- 0.019	0.035	0.2	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.429	3.23	pCi/l	72.9	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907016-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1906768

Client Name: Engineering Analytics

ClientProject ID: Rocky Flats Trails (FWS) 110876

Field ID:	SB-47-0-2-01
Lab ID:	1906768-25DUP

Sample Matrix: SOIL  
Prep SOP: PAI 778 Rev 16  
Date Collected: 28-Jun-19  
Date Prepared: 23-Jul-19  
Date Analyzed: 09-Aug-19

Prep Batch: AS190723-3  
QCBatchID: AS190723-3-1  
Run ID: AS190723-3AM  
Count Time: 600 minutes

Final Aliquot: 1.07 g  
Prep Basis: Dry Weight  
Moisture(%): NA  
Result Units: pCi/g  
File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
14596-10-2	Am-241	0.012 +/-	0.017	0.030	U	0.002 +/-	0.016	0.034	U	0.456	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID: AM1906768-1**

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1906768

Client Name: Engineering Analytics

ClientProject ID: Rocky Flats Trails (FWS) 110876

Field ID:	SB-47-0-2-01
Lab ID:	1906768-25DUP

Sample Matrix: SOIL  
Prep SOP: PAI 778 Rev 16  
Date Collected: 28-Jun-19  
Date Prepared: 23-Jul-19  
Date Analyzed: 07-Aug-19

Prep Batch: AS190723-3  
QCBatchID: AS190723-3-1  
Run ID: AS190723-3PU  
Count Time: 360 minutes

Final Aliquot: 1.07 g  
Prep Basis: Dry Weight  
Moisture(%): NA  
Result Units: pCi/g  
File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13981-16-3	Pu-238	0.002 +/-	0.030	0.055	U	-0.005 +/-	0.018	0.036	U	0.213	2.13
10-12-8	Pu-239/240	0.054 +/-	0.045	0.045		0.031 +/-	0.028	0.040	U	0.436	2.13

### Comments:

#### Duplicate Qualifiers/Flags:

U - Result is less than the sample specific MDC.  
Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.  
Y2 - Chemical Yield outside default limits.  
W - DER is greater than Warning Limit of 1.42  
D - DER is greater than Control Limit of 2.13  
LT - Result is less than Request MDC, greater than sample specific MDC  
M - Requested MDC not met.  
M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.  
L - LCS Recovery below lower control limit.  
H - LCS Recovery above upper control limit.  
P - LCS, Matrix Spike Recovery within control limits.  
N - Matrix Spike Recovery outside control limits

#### Abbreviations:

TPU - Total Propagated Uncertainty  
DER - Duplicate Error Ratio  
BDL - Below Detection Limit  
NR - Not Reported

Data Package ID: *PU1906768-1*

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1906768

Client Name: Engineering Analytics

ClientProject ID: Rocky Flats Trails (FWS) 110876

Field ID:	SB-47-0-2-01
Lab ID:	1906768-25DUP

Sample Matrix: SOIL  
Prep SOP: PAI 778 Rev 16  
Date Collected: 28-Jun-19  
Date Prepared: 23-Jul-19  
Date Analyzed: 07-Aug-19

Prep Batch: AS190723-3  
QCBatchID: AS190723-3-1  
Run ID: AS190723-3UD  
Count Time: 420 minutes

Final Aliquot: 1.07 g  
Prep Basis: Dry Weight  
Moisture(%): NA  
Result Units: pCi/g  
File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13966-29-5	U-234	1.14 +/-	0.25	0.05		0.97 +/-	0.21	0.04		0.518	2.13
15117-96-1	U-235	0.040 +/-	0.034	0.018		0.071 +/-	0.041	0.030		0.58	2.13
7440-61-1	U-238	1.20 +/-	0.26	0.05		0.91 +/-	0.19	0.04		0.9	2.13

### Comments:

#### Duplicate Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

#### Abbreviations:

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

Data Package ID: UR1906768-1



**APPENDIX B.3**  
**ALS LABORATORY REPORT**  
**WORK ORDER NUMBER 1907083 ACID DIGESTION**



# Isotopic Americium Case Narrative

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## Engineering Analytics

Jeffco FLAP – 110836a

Work Order Number: 1907083

1. This report consists of the analytical results for nine soil samples and one water sample received by ALS on 07/03/2019.
2. The soil samples were prepared according to the current revisions of SOP 736, SOP 773, SOP 778, and SOP 75. The water sample was prepared according to the current revisions of SOP 776, SOP 778, and SOP 751. The soil samples in this report did not undergo the fusion procedure, SOP768.
3. The samples were analyzed for the presence of  $^{241}\text{Am}$  according to the current revision of SOP 714. The analyses were completed on 08/11/2019.
4. The analysis results for the soil samples are reported on a 'Dry Weight' basis in units of pCi/gram.
5. The analysis results for the water sample are reported in units of pCi/L. The water sample was not filtered prior to analysis.
6. Sample volume was insufficient to allow preparation of a duplicate. A laboratory control sample duplicate (LCSD) was prepared in lieu of a client sample duplicate for batch AS190717-1.
7. The tracer recovery of 101% for AS190717-1LCS and 103% for sample 1907083-11 is within the requested 30-110% limit. However, in such cases ALS assumes a 100% quantitative recovery in the calculations. While the 'Tracer Yield' on the report form shows the observed recovery (101% and 103%, respectively), a 'Y1' flag signifies this calculation convention. Results are submitted without further qualification.
8. No further anomalous situations were encountered during the preparation or analysis of these samples. All remaining quality control criteria were met.



The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Jean Anderson  
Jean Anderson  
Radiochemistry Primary Data Reviewer

8/13/19  
Date

June Hen  
Radiochemistry Final Data Reviewer

8/14/09  
Date

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

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**OrderNum:** 1907083

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**


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Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
E2G-070219-0-2-01	1907083-1		SOIL	02-Jul-19	8:45
E2G-070219-0-2-99	1907083-2		SOIL	02-Jul-19	8:45
E1G-070219-0-2-01	1907083-3		SOIL	02-Jul-19	9:15
E1G-070219-0-2-99	1907083-4		SOIL	02-Jul-19	9:15
E6G-070219-0-2-01	1907083-5		SOIL	02-Jul-19	11:20
E6G-070219-0-2-99	1907083-6		SOIL	02-Jul-19	11:20
E10G-070219-0-2-01	1907083-7		SOIL	02-Jul-19	11:30
E10G-070219-0-2-99	1907083-8		SOIL	02-Jul-19	11:30
E9G-070219-0-2-01	1907083-9		SOIL	02-Jul-19	12:00
E9G-070219-0-2-99	1907083-10		SOIL	02-Jul-19	12:00
E10G-070219-0-2-ERB	1907083-11		WATER	02-Jul-19	11:45
E17G-070219-0-2-01	1907083-12		SOIL	02-Jul-19	13:50
E17G-070219-0-2-99	1907083-13		SOIL	02-Jul-19	13:50
E16G-070219-0-2-01	1907083-14		SOIL	02-Jul-19	14:20
E16G-070219-0-2-99	1907083-15		SOIL	02-Jul-19	14:20
E16G-070219-0-2-DUP	1907083-16		SOIL	02-Jul-19	14:20
E15G-070219-0-2-01	1907083-17		SOIL	02-Jul-19	15:55
E15G-070219-0-2-99	1907083-18		SOIL	02-Jul-19	15:55



## Chain-of-Custody

**Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.**

**ALB WORKORDER #**

1907083

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## SAMPLER

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## AD TIME

**APPENDIX A**

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PROJECT NAME	PROJECT No.	COMPANY NAME	SEND REPORT TO	ADDRESS	CITY / STATE / ZIP	PHONE	FAX	E-MAIL	LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
Jeffrey ELAP (SHE)	11083300	Engineering Analytics	Sarah Andrews	1600 Specht Point Rd Ste 200	Fort Collins, CO 80524	970 488 3111		J.Andrews@engnanalytics.com	1	E2G-070219-02-01	S	7/2/19	0845	1	None		X	X	X								
									2	99		0845					X	X	X							Hold	
									3	E1G-070219-02-01		0915					X	X	X							Hold	
									4	99		0915					X	X	X							Hold	
									5	E1G-070219-02-01		0915					X	X	X								
									6	<del>E1G-070219-02-01</del>		1120					X	X	X								
									7	E1G-070219-02-01		1120					X	X	X							Hold	
									8	02-02-99		1130					X	X	X							Hold	
									9	E9G-070219-02-01		1200					X	X	X							Hold	
									10	99		1200															
									11	E10G-070219-02-01	W	1145		3	HNO3					X	X	X				Hold	

RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY
	U. J. J. J.		U. J. J. J.		U. J. J. J.

PRINTED NAME	SIGNATURE	DATE	TIME
Meagan Carroll	U. J. J. J.	7/3/19	1346
E. J. J. J.	U. J. J. J.	7/3/19	1340

REPORT LEVEL / QC REQUIRED	Summary (Standard QC)	LEVEL II (Standard QC)	LEVEL III (Std QC - formal)	LEVEL IV (Std QC - formal + raw)

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
1	E2G-070219-02-01	S	7/2/19	0845	1	None		X	X	X								
2	99			0845				X	X	X								Hold
3	E1G-070219-02-01			0915				X	X	X								Hold
4	99			0915				X	X	X								Hold
5	E1G-070219-02-01			0915				X	X	X								Hold
6	<del>E1G-070219-02-01</del>			1120				X	X	X								Hold
7	E1G-070219-02-01			1120				X	X	X								Hold
8	02-02-99			1130				X	X	X	</							

**4 of 24**





**ALS Environmental - Fort Collins**  
**CONDITION OF SAMPLE UPON RECEIPT FORM**

Client: Engineering AnalyticsWorkorder No: 1907083Project Manager: LRSInitials: EEDate: 7/8/19

1. Are airbills / shipping documents present and/or removable?	<input checked="" type="radio"/> YES	<input type="radio"/> NO
2. Are custody seals on <b>shipping</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
3. Are custody seals on <b>sample</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
4. Is there a COC (chain-of-custody) present?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
6. Are short-hold samples present?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
7. Are all samples within holding times for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
8. Were all sample containers received intact? (not broken or leaking)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
9. Is there sufficient sample for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
10. Are all samples in the proper containers for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
12. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	<input checked="" type="radio"/> YES	<input type="radio"/> NO
14. Were the samples shipped on ice?	<input checked="" type="radio"/> YES	<input type="radio"/> NO
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #1 #3 #4	RAD ONLY
Cooler #: <u>1</u>		
Temperature (°C): <u>AMB</u>		
No. of custody seals on cooler: <u>0</u>		
External µR/hr reading: <u>N/A</u>		
Background µR/hr reading: <u>8</u>		
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / <u>N/A</u> (If no, see Form 008.)		

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

All client bottle ID's vs ALS lab ID's double-checked by: EE

If applicable, was the client contacted? YES / NO / NA Contact: \_\_\_\_\_

Date/Time: \_\_\_\_\_

Project Manager Signature / Date: \_\_\_\_\_

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1MB

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1AM

Count Time: 1000 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.005 +/- 0.013	0.024	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.271	2.07	pCi/l	91.2	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** AM1907083-1



# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-4MB

Sample Matrix: SOIL

Prep Batch: AS190723-4

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS190723-4-1

Result Units: pCi/g

Date Collected: 23-Jul-19

Run ID: AS190723-4AM

File Name: Spectrum #1

Date Prepared: 23-Jul-19

Count Time: 600 minutes

Date Analyzed: 11-Aug-19

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	-0.0043 +/- 0.0077	0.0202	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	1.135	1.01	pCi/g	88.6	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

Data Package ID: AM1907083-1

Date Printed: Tuesday, August 13, 2019

ALS -- Fort Collins

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LIMS Version: 6.906

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1LCS

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1AM

Count Time: 1000 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14596-10-2	Am-241	4.52 +/- 0.73	0.02	4.935	91.7	79 - 118	P,Y1

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.271	2.30	pCi/l	101	30 - 110 %	Y1

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: AM1907083-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1AM

Count Time: 1000 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14596-10-2	Am-241	4.53 +/- 0.73	0.02	4.935	91.9	79 - 118	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.271	2.19	pCi/l	96.7	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

**Data Package ID:** AM1907083-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-4LCS

Sample Matrix: SOIL

Prep Batch: AS190723-4

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS190723-4-1

Result Units: pCi/g

Date Collected: 23-Jul-19

Run ID: AS190723-4AM

File Name: Spectrum #1

Date Prepared: 23-Jul-19

Count Time: 600 minutes

Date Analyzed: 11-Aug-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14596-10-2	Am-241	2.43 +/- 0.41	0.02	2.467	98.4	67 - 111	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	1.135	0.96	pCi/g	84.6	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: AM1907083-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E1G-070219-0-2-01

Lab ID: 1907083-3DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 10-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4AM

Count Time: 600 minutes

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
14596-10-2	Am-241	1.21 +/-	0.24	0.04		1.22 +/-	0.25	0.05		0.0553	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID: AM1907083-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID:	
Lab ID:	AS190717-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1AM

Count Time: 1000 minutes

Final Aliquot: 1000 ml

Prep Basis: Unfiltered

Moisture(%): NA

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
14596-10-2	Am-241	4.52 +/- 0.73		0.02	P,Y1	4.53 +/- 0.73		0.02	P	0.011	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID:** AM1907083-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E2G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-4	Final Aliquot: 1.05 g
Lab ID: 1907083-1	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-4-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS190723-4AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 10-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.379 +/- 0.092	0.036	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.153	1.76	pCi/g	81.9	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID:** AM1907083-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E1G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-4	Final Aliquot: 1.01 g
Lab ID: 1907083-3	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-4-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS190723-4AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 10-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	1.21 +/- 0.24	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.250	1.70	pCi/g	75.7	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907083-1**



# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Duplicate Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E1G-070219-0-2-01

Lab ID: 1907083-3DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 10-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4AM

Count Time: 600 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	1.22 +/- 0.25	0.05	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.204	1.44	pCi/g	65.4	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907083-1**

Date Printed:

Tuesday, August 13, 2019

ALS -- Fort Collins

LIMS Version: 6.906

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# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E6G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-4	Final Aliquot: 1.05 g
Lab ID: 1907083-5	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-4-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS190723-4AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 10-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.65 +/- 0.14	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.154	1.68	pCi/g	77.9	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907083-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E10G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-4	Final Aliquot: 1.08 g
Lab ID: 1907083-7	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-4-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS190723-4AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 10-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.391 +/- 0.094	0.036	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.106	1.70	pCi/g	80.6	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907083-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E9G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-4	Final Aliquot: 1.05 g
Lab ID: 1907083-9	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-4-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS190723-4AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 10-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	1.23 +/- 0.23	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.162	1.84	pCi/g	85.2	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907083-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E10G-070219-0-2-ERB	Sample Matrix: WATER	Prep Batch: AS190717-1	Final Aliquot: 1000 ml
Lab ID: 1907083-11	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190717-1-1	Prep Basis: Unfiltered
	Date Collected: 02-Jul-19	Run ID: AS190717-1AM	Moisture(%): NA
	Date Prepared: 17-Jul-19	Count Time: 1000 minutes	Result Units: pCi/l
	Date Analyzed: 23-Jul-19	Report Basis: Unfiltered	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	-0.007 +/- 0.011	0.025	0.1	NA	Y1,U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.271	2.33	pCi/l	103	30 - 110 %	Y1

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907083-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E17G-070219-0-2-01

Lab ID: 1907083-12

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 10-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4AM

Count Time: 600 minutes

Report Basis: Dry Weight

Final Aliquot: 1.01 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.332 +/- 0.087	0.039	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.237	1.64	pCi/g	73.1	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907083-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E16G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-4	Final Aliquot: 1.02 g
Lab ID: 1907083-14	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-4-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS190723-4AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 10-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.53 +/- 0.12	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.229	1.70	pCi/g	76.2	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907083-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E16G-070219-0-2-DUP	Sample Matrix: SOIL	Prep Batch: AS190723-4	Final Aliquot: 1.03 g
Lab ID: 1907083-16	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-4-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS190723-4AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 10-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	1.05 +/- 0.21	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.209	1.77	pCi/g	80.3	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907083-1



# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E15G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-4	Final Aliquot: 1.05 g
Lab ID: 1907083-17	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-4-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS190723-4AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 600 minutes	Result Units: pCi/g
	Date Analyzed: 10-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	1.63 +/- 0.30	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.171	1.78	pCi/g	82.1	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907083-1



# Isotopic Plutonium Case Narrative

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## Engineering Analytics

Jeffco FLAP – 110836a

Work Order Number: 1907083

1. This report consists of the analytical results for nine soil samples and one water sample received by ALS on 07/03/2019.
2. The soil samples were prepared according to the current revisions of SOP 736, SOP 773, SOP 777, and SOP 778. The water sample was prepared according to the current revisions of SOP 776, SOP 777, and SOP 778. The soil samples in this report did not undergo the fusion procedure, SOP768.
3. The samples were analyzed for the presence of isotopic plutonium according to the current revision of SOP 714. The analyses were completed on 08/08/2019.
4. The analysis results for the soil samples are reported on a 'Dry Weight' basis in units of pCi/gram.
5. The analysis results for the water sample are reported in units of pCi/L. The water sample was not filtered prior to analysis.
6. Plutonium-240 is indistinguishable from Plutonium-239. In this report, any plutonium in this region of interest will be reported as Pu-239/240.
7. Sample volume was insufficient to allow preparation of a duplicate. A laboratory control sample duplicate (LCSD) was prepared in lieu of a client sample duplicate for batch AS190717-1.
8. ALS uses the following convention for reporting significant digits in the TPU and MDC results. The TPU value is rounded to two significant digits. The MDC value is rounded to the same decimal place as the TPU value. In practice, this could result in an MDC reported value of zero for samples with significant activity, including the batch laboratory control sample.
9. No anomalous situations were encountered during the preparation or analysis of these samples. All quality control criteria were met.



The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Jean Anderson  
Radiochemistry Primary Data Reviewer

8/12/19  
Date

James Allen  
Radiochemistry Final Data Reviewer

8/14/19  
Date

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

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**OrderNum:** 1907083

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**


---

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
E2G-070219-0-2-01	1907083-1		SOIL	02-Jul-19	8:45
E2G-070219-0-2-99	1907083-2		SOIL	02-Jul-19	8:45
E1G-070219-0-2-01	1907083-3		SOIL	02-Jul-19	9:15
E1G-070219-0-2-99	1907083-4		SOIL	02-Jul-19	9:15
E6G-070219-0-2-01	1907083-5		SOIL	02-Jul-19	11:20
E6G-070219-0-2-99	1907083-6		SOIL	02-Jul-19	11:20
E10G-070219-0-2-01	1907083-7		SOIL	02-Jul-19	11:30
E10G-070219-0-2-99	1907083-8		SOIL	02-Jul-19	11:30
E9G-070219-0-2-01	1907083-9		SOIL	02-Jul-19	12:00
E9G-070219-0-2-99	1907083-10		SOIL	02-Jul-19	12:00
E10G-070219-0-2-ERB	1907083-11		WATER	02-Jul-19	11:45
E17G-070219-0-2-01	1907083-12		SOIL	02-Jul-19	13:50
E17G-070219-0-2-99	1907083-13		SOIL	02-Jul-19	13:50
E16G-070219-0-2-01	1907083-14		SOIL	02-Jul-19	14:20
E16G-070219-0-2-99	1907083-15		SOIL	02-Jul-19	14:20
E16G-070219-0-2-DUP	1907083-16		SOIL	02-Jul-19	14:20
E15G-070219-0-2-01	1907083-17		SOIL	02-Jul-19	15:55
E15G-070219-0-2-99	1907083-18		SOIL	02-Jul-19	15:55



# ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

ALS WORKORDER #	1907083
PAGE	1 of 2
DISPOSAL	
BY LAB	
or RETURN	

TURNAROUND TIME	std	SAMPLER	SK MC
SITE ID			
EDD FORMAT			
PURCHASE ORDER			
BILL TO COMPANY			
INVOICE ATTN TO			
ADDRESS			
CITY/STATE/ZIP			
PHONE			
FAX			
E-MAIL			

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	J											SEE NOTES SECTION
								A	B	C	D	E	F	G	H	I	J		
1	E25-070219-0-2-01	S	7/2/19	0845	1	None		X	X	X									Hold
2	99			0845	1														Hold
3	E15-070219-0-2-01			0915				X	X	X									
4	99			0915				X	X	X									Hold
	<del>E65-070219-0-2-01</del>	<del>bb</del>	<del></del>	<del>0915</del>	<del></del>	<del></del>	<del></del>	<del>X</del>	<del>X</del>	<del>X</del>	<del></del>	<del></del>	<del></del>	<del></del>	<del></del>	<del></del>	<del></del>	<del></del>	<del>Hold</del>
5	E65-070219-0-2-01			1120				X	X	X									
6	<del>E65-070219-0-2-01</del>	<del>bb</del>	<del></del>	<del>1120</del>	<del></del>	<del></del>	<del></del>	<del>X</del>	<del>X</del>	<del>X</del>	<del></del>	<del></del>	<del></del>	<del></del>	<del></del>	<del></del>	<del></del>	<del></del>	<del>Hold</del>
7	E105-070219-0-2-01			1130				X	X	X									
8	0-2-99			1130															Hold
9	E95-070219-0-2-01			1200				X	X	X									
10	99			1200	1														Hold
11	E105-070219-0-2-01	W		1145	3	HA03							X	X			X	X	Hold

RELINQUISHED BY		SIGNATURE	PRINTED NAME	DATE	TIME
RECEIVED BY		<i>[Signature]</i>	Megan Connell	7/3/19	1345
RELINQUISHED BY		<i>[Signature]</i>	Eric Connell	7/3/19	1340
RECEIVED BY					
RELINQUISHED BY					
RECEIVED BY					

Time Zone (Circle): EST CST MST PST    Matrix: 0 = oil S = soil NS = non-sol solid W = water L = liquid E = extract F = filter

REPORT LEVEL / QC REQUIRED

Summary (Standard QC)	LEVEL II (Standard QC)	LEVEL III (Std QC + form)	LEVEL IV (Std QC + form + raw)

4 of 24

PRESERVATION KEY    1-HCI 2-HNO3 3-H2SO4 4-HClO4 5-NH4OH/2-NaOH 6-NaHSO4 7-4°C 8-Other





**ALS Environmental - Fort Collins**  
**CONDITION OF SAMPLE UPON RECEIPT FORM**

Client: Engineering AnalyticsWorkorder No: 1907083Project Manager: LRSInitials: EEDate: 7/8/19

1. Are airbills / shipping documents present and/or removable?	<input checked="" type="radio"/> YES	<input type="radio"/> NO
2. Are custody seals on <b>shipping</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
3. Are custody seals on <b>sample</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
4. Is there a COC (chain-of-custody) present?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
6. Are short-hold samples present?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
7. Are all samples within holding times for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
8. Were all sample containers received intact? (not broken or leaking)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
9. Is there sufficient sample for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
10. Are all samples in the proper containers for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
12. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	<input checked="" type="radio"/> YES	<input type="radio"/> NO
14. Were the samples shipped on ice?	<input checked="" type="radio"/> YES	<input type="radio"/> NO
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #1 #3 #4	RAD ONLY
Cooler #: <u>1</u>		
Temperature (°C): <u>AMB</u>		
No. of custody seals on cooler: <u>0</u>		
External µR/hr reading: <u>N/A</u>		
Background µR/hr reading: <u>8</u>		
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / <u>N/A</u> (If no, see Form 008.)		

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

All client bottle ID's vs ALS lab ID's double-checked by: EE

If applicable, was the client contacted? YES / NO / NA Contact: \_\_\_\_\_

Date/Time: \_\_\_\_\_

Project Manager Signature / Date: \_\_\_\_\_

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1MB

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 22-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1PU

Count Time: 420 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	-0.013 +/- 0.023	0.059	0.15	NA	U
10-12-8	Pu-239/240	-0.003 +/- 0.023	0.036	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.133	2.10	pCi/l	50.8	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

Data Package ID: PU1907083-1



# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-4MB

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4PU

Count Time: 360 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	-0.005 +/- 0.010	0.025	0.15	NA	U
10-12-8	Pu-239/240	-0.001 +/- 0.010	0.023	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	2.304	1.52	pCi/g	65.8	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

Data Package ID: PU1907083-1

Date Printed: Monday, August 12, 2019

ALS -- Fort Collins

LIMS Version: 6.901

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# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1LCS

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 22-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1PU

Count Time: 420 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
10-12-8	Pu-239/240	4.74 +/- 0.83	0.03	4.553	104	82 - 118	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.133	2.71	pCi/l	65.5	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

**Data Package ID:** PU1907083-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1LCSD

Sample Matrix: WATER

Prep Batch: AS190717-1

Final Aliquot: 1000 ml

Prep SOP: PAI 778 Rev 16

QCBatchID: AS190717-1-1

Result Units: pCi/l

Date Collected: 17-Jul-19

Run ID: AS190717-1PU

File Name: Spectrum #1

Date Prepared: 17-Jul-19

Count Time: 420 minutes

Date Analyzed: 22-Jul-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
10-12-8	Pu-239/240	5.32 +/- 0.94	0.02	4.553	117	82 - 118	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.133	2.47	pCi/l	59.7	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: PU1907083-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-4LCS

Sample Matrix: SOIL

Prep Batch: AS190723-4

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS190723-4-1

Result Units: pCi/g

Date Collected: 23-Jul-19

Run ID: AS190723-4PU

File Name: Spectrum #1

Date Prepared: 23-Jul-19

Count Time: 360 minutes

Date Analyzed: 08-Aug-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
10-12-8	Pu-239/240	2.21 +/- 0.39	0.01	2.277	97.1	82 - 118	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	2.304	1.84	pCi/g	79.9	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: PU1907083-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E1G-070219-0-2-01

Lab ID: 1907083-3DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4PU

Count Time: 360 minutes

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13981-16-3	Pu-238	0.086 +/-	0.044	0.036		0.077 +/-	0.044	0.036		0.144	2.13
10-12-8	Pu-239/240	7.2 +/-	1.2	0		5.43 +/-	0.95	0.03		1.11	2.13

### Comments:

#### Duplicate Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

#### Abbreviations:

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

Data Package ID: *PU1907083-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID:	
Lab ID:	AS190717-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 22-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1PU

Count Time: 420 minutes

Final Aliquot: 1000 ml

Prep Basis: Unfiltered

Moisture(%): NA

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
10-12-8	Pu-239/240	4.74 +/- 0.83		0.03	P	5.32 +/- 0.94		0.02	P	0.454	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID:** PU1907083-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E2G-070219-0-2-01

Lab ID: 1907083-1

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.019 +/- 0.019	0.013	0.15	NA	
10-12-8	Pu-239/240	2.47 +/- 0.46	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.370	3.26	pCi/g	74.7	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907083-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E1G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-4	Final Aliquot: 1.01 g
Lab ID: 1907083-3	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-4-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS190723-4PU	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 360 minutes	Result Units: pCi/g
	Date Analyzed: 07-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.086 +/- 0.044	0.036	0.15	NA	
10-12-8	Pu-239/240	7.2 +/- 1.2	0	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.567	3.56	pCi/g	77.9	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907083-1*



# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Duplicate Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E1G-070219-0-2-01

Lab ID: 1907083-3DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.077 +/- 0.044	0.036	0.15	NA	
10-12-8	Pu-239/240	5.43 +/- 0.95	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.475	2.98	pCi/g	66.6	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: PU1907083-1****Date Printed:**

Monday, August 12, 2019

**ALS -- Fort Collins**

LIMS Version: 6.901

Page 1 of 1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E6G-070219-0-2-01

Lab ID: 1907083-5

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.043 +/- 0.032	0.037	0.15	NA	
10-12-8	Pu-239/240	3.31 +/- 0.59	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.372	3.50	pCi/g	80.2	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907083-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E10G-070219-0-2-01

Lab ID: 1907083-7

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.08 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.032 +/- 0.028	0.034	0.15	NA	U
10-12-8	Pu-239/240	1.82 +/- 0.36	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.274	3.15	pCi/g	73.7	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907083-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID:	E9G-070219-0-2-01
Lab ID:	1907083-9

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.096 +/- 0.049	0.052	0.15	NA	
10-12-8	Pu-239/240	5.9 +/- 1.0	0	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.389	3.71	pCi/g	84.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907083-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E10G-070219-0-2-ERB	Sample Matrix: WATER	Prep Batch: AS190717-1	Final Aliquot: 1000 ml
Lab ID: 1907083-11	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190717-1-1	Prep Basis: Unfiltered
	Date Collected: 02-Jul-19	Run ID: AS190717-1PU	Moisture(%): NA
	Date Prepared: 17-Jul-19	Count Time: 420 minutes	Result Units: pCi/l
	Date Analyzed: 22-Jul-19	Report Basis: Unfiltered	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.008 +/- 0.020	0.030	0.15	NA	U
10-12-8	Pu-239/240	0.005 +/- 0.020	0.014	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.133	2.56	pCi/l	62.1	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: PU1907083-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E17G-070219-0-2-01

Lab ID: 1907083-12

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.01 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.013 +/- 0.021	0.037	0.15	NA	U
10-12-8	Pu-239/240	1.47 +/- 0.30	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.541	3.21	pCi/g	70.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907083-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E16G-070219-0-2-01

Lab ID: 1907083-14

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.02 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.063 +/- 0.038	0.036	0.15	NA	
10-12-8	Pu-239/240	2.55 +/- 0.47	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.525	3.69	pCi/g	81.6	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907083-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E16G-070219-0-2-DUP

Lab ID: 1907083-16

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.120 +/- 0.055	0.029	0.15	NA	
10-12-8	Pu-239/240	6.1 +/- 1.1	0	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.484	3.25	pCi/g	72.5	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: PU1907083-1



# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E15G-070219-0-2-01

Lab ID: 1907083-17

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 07-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.146 +/- 0.058	0.031	0.15	NA	
10-12-8	Pu-239/240	14.0 +/- 2.3	0	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.408	3.51	pCi/g	79.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907083-1*



# Isotopic Uranium Case Narrative

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## Engineering Analytics

Jeffco FLAP – 110836a

Work Order Number: 1907083

1. This report consists of the analytical results for nine soil samples and one water sample received by ALS on 07/03/2019.
2. The soil samples were prepared according to the current revisions of SOP 736, SOP 773, and SOP 778. The water sample was prepared according to the current revisions of SOP 776 and SOP 778. The soil samples in this report did not undergo the fusion procedure, SOP768.
3. The samples were analyzed for the presence of isotopic uranium according to the current revision of SOP 714. The analyses were completed on 08/09/2019.
4. The analysis results for the soil samples are reported on a 'Dry Weight' basis in units of pCi/gram.
5. The analysis results for the water sample are reported in units of pCi/L. The water sample was not filtered prior to analysis.
6. Sample volume was insufficient to allow preparation of a duplicate. A laboratory control sample duplicate (LCSD) was prepared in lieu of a client sample duplicate for batch AS190717-1.
7. This analytical method quantifies U-235 alpha activity in a specific region of interest corresponding to emission energies between those of U-234 and U-238. A potential limitation of this method is that measurable amounts of U-234 in the sample may cause a small amount of characteristic activity in the U-235 region of interest due to poorly resolved alpha activity at the boundary between the two regions. To minimize the potential for a high bias in the U-235 analytical results, the U-235 region of interest has been narrowed and limited to a lower energy region. An 85.1% abundance correction has been made to the final U-235 results.
8. No anomalous situations were encountered during the preparation or analysis of these samples. All quality control criteria were met.



The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Jean Anderson

Radiochemistry Primary Data Reviewer

8/13/19

Date

Radiochemistry Final Data Reviewer

8/14/19

Date

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

---

**OrderNum:** 1907083

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**


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Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
E2G-070219-0-2-01	1907083-1		SOIL	02-Jul-19	8:45
E2G-070219-0-2-99	1907083-2		SOIL	02-Jul-19	8:45
E1G-070219-0-2-01	1907083-3		SOIL	02-Jul-19	9:15
E1G-070219-0-2-99	1907083-4		SOIL	02-Jul-19	9:15
E6G-070219-0-2-01	1907083-5		SOIL	02-Jul-19	11:20
E6G-070219-0-2-99	1907083-6		SOIL	02-Jul-19	11:20
E10G-070219-0-2-01	1907083-7		SOIL	02-Jul-19	11:30
E10G-070219-0-2-99	1907083-8		SOIL	02-Jul-19	11:30
E9G-070219-0-2-01	1907083-9		SOIL	02-Jul-19	12:00
E9G-070219-0-2-99	1907083-10		SOIL	02-Jul-19	12:00
E10G-070219-0-2-ERB	1907083-11		WATER	02-Jul-19	11:45
E17G-070219-0-2-01	1907083-12		SOIL	02-Jul-19	13:50
E17G-070219-0-2-99	1907083-13		SOIL	02-Jul-19	13:50
E16G-070219-0-2-01	1907083-14		SOIL	02-Jul-19	14:20
E16G-070219-0-2-99	1907083-15		SOIL	02-Jul-19	14:20
E16G-070219-0-2-DUP	1907083-16		SOIL	02-Jul-19	14:20
E15G-070219-0-2-01	1907083-17		SOIL	02-Jul-19	15:55
E15G-070219-0-2-99	1907083-18		SOIL	02-Jul-19	15:55



Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.

**ALB WORKORDER #**

of 2 or RETURN  
Y313  
AL508711

[illegible]





**ALS Environmental - Fort Collins**  
**CONDITION OF SAMPLE UPON RECEIPT FORM**

Client: Engineering AnalyticsWorkorder No: 1907083Project Manager: LRSInitials: EEDate: 7/8/19

1. Are airbills / shipping documents present and/or removable?	<input checked="" type="radio"/> YES	<input type="radio"/> NO
2. Are custody seals on <b>shipping</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
3. Are custody seals on <b>sample</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
4. Is there a COC (chain-of-custody) present?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
6. Are short-hold samples present?	<input type="radio"/> YES	<input checked="" type="radio"/> NO
7. Are all samples within holding times for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
8. Were all sample containers received intact? (not broken or leaking)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
9. Is there sufficient sample for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
10. Are all samples in the proper containers for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
12. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	<input checked="" type="radio"/> YES	<input type="radio"/> NO
14. Were the samples shipped on ice?	<input type="radio"/> YES	<input checked="" type="radio"/> NO
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #1 #3 #4	RAD ONLY
Cooler #: <u>1</u>		
Temperature (°C): <u>AMB</u>		
No. of custody seals on cooler: <u>0</u>		
External µR/hr reading: <u>N/A</u>		
Background µR/hr reading: <u>8</u>		
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / <input checked="" type="radio"/> NA (If no, see Form 008.)		

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

All client bottle ID's vs ALS lab ID's double-checked by: EE

If applicable, was the client contacted? YES / NO / NA Contact: \_\_\_\_\_

Date/Time: \_\_\_\_\_

Project Manager Signature / Date: \_\_\_\_\_

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1MB

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1UD

Count Time: 420 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.009 +/- 0.018	0.035	0.2	NA	U
15117-96-1	U-235	-0.002 +/- 0.018	0.027	0.2	NA	U
7440-61-1	U-238	-0.002 +/- 0.015	0.023	0.2	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.429	3.48	pCi/l	78.6	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** UR1907083-1



# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-4MB

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4UDA

Count Time: 420 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.010 +/- 0.011	0.016	0.1	NA	U
15117-96-1	U-235	0 +/- 0.010	0.007	0.1	NA	U
7440-61-1	U-238	-0.0010 +/- 0.0087	0.0133	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	2.214	1.65	pCi/g	74.6	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

Data Package ID: UR1907083-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1LCS

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1UD

Count Time: 420 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
13966-29-5	U-234	4.86 +/- 0.82	0.04	4.220	115	82 - 122	P
7440-61-1	U-238	5.08 +/- 0.86	0.03	4.382	116	78 - 126	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.429	3.56	pCi/l	80.4	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

**Data Package ID:** UR1907083-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190717-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1UD

Count Time: 420 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
13966-29-5	U-234	4.43 +/- 0.75	0.03	4.220	105	82 - 122	P
7440-61-1	U-238	4.67 +/- 0.79	0.02	4.382	107	78 - 126	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.429	4.02	pCi/l	90.8	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: UR1907083-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-4LCS

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4UDA

Count Time: 420 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
13966-29-5	U-234	2.06 +/- 0.37	0.02	2.110	97.5	82 - 122	P
7440-61-1	U-238	2.30 +/- 0.41	0.03	2.191	105	82 - 122	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	2.214	1.40	pCi/g	63.3	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: UR1907083-1

Date Printed: Tuesday, August 13, 2019

ALS -- Fort Collins

LIMS Version: 6.906

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Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins  
Work Order Number: 1907083  
Client Name: Engineering Analytics  
ClientProject ID: Jeffco FLAP 110836a

Field ID:	E1G-070219-0-2-01
Lab ID:	1907083-3DUP

Sample Matrix: SOIL  
Prep SOP: PAI 778 Rev 16  
Date Collected: 02-Jul-19  
Date Prepared: 23-Jul-19  
Date Analyzed: 08-Aug-19  
Prep Batch: AS190723-4  
QCBatchID: AS190723-4-1  
Run ID: AS190723-4UDA  
Count Time: 420 minutes  
Final Aliquot: 1.03 g  
Prep Basis: Dry Weight  
Moisture(%): NA  
Result Units: pCi/g  
File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13966-29-5	U-234	0.68 +/- 0.15		0.04		0.65 +/- 0.16		0.04		0.155	2.13
15117-96-1	U-235	0.048 +/- 0.034		0.039		0.018 +/- 0.031		0.059	U	0.649	2.13
7440-61-1	U-238	0.71 +/- 0.16		0.03		0.68 +/- 0.16		0.04		0.157	2.13

Comments:

Duplicate Qualifiers/Flags:

U - Result is less than the sample specific MDC.  
Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.  
Y2 - Chemical Yield outside default limits.  
W - DER is greater than Warning Limit of 1.42  
D - DER is greater than Control Limit of 2.13  
LT - Result is less than Request MDC, greater than sample specific MDC  
M - Requested MDC not met.  
M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.  
L - LCS Recovery below lower control limit.  
H - LCS Recovery above upper control limit.  
P - LCS, Matrix Spike Recovery within control limits.  
N - Matrix Spike Recovery outside control limits

Abbreviations:  
TPU - Total Propagated Uncertainty  
DER - Duplicate Error Ratio  
BDL - Below Detection Limit  
NR - Not Reported

Data Package ID: UR1907083-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID:	
Lab ID:	AS190717-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 17-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1UD

Count Time: 420 minutes

Final Aliquot: 1000 ml

Prep Basis: Unfiltered

Moisture(%): NA

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13966-29-5	U-234	4.86 +/- 0.82		0.04	P	4.43 +/- 0.75		0.03	P	0.389	2.13
7440-61-1	U-238	5.08 +/- 0.86		0.03	P	4.67 +/- 0.79		0.02	P	0.354	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID:** UR1907083-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E2G-070219-0-2-01

Lab ID: 1907083-1

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4UDA

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.66 +/- 0.15	0.04	0.1	NA	
15117-96-1	U-235	0.020 +/- 0.023	0.034	0.1	NA	U
7440-61-1	U-238	0.66 +/- 0.15	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.197	3.08	pCi/g	73.4	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907083-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E1G-070219-0-2-01

Lab ID: 1907083-3

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4UDA

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.01 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.68 +/- 0.15	0.04	0.1	NA	
15117-96-1	U-235	0.048 +/- 0.034	0.039	0.1	NA	
7440-61-1	U-238	0.71 +/- 0.16	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.387	3.28	pCi/g	74.8	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907083-1



# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Duplicate Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E1G-070219-0-2-01

Lab ID: 1907083-3DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4UDA

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.65 +/- 0.16	0.04	0.1	NA	
15117-96-1	U-235	0.018 +/- 0.031	0.059	0.1	NA	U
7440-61-1	U-238	0.68 +/- 0.16	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.298	2.47	pCi/g	57.4	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907083-1

Date Printed:

Tuesday, August 13, 2019

ALS -- Fort Collins

LIMS Version: 6.906

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# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E6G-070219-0-2-01

Lab ID: 1907083-5

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4UDA

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.67 +/- 0.15	0.02	0.1	NA	
15117-96-1	U-235	0.026 +/- 0.024	0.027	0.1	NA	U
7440-61-1	U-238	0.61 +/- 0.14	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.200	3.15	pCi/g	75.0	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907083-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E10G-070219-0-2-01

Lab ID: 1907083-7

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4UDA

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.08 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.70 +/- 0.15	0.02	0.1	NA	
15117-96-1	U-235	0.030 +/- 0.025	0.026	0.1	NA	
7440-61-1	U-238	0.71 +/- 0.16	0.02	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.106	3.10	pCi/g	75.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907083-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E9G-070219-0-2-01

Lab ID: 1907083-9

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4UDA

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.81 +/- 0.17	0.03	0.1	NA	
15117-96-1	U-235	0.043 +/- 0.029	0.013	0.1	NA	
7440-61-1	U-238	0.77 +/- 0.17	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.216	3.48	pCi/g	82.5	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907083-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E10G-070219-0-2-ERB

Lab ID: 1907083-11

Sample Matrix: WATER

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 17-Jul-19

Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1

QCBatchID: AS190717-1-1

Run ID: AS190717-1UD

Count Time: 420 minutes

Report Basis: Unfiltered

Final Aliquot: 1000 ml

Prep Basis: Unfiltered

Moisture(%): NA

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.034 +/- 0.029	0.040	0.2	NA	U
15117-96-1	U-235	0.021 +/- 0.023	0.035	0.2	NA	U
7440-61-1	U-238	0.012 +/- 0.018	0.034	0.2	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.429	3.29	pCi/l	74.3	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907083-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E17G-070219-0-2-01

Lab ID: 1907083-12

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 09-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4UDA

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.01 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.82 +/- 0.18	0.02	0.1	NA	
15117-96-1	U-235	0.039 +/- 0.030	0.029	0.1	NA	
7440-61-1	U-238	0.78 +/- 0.17	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.362	3.17	pCi/g	72.7	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907083-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E16G-070219-0-2-01

Lab ID: 1907083-14

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4UDA

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.02 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.87 +/- 0.19	0.04	0.1	NA	
15117-96-1	U-235	0.058 +/- 0.038	0.036	0.1	NA	
7440-61-1	U-238	0.96 +/- 0.20	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.347	3.31	pCi/g	76.2	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907083-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E16G-070219-0-2-DUP

Lab ID: 1907083-16

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4UDA

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.80 +/- 0.17	0.03	0.1	NA	
15117-96-1	U-235	0.034 +/- 0.028	0.033	0.1	NA	
7440-61-1	U-238	0.70 +/- 0.16	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.307	3.65	pCi/g	84.6	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907083-1



# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907083

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E15G-070219-0-2-01

Lab ID: 1907083-17

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-4

QCBatchID: AS190723-4-1

Run ID: AS190723-4UDA

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.73 +/- 0.17	0.04	0.1	NA	
15117-96-1	U-235	0.029 +/- 0.026	0.030	0.1	NA	U
7440-61-1	U-238	0.79 +/- 0.17	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.234	3.21	pCi/g	75.9	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907083-1

**APPENDIX B.4**  
**ALS LABORATORY REPORT**  
**WORK ORDER NUMBER 1907103 ACID DIGESTION**



Pages containing results for 2-4, 4-6, 6-8, 8-10 and 10-12-inch depth samples have been removed from this file and are reported elsewhere.

## Isotopic Americium Case Narrative

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### Engineering Analytics

Jeffco FLAP – 110836a


Work Order Number: 1907103

1. This report consists of the analytical results for 18 soil samples received by ALS on 07/05/2019.
2. The soil samples were prepared according to the current revisions of SOP 736, SOP 773, SOP 778, and SOP 75. The soil samples in this report did not undergo the fusion procedure, SOP768.
3. The samples were analyzed for the presence of  $^{241}\text{Am}$  according to the current revision of SOP 714. The analyses were completed on 08/23/2019.
4. The analysis results for the soil samples are reported on a 'Dry Weight' basis in units of pCi/gram.
5. No anomalous situations were encountered during the preparation or analysis of these samples. All quality control criteria were met.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

  
Jean Anderson  
Radiochemistry Primary Data Reviewer

8/24/19  
Date

  
Radiochemistry Final Data Reviewer

8/24/19  
Date

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

**OrderNum:** 1907103

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
E13G-070319-0-2-01	1907103-1		SOIL	03-Jul-19	8:40
E13G-070319-0-2-99	1907103-2		SOIL	03-Jul-19	8:40
E14G-070319-0-2-01	1907103-3		SOIL	03-Jul-19	9:00
E14G-070319-0-2-99	1907103-4		SOIL	03-Jul-19	9:00
E11G-070319-0-2-01	1907103-5		SOIL	03-Jul-19	14:00
E11G-070319-0-2-99	1907103-6		SOIL	03-Jul-19	14:00
E8G-070319-0-2-01	1907103-7		SOIL	03-Jul-19	14:15
E8G-070319-0-2-99	1907103-8		SOIL	03-Jul-19	14:15
E5G-070319-0-2-01	1907103-9		SOIL	03-Jul-19	15:30
E5G-070319-0-2-99	1907103-10		SOIL	03-Jul-19	15:30
E7G-070319-0-2-01	1907103-11		SOIL	03-Jul-19	15:40
E7G-070319-0-2-99	1907103-12		SOIL	03-Jul-19	15:40
E12G-070319-0-2-01	1907103-13		SOIL	03-Jul-19	9:20
E12G-070319-0-2-99	1907103-14		SOIL	03-Jul-19	9:20
E12G-070319-2-4-01	1907103-15		SOIL	03-Jul-19	9:30
E12G-070319-2-4-99	1907103-16		SOIL	03-Jul-19	9:30
E12G-070319-4-6-01	1907103-17		SOIL	03-Jul-19	10:00
E12G-070319-4-6-99	1907103-18		SOIL	03-Jul-19	10:00
E12G-070319-6-8-01	1907103-19		SOIL	03-Jul-19	10:18
E12G-070319-6-8-99	1907103-20		SOIL	03-Jul-19	10:18
E12G-070319-8-10-01	1907103-21		SOIL	03-Jul-19	10:40
E12G-070319-8-10-99	1907103-22		SOIL	03-Jul-19	10:40
E12G-070319-10-12-01	1907103-23		SOIL	03-Jul-19	11:00
E12G-070319-10-12-99	1907103-24		SOIL	03-Jul-19	11:00
E4G-070319-0-2-01	1907103-25		SOIL	03-Jul-19	11:25
E4G-070319-0-2-99	1907103-26		SOIL	03-Jul-19	11:25
E4G-070319-2-4-01	1907103-27		SOIL	03-Jul-19	11:35
E4G-070319-2-4-99	1907103-28		SOIL	03-Jul-19	11:35
E4G-070319-4-6-01	1907103-29		SOIL	03-Jul-19	11:50
E4G-070319-4-6-99	1907103-30		SOIL	03-Jul-19	11:50

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

---

**OrderNum:** 1907103

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**

---

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
E4G-070319-6-8-01	1907103-31		SOIL	03-Jul-19	12:00
E4G-070319-6-8-99	1907103-32		SOIL	03-Jul-19	12:00
E4G-070319-8-10-01	1907103-33		SOIL	03-Jul-19	12:25
E4G-070319-8-10-99	1907103-34		SOIL	03-Jul-19	12:25
E4G-070319-10-12-01	1907103-35		SOIL	03-Jul-19	12:45
E4G-070319-10-12-99	1907103-36		SOIL	03-Jul-19	12:45



# ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
TF: (800) 443-1511 PH: (970) 480-1511 FX: (970) 480-1522

# Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

ALS WORKORDER #	1907103
PAGE	1 of 3
DISPOSAL	BY LAB or RETURN

PROJECT NAME	Jeffco FLAP	TURNAROUND TIME	STD	SAMPLER	IS, SK
PROJECT NO.	1108364	SITE ID			
COMPANY NAME	Engineering Analytics	EDD FORMAT			
SEND REPORT TO	Jason Andrews	PURCHASE ORDER			
ADDRESS	1600 Specht Point Rd	BILL TO COMPANY	Jeffco		
CITY/STATE/ZIP	Fort Collins CO 80525	INVOICE ATTN TO	Same		
PHONE	970 498 3111	ADDRESS			
FAX		CITY/STATE/ZIP			
E-MAIL	J.Andrews@enganalytics.com	PHONE			
		FAX			
		E-MAIL			

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
1	E13G-070319-0-2-01	S	7/31/19	0840	1	None		X	X	X								HOLD
2	E13G-070319-0-2-99			0840				X	X	X								HOLD
3	E14G-070319-0-2-01			0900														
4	E14G-070319-0-2-99			0700														HOLD
5	E11G-070315-0-2-01			1400	2			X	X	X								HOLD
6	E11G-070319-0-2-99			1400	1			X	X	X								HOLD
7	E8G-070319-0-2-01			1415	2			X	X	X								HOLD
8	E8G-070319-0-2-99			1415	1													HOLD
9	E9G-070319-0-2-01			1530	2			X	X	X								HOLD
10	E9G-070319-0-2-99			1530	1													HOLD
11	E7G-070319-0-2-01			1540	1			X	X	X								HOLD
12	E7G-070319-0-2-99			1540	1													HOLD

Time Zone (Circle): EST CST (MST) PST		Matrix: O = oil S = soil NS = non-sol solid W = water L = liquid E = extract F = fiber		Form 2029	
RELINQUISHED BY	SIGNATURE	PRINTED NAME	DATE	TIME	
RECEIVED BY	<i>[Signature]</i>	Jan Stokli	7/29/19	1150	
RELINQUISHED BY	<i>[Signature]</i>	Eric Evans	7/29/19	1150	
RECEIVED BY					
RELINQUISHED BY					
RECEIVED BY					
PRESERVATION KEY	1-HCl 2-HNO3 3-H2SO4 4-HNOH 5-NaOH 6-NaOH/NaAcetate 7-J-Cl 8-Other				

REPORT LEVEL / QC REQUIRED	Summary (Standard QC)	LEVEL II (Standard QC)	LEVEL III (Std QC + form)	LEVEL IV (Std QC + form + raw)

Hold an -99 samples for Archive

4 of 33



2225 Commerce Drive, Fort Collins, Colorado 80524  
 Tel: (800) 443-1511 PH: (970) 480-1511 FX: (970) 480-1511

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.

[illegible]





**ALS Environmental - Fort Collins**  
**CONDITION OF SAMPLE UPON RECEIPT FORM**

Client: Engineering AnalyticsWorkorder No: 1907103Project Manager: LRSInitials: EEDate: 7/5/19

1. Are airbills / shipping documents present and/or removable?	<input checked="" type="radio"/> YES	<input type="radio"/> NO
2. Are custody seals on <b>shipping</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
3. Are custody seals on <b>sample</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
4. Is there a COC (chain-of-custody) present?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
6. Are short-hold samples present?	<input type="radio"/> YES	<input checked="" type="radio"/> NO *
7. Are all samples within holding times for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
8. Were all sample containers received intact? (not broken or leaking)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
9. Is there sufficient sample for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
10. Are all samples in the proper containers for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
12. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	<input checked="" type="radio"/> YES	<input type="radio"/> NO
14. Were the samples shipped on ice?	<input type="radio"/> YES	<input checked="" type="radio"/> NO *
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #1 #3 #4	RAD ONLY YES NO
Cooler #: <u>1</u> <u>2</u>		
Temperature (°C): <u>AMB</u> <u>AMB</u>		
No. of custody seals on cooler: <u>0</u> <u>0</u>		
External µR/hr reading: <u>N/A</u> <u>N/A</u>		
Background µR/hr reading: <u>10</u>		
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / <u>NA</u> (If no, see Form 008.)		

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

All client bottle ID's vs ALS lab ID's double-checked by: EE

If applicable, was the client contacted? YES / NO / NA Contact: \_\_\_\_\_ Date/Time: \_\_\_\_\_

Project Manager Signature / Date: \_\_\_\_\_

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-5MB

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 22-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5AM

Count Time: 1000 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	-0.0040 +/- 0.0054	0.0128	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	1.135	1.04	pCi/g	91.8	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** AM1907103-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-6MB

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 11-Aug-19

Prep Batch: AS190723-6

QCBatchID: AS190723-6-2

Run ID: AS190723-6AM

Count Time: 1000 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.0011 +/- 0.0065	0.0125	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	1.135	0.98	pCi/g	86.2	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** AM1907103-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-5LCS

Sample Matrix: SOIL

Prep Batch: AS190723-5

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS190723-5-1

Result Units: pCi/g

Date Collected: 23-Jul-19

Run ID: AS190723-5AM

File Name: Spectrum #1

Date Prepared: 23-Jul-19

Count Time: 1000 minutes

Date Analyzed: 22-Aug-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14596-10-2	Am-241	2.03 +/- 0.33	0.01	2.467	82.3	67 - 111	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	1.135	1.04	pCi/g	91.5	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: AM1907103-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-6LCS

Sample Matrix: SOIL

Prep Batch: AS190723-6

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS190723-6-2

Result Units: pCi/g

Date Collected: 23-Jul-19

Run ID: AS190723-6AM

File Name: Spectrum #2

Date Prepared: 23-Jul-19

Count Time: 1000 minutes

Date Analyzed: 11-Aug-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14596-10-2	Am-241	2.27 +/- 0.37	0.01	2.467	91.9	67 - 111	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	1.135	1.00	pCi/g	87.9	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: AM1907103-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E5G-070319-0-2-01

Lab ID: 1907103-9DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 22-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5AM

Count Time: 1000 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
14596-10-2	Am-241	0.460 +/-	0.092	0.023		0.482 +/-	0.099	0.005		0.163	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID:** AM1907103-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E4G-070319-4-6-01

Lab ID: 1907103-29DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 11-Aug-19

Prep Batch: AS190723-6

QCBatchID: AS190723-6-2

Run ID: AS190723-6AM

Count Time: 480 minutes

Report Basis: Dry Weight

Final Aliquot: 1.02 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
14596-10-2	Am-241	0.043 +/-	0.027	0.033		0.183 +/-	0.060	0.038		2.1	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID:** AM1907103-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E13G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-5	Final Aliquot: 1.01 g
Lab ID: 1907103-1	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-5-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS190723-5AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 1000 minutes	Result Units: pCi/g
	Date Analyzed: 20-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.57 +/- 0.11	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.242	1.63	pCi/g	72.7	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907103-1**



# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E14G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-5	Final Aliquot: 1.04 g
Lab ID: 1907103-3	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-5-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS190723-5AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 1000 minutes	Result Units: pCi/g
	Date Analyzed: 20-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.88 +/- 0.17	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.187	1.39	pCi/g	63.6	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907103-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E11G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-5	Final Aliquot: 1.02 g
Lab ID: 1907103-5	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-5-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS190723-5AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 1000 minutes	Result Units: pCi/g
	Date Analyzed: 22-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.439 +/- 0.088	0.012	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.226	1.83	pCi/g	82.2	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907103-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E8G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-5	Final Aliquot: 1.03 g
Lab ID: 1907103-7	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-5-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS190723-5AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 1000 minutes	Result Units: pCi/g
	Date Analyzed: 22-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.419 +/- 0.085	0.012	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.215	1.73	pCi/g	77.9	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907103-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E5G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-5	Final Aliquot: 1.05 g
Lab ID: 1907103-9	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-5-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS190723-5AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 1000 minutes	Result Units: pCi/g
	Date Analyzed: 22-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.460 +/- 0.092	0.023	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.154	1.75	pCi/g	81.2	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907103-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Duplicate Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E5G-070319-0-2-01

Lab ID: 1907103-9DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 22-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5AM

Count Time: 1000 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.482 +/- 0.099	0.005	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.168	1.42	pCi/g	65.5	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907103-1

Date Printed:

Saturday, August 24, 2019

ALS -- Fort Collins

LIMS Version: 6.907

Page 1 of 2

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E7G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-5	Final Aliquot: 1.03 g
Lab ID: 1907103-11	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-5-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS190723-5AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 1000 minutes	Result Units: pCi/g
	Date Analyzed: 22-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.50 +/- 0.11	0.02	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.204	1.20	pCi/g	54.5	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907103-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E12G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-5	Final Aliquot: 1.09 g
Lab ID: 1907103-13	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-5-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS190723-5AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 1000 minutes	Result Units: pCi/g
	Date Analyzed: 22-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.316 +/- 0.067	0.004	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.085	1.64	pCi/g	78.7	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907103-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E4G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-5	Final Aliquot: 1.07 g
Lab ID: 1907103-25	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-5-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS190723-5AM	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 1000 minutes	Result Units: pCi/g
	Date Analyzed: 22-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.86 +/- 0.15	0.02	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.120	1.73	pCi/g	81.4	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907103-1**





Pages containing results for 2-4, 4-6, 6-8, 8-10 and 10-12-inch depth samples have been removed from this file and are reported elsewhere.

# Isotopic Plutonium Case Narrative

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## Engineering Analytics

Jeffco FLAP – 110836a

Work Order Number: 1907103

1. This report consists of the analytical results for 18 soil samples received by ALS on 07/05/2019.
2. The soil samples were prepared according to the current revisions of SOP 736, SOP 773, SOP 777, and SOP 778. The soil samples in this report did not undergo the fusion procedure, SOP768.
3. The samples were analyzed for the presence of isotopic plutonium according to the current revision of SOP 714. The analyses were completed on 08/17/2019.
4. The analysis results for the soil samples are reported on a 'Dry Weight' basis in units of pCi/gram.
5. Plutonium-240 is indistinguishable from Plutonium-239. In this report, any plutonium in this region of interest will be reported as Pu-239/240.
6. The duplicate error ratio (DER) for sample 1907103-29 and its duplicate for Pu-239/240 was elevated above the control limit of 2.13 at 3.49. DER is defined as:

$$DER = \frac{|S - D|}{2 * \sqrt{\sigma_s^2 + \sigma_D^2}}$$

Where: S = sample result, D = duplicate result,  $\sigma_s$  = 1 sigma uncertainty of sample result, and  $\sigma_D$  = 1 sigma uncertainty of the duplicate result. The DER for Pu-238 for this sample/duplicate pair is in control. The elevated DER for Pu-239/240 is likely attributable to sample inhomogeneity. Results are submitted with project manager approval.

7. ALS uses the following convention for reporting significant digits in the TPU and MDC results. The TPU value is rounded to two significant digits. The MDC value is rounded to the same decimal place as the TPU value. In practice, this could result in an MDC reported value of zero for samples with significant activity, including the batch laboratory control sample



8. No further anomalous situations were encountered during the preparation or analysis of these samples. All remaining quality control criteria were met.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Pik Yee Yuen  
Pik Yee Yuen  
Radiochemistry Primary Data Reviewer

8/20/19  
Date

James Chen  
Radiochemistry Final Data Reviewer

8/24/19  
Date

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

**OrderNum:** 1907103

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
E13G-070319-0-2-01	1907103-1		SOIL	03-Jul-19	8:40
E13G-070319-0-2-99	1907103-2		SOIL	03-Jul-19	8:40
E14G-070319-0-2-01	1907103-3		SOIL	03-Jul-19	9:00
E14G-070319-0-2-99	1907103-4		SOIL	03-Jul-19	9:00
E11G-070319-0-2-01	1907103-5		SOIL	03-Jul-19	14:00
E11G-070319-0-2-99	1907103-6		SOIL	03-Jul-19	14:00
E8G-070319-0-2-01	1907103-7		SOIL	03-Jul-19	14:15
E8G-070319-0-2-99	1907103-8		SOIL	03-Jul-19	14:15
E5G-070319-0-2-01	1907103-9		SOIL	03-Jul-19	15:30
E5G-070319-0-2-99	1907103-10		SOIL	03-Jul-19	15:30
E7G-070319-0-2-01	1907103-11		SOIL	03-Jul-19	15:40
E7G-070319-0-2-99	1907103-12		SOIL	03-Jul-19	15:40
E12G-070319-0-2-01	1907103-13		SOIL	03-Jul-19	9:20
E12G-070319-0-2-99	1907103-14		SOIL	03-Jul-19	9:20
E12G-070319-2-4-01	1907103-15		SOIL	03-Jul-19	9:30
E12G-070319-2-4-99	1907103-16		SOIL	03-Jul-19	9:30
E12G-070319-4-6-01	1907103-17		SOIL	03-Jul-19	10:00
E12G-070319-4-6-99	1907103-18		SOIL	03-Jul-19	10:00
E12G-070319-6-8-01	1907103-19		SOIL	03-Jul-19	10:18
E12G-070319-6-8-99	1907103-20		SOIL	03-Jul-19	10:18
E12G-070319-8-10-01	1907103-21		SOIL	03-Jul-19	10:40
E12G-070319-8-10-99	1907103-22		SOIL	03-Jul-19	10:40
E12G-070319-10-12-01	1907103-23		SOIL	03-Jul-19	11:00
E12G-070319-10-12-99	1907103-24		SOIL	03-Jul-19	11:00
E4G-070319-0-2-01	1907103-25		SOIL	03-Jul-19	11:25
E4G-070319-0-2-99	1907103-26		SOIL	03-Jul-19	11:25
E4G-070319-2-4-01	1907103-27		SOIL	03-Jul-19	11:35
E4G-070319-2-4-99	1907103-28		SOIL	03-Jul-19	11:35
E4G-070319-4-6-01	1907103-29		SOIL	03-Jul-19	11:50
E4G-070319-4-6-99	1907103-30		SOIL	03-Jul-19	11:50

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

---

**OrderNum:** 1907103

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**

---

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
E4G-070319-6-8-01	1907103-31		SOIL	03-Jul-19	12:00
E4G-070319-6-8-99	1907103-32		SOIL	03-Jul-19	12:00
E4G-070319-8-10-01	1907103-33		SOIL	03-Jul-19	12:25
E4G-070319-8-10-99	1907103-34		SOIL	03-Jul-19	12:25
E4G-070319-10-12-01	1907103-35		SOIL	03-Jul-19	12:45
E4G-070319-10-12-99	1907103-36		SOIL	03-Jul-19	12:45



# ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
TF: (800) 443-1511 PH: (970) 480-1511 FX: (970) 480-1522

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

ALS WORKORDER #	1907103
PAGE	1 of 3
DISPOSAL	BY LAB or RETURN

PROJECT NAME	Jeffco FLAP	TURNAROUND TIME	STD	SAMPLER	IS, SK
PROJECT No.	1108364	SITE ID			
COMPANY NAME	Engineering Analytics	EDD FORMAT			
SEND REPORT TO	Jason Andrews	PURCHASE ORDER			
ADDRESS	1600 Specht Point Rd	BILL TO COMPANY	Jeffco		
CITY/STATE/ZIP	Fort Collins CO 80525	INVOICE ATTN TO	Same		
PHONE	970 498 3111	ADDRESS			
FAX		CITY/STATE/ZIP			
E-MAIL	J.Andrews@enganalytics.com	PHONE			
		FAX			
		E-MAIL			

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
1	E13G-070319-0-2-01	S	7/31/19	0840	1	None		X	X	X								HOLD
2	E13G-070319-0-2-99			0840				X	X	X								HOLD
3	E14G-070319-0-2-01			0900														
4	E14G-070319-0-2-99			0700														HOLD
5	E11G-070315-0-2-01			1400	2			X	X	X								HOLD
6	E11G-070319-0-2-99			1400	1			X	X	X								HOLD
7	E8G-070319-0-2-01			1415	2			X	X	X								HOLD
8	E8G-070319-0-2-99			1415	1													HOLD
9	E5G-070319-0-2-01			1530	2			X	X	X								HOLD
10	E5G-070319-0-2-99			1530	1													HOLD
11	E7G-070319-0-2-01			1540	1			X	X	X								HOLD
12	E7G-070319-0-2-99			1540	1													HOLD

*Time Zone (Circle): EST CST (MST) PST		Matrix: O = oil S = soil NS = non-sol solid W = water L = liquid E = extract F = fiber		Form 2029	
RELINQUISHED BY	SIGNATURE	PRINTED NAME	DATE	TIME	
RECEIVED BY	<i>[Signature]</i>	Jan Stokli	7/29/19	1150	
RELINQUISHED BY	<i>[Signature]</i>	Eric Evans	7/29/19	1150	
RECEIVED BY					
RELINQUISHED BY					
RECEIVED BY					
PRESERVATION KEY	1-HCl 2-HNO3 3-H2SO4 4-HClO4 5-H2O2 6-H2O2/H2O2 7-H2O2/H2O2 8-Other				



# ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

ALS WORKORDER #	
1907103	
PAGE	2 of 3
DISPOSAL	BY LAB or RETURN

TURNAROUND TIME	STD	SAMPLER	ES, SK	PARAMETER/METHOD REQUEST FOR ANALYSIS															
SITE ID	A M-241 ALS SOP-714																		
EDD FORMAT	B PU-238, 239/240 ALS SOP-714																		
PURCHASE ORDER	C U-235, 238, 234 SOP-714																		
BILL TO COMPANY	D																		
INVOICE ATTN TO	E																		
ADDRESS	F																		
CITY/STATE/ZIP	G																		
PHONE	H																		
FAX	I																		
E-MAIL	J																		
LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION	
13	E12G-070319-0-2-01	S	7/3/19	0920	1	None		X	X	X								HOLD	
14	E12G-070319-0-2-99			0920				X	X	X								HOLD	
15	E12G-070319-2-4-01			0930				X	X	X								HOLD	
16	E12G-070319-2-4-99			0930				X	X	X								HOLD	
17	E12G-070319-4-6-01			1000				X	X	X								HOLD	
18	E12G-070319-4-6-99			1000				X	X	X								HOLD	
19	E12G-070319-6-8-01			1018				X	X	X								HOLD	
20	E12G-070319-6-8-99			1018				X	X	X								HOLD	
21	E12G-070319-8-10-01			1040				X	X	X								HOLD	
22	E12G-070319-8-10-99			1040				X	X	X								HOLD	
23	E12G-070319-10-12-01			1100				X	X	X								HOLD	
24	E12G-070319-10-12-99			1100				X	X	X								HOLD	

Time Zone (Circle): EST CST (NST) PST MATR: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = fiber

Form 2022

RELINQUISHED BY: [Signature]

RECEIVED BY: [Signature]

RELINQUISHED BY: [Signature]

RECEIVED BY: [Signature]

RELINQUISHED BY: [Signature]

RECEIVED BY: [Signature]

PRINTED NAME: Dan Stockstill

DATE: 7/8/19

TIME: 1156

PRINTED NAME: Eric Evans

DATE: 7/5/19

TIME: 1150

PROJECT NAME	Jeff FLAP (Broomfield)
PROJECT No.	1083606
COMPANY NAME	Engineering Analytics
SEND REPORT TO	Sean Andrews
ADDRESS	1600 Specht Point Rd
CITY/STATE/ZIP	Fort Collins CO 80525
PHONE	(970)-458-3111
FAX	
E-MAIL	S.Andrews@enganalytics.com

REPORT LEVEL / QC REQUIRED

Summary (Standard QC)

LEVEL II (Standard QC)

LEVEL III (Std QC + form)

LEVEL IV (Std QC + form + raw)

NOTES

Hold all -99 samples for archive

No carb fusion testing

PRESERVATION KEY

1-HQ 2-HQ3 3-HQ4 4-HQ5 5-HQ6 6-HQ7 7-HQ8 8-Other



# ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
Tel: (800) 443-1811 Fax: (970) 480-1511

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

PROJECT NAME		Jeffco FLAP (Broomfield)		ALS WORKORDER #		1907103	
PROJECT NO.		1108364		PAGE		3 of 3	
COMPANY NAME		Engineering Analytics		DISPOSAL		BY LAB or RETURN	
SEND REPORT TO		Jason Andrews		PARAMETER/METHOD REQUEST FOR ANALYSIS			
ADDRESS		1600 Spectra Point Rd Ste 209		A		AM-241 ALS SOP 714	
CITY/STATE/ZIP		Fort Collins CO 80525		B		PU-238, 239/240 ALS SOP 714	
PHONE		(970) 488-3111		C		U-235, 238, 234 ALS SOP 714	
FAX				D			
E-MAIL		J.Andrews@enganalytics.com		E			
				F			
				G			
				H			
				I			
				J			
LAB ID		FIELD ID		MATRIX		SAMPLE DATE	
25		E4G-070319-0-2-01		S		7/3/19	
26		E4G-070319-0-2-99				11:25	
27		E4G-070319-2-4-01				11:35	
28		E4G-070319-2-4-99				11:35	
29		E4G-070319-4-6-01				11:50	
30		E4G-070319-4-6-99				11:50	
31		E4G-070319-6-8-01				12:00	
32		E4G-070319-6-8-99				12:00	
33		E4G-070319-8-10-01				12:25	
34		E4G-070319-8-10-99				12:25	
35		E4G-070319-10-12-01				12:45	
36		E4G-070319-10-12-99				12:45	
TIME ZONE (Circle):		EST CST (MST) PST		Matrix: O = oil S = soil NS = non-sol solid W = water L = liquid E = extract F = filter			
NOTES		Hold all No carb Fusion testing		SIGNATURE		DATE	
-99				RELINQUISHED BY		7/29/19	
Samples				RECEIVED BY		7/25/19	
01				RELINQUISHED BY			
33				RECEIVED BY			
Archive				RELINQUISHED BY			
PRESERVATION KEY		1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaOH/NaAcid 6-NaHSO4 7-4°C 8-Other		PRINTED NAME		TIME	
				Ian Stockdill		1150	
				Eric Evans		180	



**ALS Environmental - Fort Collins**  
**CONDITION OF SAMPLE UPON RECEIPT FORM**

Client: Engineering AnalyticsWorkorder No: 1907103Project Manager: LRSInitials: EEDate: 7/5/19

1. Are airbills / shipping documents present and/or removable?	<input checked="" type="radio"/> YES	<input type="radio"/> NO
2. Are custody seals on <b>shipping</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
3. Are custody seals on <b>sample</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
4. Is there a COC (chain-of-custody) present?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
6. Are short-hold samples present?	<input type="radio"/> YES	<input checked="" type="radio"/> NO
7. Are all samples within holding times for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
8. Were all sample containers received intact? (not broken or leaking)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
9. Is there sufficient sample for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
10. Are all samples in the proper containers for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
12. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	<input checked="" type="radio"/> YES	<input type="radio"/> NO
14. Were the samples shipped on ice?	<input type="radio"/> YES	<input checked="" type="radio"/> NO
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #1 #3 #4	RAD ONLY YES NO
Cooler #: <u>1</u> <u>2</u>		
Temperature (°C): <u>AMB</u> <u>AMB</u>		
No. of custody seals on cooler: <u>0</u> <u>0</u>		
External µR/hr reading: <u>N/A</u> <u>N/A</u>		
Background µR/hr reading: <u>10</u>		
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / <u>NA</u> (If no, see Form 008.)		

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

All client bottle ID's vs ALS lab ID's double-checked by: EE

If applicable, was the client contacted? YES / NO / NA Contact: \_\_\_\_\_ Date/Time: \_\_\_\_\_

Project Manager Signature / Date: \_\_\_\_\_



# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-5MB

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5PU

Count Time: 480 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.0034 +/- 0.0086	0.0133	0.15	NA	U
10-12-8	Pu-239/240	0.012 +/- 0.011	0.013	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	2.304	1.56	pCi/g	67.8	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** PU1907103-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-6MB

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-6

QCBatchID: AS190723-6-2

Run ID: AS190723-6PU

Count Time: 1000 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.0020 +/- 0.0049	0.0073	0.15	NA	U
10-12-8	Pu-239/240	0.0010 +/- 0.0053	0.0107	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	2.304	1.54	pCi/g	66.7	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** PU1907103-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-5LCS

Sample Matrix: SOIL

Prep Batch: AS190723-5

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS190723-5-1

Result Units: pCi/g

Date Collected: 23-Jul-19

Run ID: AS190723-5PU

File Name: Spectrum #1

Date Prepared: 23-Jul-19

Count Time: 480 minutes

Date Analyzed: 17-Aug-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
10-12-8	Pu-239/240	2.65 +/- 0.45	0.02	2.277	116	82 - 118	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	2.304	1.78	pCi/g	77.3	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: PU1907103-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-6LCS

Sample Matrix: SOIL

Prep Batch: AS190723-6

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS190723-6-2

Result Units: pCi/g

Date Collected: 23-Jul-19

Run ID: AS190723-6PU

File Name: Spectrum #1

Date Prepared: 23-Jul-19

Count Time: 1000 minutes

Date Analyzed: 08-Aug-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
10-12-8	Pu-239/240	2.45 +/- 0.39	0	2.277	108	82 - 118	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	2.304	1.58	pCi/g	68.4	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

**Data Package ID:** PU1907103-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E5G-070319-0-2-01

Lab ID: 1907103-9DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5PU

Count Time: 480 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13981-16-3	Pu-238	0.033 +/- 0.026		0.032		0.054 +/- 0.030		0.026		0.526	2.13
10-12-8	Pu-239/240	2.44 +/- 0.44		0.03		3.70 +/- 0.63		0.02		1.64	2.13

### Comments:

#### Duplicate Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

#### Abbreviations:

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

Data Package ID: *PU1907103-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E4G-070319-4-6-01

Lab ID: 1907103-29DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 08-Aug-19

Prep Batch: AS190723-6

QCBatchID: AS190723-6-2

Run ID: AS190723-6PU

Count Time: 1000 minutes

Report Basis: Dry Weight

Final Aliquot: 1.02 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13981-16-3	Pu-238	0.005 +/- 0.013		0.023	U	0.013 +/- 0.013		0.018	U	0.443	2.13
10-12-8	Pu-239/240	0.236 +/- 0.056		0.022		0.76 +/- 0.14		0.01	D	3.49	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID:** *PU1907103-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E13G-070319-0-2-01

Lab ID: 1907103-1

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5PU

Count Time: 480 minutes

Report Basis: Dry Weight

Final Aliquot: 1.01 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.066 +/- 0.037	0.013	0.15	NA	
10-12-8	Pu-239/240	3.23 +/- 0.58	0.01	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.551	2.64	pCi/g	58.0	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907103-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E14G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-5	Final Aliquot: 1.04 g
Lab ID: 1907103-3	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-5-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS190723-5PU	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 480 minutes	Result Units: pCi/g
	Date Analyzed: 17-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.069 +/- 0.035	0.022	0.15	NA	
10-12-8	Pu-239/240	4.10 +/- 0.70	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.440	3.22	pCi/g	72.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: PU1907103-1



# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E11G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS190723-5	Final Aliquot: 1.02 g
Lab ID: 1907103-5	Prep SOP: PAI 778 Rev 16	QCBatchID: AS190723-5-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS190723-5PU	Moisture(%): NA
	Date Prepared: 23-Jul-19	Count Time: 480 minutes	Result Units: pCi/g
	Date Analyzed: 17-Aug-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.056 +/- 0.037	0.015	0.15	NA	
10-12-8	Pu-239/240	2.56 +/- 0.48	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.519	2.17	pCi/g	48.1	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907103-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E8G-070319-0-2-01

Lab ID: 1907103-7

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5PU

Count Time: 480 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.026 +/- 0.020	0.010	0.15	NA	
10-12-8	Pu-239/240	1.73 +/- 0.32	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.496	3.25	pCi/g	72.3	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907103-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E5G-070319-0-2-01

Lab ID: 1907103-9

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5PU

Count Time: 480 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.033 +/- 0.026	0.032	0.15	NA	
10-12-8	Pu-239/240	2.44 +/- 0.44	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.372	3.03	pCi/g	69.2	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907103-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Duplicate Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E5G-070319-0-2-01

Lab ID: 1907103-9DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5PU

Count Time: 480 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.054 +/- 0.030	0.026	0.15	NA	
10-12-8	Pu-239/240	3.70 +/- 0.63	0.02	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.402	3.24	pCi/g	73.5	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: PU1907103-1**

Date Printed:

Tuesday, August 20, 2019

ALS -- Fort Collins

LIMS Version: 6.906

Page 1 of 2

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E7G-070319-0-2-01

Lab ID: 1907103-11

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5PU

Count Time: 480 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.032 +/- 0.029	0.040	0.15	NA	U
10-12-8	Pu-239/240	2.67 +/- 0.49	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.473	2.78	pCi/g	62.2	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907103-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E12G-070319-0-2-01

Lab ID: 1907103-13

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5PU

Count Time: 480 minutes

Report Basis: Dry Weight

Final Aliquot: 1.09 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.058 +/- 0.035	0.032	0.15	NA	
10-12-8	Pu-239/240	2.00 +/- 0.37	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.233	2.68	pCi/g	63.4	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907103-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E4G-070319-0-2-01

Lab ID: 1907103-25

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5PU

Count Time: 480 minutes

Report Basis: Dry Weight

Final Aliquot: 1.07 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.106 +/- 0.044	0.036	0.15	NA	
10-12-8	Pu-239/240	5.98 +/- 0.99	0.01	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.303	3.49	pCi/g	81.2	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907103-1*



Pages containing results for 2-4, 4-6, 6-8, 8-10 and 10-12-inch depth samples have been removed from this file and are reported elsewhere.

# Isotopic Uranium Case Narrative

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## Engineering Analytics

Jeffco FLAP – 110836a

Work Order Number: 1907103

1. This report consists of the analytical results for 18 soil samples received by ALS on 07/05/2019.
2. The soil samples were prepared according to the current revisions of SOP 736, SOP 773, and SOP 778. The soil samples in this report did not undergo the fusion procedure, SOP768.
3. The samples were analyzed for the presence of isotopic uranium according to the current revision of SOP 714. The analyses were completed on 08/17/2019.
4. The analysis results for the soil samples are reported on a 'Dry Weight' basis in units of pCi/gram.
5. This analytical method quantifies U-235 alpha activity in a specific region of interest corresponding to emission energies between those of U-234 and U-238. A potential limitation of this method is that measurable amounts of U-234 in the sample may cause a small amount of characteristic activity in the U-235 region of interest due to poorly resolved alpha activity at the boundary between the two regions. To minimize the potential for a high bias in the U-235 analytical results, the U-235 region of interest has been narrowed and limited to a lower energy region. An 85.1% abundance correction has been made to the final U-235 results.
6. U-235 activity is reported in the associated method blank AS190723-6MB above the minimum detectable concentration value, as indicated with a "B3" qualifier on the final reports. The measured blank activity is below the requested MDC. Results are acceptable according to the current revision of SOP 715 and are submitted without further qualification.
7. No further anomalous situations were encountered during the preparation or analysis of these samples. All remaining quality control criteria were met.





The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Pik Yee Yuen  
Pik Yee Yuen  
Radiochemistry Primary Data Reviewer

8/20/19  
Date

James Chen  
Radiochemistry Final Data Reviewer

8/24/19  
Date

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

**OrderNum:** 1907103

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
E13G-070319-0-2-01	1907103-1		SOIL	03-Jul-19	8:40
E13G-070319-0-2-99	1907103-2		SOIL	03-Jul-19	8:40
E14G-070319-0-2-01	1907103-3		SOIL	03-Jul-19	9:00
E14G-070319-0-2-99	1907103-4		SOIL	03-Jul-19	9:00
E11G-070319-0-2-01	1907103-5		SOIL	03-Jul-19	14:00
E11G-070319-0-2-99	1907103-6		SOIL	03-Jul-19	14:00
E8G-070319-0-2-01	1907103-7		SOIL	03-Jul-19	14:15
E8G-070319-0-2-99	1907103-8		SOIL	03-Jul-19	14:15
E5G-070319-0-2-01	1907103-9		SOIL	03-Jul-19	15:30
E5G-070319-0-2-99	1907103-10		SOIL	03-Jul-19	15:30
E7G-070319-0-2-01	1907103-11		SOIL	03-Jul-19	15:40
E7G-070319-0-2-99	1907103-12		SOIL	03-Jul-19	15:40
E12G-070319-0-2-01	1907103-13		SOIL	03-Jul-19	9:20
E12G-070319-0-2-99	1907103-14		SOIL	03-Jul-19	9:20
E12G-070319-2-4-01	1907103-15		SOIL	03-Jul-19	9:30
E12G-070319-2-4-99	1907103-16		SOIL	03-Jul-19	9:30
E12G-070319-4-6-01	1907103-17		SOIL	03-Jul-19	10:00
E12G-070319-4-6-99	1907103-18		SOIL	03-Jul-19	10:00
E12G-070319-6-8-01	1907103-19		SOIL	03-Jul-19	10:18
E12G-070319-6-8-99	1907103-20		SOIL	03-Jul-19	10:18
E12G-070319-8-10-01	1907103-21		SOIL	03-Jul-19	10:40
E12G-070319-8-10-99	1907103-22		SOIL	03-Jul-19	10:40
E12G-070319-10-12-01	1907103-23		SOIL	03-Jul-19	11:00
E12G-070319-10-12-99	1907103-24		SOIL	03-Jul-19	11:00
E4G-070319-0-2-01	1907103-25		SOIL	03-Jul-19	11:25
E4G-070319-0-2-99	1907103-26		SOIL	03-Jul-19	11:25
E4G-070319-2-4-01	1907103-27		SOIL	03-Jul-19	11:35
E4G-070319-2-4-99	1907103-28		SOIL	03-Jul-19	11:35
E4G-070319-4-6-01	1907103-29		SOIL	03-Jul-19	11:50
E4G-070319-4-6-99	1907103-30		SOIL	03-Jul-19	11:50

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

---

**OrderNum:** 1907103

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**

---

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
E4G-070319-6-8-01	1907103-31		SOIL	03-Jul-19	12:00
E4G-070319-6-8-99	1907103-32		SOIL	03-Jul-19	12:00
E4G-070319-8-10-01	1907103-33		SOIL	03-Jul-19	12:25
E4G-070319-8-10-99	1907103-34		SOIL	03-Jul-19	12:25
E4G-070319-10-12-01	1907103-35		SOIL	03-Jul-19	12:45
E4G-070319-10-12-99	1907103-36		SOIL	03-Jul-19	12:45



# ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
TF: (800) 443-1511 PH: (970) 480-1511 FX: (970) 480-1522

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

ALS WORKORDER #
1907103
PAGE 1 of 3
DISPOSAL BY LAB or RETURN

TURNAROUND TIME	STD	SAMPLER	IS, SK
SITE ID			
EDD FORMAT			
PURCHASE ORDER			
BILL TO COMPANY	Jeffco		
INVOICE ATTN TO	Same		
ADDRESS			
CITY/STATE / ZIP			
PHONE			
FAX			
E-MAIL			

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	PARAMETER/METHOD REQUEST FOR ANALYSIS										SEE NOTES SECTION
								A	B	C	D	E	F	G	H	I	J	
1	E13G-070319-0-2-01	S	7/31/19	0840	1	None		X	X	X								HOLD
2	E13G-070319-0-2-99			0840	1			X	X	X								HOLD
3	E14G-070319-0-2-01			0900	1													
4	E14G-070319-0-2-99			0700	1													HOLD
5	E11G-070315-0-2-01			1400	2			X	X	X								HOLD
6	E11G-070319-0-2-99			1400	1													HOLD
7	E8G-070319-0-2-01			1415	2			X	X	X								HOLD
8	E8G-070319-0-2-99			1415	1													HOLD
9	E5G-070319-0-2-01			1530	2			X	X	X								HOLD
10	E5G-070319-0-2-99			1530	1													HOLD
11	E7G-070319-0-2-01			1540	1			X	X	X								HOLD
12	E7G-070319-0-2-99			1540	1													HOLD

\*Time Zone (Circle): EST CST (MST) PST MSLT: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = fiber

PROJECT NAME	Jeffco FLAP	REPORT LEVEL / QC REQUIRED	Summary (Standard QC)	LEVEL II (Standard QC)	LEVEL III (Std QC + form)	LEVEL IV (Std QC + form + raw)
PROJECT No.	1108364	Hold an -99 samples for Archive				
COMPANY NAME	Engineering Analytics	No carb fusion testing				
SEND REPORT TO	Jason Andrews					
ADDRESS	1600 Specht Point Rd					
CITY/STATE / ZIP	Fort Collins CO 80525					
PHONE	970 498 3111					
FAX						
E-MAIL	J.Andrews@enganalytics.com					
RELINQUISHED BY	RELINQUISHED BY	RELINQUISHED BY	RELINQUISHED BY	RELINQUISHED BY	RELINQUISHED BY	RELINQUISHED BY
RECEIVED BY	RECEIVED BY	RECEIVED BY	RECEIVED BY	RECEIVED BY	RECEIVED BY	RECEIVED BY
SIGNATURE	SIGNATURE	SIGNATURE	SIGNATURE	SIGNATURE	SIGNATURE	SIGNATURE
DATE	DATE	DATE	DATE	DATE	DATE	DATE
TIME	TIME	TIME	TIME	TIME	TIME	TIME

1-HCl 2-HNO3 3-H2SO4 4-HNOH 5-HNOH 6-HNOH 7-HCl 8-Other





# ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
Tel: (800) 443-1811 Fax: (970) 480-1511

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

ALS WORKORDER #  
1907103

PAGE 3 of 3

TURNAROUND TIME  
STD

SAMPLER  
IS, SK

PARAMETER/METHOD REQUEST FOR ANALYSIS

PROJECT NAME  
Jeffco FLAP (Broomfield)

PROJECT NO.  
1108364

COMPANY NAME  
Engineering Analytics

SEND REPORT TO  
Jason Andrews

ADDRESS  
1600 Spectra Point Rd Ste 209

CITY/STATE/ZIP  
Fort Collins CO 80525

PHONE  
(970) 488-3111

FAX

E-MAIL  
J.Andrews@enganalytics.com

EDD FORMAT

PURCHASE ORDER

BILL TO COMPANY  
Broomfield

INVOICE ATTN TO  
Same

CITY/STATE/ZIP

PHONE

FAX

E-MAIL

LAB ID

FIELD ID

25 E4G-070319-0-2-01

26 E4G-070319-0-2-99

27 E4G-070319-2-4-01

28 E4G-070319-2-4-99

29 E4G-070319-4-6-01

30 E4G-070319-4-6-99

31 E4G-070319-6-8-01

32 E4G-070319-6-8-99

33 E4G-070319-8-10-01

34 E4G-070319-8-10-99

35 E4G-070319-10-12-01

36 E4G-070319-10-12-99

MATRIX

SAMPLE DATE

SAMPLE TIME

# OF BOTTLES

PRESERVATIVE

QC

A

B

C

D

E

F

G

H

I

J

SEE NOTES SECTION

25

7/3/19

1125

1

None

X

X

X

X

X

X

X

X

X

X

HOLD

26

1125

X

X

X

X

X

X

X

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X

X

HOLD

27

1135

X

X

X

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HOLD

28

1135

X

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HOLD

29

11:50

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11:50

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HOLD

31

12:00

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33

12:25

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HOLD

34

12:25

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X

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HOLD

35

12:45

X

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X

X

X

X

X

X

X

X

HOLD

36

12:45

X

X

X

X

X

X

X

X

X

X

HOLD

Time Zone (Circle): EST CST MST PST

Matrix: O = oil S = soil NS = non-sol solid W = water L = liquid E = extract F = filter

NOTES

Hold all - 99 samples for Archival

No early fusion testing

REPORT LEVEL / QC REQUIRED

Summary (Standard QC)

LEVEL II (Standard QC)

LEVEL III (Std QC + form)

LEVEL IV (Std QC + form + raw)

PRESERVATION KEY

1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaOH/NaAc 6-NaHSO4 7-4°C 8-Other

RELINQUISHED BY

RECEIVED BY

RELINQUISHED BY

RECEIVED BY

RELINQUISHED BY

RECEIVED BY

SIGNATURE

PRINTED NAME

DATE

TIME

RELINQUISHED BY

RECEIVED BY

RELINQUISHED BY

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RELINQUISHED BY

RECEIVED BY



**ALS Environmental - Fort Collins**  
**CONDITION OF SAMPLE UPON RECEIPT FORM**

Client: Engineering AnalyticsWorkorder No: 1907103Project Manager: LRSInitials: EEDate: 7/5/19

1. Are airbills / shipping documents present and/or removable?	<input checked="" type="radio"/> YES	<input type="radio"/> NO
2. Are custody seals on <b>shipping</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
3. Are custody seals on <b>sample</b> containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
4. Is there a COC (chain-of-custody) present?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
6. Are short-hold samples present?	<input type="radio"/> YES	<input checked="" type="radio"/> NO *
7. Are all samples within holding times for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
8. Were all sample containers received intact? (not broken or leaking)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
9. Is there sufficient sample for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
10. Are all samples in the proper containers for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
12. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	<input checked="" type="radio"/> YES	<input type="radio"/> NO
14. Were the samples shipped on ice?	<input type="radio"/> YES	<input checked="" type="radio"/> NO *
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #1 #3 #4	RAD ONLY YES NO
Cooler #: <u>1</u> <u>2</u>		
Temperature (°C): <u>AMB</u> <u>AMB</u>		
No. of custody seals on cooler: <u>0</u> <u>0</u>		
External µR/hr reading: <u>N/A</u> <u>N/A</u>		
Background µR/hr reading: <u>10</u>		
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / <u>NA</u> (If no, see Form 008.)		

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

All client bottle ID's vs ALS lab ID's double-checked by: EE

If applicable, was the client contacted? YES / NO / NA Contact: \_\_\_\_\_ Date/Time: \_\_\_\_\_

Project Manager Signature / Date: \_\_\_\_\_

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-5MB

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5UR

Count Time: 420 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.009 +/- 0.012	0.020	0.1	NA	U
15117-96-1	U-235	0.006 +/- 0.011	0.008	0.1	NA	U
7440-61-1	U-238	0.0018 +/- 0.0093	0.0195	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	2.213	1.54	pCi/g	69.8	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

Data Package ID: UR1907103-1



# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-6MB

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 10-Aug-19

Prep Batch: AS190723-6

QCBatchID: AS190723-6-2

Run ID: AS190723-6UR

Count Time: 1000 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.0074 +/- 0.0065	0.0089	0.1	NA	U
15117-96-1	U-235	0.0029 +/- 0.0048	0.0026	0.1	NA	B3
7440-61-1	U-238	0.0008 +/- 0.0049	0.0099	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	2.213	1.80	pCi/g	81.5	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** UR1907103-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-5LCS

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5UR

Count Time: 420 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
13966-29-5	U-234	2.26 +/- 0.39	0.02	2.110	107	82 - 122	P
7440-61-1	U-238	2.41 +/- 0.41	0.02	2.191	110	82 - 122	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	2.213	1.74	pCi/g	78.7	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: UR1907103-1

Date Printed: Tuesday, August 20, 2019

ALS -- Fort Collins

LIMS Version: 6.906

Page 1 of 2

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS190723-6LCS

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 23-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 05-Aug-19

Prep Batch: AS190723-6

QCBatchID: AS190723-6-2

Run ID: AS190723-6UR

Count Time: 480 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
13966-29-5	U-234	2.21 +/- 0.37	0.01	2.110	105	82 - 122	P
7440-61-1	U-238	2.22 +/- 0.37	0.02	2.191	101	82 - 122	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	2.214	1.86	pCi/g	84.1	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

**Data Package ID:** UR1907103-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E5G-070319-0-2-01

Lab ID: 1907103-9DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13966-29-5	U-234	0.69 +/- 0.15		0.03		0.79 +/- 0.17		0.02		0.442	2.13
15117-96-1	U-235	0.029 +/- 0.029		0.046	U	0.058 +/- 0.036		0.029		0.631	2.13
7440-61-1	U-238	0.74 +/- 0.16		0.03		0.70 +/- 0.16		0.03		0.186	2.13

### Comments:

#### Duplicate Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

#### Abbreviations:

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

Data Package ID: UR1907103-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E4G-070319-4-6-01

Lab ID: 1907103-29DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 05-Aug-19

Prep Batch: AS190723-6

QCBatchID: AS190723-6-2

Run ID: AS190723-6UR

Count Time: 480 minutes

Report Basis: Dry Weight

Final Aliquot: 1.02 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13966-29-5	U-234	0.68 +/- 0.15		0.03		0.90 +/- 0.18		0.01		0.909	2.13
15117-96-1	U-235	0.055 +/- 0.033		0.012		0.026 +/- 0.023		0.031	U	0.723	2.13
7440-61-1	U-238	0.71 +/- 0.16		0.04		0.77 +/- 0.16		0.03		0.276	2.13

### Comments:

#### Duplicate Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

#### Abbreviations:

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

Data Package ID: UR1907103-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E13G-070319-0-2-01

Lab ID: 1907103-1

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.01 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.91 +/- 0.19	0.03	0.1	NA	
15117-96-1	U-235	0.050 +/- 0.033	0.014	0.1	NA	
7440-61-1	U-238	0.87 +/- 0.19	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.370	3.21	pCi/g	73.3	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907103-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E14G-070319-0-2-01

Lab ID: 1907103-3

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.04 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.93 +/- 0.20	0.05	0.1	NA	
15117-96-1	U-235	0.036 +/- 0.030	0.035	0.1	NA	
7440-61-1	U-238	0.92 +/- 0.20	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.264	3.01	pCi/g	70.7	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907103-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E11G-070319-0-2-01

Lab ID: 1907103-5

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.02 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.76 +/- 0.18	0.05	0.1	NA	
15117-96-1	U-235	0.001 +/- 0.024	0.044	0.1	NA	U
7440-61-1	U-238	0.68 +/- 0.17	0.05	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.339	2.56	pCi/g	59.0	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907103-1



# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E8G-070319-0-2-01

Lab ID: 1907103-7

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.81 +/- 0.18	0.04	0.1	NA	
15117-96-1	U-235	0.048 +/- 0.034	0.039	0.1	NA	
7440-61-1	U-238	0.81 +/- 0.17	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.317	3.18	pCi/g	73.6	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907103-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E5G-070319-0-2-01

Lab ID: 1907103-9

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.69 +/- 0.15	0.03	0.1	NA	
15117-96-1	U-235	0.029 +/- 0.029	0.046	0.1	NA	U
7440-61-1	U-238	0.74 +/- 0.16	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.198	3.03	pCi/g	72.3	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907103-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Duplicate Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E5G-070319-0-2-01

Lab ID: 1907103-9DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.79 +/- 0.17	0.02	0.1	NA	
15117-96-1	U-235	0.058 +/- 0.036	0.029	0.1	NA	
7440-61-1	U-238	0.70 +/- 0.16	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.227	3.01	pCi/g	71.3	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: UR1907103-1**

Date Printed:

Tuesday, August 20, 2019

ALS -- Fort Collins

LIMS Version: 6.906

Page 1 of 2

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E7G-070319-0-2-01

Lab ID: 1907103-11

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.73 +/- 0.16	0.03	0.1	NA	
15117-96-1	U-235	0.060 +/- 0.037	0.030	0.1	NA	
7440-61-1	U-238	0.82 +/- 0.18	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.295	2.96	pCi/g	68.8	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907103-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E12G-070319-0-2-01

Lab ID: 1907103-13

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.09 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.90 +/- 0.19	0.03	0.1	NA	
15117-96-1	U-235	0.039 +/- 0.028	0.013	0.1	NA	
7440-61-1	U-238	0.83 +/- 0.18	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.065	3.12	pCi/g	76.7	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907103-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907103

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E4G-070319-0-2-01

Lab ID: 1907103-25

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 23-Jul-19

Date Analyzed: 17-Aug-19

Prep Batch: AS190723-5

QCBatchID: AS190723-5-1

Run ID: AS190723-5UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.07 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.70 +/- 0.15	0.02	0.1	NA	
15117-96-1	U-235	0.033 +/- 0.026	0.025	0.1	NA	
7440-61-1	U-238	0.69 +/- 0.15	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.132	3.53	pCi/g	85.5	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907103-1

**APPENDIX B.5**  
**ALS LABORATORY REPORT**  
**WORK ORDER NUMBER 1907579 CARBONATE**  
**FUSION**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1909129

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP (RM Greenway) 110836a

Field ID:	E4G-072419-108-114-01
Lab ID:	1909129-17DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 24-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 21-Oct-19

Prep Batch: AS191004-2

QCBatchID: AS191004-2-1

Run ID: AS191004-2AM

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.06 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
14596-10-2	Am-241	-0.023 +/-	0.016	0.056	U	-0.011 +/-	0.024	0.069	U	0.39	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID: AM1909129-1**



# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1909129

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP (RM Greenway) 110836a

Field ID:	E4G-072419-108-114-01
Lab ID:	1909129-17DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 24-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 15-Oct-19

Prep Batch: AS191004-2

QCBatchID: AS191004-2-1

Run ID: AS191004-2PU

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.06 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13981-16-3	Pu-238	0.008 +/- 0.020		0.030	U	-0.001 +/- 0.021		0.044	U	0.338	2.13
10-12-8	Pu-239/240	0.013 +/- 0.020		0.030	U	0.009 +/- 0.021		0.032	U	0.163	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID:** *PU1909129-1*

Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins  
Work Order Number: 1909129  
Client Name: Engineering Analytics  
ClientProject ID: Jeffco FLAP (RM Greenway) 110836a

Field ID:	E4G-072419-108-114-01
Lab ID:	1909129-17DUP

Sample Matrix: SOIL  
Prep SOP: PAI 778 Rev 16  
Date Collected: 24-Jul-19  
Date Prepared: 04-Oct-19  
Date Analyzed: 17-Oct-19  
Prep Batch: AS191004-2  
QCBatchID: AS191004-2-1  
Run ID: AS191004-2UD  
Count Time: 370 minutes  
Report Basis: Dry Weight  
Final Aliquot: 1.06 g  
Prep Basis: Dry Weight  
Moisture(%): NA  
Result Units: pCi/g  
File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13966-29-5	U-234	0.60 +/- 0.14		0.04		0.53 +/- 0.13		0.04		0.336	2.13
15117-96-1	U-235	0.042 +/- 0.030		0.014		0.033 +/- 0.031		0.042	U	0.207	2.13
7440-61-1	U-238	0.59 +/- 0.14		0.03		0.53 +/- 0.13		0.04		0.28	2.13

Comments:

Duplicate Qualifiers/Flags:

U - Result is less than the sample specific MDC.  
Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.  
Y2 - Chemical Yield outside default limits.  
W - DER is greater than Warning Limit of 1.42  
D - DER is greater than Control Limit of 2.13  
LT - Result is less than Request MDC, greater than sample specific MDC  
M - Requested MDC not met.  
M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.  
L - LCS Recovery below lower control limit.  
H - LCS Recovery above upper control limit.  
P - LCS, Matrix Spike Recovery within control limits.  
N - Matrix Spike Recovery outside control limits

Abbreviations:  
TPU - Total Propagated Uncertainty  
DER - Duplicate Error Ratio  
BDL - Below Detection Limit  
NR - Not Reported

Data Package ID: UR1909129-1

**APPENDIX B.6**  
**ALS LABORATORY REPORT**  
**WORK ORDER NUMBER 1907581 CARBONATE**  
**FUSION**



# Isotopic Americium Case Narrative

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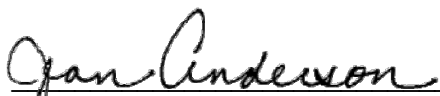
## Engineering Analytics

Jeffco FLAP – 110836a

Work Order Number: 1907083

1. This report consists of the analytical results for nine soil samples sample received by ALS on 07/03/2019. This is a re-log of 1907083.
2. The soil samples were prepared according to the current revisions of SOP 736, SOP 773, SOP 778, and SOP 75. The samples in this report utilized the fusion prep procedure, SOP 768.
3. The samples were analyzed for the presence of  $^{241}\text{Am}$  according to the current revision of SOP 714. The analyses were completed on 10/24/2019.
4. The analysis results for the soil samples are reported on a 'Dry Weight' basis in units of pCi/gram.
5. No anomalous situations were encountered during the preparation or analysis of these samples. All quality control criteria were met.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

  
Jean Anderson  
Radiochemistry Primary Data Reviewer

10/26/19  
Date

  
Radiochemistry Final Data Reviewer

10/31/19  
Date

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

---

**OrderNum:** 1907581**Client Name:** Engineering Analytics**Client Project Name:** Jeffco FLAP**Client Project Number:** 110836a**Client PO Number:**

---

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
E2G-070219-0-2-01	1907581-1		SOIL	02-Jul-19	8:45
E1G-070219-0-2-01	1907581-3		SOIL	02-Jul-19	9:15
E6G-070219-0-2-01	1907581-5		SOIL	02-Jul-19	11:20
E10G-070219-0-2-01	1907581-7		SOIL	02-Jul-19	11:30
E9G-070219-0-2-01	1907581-9		SOIL	02-Jul-19	12:00
E17G-070219-0-2-01	1907581-12		SOIL	02-Jul-19	13:50
E16G-070219-0-2-01	1907581-14		SOIL	02-Jul-19	14:20
E16G-070219-0-2-DUP	1907581-16		SOIL	02-Jul-19	14:20
E15G-070219-0-2-01	1907581-17		SOIL	02-Jul-19	15:55





## ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
 TF: (800) 443-1811 PR: (970) 490-1811 FX: (970) 490-1522

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
 Turnaround time for samples received Saturday will be calculated beginning from the next business day.

ALS WORKORDER #

1907083

Turnaround Time: Std, Sampler: MC, SK

PROJECT NAME: Jeffco FLAP  
 PROJECT NO: 11083602

COMPANY NAME: Engineering Analytics  
 SEND REPORT TO: Jason Andrews  
 ADDRESS: 1400 Specht Point Rd Ste 200  
 CITY / STATE / ZIP: Fort Collins CO 80524  
 PHONE: 970 488 3111  
 FAX:  
 E-MAIL: JAndrews@enganalytics.com

PARAMETER/METHOD REQUEST FOR ANALYSIS

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
12	E176-070219-0-2-01	S	7/19/19	1350	1	None		X	X	X								Hold
13	" " -99			1350				X	X	X								Hold
14	E166-030219-0-2-01			1420				X	X	X								Hold
15	" -99			1420				X	X	X								Hold
16	DUR			1420				X	X	X								Hold
17	E158-070219-0-2-01			1555				X	X	X								Hold
18	" -99			1555				X	X	X								Hold

Form 2009

RELINQUISHED BY: YN call  
 RECEIVED BY: Mike  
 RELINQUISHED BY: EAT Evans  
 RECEIVED BY:  
 RELINQUISHED BY:  
 RECEIVED BY:

PRINTED NAME: Megan Carroll  
 DATE: 7/13/19  
 TIME: 1340

NOTES: No condensate  
 division  
 Hold all  
 6/16/19  
 for future  
 analysis

PRESERVATION KEY: 1-H3 2-H300 3-H2SO4 4-H3OH 5-H3OH/2-H3OH 6-H3OH/3-H3OH 7-4°C 8-Other



ALS Environmental - Fort Collins  
CONDITION OF SAMPLE UPON RECEIPT FORM

1907581

Client: Engineering Analytics  
Project Manager: LPS

Workorder No: 1907083

Initials: EE

Date: 7/3/19

1. Are airbills / shipping documents present and/or removable?	<input checked="" type="radio"/> OFF	YES	NO
2. Are custody seals on shipping containers intact?	<input checked="" type="radio"/> NONE	YES	NO *
3. Are custody seals on sample containers intact?	<input checked="" type="radio"/> NONE	YES	NO *
4. Is there a COC (chain-of-custody) present?		<input checked="" type="radio"/> YES	NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)		<input checked="" type="radio"/> YES	NO *
6. Are short-hold samples present?		YES	<input checked="" type="radio"/> NO
7. Are all samples within holding times for the requested analyses?		<input checked="" type="radio"/> YES	NO *
8. Were all sample containers received intact? (not broken or leaking)		<input checked="" type="radio"/> YES	NO *
9. Is there sufficient sample for the requested analyses?		<input checked="" type="radio"/> YES	NO *
10. Are all samples in the proper containers for the requested analyses?		<input checked="" type="radio"/> YES	NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)	<input checked="" type="radio"/> N/A	YES	NO *
12. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="radio"/> N/A	YES	NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	<input checked="" type="radio"/> N/A	YES	NO
14. Were the samples shipped on ice?		YES	<input checked="" type="radio"/> NO
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #1 #3 #4	RAD ONLY	YES <input checked="" type="radio"/> NO <input checked="" type="radio"/>
Cooler #: <u>1</u>			
Temperature (°C): <u>AMB</u>			
No. of custody seals on cooler: <u>0</u>			
External µR/hr reading: <u>N/A</u>			
Background µR/hr reading: <u>8</u>			
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / <input checked="" type="radio"/> N/A (If no, see Form 008.)			

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

All client bottle ID's vs ALS lab ID's double-checked by: EE

If applicable, was the client contacted? YES / NO / NA Contact: EE

Date/Time: 7/8/19

Project Manager Signature / Date: EE 7/8/19



# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS191002-1MB

Sample Matrix: SOIL

Prep Batch: AS191002-1

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS191002-1-1

Result Units: pCi/g

Date Collected: 02-Oct-19

Run ID: AS191002-1AM

File Name: Spectrum #1

Date Prepared: 02-Oct-19

Count Time: 360 minutes

Date Analyzed: 24-Oct-19

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	-0.0030 +/- 0.0095	0.0276	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.248	2.01	pCi/g	89.6	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID: AM1907581-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS191002-1LCS

Sample Matrix: SOIL

Prep Batch: AS191002-1

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS191002-1-1

Result Units: pCi/g

Date Collected: 02-Oct-19

Run ID: AS191002-1AM

File Name: Spectrum #1

Date Prepared: 02-Oct-19

Count Time: 360 minutes

Date Analyzed: 24-Oct-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14596-10-2	Am-241	2.19 +/- 0.38	0.03	2.466	88.9	67 - 111	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.248	2.10	pCi/g	93.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: AM1907581-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E2G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191002-1	Final Aliquot: 1.03 g
Lab ID: 1907581-1	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191002-1-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS191002-1AM	Moisture(%): NA
	Date Prepared: 02-Oct-19	Count Time: 360 minutes	Result Units: pCi/g
	Date Analyzed: 24-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.62 +/- 0.15	0.06	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.359	3.20	pCi/g	73.4	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907581-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E1G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191002-1	Final Aliquot: 1.04 g
Lab ID: 1907581-3	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191002-1-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS191002-1AM	Moisture(%): NA
	Date Prepared: 02-Oct-19	Count Time: 360 minutes	Result Units: pCi/g
	Date Analyzed: 24-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	1.08 +/- 0.23	0.06	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.323	3.26	pCi/g	75.4	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907581-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E6G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191002-1	Final Aliquot: 1.10 g
Lab ID: 1907581-5	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191002-1-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS191002-1AM	Moisture(%): NA
	Date Prepared: 02-Oct-19	Count Time: 360 minutes	Result Units: pCi/g
	Date Analyzed: 24-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.81 +/- 0.18	0.06	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.099	3.17	pCi/g	77.3	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907581-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E10G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191002-1	Final Aliquot: 1.04 g
Lab ID: 1907581-7	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191002-1-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS191002-1AM	Moisture(%): NA
	Date Prepared: 02-Oct-19	Count Time: 360 minutes	Result Units: pCi/g
	Date Analyzed: 24-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.339 +/- 0.098	0.056	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.313	3.44	pCi/g	79.7	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907581-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E9G-070219-0-2-01

Lab ID: 1907581-9

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 24-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1AM

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	1.11 +/- 0.24	0.06	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.284	3.05	pCi/g	71.1	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907581-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E17G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191002-1	Final Aliquot: 1.07 g
Lab ID: 1907581-12	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191002-1-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS191002-1AM	Moisture(%): NA
	Date Prepared: 02-Oct-19	Count Time: 360 minutes	Result Units: pCi/g
	Date Analyzed: 24-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.38 +/- 0.11	0.06	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.218	3.12	pCi/g	74.0	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907581-1**



# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E16G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191002-1	Final Aliquot: 1.08 g
Lab ID: 1907581-14	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191002-1-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS191002-1AM	Moisture(%): NA
	Date Prepared: 02-Oct-19	Count Time: 360 minutes	Result Units: pCi/g
	Date Analyzed: 24-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.50 +/- 0.13	0.06	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.163	2.84	pCi/g	68.2	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907581-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E16G-070219-0-2-DUP	Sample Matrix: SOIL	Prep Batch: AS191002-1	Final Aliquot: 1.04 g
Lab ID: 1907581-16	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191002-1-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS191002-1AM	Moisture(%): NA
	Date Prepared: 02-Oct-19	Count Time: 360 minutes	Result Units: pCi/g
	Date Analyzed: 24-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.69 +/- 0.16	0.06	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.332	3.15	pCi/g	72.8	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907581-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E15G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191002-1	Final Aliquot: 1.03 g
Lab ID: 1907581-17	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191002-1-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS191002-1AM	Moisture(%): NA
	Date Prepared: 02-Oct-19	Count Time: 360 minutes	Result Units: pCi/g
	Date Analyzed: 24-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	1.74 +/- 0.34	0.07	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.378	3.35	pCi/g	76.5	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907581-1



# Isotopic Plutonium Case Narrative

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## Engineering Analytics

Jeffco FLAP – 110836a

Work Order Number: 1907581

1. This report consists of the analytical results for nine soil samples sample received by ALS on 07/03/2019. This is a re-log of 1907083.
2. The soil samples were prepared according to the current revisions of SOP 736, SOP 773, SOP 777, and SOP 778. The samples in this report utilized the fusion prep procedure, SOP 768.
3. The samples were analyzed for the presence of isotopic plutonium according to the current revision of SOP 714. The analyses were completed on 10/14/2019.
4. The analysis results for the soil samples are reported on a 'Dry Weight' basis in units of pCi/gram.
5. Plutonium-236/240 activity is reported in method blank AS191002-1MB above the minimum detectable concentration value, as indicated with a "B3" qualifier on the final reports. The measured blank activity is below the requested MDC. Results are acceptable according to the current revision of SOP 715, and are submitted without further qualification.
6. Plutonium-240 is indistinguishable from Plutonium-239. In this report, any plutonium in this region of interest will be reported as Pu-239/240.
7. ALS uses the following convention for reporting significant digits in the TPU and MDC results. The TPU value is rounded to two significant digits. The MDC value is rounded to the same decimal place as the TPU value. In practice, this could result in an MDC reported value of zero for samples with significant activity, including the batch laboratory control sample.
8. No further anomalous situations were encountered during the preparation or analysis of these samples. All remaining quality control criteria were met.



The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Jean Anderson  
Jean Anderson  
Radiochemistry Primary Data Reviewer

10/26/19  
Date

Julie Ellison  
Radiochemistry Final Data Reviewer

10/31/19  
Date

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

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**OrderNum:** 1907581

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**

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Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
E2G-070219-0-2-01	1907581-1		SOIL	02-Jul-19	8:45
E1G-070219-0-2-01	1907581-3		SOIL	02-Jul-19	9:15
E6G-070219-0-2-01	1907581-5		SOIL	02-Jul-19	11:20
E10G-070219-0-2-01	1907581-7		SOIL	02-Jul-19	11:30
E9G-070219-0-2-01	1907581-9		SOIL	02-Jul-19	12:00
E17G-070219-0-2-01	1907581-12		SOIL	02-Jul-19	13:50
E16G-070219-0-2-01	1907581-14		SOIL	02-Jul-19	14:20
E16G-070219-0-2-DUP	1907581-16		SOIL	02-Jul-19	14:20
E15G-070219-0-2-01	1907581-17		SOIL	02-Jul-19	15:55

## ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
 Tel: (800) 443-1811 Fax: (970) 480-1822



## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
 Turnaround time for samples received Saturday will be calculated beginning from the next business day.

ALS WORKORDER #

1907083

PROJECT NAME	PROJECT NO.	TURNAROUND TIME	SITE ID	SAMPLER	SKMC	DISPOSAL	PAGE	BY/LAB	OR RETURN
Jeffrey ELAP/STC	1102350						2		
COMPANY NAME	Engineering Analytics								
SEND REPORT TO	Sarah Andrews								
ADDRESS	1000 Spectra Point Dr								
CITY/STATE/ZIP	Fort Collins, CO 80524								
PHONE	970 488 3111								
FAX									
E-MAIL	SAndrews@enganalytics.com								
PURCHASE ORDER									
BILL TO COMPANY									
INVOICE ATTN TO									
ADDRESS									
CITY/STATE/ZIP									
PHONE									
FAX									
E-MAIL									
PARAMETER/METHOD REQUEST FOR ANALYSIS									
A	AM-241								
B	PU-238, 239, 240								
C	U-234, 235, 238								
D	AM 241								
E	PU-238, 239, 240								
F	U-234, 235, 238								
G									
H									
I									
J									

RELINQUISHED BY	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY		Meagan Connell	7/3/19	1345
RECEIVED BY		Eric Davis	7/3/19	1340
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

REPORT LEVEL / OC	REQUIRED
Summary	
Standard OC	
LEVEL I	
Standard OC	
LEVEL II (SM)	
Standard OC	
LEVEL III (SM)	
Standard OC	
LEVEL IV (SM)	
Standard OC	
LEVEL V (SM)	
Standard OC	
OC + form + rse	

NOTES

No card  
 Holding  
 10/1/19  
 Samples  
 10/1/19

Form 2009

L = Liquid E = extract F = filter

2225 Commerce Drive, Fort Collins, Colorado 80524  
 TF: (800) 443-1511 FH: (970) 490-1511 FX: (970) 460-1522

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.

1886061(\*)

ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
TF: (800) 443-1811 PH: (970) 480-1811 FX: (970) 480-1822

Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

(X) 1907083

ALS WORKORDER #

1907083

PROJECT NAME	PROJECT NO.	COMPANY NAME	SEND REPORT TO	ADDRESS	CITY / STATE / ZIP	PHONE	FAX	E-MAIL	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
Jeffco FLAP	1108360A	Engineering Analytics	Susan Andrews	1600 Specht Point Rd Ste 200	Fort Collins CO 80524	970 488 3111		J.Andrews@enganalytics.com	S	7/19/19	1350	1	None		X	X	X								Hold
											1350				X	X	X								Hold
											1420				X	X	X								Hold
											1420				X	X	X								Hold
											1555				X	X	X								Hold
											1555				X	X	X								Hold

Time Zone (Circle)	EST	CST	(MST)	PST	Notes	REPORT LEVEL / QC REQUIRED	Signature	Printed Name	Date	Time
No carbonate suspension					Hold all - 9/9/19 - 10/1/19	Summary (Standard CC) LEVEL II (Standard CC) LEVEL III (Std CC + Ions) LEVEL IV (Std CC + Ions + pH)	[Signature]	Megan Carroll	7/13/19	1340
							[Signature]	Eric Evans	7/13/19	1340

RESERVATION KEY 1-HO 2-HMO 3-HMO4 4-HOH 5-NH<sub>4</sub>/NH<sub>2</sub>-NHS 6-NH<sub>4</sub>-SO<sub>4</sub> 7-PC 8-OH





ALS Environmental - Fort Collins  
CONDITION OF SAMPLE UPON RECEIPT FORM

1907581/

Client: Engineering Analytics  
Project Manager: LPS

Workorder No: 1907083

Initials: EE

Date: 7/3/19

1. Are airbills / shipping documents present and/or removable?	<input checked="" type="radio"/> OFF	YES	NO
2. Are custody seals on shipping containers intact?	<input checked="" type="radio"/> NONE	YES	NO *
3. Are custody seals on sample containers intact?	<input checked="" type="radio"/> NONE	YES	NO *
4. Is there a COC (chain-of-custody) present?		<input checked="" type="radio"/> YES	NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)		<input checked="" type="radio"/> YES	NO *
6. Are short-hold samples present?		YES	<input checked="" type="radio"/> NO
7. Are all samples within holding times for the requested analyses?		<input checked="" type="radio"/> YES	NO *
8. Were all sample containers received intact? (not broken or leaking)		<input checked="" type="radio"/> YES	NO *
9. Is there sufficient sample for the requested analyses?		<input checked="" type="radio"/> YES	NO *
10. Are all samples in the proper containers for the requested analyses?		<input checked="" type="radio"/> YES	NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)	<input checked="" type="radio"/> N/A	YES	NO *
12. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="radio"/> N/A	YES	NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	<input checked="" type="radio"/> N/A	YES	NO
14. Were the samples shipped on ice?		YES	<input checked="" type="radio"/> NO
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #1 #3 #4	RAD ONLY	YES <input checked="" type="radio"/> NO <input checked="" type="radio"/>
Cooler #: <u>1</u>			
Temperature (°C): <u>AMB</u>			
No. of custody seals on cooler: <u>0</u>			
External µR/hr reading: <u>N/A</u>			
Background µR/hr reading: <u>8</u>			
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / <input checked="" type="radio"/> N/A (If no, see Form 008.)			

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

All client bottle ID's vs ALS lab ID's double-checked by: EE

If applicable, was the client contacted? YES / NO / NA Contact: EE

Date/Time: 7/8/19

Project Manager Signature / Date: EE 7/8/19

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS191002-1MB

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Oct-19

Date Prepared: 02-Oct-19

Date Analyzed: 14-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1PU

Count Time: 420 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.014 +/- 0.015	0.023	0.15	NA	U
10-12-8	Pu-239/240	0.020 +/- 0.016	0.009	0.1	NA	B3

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	2.225	1.08	pCi/g	48.6	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

Data Package ID: PU1907581-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS191002-1LCS

Sample Matrix: SOIL

Prep Batch: AS191002-1

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS191002-1-1

Result Units: pCi/g

Date Collected: 02-Oct-19

Run ID: AS191002-1PU

File Name: Spectrum #1

Date Prepared: 02-Oct-19

Count Time: 420 minutes

Date Analyzed: 14-Oct-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
10-12-8	Pu-239/240	2.48 +/- 0.44	0.02	2.277	109	82 - 118	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	2.225	1.26	pCi/g	56.5	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: PU1907581-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E2G-070219-0-2-01

Lab ID: 1907581-1

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 13-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1PU

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.081 +/- 0.042	0.033	0.15	NA	
10-12-8	Pu-239/240	2.74 +/- 0.50	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.314	3.08	pCi/g	71.3	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: PU1907581-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID:	E1G-070219-0-2-01
Lab ID:	1907581-3

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 13-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1PU

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.04 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.087 +/- 0.052	0.055	0.15	NA	
10-12-8	Pu-239/240	6.1 +/- 1.1	0	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.278	2.37	pCi/g	55.5	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907581-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID:	E6G-070219-0-2-01
Lab ID:	1907581-5

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 13-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1PU

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.10 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.069 +/- 0.039	0.027	0.15	NA	
10-12-8	Pu-239/240	4.61 +/- 0.81	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.056	2.66	pCi/g	65.5	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907581-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E10G-070219-0-2-01

Lab ID: 1907581-7

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 13-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1PU

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.04 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.022 +/- 0.023	0.028	0.15	NA	U
10-12-8	Pu-239/240	2.44 +/- 0.45	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.269	2.76	pCi/g	64.7	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907581-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E9G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191002-1	Final Aliquot: 1.05 g
Lab ID: 1907581-9	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191002-1-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS191002-1PU	Moisture(%): NA
	Date Prepared: 02-Oct-19	Count Time: 420 minutes	Result Units: pCi/g
	Date Analyzed: 13-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.095 +/- 0.048	0.040	0.15	NA	
10-12-8	Pu-239/240	6.1 +/- 1.1	0	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.240	2.68	pCi/g	63.3	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907581-1*



# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E17G-070219-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191002-1	Final Aliquot: 1.07 g
Lab ID: 1907581-12	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191002-1-1	Prep Basis: Dry Weight
	Date Collected: 02-Jul-19	Run ID: AS191002-1PU	Moisture(%): NA
	Date Prepared: 02-Oct-19	Count Time: 420 minutes	Result Units: pCi/g
	Date Analyzed: 13-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.045 +/- 0.032	0.038	0.15	NA	
10-12-8	Pu-239/240	1.87 +/- 0.35	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.175	3.05	pCi/g	73.2	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907581-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E16G-070219-0-2-01

Lab ID: 1907581-14

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 13-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1PU

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.08 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.017 +/- 0.020	0.027	0.15	NA	U
10-12-8	Pu-239/240	2.56 +/- 0.47	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.120	2.74	pCi/g	66.5	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907581-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E16G-070219-0-2-DUP

Lab ID: 1907581-16

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 13-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1PU

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.04 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.049 +/- 0.032	0.031	0.15	NA	
10-12-8	Pu-239/240	3.28 +/- 0.58	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.287	3.13	pCi/g	73.0	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907581-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E15G-070219-0-2-01

Lab ID: 1907581-17

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 13-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1PU

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.200 +/- 0.068	0.012	0.15	NA	
10-12-8	Pu-239/240	19.4 +/- 3.2	0	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.332	3.24	pCi/g	74.7	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907581-1*



# Isotopic Uranium Case Narrative

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## Engineering Analytics

Jeffco FLAP – 110836a

Work Order Number: 1907581

1. This report consists of the analytical results for nine soil samples sample received by ALS on 07/03/2019. This is a re-log of 1907083.
2. The soil samples were prepared according to the current revisions of SOP 736, SOP 773, and SOP 778. The samples in this report utilized the fusion prep procedure, SOP 768.
3. The samples were analyzed for the presence of isotopic uranium according to the current revision of SOP 714. The analyses were completed on 10/16/2019.
4. The analysis results for the soil samples are reported on a 'Dry Weight' basis in units of pCi/gram.
5. This analytical method quantifies U-235 alpha activity in a specific region of interest corresponding to emission energies between those of U-234 and U-238. A potential limitation of this method is that measurable amounts of U-234 in the sample may cause a small amount of characteristic activity in the U-235 region of interest due to poorly resolved alpha activity at the boundary between the two regions. To minimize the potential for a high bias in the U-235 analytical results, the U-235 region of interest has been narrowed and limited to a lower energy region. An 85.1% abundance correction has been made to the final U-235 results.
6. Uranium-238 activity is reported in method blank AS191002-1MB above the minimum detectable concentration value, as indicated with a "B3" qualifier on the final reports. The measured blank activity is below the requested MDC. Results are acceptable according to the current revision of SOP 715, and are submitted without further qualification.
7. No further anomalous situations were encountered during the preparation or analysis of these samples. All remaining quality control criteria were met.



The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Jean Anderson  
Jean Anderson  
Radiochemistry Primary Data Reviewer

10/26/19  
Date

Julie Ellze  
Radiochemistry Final Data Reviewer

10/31/19  
Date

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

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**OrderNum:** 1907581

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**

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Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
E2G-070219-0-2-01	1907581-1		SOIL	02-Jul-19	8:45
E1G-070219-0-2-01	1907581-3		SOIL	02-Jul-19	9:15
E6G-070219-0-2-01	1907581-5		SOIL	02-Jul-19	11:20
E10G-070219-0-2-01	1907581-7		SOIL	02-Jul-19	11:30
E9G-070219-0-2-01	1907581-9		SOIL	02-Jul-19	12:00
E17G-070219-0-2-01	1907581-12		SOIL	02-Jul-19	13:50
E16G-070219-0-2-01	1907581-14		SOIL	02-Jul-19	14:20
E16G-070219-0-2-DUP	1907581-16		SOIL	02-Jul-19	14:20
E15G-070219-0-2-01	1907581-17		SOIL	02-Jul-19	15:55

## ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
 Tel: (970) 443-1811 Fax: (970) 440-1822



## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
 Turnaround time for samples received Saturday will be calculated beginning from the next business day.

ALS WORKORDER #

1907083

PROJECT NAME	PROJECT NO.	TURNAROUND TIME	SITE ID	SAMPLER	SKMC	DISPOSAL	PAGE	BY/LAB	OR RETURN
Jeffrey ELAP/STC	1102350						2		
COMPANY NAME	Engineering Analytics								
SEND REPORT TO	Sarah Andrews								
ADDRESS	1000 Spectra Point Dr								
CITY/STATE/ZIP	Fort Collins, CO 80524								
PHONE	970 488 3111								
FAX									
E-MAIL	SAndrews@enganalytics.com								
PURCHASE ORDER									
BILL TO COMPANY									
INVOICE ATTN TO									
ADDRESS									
CITY/STATE/ZIP									
PHONE									
FAX									
E-MAIL									

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
1	E25-070219-0-2-01	S	7/21/19	0845	1	None		X	X	X								
2	99			0845														Hold
3	E15-070219-0-2-01			0915				X	X	X								
4	99			0915														Hold
5	E15-070219-0-2-01			0915				X	X	X								
6	E15-070219-0-2-01			1120				X	X	X								
7	E10G-170219-0-2-01			1120														Hold
8	0-2-99			1130				X	X	X								
9	E9G-070219-0-2-01			1200				X	X	X								Hold
10	99			1200														Hold
11	E10G-070219-0-2-01	W		1145	3	HNO3					X	X	X					

RELINQUISHED BY	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY	<i>[Signature]</i>	Meagan Connell	7/31/19	1345
RECEIVED BY	<i>[Signature]</i>	Eric Davis	7/31/19	1340
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

REPORT LEVEL / QC	REQUIRED
Summary	
Standard OC	
LEVEL I	
Standard OC	
LEVEL II (SM)	
Standard OC	
LEVEL III (SM)	
Standard OC	
LEVEL IV (SM)	
Standard OC	
LEVEL V (SM)	
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LEVEL XLV (SM)	
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LEVEL XLVII (SM)	
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LEVEL XLVIII (SM)	
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LEVEL XLIX (SM)	
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LEVEL LI (SM)	
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LEVEL LII (SM)	
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LEVEL LIII (SM)	
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## ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
 TF: (800) 443-1811 PR: (970) 490-1811 FX: (970) 490-1822

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
 Turnaround time for samples received Saturday will be calculated beginning from the next business day.

ALS WORKORDER #

1907083

Turnaround Time: Std, Sampler: MC, SK

PROJECT NAME: Jeffco FLAP  
 PROJECT NO: 11083602

COMPANY NAME: Engineering Analytics  
 SEND REPORT TO: Jason Andrews  
 ADDRESS: 1400 Specht Point Rd Ste 200  
 CITY / STATE / ZIP: Fort Collins CO 80524  
 PHONE: 970 488 3111  
 FAX:  
 E-MAIL: JAndrews@enganalytics.com

PARAMETER/METHOD REQUEST FOR ANALYSIS

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
12	E176-070219-0-2-01	S	7/19/19	1350	1	None		X	X	X								Hold
13	" " -99			1350				X	X	X								Hold
14	E116G-030219-0-2-01			1420				X	X	X								Hold
15	" -99			1420				X	X	X								Hold
16	DUR			1420				X	X	X								Hold
17	E158-070219-0-2-01			1555				X	X	X								Hold
18	" -99			1555				X	X	X								Hold

Form 2009

RELINQUISHED BY: YN call  
 RECEIVED BY: Mike  
 RELINQUISHED BY: Megan Carroll  
 RECEIVED BY: Eric Evans

DATE: 7/13/19  
 TIME: 1340

REPORT LEVEL / QC REQUIRED

Summary (Standard QC)  
 LEVEL II (Standard QC)  
 LEVEL III (RM QC + forms)  
 LEVEL IV (RM QC + forms + raw)

NOTES: No condensate  
 Division  
 Hold all samples for 24 hours

PRESERVATION KEY: 1-HCl 2-HNO3 3-H2SO4 4-HNO3 5-HNO3/Ascorbic 6-HNO3 7-4°C 8-Other



ALS Environmental - Fort Collins  
CONDITION OF SAMPLE UPON RECEIPT FORM

1907581

Client: Engineering Analytics

Workorder No: 1907083

Project Manager: LPS

Initials: EE

Date: 7/3/19

1. Are airbills / shipping documents present and/or removable?	<input checked="" type="radio"/> YES	<input type="radio"/> NO
2. Are custody seals on shipping containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
3. Are custody seals on sample containers intact?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
4. Is there a COC (chain-of-custody) present?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
6. Are short-hold samples present?	<input type="radio"/> YES	<input checked="" type="radio"/> NO
7. Are all samples within holding times for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
8. Were all sample containers received intact? (not broken or leaking)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
9. Is there sufficient sample for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
10. Are all samples in the proper containers for the requested analyses?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
12. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="radio"/> YES	<input type="radio"/> NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	<input checked="" type="radio"/> YES	<input type="radio"/> NO
14. Were the samples shipped on ice?	<input type="radio"/> YES	<input checked="" type="radio"/> NO
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #1 #3 #4	RAD ONLY YES <input checked="" type="radio"/> NO <input type="radio"/>
Cooler #: <u>1</u>		
Temperature (°C): <u>AMB</u>		
No. of custody seals on cooler: <u>0</u>		
External µR/hr reading: <u>N/A</u>		
Background µR/hr reading: <u>8</u>		
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / <input checked="" type="radio"/> N/A (If no, see Form 008.)		

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

All client bottle ID's vs ALS lab ID's double-checked by: EE

If applicable, was the client contacted? YES / NO / NA Contact: EE

Date/Time: 7/8/19

Project Manager Signature / Date: EE 7/8/19

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS191002-1MB

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Oct-19

Date Prepared: 02-Oct-19

Date Analyzed: 16-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1UR

Count Time: 420 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.016 +/- 0.014	0.019	0.1	NA	U
15117-96-1	U-235	0 +/- 0.011	0.008	0.1	NA	U
7440-61-1	U-238	0.0073 +/- 0.0092	0.0066	0.1	NA	B3

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	2.287	1.68	pCi/g	73.3	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** UR1907581-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS191002-1LCS

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Oct-19

Date Prepared: 02-Oct-19

Date Analyzed: 16-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1UR

Count Time: 420 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
13966-29-5	U-234	2.09 +/- 0.36	0.02	2.110	98.9	82 - 122	P
7440-61-1	U-238	2.26 +/- 0.39	0.01	2.191	103	82 - 122	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	2.287	1.86	pCi/g	81.4	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: UR1907581-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E2G-070219-0-2-01

Lab ID: 1907581-1

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 16-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.90 +/- 0.19	0.03	0.1	NA	
15117-96-1	U-235	0.016 +/- 0.021	0.035	0.1	NA	U
7440-61-1	U-238	0.88 +/- 0.19	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.436	3.27	pCi/g	73.7	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907581-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E1G-070219-0-2-01

Lab ID: 1907581-3

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 16-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.04 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	1.15 +/- 0.25	0.06	0.1	NA	
15117-96-1	U-235	0.036 +/- 0.036	0.049	0.1	NA	U
7440-61-1	U-238	1.11 +/- 0.25	0.07	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.398	2.19	pCi/g	49.8	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907581-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E6G-070219-0-2-01

Lab ID: 1907581-5

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 16-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.10 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	1.05 +/- 0.21	0.05	0.1	NA	
15117-96-1	U-235	0.064 +/- 0.036	0.012	0.1	NA	
7440-61-1	U-238	1.13 +/- 0.23	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.171	3.07	pCi/g	73.7	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907581-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E10G-070219-0-2-01

Lab ID: 1907581-7

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 16-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.04 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	1.06 +/- 0.22	0.03	0.1	NA	
15117-96-1	U-235	0.033 +/- 0.027	0.015	0.1	NA	
7440-61-1	U-238	1.23 +/- 0.25	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.389	2.90	pCi/g	66.0	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907581-1



# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E9G-070219-0-2-01

Lab ID: 1907581-9

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 16-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.05 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	1.11 +/- 0.23	0.01	0.1	NA	
15117-96-1	U-235	0.047 +/- 0.034	0.031	0.1	NA	
7440-61-1	U-238	1.10 +/- 0.23	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.359	2.86	pCi/g	65.7	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907581-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E17G-070219-0-2-01

Lab ID: 1907581-12

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 16-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.07 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	1.17 +/- 0.23	0.03	0.1	NA	
15117-96-1	U-235	0.060 +/- 0.035	0.013	0.1	NA	
7440-61-1	U-238	1.05 +/- 0.21	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.292	3.27	pCi/g	76.1	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907581-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E16G-070219-0-2-01

Lab ID: 1907581-14

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 16-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.08 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.97 +/- 0.20	0.02	0.1	NA	
15117-96-1	U-235	0.064 +/- 0.037	0.013	0.1	NA	
7440-61-1	U-238	1.10 +/- 0.22	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.236	2.91	pCi/g	68.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907581-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E16G-070219-0-2-DUP

Lab ID: 1907581-16

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 16-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.04 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	1.12 +/- 0.23	0.03	0.1	NA	
15117-96-1	U-235	0.079 +/- 0.041	0.013	0.1	NA	
7440-61-1	U-238	1.03 +/- 0.21	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.408	3.29	pCi/g	74.7	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907581-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907581

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E15G-070219-0-2-01

Lab ID: 1907581-17

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 02-Jul-19

Date Prepared: 02-Oct-19

Date Analyzed: 16-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	1.15 +/- 0.23	0.03	0.1	NA	
15117-96-1	U-235	0.030 +/- 0.025	0.013	0.1	NA	
7440-61-1	U-238	1.20 +/- 0.24	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.455	3.31	pCi/g	74.2	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907581-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number:

Client Name:

ClientProject ID:

Field ID: 817+50-0-2-02

Lab ID: 1907602-30DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 19-Jun-19

Date Prepared: 02-Oct-19

Date Analyzed: 24-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1AM

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.09 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
14596-10-2	Am-241	0.015 +/-	0.029	0.059	U	0.069 +/-	0.045	0.063		1.01	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID: AM1907602-1**

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number:

Client Name:

ClientProject ID:

Field ID:	817+50-0-2-02	Sample Matrix:	SOIL	Prep Batch:	AS191002-1	Final Aliquot:	1.09 g
Lab ID:	1907602-30DUP	Prep SOP:	PAI 778 Rev 16	QC Batch ID:	AS191002-1-1	Prep Basis:	Dry Weight
		Date Collected:	19-Jun-19	Run ID:	AS191002-1PU	Moisture(%):	NA
		Date Prepared:	02-Oct-19	Count Time:	420 minutes	Result Units:	pCi/g
		Date Analyzed:	14-Oct-19	Report Basis:	Dry Weight	File Name:	Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13981-16-3	Pu-238	0.013 +/-	0.021	0.038	U	0.007 +/-	0.018	0.027	U	0.212	2.13
10-12-8	Pu-239/240	0.140 +/-	0.057	0.033		0.138 +/-	0.056	0.027		0.0143	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID:** PU1907602-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number:

Client Name:

ClientProject ID:

Field ID: 817+50-0-2-02

Lab ID: 1907602-30DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 19-Jun-19

Date Prepared: 02-Oct-19

Date Analyzed: 16-Oct-19

Prep Batch: AS191002-1

QCBatchID: AS191002-1-1

Run ID: AS191002-1UR

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.09 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13966-29-5	U-234	1.23 +/- 0.26		0.04		1.10 +/- 0.22		0.04		0.384	2.13
15117-96-1	U-235	0.059 +/- 0.039		0.016		0.053 +/- 0.033		0.026		0.127	2.13
7440-61-1	U-238	1.26 +/- 0.26		0.04		1.08 +/- 0.22		0.03		0.544	2.13

### Comments:

**Duplicate Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

**Abbreviations:**

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

**Data Package ID:** UR1907602-1



**APPENDIX B.7**  
**ALS LABORATORY REPORT**  
**WORK ORDER NUMBER 1907579 CARBONATE**  
**FUSION**



Pages containing results for the 2-4, 4-6, 6-8, 8-10 and 10-12 inch depth samples have been removed from this file and are reported elsewhere.

## Isotopic Americium Case Narrative

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### Engineering Analytics

Jeffco FLAP – 110836a

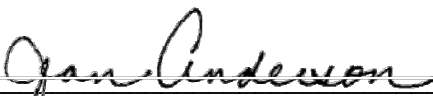
Work Order Number: 1907583

1. This report consists of the analytical results for 18 soil samples received by ALS on 07/05/2019. This is a re-log of 1907103.
2. The soil samples were prepared according to the current revisions of SOP 736, SOP 773, SOP 778, and SOP 75. The samples in this report utilized the fusion prep procedure, SOP 768.
3. The samples were analyzed for the presence of  $^{241}\text{Am}$  according to the current revision of SOP 714. The analyses were completed on 11/17/2019.
4. The analysis results for the soil samples are reported on a 'Dry Weight' basis in units of pCi/gram.
5. Sample 1907583-25 was originally prepared in batch AS191004-1 on 10/04/2019. The sample had a low tracer recovery of 0.48%. This sample was re-prepared in batch AS191104-4 on 11/04/2019. During the re-preparation of the batch, the method blank was flipped when it was mounted. The method blank was sent for a clean-up procedure per QASS #385164. The method blank was re-analyzed on 11/17/2019. All QC criteria were met for the clean-up procedure. The results of the method blank are reported from the clean-up batch analyzed on 11/17/2019 without further qualification.
6. The magnitude of the negative activity for AS191104-4MB is greater than the 2 sigma TPU. The analyst's review of the data does not indicate a problem with the instrument data or the subsequent reporting systems. The negative activity is likely attributable to the blank correction being performed due to Am-241 activity (impurity) seen in method blanks for standard verifications with parent standard ID's #900 and #945. Due to this activity/impurity, 0.43% of the Am-243 tracer counts are subtracted out of the Am-241 region-of-interest (ROI), and added in as additional Am-241 ROI background counts. This blank correction can result in negative counts in the Am-241 ROI, which may result in negative activity greater than the 2 sigma TPU. The data quality is not believed to be significantly affected and the results are submitted without further qualification.

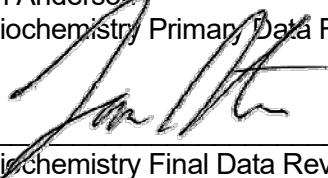


7. No further anomalous situations were encountered during the preparation or analysis of these samples. All remaining quality control criteria were met.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

  
\_\_\_\_\_  
Jean Anderson  
Radiochemistry Primary Data Reviewer

11/19/19  
Date

  
\_\_\_\_\_  
Radiochemistry Final Data Reviewer

11/19/19  
Date

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

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**OrderNum:** 1907583

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**


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Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
E13G-070319-0-2-01	1907583-1		SOIL	03-Jul-19	8:40
E14G-070319-0-2-01	1907583-3		SOIL	03-Jul-19	9:00
E11G-070319-0-2-01	1907583-5		SOIL	03-Jul-19	14:00
E8G-070319-0-2-01	1907583-7		SOIL	03-Jul-19	14:15
E5G-070319-0-2-01	1907583-9		SOIL	03-Jul-19	15:30
E7G-070319-0-2-01	1907583-11		SOIL	03-Jul-19	15:40
E12G-070319-0-2-01	1907583-13		SOIL	03-Jul-19	9:20
E12G-070319-2-4-01	1907583-15		SOIL	03-Jul-19	9:30
E12G-070319-4-6-01	1907583-17		SOIL	03-Jul-19	10:00
E12G-070319-6-8-01	1907583-19		SOIL	03-Jul-19	10:18
E12G-070319-8-10-01	1907583-21		SOIL	03-Jul-19	10:40
E12G-070319-10-12-01	1907583-23		SOIL	03-Jul-19	11:00
E4G-070319-0-2-01	1907583-25		SOIL	03-Jul-19	11:25
E4G-070319-2-4-01	1907583-27		SOIL	03-Jul-19	11:35
E4G-070319-4-6-01	1907583-29		SOIL	03-Jul-19	11:50
E4G-070319-6-8-01	1907583-31		SOIL	03-Jul-19	12:00
E4G-070319-8-10-01	1907583-33		SOIL	03-Jul-19	12:25
E4G-070319-10-12-01	1907583-35		SOIL	03-Jul-19	12:45



# ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
 Tel: (970) 443-1511 Fax: (970) 490-1522

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
 Turnaround time for samples received Saturday will be calculated beginning from the next business day.

PROJECT NAME Jeffco FLAP		TURNAROUND TIME STD		SAMPLER IS, SK		PAGE 1 of 3		ALS WORK ORDER # 1907103	
PROJECT NO. 110836		SITE ID		DISPOSAL		BY LAB		OR RETURN	
PURCHASE ORDER		EDD FORMAT		PARAMETER/METHOD REQUEST FOR ANALYSIS					
BILL TO COMPANY		JEFFCO		A		AM-241		ALS SOP 714	
INVOICE ATTN TO		Same		B		PU-238		239/246 ALS SOP 714	
ADDRESS		1600 Specht Point Rd		C		U-235		238, 234 SOP 714	
CITY/STATE/ZIP		Fort Collins CO 80525		D					
PHONE		970 4258 3111		E					
FAX				F					
E-MAIL		J.Anderson@enganalytix.com		G					
				H					
				I					
				J					

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
1	E136-070319-0-2-01	S	7/31/19	0840	1	None		X	X	X								
2	E136-070319-0-2-99			0840	1			X	X	X								HOLD
3	E146-070319-0-2-01			0900	1			X	X	X								
4	E146-070319-0-2-99			0900	1			X	X	X								HOLD
5	E116-070319-0-2-01			1400	2			X	X	X								
6	E116-070319-0-2-99			1400	1			X	X	X								HOLD
7	E86-070319-0-2-01			1415	2			X	X	X								
8	E86-070319-0-2-99			1415	1			X	X	X								HOLD
9	E96-070319-0-2-01			1530	2			X	X	X								
10	E96-070319-0-2-99			1530	1			X	X	X								HOLD
11	E76-070319-0-2-01			1540	1			X	X	X								
12	E76-070319-0-2-99			1540	1			X	X	X								HOLD

REPORT LEVEL / QC REQUIRED		SIGNATURE		PRINTED NAME		DATE		TIME	
Summary (Standard OC)		E. Anderson		Jon Steckel		7/28/19		1150	
LEVEL II (Standard OC)		E. Anderson		Coke Labs		7/28/19		1150	
LEVEL III (Std OC + Name)									
LEVEL IV (Std OC + Name + Rev)									
RECEIVED BY		RECEIVED BY		RECEIVED BY		RECEIVED BY		RECEIVED BY	
RELINQUISHED BY		RELINQUISHED BY		RELINQUISHED BY		RELINQUISHED BY		RELINQUISHED BY	
RELINQUISHED BY		RELINQUISHED BY		RELINQUISHED BY		RELINQUISHED BY		RELINQUISHED BY	

NOTES	
Hold on -99 samples for Archive	
No carb fusion testing	

4 of 34



# ALS Environmental

228 Commerce Drive, Fort Collins, Colorado 80524  
Tel: (970) 483-1611 Fax: (970) 480-1622

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

PROJECT NAME		Jeffrey FLAP (Broomfield)	
PROJECT No.		108366	
COMPANY NAME		Engineering Analytics	
SEND REPORT TO		Sean Andrews	
ADDRESS		1600 Specht Point Rd	
CITY/STATE/ZIP		Fort Collins CO 80525	
PHONE		(970) 488-3311	
FAX			
E-MAIL		S.Andrews@enganalytics.com	
LAB ID		FIELD ID	
13		E12G-070319-0-2-01	
14		E12G-070319-0-2-99	
15		E12G-070319-2-4-01	
16		E12G-070319-2-4-99	
17		E12G-070319-4-6-01	
18		E12G-070319-4-6-99	
19		E12G-070319-6-8-01	
20		E12G-070319-6-8-99	
21		E12G-070319-8-10-01	
22		E12G-070319-8-10-99	
23		E12G-070319-10-12-01	
24		E12G-070319-10-12-99	
Time Zone (Circle):		EST CST (MST) PST MDT CDT 8 = sol NS = non-sol cells W = water L = liquid E = extract F = filter	

TURNAROUND TIME	STD	SAMPLER	ES, SK
DATE ID			
EDD FORMAT			
PURCHASE ORDER			
BILL TO COMPANY	Broomfield		
INVOICE ATTN TO			
ADDRESS	Same		
CITY/STATE/ZIP			
PHONE			
FAX			
E-MAIL			

PARAMETER/METHOD REQUEST FOR ANALYSIS	
A	AM-241 ALS SOP 7M
B	PJ-238, 239/240 ALS SOP 7M
C	V-235, 238, 234 SOP 7M
D	
E	
F	
G	
H	
I	
J	

MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	OC	A	B	C	D	E	F	G	H	I	J	EX. NOTES SECTION
5	7/13/19	0920	1	None		X	X	X								
		0920														
		0930				X	X	X								Hold
		0930				X	X	X								Hold
		1000				X	X	X								Hold
		1000														
		1018				X	X	X								Hold
		1018														
		1040				X	X	X								Hold
		1040														
		1100				X	X	X								Hold
		1100														

RELINQUISHED BY		SIGNATURE		PRINTED NAME		DATE		TIME	
				Ian Stockell		7/18/19		1156	
RECEIVED BY		SIGNATURE		PRINTED NAME		DATE		TIME	
				Eric Evans		7/18/19		1150	
RELINQUISHED BY		SIGNATURE		PRINTED NAME		DATE		TIME	
RECEIVED BY		SIGNATURE		PRINTED NAME		DATE		TIME	
RELINQUISHED BY		SIGNATURE		PRINTED NAME		DATE		TIME	
RECEIVED BY		SIGNATURE		PRINTED NAME		DATE		TIME	

IMPORT LEVEL / OC REQUIRED	Summary
LEVEL I (Standard OC)	
LEVEL II (Standard OC)	
LEVEL III (Rel OC + Name)	
LEVEL IV (Rel OC + Name + Test)	

1-HO 2-HO 3-HO 4-HO 5-HO 6-HO 7-HO 8-HO 9-HO 10-HO 11-HO 12-HO 13-HO 14-HO 15-HO 16-HO 17-HO 18-HO 19-HO 20-HO 21-HO 22-HO 23-HO 24-HO



# ALS Environmental

225 Cassinette Drive, Fort Collins, Colorado 80524  
Tel: (970) 443-1811 Fax: (970) 443-1811 E-mail: (970) 443-1822

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

PROJECT NAME		Jeffco FLAP (Broomfield)		ALS WORKORDER #		1907103												
PROJECT NO.		1108364		PAGE		3 of 3												
COMPANY NAME		Engineering Analytics		DISPOSAL		BY LAB or RETURN												
SEND REPORT TO		John Andrews		PARAMETER/METHOD REQUEST FOR ANALYSIS														
ADDRESS		1600 Squat Point Rd Ste 209		A		AM-241 ALS SOP 714												
CITY/STATE/ZIP		Fort Collins CO 80525		B		PU-238 238/240 ALS SOP 714												
PHONE		(970) 498-3111		C		U-235, 238, 234 SOP 714												
FAX				D														
E-MAIL		J.Andrews@enganalytics.com		E														
				F														
				G														
				H														
				I														
				J														
LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
(X) 25	E4G-070319-0-2-01	S	7/3/19	11:25	1	None		X	X	X								HOLD
(X) 26	E4G-070319-0-2-99			11:25														
(X) 27	E4G-070319-2-4-01			11:35				X	X	X								HOLD
(X) 28	E4G-070319-2-4-99			11:35				X	X	X								HOLD
(X) 29	E4G-070319-4-6-01			11:50				X	X	X								HOLD
(X) 30	E4G-070319-4-6-99			11:50				X	X	X								HOLD
(X) 31	E4G-070319-6-8-01			12:00				X	X	X								HOLD
(X) 32	E4G-070319-6-8-99			12:00				X	X	X								HOLD
(X) 33	E4G-070319-8-10-01			12:25				X	X	X								HOLD
(X) 34	E4G-070319-8-10-99			12:25				X	X	X								HOLD
(X) 35	E4G-070319-10-12-01			12:45				X	X	X								HOLD
(X) 36	E4G-070319-10-12-99			12:45				X	X	X								HOLD

Time Zone (Circle): EST CST (MST) PST Matrix: 0=all S=all NS=non-aq solid W=water L=liquid E=effluent F=filter

PRESERVATION KEY	1-HI 2-HI 3-HI 4-HI 5-HI 6-HI 7-HI 8-HI 9-HI 10-HI 11-HI 12-HI 13-HI 14-HI 15-HI 16-HI 17-HI 18-HI 19-HI 20-HI 21-HI 22-HI 23-HI 24-HI 25-HI 26-HI 27-HI 28-HI 29-HI 30-HI 31-HI 32-HI 33-HI 34-HI 35-HI 36-HI 37-HI 38-HI 39-HI 40-HI 41-HI 42-HI 43-HI 44-HI 45-HI 46-HI 47-HI 48-HI 49-HI 50-HI 51-HI 52-HI 53-HI 54-HI 55-HI 56-HI 57-HI 58-HI 59-HI 60-HI 61-HI 62-HI 63-HI 64-HI 65-HI 66-HI 67-HI 68-HI 69-HI 70-HI 71-HI 72-HI 73-HI 74-HI 75-HI 76-HI 77-HI 78-HI 79-HI 80-HI 81-HI 82-HI 83-HI 84-HI 85-HI 86-HI 87-HI 88-HI 89-HI 90-HI 91-HI 92-HI 93-HI 94-HI 95-HI 96-HI 97-HI 98-HI 99-HI 100-HI	REPORT LEVEL / QC REQUIRED	RECEIVED BY	SIGNATURE	PRINTED NAME	DATE	TIME	
	Hold all -99 samples for archive	No carb fusion testing	RECEIVED BY	RECEIVED BY	RECEIVED BY	RECEIVED BY	RECEIVED BY	RECEIVED BY

Form 2009



ALS Environmental - Fort Collins  
CONDITION OF SAMPLE UPON RECEIPT FORM

① 1907JF3 /h

Client: Engineering Analytics

Workorder No: 1907103

Project Manager: LPS

Initials: EE

Date: 7/5/19

1. Are airbills / shipping documents present and/or removable?	<input checked="" type="checkbox"/>	YES	NO
2. Are custody seals on <b>shipping</b> containers intact?	<input checked="" type="checkbox"/>	YES	NO *
3. Are custody seals on <b>sample</b> containers intact?	<input checked="" type="checkbox"/>	YES	NO *
4. Is there a COC (chain-of-custody) present?	<input checked="" type="checkbox"/>	YES	NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)	<input checked="" type="checkbox"/>	YES	NO *
6. Are short-hold samples present?	<input checked="" type="checkbox"/>	YES	NO *
7. Are all samples within holding times for the requested analyses?	<input checked="" type="checkbox"/>	YES	NO *
8. Were all sample containers received intact? (not broken or leaking)	<input checked="" type="checkbox"/>	YES	NO *
9. Is there sufficient sample for the requested analyses?	<input checked="" type="checkbox"/>	YES	NO *
10. Are all samples in the proper containers for the requested analyses?	<input checked="" type="checkbox"/>	YES	NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)	<input checked="" type="checkbox"/>	YES	NO *
12. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="checkbox"/>	YES	NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	<input checked="" type="checkbox"/>	YES	NO
14. Were the samples shipped on ice?	<input checked="" type="checkbox"/>	YES	NO *
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #1 #3 #4	RAD ONLY	YES NO
Cooler #: <u>1</u> <u>2</u>			
Temperature (°C): <u>AMB</u> <u>AMB</u>			
No. of custody seals on cooler: <u>0</u> <u>0</u>			
External µR/hr reading: <u>N/A</u> <u>N/A</u>			
Background µR/hr reading: <u>10</u>			
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO <u>(NA)</u> (If no, see Form 008.)			

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

All client bottle ID's vs ALS lab ID's double-checked by: EE

If applicable, was the client contacted? YES / NO / NA Contact: \_\_\_\_\_

Date/Time: \_\_\_\_\_

Project Manager Signature / Date: \_\_\_\_\_



# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS191004-1MB

Sample Matrix: SOIL

Prep Batch: AS191004-1

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS191004-1-1

Result Units: pCi/g

Date Collected: 04-Oct-19

Run ID: AS191004-1C

File Name: Spectrum #1

Date Prepared: 04-Oct-19

Count Time: 420 minutes

Date Analyzed: 17-Oct-19

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	-0.001 +/- 0.010	0.026	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.248	1.89	pCi/g	83.9	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

Data Package ID: AM1907583-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 15

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS191104-4MB

Sample Matrix: SOIL

Prep Batch: AS191104-4

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS191104-4-1

Result Units: pCi/g

Date Collected: 04-Nov-19

Run ID: AS191104-4AM

File Name: Spectrum #1

Date Prepared: 04-Nov-19

Count Time: 1000 minutes

Date Analyzed: 17-Nov-19

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	-0.0097 +/- 0.0077	0.0184	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.248	1.61	pCi/g	71.7	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

Data Package ID: AM1907583-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS191004-1LCS

Sample Matrix: SOIL

Prep Batch: AS191004-1

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS191004-1-1

Result Units: pCi/g

Date Collected: 04-Oct-19

Run ID: AS191004-1C

File Name: Spectrum #1

Date Prepared: 04-Oct-19

Count Time: 420 minutes

Date Analyzed: 17-Oct-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14596-10-2	Am-241	2.18 +/- 0.38	0.03	2.466	88.5	67 - 111	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.248	1.61	pCi/g	71.5	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: AM1907583-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 15

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS191104-4LCS

Sample Matrix: SOIL

Prep Batch: AS191104-4

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS191104-4-1

Result Units: pCi/g

Date Collected: 04-Nov-19

Run ID: AS191104-4AM

File Name: Spectrum #1

Date Prepared: 04-Nov-19

Count Time: 1000 minutes

Date Analyzed: 14-Nov-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14596-10-2	Am-241	2.21 +/- 0.35	0.02	2.466	89.7	67 - 111	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	2.248	1.91	pCi/g	85.1	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: AM1907583-1

Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 15

Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins  
Work Order Number: 1907583  
Client Name: Engineering Analytics  
ClientProject ID: Jeffco FLAP 110836a

Field ID:	E4G-070319-0-2-01
Lab ID:	1907583-25DUP

Sample Matrix: SOIL	Prep Batch: AS191104-4	Final Aliquot: 1.01 g
Prep SOP: PAI 778 Rev 16	QCBatchID: AS191104-4-1	Prep Basis: Dry Weight
Date Collected: 03-Jul-19	Run ID: AS191104-4AM	Moisture(%): NA
Date Prepared: 04-Nov-19	Count Time: 1000 minutes	Result Units: pCi/g
Date Analyzed: 14-Nov-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
14596-10-2	Am-241	0.455 +/-	0.092	0.035		0.58 +/-	0.12	0.04		0.867	2.13

Comments:

Duplicate Qualifiers/Flags:

U - Result is less than the sample specific MDC.  
Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.  
Y2 - Chemical Yield outside default limits.  
W - DER is greater than Warning Limit of 1.42  
D - DER is greater than Control Limit of 2.13  
LT - Result is less than Request MDC, greater than sample specific MDC  
M - Requested MDC not met.  
M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.  
L - LCS Recovery below lower control limit.  
H - LCS Recovery above upper control limit.  
P - LCS, Matrix Spike Recovery within control limits.  
N - Matrix Spike Recovery outside control limits

Abbreviations:  
TPU - Total Propagated Uncertainty  
DER - Duplicate Error Ratio  
BDL - Below Detection Limit  
NR - Not Reported

Data Package ID: AM1907583-1

Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins  
Work Order Number: 1907583  
Client Name: Engineering Analytics  
ClientProject ID: Jeffco FLAP 110836a

Field ID:	E4G-070319-10-12-01
Lab ID:	1907583-35DUP

Sample Matrix: SOIL  
Prep SOP: PAI 778 Rev 16  
Date Collected: 03-Jul-19  
Date Prepared: 04-Oct-19  
Date Analyzed: 17-Oct-19  
Prep Batch: AS191004-1  
QCBatchID: AS191004-1-1  
Run ID: AS191004-1C  
Count Time: 420 minutes  
Report Basis: Dry Weight  
Final Aliquot: 1.01 g  
Prep Basis: Dry Weight  
Moisture(%): NA  
Result Units: pCi/g  
File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
14596-10-2	Am-241	-0.008 +/-	0.022	0.062	U	0.020 +/-	0.029	0.054	U	0.775	2.13

Comments:

Duplicate Qualifiers/Flags:  
U - Result is less than the sample specific MDC.  
Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.  
Y2 - Chemical Yield outside default limits.  
W - DER is greater than Warning Limit of 1.42  
D - DER is greater than Control Limit of 2.13  
LT - Result is less than Request MDC, greater than sample specific MDC  
M - Requested MDC not met.  
M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.  
L - LCS Recovery below lower control limit.  
H - LCS Recovery above upper control limit.  
P - LCS, Matrix Spike Recovery within control limits.  
N - Matrix Spike Recovery outside control limits

Abbreviations:  
TPU - Total Propagated Uncertainty  
DER - Duplicate Error Ratio  
BDL - Below Detection Limit  
NR - Not Reported

Data Package ID: AM1907583-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E13G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191004-1	Final Aliquot: 1.02 g
Lab ID: 1907583-1	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191004-1-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS191004-1C	Moisture(%): NA
	Date Prepared: 04-Oct-19	Count Time: 420 minutes	Result Units: pCi/g
	Date Analyzed: 17-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.61 +/- 0.14	0.05	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.392	3.49	pCi/g	79.4	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907583-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E14G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191004-1	Final Aliquot: 1.04 g
Lab ID: 1907583-3	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191004-1-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS191004-1C	Moisture(%): NA
	Date Prepared: 04-Oct-19	Count Time: 420 minutes	Result Units: pCi/g
	Date Analyzed: 17-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.96 +/- 0.20	0.05	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.312	3.23	pCi/g	75.0	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907583-1



# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E11G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191004-1	Final Aliquot: 1.01 g
Lab ID: 1907583-5	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191004-1-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS191004-1C	Moisture(%): NA
	Date Prepared: 04-Oct-19	Count Time: 420 minutes	Result Units: pCi/g
	Date Analyzed: 17-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.41 +/- 0.10	0.05	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.434	3.62	pCi/g	81.7	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907583-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E8G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191004-1	Final Aliquot: 1.10 g
Lab ID: 1907583-7	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191004-1-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS191004-1C	Moisture(%): NA
	Date Prepared: 04-Oct-19	Count Time: 420 minutes	Result Units: pCi/g
	Date Analyzed: 18-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.320 +/- 0.092	0.053	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.092	2.88	pCi/g	70.4	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907583-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E5G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191004-1	Final Aliquot: 1.06 g
Lab ID: 1907583-9	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191004-1-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS191004-1C	Moisture(%): NA
	Date Prepared: 04-Oct-19	Count Time: 420 minutes	Result Units: pCi/g
	Date Analyzed: 21-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.49 +/- 0.12	0.05	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.223	3.03	pCi/g	71.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907583-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E7G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191004-1	Final Aliquot: 1.04 g
Lab ID: 1907583-11	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191004-1-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS191004-1C	Moisture(%): NA
	Date Prepared: 04-Oct-19	Count Time: 420 minutes	Result Units: pCi/g
	Date Analyzed: 17-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.51 +/- 0.13	0.06	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.332	2.62	pCi/g	60.4	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907583-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E12G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191004-1	Final Aliquot: 1.03 g
Lab ID: 1907583-13	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191004-1-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS191004-1C	Moisture(%): NA
	Date Prepared: 04-Oct-19	Count Time: 420 minutes	Result Units: pCi/g
	Date Analyzed: 17-Oct-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.43 +/- 0.11	0.05	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.364	3.16	pCi/g	72.4	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

**Data Package ID: AM1907583-1**

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 15

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E4G-070319-0-2-01	Sample Matrix: SOIL	Prep Batch: AS191104-4	Final Aliquot: 1.02 g
Lab ID: 1907583-25	Prep SOP: PAI 778 Rev 16	QCBatchID: AS191104-4-1	Prep Basis: Dry Weight
	Date Collected: 03-Jul-19	Run ID: AS191104-4AM	Moisture(%): NA
	Date Prepared: 04-Nov-19	Count Time: 1000 minutes	Result Units: pCi/g
	Date Analyzed: 14-Nov-19	Report Basis: Dry Weight	File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.455 +/- 0.092	0.035	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.425	3.29	pCi/g	74.3	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907583-1

# Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 15

## Sample Duplicate Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E4G-070319-0-2-01

Lab ID: 1907583-25DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Nov-19

Date Analyzed: 14-Nov-19

Prep Batch: AS191104-4

QCBatchID: AS191104-4-1

Run ID: AS191104-4AM

Count Time: 1000 minutes

Report Basis: Dry Weight

Final Aliquot: 1.01 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14596-10-2	Am-241	0.58 +/- 0.12	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Am-243	4.450	2.99	pCi/g	67.1	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: AM1907583-1

Date Printed:

Tuesday, November 19, 2019

ALS -- Fort Collins

LIMS Version: 6.915

Page 1 of 2



ALS Laboratory Group - Fort Collins

## QUALITY ASSURANCE SUMMARY SHEET

PAR W.O. # BATCH Cleanup w/out column  
 TEST Am, Cm, Pu, Th, U  
 METHOD Prep  
 SOP REV (PREP) various  
 SOP REV (ANAL) \_\_\_\_\_

Briefly document any QA or other problems or deviations associated with the analysis of samples. Problems could result from: log-in, color, odor, dilution, consistency, scheduling, equipment, or instrumentation, or may include documentation of minor deviations necessary due to unique DQO's or sample characteristics.

The following procedure is used for the "cleanup without column" for Am, Cm, Pu, Th, and Np:

1. The sample filter is peeled from the planchet with forceps and placed into a plastic cup.
2. In the cup, the filter is completely submerged in 2g boric acid and 20mL HNO<sub>3</sub>.
3. The cup is placed on the hotblock for 1 hour.
4. After 1 hour, ~70mL DI water is added to the cup. After 15 minutes, the contents of the cup (excluding filter) are transferred to a labeled centrifuge bottle where a ferric hydroxide precipitate is performed by adding 1mL Fe carrier and ~50mL ammonium hydroxide.
5. The sample is centrifuged and the supernate decanted.
6. 1mL conc. HCl is added to the centrifuge bottle to dissolve the precipitate.
7. Microprecipitation is performed per the analyte SOP. However, only 0.5mL La carrier is added instead of the normal 1.0mL due to potential matrix interference caused by a surplus of La carrier from both the first prep and the clean-up.

TECHNICIAN ANALYST

DATE

3/22/12

DEPARTMENT MANAGER

DATE

3/28/12

385164

FORM 302r6b.doc (4/22/04)





Pages containing results for the 2-4, 4-6, 6-8, 8-10 and 10-12 inch depth samples have been removed from this file and are reported elsewhere.

## Isotopic Plutonium Case Narrative

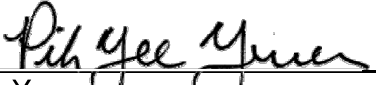
### Engineering Analytics

Jeffco FLAP – 110836a


Work Order Number: 1907583

1. This report consists of the analytical results for 18 soil samples sample received by ALS on 07/05/2019. This is a re-log of 1907103.
2. The soil samples were prepared according to the current revisions of SOP 736, SOP 773, SOP 777, and SOP 778. The samples in this report utilized the fusion prep procedure, SOP 768.
3. The samples were analyzed for the presence of isotopic plutonium according to the current revision of SOP 714. The analyses were completed on 10/17/2019.
4. The analysis results for the soil samples are reported on a 'Dry Weight' basis in units of pCi/gram.
5. Plutonium-240 is indistinguishable from Plutonium-239. In this report, any plutonium in this region of interest will be reported as Pu-239/240.
6. No anomalous situations were encountered during the preparation or analysis of these samples. All quality control criteria were met.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

  
Pik Yee Yuen  
Radiochemistry Primary Data Reviewer

10/28/19  
Date

  
Radiochemistry Final Data Reviewer

11/09/19  
Date

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

---

**OrderNum:** 1907583

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**


---

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
E13G-070319-0-2-01	1907583-1		SOIL	03-Jul-19	8:40
E14G-070319-0-2-01	1907583-3		SOIL	03-Jul-19	9:00
E11G-070319-0-2-01	1907583-5		SOIL	03-Jul-19	14:00
E8G-070319-0-2-01	1907583-7		SOIL	03-Jul-19	14:15
E5G-070319-0-2-01	1907583-9		SOIL	03-Jul-19	15:30
E7G-070319-0-2-01	1907583-11		SOIL	03-Jul-19	15:40
E12G-070319-0-2-01	1907583-13		SOIL	03-Jul-19	9:20
E12G-070319-2-4-01	1907583-15		SOIL	03-Jul-19	9:30
E12G-070319-4-6-01	1907583-17		SOIL	03-Jul-19	10:00
E12G-070319-6-8-01	1907583-19		SOIL	03-Jul-19	10:18
E12G-070319-8-10-01	1907583-21		SOIL	03-Jul-19	10:40
E12G-070319-10-12-01	1907583-23		SOIL	03-Jul-19	11:00
E4G-070319-0-2-01	1907583-25		SOIL	03-Jul-19	11:25
E4G-070319-2-4-01	1907583-27		SOIL	03-Jul-19	11:35
E4G-070319-4-6-01	1907583-29		SOIL	03-Jul-19	11:50
E4G-070319-6-8-01	1907583-31		SOIL	03-Jul-19	12:00
E4G-070319-8-10-01	1907583-33		SOIL	03-Jul-19	12:25
E4G-070319-10-12-01	1907583-35		SOIL	03-Jul-19	12:45





# ALS Environmental

228 Commerce Drive, Fort Collins, Colorado 80524  
Tel: (970) 483-1611 Fax: (970) 480-1622

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

PROJECT NAME	Jeffers FLAP (Broomfield)	TURNAROUND TIME	STD	SAMPLER	ES, SK	PAGE	2 of 3
PROJECT No.	108366	DATE ID				DISPOSAL	BY LAB or RETURN
COMPANY NAME	Engineering Analytics	EDD FORMAT					
SEND REPORT TO	Sean Andrews	PURCHASE ORDER					PARAMETER/METHOD REQUEST FOR ANALYSIS
ADDRESS	1600 Specht Point Rd	BILL TO COMPANY	Broomfield				
CITY/STATE/ZIP	Fort Collins CO 80525	INVOICE ATTN TO					
PHONE	(970)-488-3111	ADDRESS	Same				
FAX		CITY/STATE/ZIP					
E-MAIL	J.Andrews@enganalytics.com	PHONE					
		FAX					
		E-MAIL					
LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	OC
(X) 13	E12G-070319-0-2-01	S	7/13/19	0920	1	None	
14	E12G-070319-0-2-99			0920			
(X) 15	E12G-070319-2-4-01			0930			
16	E12G-070319-2-4-99			0930			
(X) 17	E12G-070319-4-6-01			1000			
18	E12G-070319-4-6-99			1000			
(X) 19	E12G-070319-6-8-01			1018			
20	E12G-070319-6-8-99			1018			
(X) 21	E12G-070319-8-10-01			1040			
22	E12G-070319-8-10-99			1040			
(X) 23	E12G-070319-10-12-01			1100			
24	E12G-070319-10-12-99			1100			
Time Zone (City):	EST CST (MST) PST	Metric 0 = gal 8 = sol NS = non-sol cells W = water L = liquid E = extract F = fiber					

RELINQUISHED BY	SIGNATURE	PRINTED NAME	DATE	TIME
RECEIVED BY	<i>[Signature]</i>	Jan Stockstill	7/18/19	1156
RELINQUISHED BY		Erin Evans	7/18/19	1150
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

IMPORT LEVEL / OC REQUIRED	NO carb
LEVEL I (Standard OC)	
LEVEL II (Standard OC)	
LEVEL III (Rel OC + Name)	
LEVEL IV (Rel OC + Name + Test)	

1-HQ 2-HQS 3-HQS 4-HQS 5-HQS 6-HQS 7-HQS 8-HQS





ALS Environmental - Fort Collins  
CONDITION OF SAMPLE UPON RECEIPT FORM

① 19075F3 /h

Client: Engineering Analytics

Workorder No: 1907103

Project Manager: LPS

Initials: EE

Date: 7/5/19

1. Are airbills / shipping documents present and/or removable?	<input checked="" type="checkbox"/>	YES	NO
2. Are custody seals on <b>shipping</b> containers intact?	<input checked="" type="checkbox"/>	YES	NO *
3. Are custody seals on <b>sample</b> containers intact?	<input checked="" type="checkbox"/>	YES	NO *
4. Is there a COC (chain-of-custody) present?	<input checked="" type="checkbox"/>	YES	NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)	<input checked="" type="checkbox"/>	YES	NO *
6. Are short-hold samples present?	<input checked="" type="checkbox"/>	YES	NO *
7. Are all samples within holding times for the requested analyses?	<input checked="" type="checkbox"/>	YES	NO *
8. Were all sample containers received intact? (not broken or leaking)	<input checked="" type="checkbox"/>	YES	NO *
9. Is there sufficient sample for the requested analyses?	<input checked="" type="checkbox"/>	YES	NO *
10. Are all samples in the proper containers for the requested analyses?	<input checked="" type="checkbox"/>	YES	NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)	<input checked="" type="checkbox"/>	YES	NO *
12. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="checkbox"/>	YES	NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	<input checked="" type="checkbox"/>	YES	NO
14. Were the samples shipped on ice?	<input checked="" type="checkbox"/>	YES	NO *
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #1 #3 #4	RAD ONLY	YES NO
Cooler #: <u>1</u> <u>2</u>			
Temperature (°C): <u>AMB</u> <u>AMB</u>			
No. of custody seals on cooler: <u>0</u> <u>0</u>			
External µR/hr reading: <u>N/A</u> <u>N/A</u>			
Background µR/hr reading: <u>10</u>			
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO <u>(NA)</u> (If no, see Form 008.)			

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

All client bottle ID's vs ALS lab ID's double-checked by: EE

If applicable, was the client contacted? YES / NO / NA Contact: \_\_\_\_\_

Date/Time: \_\_\_\_\_

Project Manager Signature / Date: \_\_\_\_\_

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS191004-1MB

Sample Matrix: SOIL

Prep Batch: AS191004-1

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS191004-1-1

Result Units: pCi/g

Date Collected: 04-Oct-19

Run ID: AS191004-1PU

File Name: Spectrum #1

Date Prepared: 04-Oct-19

Count Time: 360 minutes

Date Analyzed: 17-Oct-19

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.002 +/- 0.013	0.020	0.15	NA	U
10-12-8	Pu-239/240	0.010 +/- 0.015	0.027	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	2.225	1.24	pCi/g	55.9	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** PU1907583-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS191004-1LCS

Sample Matrix: SOIL

Prep Batch: AS191004-1

Final Aliquot: 2.00 g

Prep SOP: PAI 778 Rev 16

QCBatchID: AS191004-1-1

Result Units: pCi/g

Date Collected: 04-Oct-19

Run ID: AS191004-1PU

File Name: Spectrum #1

Date Prepared: 04-Oct-19

Count Time: 360 minutes

Date Analyzed: 17-Oct-19

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
10-12-8	Pu-239/240	2.45 +/- 0.46	0.02	2.277	108	82 - 118	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	2.225	1.19	pCi/g	53.4	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: PU1907583-1



# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E4G-070319-10-12-01

Lab ID: 1907583-35DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 17-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.01 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13981-16-3	Pu-238	0.015 +/-	0.028	0.058	U	0.004 +/-	0.027	0.060	U	0.275	2.13
10-12-8	Pu-239/240	0.028 +/-	0.032	0.042	U	0.190 +/-	0.082	0.048		1.84	2.13

### Comments:

#### Duplicate Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

#### Abbreviations:

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

Data Package ID: *PU1907583-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E13G-070319-0-2-01

Lab ID: 1907583-1

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 17-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.02 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.071 +/- 0.050	0.051	0.15	NA	
10-12-8	Pu-239/240	3.04 +/- 0.60	0.02	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.346	2.06	pCi/g	47.5	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907583-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E14G-070319-0-2-01

Lab ID: 1907583-3

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 17-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.04 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.091 +/- 0.058	0.058	0.15	NA	
10-12-8	Pu-239/240	6.8 +/- 1.2	0.1	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.268	1.97	pCi/g	46.2	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: PU1907583-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E11G-070319-0-2-01

Lab ID: 1907583-5

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 17-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.01 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	-0.001 +/- 0.027	0.056	0.15	NA	U
10-12-8	Pu-239/240	2.49 +/- 0.50	0.05	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.388	2.21	pCi/g	50.4	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: PU1907583-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E8G-070319-0-2-01

Lab ID: 1907583-7

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 17-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.10 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.023 +/- 0.026	0.034	0.15	NA	U
10-12-8	Pu-239/240	1.79 +/- 0.37	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.050	2.21	pCi/g	54.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: PU1907583-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E5G-070319-0-2-01

Lab ID: 1907583-9

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 17-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1PU

Count Time: 420 minutes

Report Basis: Dry Weight

Final Aliquot: 1.06 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.007 +/- 0.023	0.043	0.15	NA	U
10-12-8	Pu-239/240	0.72 +/- 0.18	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.180	2.03	pCi/g	48.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PU1907583-1*

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E7G-070319-0-2-01

Lab ID: 1907583-11

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 17-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.04 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.023 +/- 0.029	0.046	0.15	NA	U
10-12-8	Pu-239/240	2.17 +/- 0.44	0.05	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.287	2.20	pCi/g	51.4	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: PU1907583-1

# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E12G-070319-0-2-01

Lab ID: 1907583-13

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 17-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.047 +/- 0.045	0.059	0.15	NA	U
10-12-8	Pu-239/240	2.73 +/- 0.57	0.05	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.319	1.74	pCi/g	40.3	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: PU1907583-1



# Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E4G-070319-0-2-01

Lab ID: 1907583-25

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 17-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1PU

Count Time: 360 minutes

Report Basis: Dry Weight

Final Aliquot: 1.09 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-16-3	Pu-238	0.093 +/- 0.056	0.040	0.15	NA	
10-12-8	Pu-239/240	3.21 +/- 0.63	0.02	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Pu-242	4.074	2.06	pCi/g	50.5	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: PU1907583-1



Pages containing results for the 2-4, 4-6, 6-8, 8-10 and 10-12 inch depth samples have been removed from this file and are reported elsewhere.

# Isotopic Uranium Case Narrative

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## Engineering Analytics

Jeffco FLAP – 110836a

Work Order Number: 1907583

1. This report consists of the analytical results for 18 soil samples sample received by ALS on 07/05/2019. This is a re-log of 1907103.
2. The soil samples were prepared according to the current revisions of SOP 736, SOP 773, and SOP 778. The samples in this report utilized the fusion prep procedure, SOP 768.
3. The samples were analyzed for the presence of isotopic uranium according to the current revision of SOP 714. The analyses were completed on 10/21/2019.
4. The analysis results for the soil samples are reported on a 'Dry Weight' basis in units of pCi/gram.
5. This analytical method quantifies U-235 alpha activity in a specific region of interest corresponding to emission energies between those of U-234 and U-238. A potential limitation of this method is that measurable amounts of U-234 in the sample may cause a small amount of characteristic activity in the U-235 region of interest due to poorly resolved alpha activity at the boundary between the two regions. To minimize the potential for a high bias in the U-235 analytical results, the U-235 region of interest has been narrowed and limited to a lower energy region. An 85.1% abundance correction has been made to the final U-235 results.
6. Uranium-234 and -235 activity is reported in method blank AS191004-1MB above the minimum detectable concentration value, as indicated with a "B3" qualifier on the final reports. The measured blank activity is below the requested MDC. Results are acceptable according to the current revision of SOP 715 and are submitted without further qualification.
7. No further anomalous situations were encountered during the preparation or analysis of these samples. All remaining quality control criteria were met.



The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Pik Yee Yuen  
Pik Yee Yuen  
Radiochemistry Primary Data Reviewer

10/28/19  
Date

[Signature]  
Radiochemistry Final Data Reviewer

11/09/19  
Date

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

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**OrderNum:** 1907583

**Client Name:** Engineering Analytics

**Client Project Name:** Jeffco FLAP

**Client Project Number:** 110836a

**Client PO Number:**


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Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
E13G-070319-0-2-01	1907583-1		SOIL	03-Jul-19	8:40
E14G-070319-0-2-01	1907583-3		SOIL	03-Jul-19	9:00
E11G-070319-0-2-01	1907583-5		SOIL	03-Jul-19	14:00
E8G-070319-0-2-01	1907583-7		SOIL	03-Jul-19	14:15
E5G-070319-0-2-01	1907583-9		SOIL	03-Jul-19	15:30
E7G-070319-0-2-01	1907583-11		SOIL	03-Jul-19	15:40
E12G-070319-0-2-01	1907583-13		SOIL	03-Jul-19	9:20
E12G-070319-2-4-01	1907583-15		SOIL	03-Jul-19	9:30
E12G-070319-4-6-01	1907583-17		SOIL	03-Jul-19	10:00
E12G-070319-6-8-01	1907583-19		SOIL	03-Jul-19	10:18
E12G-070319-8-10-01	1907583-21		SOIL	03-Jul-19	10:40
E12G-070319-10-12-01	1907583-23		SOIL	03-Jul-19	11:00
E4G-070319-0-2-01	1907583-25		SOIL	03-Jul-19	11:25
E4G-070319-2-4-01	1907583-27		SOIL	03-Jul-19	11:35
E4G-070319-4-6-01	1907583-29		SOIL	03-Jul-19	11:50
E4G-070319-6-8-01	1907583-31		SOIL	03-Jul-19	12:00
E4G-070319-8-10-01	1907583-33		SOIL	03-Jul-19	12:25
E4G-070319-10-12-01	1907583-35		SOIL	03-Jul-19	12:45



# ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524  
 Tel: (970) 443-1511 Fax: (970) 490-1522

## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
 Turnaround time for samples received Saturday will be calculated beginning from the next business day.

PROJECT NAME Jeffco FLAP		TURNAROUND TIME STD		SAMPLER IS, SK		PAGE 1 of 3		ALS WORK ORDER # 1907103	
PROJECT NO. 110836		SITE ID		DISPOSAL		BY LAB		OR RETURN	
PURCHASE ORDER		EDD FORMAT		PARAMETER/METHOD REQUEST FOR ANALYSIS					
BILL TO COMPANY		JEFFCO		A		AM-241		ALS SOP 714	
INVOICE ATTN TO		Same		B		PU-238		239/246 ALS SOP 714	
ADDRESS		1600 Specht Point Rd		C		U-235		238, 234 SOP 714	
CITY/STATE/ZIP		Fort Collins CO 80525		D					
PHONE		970 4258 3111		E					
FAX				F					
E-MAIL		J.Anderson@enganalytix.com		G					
				H					
				I					
				J					

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
1	E136-070319-0-2-01	S	7/31/19	0840	1	None		X	X	X								
2	E136-070319-0-2-99			0840	1			X	X	X								HOLD
3	E146-070319-0-2-01			0900	1			X	X	X								
4	E146-070319-0-2-99			0900	1			X	X	X								HOLD
5	E116-070319-0-2-01			1400	2			X	X	X								
6	E116-070319-0-2-99			1400	1			X	X	X								HOLD
7	E86-070319-0-2-01			1415	2			X	X	X								
8	E86-070319-0-2-99			1415	1			X	X	X								HOLD
9	E96-070319-0-2-01			1530	2			X	X	X								
10	E96-070319-0-2-99			1530	1			X	X	X								HOLD
11	E76-070319-0-2-01			1540	1			X	X	X								
12	E76-070319-0-2-99			1540	1			X	X	X								HOLD

REPORT LEVEL / QC REQUIRED		SIGNATURE		PRINTED NAME		DATE		TIME	
Summary (Standard OC)		E. Anderson		Jon Steckel		7/28/19		1150	
LEVEL II (Standard OC)		E. Anderson		Coke Lines		7/28/19		1150	
LEVEL III (Std OC + Name)									
LEVEL IV (Std OC + Name + Rev)									

RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY

Time Zone (Circle): EST CST (MST) PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = fiber

NOTES: Hold #1 - 99 samples for Archive. No carb fusion testing.

4 of 29

PRESERVATION KEY: 1-HCI 2-HNO3 3-H2SO4 4-HNO3 5-HNO3/ZnAcetate 6-HNO3 7-4°C 8-Other







ALS Environmental - Fort Collins  
CONDITION OF SAMPLE UPON RECEIPT FORM

① 19075F3 /h

Client: Engineering Analytics

Workorder No: 1907103

Project Manager: LPS

Initials: EE

Date: 7/5/19

1. Are airbills / shipping documents present and/or removable?	<input checked="" type="checkbox"/>	YES	NO
2. Are custody seals on <b>shipping</b> containers intact?	<input checked="" type="checkbox"/>	YES	NO *
3. Are custody seals on <b>sample</b> containers intact?	<input checked="" type="checkbox"/>	YES	NO *
4. Is there a COC (chain-of-custody) present?	<input checked="" type="checkbox"/>	YES	NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)	<input checked="" type="checkbox"/>	YES	NO *
6. Are short-hold samples present?	<input checked="" type="checkbox"/>	YES	NO *
7. Are all samples within holding times for the requested analyses?	<input checked="" type="checkbox"/>	YES	NO *
8. Were all sample containers received intact? (not broken or leaking)	<input checked="" type="checkbox"/>	YES	NO *
9. Is there sufficient sample for the requested analyses?	<input checked="" type="checkbox"/>	YES	NO *
10. Are all samples in the proper containers for the requested analyses?	<input checked="" type="checkbox"/>	YES	NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)	<input checked="" type="checkbox"/>	YES	NO *
12. Are all aqueous non-preserved samples pH 4-9?	<input checked="" type="checkbox"/>	YES	NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	<input checked="" type="checkbox"/>	YES	NO
14. Were the samples shipped on ice?	<input checked="" type="checkbox"/>	YES	NO *
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*: #1 #3 #4	RAD ONLY	YES NO
Cooler #:	<u>1</u>	<u>2</u>	
Temperature (°C):	<u>AMB</u>	<u>AMB</u>	
No. of custody seals on cooler:	<u>0</u>	<u>0</u>	
External µR/hr reading:	<u>N/A</u>	<u>N/A</u>	
Background µR/hr reading:	<u>10</u>		
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO (NA) (If no, see Form 008.)			

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

All client bottle ID's vs ALS lab ID's double-checked by: EE

If applicable, was the client contacted? YES / NO / NA Contact: \_\_\_\_\_

Date/Time: \_\_\_\_\_

Project Manager Signature / Date: \_\_\_\_\_



# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS191004-1MB

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 04-Oct-19

Date Prepared: 04-Oct-19

Date Analyzed: 21-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1UD

Count Time: 370 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.031 +/- 0.020	0.021	0.1	NA	B3
15117-96-1	U-235	0.012 +/- 0.012	0.008	0.1	NA	B3
7440-61-1	U-238	0.012 +/- 0.013	0.019	0.1	NA	U

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	2.287	1.84	pCi/g	80.3	30 - 110 %	

### Comments:

**Qualifiers/Flags:**

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

**Abbreviations:**

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

**Data Package ID:** UR1907583-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Lab ID: AS191004-1LCS

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 04-Oct-19

Date Prepared: 04-Oct-19

Date Analyzed: 21-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1UD

Count Time: 370 minutes

Final Aliquot: 2.00 g

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
13966-29-5	U-234	2.23 +/- 0.40	0.03	2.110	106	82 - 122	P
7440-61-1	U-238	2.45 +/- 0.43	0.02	2.191	112	82 - 122	P

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	2.287	1.65	pCi/g	72.0	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: UR1907583-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E4G-070319-10-12-01

Lab ID: 1907583-35DUP

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 21-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1UD

Count Time: 370 minutes

Report Basis: Dry Weight

Final Aliquot: 1.01 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
13966-29-5	U-234	1.11 +/- 0.23		0.04		1.00 +/- 0.22		0.06		0.33	2.13
15117-96-1	U-235	0.034 +/- 0.032		0.044	U	0.052 +/- 0.036		0.016		0.368	2.13
7440-61-1	U-238	1.28 +/- 0.26		0.04		1.06 +/- 0.22		0.03		0.638	2.13

### Comments:

#### Duplicate Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

LT - Result is less than Request MDC, greater than sample specific MDC

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

#### Abbreviations:

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

Data Package ID: UR1907583-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E13G-070319-0-2-01

Lab ID: 1907583-1

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 21-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1UD

Count Time: 370 minutes

Report Basis: Dry Weight

Final Aliquot: 1.02 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	1.09 +/- 0.23	0.04	0.1	NA	
15117-96-1	U-235	0.061 +/- 0.040	0.017	0.1	NA	
7440-61-1	U-238	1.09 +/- 0.23	0.01	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.468	3.40	pCi/g	76.1	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907583-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E14G-070319-0-2-01

Lab ID: 1907583-3

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 21-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1UD

Count Time: 370 minutes

Report Basis: Dry Weight

Final Aliquot: 1.04 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	1.16 +/- 0.24	0.05	0.1	NA	
15117-96-1	U-235	0.049 +/- 0.033	0.015	0.1	NA	
7440-61-1	U-238	1.15 +/- 0.24	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.387	3.27	pCi/g	74.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907583-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E11G-070319-0-2-01

Lab ID: 1907583-5

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 17-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1UD

Count Time: 370 minutes

Report Basis: Dry Weight

Final Aliquot: 1.01 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.94 +/- 0.21	0.05	0.1	NA	
15117-96-1	U-235	0.066 +/- 0.043	0.018	0.1	NA	
7440-61-1	U-238	0.98 +/- 0.22	0.03	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.512	2.96	pCi/g	65.6	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907583-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E8G-070319-0-2-01

Lab ID: 1907583-7

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 21-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1UD

Count Time: 370 minutes

Report Basis: Dry Weight

Final Aliquot: 1.10 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	1.16 +/- 0.24	0.04	0.1	NA	
15117-96-1	U-235	0.075 +/- 0.044	0.038	0.1	NA	
7440-61-1	U-238	1.19 +/- 0.25	0.05	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.163	2.79	pCi/g	67.0	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907583-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E5G-070319-0-2-01

Lab ID: 1907583-9

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 21-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1UD

Count Time: 370 minutes

Report Basis: Dry Weight

Final Aliquot: 1.06 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.94 +/- 0.22	0.07	0.1	NA	
15117-96-1	U-235	0.023 +/- 0.028	0.021	0.1	NA	
7440-61-1	U-238	1.04 +/- 0.24	0.05	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.297	2.23	pCi/g	52.0	30 - 110 %	

## Comments:

### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907583-1



# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E7G-070319-0-2-01

Lab ID: 1907583-11

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 21-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1UD

Count Time: 370 minutes

Report Basis: Dry Weight

Final Aliquot: 1.04 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.89 +/- 0.20	0.03	0.1	NA	
15117-96-1	U-235	0.066 +/- 0.041	0.016	0.1	NA	
7440-61-1	U-238	1.17 +/- 0.25	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.408	3.02	pCi/g	68.6	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907583-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E12G-070319-0-2-01

Lab ID: 1907583-13

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 21-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1UD

Count Time: 370 minutes

Report Basis: Dry Weight

Final Aliquot: 1.03 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	1.01 +/- 0.21	0.01	0.1	NA	
15117-96-1	U-235	0.061 +/- 0.038	0.029	0.1	NA	
7440-61-1	U-238	1.07 +/- 0.22	0.02	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.440	3.53	pCi/g	79.5	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1907583-1

# Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1907583

Client Name: Engineering Analytics

ClientProject ID: Jeffco FLAP 110836a

Field ID: E4G-070319-0-2-01

Lab ID: 1907583-25

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Date Collected: 03-Jul-19

Date Prepared: 04-Oct-19

Date Analyzed: 21-Oct-19

Prep Batch: AS191004-1

QCBatchID: AS191004-1-1

Run ID: AS191004-1UD

Count Time: 370 minutes

Report Basis: Dry Weight

Final Aliquot: 1.09 g

Prep Basis: Dry Weight

Moisture(%): NA

Result Units: pCi/g

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	0.96 +/- 0.21	0.03	0.1	NA	
15117-96-1	U-235	0.047 +/- 0.034	0.030	0.1	NA	
7440-61-1	U-238	1.11 +/- 0.23	0.04	0.1	NA	

## Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.188	2.99	pCi/g	71.4	30 - 110 %	

### Comments:

#### Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

#### Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

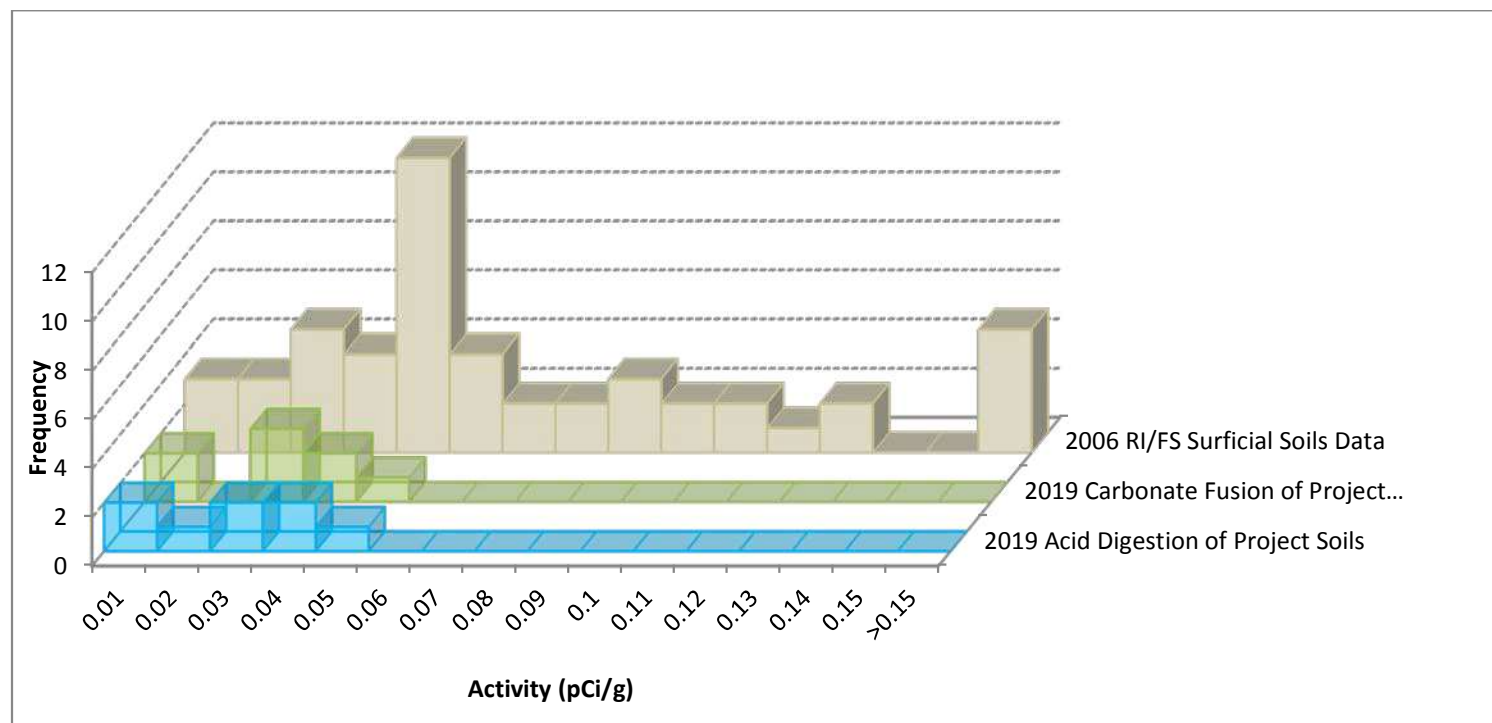
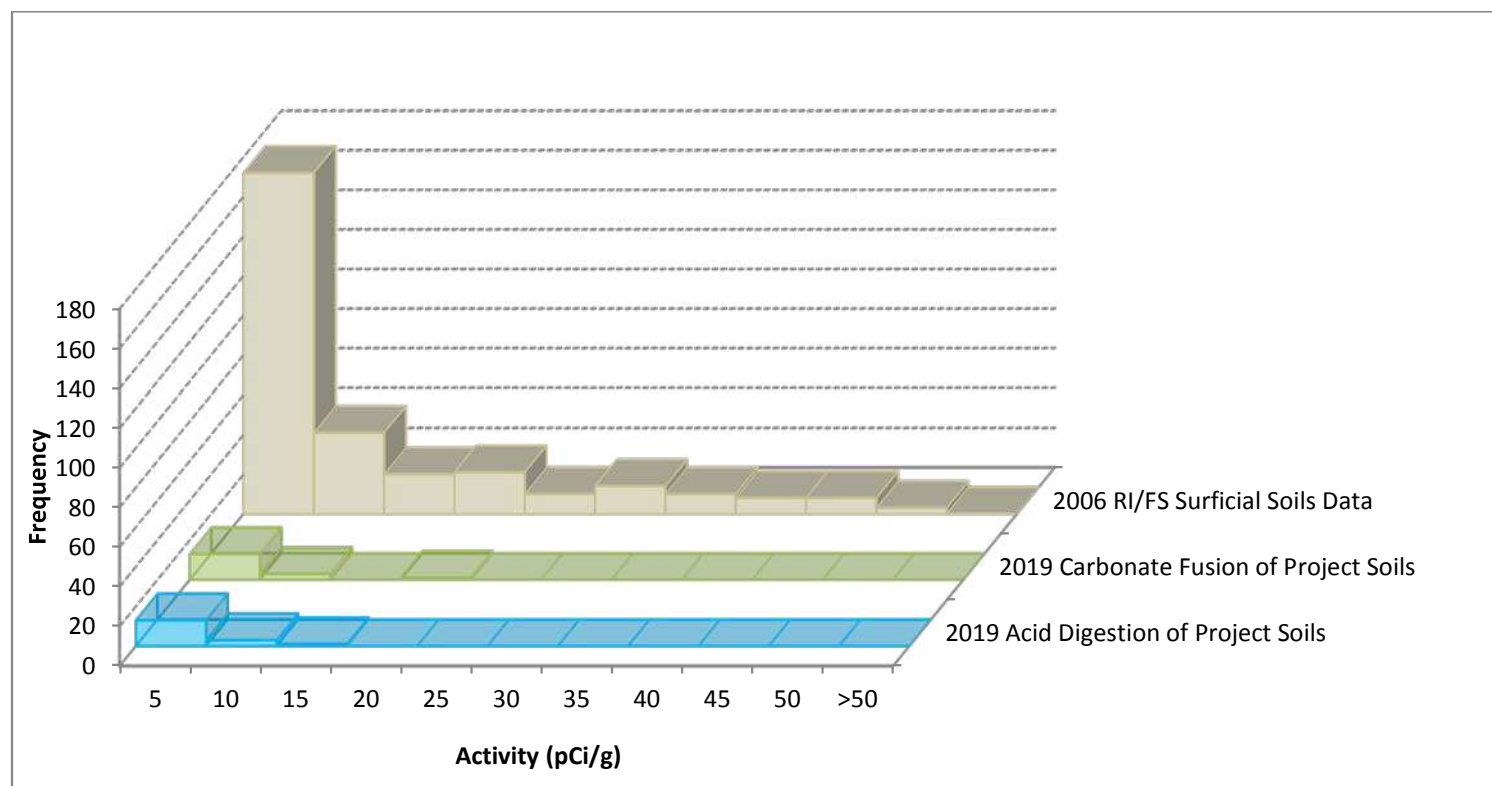
BDL - Below Detection Limit

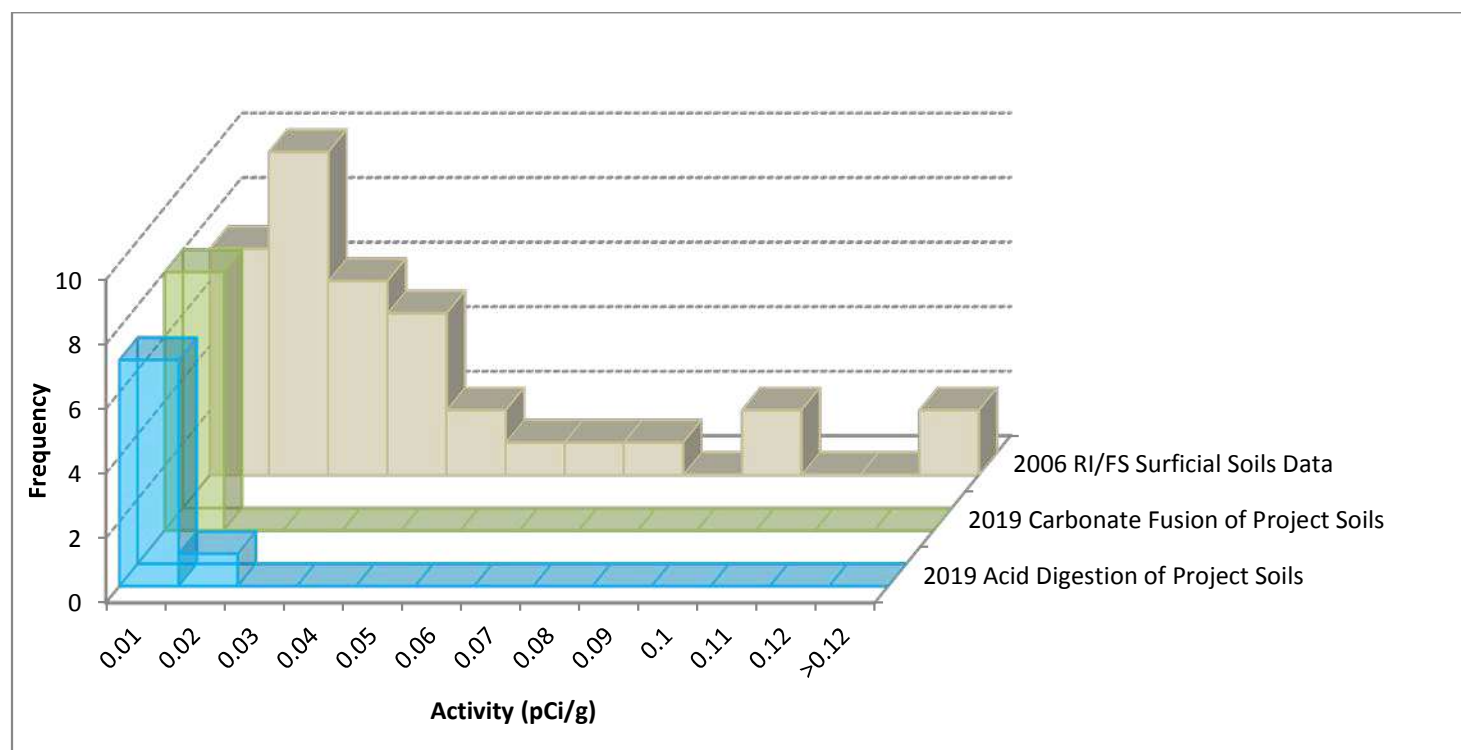
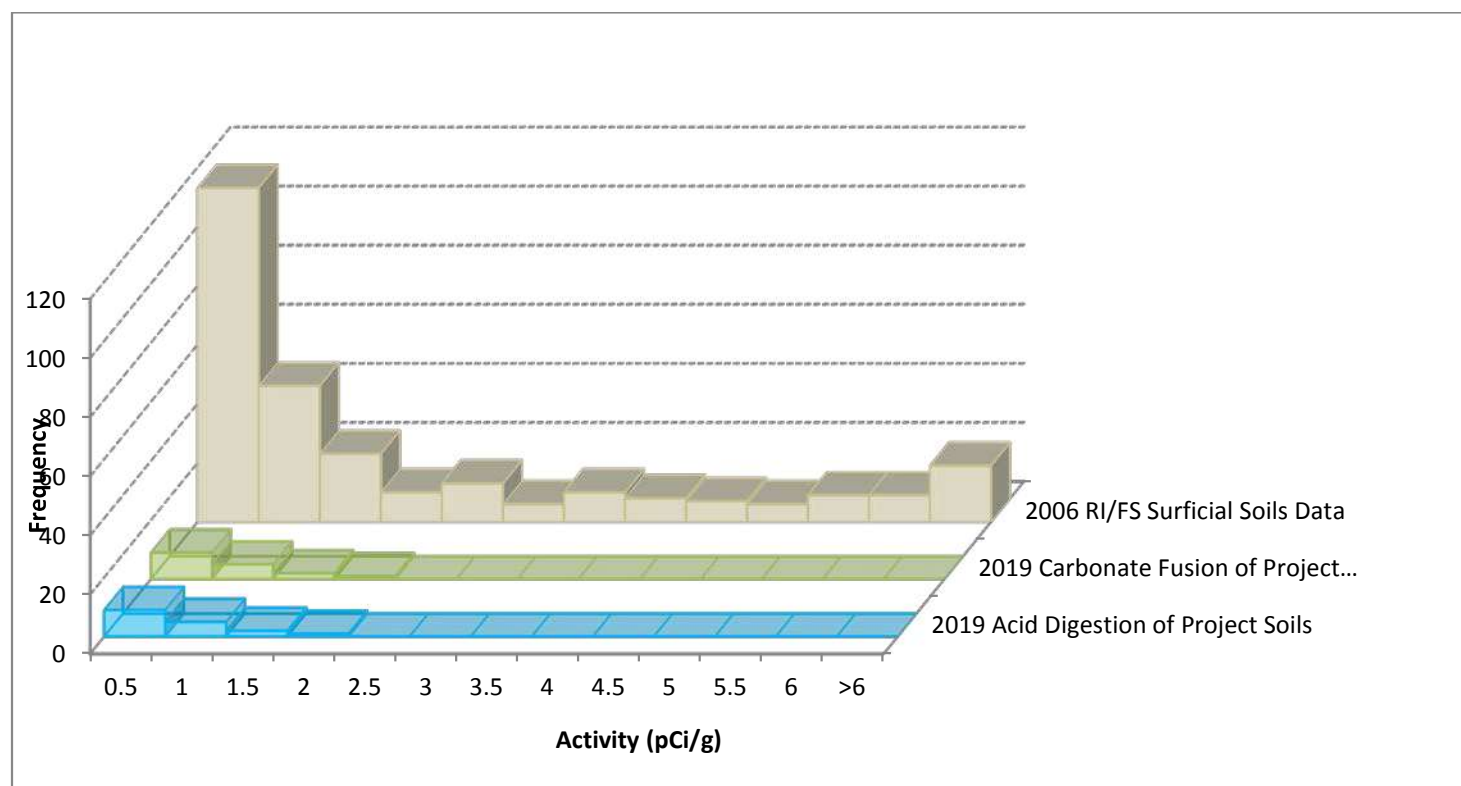
DL - Decision Level

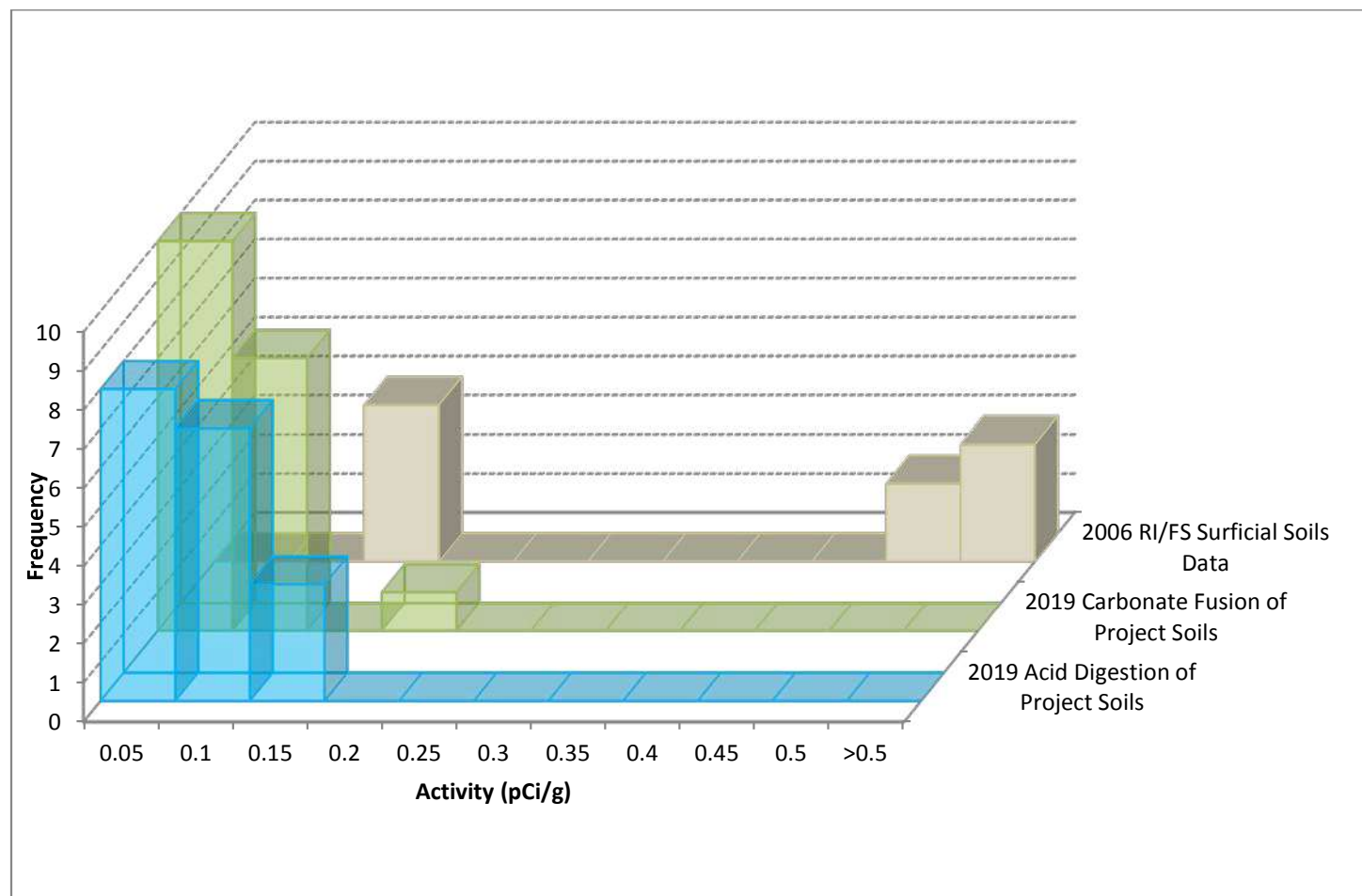
Data Package ID: UR1907583-1

## **APPENDIX C**

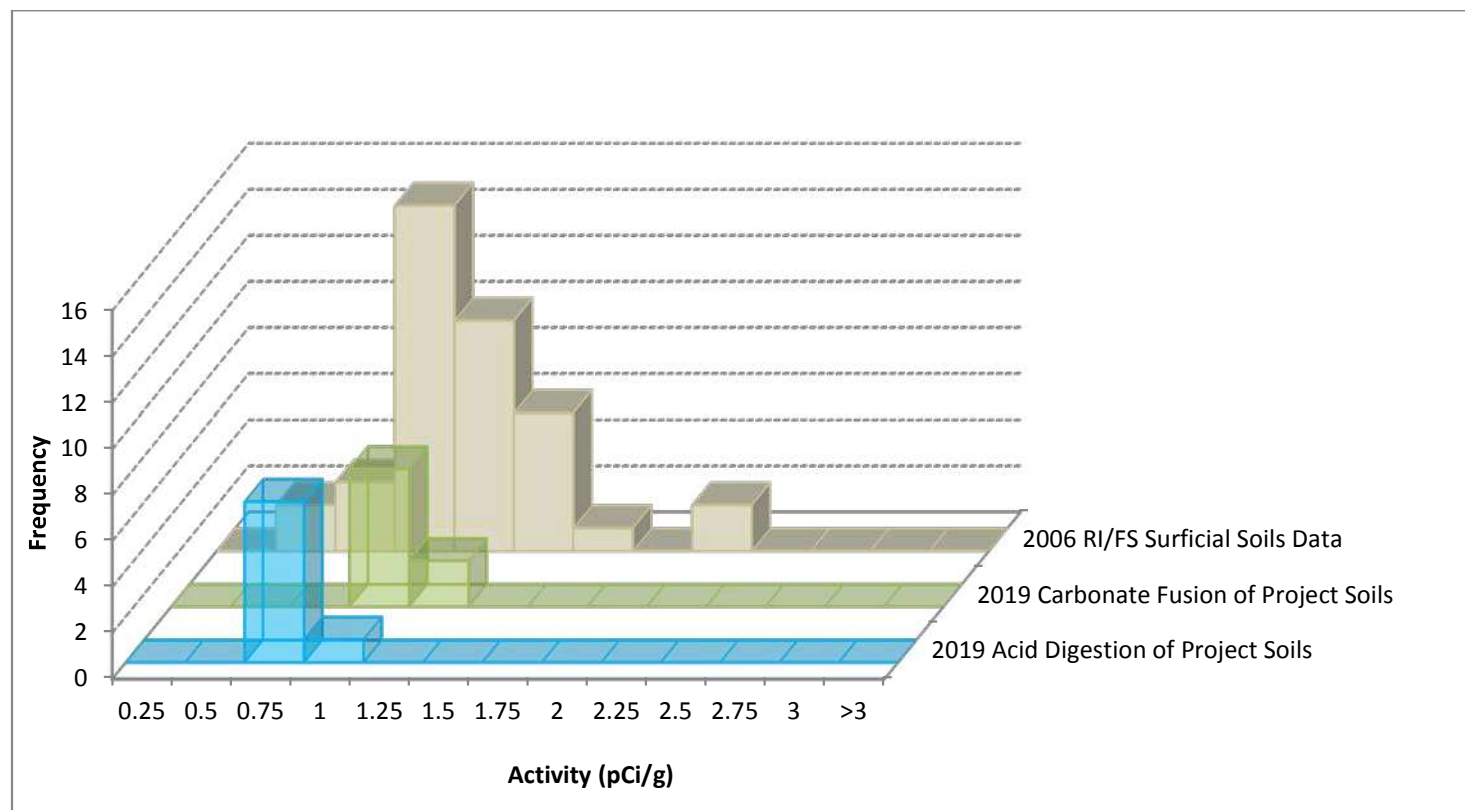
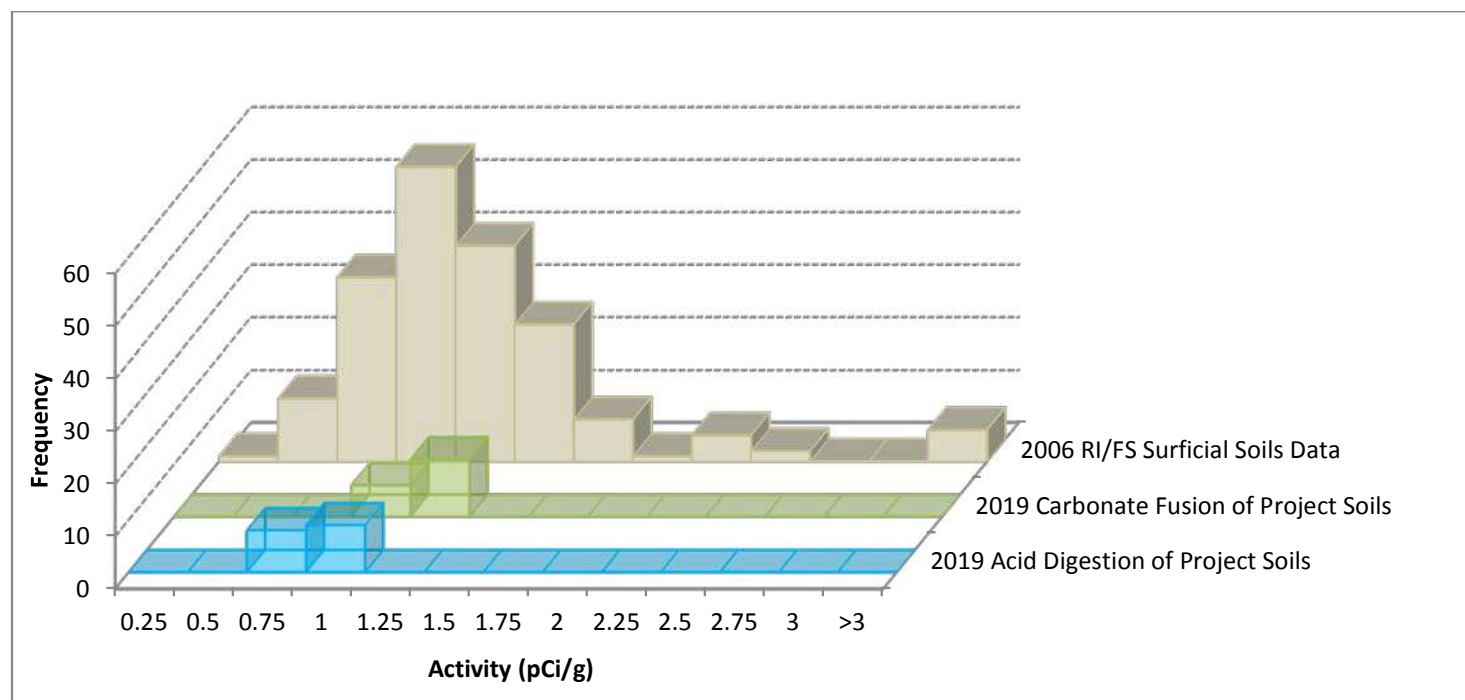
# **SURFACE SOIL RADIONUCLIDE HISTOGRAMS**

**Figure C-1 Rock Creek Drainage EU/CO-128 Crossing Pu-239/240 Histogram****Figure C-2 Wind Blown Area EU/Indiana Street Crossing Pu-239/240 Histogram**

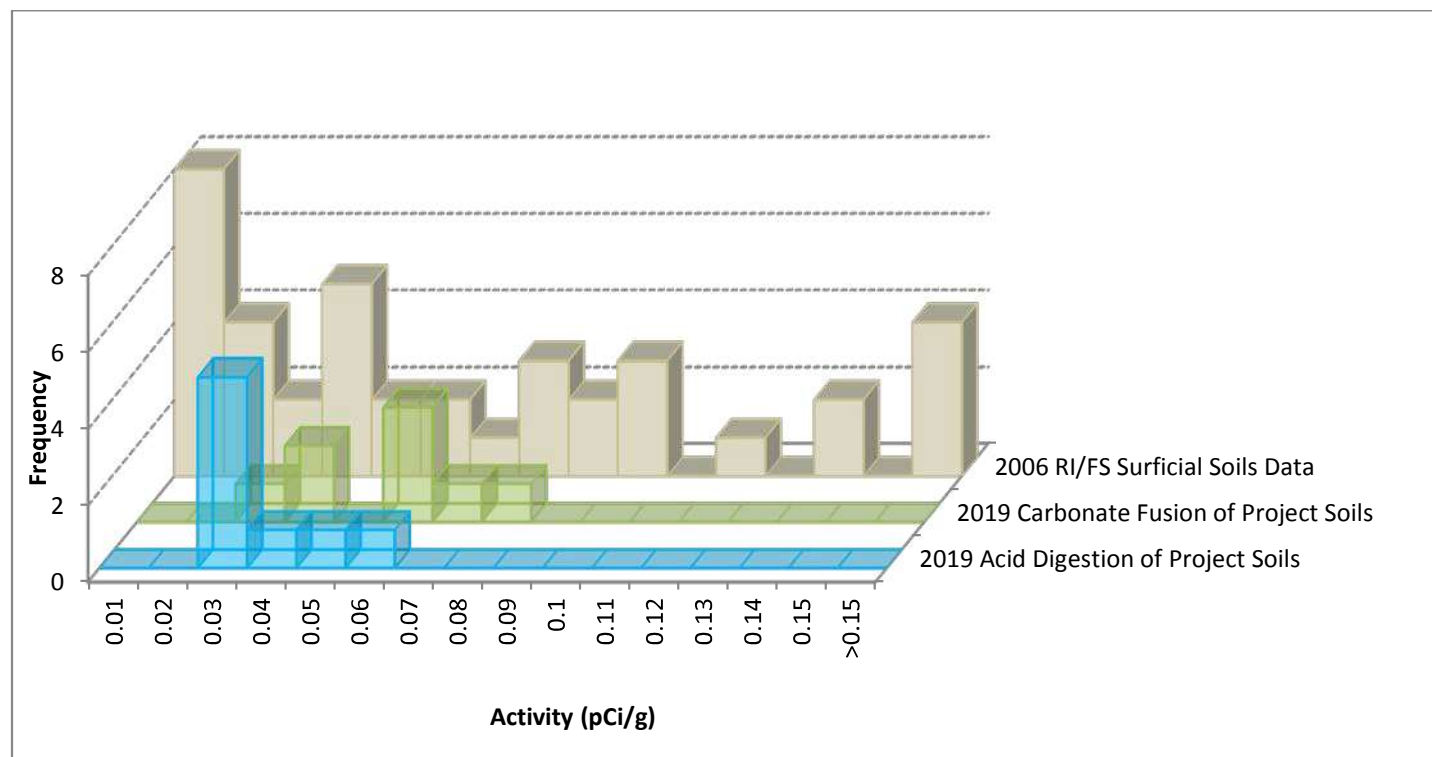
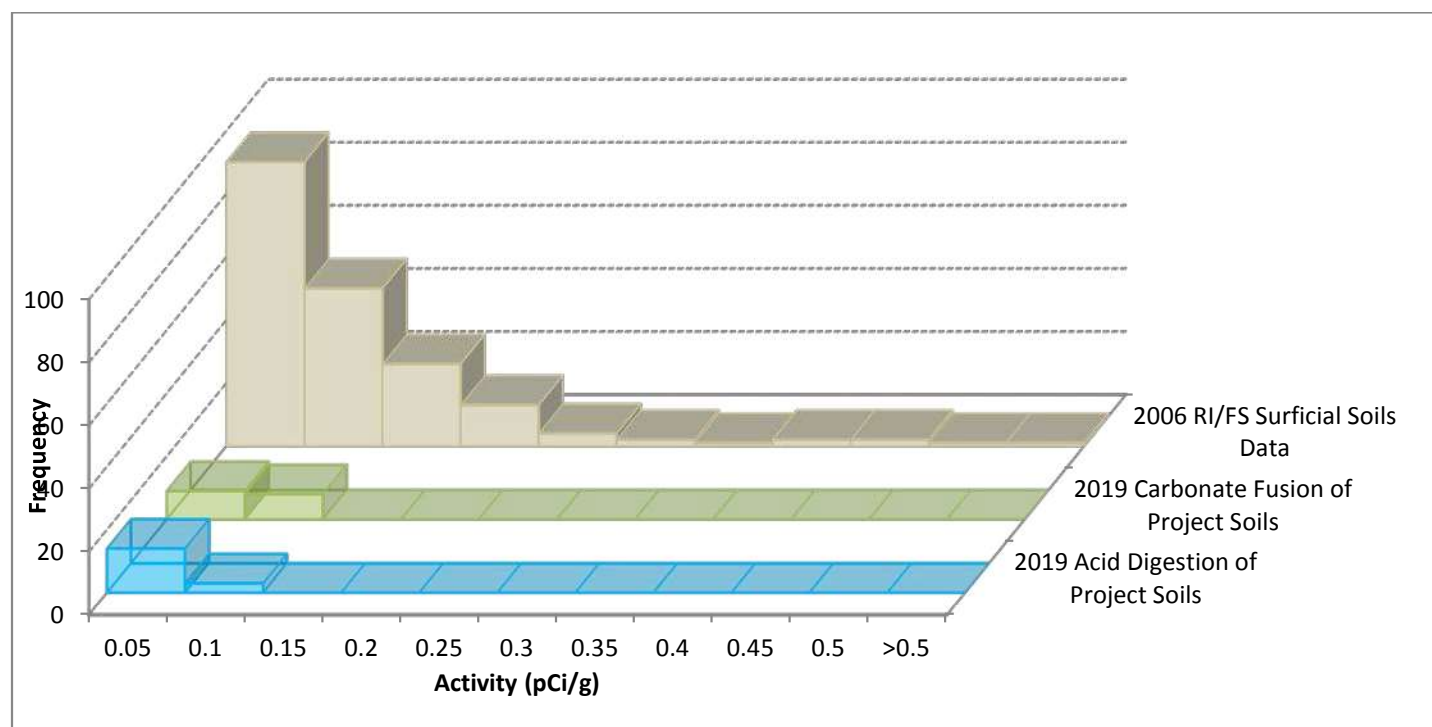
**Figure C-3 Rock Creek Drainage EU/CO-128 Crossing AM-241 Histogram****Figure C-4 Wind Blown Area EU/Indiana Street Crossing AM-241 Histogram**

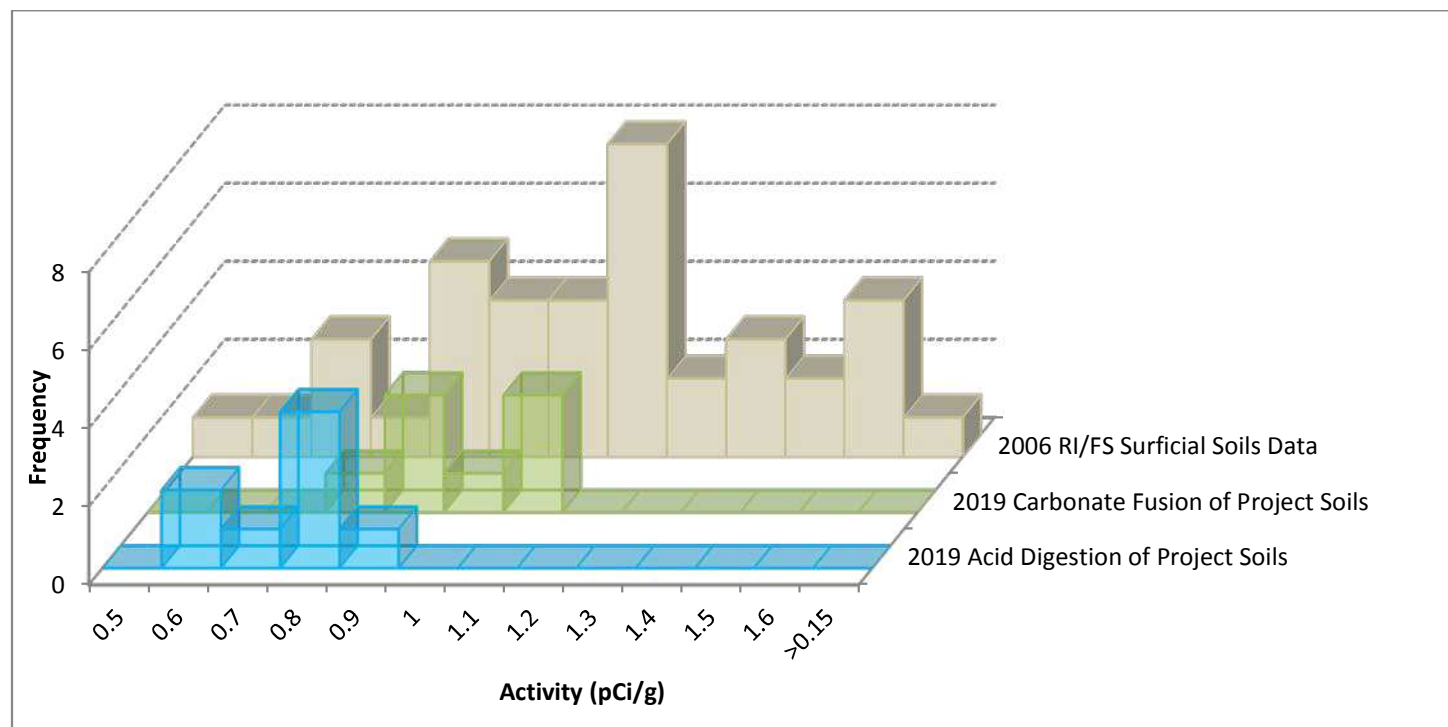
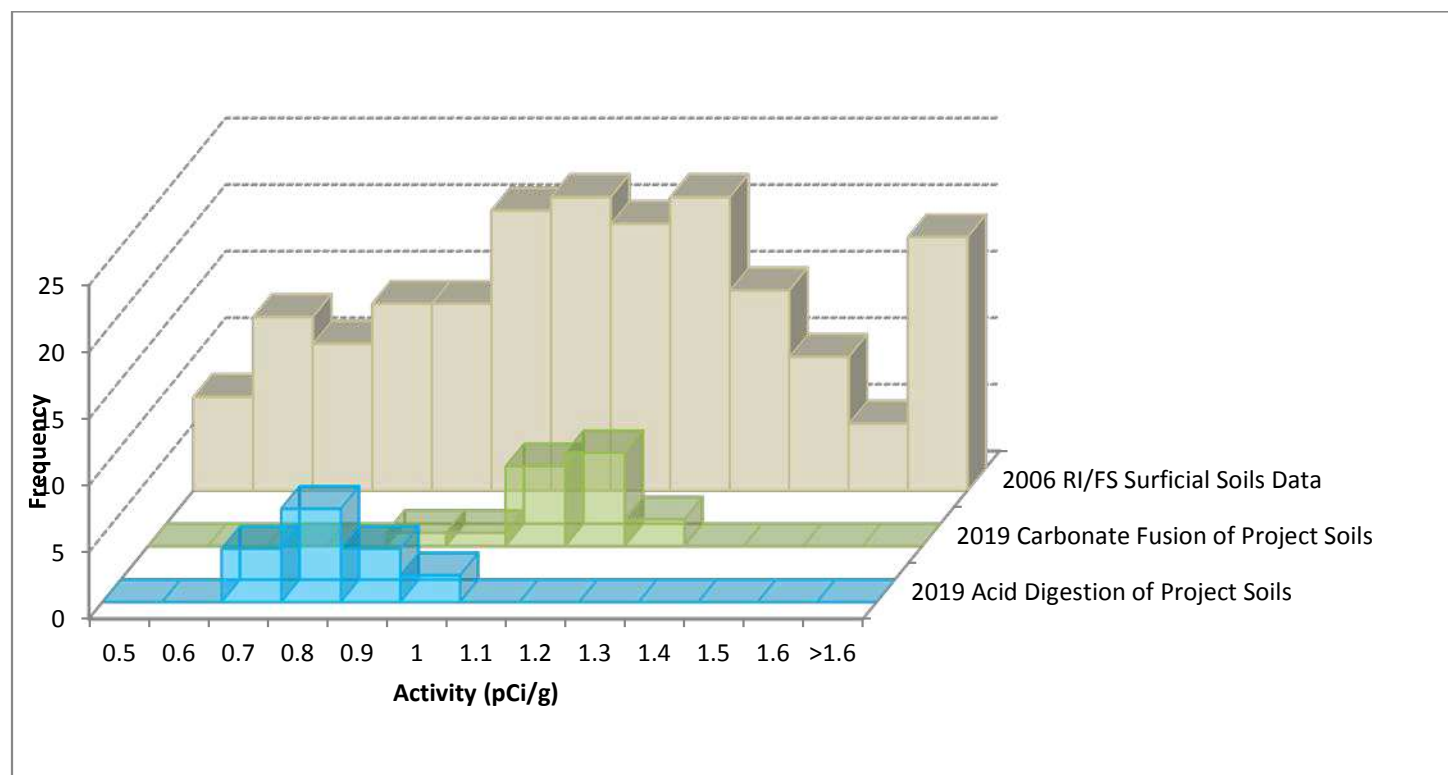
**Figure C-5 Wind Blown Area EU/Indiana Street Crossing Pu-238 Histogram**

Note: Data for 2006 RI/FS Pu-238 for the Rock Creek Drainage EU was not available.

**Figure C-6 Rock Creek Drainage EU/CO-128 Crossing U-234 Histogram****Figure C-7 Wind Blown Area EU/Indiana Street Crossing U-234 Histogram**



**Figure C-8 Rock Creek Drainage EU/CO-128 Crossing U-235 Histogram****Figure C-9 Wind Blown Area EU/Indiana Street Crossing U-235 Histogram**

**Figure C-10 Rock Creek Drainage EU/CO-128 Crossing U-238 Histogram****Figure C-11 Wind Blown Area EU/Indiana Street Crossing U-238 Histogram**

## INTERGOVERNMENTAL AGREEMENT FOR FUNDING OF ROCKY MOUNTAIN GREENWAY TRAIL CROSSINGS

THIS INTERGOVERNMENTAL AGREEMENT ("IGA"), dated for reference purposes this \_\_\_\_\_ day of \_\_\_\_\_, 2020, is by and between the **City of Boulder**, a home-rule municipal corporation and political subdivision of the State of Colorado ("City of Boulder"), **County of Boulder**, a body politic and corporate and political subdivision of the State of Colorado ("Boulder County"), **City of Arvada**, a home-rule municipal corporation and political subdivision of the State of Colorado ("Arvada"), **City of Westminster**, a home-rule municipal corporation and political subdivision of the State of Colorado ("Westminster"), and **County of Jefferson**, a body politic and corporate and political subdivision of the State of Colorado ("Jefferson County"). The above parties may be individually referred to herein as a "Party" and collectively as the "Parties."

### RECITALS

- A. Section 18(2)(a) of Article XIV of the Colorado Constitution and C.R.S. §§ 29-1-201, *et seq.*, and 29-20-105 authorize and encourage governments to cooperate with each other for purposes of planning and development and to provide for the joint exercise of functions and services to which each is individually authorized.
- B. The governing board of each Party and of the City and County of Broomfield ("Broomfield") adopted a resolution supporting, or conditionally supporting, Jefferson County's submission of an application for a Federal Lands Access Program Grant ("FLAP Grant") to fund a project ("Project") for the design and construction of grade-separated trail crossings entering the Rocky Flats National Wildlife Refuge at SH 128 and Indiana Street ("Trail Crossings").
- C. Jefferson County expended \$40,000.00 to retain Amec Foster Wheeler Environment & Infrastructure, Inc. to prepare the FLAP Grant application ("Application Costs").
- D. Jefferson County's FLAP Grant application was one of ten applications selected by the Colorado FLAP Programming Decisions Committee for consideration of Colorado FLAP funding.
- E. Jefferson County provided \$10,000.00 ("Scoping Costs") to the FHWA to develop a scoping summary, scoping report, and preliminary estimate for design, construction, and construction engineering to verify the scope and cost of the Project.
- F. The Parties and Broomfield entered into the Intergovernmental Agreement for Evaluation and Funding of a Rocky Mountain Greenway Trail – Radionuclide Soil Sampling and Analysis Plan dated December 11, 2017 (the "Prior IGA") that addressed the joint development of the radionuclide soil sampling analysis plan ("SAP") and each Parties' and Broomfield's respective share of the cost to procure the SAP.

- G. The Parties and Broomfield retained Engineering Analytics, Inc. to complete the SAP, SAP sampling results, and SAP final report that independently verifies the conclusions of the CERCLA cleanup efforts that the levels of Americium, Plutonium, Uranium, and their related isotopes at the Project sites are in a state protective of human health and the environment.
- H. The soil samples included in the Rocky Mountain Greenway Trail Crossings Soil Sampling Results Report (Sampling Report), dated February 5, 2020, produced 650 new data points from 130 sample locations of surface and sub-surface soils. Samples were, without exception, lower than historic values for the relevant exposure units. Preliminary Remediation Goals (PRGs), are extremely conservative benchmarks established as part of the CERCLA process, and with one exception, maximum detected values for all analytes were one or two orders of magnitude lower than related PRGs, and the mean and median values were even lower.
- I. The Parties have reviewed the Sampling Report, presented the results of the Sample Report to their respective governing boards, and have determined to proceed with funding the design and construction of the Project.
- J. The estimated total cost for the design and construction of the Project is \$3,930,000.00. As set forth herein, each Party shall contribute a portion of the 17.21% match requirement for the Project, which totals \$676,353.00.
- K. The Parties desire to enter into this IGA to address the Parties' participation in and financial contributions toward the Project.

## **AGREEMENT**

NOW, THEREFORE, in consideration of the recitals, promises, covenants, and undertakings hereinafter set forth, the Parties agree as follows:

- 1. **RECITALS.** The Recitals set forth above are incorporated into and made a part of this IGA.
- 2. **FUNDING CONTRIBUTION.**
  - a. Within 30 days of receipt of an invoice from Jefferson County, each Party shall reimburse Jefferson County for a portion of the \$676,353.00 Project match required under the FLAP Grant as set forth below:

Highway 128 Crossing - \$298,697

- i. City of Boulder: \$74,674
- ii. Boulder County: \$74,674
- iii. Arvada: \$49,783
- iv. Westminster: \$49,783

Indiana Crossing - \$377,656

- i. Arvada: \$125,885
- ii. Westminster: \$125,885

- b. As a result of these contributions, Jefferson County's share of the Project's match requirement is \$175,669.
  - c. Within 60 days following the Effective Date of this IGA, and in accordance with the Prior IGA, the Parties (and Broomfield) shall each reimburse Jefferson County a percentage of the Application Costs (\$40,000.00) and Scoping Costs (\$10,000.00) it expended. The percentage of each Party's reimbursement obligation is set forth in the Prior IGA and restated below:
    - i. City of Boulder: \$5,520.34
    - ii. Boulder County: \$5,520.34
    - iii. Westminster: \$12,986.44
    - iv. Arvada: \$12,986.44
3. **TRAIL CROSSINGS MAINTENANCE, OPERATION, AND OWNERSHIP.** The Parties agree to negotiate in good faith a third Intergovernmental Agreement that, to the extent required, addresses the maintenance, operation, and ownership of the Trail Crossings.
4. **NOTICES.** Communications pertaining to this IGA shall be directed to each Party as follows:

**City of Boulder**

Mark Gershman, Senior Planner/Special Projects Manager  
City of Boulder Open Space and Mountain Parks  
2520 55<sup>th</sup> Street  
Boulder, Colorado 80301  
Phone: 303-579-4811  
Email: gershmanm@bouldercolorado.gov

**County of Boulder**

Summer Laws, Policy Analyst  
Boulder County Commissioners Office  
P.O. Box 471 Boulder CO 80306  
Phone: 720-665-7095  
Email: [slaws@bouldercounty.org](mailto:slaws@bouldercounty.org)

**Arvada**

Emily Sexton, Parks and Urban Design Manager  
City of Arvada  
8101 Ralston Road  
Arvada, CO 80002  
Phone: (720) 898-7391  
Email: [esexton@arvada.org](mailto:esexton@arvada.org)

**Westminster**

Joe Reale, Open Space Superintendent  
City of Westminster  
4800 West 92<sup>nd</sup> Avenue  
Westminster, CO 80031  
Phone: 303.658.2142  
Email: [jreale@CityofWestminster.us](mailto:jreale@CityofWestminster.us)

**Jefferson County**

Hillary Merritt, Deputy Director  
Jefferson County Open Space  
700 Jefferson County Parkway  
Golden, CO  
Phone: 303-271-5948  
Email: [hmerritt@jeffco.us](mailto:hmerritt@jeffco.us)

5. **ENTIRE AGREEMENT.** This IGA is intended as the complete integration of all understandings among the Parties. No prior resolution, and no prior or contemporaneous addition, deletion, or other amendment to this IGA shall have any force or effect, unless embodied herein in writing. No subsequent amendment shall have any force or effect unless contained in a written agreement executed by the Parties.
6. **ENFORCEMENT.** The enforcement of this IGA and all rights of action relating to such enforcement, are reserved to the Parties.
7. **NO ASSUMPTION OF LIABILITIES.** By entering into and performing under this IGA no Party is assuming any liability for the acts or omissions of any other Party or third parties.
8. **GOVERNMENTAL IMMUNITY.** Nothing contained in this IGA shall give or allow any claim or right of action by any other third person, nor shall anything contained in this IGA be construed as a waiver of any provision of the Colorado Governmental Immunity Act, C.R.S. §§ 24-10-101, *et. seq.*, as amended. The Parties intend that any person or entity other than the Parties be deemed an incidental beneficiary only.

9. **OFFICIALS NOT TO BENEFIT.** No elected or employed member of any Party shall be paid or receive, directly or indirectly, any share or part of this IGA or any benefit that may arise therefrom.

10. **NON-APPROPRIATION.** This IGA shall not be interpreted to impose a multi-year obligation on the Parties. Financial commitments of the Parties under this IGA payable after the current fiscal year are contingent upon funds for this IGA being appropriated, budgeted and otherwise made available by a Party. If funds for this IGA are not budgeted and appropriated in any year subsequent to the fiscal year of execution of this IGA, a Party may immediately terminate its participation in this IGA by giving the other Parties notice of such non-appropriation.

11. **NO EMPLOYMENT RELATIONSHIP.** By entering into and performing under this IGA no Party is acting as an agent, servant or employee of any other Party.

12. **EXECUTION BY COUNTERPARTS; ELECTRONIC SIGNATURES.** This IGA may be executed in counterparts, each of which shall be deemed an original and shall constitute one and the same instrument. The Parties approve the use of electronic signatures for execution of this IGA. Only the following two forms of electronic signatures shall bind the Parties: (1) Electronic or facsimile delivery of a fully executed copy of a signature page; or (2) The image of the signature of an authorized signer inserted onto PDF format documents. All use of electronic signatures shall be governed by the Uniform Electronic Transactions Act, C.R.S. §24-71.3-101 through §24-71.3-121.

13. **EFFECTIVE DATE.** The Effective Date of this IGA is the date on which it has been fully executed by the Parties.

**IN WITNESS WHEREOF**, the Parties have caused this instrument to be duly executed.

**CITY OF BOULDER**

By: \_\_\_\_\_,  
\_\_\_\_\_, City Manager

Date: \_\_\_\_\_

ATTEST:

By: \_\_\_\_\_  
City Clerk

APPROVED AS TO FORM:

By: \_\_\_\_\_  
City Attorney

**COUNTY OF BOULDER**

By: \_\_\_\_\_  
\_\_\_\_\_, Chair

Date: \_\_\_\_\_

APPROVED AS TO FORM:

By: \_\_\_\_\_  
County Attorney

**CITY OF ARVADA**

By: \_\_\_\_\_

Date: \_\_\_\_\_

APPROVED AS TO FORM:

By: \_\_\_\_\_  
\_\_\_\_\_



**CITY OF WESTMINSTER**

By: \_\_\_\_\_

Date: \_\_\_\_\_

APPROVED AS TO FORM:

By: \_\_\_\_\_  
\_\_\_\_\_

**COUNTY OF JEFFERSON**, a body corporate and  
politic

By: \_\_\_\_\_  
Lesley Dahlkemper, Chairman

Date: \_\_\_\_\_

APPROVED AS TO FORM:

By: \_\_\_\_\_  
Steven L. Snyder  
Senior Assistant County Attorney