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1.0 INTRODUCTION

In September 2018, the United States Fish and Wildlife Service (USFWS) retained Engineering Analytics, Inc. (EA) of Fort Collins, Colorado to collect, analyze and evaluate surficial soil samples (the Project) along proposed trail improvements within the Rocky Flats National Wildlife Refuge (Refuge or RFNWR). The USFWS amended EA’s contact in January 2019 to extend the contract period. The Refuge location is illustrated on Figure 1-1 and information on the Refuge and the existing trail system is available at https://www.fws.gov/refuge/rocky_flats/.

The goal of this Project is to collect radionuclide data for soils along the proposed new trails 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 new Refuge trails 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. 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.

After nuclear weapons components production ended, the Rocky Flats 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 1-2). In October 2005, the United States Department of Energy (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 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 1-2), 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.

The Peripheral OU was 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) 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; characterization of radionuclides on these planned trails is the purpose of this study (the Project).

1.2 Previous Studies

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 these radionuclides was 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 six exposure units intersected by the proposed trails that are the subject of this Project are reproduced from the RI/FS Report in Tables 1-1 through 1-6. “Surface” soils were defined in the RI/FS Report as material in the upper six inches (~15 cm) of the soil horizon.

Within these six exposure units\(^1\), the RI/FS Report indicated that the highest levels of Am-241 and Pu-238/240 were found in the Wind Blown EU (Table 1-4) and the Lower Woman Drainage EU (Table 1-5). These exposure units are located east and southeast, or generally downwind of, the Industrial Area EU. Within these same six exposure units, the RI/FS report indicated that the highest levels of the three uranium isotopes were found in the Upper Woman Drainage EU (Table 1-6), which lies south of the Industrial Area EU. For the six exposure units investigated for this project, historic Pu-238 data were only published in the RI/FS Report for three of the exposure units (Tables 1-4, 1-5 and 1-6).

Table 1-1 Summary Statistics for Surface Soil Samples in the Rock Creek Drainage Exposure Unit Published in the 2006 RI/FS

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

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.

\(^1\) Planned trails in an area outside the Rocky Flats Plant were also investigated for this Project. This offsite area is located west of the southwestern corner of the site, abutting the Upper Woman Creek Drainage EU and within the Woman Creek drainage basin. The RI/FS Report data published for the Upper Woman Creek Drainage EU is used for comparative purposes for samples collected in this offsite area.
### Table 1-2  Summary Statistics for Surface Soil Samples in the Inter-Drainage Exposure Unit Published in the 2006 RI/FS

<table>
<thead>
<tr>
<th>Summary Statistic</th>
<th>Am-241</th>
<th>Pu-238</th>
<th>Pu-239/240</th>
<th>U-233/234</th>
<th>U-235</th>
<th>U-238</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>61</td>
<td>-</td>
<td>81</td>
<td>63</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>-0.082</td>
<td>-</td>
<td>-0.00869</td>
<td>0.246</td>
<td>-0.0126</td>
<td>0.551</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>0.43</td>
<td>-</td>
<td>2.2</td>
<td>4.3</td>
<td>0.3</td>
<td>4.5</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>0.0307</td>
<td>-</td>
<td>0.135</td>
<td>1.75</td>
<td>0.082</td>
<td>1.79</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.0598</td>
<td>-</td>
<td>0.238</td>
<td>0.732</td>
<td>0.0605</td>
<td>0.683</td>
</tr>
</tbody>
</table>

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.

### Table 1-3  Summary Statistics for Surface Soil Samples in the No Name Gulch Drainage Exposure Unit Published in the 2006 RI/FS

<table>
<thead>
<tr>
<th>Summary Statistic</th>
<th>Am-241</th>
<th>Pu-238</th>
<th>Pu-239/240</th>
<th>U-233/234</th>
<th>U-235</th>
<th>U-238</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>263</td>
<td>-</td>
<td>261</td>
<td>267</td>
<td>267</td>
<td>267</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>-0.0301</td>
<td>-</td>
<td>-6.18E-04</td>
<td>0.439</td>
<td>-0.0754</td>
<td>0.386</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>1.15</td>
<td>-</td>
<td>2.31</td>
<td>1.79</td>
<td>0.276</td>
<td>1.75</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>0.0311</td>
<td>-</td>
<td>0.0807</td>
<td>0.915</td>
<td>0.0435</td>
<td>0.95</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.104</td>
<td>-</td>
<td>0.203</td>
<td>0.241</td>
<td>0.0367</td>
<td>0.242</td>
</tr>
</tbody>
</table>

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.

### Table 1-4  Summary Statistics for Surface Soil Samples in the Wind Blown Area Exposure Unit Published in the 2006 RI/FS

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

Notes:
1. Activity in pCi/g.
2. All values were considered “detected.”
Table 1-5  Summary Statistics for Surface Soil Samples in the Lower Woman Drainage Exposure Unit Published in the 2006 RI/FS

<table>
<thead>
<tr>
<th>Summary Statistic</th>
<th>Am-241</th>
<th>Pu-238</th>
<th>Pu-239/240</th>
<th>U-233/234</th>
<th>U-235</th>
<th>U-238</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>88</td>
<td>6</td>
<td>94</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>-0.015</td>
<td>0.01</td>
<td>-0.002</td>
<td>0.334</td>
<td>-0.056</td>
<td>0.477</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>1.66</td>
<td>0.06</td>
<td>12.2</td>
<td>2</td>
<td>0.38</td>
<td>2.2</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>0.302</td>
<td>0.034</td>
<td>1.89</td>
<td>1.12</td>
<td>0.059</td>
<td>1.18</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.341</td>
<td>0.02</td>
<td>2.28</td>
<td>0.322</td>
<td>0.072</td>
<td>0.332</td>
</tr>
</tbody>
</table>

Notes:
1. Activity in pCi/g.
2. All values were considered “detected.”

Table 1-6  Summary Statistics for Surface Soil Samples in the Upper Woman Drainage Exposure Unit Published in the 2006 RI/FS

<table>
<thead>
<tr>
<th>Summary Statistic</th>
<th>Am-241</th>
<th>Pu-238</th>
<th>Pu-239/240</th>
<th>U-233/234</th>
<th>U-235</th>
<th>U-238</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>152</td>
<td>14</td>
<td>175</td>
<td>154</td>
<td>154</td>
<td>154</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>-0.0288</td>
<td>-0.002</td>
<td>-0.0126</td>
<td>0.191</td>
<td>-0.023</td>
<td>0.283</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>0.802</td>
<td>0.0253</td>
<td>5.01</td>
<td>47.5</td>
<td>2.24</td>
<td>209</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>0.0366</td>
<td>0.00236</td>
<td>0.147</td>
<td>1.49</td>
<td>0.092</td>
<td>3.54</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.0763</td>
<td>0.00671</td>
<td>0.421</td>
<td>3.9</td>
<td>0.25</td>
<td>18.2</td>
</tr>
</tbody>
</table>

Notes:
1. Activity in pCi/g.
2. All values were considered “detected.”

The RI/FS report also provided estimates for background levels of metals and 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 1-7.

Table 1-7  Sitewide Surface Soil Background Radionuclide Activities

<table>
<thead>
<tr>
<th>Am-241 (pCi/g)</th>
<th>Pu-239/240 (pCi/g)</th>
<th>U-233/234 (pCi/g)</th>
<th>U-235 (pCi/g)</th>
<th>U-238 (pCi/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.022</td>
<td>0.066</td>
<td>2.25</td>
<td>0.095</td>
<td>2.00</td>
</tr>
</tbody>
</table>

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.

As part of their land acquisition process, the USFWS collected grab soil samples from 0-2 inch depths at 41 locations (USFWS, 2006) at Rocky Flats. These locations were primarily in the northern, western, and southern portions of the site. The results of these samples are summarized, by the isotopes of interest, below:
- Am-241: Activities reportedly ranged from 0.0043 pCi/g to 5.27 pCi/g. The samples with the two highest values were in the eastern and southeastern portions of the site.
- Pu-238: Activities were below the minimum detectable concentration (MDC) in the majority of the soil samples. The samples with the two highest values were in the eastern and southeastern portions of the site.
- Pu-239/240: Activities reportedly ranged from 0.004 pCi/g to 21.8 pCi/g. The samples with the two highest values were in the eastern and southeastern portions of the site.
- U-234: Activities reportedly ranged from 0.585 pCi/g to 1.58 pCi/g. The samples with the two highest values were in the eastern and southeastern portions of the site.
- U-235/236: Activities reportedly ranged from 0.033 pCi/g to 0.107 pCi/g. The sample with the highest value was in the eastern portion of the site. The sample with the second highest value was located in the northwest portion of the site.
- U-238: Activities reportedly ranged from 0.551 pCi/g to 1.61 pCi/g. The samples with the two highest values were in the eastern and southeastern portions of the site.

The USFWS concluded that “sampling results were, although not always at or below background levels, well within the range of results that the DOE presented” (referring to the RI/FS Report data).

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 the proposed trails at the Refuge with existing Partner Group trail infrastructure adjacent to the Refuge. In fall 2017, the Partner Group retained EA to perform confirmatory soil sampling at the two crossing locations. EA developed a Sampling and Analysis Plan (SAP) for the Partner Group that documented the procedural and analytical requirements of soil sampling. A draft version of the SAP was publicized by the Partner Group for public review and public meetings were held in Boulder and Westminster to discuss the SAP. EA finalized the SAP in March 2019 (EA, 2019) and used the SAP as the basis for sampling the Refuge soils on this Project. The SAP is provided in Appendix A.

1.3 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 USFWS 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

As described in the SAP (EA, 2019), EA utilized the software tool Visual Sample Plan (VSP) to evaluate the number of samples to collect for the Project. The USFWS requested that EA sample approximately 21,500 feet of planned trail. Using VSP, EA calculated a sample density of one sample per 450 feet of trail. This density resulted in 48 planned locations, which were plotted at regularly spaced intervals along the planned trail routes. EA pre-loaded the sample location coordinates into a hand-held GPS unit, and then proceeded to each planned sample location in the field. Sample locations were adjusted a few feet in the field, if necessary, to account for site-specific conditions (e.g., rock, large plant).

2.2 Sample Collection

EA personnel collected soil samples from the 48 locations over three consecutive days (June 26-28, 2019). Per the SAP (EA, 2019), 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 also 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 (“02” sample suffix) each day. One deviation from the SAP (EA, 2019) is that EA personnel did not field sieve the samples. The field sieving step was omitted because the abundant precipitation this spring and early summer 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) each day 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

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<th>Sample Type</th>
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Table 2-2 Soil Sample Breakdown by Exposure Unit

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Note:
1. An Archive soil sample (Field Sample ID with a “99” suffix) was collected by EA at each sample location.

The 48 Project sample locations are illustrated on Figure 2-1. 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 located in.

Table 2-2 Soil Sample Breakdown by Exposure Unit

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<th>Longitude</th>
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<td>-105.2225453</td>
<td>39.88378001</td>
<td>Southwest Offsite*</td>
</tr>
</tbody>
</table>

Notes:
1. Latitude and Longitude approximate. Coordinate system is GCS North America (1927).
2. “Southwest Offsite” is not an exposure unit associated with the 2006 RI/FS. Rather it refers to the location of these samples. For comparison purposes, these Project samples are considered from the Upper Woman Creek EU RI/FS data (see Section 1.2).

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

<table>
<thead>
<tr>
<th>Document Number</th>
<th>Document Title</th>
<th>Revision Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOP 736</td>
<td>Representative Laboratory Subsampling – Radiochemistry</td>
<td>1</td>
</tr>
<tr>
<td>SOP 773</td>
<td>Total Dissolution of Solids for the Radiochemical Determination of Actinides and other Non-Volatile Radionuclides</td>
<td>12</td>
</tr>
<tr>
<td>SOP 777</td>
<td>Actinides – Thorium, Americium and Plutonium Sequential Separation by Ion Exchange</td>
<td>13</td>
</tr>
<tr>
<td>SOP 778</td>
<td>Actinides - Uranium, Plutonium and Americium/Curium (Partial) Sequential Separation by Ion Exchange</td>
<td>14</td>
</tr>
<tr>
<td>SOP 751</td>
<td>Actinides – Americium/Curium Separation – Purification by TRUTM and TEVATM Spec Column</td>
<td>6</td>
</tr>
</tbody>
</table>

Water (Equipment Rinsate Blank) Samples

<table>
<thead>
<tr>
<th>Document Number</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOP 776</td>
<td>Preparation of Water Samples for Actinides</td>
</tr>
</tbody>
</table>

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 2-2.

ALS initially processed the soil samples per ALS SOP 736, Representative Laboratory Subsampling – Radiochemistry. 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 cannister 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.

The milled samples were 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, 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 nitric, hydrochloric, and hydrofluoric acids. A subsequent ferric hydroxide co-precipitation (not shown on Figure 2-2) was performed to preconcentrate 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 TRUTM and TEVATM 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 being well below the levels provided in Table 2-4.

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

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

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 first two preparation steps shown for soils (SOPs 736 and 773) on Figure 2-2. 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. The data quality is summarized in Section 3.1. The radionuclide results are summarized in Section 3.2. Section 4 provides a detailed description of the radionuclide results within each exposure unit.

3.1 Data Quality Review

ALS reported the Project results in work order numbers 1906661, 1906738, and 1906768. Each ALS work order consisted of samples collected on a separate day. 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. 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 with a few exceptions involving Pu-239/240 and U-234. A low level of Pu-239/240 was present in one MB while low levels of U-234 were detected in two of the MBs. However, the level of Pu-239/240 detected was only 8% of the Project required MDC, while the levels of U-234 detected ranged from 16% to 18% of the Project required MDC. ALS flagged these result as “B3” but did not qualify any sample results associated with the MBs. EA agrees with this decision.
  - 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 minutes. Plutonium isotopes were counted for 360 to 480 minutes. Uranium isotopes were counted for 420 to 480 minutes.
- The specified MDCs (Table 2-4) were achieved in all samples.

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

- The three ERB samples were combined in one preparation batch. 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 LCDS results were within ALS control limits.
  - The LCS to LCDS 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 each field duplicate and equipment rinsate blank each day. As 15 to 18 primary soil samples were collected each day, the ratio of field quality assurance samples to primary samples meets the generally accepted 1:20 (of each) requirement. The following provides a review of the field quality control sample results.

- The results for the three ERB samples (SB-9-0-2-03, SB-26-0-2-03 and SB-34-0-2-03) were all reported as below the MDC.
- The results from the three 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 was reported below the MDC, which precludes the calculation of the RPD.

Table 3-1 Summary of Field Duplicate Sample RPD Results

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Field Sample IDs (-01 = primary &amp; -02 = duplicate)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SB-19-0-2-01/02</td>
</tr>
<tr>
<td>Am-241</td>
<td>U</td>
</tr>
<tr>
<td>Pu-238</td>
<td>U</td>
</tr>
<tr>
<td>Pu-239/240</td>
<td>U</td>
</tr>
<tr>
<td>U-234</td>
<td>13%</td>
</tr>
<tr>
<td>U-235</td>
<td>U</td>
</tr>
<tr>
<td>U-238</td>
<td>23%</td>
</tr>
</tbody>
</table>

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

Based on a review of the laboratory and field quality control sample results, EA judges the Project data quality sufficient to meet the Project goal. No qualifiers, other than those given by ALS, are recommended for the Project sample results.

### 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 1-7) and Wildlife Refuge Worker PRG levels (Table 2-4), where applicable. As described in DOE (2017), 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.4. Each appendix contains a separate report for americium, plutonium, and uranium. Sample locations are illustrated on Figure 2-1.
3.2.1 Americium

The Project americium soil sample results are summarized in Table 3-2. Thirty-four of the 48 samples (71%) possessed an Am-241 activity below the sample MDC (“U” qualifier). The sample MDCs for all samples qualified as “U” in Table 3-2 are less than the background level of 0.022 pCi/g (Table 1-7). However, the 14 samples with detectable Am-241 all expressed activities greater than the background level. Nevertheless, the maximum Am-241 activity detected in a Project sample (0.66 pCi/g in Wind Blown Area EU sample SB-23, which is bolded in Table 3-2) is an order of magnitude lower than the Wildlife Refuge Worker PRG of 11.5 pCi/g (Table 2-4).

Table 3-2 Americium Results

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>Am-241 Activity</th>
<th>2s TPU</th>
<th>Q</th>
<th>RI/FS Exposure Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-1</td>
<td>0.001</td>
<td>0.015</td>
<td>U</td>
<td>No Name Gulch Drainage</td>
</tr>
<tr>
<td>SB-2</td>
<td>0.010</td>
<td>0.017</td>
<td>U</td>
<td>No Name Gulch Drainage</td>
</tr>
<tr>
<td>SB-3</td>
<td>0.011</td>
<td>0.018</td>
<td>U</td>
<td>No Name Gulch Drainage</td>
</tr>
<tr>
<td>SB-4</td>
<td>0.017</td>
<td>0.020</td>
<td>U</td>
<td>No Name Gulch Drainage</td>
</tr>
<tr>
<td>SB-5</td>
<td>0.007</td>
<td>0.015</td>
<td>U</td>
<td>Inter-Drainage</td>
</tr>
<tr>
<td>SB-6</td>
<td>0.003</td>
<td>0.020</td>
<td>U</td>
<td>Inter-Drainage</td>
</tr>
<tr>
<td>SB-7</td>
<td>0.010</td>
<td>0.018</td>
<td>U</td>
<td>Inter-Drainage</td>
</tr>
<tr>
<td>SB-8</td>
<td>0.009</td>
<td>0.016</td>
<td>U</td>
<td>Inter-Drainage</td>
</tr>
<tr>
<td>SB-9</td>
<td>0.002</td>
<td>0.018</td>
<td>U</td>
<td>Inter-Drainage</td>
</tr>
<tr>
<td>SB-10</td>
<td>0.006</td>
<td>0.012</td>
<td>U</td>
<td>Inter-Drainage</td>
</tr>
<tr>
<td>SB-11</td>
<td>-0.007</td>
<td>0.015</td>
<td>U</td>
<td>Inter-Drainage</td>
</tr>
<tr>
<td>SB-12</td>
<td>-0.007</td>
<td>0.022</td>
<td>U</td>
<td>No Name Gulch Drainage</td>
</tr>
<tr>
<td>SB-13</td>
<td>0.010</td>
<td>0.020</td>
<td>U</td>
<td>Rock Creek Drainage</td>
</tr>
<tr>
<td>SB-14</td>
<td>0.005</td>
<td>0.016</td>
<td>U</td>
<td>Rock Creek Drainage</td>
</tr>
<tr>
<td>SB-15</td>
<td>0.011</td>
<td>0.018</td>
<td>U</td>
<td>Rock Creek Drainage</td>
</tr>
<tr>
<td>SB-16</td>
<td>-0.008</td>
<td>0.010</td>
<td>U</td>
<td>Rock Creek Drainage</td>
</tr>
<tr>
<td>SB-17</td>
<td>-0.005</td>
<td>0.018</td>
<td>U</td>
<td>Rock Creek Drainage</td>
</tr>
<tr>
<td>SB-18</td>
<td>-0.012</td>
<td>0.015</td>
<td>U</td>
<td>Rock Creek Drainage</td>
</tr>
<tr>
<td>SB-19</td>
<td>0.013</td>
<td>0.015</td>
<td>U</td>
<td>Rock Creek Drainage</td>
</tr>
<tr>
<td>SB-20</td>
<td>-0.001</td>
<td>0.016</td>
<td>U</td>
<td>Rock Creek Drainage</td>
</tr>
<tr>
<td>SB-21</td>
<td>0.221</td>
<td>0.065</td>
<td></td>
<td>Wind Blown Area</td>
</tr>
<tr>
<td>SB-22</td>
<td>0.358</td>
<td>0.087</td>
<td></td>
<td>Wind Blown Area</td>
</tr>
<tr>
<td>SB-23</td>
<td><strong>0.660</strong></td>
<td>0.140</td>
<td></td>
<td>Wind Blown Area</td>
</tr>
<tr>
<td>SB-24</td>
<td>0.630</td>
<td>0.130</td>
<td></td>
<td>Wind Blown Area</td>
</tr>
<tr>
<td>SB-25</td>
<td>0.560</td>
<td>0.120</td>
<td></td>
<td>Wind Blown Area</td>
</tr>
<tr>
<td>SB-26</td>
<td>0.450</td>
<td>0.100</td>
<td></td>
<td>Wind Blown Area</td>
</tr>
<tr>
<td>SB-27</td>
<td>0.334</td>
<td>0.090</td>
<td></td>
<td>Wind Blown Area</td>
</tr>
<tr>
<td>SB-28</td>
<td>0.152</td>
<td>0.053</td>
<td></td>
<td>Wind Blown Area</td>
</tr>
<tr>
<td>SB-29</td>
<td>0.354</td>
<td>0.090</td>
<td></td>
<td>Wind Blown Area</td>
</tr>
</tbody>
</table>
**Soil Sample Location** | **Am-241** | **RI/FS Exposure Unit**
---|---|---
SB-30 | 0.143 | Lower Woman Drainage
SB-31 | 0.110 | Lower Woman Drainage
SB-32 | 0.249 | Lower Woman Drainage
SB-33 | 0.219 | Lower Woman Drainage
SB-34 | 0.02 | U Southwest Offsite*
SB-35 | -0.005 | U Southwest Offsite*
SB-36 | 0.035 | U Southwest Offsite*
SB-37 | 0.007 | U Southwest Offsite*
SB-38 | -0.005 | U Southwest Offsite*
SB-39 | -0.004 | U Southwest Offsite*
SB-40 | 0.006 | U Southwest Offsite*
SB-41 | -0.002 | U Southwest Offsite*
SB-42 | 0.002 | U Southwest Offsite*
SB-43 | 0.021 | U Southwest Offsite*
SB-44 | 0.016 | U Southwest Offsite*
SB-45 | 0.003 | U Southwest Offsite*
SB-46 | 0.003 | U Southwest Offsite*
SB-47 | 0.012 | U Southwest Offsite*
SB-48 | 0.003 | U Southwest Offsite*

Notes:
1. Activity is in pCi/g.
2. “Q” is sample qualifier assigned by lab. A “U” indicates that the result was below the MDC.
3. Southwest Offsite is not an exposure unit associated with the 2006 RI/FS. Rather, it refers to the location of these samples. For comparison purposes, these Project samples are considered from the Upper Woman Creek EU RI/FS data (see Section 1.2).
4. TPU = Total Propagated Uncertainty.

**3.2.2 Plutonium**

The Project plutonium soil sample results are summarized in Table 3-3. The Pu-238 and Pu-239/240 results are summarized below. The maximum value of each radionuclide is bolded in Table 3-3.

Thirty-nine of the 48 samples (81%) possessed a Pu-238 activity below the sample MDC. The maximum Pu-238 activity detected in a Project sample (0.072 pCi/g in Wind Blown Area EU sample SB-24) is two 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 surface soil background summary table (Table 3.9 in the RI/FS).

Thirty-three of the 48 samples (69%) in Table 3-3 possessed a Pu-239/240 activity below the background level of 0.066 pCi/g (Table 1-7) including the 15 results reported below the sample
MDC. The maximum Pu-239/240 activity detected in a Project sample (3.51 pCi/g in Wind Blown Area EU sample SB-25) is one-third the Wildlife Refuge Worker PRG of 9.3 pCi/g (Table 2-4).

Table 3-3  Plutonium Results

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>Pu-238 Activity</th>
<th>2s TPU</th>
<th>Q</th>
<th>Pu-239/240 Activity</th>
<th>2s TPU</th>
<th>Q</th>
<th>RI/FS Exposure Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-1</td>
<td>0.004</td>
<td>0.017</td>
<td>U</td>
<td>0.013</td>
<td>0.017</td>
<td>U</td>
<td>No Name Gulch Drainage</td>
</tr>
<tr>
<td>SB-2</td>
<td>0.008</td>
<td>0.019</td>
<td>U</td>
<td>0.013</td>
<td>0.022</td>
<td>U</td>
<td>No Name Gulch Drainage</td>
</tr>
<tr>
<td>SB-3</td>
<td>0.004</td>
<td>0.014</td>
<td>U</td>
<td>0.048</td>
<td>0.029</td>
<td></td>
<td>No Name Gulch Drainage</td>
</tr>
<tr>
<td>SB-4</td>
<td>0</td>
<td>0.015</td>
<td>U</td>
<td>0.048</td>
<td>0.030</td>
<td></td>
<td>No Name Gulch Drainage</td>
</tr>
<tr>
<td>SB-5</td>
<td>0.010</td>
<td>0.018</td>
<td>U</td>
<td>0.017</td>
<td>0.019</td>
<td>U</td>
<td>Inter-Drainage</td>
</tr>
<tr>
<td>SB-6</td>
<td>0.005</td>
<td>0.019</td>
<td>U</td>
<td>0.056</td>
<td>0.035</td>
<td></td>
<td>Inter-Drainage</td>
</tr>
<tr>
<td>SB-7</td>
<td>0.002</td>
<td>0.016</td>
<td>U</td>
<td>0.030</td>
<td>0.027</td>
<td>U</td>
<td>Inter-Drainage</td>
</tr>
<tr>
<td>SB-8</td>
<td>0.005</td>
<td>0.017</td>
<td>U</td>
<td>0.078</td>
<td>0.042</td>
<td></td>
<td>Inter-Drainage</td>
</tr>
<tr>
<td>SB-9</td>
<td>0.008</td>
<td>0.015</td>
<td>U</td>
<td>0.026</td>
<td>0.024</td>
<td>U</td>
<td>Inter-Drainage</td>
</tr>
<tr>
<td>SB-10</td>
<td>0.018</td>
<td>0.024</td>
<td>U</td>
<td>0.022</td>
<td>0.023</td>
<td>U</td>
<td>Inter-Drainage</td>
</tr>
<tr>
<td>SB-11</td>
<td>0.002</td>
<td>0.015</td>
<td>U</td>
<td>0.031</td>
<td>0.024</td>
<td></td>
<td>Inter-Drainage</td>
</tr>
<tr>
<td>SB-12</td>
<td>-0.004</td>
<td>0.017</td>
<td>U</td>
<td>0.033</td>
<td>0.026</td>
<td></td>
<td>No Name Gulch Drainage</td>
</tr>
<tr>
<td>SB-13</td>
<td>-0.024</td>
<td>0.020</td>
<td>U</td>
<td>0.058</td>
<td>0.036</td>
<td></td>
<td>Rock Creek Drainage</td>
</tr>
<tr>
<td>SB-14</td>
<td>-0.005</td>
<td>0.021</td>
<td>U</td>
<td>0.031</td>
<td>0.031</td>
<td>U</td>
<td>Rock Creek Drainage</td>
</tr>
<tr>
<td>SB-15</td>
<td>0.006</td>
<td>0.017</td>
<td>U</td>
<td>0.019</td>
<td>0.022</td>
<td>U</td>
<td>Rock Creek Drainage</td>
</tr>
<tr>
<td>SB-16</td>
<td>0</td>
<td>0.016</td>
<td>U</td>
<td>0.010</td>
<td>0.016</td>
<td>U</td>
<td>Rock Creek Drainage</td>
</tr>
<tr>
<td>SB-17</td>
<td>0.003</td>
<td>0.020</td>
<td>U</td>
<td>0.010</td>
<td>0.020</td>
<td>U</td>
<td>Rock Creek Drainage</td>
</tr>
<tr>
<td>SB-18</td>
<td>0.004</td>
<td>0.016</td>
<td>U</td>
<td>0.023</td>
<td>0.021</td>
<td>U</td>
<td>Rock Creek Drainage</td>
</tr>
<tr>
<td>SB-19</td>
<td>0.004</td>
<td>0.016</td>
<td>U</td>
<td>0.017</td>
<td>0.019</td>
<td>U</td>
<td>Rock Creek Drainage</td>
</tr>
<tr>
<td>SB-20</td>
<td>0.001</td>
<td>0.018</td>
<td>U</td>
<td>0.042</td>
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The Project uranium soil sample results are summarized in Table 3-4 and are discussed below. The maximum value of each radionuclide is bolded in Table 3-4.

All 48 samples possessed a U-234 activity above the sample MDC. However, the U-234 activity in all samples was less than the background level of 2.25 pCi/g (Table 1-7). The maximum U-234 activity detected in a Project sample (1.14 pCi/g in Southwest Offsite area sample SB -47) is an order of magnitude lower than Wildlife Refuge Worker PRG of 20.0 pCi/g (Table 2-4).

Twelve of the 48 samples (25%) possessed a U-235 activity below the sample MDC. However, the U-235 activity in all samples was less than the background level of 0.095 pCi/g (Table 1-7). The maximum U-235 activity detected in a Project sample (0.09 pCi/g in Wind Blown Area EU sample SB-29) is an order of magnitude lower than the Wildlife Refuge Worker PRG of 4.5 pCi/g (Table 2-4).

All 48 samples possessed a U-238 activity above the sample MDC. However, the U-238 activity in all samples was less than the background level of 2.00 pCi/g (Table 1-7). The maximum U-238 activity detected in a Project sample (1.2 pCi/g in Southwest Offsite area sample SB-47) is an order of magnitude lower than Wildlife Refuge Worker PRG of 22.9 pCi/g (Table 2-4).
Table 3-4  Uranium Results

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Notes:
1. Activity is in pCi/g.
2. “Q” is sample qualifier assigned by lab. A “U” indicates that the result was below the MDC.
3. Southwest Offsite is not an exposure unit associated with the 2006 RI/FS. Rather, it refers to the location of these samples. For comparison purposes, these Project samples are considered from the Upper Woman Creek EU RI/FS data (see Section 1.2).
4. TPU = Total Propagated Uncertainty.
4.0 EVALUATION

The americium, plutonium, and uranium results from the Project soils samples from each exposure unit are discussed in this section. The levels of the radionuclides 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 through 1-6), the sitewide surface soil background levels (Table 1-7), 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 Rock Creek Drainage EU

The Rock Creek Drainage EU lies on the north side of the site (Figure 2-1). EA collected eight soil samples along the planned trail alignment in this exposure unit (Figure 4-1).

4.1.1 Americium

The Am-241 results from the eight soil samples collected within the Rock Creek Drainage EU are summarized in Table 4-1. All values were below their MDCs, with the sample MDCs being below the background level of 0.022 pCi/g. The maximum Am-241 activity reported for a Project sample from this exposure unit (0.013 pCi/g in sample SB-19) is two orders of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum Project MDC is also less than the mean Am-241 activity (0.0613 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-1).
Table 4-1  Americium Summary Statistics for Soil Samples from Rock Creek Drainage EU

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>Activity</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-13</td>
<td>0.010</td>
<td>U</td>
</tr>
<tr>
<td>SB-14</td>
<td>0.005</td>
<td>U</td>
</tr>
<tr>
<td>SB-15</td>
<td>0.011</td>
<td>U</td>
</tr>
<tr>
<td>SB-16</td>
<td>-0.008</td>
<td>U</td>
</tr>
<tr>
<td>SB-17</td>
<td>-0.005</td>
<td>U</td>
</tr>
<tr>
<td>SB-18</td>
<td>-0.012</td>
<td>U</td>
</tr>
<tr>
<td>SB-19</td>
<td>0.013</td>
<td>U</td>
</tr>
<tr>
<td>SB-20</td>
<td>-0.001</td>
<td>U</td>
</tr>
</tbody>
</table>

Summary Statistics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>8</td>
</tr>
<tr>
<td>Total Number of Results above MDC</td>
<td>0</td>
</tr>
<tr>
<td>Detection Frequency</td>
<td>0%</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>-0.012</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>0.013</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>N.A.</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

Notes:
1. Activity is in pCi/g.
2. Qualifier assigned by lab. A “U” indicated that the result was below the MDC.
3. N.A. = Not applicable. All values below MDC.

4.1.2  Plutonium

The plutonium results from the eight soil samples collected within the Rock Creek Drainage EU are summarized in Table 4-2.

All Pu-238 values were below their MDCs. The maximum Pu-238 activity reported for a Project sample from this exposure unit (0.006 pCi/g in sample SB-15) is three orders of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4).

Six of the eight Pu-239/240 values were below 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 (0.058 pCi/g in sample SB-13) is two orders of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum Project value 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).
Table 4-2  Plutonium Summary Statistics for Soil Samples from Rock Creek Drainage EU

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>Pu-238 Activity</th>
<th>Qualifier</th>
<th>Pu-239/240 Activity</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-13</td>
<td>-0.024</td>
<td>U</td>
<td>0.058</td>
<td></td>
</tr>
<tr>
<td>SB-14</td>
<td>-0.005</td>
<td>U</td>
<td>0.031</td>
<td>U</td>
</tr>
<tr>
<td>SB-15</td>
<td>0.006</td>
<td>U</td>
<td>0.019</td>
<td>U</td>
</tr>
<tr>
<td>SB-16</td>
<td>0</td>
<td>U</td>
<td>0.010</td>
<td>U</td>
</tr>
<tr>
<td>SB-17</td>
<td>0.003</td>
<td>U</td>
<td>0.010</td>
<td>U</td>
</tr>
<tr>
<td>SB-18</td>
<td>0.004</td>
<td>U</td>
<td>0.023</td>
<td>U</td>
</tr>
<tr>
<td>SB-19</td>
<td>0.004</td>
<td>U</td>
<td>0.017</td>
<td>U</td>
</tr>
<tr>
<td>SB-20</td>
<td>0.001</td>
<td>U</td>
<td>0.042</td>
<td></td>
</tr>
</tbody>
</table>

Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>Pu-238</th>
<th>Pu-239/240</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Total Number of Results above MDC</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Detection Frequency</td>
<td>0%</td>
<td>25%</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>-0.024</td>
<td>0.010</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>0.006</td>
<td>0.058</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>N.A</td>
<td>0.050</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>N.A</td>
<td>0.011</td>
</tr>
</tbody>
</table>

Notes:
1. Activity is in pCi/g.
2. Qualifier assigned by lab. A “U” indicated 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.

4.1.3  Uranium

The uranium results from the eight soil samples collected within the Rock Creek Drainage EU are summarized in Table 4-3.

All U-234 values were above their MDCs, but below the background level of 2.25 pCi/g (Table 1-7). The maximum U-234 activity reported in a Project sample from this exposure unit (1.02 pCi/g in sample SB-15) is an order of magnitude lower than Wildlife Refuge Worker PRG (Table 2-4). This maximum activity is slightly less than the mean U-234 activity (1.07 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-1).

Three of the eight U-235 values were below their MDCs. All values were below the background level of 0.095 pCi/g. The maximum U-235 activity reported in a Project sample from this exposure unit (0.076 pCi/g in sample SB-15) is an order of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum activity is above the mean U-235 activity (0.0641 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-1); however, the mean activity of the Project soil samples (Table 4-3) is less than the mean RI/FS Report value (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 (0.98 pCi/g in sample SB-15) is an order of magnitude lower than Wildlife Refuge Worker PRG (Table 2-4). This maximum activity 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).

Table 4-3  Uranium Summary Statistics for Soil Samples from Rock Creek Drainage EU

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>U-234 Activity</th>
<th>U-234 Qualifier</th>
<th>U-235 Activity</th>
<th>U-235 Qualifier</th>
<th>U-238 Activity</th>
<th>U-238 Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-13</td>
<td>0.63</td>
<td></td>
<td>0.028</td>
<td>U</td>
<td>0.63</td>
<td></td>
</tr>
<tr>
<td>SB-14</td>
<td>0.58</td>
<td></td>
<td>0.017</td>
<td>U</td>
<td>0.54</td>
<td></td>
</tr>
<tr>
<td>SB-15</td>
<td>1.02</td>
<td></td>
<td>0.076</td>
<td></td>
<td>0.98</td>
<td></td>
</tr>
<tr>
<td>SB-16</td>
<td>0.74</td>
<td></td>
<td>0.034</td>
<td></td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>SB-17</td>
<td>0.71</td>
<td></td>
<td>0.041</td>
<td></td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>SB-18</td>
<td>0.64</td>
<td></td>
<td>0.042</td>
<td></td>
<td>0.82</td>
<td></td>
</tr>
<tr>
<td>SB-19</td>
<td>0.73</td>
<td></td>
<td>0.028</td>
<td>U</td>
<td>0.55</td>
<td></td>
</tr>
<tr>
<td>SB-20</td>
<td>0.64</td>
<td></td>
<td>0.04</td>
<td></td>
<td>0.67</td>
<td></td>
</tr>
</tbody>
</table>

Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>Total Number of Results</th>
<th>Total Number of Results above MDC</th>
<th>Detection Frequency</th>
<th>Minimum Activity</th>
<th>Maximum Activity</th>
<th>Arithmetic Mean Activity</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>8</td>
<td>8</td>
<td>100%</td>
<td>0.58</td>
<td>1.02</td>
<td>0.71</td>
<td>0.14</td>
</tr>
<tr>
<td>Total Number of Results above MDC</td>
<td>8</td>
<td>5</td>
<td>63%</td>
<td>0.017</td>
<td>0.076</td>
<td>0.047</td>
<td>0.017</td>
</tr>
</tbody>
</table>

Notes:
1. Activity is in pCi/g.
2. Qualifier assigned by lab. A “U” indicated 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.

4.2  Inter-Drainage EA

The Inter-Drainage EU lies on the north side of the site, immediately southeast of the Rock Creek Drainage EU (Figure 2-1). EA collected seven soil samples along the planned trail alignments in this exposure unit (Figure 4-1).

4.2.1  Americium

The Am-241 results from the seven soil samples collected within the Inter-Drainage EU are summarized in Table 4-4. All values were below their MDCs, with the sample MDCs being less than the background level of 0.022 pCi/g. The maximum Am-241 activity reported for a Project sample from this exposure unit (0.010 pCi/g in sample SB-7) is three orders of magnitude lower than Wildlife Refuge Worker PRG (Table 2-4). This maximum Project MDC is also less than the
mean Am-241 activity (0.0307 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-2).

Table 4-4  Americium Summary Statistics for Soil Samples from Inter-Drainage EU

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>Activity</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-5</td>
<td>0.007</td>
<td>U</td>
</tr>
<tr>
<td>SB-6</td>
<td>0.003</td>
<td>U</td>
</tr>
<tr>
<td>SB-7</td>
<td>0.010</td>
<td>U</td>
</tr>
<tr>
<td>SB-8</td>
<td>0.009</td>
<td>U</td>
</tr>
<tr>
<td>SB-9</td>
<td>0.002</td>
<td>U</td>
</tr>
<tr>
<td>SB-10</td>
<td>0.006</td>
<td>U</td>
</tr>
<tr>
<td>SB-11</td>
<td>-0.007</td>
<td>U</td>
</tr>
</tbody>
</table>

Summary Statistics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>7</td>
</tr>
<tr>
<td>Total Number of Results above MDC</td>
<td>0</td>
</tr>
<tr>
<td>Detection Frequency</td>
<td>0%</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>-0.007</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>0.010</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>N.A</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>N.A</td>
</tr>
</tbody>
</table>

Notes:
1. Activity is in pCi/g.
2. Qualifier assigned by lab. A “U” indicated that the result was below the MDC.
3. N.A. = Not applicable. All values below MDC.

4.2.2  Plutonium

The plutonium results from the seven soil samples collected within the Inter-Drainage EU are summarized in Table 4-5.

All Pu-238 values were below their MDCs. The maximum Pu-238 MDC reported for a Project sample from this exposure unit (0.018 pCi/g in sample SB-10) is three orders of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4).

Four of the seven Pu-239/240 values were below their MDCs and six of the seven activities were less than the background level of 0.066 pCi/g. The maximum Pu-239/240 MDC reported for a Project sample from this exposure unit (0.078 pCi/g in sample SB-8) is two orders of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum Project value is also less than the mean Pu-239/240 activity (0.135 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-2).
Table 4-5  Plutonium Summary Statistics for Soil Samples from Inter-Drainage EU

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>Pu-238 Activity</th>
<th>Pu-238 Qualifier</th>
<th>Pu-239/240 Activity</th>
<th>Pu-239/240 Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-5</td>
<td>0.010</td>
<td>U</td>
<td>0.017</td>
<td>U</td>
</tr>
<tr>
<td>SB-6</td>
<td>0.005</td>
<td>U</td>
<td>0.056</td>
<td></td>
</tr>
<tr>
<td>SB-7</td>
<td>0.002</td>
<td>U</td>
<td>0.030</td>
<td>U</td>
</tr>
<tr>
<td>SB-8</td>
<td>0.005</td>
<td>U</td>
<td>0.078</td>
<td></td>
</tr>
<tr>
<td>SB-9</td>
<td>0.008</td>
<td>U</td>
<td>0.026</td>
<td>U</td>
</tr>
<tr>
<td>SB-10</td>
<td>0.018</td>
<td>U</td>
<td>0.022</td>
<td>U</td>
</tr>
<tr>
<td>SB-11</td>
<td>0.002</td>
<td>U</td>
<td>0.031</td>
<td></td>
</tr>
</tbody>
</table>

Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>Pu-238</th>
<th>Pu-239/240</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Total Number of Results above MDC</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Detection Frequency</td>
<td>0%</td>
<td>43%</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>0.002</td>
<td>U</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>0.018</td>
<td>u</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>N.A</td>
<td>0.055</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>N.A</td>
<td>0.024</td>
</tr>
</tbody>
</table>

Notes:
1. Activity is in pCi/g.
2. Qualifier assigned by lab. A “U” indicated 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.

4.2.3  Uranium

The uranium results from the seven soil samples collected within the Inter-Drainage EU are summarized in Table 4-6.

All U-234 values were above their MDCs, but less than the background level of 2.25 pCi/g (Table 1-7). The maximum U-234 activity reported in a Project sample from this exposure unit (0.81 pCi/g in sample SB-5) is an order of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum activity is less than half the mean U-234 activity (1.75 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-2).

Two of the seven U-235 values were below their MDCs. All values were less than the background level of 0.095 pCi/g. The maximum U-235 activity reported in a Project sample from this exposure unit (0.062 pCi/g in sample SB-5) is an order of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum activity is less than the mean U-235 activity (0.082 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-2).

All U-238 values were above their MDCs, but less than 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 (0.89 pCi/g in sample SB-5) is an order of magnitude lower than Wildlife Refuge Worker PRG (Table 1-2).
This maximum activity is less than half the mean U-238 activity (1.79 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-2).

### Table 4-6  Uranium Summary Statistics for Soil Samples from Inter-Drainage EU

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>U-234 Activity</th>
<th>U-234 Qualifier</th>
<th>U-235 Activity</th>
<th>U-235 Qualifier</th>
<th>U-238 Activity</th>
<th>U-238 Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-5</td>
<td>0.81</td>
<td></td>
<td>0.062</td>
<td></td>
<td>0.82</td>
<td></td>
</tr>
<tr>
<td>SB-6</td>
<td>0.7</td>
<td></td>
<td>0.032</td>
<td>U</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>SB-7</td>
<td>0.77</td>
<td></td>
<td>0.039</td>
<td></td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>SB-8</td>
<td>0.74</td>
<td></td>
<td>0.004</td>
<td>U</td>
<td>0.60</td>
<td></td>
</tr>
<tr>
<td>SB-9</td>
<td>0.73</td>
<td></td>
<td>0.056</td>
<td></td>
<td>0.69</td>
<td></td>
</tr>
<tr>
<td>SB-10</td>
<td>0.79</td>
<td></td>
<td>0.041</td>
<td></td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td>SB-11</td>
<td>0.7</td>
<td></td>
<td>0.046</td>
<td></td>
<td>0.71</td>
<td></td>
</tr>
</tbody>
</table>

### Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>U-234</th>
<th>U-235</th>
<th>U-238</th>
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<tbody>
<tr>
<td>Total Number of Results</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Total Number of Results above MDC</td>
<td>7</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Detection Frequency</td>
<td>100%</td>
<td>71%</td>
<td>100%</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>0.70</td>
<td>0.004</td>
<td>U</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>0.81</td>
<td>0.062</td>
<td>0.89</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>0.75</td>
<td>0.049</td>
<td>0.74</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.04</td>
<td>0.010</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Notes:
1. Activity is in pCi/g
2. Qualifier assigned by lab. A “U” indicated 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.

### 4.3 No Name Gulch Drainage EU

The No Name Gulch Drainage EU lies in the north-central portion of the site, immediately southeast of the Inter-Drainage EU (Figure 2-1). EA collected five soil samples along the planned trail alignments in this exposure unit (Figure 4-1).

#### 4.3.1 Americium

The Am-241 results from the five soil samples collected within the No Name Gulch Drainage EU are summarized in Table 4-7. All values were below their MDCs, with the sample MDCs being less than the background level of 0.022 pCi/g. The maximum Am-241 activity reported for a Project sample from this exposure unit (0.017 pCi/g in sample SB-4) is two orders of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum activity is also less than the mean Am-241 activity (0.0311 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-3).
### Table 4-7  
**Ameriacium Summary Statistics for Soil Samples from No Name Gulch EU**

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>Activity</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-1</td>
<td>0.001</td>
<td>U</td>
</tr>
<tr>
<td>SB-2</td>
<td>0.010</td>
<td>U</td>
</tr>
<tr>
<td>SB-3</td>
<td>0.011</td>
<td>U</td>
</tr>
<tr>
<td>SB-4</td>
<td>0.017</td>
<td>U</td>
</tr>
<tr>
<td>SB-12</td>
<td>-0.007</td>
<td>U</td>
</tr>
</tbody>
</table>

**Summary Statistics**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>5</td>
</tr>
<tr>
<td>Total Number of Results above MDC</td>
<td>0</td>
</tr>
<tr>
<td>Detection Frequency</td>
<td>0%</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>-0.007</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>0.017</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>N.A</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>N.A</td>
</tr>
</tbody>
</table>

Notes:
1. Activity is in pCi/g
2. Qualifier assigned by lab. A “U” indicated that the result was below the MDC
3. N.A. = Not applicable. All values below MDC

#### 4.3.2 Plutonium

The plutonium results from the five soil samples collected within the No Name Gulch Drainage EU are summarized in Table 4-8.

All Pu-238 values were below their MDCs. The maximum Pu-238 activity reported for a Project sample from this exposure unit (0.008 pCi/g in sample SB-2) is three orders of magnitude lower than Wildlife Refuge Worker PRG (Table 2-4).

One of the five Pu-239/240 values was below its MDC. Activities in all samples were less than the background level of 0.066 pCi/g. The maximum Pu-239/240 activity reported for a Project sample from this exposure unit (0.048 pCi/g in samples SB-3 and SB-4) is two orders of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum activity is also less than the mean Pu-239/240 activity (0.0807 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-3).
Table 4-8 **Plutonium Summary Statistics for Soil Samples from No Name Gulch EU**

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>Pu-238</th>
<th>Pu-239/240</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Activity</td>
<td>Qualifier</td>
</tr>
<tr>
<td>SB-1</td>
<td>0.004</td>
<td>U</td>
</tr>
<tr>
<td>SB-2</td>
<td>0.008</td>
<td>U</td>
</tr>
<tr>
<td>SB-3</td>
<td>0.004</td>
<td>U</td>
</tr>
<tr>
<td>SB-4</td>
<td>0</td>
<td>U</td>
</tr>
<tr>
<td>SB-12</td>
<td>-0.004</td>
<td>U</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Activity</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.013</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>0.013</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>0.048</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>0.048</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.033</td>
<td></td>
</tr>
</tbody>
</table>

**Summary Statistics**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>5</td>
</tr>
<tr>
<td>Total Number of Results above MDC</td>
<td>0</td>
</tr>
<tr>
<td>Detection Frequency</td>
<td>0%</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>-0.004</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>0.008</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>N.A</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>N.A</td>
</tr>
</tbody>
</table>

|                        | 5    | 5 |
| Total Number of Results above MDC | 0 | 4 |
| Detection Frequency         | 80%  |
| Minimum Activity             | U    |
| Maximum Activity              | U    |
| Arithmetic Mean Activity     | 0.036 |
| Standard Deviation            | 0.017 |

Notes:
1. Activity is in pCi/g
2. Qualifier assigned by lab. A “U” indicated 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.

**4.3.3 Uranium**

The uranium results from the five soil samples collected within the No Name Gulch Drainage EU are summarized in Table 4-9.

All five U-234 values were above their MDCs, but less than the background level of 2.25 pCi/g (Table 1-7). The maximum U-234 activity reported in a Project sample from this exposure unit (1.04 pCi/g in sample SB-12) is an order of magnitude lower than Wildlife Refuge Worker PRG (Table 2-4). This maximum activity is above the mean U-234 activity (0.915 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-3); however, the mean activity of the Project soil samples (Table 4-9) is less than the mean RI/FS Report value (Table 1-3).

All five U-235 values were above their MDCs, but less than the background level of 0.095 pCi/g. The maximum U-235 activity reported in a Project sample from this exposure unit (0.060 pCi/g in sample SB-4) is an order of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). The maximum and mean activities for the Project samples are greater than the mean U-235 activity (0.0435 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-3).

All U-238 values were above their MDCs, but less than 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 (0.95 pCi/g in sample SB-12) is an order of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum activity equals the mean U-238 activity calculated for this exposure unit in the RI/FS Report (Table 1-3).
unit in the RI/FS Report (Table 1-3); however, the mean activity of the Project soil samples (Table 4-9) is less than the mean RI/FS Report value (Table 1-3).

### Table 4-9 Uranium Summary Statistics for Soil Samples from No Name Gulch EU

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>U-234 Activity</th>
<th>U-234 Qualifier</th>
<th>U-235 Activity</th>
<th>U-235 Qualifier</th>
<th>U-238 Activity</th>
<th>U-238 Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-1</td>
<td>0.79</td>
<td>0.02</td>
<td></td>
<td></td>
<td>0.73</td>
<td></td>
</tr>
<tr>
<td>SB-2</td>
<td>0.59</td>
<td>0.048</td>
<td></td>
<td></td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>SB-3</td>
<td>0.76</td>
<td>0.055</td>
<td></td>
<td></td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>SB-4</td>
<td>0.72</td>
<td>0.060</td>
<td></td>
<td></td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>SB-12</td>
<td>1.04</td>
<td>0.055</td>
<td></td>
<td></td>
<td>0.95</td>
<td></td>
</tr>
</tbody>
</table>

### Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>U-234</th>
<th>U-235</th>
<th>U-238</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Total Number of Results above MDC</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Detection Frequency</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>0.59</td>
<td>0.020</td>
<td>0.57</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>1.04</td>
<td>0.060</td>
<td>0.95</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>0.78</td>
<td>0.048</td>
<td>0.77</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.16</td>
<td>0.016</td>
<td>0.14</td>
</tr>
</tbody>
</table>

### Notes:
1. Activity is in pCi/g.
2. Qualifier assigned by lab. A “U” indicated 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.

### 4.4 Wind Blown Area EU

The Wind Blown Area EU lies in the east-central portion of the site. This exposure unit shares its western boundary with the Industrial Area EU (Figure 2-1). 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 nine soil samples along the planned trail alignment in this exposure unit (Figure 4-2).

#### 4.4.1 Americium

The Am-241 results from the nine soil samples collected within the Wind Blown Area EU are summarized in Table 4-10. All values were above their MDCs, with the sample activities being greater than the background level of 0.022 pCi/g. However, the maximum Am-241 activity reported for a Project sample from this exposure unit (0.660 pCi/g in sample SB-23) is an order of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum Project value is also less than the mean Am-241 activity (1.86 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-4).
Table 4-10  Americium Summary Statistics for Soil Samples from Wind Blown Area EU

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>Am-241</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Activity</td>
</tr>
<tr>
<td>SB-21</td>
<td>0.221</td>
</tr>
<tr>
<td>SB-22</td>
<td>0.358</td>
</tr>
<tr>
<td>SB-23</td>
<td>0.660</td>
</tr>
<tr>
<td>SB-24</td>
<td>0.630</td>
</tr>
<tr>
<td>SB-25</td>
<td>0.560</td>
</tr>
<tr>
<td>SB-26</td>
<td>0.450</td>
</tr>
<tr>
<td>SB-27</td>
<td>0.334</td>
</tr>
<tr>
<td>SB-28</td>
<td>0.152</td>
</tr>
<tr>
<td>SB-29</td>
<td>0.354</td>
</tr>
</tbody>
</table>

**Summary Statistics**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>9</td>
</tr>
<tr>
<td>Total Number of Results above MDC</td>
<td>9</td>
</tr>
<tr>
<td>Detection Frequency</td>
<td>100%</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>0.152</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>0.660</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>0.413</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.176</td>
</tr>
</tbody>
</table>

Notes:
1. Activity is in pCi/g.
2. Qualifier assigned by lab. A “U” indicated that the result was below the MDC.
3. N.A. = Not applicable. All values below MDC.

### 4.4.2 Plutonium

The plutonium results from the nine soil samples collected within the Wind Blown Area EU are summarized in Table 4-11.

Three of the nine Pu-238 values were below their MDCs. The maximum Pu-238 value reported for a Project sample from this exposure unit (0.072 pCi/g in sample SB-24) is two orders of magnitude lower than Wildlife Refuge Worker PRG (Table 2-4). This maximum Project value is also less than the mean Pu-238 activity (0.447 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-4).

All nine Pu-239/240 values were above their sample MDC and greater than the background level of 0.066 pCi/g. However, the maximum Pu-239/240 activity reported for a Project sample from this exposure unit (3.51 pCi/g in sample SB-25) is below the Wildlife Refuge Worker PRG (Table 2-4). This maximum Project value is also less than the mean Pu-239/240 activity (9.44 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-4).
Table 4-11  Plutonium Summary Statistics for Soil Samples from Wind Blown Area EU

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>Pu-238 Activity</th>
<th>Pu-239/240 Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-21</td>
<td>0.029</td>
<td>1.27</td>
</tr>
<tr>
<td>SB-22</td>
<td>0.027</td>
<td>1.5</td>
</tr>
<tr>
<td>SB-23</td>
<td>0.057</td>
<td>3.15</td>
</tr>
<tr>
<td>SB-24</td>
<td>0.072</td>
<td>2.84</td>
</tr>
<tr>
<td>SB-25</td>
<td>0.035</td>
<td>3.51</td>
</tr>
<tr>
<td>SB-26</td>
<td>0.04</td>
<td>2.19</td>
</tr>
<tr>
<td>SB-27</td>
<td>0.024</td>
<td>U</td>
</tr>
<tr>
<td>SB-28</td>
<td>0.006</td>
<td>U</td>
</tr>
<tr>
<td>SB-29</td>
<td>0.032</td>
<td>U</td>
</tr>
</tbody>
</table>

Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>Pu-238</th>
<th>Pu-239/240</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Total Number of Results above MDC</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Detection Frequency</td>
<td>67%</td>
<td>100%</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>0.006</td>
<td>U</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>0.072</td>
<td>3.51</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>0.04</td>
<td>2.14</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.018</td>
<td>0.91</td>
</tr>
</tbody>
</table>

Notes:
1. Activity is in pCi/g.
2. Qualifier assigned by lab. A “U” indicated 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.

4.4.3  Uranium

The uranium results from the nine soil samples collected within the Wind Blown Area EU are summarized in Table 4-12.

All nine U-234 values were above their MDCs, but less than the background level of 2.25 pCi/g (Table 1-7). The maximum U-234 activity reported in a Project sample from this exposure unit (1.10 pCi/g in sample SB-29) is an order of magnitude lower than Wildlife Refuge Worker PRG (Table 2-4). This maximum activity is slightly less than the mean U-234 activity (1.12 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-4).

Two of the nine U-235 values were below their MDCs. All nine U-235 values were less than the background level of 0.095 pCi/g. The maximum U-235 activity reported in a Project sample from this exposure unit (0.090 pCi/g in sample SB-29) is an order of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum activity for a Project sample is slightly higher than the mean U-235 activity (0.0827 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-4); however, the mean activity of the Project soil samples (Table 4-12) is less than the mean RI/FS Report value (Table 1-4).
All nine U-238 values were above their MDCs, but less than 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 (1.05 pCi/g in sample SB-29) is an order of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum activity is slightly less than the mean U-238 activity calculated for this exposure unit in the RI/FS Report (Table 1-4).

### Table 4-12 Uranium Summary Statistics for Soil Samples from Wind Blown Area EU

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>U-234 Activity</th>
<th>U-234 Qualifier</th>
<th>U-235 Activity</th>
<th>U-235 Qualifier</th>
<th>U-238 Activity</th>
<th>U-238 Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-21</td>
<td>0.76</td>
<td>U</td>
<td>0.034</td>
<td>U</td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td>SB-22</td>
<td>0.61</td>
<td>U</td>
<td>0.016</td>
<td>U</td>
<td>0.55</td>
<td></td>
</tr>
<tr>
<td>SB-23</td>
<td>0.82</td>
<td></td>
<td>0.039</td>
<td>U</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>SB-24</td>
<td>0.86</td>
<td></td>
<td>0.046</td>
<td>U</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>SB-25</td>
<td>0.73</td>
<td></td>
<td>0.045</td>
<td>U</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>SB-26</td>
<td>0.73</td>
<td></td>
<td>0.054</td>
<td>U</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>SB-27</td>
<td>0.82</td>
<td></td>
<td>0.044</td>
<td>U</td>
<td>0.87</td>
<td></td>
</tr>
<tr>
<td>SB-28</td>
<td>1</td>
<td></td>
<td>0.038</td>
<td>U</td>
<td>0.98</td>
<td></td>
</tr>
<tr>
<td>SB-29</td>
<td>1.10</td>
<td></td>
<td>0.090</td>
<td>U</td>
<td>1.05</td>
<td></td>
</tr>
</tbody>
</table>

**Summary Statistics**

<table>
<thead>
<tr>
<th></th>
<th>U-234</th>
<th>U-235</th>
<th>U-238</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Total Number of Results above MDC</td>
<td>9</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Detection Frequency</td>
<td>100%</td>
<td>78%</td>
<td>100%</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>0.61</td>
<td>0.016</td>
<td>0.55</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>1.10</td>
<td>0.090</td>
<td>1.05</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>0.83</td>
<td>0.051</td>
<td>0.80</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.15</td>
<td>0.018</td>
<td>0.15</td>
</tr>
</tbody>
</table>

**Notes:**

1. Activity is in pCi/g.
2. Qualifier assigned by lab. A “U” indicated 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.

#### 4.5 Lower Woman Drainage EU

The Lower Woman Drainage EU lies in the southeastern portion of the site, immediately south of the Wind Blown Area EU (Figure 2-1). EA collected four soil samples along the planned trail alignment in this exposure unit (Figure 4-2).

**4.5.1 Americium**

The Am-241 results from the four soil samples collected within the Lower Woman Drainage EU are summarized in Table 4-13. All values were above their MDCs and above the background level of 0.022 pCi/g. However, the maximum Am-241 activity reported for a Project sample from this exposure unit (0.249 pCi/g in sample SB-32) is an order of magnitude lower than the Wildlife
Refuge Worker PRG (Table 2-4). This maximum Project value is also less than the mean Am-241 activity (0.302 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-5).

Table 4-13  **Americium Summary Statistics for Soil Samples from Lower Woman Drainage EU**

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>Am-241</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Activity</td>
</tr>
<tr>
<td>SB-30</td>
<td>0.143</td>
</tr>
<tr>
<td>SB-31</td>
<td>0.110</td>
</tr>
<tr>
<td>SB-32</td>
<td>0.249</td>
</tr>
<tr>
<td>SB-33</td>
<td>0.219</td>
</tr>
</tbody>
</table>

**Summary Statistics**

- Total Number of Results: 4
- Total Number of Results above MDC: 4
- Detection Frequency: 100%
- Minimum Activity: 0.110
- Maximum Activity: 0.249
- Arithmetic Mean Activity: 0.18
- Standard Deviation: 0.06

Notes:
1. Activity is in pCi/g.
2. Qualifier assigned by lab. A “U” indicated that the result was below the MDC.
3. N.A. = Not applicable. All values below MDC.

### 4.5.2  **Plutonium**

The plutonium results from the four soil samples collected within the Lower Woman Drainage EU are summarized in Table 4-14.

Three of the four Pu-238 values were below their MDCs. The maximum Pu-238 value reported for a Project sample from this exposure unit (0.041 pCi/g in sample SB-33) is two orders of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum Project value is greater than the mean Pu-238 activity (0.034 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-5).

All four Pu-239/240 values were above their sample MDC and greater than the background level of 0.066 pCi/g. However, the maximum Pu-239/240 activity reported for a Project sample from this exposure unit (1.20 pCi/g in sample SB-32) is below the Wildlife Refuge Worker PRG (Table 2-4). This maximum Project value is also less than the mean Pu-239/240 activity (1.89 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-5).
Table 4-14  Plutonium Summary Statistics for Soil Samples from Lower Woman Drainage EU

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>Pu-238 Activity</th>
<th>Pu-239/240 Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Qualifier</td>
<td></td>
</tr>
<tr>
<td>SB-30</td>
<td>-0.01 U</td>
<td>0.77</td>
</tr>
<tr>
<td>SB-31</td>
<td>0.023 U</td>
<td>0.71</td>
</tr>
<tr>
<td>SB-32</td>
<td>0.013 U</td>
<td>1.20</td>
</tr>
<tr>
<td>SB-33</td>
<td>0.041</td>
<td>1.10</td>
</tr>
</tbody>
</table>

Summary Statistics

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total Number of Results above MDC</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Detection Frequency</td>
<td>25%</td>
<td>100%</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>-0.010 U</td>
<td>0.71</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>0.041</td>
<td>1.20</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>0.041</td>
<td>0.95</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>N.A.</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Notes:
1. Activity is in pCi/g.
2. Qualifier assigned by lab. A “U” indicated 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.

4.5.3  Uranium

The uranium results from the four soil samples collected within the Lower Woman Drainage EU are summarized in Table 4-15.

All four U-234 values were above their MDCs, but less than the background level of 2.25 pCi/g (Table 1-7). The maximum U-234 activity reported in a Project sample from this exposure unit (0.83 pCi/g in sample SB-30) is an order of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum activity is also less than the mean U-234 activity (1.12 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-5).

One of the four U-235 values was below its MDC. All four U-235 values were less than the background level of 0.095 pCi/g. The maximum U-235 activity reported in a Project sample from this exposure unit (0.046 pCi/g in samples SB-30 and SB-32) is an order of magnitude lower than Wildlife Refuge Worker PRG (Table 2-4). This maximum activity for a Project sample is also lower than the mean U-235 activity (0.059 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-5).

All four U-238 values were above their MDCs, but less than the background level of 2.00 pCi/g (Table 1-7). The Wildlife Refuge Worker PRG (Table 2-4) is over one order of magnitude greater than the maximum U-238 activity reported in a Project sample from this exposure unit (0.84 pCi/g in samples SB-30 and SB-31). This maximum activity is less than the mean U-238 activity calculated for this exposure unit in the RI/FS Report (Table 1-5).
### Table 4-15  Uranium Summary Statistics for Soil Samples from Lower Woman Drainage EU

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>U-234</th>
<th></th>
<th>U-235</th>
<th></th>
<th>U-238</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Activity</td>
<td>Qualifier</td>
<td>Activity</td>
<td>Qualifier</td>
<td>Activity</td>
<td>Qualifier</td>
</tr>
<tr>
<td>SB-30</td>
<td>0.83</td>
<td></td>
<td>0.046</td>
<td></td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>SB-31</td>
<td>0.74</td>
<td></td>
<td>0.029</td>
<td></td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>SB-32</td>
<td>0.78</td>
<td></td>
<td>0.046</td>
<td></td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>SB-33</td>
<td>0.77</td>
<td></td>
<td>0.033</td>
<td>U</td>
<td>0.71</td>
<td></td>
</tr>
</tbody>
</table>

**Summary Statistics**

<table>
<thead>
<tr>
<th></th>
<th>U-234</th>
<th></th>
<th>U-235</th>
<th></th>
<th>U-238</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>4</td>
<td></td>
<td>4</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Total Number of Results above MDC</td>
<td>4</td>
<td></td>
<td>3</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Detection Frequency</td>
<td>100%</td>
<td></td>
<td>75%</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>0.74</td>
<td></td>
<td>0.029</td>
<td>U</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>0.83</td>
<td></td>
<td>0.046</td>
<td></td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>0.78</td>
<td></td>
<td>0.040</td>
<td></td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.04</td>
<td></td>
<td>0.010</td>
<td></td>
<td>0.09</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

1. Activity is in pCi/g
2. Qualifier assigned by lab. A “U” indicated 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.

#### 4.6  Southwest Offsite Locations

EA collected Project samples in an area just outside the historic southwest boundary of the site (Figure 2-1). This area abuts the western boundary of the Upper Woman Drainage EU and lies within the Upper Woman Drainage basin. Consequently, EA compared data from the Project soil samples collect in the proposed trails in this area to data in the RI/FS Report from the Upper Woman Drainage EU (Table 1-6). EA collected 15 soil samples along the planned trail alignment in this the southwest offsite area (Figure 4-3).

#### 4.6.1  Americium

The Am-241 results from the 15 soil samples collected in the southwest offsite area are summarized in Table 4-16. All but one of the values were below their MDCs, with these 14 sample MDCs less than the background level of 0.022 pCi/g. However, the one detected value was greater than the background level of 0.022 pCi/g. The maximum Am-241 activity reported for a Project sample from this area (0.035 pCi/g in sample SB-36) is two orders of magnitude lower than Wildlife Refuge Worker PRG (Table 2-4). This maximum Project value is also less than the mean Am-241 activity (0.0366 pCi/g) calculated for the adjacent Upper Woman Drainage EU in the RI/FS Report (Table 1-6).
Table 4-16  Americium Summary Statistics for Soil Samples from Southwest Offsite Locations

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>Am-241 Activity</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-34</td>
<td>0.02</td>
<td>U</td>
</tr>
<tr>
<td>SB-35</td>
<td>-0.005</td>
<td>U</td>
</tr>
<tr>
<td>SB-36</td>
<td>0.035</td>
<td>U</td>
</tr>
<tr>
<td>SB-37</td>
<td>0.007</td>
<td>U</td>
</tr>
<tr>
<td>SB-38</td>
<td>-0.005</td>
<td>U</td>
</tr>
<tr>
<td>SB-39</td>
<td>-0.004</td>
<td>U</td>
</tr>
<tr>
<td>SB-40</td>
<td>0.006</td>
<td>U</td>
</tr>
<tr>
<td>SB-41</td>
<td>-0.002</td>
<td>U</td>
</tr>
<tr>
<td>SB-42</td>
<td>0.002</td>
<td>U</td>
</tr>
<tr>
<td>SB-43</td>
<td>0.021</td>
<td>U</td>
</tr>
<tr>
<td>SB-44</td>
<td>0.016</td>
<td>U</td>
</tr>
<tr>
<td>SB-45</td>
<td>0.003</td>
<td>U</td>
</tr>
<tr>
<td>SB-46</td>
<td>0.003</td>
<td>U</td>
</tr>
<tr>
<td>SB-47</td>
<td>0.012</td>
<td>U</td>
</tr>
<tr>
<td>SB-48</td>
<td>0.003</td>
<td>U</td>
</tr>
</tbody>
</table>

Summary Statistics

- Total Number of Results: 15
- Total Number of Results above MDC: 1
- Detection Frequency: 7%
- Minimum Activity: -0.005 U
- Maximum Activity: 0.035 U
- Arithmetic Mean Activity: 0.035 U
- Standard Deviation: N.A

Notes:
1. Activity is in pCi/g.
2. Qualifier assigned by lab. A “U” indicated that the result was below the MDC.
3. N.A. = Not applicable. All values below MDC.

4.6.2  Plutonium

The plutonium results from the 15 soil samples collected within the southwest offsite area are summarized in Table 4-17.

Thirteen of the 15 Pu-238 values were below their MDCs. The maximum Pu-238 value reported for a Project sample from this area (0.019 pCi/g in sample SB-40) is three orders of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). The maximum Pu-238 reported for a Project sample from this area is 0.019 pCi/g in sample SB-40. Two Project samples (SB-40 and SB-44) possessed Pu-238 activities greater than the mean Pu-238 activity (0.00236 pCi/g) calculated for the adjacent Upper Woman Drainage EU in the RI/FS Report (Table 1-6). In
addition, seven other Project samples with Pu-238 values reported below their MDCs had activities greater than the mean value reported in the RI/FS Report.

Four of 15 Pu-239/240 values were below their sample MDC. The four MDCs and all but one detected value were less than the background level of 0.066 pCi/g. However, the maximum Pu-239/240 value reported for a Project sample from this area (0.070 pCi/g in sample SB-36) is two orders of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum Project value is also less than the mean Pu-239/240 activity (0.147 pCi/g) calculated for the adjacent Upper Woman Drainage Area EU in the RI/FS Report (Table 1-6).
Table 4-17 Plutonium Summary Statistics for Soil Samples from Southwest Offsite Locations

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>Pu-238 Activity</th>
<th>Pu-238 Qualifier</th>
<th>Pu-239/240 Activity</th>
<th>Pu-239/240 Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-34</td>
<td>0.006 U</td>
<td></td>
<td>0.035</td>
<td></td>
</tr>
<tr>
<td>SB-35</td>
<td>0.002 U</td>
<td></td>
<td>0.057</td>
<td></td>
</tr>
<tr>
<td>SB-36</td>
<td>0.015 U</td>
<td></td>
<td>0.070</td>
<td></td>
</tr>
<tr>
<td>SB-37</td>
<td>0 U</td>
<td></td>
<td>0.044</td>
<td></td>
</tr>
<tr>
<td>SB-38</td>
<td>0.012 U</td>
<td></td>
<td>0.039</td>
<td></td>
</tr>
<tr>
<td>SB-39</td>
<td>-0.002 U</td>
<td></td>
<td>0.028</td>
<td></td>
</tr>
<tr>
<td>SB-40</td>
<td>0.019</td>
<td></td>
<td>0.032</td>
<td></td>
</tr>
<tr>
<td>SB-41</td>
<td>0.008 U</td>
<td></td>
<td>0.037</td>
<td></td>
</tr>
<tr>
<td>SB-42</td>
<td>0 U</td>
<td></td>
<td>0.009 U</td>
<td></td>
</tr>
<tr>
<td>SB-43</td>
<td>0.004 U</td>
<td></td>
<td>0.045</td>
<td></td>
</tr>
<tr>
<td>SB-44</td>
<td>0.015</td>
<td></td>
<td>0.006 U</td>
<td></td>
</tr>
<tr>
<td>SB-45</td>
<td>0.005 U</td>
<td></td>
<td>0.045</td>
<td></td>
</tr>
<tr>
<td>SB-46</td>
<td>-0.006 U</td>
<td></td>
<td>0.023 U</td>
<td></td>
</tr>
<tr>
<td>SB-47</td>
<td>0.002 U</td>
<td></td>
<td>0.054</td>
<td></td>
</tr>
<tr>
<td>SB-48</td>
<td>0.007 U</td>
<td></td>
<td>0.018 U</td>
<td></td>
</tr>
</tbody>
</table>

Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>Pu-238</th>
<th>Pu-239/240</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Results</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Total Number of Results above MDC</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Detection Frequency</td>
<td>13%</td>
<td>73%</td>
</tr>
<tr>
<td>Minimum Activity</td>
<td>-0.006 U</td>
<td>0.006 U</td>
</tr>
<tr>
<td>Maximum Activity</td>
<td>0.019</td>
<td>0.070</td>
</tr>
<tr>
<td>Arithmetic Mean Activity</td>
<td>0.017</td>
<td>0.044</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.003</td>
<td>0.012</td>
</tr>
</tbody>
</table>

Notes:
1. Activity is in pCi/g.
2. Qualifier assigned by lab. A “U” indicated 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.

4.6.3 Uranium

The uranium results from the 15 soil samples collected within the southwest offsite area are summarized in Table 4-18.

All 15 U-234 values were above their MDCs, but less than the background level of 2.25 pCi/g (Table 1-7). The maximum U-234 activity reported in a Project sample from this area (1.14 pCi/g in sample SB-47) is an order of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum activity is also less than the mean U-234 activity (1.49 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-6).
Four of the 15 U-235 values were below their MDCs. All U-235 values, including the aforementioned MDCs, were less than the background level of 0.095 pCi/g. The maximum U-235 activity reported in a Project sample from this exposure unit (0.071 pCi/g in sample SB-45) is an order of magnitude lower than the Wildlife Refuge Worker PRG (Table 2-4). This maximum activity for a Project sample is also lower than the mean U-235 activity (0.092 pCi/g) calculated for the adjacent Upper Woman Drainage Area EU in the RI/FS Report (Table 1-6).

All 15 U-238 values were above their MDCs, but less than 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 (1.20 pCi/g in sample SB-47) is an order of magnitude lower than Wildlife Refuge Worker PRG (Table 2-4). This maximum activity is less than the mean U-238 activity (3.54 pCi/g) calculated for this exposure unit in the RI/FS Report (Table 1-6).

Table 4-18  Uranium Summary Statistics for Soil Samples from Southwest Offsite Locations

<table>
<thead>
<tr>
<th>Soil Sample Location</th>
<th>U-234 Activity</th>
<th>U-235 Activity</th>
<th>U-238 Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Qualifier</td>
<td>Activity</td>
<td>Qualifier</td>
</tr>
<tr>
<td>SB-34</td>
<td>0.67</td>
<td>0.021</td>
<td>U</td>
</tr>
<tr>
<td>SB-35</td>
<td>0.72</td>
<td>0.028</td>
<td>U</td>
</tr>
<tr>
<td>SB-36</td>
<td>0.90</td>
<td>0.061</td>
<td>U</td>
</tr>
<tr>
<td>SB-37</td>
<td>0.89</td>
<td>0.064</td>
<td>U</td>
</tr>
<tr>
<td>SB-38</td>
<td>0.83</td>
<td>0.012</td>
<td>U</td>
</tr>
<tr>
<td>SB-39</td>
<td>0.98</td>
<td>0.024</td>
<td>U</td>
</tr>
<tr>
<td>SB-40</td>
<td>0.73</td>
<td>0.051</td>
<td>U</td>
</tr>
<tr>
<td>SB-41</td>
<td>0.73</td>
<td>0.043</td>
<td>U</td>
</tr>
<tr>
<td>SB-42</td>
<td>0.62</td>
<td>0.052</td>
<td>U</td>
</tr>
<tr>
<td>SB-43</td>
<td>1.02</td>
<td>0.018</td>
<td>U</td>
</tr>
<tr>
<td>SB-44</td>
<td>0.85</td>
<td>0.04</td>
<td>U</td>
</tr>
<tr>
<td>SB-45</td>
<td>0.91</td>
<td>0.071</td>
<td>U</td>
</tr>
<tr>
<td>SB-46</td>
<td>0.88</td>
<td>0.055</td>
<td>U</td>
</tr>
<tr>
<td>SB-47</td>
<td>1.14</td>
<td>0.040</td>
<td>U</td>
</tr>
<tr>
<td>SB-48</td>
<td>0.85</td>
<td>0.039</td>
<td>U</td>
</tr>
</tbody>
</table>

Summary Statistics

| Total Number of Results | 15 | 15 | 15 |
| Detection Frequency    | 100% | 73% | 100% |
| Minimum Activity       | 0.62 | 0.012 | U | 0.69 |
| Maximum Activity       | 1.14 | 0.071 | U | 1.20 |
| Arithmetic Mean Activity | 0.85 | 0.046 | U | 0.82 |
| Standard Deviation     | 0.14 | 0.016 | U | 0.13 |

Notes:
1. Activity is in pCi/g
2. Qualifier assigned by lab. A “U” indicated 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.
5.0 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 48 surface soil samples along planned trail routes on the Refuge on June 26-28, 2019 (Figure 2-1). 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 Am-241 activities compare to background levels (Table 1-7), 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 1-6).

Thirty-four of the 48 samples (71%) possessed Am-241 activities below the sample MDC. For the 14 samples with results above the MDC, the Am-241 activities ranged from 0.035 pCi/g to 0.66 pCi/g.

Background

The sample MDCs for the 34 “non-detect” samples are less than the background level of 0.022 pCi/g. The 14 samples with detectable Am-241 possessed Am-241 activities above this background level. These 14 samples were collected from the Wind Blown Area (9 of 9 samples above MDC), the Lower Woman Drainage EU (4 of 4 samples above MDC), and the southwest offsite area (1 of 15 samples above MDC).

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 (0.66 pCi/g in Wind Blown Area EU sample SB-23).

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 through 1-6. The maximum Am-241 activity in a Project soil sample was less than the mean value calculated in the RI/FS Report for all the corresponding exposure units.

5.1.2 Plutonium

The following discussion provides a summary of how the plutonium isotope activities compare to background levels (Table 1-7), 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 1-6).
5.1.2.1 Pu-238

Thirty-nine of the 48 samples (81%) possessed Pu-238 activities below the sample MDC. For the nine samples with results above their MDC, the Pu-238 activities ranged from 0.015 pCi/g to 0.072 pCi/g.

Background
A background level for Pu-238 was not included in the RI/FS Report table used as the reference for Table 1-7.

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 (0.072 pCi/g in Wind Blown Area EU sample SB-24).

RI/FS Report Mean Activity
Mean Pu-238 activities were only calculated for three exposure units in the RI/FS Report (Tables 1-1 through 1-6).

- The maximum Pu-238 activity in a Project soil sample from the Wind Blown Area EU was less than the mean value calculated in the RI/FS Report.
- The Pu-238 activity in one of four Project soil samples from the Lower Woman Drainage EU was greater than the mean value calculated in the RI/FS Report.
- The Pu-238 activity in two of 15 Project soil samples from southwest offsite area was greater than the mean value calculated for the Upper Woman Drainage EU in the RI/FS Report. The Pu-238 levels in an additional seven samples from the southwest offsite area were reported as below their MDCs, but these MDCs were above the mean value calculated for the Upper Woman Drainage EU in the RI/FS Report.

5.1.2.2 Pu-239/240

Fifteen of the 48 samples (31%) possessed Pu-239/240 activities below the sample MDC. For the 33 samples with results above the MDC, the Pu-239/240 activities ranged from 0.013 pCi/g to 3.51 pCi/g.

Background
The sample MDCs for the 15 “non-detect” samples are less than the background level for Pu-239/240 of 0.066 pCi/g. Of the 33 samples with detectable Pu-239/240, 15 possessed activities above this background level. These 15 samples were collected from the Wind Blown Area (9 of 9 samples above background), the Lower Woman Drainage EU (4 of 4 samples above background), the Inter-Drainage EU (1 of 7 samples above background) and the southwest offsite area (1 of 15 samples above background).
Wildlife Refuge Worker PRG
The WRW PRG for Pu-239/240 is 9.3 pCi/g (Table 2-4). This PRG is greater than the maximum Pu-239/240 activity detected in a Project sample (3.51 pCi/g in Wind Blown Area EU sample SB-25).

RI/FS Report Mean Activity
The mean Pu-239/240 activities calculated for the various exposure units in the RI/FS Report are summarized in Tables 1-1 through 1-6. The maximum Pu-239/240 activities in Project soil samples were less than the mean value calculated in the RI/FS Report for all the corresponding exposure units.

5.1.3  Uranium
The following discussion provides a summary of how the uranium isotope activities compare to background levels (Table 1-7), 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 1-6).

5.1.3.1  U-234
U-234 activities were reported above the sample MDC in all 48 samples. The U-234 activities in Project soil samples ranged from 0.58 pCi/g to 1.14 pCi/g.

Background
The U-234 activity in all Project samples 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 a Project sample (1.14 pCi/g in the southwest offsite area sample SB-47).

RI/FS Report Mean Activity
The mean U-234 activities calculated for the various exposure units in the RI/FS Report are summarized in Tables 1-1 through 1-6. The maximum U-234 activities in Project soil samples was less than the mean values in the five of the six areas sampled. The exception was the No Name Drainage EU, where the U-234 concentration in one of five samples (1.04 pCi/g in SB-12) was greater than the mean value calculated in the RI/FS Report (0.915 pCi/g). However, the mean U-234 activity for the No Name Drainage EU Project soil samples (0.78 pCi/g) was less than the mean value calculated in the RI/FS Report.

5.1.3.2  U-235
Twelve of the 48 samples (25%) possessed U-235 activities below the sample MDC. For the 36 samples with results above the MDC, the U-235 activities ranged from 0.018 pCi/g to 0.090 pCi/g.

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 over one order of magnitude greater than the maximum U-235 activity detected in a Project sample (0.90 pCi/g in the Wind Blown Area EU sample SB-29).

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 1-6.

- The maximum U-235 activities in Project soil samples were less than the mean value calculated in the RI/FS Report for the Inter-Drainage EU, the Lower Woman Drainage EU and the southwest offsite area (Upper Woman Drainage EU).
- The maximum U-235 activity in Project soil samples from the Rock Creek Drainage EU (0.076 pCi/g in SB-15) is above the mean U-235 activity calculated for this exposure unit in the RI/FS Report (0.0641 pCi/g); however, the mean activity of the Project soil samples (0.047 pCi/g) is less than the mean RI/FS Report value.
- The maximum (0.060 pCi/g in sample SB-4) and mean U-235 activities (0.048 pCi/g) for the Project samples from the No Name Gulch Drainage EU are greater than the mean U-235 activity (0.0435 pCi/g) calculated for this exposure unit in the RI/FS Report.
- The maximum U-235 activity reported in a Project sample from the Wind Blown Area EU (0.090 pCi/g in sample SB-29) is greater than the mean U-235 activity (0.0827 pCi/g) calculated for this exposure unit in the RI/FS Report; however, the mean activity of the Project soil samples (0.051 pCi/g) is less than the mean RI/FS Report value for this exposure unit.

5.1.3.3 U-238
U-238 activities were reported above the sample MDC in all 48 samples. The U-238 activities in Project soil samples ranged from 0.54 pCi/g to 1.20 pCi/g.

Background
The U-238 activity in all Project 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 (1.20 pCi/g in the southwest offsite area sample SB-47).

RI/FS Report Mean Activity
The mean U-238 activities calculated for the various exposure units in the RI/FS Report are summarized in Tables 1-1 through 1-6. The maximum U-238 activities in Project soil samples were less than or equal to the mean values calculated in the RI/FS Report.

5.2 Conclusions
The goal of this Project is to generate radionuclide data for soils along the proposed trail improvements 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 1-7), 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 1-6). 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**

<table>
<thead>
<tr>
<th>Sampled Area/Exposure Unit</th>
<th>Project Samples Less Than Background</th>
<th>Project Samples Less Than WRW PRG</th>
<th>Comparison to RI/FS Mean</th>
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<tbody>
<tr>
<td></td>
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</tr>
<tr>
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<td>✓</td>
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<tr>
<td>Inter-Drainage</td>
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<td>✓</td>
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<tr>
<td>No-Name Gulch Drainage</td>
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<td>✓</td>
</tr>
<tr>
<td>Wind Blown Area</td>
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<tr>
<td>Lower Woman Drainage</td>
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<tr>
<td>Southwest Offsite (Upper Woman Drainage)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Note: A check indicates that the Project result was less than the RI/FS benchmark value.

The maximum Am-241 values in the Wind Blown Area EU, the Lower Woman Drainage EU and the southwest offsite area (Upper Woman Drainage) 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 the various exposure units in the RI/FS Report.
Table 5-2  Comparison of Project Pu-238 Results to RI/FS Benchmarks

<table>
<thead>
<tr>
<th>Sampled Area/Exposure Unit</th>
<th>Project Samples Less Than Background</th>
<th>Project Samples Less Than WRW PRG</th>
<th>Comparison to RI/FS Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock Creek Drainage</td>
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<tr>
<td>Inter-Drainage</td>
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<td>N.A.</td>
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<tr>
<td>No-Name Gulch Drainage</td>
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<td>N.A.</td>
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<tr>
<td>Wind Blown Area</td>
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<tr>
<td>Lower Woman Drainage</td>
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<tr>
<td>Southwest Offsite (Upper Woman Drainage)</td>
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<td></td>
</tr>
</tbody>
</table>

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 select Project soil samples in the Lower Woman Drainage and the southwest offsite area (Upper Woman Drainage) were above the mean values calculated for those exposure units in the RI/FS Report. However, the Pu-238 activity in all Project samples was below the Wildlife Refuge Worker PRG. The WRW PRG is over two orders of magnitude greater than the maximum Pu-238 activity detected in a Project sample.
The maximum Pu-239/240 values in the Inter-Drainage EU, the Wind Blown Area EU, the Lower Woman Drainage EU, and the southwest offsite area (Upper Woman Drainage) were above background levels. However, the Pu-239/240 activity in all Project samples was below the Wildlife Refuge Worker PRG and less than the mean values calculated for the various exposure units in the RI/FS Report.

### Table 5-3  Comparison of Project Pu-239/240 Results to RI/FS Benchmarks

<table>
<thead>
<tr>
<th>Sampled Area/Exposure Unit</th>
<th>Project Samples Less Than Background</th>
<th>Project Samples Less Than WRW PRG</th>
<th>Comparison to RI/FS Mean</th>
<th>Project Sample Maximum Less Than RI/FS Mean</th>
<th>Project Sample Mean Less Than RI/FS Mean</th>
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<tr>
<td>No-Name Gulch Drainage</td>
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<tr>
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<td>Lower Woman Drainage</td>
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<tr>
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</table>

Note: A check indicates that the Project result was less than the RI/FS benchmark value.

### Table 5-4  Comparison of Project U-234 Results to RI/FS Benchmarks

<table>
<thead>
<tr>
<th>Sampled Area/Exposure Unit</th>
<th>Project Samples Less Than Background</th>
<th>Project Samples Less Than WRW PRG</th>
<th>Comparison to RI/FS Mean</th>
<th>Project Sample Maximum Less Than RI/FS Mean</th>
<th>Project Sample Mean Less Than RI/FS Mean</th>
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</thead>
<tbody>
<tr>
<td>Rock Creek Drainage</td>
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<tr>
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<tr>
<td>No-Name Gulch Drainage</td>
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<tr>
<td>Wind Blown Area</td>
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<tr>
<td>Lower Woman Drainage</td>
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<td></td>
</tr>
<tr>
<td>Southwest Offsite (Upper Woman Drainage)</td>
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<td>✓</td>
<td>✓</td>
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</tr>
</tbody>
</table>

Note: A check indicates that the Project result was less than the RI/FS benchmark value.
The U-234 activity of one of the five Project samples in the No Name Gulch Drainage EU was higher than the mean value calculated in the RI/FS Report, but the mean activity of the Project samples was less than the RI/FS mean value for this exposure unit. All U-234 values were below both the applicable background levels and the Wildlife Refuge Worker PRG.

Table 5-5  Comparison of Project U-235 Results to RI/FS Benchmarks

<table>
<thead>
<tr>
<th>Sampled Area/Exposure Unit</th>
<th>Project Samples Less Than Background</th>
<th>Project Samples Less Than WRW PRG</th>
<th>Comparison to RI/FS Mean</th>
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<tr>
<td>Rock Creek Drainage</td>
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<td>✔</td>
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<tr>
<td>Inter-Drainage</td>
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</tr>
<tr>
<td>No-Name Gulch Drainage</td>
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<td></td>
</tr>
<tr>
<td>Wind Blown Area</td>
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<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Lower Woman Drainage</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Southwest Offsite (Upper Woman Drainage)</td>
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</tr>
</tbody>
</table>

Note: A check indicates that the Project result was less than the RI/FS benchmark value.

The U-235 activity of select Project samples in the Rock Creek Drainage EU, the No Name Gulch Drainage EU, and the Wind Blown Area EU were higher than the mean value calculated in the RI/FS Report. In addition, the mean of the Project samples from the No Name Gulch Drainage was higher than the RI/FS mean value for this exposure unit. However, all U-235 values were below both the background level and the Wildlife Refuge Worker PRG.
### Table 5-6  Comparison of Project U-238 Results to RI/FS Benchmarks

<table>
<thead>
<tr>
<th>Sampled Area/Exposure Unit</th>
<th>Project Samples Less Than Background</th>
<th>Project Samples Less Than WRW PRG</th>
<th>Comparison to RI/FS Mean</th>
<th>Project Sample Maximum Less Than RI/FS Mean</th>
<th>Project Sample Mean Less Than RI/FS Mean</th>
</tr>
</thead>
<tbody>
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<tr>
<td>Inter-Drainage</td>
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<td>✓</td>
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<tr>
<td>No-Name Gulch Drainage</td>
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</table>

Note: A check indicates that the Project result was less than the RI/FS benchmark value.

The U-238 activity in the Project samples were below all RI/FS Benchmark values.

In the RI/FS Report (Kaiser-Hill Company, 2006), Pu-239/240 was the only radionuclide of the six evaluated in this Project that was evaluated as a contaminant of concern (COC) and then only in the Wind Blown Area EU. To assess the Project Pu-239/240 data population further, EA compared the distribution of the Pu-239/240 activity in Project soil samples to the Pu-239/240 activity in surface soils in the corresponding exposure unit populations from the RI/FS Report. The results of these comparison are provided in Inserts 5-1 through 5-6.
Insert 5-1  Rock Creek Drainage Exposure Unit Pu-239/240 Histogram

Insert 5-2  Inter-Drainage Exposure Unit Pu-239/240 Histogram
Insert 5-3  No Name Gulch Drainage Exposure Unit Pu-239/240 Histogram

Insert 5-4  Wind Blown Area Exposure Unit Pu-239/240 Histogram
Insert 5-5  Lower Woman Drainage Exposure Unit Pu-239/240 Histogram

![Lower Woman Drainage Exposure Unit Pu-239/240 Histogram](image1)

Insert 5-6  Southwest Offsite Area (Upper Woman Drainage Exposure Unit) Pu-239/240 Histogram

![Southwest Offsite Area (Upper Woman Drainage Exposure Unit) Pu-239/240 Histogram](image2)
Review of these histograms indicates that the Pu-234/240 activity in surface soils along the planned new or improved trail routes are at the lower end of the activities observed within the six exposure units investigated as part of the 2006 RI/FS.

The Project data summarized in Tables 5-1 through 5-6 and illustrated in Inserts 5-1 through 5-6 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


Map Service Layer Credits: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


Legend

- Central Operable Unit (OU 1)
- RI/FS Exposure Units
FIGURE 2-1
TRAIL SAMPLING LOCATIONS
USFWS RFNWR

Legend
- Sample Locations
- RFNWR Trails
- RI/FS Exposure Units
- Site Boundary
- RFNWR Trails (Locations to be Sampled)

Project No. 110876

August 2019
FIGURE 4-2
TRAIL SAMPLING LOCATIONS - EAST
USFWS RFNWR

Legend
- Sample Locations
- RFNWR Trails
- RI/FS Exposure Units
- Site Boundary
- RFNWR Trails (Locations to be Sampled)
FIGURE 4-3
TRAIL SAMPLING LOCATIONS - SOUTHWEST
USFWS RFNWR

Legend
- Sample Locations
- RI/FS Exposure Units
- Site Boundary
- RFNWR Trails
- RFNWR Trails (Locations to be Sampled)
# Sampling and Analysis Plan

## Rocky Mountain Greenway Trail Crossings

### Rocky Mountain Greenway Partner Group

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<tr>
<th>Acronym</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD</td>
<td>Absolute Difference</td>
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<tr>
<td>AEU</td>
<td>Aquatic Exposure Unit</td>
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<td>ALS</td>
<td>ALS Global Laboratories</td>
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<tr>
<td>CAD/ROD</td>
<td>Corrective Action Decision/Record of Decision</td>
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<td>CDPHE</td>
<td>Colorado Department of Public Health and Environment</td>
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<td>CERCLA</td>
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<td>Department of Energy.</td>
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<td>United States Environmental Protection Agency</td>
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<tr>
<td>M2SD</td>
<td>Background Mean Plus Two Standard Deviations</td>
</tr>
<tr>
<td>MARSSIM,</td>
<td>Multi-Agency Radiation Survey and Site Investigation Manual</td>
</tr>
<tr>
<td>MARLAP</td>
<td>Multi-Agency Radiological Laboratory Analytical Protocols</td>
</tr>
<tr>
<td>MB</td>
<td>Matrix Blanks</td>
</tr>
<tr>
<td>MDC</td>
<td>Minimum Detectable Concentrations</td>
</tr>
<tr>
<td>MQO</td>
<td>Method Quality Objective</td>
</tr>
<tr>
<td>MS</td>
<td>Matrix Spike</td>
</tr>
<tr>
<td>MSD</td>
<td>Matrix Spike Duplicate</td>
</tr>
<tr>
<td>NIST</td>
<td>National Institute of Standards and Technology</td>
</tr>
<tr>
<td>NRC</td>
<td>Nuclear Regulatory Commission</td>
</tr>
<tr>
<td>OU</td>
<td>Operable Unit</td>
</tr>
<tr>
<td>pCi/g</td>
<td>Picocuries per gram.</td>
</tr>
<tr>
<td>PCOC</td>
<td>Potential Contaminants Of Concern</td>
</tr>
<tr>
<td>PNNL</td>
<td>Pacific Northwest National Laboratory</td>
</tr>
<tr>
<td>PRG</td>
<td>Preliminary Remediation Goals</td>
</tr>
<tr>
<td>QAPP</td>
<td>Quality Assurance Project Plan</td>
</tr>
<tr>
<td>QC</td>
<td>Quality Control</td>
</tr>
</tbody>
</table>
## Acronym | Explanation
--- | ---
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

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

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

<table>
<thead>
<tr>
<th>Published by</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable standards from the United States Nuclear Regulatory Commission (NRC)</td>
<td>(NRC Title 10 Part 20) and Environmental Protection Agency Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).</td>
</tr>
<tr>
<td>Colorado Department of Public Health and Environment</td>
<td>Colorado Code of Regulations, Radiation Control – Standards for Protection Against Radiation (6 CCR 1007-1 Part 04), Adopted June 17, 2015</td>
</tr>
</tbody>
</table>
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:
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.
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>
<thead>
<tr>
<th>Radionuclide</th>
<th>Number of Results</th>
<th>Minimum Value (pCi/g)</th>
<th>Maximum Value (pCi/g)</th>
<th>Arithmetic Mean Value (pCi/g)</th>
<th>Standard Deviation (pCi/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-241</td>
<td>37</td>
<td>-0.00738</td>
<td>0.950</td>
<td>0.0613</td>
<td>0.160</td>
</tr>
<tr>
<td>Pu-239/240</td>
<td>50</td>
<td>-0.00602</td>
<td>7.25</td>
<td>0.222</td>
<td>1.02</td>
</tr>
<tr>
<td>U-233/234</td>
<td>39</td>
<td>0.343</td>
<td>2.17</td>
<td>1.07</td>
<td>0.362</td>
</tr>
<tr>
<td>U-235</td>
<td>39</td>
<td>-0.109</td>
<td>0.466</td>
<td>0.0641</td>
<td>0.113</td>
</tr>
<tr>
<td>U-238</td>
<td>39</td>
<td>0.417</td>
<td>1.83</td>
<td>1.11</td>
<td>0.311</td>
</tr>
</tbody>
</table>

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)

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

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 95th percent upper confidence limit (UCL) on the average (mean) concentration within an EU. The 95th 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)**

<table>
<thead>
<tr>
<th>Wildlife Refuge Worker (WRW)</th>
<th>Wildlife Refuge Visitor (WRV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excess Lifetime Cancer Risk</td>
<td>Annual Dose Rate (mrem)</td>
</tr>
<tr>
<td>Tier 1</td>
<td>2 x 10^{-6}</td>
</tr>
<tr>
<td>Tier 2</td>
<td>9 x 10^{-7}</td>
</tr>
<tr>
<td>Annual Dose Rate (mrem)</td>
<td>0.3</td>
</tr>
<tr>
<td>Tier 1</td>
<td>0.07 (adult)</td>
</tr>
<tr>
<td>Tier 2</td>
<td>0.1 (child)</td>
</tr>
</tbody>
</table>


The cancer risk estimates were at the lower end of EPA’s risk range of 1 x 10^{-6} (one in a million) to 1 x 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\(^1\). EA used the historic Plutonium 239/240 data from the two EUs

\(^1\) 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 ft², 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 ft², 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.
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>
<thead>
<tr>
<th>Radionuclide</th>
<th>Method¹</th>
<th>Minimum Detectable Concentration² (MDC) (pCi/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-241</td>
<td>alpha spectroscopy</td>
<td>0.1</td>
</tr>
<tr>
<td>Pu-238</td>
<td>alpha spectroscopy</td>
<td>0.15</td>
</tr>
<tr>
<td>Pu-239/240</td>
<td>alpha spectroscopy</td>
<td>0.1</td>
</tr>
<tr>
<td>U-234</td>
<td>alpha spectroscopy</td>
<td>0.1</td>
</tr>
<tr>
<td>U-235</td>
<td>alpha spectroscopy</td>
<td>0.1</td>
</tr>
<tr>
<td>U-238</td>
<td>alpha spectroscopy</td>
<td>0.1</td>
</tr>
</tbody>
</table>

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-

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party analysis\textsuperscript{2} 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

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

ALS will initially process the field samples per ALS SOP 736, \textit{Representative Laboratory Subsampling – Radiochemistry}, which will include drying and milling\textsuperscript{3}. 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 powered 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, \textit{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 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, \textit{Actinides – Uranium, Plutonium and Americium/Curium (Partial) Sequential Separation by Ion Exchange}. This step will be followed by ALS SOP # 751, \textit{Actinides

\textsuperscript{2} Quality Assurance/Quality Control of Project samples is the responsibility of other entities following relinquishment of sample custody by ALS/EA.

\textsuperscript{3} 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 TRUTM and TEVATM 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 ERB 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:

$$\sigma^2 = \sigma^2_M + \sigma^2_S$$

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:

$$\text{RPD} = \frac{|D_1 - D_2|}{\text{avg}(D_1 + D_2)} \times 100$$

Where:
- $D_1 =$ First or primary sample value
- $D_2 =$ 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:

$$\text{AD} = |D_1 - D_2|$$

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:

\[
% \text{D} = \frac{\text{SSR} - \text{SA}}{\text{SA}} \times 100
\]

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

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

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

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


FIGURES
Potential Areas of Disturbance

Exposure Unit boundary

Indiana Crossing

Crossing

Wind Blown Area

No Name Gulch Drainages

Inter Drainage

West Area

Upper Walnut Drainage

South Area

Upper Woman Drainage

No Name Woman Drainages

Lower Woman Drainage

Southeast Buffer Zone Area

No Name Gulch Drainages

Upper Woman Drainage

Southwest Buffer Zone Area

No Name Woman Drainages

Lower Woman Drainage

Southeast Buffer Zone Area

Figure 3.16
Plutonium-239/240 Activity in Surface Soil

KEY

- VWR PRG
- Background MSDG and < VWR PRG
- Detected + Background MSDG
- Not detected

Measurements reported value = 0.076 Bq/g

Background measured reported value = 0.316 Bq/g

VWR PRG = 0.009 Bq/g

Notes:

Data presented are the results from soil samples collected between 6201/91 and 622/2005.

See Tables 3.1 and 3.13 for additional information.

Standard Map Features

AOV inventory

Pond

Perennial stream

Creeks/Runoff

Site boundary

Potential Areas of Disturbance

Exposure Unit boundary

Scale 1/24,000

State Plane Coordinates Projection

Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site


March 2019
Rev 4.0

FIGURE 3.2
PLUTONIUM-239/240 ACTIVITY IN SURFACE SOIL
ROCKY MOUNTAIN GREENWAY

NOTE:

FIGURE 3.16 FROM RCRA FACILITY INVESTIGATION - REMEDIAL INVESTIGATION CORRECTIVE MEASURES STUDY - FEASIBILITY STUDY REPORT FOR THE ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE (JUNE 2006).
Potential Areas of Disturbance

- Exposure Unit boundary
- Indiana Crossing
- 128 Crossing
- Wind Blown Area
- Rock Creek Drainage
- Inter Drainage West Area
- Industrial Area
- Upper Walnut Drainage
- Lower Walnut Drainage
- Lower Woman Drainage
- Southeast Buffer Zone Area
- No Name Gulch Drainage
- Upper Woman Drainage
- Southwest Buffer Zone Area

Project No. 110836

FIGURE 2-4

Uranium-235 Activity in Surface Soil

KEY

- VRW PPG
- Background M25D and < VRW PPG
- Detected red = Background M25D
- Not detected

Measure results reported value = 0.158 pCi/g

Measure results reported value = 0.846 pCi/g

Background M25D = 0.009 pCi/g

VRW PPG = 1.9 pCi/g

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).

Scale: 1/24,000

State Plane Coordinate System

Datum: NAD 27

U.S. Department of Energy

Rocky Flats Environmental Technology Site

March 2019

Rev 4.0

Uranium-235 Activity in Surface Soil
ROCKY MOUNTAIN GREENWAY
Potential Areas of Disturbance

- Exposure Unit boundary
- Indiana Crossing
- 128 Crossing
- Wind Blown Area
- Rock Creek Drainage
- Inter Drainage West Area
- Industrial Area
- Upper Walnut Drainage
- Lower Walnut Drainage
- Lower Woman Drainage
- Southeast Buffer Zone Area
- No Name Gulch Drainage
- Upper Woman Drainage
- Southwest Buffer Zone Area

Figure 3.19
Uranium-238 Activity in Surface Soil

KEY
- Background MDSD
- Detected rad.
- Not detected

NOTE:
FIGURE 3.19 FROM RCRA FACILITY INVESTIGATION - REMEDIAL INVESTIGATION CORRECTIVE MEASURES STUDY - FEASIBILITY STUDY REPORT FOR THE ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE (JUNE 2006).
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<tr>
<td>1</td>
<td>Primary field sample delivered to laboratory&lt;sup&gt;1&lt;/sup&gt;</td>
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<tr>
<td>2</td>
<td>Duplicate field sample delivered to laboratory&lt;sup&gt;4&lt;/sup&gt; or discarded, as appropriate&lt;sup&gt;2&lt;/sup&gt;</td>
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<tr>
<td>3</td>
<td>Archived sample</td>
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<sup>1</sup> See Figure 7-1

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

---

1 See Figure 5-1
2 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
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
QUALITY ASSURANCE MANUAL

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

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Quality Assurance Manager - Joel Nolte

Approved By: ____________________________  Date: 6-26-18
Technical Director - Steve Workman
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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
Quality Assurance Manual

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;
Quality Assurance Manual

- 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:
  o Performing routine radiation surveys and managing the radiation dosimetry program; and
  o 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:
  o Procuring and managing radioactive sources and standards;
  o Maintaining the laboratory’s radioactive materials inventory, which also includes directing prescreen analyses that provide initial characterization of potential sample radioactivity;
  o Overseeing permitted low level radioactive materials releases to the sanitary sewer; and
  o 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
Quality Assurance Manual

- 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;
  o Follow project requirements as delineated by project managers to ensure analyses are performed as requested.
  o Develop knowledge and understanding of the QAM requirements under which samples are analyzed.
  o Notify managers and Quality Assurance personnel when QA problems arise.
  o Ensure that applicable data are included in each data package in accordance with applicable SOPs.
  o 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
Quality Assurance Manual

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 ft². 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 ft².

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.) 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 samples(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 6ºC. 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 6ºC. 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:

\[
MDC = \frac{(4.65 \times \sigma_b) + 2.71}{T \times K}
\]

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 Radiochemistry

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

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

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:

\[
DER = \frac{|S - D|}{2 \times \sqrt{\sigma_S^2 + \sigma_D^2}}
\]

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
- \( C_1 \) = Concentration of analyte in spiked sample
- \( C_2 \) = Concentration of analyte in unspiked sample
- \( C_3 \) = 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 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?
Quality Assurance Manual

- 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 possibly or reasonably 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).

<table>
<thead>
<tr>
<th>GUIDELINE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above Warning Limits</td>
<td>Two of three data points above warning limits</td>
</tr>
<tr>
<td>Below Warning Limits</td>
<td>Two of three data points below warning limits</td>
</tr>
<tr>
<td>Above Mean</td>
<td>Seven consecutive data points above the mean</td>
</tr>
<tr>
<td>Below Mean</td>
<td>Seven consecutive data points below the mean</td>
</tr>
<tr>
<td>Ascending Data</td>
<td>Seven consecutive data points in ascending direction</td>
</tr>
<tr>
<td>Descending Data</td>
<td>Seven consecutive data points in descending direction</td>
</tr>
</tbody>
</table>

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
• 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
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)
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 by 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 items listed 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., benchesheets, 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

- American Industrial Hygiene Laboratory Accreditation Policies
- ANSI. Calibration and usage of Thallium-Activated Sodium Iodide Detector Systems for Assay of Radionuclides. ANSI N42.12
• The NELAC Institute (TNI), Volume 1, 2009
• USEPA. **Handbook for Analytical Quality Control in Radioanalytical Laboratories.** EPA-600/7-77-088. 1977.
• USEPA. **Handbook for Analytical Quality Control in Water and Wastewater Laboratories.** EPA 600/4-79-019. 1979.
• USEPA. **Methods for the Chemical Analysis of Waters and Wastes (MCAWW).** EPA 600/4-79-020. 1979.
• USEPA. **Methods for the Determination of Organic Compounds in Drinking Water.** EPA 600/4-88-039 (r7/91).
- USEPA. N-Hexane Extractable Material (HEM: Oil and Grease) and Silica Gel Treated n-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry (Oil and Grease and Total Petroleum Hydrocarbons). November, 1999.
Quality Assurance Manual

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
This review covers the ALS work order number 1906661. ALS work order 1906661 provides the radionuclide results for 16 soil samples (15 primary samples with a 01 suffix on the sample ID and one field duplicate samples with a 02 suffix on the sample ID) and a field equipment rinsate blank (water), or ERB, (03 suffix on the sample ID) collected by EA on June 26, 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:

- 1906661_ISO-Am.pdf
- 1906661_ISO-Pu.pdf
- 1906661_ISO-U.pdf

ALS transmitted the data to EA in an Electronic Data Deliverable (EDD) titled:

- 1906661.xls

The soil samples were collected from depths of 0-2 inches and dissolved using an acid (HCl-HNO₃-HF) digestion. The samples were analyzed for the isotopes of americium, plutonium and uranium via alpha spectroscopy.

Following provides a review of laboratory data package’s soils information.

- The Case Narratives reference 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 AS190723-1.

• The preparation batch included one each method blank (MB) and laboratory control sample (LCS). A laboratory duplicate sample was not included in the report. Note that a laboratory duplicate sample for ALS Preparation Batch number AS190723-1 was reported in ALS work order number 1906738.
  
  o The MB results were within ALS control limits except for Pu-239/240 and U-234. Pu-239/240 was detected at a level of 0.0081 pCi/g (versus a sample MDC of 0.0055 pCi/g), which is only 8% of the Project required MDC of 0.1 pCi/g. U-234 was detected at the sample MDC of 0.016 pCi/g, which is only 16% of the Project required MDC of 0.1 pCi/g ALS flagged this result as “B3” but did not qualify any sample results associated with this MB.
  
  o The results of the LCS were within ALS control limits.
  
  o As indicated above, a laboratory duplicate sample for ALS Preparation Batch number AS190723-1 was reported in ALS work order number 1906738; 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 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 (LCSD). A laboratory duplicate was not prepared due to insufficient sample volume, but the LCSD served as the duplicate for this batch.
  
  o The results of the MB were all within ALS control limits.
  
  o 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” but did not qualify any sample results.
  
  o The results of the LCSD were all within ALS control limits.
  
  o 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.
Field QC Sample Results.

- The results for ERB sample SB-9-0-2-03 from ALS work order number 1906661 were all reported as below the MDC.
- The results from one field replicate (SB-19-0-2-01/02) 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):

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>SB-19-0-2-01/02</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-241</td>
<td>U</td>
</tr>
<tr>
<td>Pu-238</td>
<td>U</td>
</tr>
<tr>
<td>Pu-239/240</td>
<td>U</td>
</tr>
<tr>
<td>U-234</td>
<td>13%</td>
</tr>
<tr>
<td>U-235</td>
<td>U</td>
</tr>
<tr>
<td>U-238</td>
<td>23%</td>
</tr>
</tbody>
</table>

A control limit of 35% is recommended for laboratory duplicate soil analyses. Field replicates may offer more variability due to sample inhomogeneity.
This review covers the ALS work order number 1906738. ALS work order 1906738 provides the radionuclide results for 19 soil samples (18 primary samples with a 01 suffix on the sample ID and one field duplicate sample with a 02 suffix on the sample ID) and a field equipment rinseate blank (water), or ERB, (03 suffix on the sample ID) collected by EA on June 27, 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:

- 1906738_ISO-Am.pdf
- 1906738_ISO-Pu.pdf
- 1906738_ISO-U.pdf

ALS transmitted the data to EA in an Electronic Data Deliverable (EDD) titled:

- 1906738.xls

The soil samples were collected from depths of 0-2 inches and dissolved using an acid (HCl-HNO₃-HF) digestion. The samples were analyzed for the isotopes of americium, plutonium and uranium via alpha spectroscopy.

Following provides a review of laboratory data package’s soils information.

- The Case Narratives reference 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. A note on the sample receipt form indicates that the primary (“01”)
samples were in 4-ounce jars; whereas, the archive (“99”) samples were in the larger (8-ounce) jars.

- Samples were prepared according to ALS SOPs. The soil samples were prepared in ALS Preparation Batch numbers AS190723-1 and AS190723-2.
- The preparation batches included one each method blank (MB), laboratory control sample (LCS) and a laboratory duplicate sample.
  - The MB results for ALS Preparation Batch number AS190723-1 were within ALS control limits except for Pu-239/240 and U-234. Pu-239/240 was detected at a level of 0.0081 pCi/g (versus a sample MDC of 0.0055 pCi/g), which is only 8% of the Project required MDC of 0.1 pCi/g. U-234 was detected at the sample MDC of 0.016 pCi/g, which is only 16% of the Project required MDC of 0.1 pCi/g. ALS flagged these results as “B3” but did not qualify any sample results associated with this MB. The MB results for ALS Preparation Batch number AS190723-2 were within ALS control limits except for U-234. U-234 was detected at a level of 0.018 pCi/g (versus a sample MDC of 0.016 pCi/g), which is only 18% of the Project required MDC of 0.1 pCi/g. ALS flagged this result as “B3” but did not qualify any sample results associated with this MB.
  - The results of both LCS were within ALS control limits.
  - The results of both laboratory duplicate samples 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 480 minutes. Uranium isotopes were counted for 420 minutes and 480 minutes in ALS Preparation Batch numbers AS190723-1 and AS190723-2, respectively.
- 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” 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.

Field QC Sample Results.

• The results for ERB sample SB-26-0-2-03 from ALS work order number 1906738 were all reported as below the MDC.
• The results from one field replicate (SB-23-0-2-01/02) were compared using the relative percent difference (RPD) method. There were 6 analytical pairs for the acid digestion results:

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>SB-23-0-2-01/02 Acid Digestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-241</td>
<td>14%</td>
</tr>
<tr>
<td>Pu-238</td>
<td>18%</td>
</tr>
<tr>
<td>Pu-239/240</td>
<td>5%</td>
</tr>
<tr>
<td>U-234</td>
<td>0%</td>
</tr>
<tr>
<td>U-235</td>
<td>3%</td>
</tr>
<tr>
<td>U-238</td>
<td>10%</td>
</tr>
</tbody>
</table>

A control limit of 35% is recommended for laboratory duplicate soil analyses. Field replicates may offer more variability due to sample inhomogeneity.
This review covers the ALS work order number 1906768. ALS work order 1906768 provides the radionuclide results for 16 soil samples (15 primary samples with a 01 suffix on the sample ID and one field duplicate sample with a 02 suffix on the sample ID) and a field equipment rinsate blank (water), or ERB, (03 suffix on the sample ID) collected by EA on June 28, 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:

- 1906768_ISO-Am.pdf
- 1906768_ISO-Pu.pdf
- 1906768_ISO-U.pdf

ALS transmitted the data to EA in an Electronic Data Deliverable (EDD) titled:

- 1906768.xls

The soil samples were collected from depths of 0-2 inches and dissolved using an acid (HCl-HNO₃-HF) digestion. The samples were analyzed for the isotopes of americium, plutonium and uranium via alpha spectroscopy.

Following provides a review of laboratory data package’s soils information:

- The Case Narratives reference 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. A note on the sample receipt form indicates that the primary (“01”) and
• Duplicate samples (“02”) were in 4-ounce jars; whereas, the archive (“99”) samples were in the larger (8-ounce) jars.

• Samples were prepared according to ALS SOPs. The soil samples were prepared in ALS Preparation Batch numbers AS190723-2 and AS190723-3.

• The preparation batches included one each method blank (MB) and laboratory control sample (LCS). A laboratory duplicate sample was only reported for ALS Preparation Batch number AS190723-3. Note that a laboratory duplicate sample for ALS Preparation Batch number AS190723-2 was reported in ALS work order number 1906738.
  
  o The MB results for ALS Preparation Batch number AS190723-2 were within ALS control limits except for U-234. U-234 was detected at a level of 0.018 pCi/g (versus a sample MDC of 0.016 pCi/g), which is only 18% of the Project required MDC of 0.1 pCi/g. ALS flagged this result as “B3” but did not qualify any sample results associated with this MB. The MB results for ALS Preparation Batch number AS190723-3 were all within ALS control limits.
  
  o The results of both LCS were within ALS control limits.
  
  o The results of the laboratory duplicate sample for ALS Preparation Batch number AS190723-3 were within ALS control limits. As indicated above, a laboratory duplicate sample for ALS Preparation Batch number AS190723-2 was reported in ALS work order number 1906738; 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 480 minutes and 360 minutes in ALS Preparation Batch numbers AS190723-2 and AS190723-3, respectively. Uranium isotopes were counted for 480 minutes and 420 minutes in ALS Preparation Batch numbers AS190723-2 and AS190723-3, respectively.

• 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.
  
  o The results of the MB were all within ALS control limits.
  
  o 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” but did not qualify any sample results.
  
  o 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.

Field QC Sample Results.

- The results for ERB sample SB-34-0-2-03 from ALS work order number 1906768 were all reported as below the MDC.
- The results from one field replicate (SB-38-0-2-01/02) 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):

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>SB-38-0-2-01/02 Acid Digestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-241</td>
<td>U</td>
</tr>
<tr>
<td>Pu-238</td>
<td>U</td>
</tr>
<tr>
<td>Pu-239/240</td>
<td>3%</td>
</tr>
<tr>
<td>U-234</td>
<td>1%</td>
</tr>
<tr>
<td>U-235</td>
<td>U</td>
</tr>
<tr>
<td>U-238</td>
<td>11%</td>
</tr>
</tbody>
</table>

A control limit of 35% is recommended for laboratory duplicate soil analyses. Field replicates may offer more variability due to sample inhomogeneity.
APPENDIX B.2
ALS LABORATORY REPORTS
WORK ORDER NUMBER: 1906661
Isotopic Americium
Case Narrative

Engineering Analytics
Rocky Flats Trails (FWS) -- 110876
Work Order Number: 1906661

1. This report consists of the analytical results for sixteen soil samples and one water sample received by ALS on 06/26/2019.

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, SOP 768.

3. The samples were analyzed for the presence of $^{241}$Am 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. 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

Date

8/13/19

Date

8/14/19

Radiochemistry Final Data Reviewer
## ALS -- Fort Collins

### Sample Number(s) Cross-Reference Table

**Client Name:** Engineering Analytics  
**Client Project Name:** Rocky Flats Trails (FWS)  
**Client Project Number:** 110876  

<table>
<thead>
<tr>
<th>Client Sample Number</th>
<th>Lab Sample Number</th>
<th>COC Number</th>
<th>Matrix</th>
<th>Date Collected</th>
<th>Time Collected</th>
</tr>
</thead>
<tbody>
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<td>SB-1-0-2-01</td>
<td>1906661-1</td>
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<td>7:45</td>
</tr>
<tr>
<td>SB-1-0-2-99</td>
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</tr>
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<td>8:40</td>
</tr>
<tr>
<td>SB-4-0-2-01</td>
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<td>9:00</td>
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<td>SB-4-0-2-99</td>
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<td></td>
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<td>26-Jun-19</td>
<td>9:00</td>
</tr>
<tr>
<td>SB-5-0-2-01</td>
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<td></td>
<td>SOIL</td>
<td>26-Jun-19</td>
<td>9:25</td>
</tr>
<tr>
<td>SB-5-0-2-99</td>
<td>1906661-10</td>
<td></td>
<td>SOIL</td>
<td>26-Jun-19</td>
<td>9:25</td>
</tr>
<tr>
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<tr>
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<td>26-Jun-19</td>
<td>9:45</td>
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## Sample Number(s) Cross-Reference Table

**OrderNum:** 1906661  
**Client Name:** Engineering Analytics  
**Client Project Name:** Rocky Flats Trails (FWS)  
**Client Project Number:** 110876  
**Client PO Number:**

<table>
<thead>
<tr>
<th>Client Sample Number</th>
<th>Lab Sample Number</th>
<th>COC Number</th>
<th>Matrix</th>
<th>Date Collected</th>
<th>Time Collected</th>
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# 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.

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Site ID</th>
<th>Sampler</th>
<th>Parameter/Method Request for Analysis</th>
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<table>
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<tr>
<th>Lab ID</th>
<th>Field ID</th>
<th>Matrix</th>
<th>Sample Date</th>
<th>Sample Time</th>
<th>No. of Bottles</th>
<th>Preservative</th>
<th>GC</th>
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<td>SB-1-0-2-01</td>
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</table>

*Time Zone (Circle): EST CST (MST) PST  Matrix: O = oil  S = soil  NS = non-soil solid  W = water  L = liquid  E = extract  F = filter*

**Notes:**
- No Carbonate
- Hold all -99
- Fusion testing
- Samples for archive
- 14NO3 24HNO3 34HBO4 4NaOH 5Na2H5OZnAcetate 6NaOH 74°C 8Other

**Preservation Key:**
- No Carbonate
- Hold all -99
- Fusion testing
- Samples for archive

**Signatures:**
- **McAuliffe:** Megan Cemal 06.24.19 1630
- **Lyes:** Emily Lyons 06.24.19 1630
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<tr>
<th>LAB ID</th>
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<th>MATRIX</th>
<th>SAMPLE DATE</th>
<th>SAMPLE TIME</th>
<th># OF BOTTLES</th>
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<th>QC</th>
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*Time Zone (Circle): EST CST MDT PST Matrix: O = oil, S = soil, NS = non-soil solid, W = water, L = liquid, E = extract, F = filter

**NOTES**

- Do not test carbonate fusion
- Samples for archive

**PRESERVATION KEY**

1+HCl 2+HNO₃ 3+H₂SO₄ 4+NH₄ 5+N₂H₄/NaAcetate 6+NH₄SO₄ 7+CuCl 8=Other

**SIGNATURE**

**PRINTED NAME**

**DATE**

**TIME**

- Relinquished by: Megan Canova
- Received by: Emily Lyons
- Date: 6/26/19
- Time: 11:30
**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.

<table>
<thead>
<tr>
<th>PROJECT NAME</th>
<th>SITE ID</th>
<th>SAMPLER</th>
<th>MC/SC</th>
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<tbody>
<tr>
<td>Rocky Flats Trails Pkrs</td>
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<th>PROJECT No.</th>
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<th>PURCHASE ORDER</th>
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<td>110836</td>
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<td>Engineering Analytics</td>
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<th>SEND REPORT TO</th>
<th>INVOICE ATTN TO</th>
<th>ADDRESS</th>
<th>CITY/STATE/ZIP</th>
<th>PHONE</th>
<th>E-MAIL</th>
</tr>
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<tbody>
<tr>
<td>Jason Andrews</td>
<td>Same</td>
<td></td>
<td>970 488 3111</td>
<td></td>
<td><a href="mailto:JAndrews@enganalytics.com">JAndrews@enganalytics.com</a></td>
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</tbody>
</table>

<table>
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<th>LAB ID</th>
<th>FIELD ID</th>
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<th>SAMPLE TIME</th>
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*Time Zone (Circle): EST CST MST PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

**NOTES**

- No carbonate
- Fusion testing
- Hold all - 99
- Samples for archive

**REPORT LEVEL/QC REQUIRED**

- Summary (Standard QC)
- Level I (Standard QC + forms)
- Level II (Standard QC + forms)
- Level III (Standard QC + forms)

**SIGNATURE**

- Relinquished By: [Handwritten]
- Received By: [Handwritten]
- Relinquished By: [Handwritten]
- Received By: [Handwritten]
- Relinquished By: [Handwritten]
- Received By: [Handwritten]

**PRINTED NAME**

- [Handwritten]

**DATE**

- 6/26/19

**TIME**

- 11:30

**PRESERVATION KEY**

- 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaOH/Zn Acetate 6-NaOH 7-4°C 8-Other
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<th>No</th>
<th>Prop Off</th>
<th>Notes</th>
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<td>1. Are airbills / shipping documents present and/or removable?</td>
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<tr>
<td>2. Are custody seals on shipping containers intact?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Are custody seals on sample containers intact?</td>
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<td></td>
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</tr>
<tr>
<td>4. Is there a COC (chain-of-custody) present?</td>
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<tr>
<td>5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)</td>
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<tr>
<td>6. Are short-hold samples present?</td>
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<tr>
<td>7. Are all samples within holding times for the requested analyses?</td>
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<td></td>
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<tr>
<td>8. Were all sample containers received intact? (not broken or leaking)</td>
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<tr>
<td>9. Is there sufficient sample for the requested analyses?</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Are all samples in the proper containers for the requested analyses?</td>
<td></td>
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<tr>
<td>11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)</td>
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<td>12. Are all aqueous non-preserved samples pH 4.9?</td>
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<tr>
<td>13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles &gt; 6 mm (1/4 inch) diameter? (i.e. size of green pea)</td>
<td></td>
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<tr>
<td>14. Were the samples shipped on ice?</td>
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<tr>
<td>15. Were cooler temperatures measured at 0.1-6.0°C?</td>
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</tbody>
</table>

### Cooler Information
- **Cooler #:**
- **Temperature (°C):** Amb.
- **No. of custody seals on cooler:** N/A
- **External μR/hr reading:** 10
- **Background μR/hr reading:**

### DOT Survey
- **Acceptance Information:**

* 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: [Signature]

If applicable, was the client contacted? **YES / NO / NA**

**Contact:**

**Date/Time:**

---

Form 201r27.xls
(02/11/2019)

*IR Gun #1, VWR SN 170560549
*IR Gun #3, VWR SN 170647571
*IR Gun #4, Oakton, SN 2372220101-0002

Page 1 of 8 of 31
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Date Collected: 17-Jul-19
Prep Batch: AS190717-1
Date Prepared: 17-Jul-19
QCBatchID: AS190717-1-1
Date Analyzed: 23-Jul-19
Run ID: AS190717-1AM

Final Aliquot: 1000 ml
Result Units: pCi/l
File Name: Spectrum #1

<table>
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<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.005 +/- 0.013</td>
<td>0.024</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

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<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Am-243</td>
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<td>2.07</td>
<td>pCi/l</td>
<td>91.2</td>
<td>30 - 110 %</td>
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</tbody>
</table>

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: AM1906661-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

<table>
<thead>
<tr>
<th>Sample Matrix: SOIL</th>
<th>Prep SOP: PAI 778 Rev 16</th>
<th>Final Aliquot: 2.00 g</th>
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<tr>
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<td>Result Units: pCi/g</td>
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Lab ID: AS190723-1MB

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<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
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<td>Am-241</td>
<td>-0.0019 +/- 0.0071</td>
<td>0.0179</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>1.135</td>
<td>0.97</td>
<td>pCi/g</td>
<td>85.4</td>
<td>30 - 110%</td>
<td></td>
</tr>
</tbody>
</table>

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 - Requested MDC not met.
B - Analyte concentration greater than MDC.
B3 - Analyte concentration greater than MDC but less than Requested MDC.
DL - Decision Level

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit

Data Package ID: AM1906661-1
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

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
Final Aliquot: 1000 ml
Result Units: pCi/l
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>4.52 +/- 0.73</td>
<td>0.02</td>
<td>4.935</td>
<td>91.7</td>
<td>79 - 118</td>
<td>P,Y1</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.271</td>
<td>2.30</td>
<td>pCi/l</td>
<td>101</td>
<td>30 - 110 %</td>
<td>Y1</td>
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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 the reported activity is greater than the reported MDC.

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Minimum Detectable Concentration

Data Package ID: AM1906661-1

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
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190717-1
QCBatchID: AS190717-1-1
Final Aliquot: 1000 ml
Result Units: pCi/l
File Name: Spectrum #1

Count Time: 1000 minutes

Lab ID: AS190717-1-LCSD
Date Analyzed: 23-Jul-19
Date Collected: 17-Jul-19
Date Prepared: 17-Jul-19
Date Analyzed: 23-Jul-19

<table>
<thead>
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<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
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</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>4.53 +/- 0.73</td>
<td>0.02</td>
<td>4.935</td>
<td>91.9</td>
<td>79 - 118</td>
<td>P</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.271</td>
<td>2.19</td>
<td>pCi/l</td>
<td>96.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

Qualified/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 the reported activity is greater than the reported MDC.

Abbreviations:
- TPU - Total Propagated Uncertainty
- MDC - Minimum Detectable Concentration

Data Package ID: AM1906661-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
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: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1AM
Final Aliquot: 2.00 g
Result Units: pCi/g
File Name: Spectrum #1

Count Time: 600 minutes
Lab ID: AS190723-1LCS
Date Collected: 23-Jul-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19

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<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>2.11 +/- 0.36</td>
<td>0.02</td>
<td>2.467</td>
<td>85.5</td>
<td>67 - 111</td>
<td>P</td>
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</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>1.135</td>
<td>1.03</td>
<td>pCi/g</td>
<td>90.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 the reported activity is greater than the reported MDC.

Abbreviations:
- TPU - Total Propagated Uncertainty
- MDC - Minimum Detectable Concentration

Data Package ID: AM1906661-1
## Isotopic Americium by Alpha Spectroscopy

### PAI 714 Rev 14

#### Duplicate Sample Results (DER)

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906661  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

---

**Sample Matrix:** WATER  
**Prep SOP:** PAI 778 Rev 16  
**Prepare SOP:** PAI 778 Rev 16  
**Final Aliquot:** 1000 ml  
**Count Time:** 1000 minutes  
**Date Collected:** 17-Jul-19  
**Date Prepared:** 17-Jul-19  
**Date Analyzed:** 23-Jul-19  
**Prep Batch:** AS190717-1  
**QC Batch ID:** AS190717-1-1  
**Run ID:** AS190717-1AM  
**Prep Basis:** Unfiltered  
**Moisture (%):** NA  
**Result Units:** pCi/l  
**File Name:** Spectrum #1

---

**CASNO** | **Analyte** | **Sample** | **Duplicate** | **DER** | **DER Lim**  
--- | --- | --- | --- | --- | ---  
14596-10-2 | Am-241 | Result +/- 2 s TPU | MDC | Flags | Result +/- 2 s TPU | MDC | Flags |  
| | 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

**Data Package ID:** AM1906661-1

---

**Date Printed:** Tuesday, August 13, 2019

**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: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-1-0-2-01
Lab ID: 1906661-1

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 08-Aug-19

Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1AM
Count Time: 600 minutes
Report Basis: Dry Weight

Final Aliquot: 1.02 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.001 +/- 0.015</td>
<td>0.037</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.225</td>
<td>1.35</td>
<td>pCi/g</td>
<td>60.8</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: AM1906661-1

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Isotopic Americium by Alpha Spectroscopy

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Sample Results

Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1AM
Count Time: 600 minutes
Report Basis: Dry Weight

Final Aliquot: 1.02 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

Field ID: SB-2-0-2-01
Lab ID: 1906661-3
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 08-Aug-19

CASNO | Target Nuclide | Result +/- 2 s TPU | MDC | Requested MDC | DL | Lab Qualifier
--- | --- | --- | --- | --- | --- | ---
14596-10-2 | Am-241 | 0.010 +/- 0.017 | 0.032 | 0.1 | NA | U

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tbody>
<tr>
<td>Am-243</td>
<td>2.224</td>
<td>1.92</td>
<td>pCi/g</td>
<td>86.2</td>
<td>30 - 110 %</td>
<td></td>
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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: AM1906661-1

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: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-3-0-2-01
Lab ID: 1906661-5

Sample Matrix: SOL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 08-Aug-19
Final Aliquot: 1.04 g
Count Time: 600 minutes
Lab Name: Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876
Work Order Number: 1906661
Field ID: SB-3-0-2-01
Lab ID: 1906661-5

<table>
<thead>
<tr>
<th>CASNO</th>
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<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.011 +/- 0.016</td>
<td>0.029</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.175</td>
<td>1.86</td>
<td>pCi/g</td>
<td>85.5</td>
<td>30 - 110 %</td>
<td></td>
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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: AM1906661-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 08-Aug-19

Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1AM
Count Time: 600 minutes
Report Basis: Dry Weight

Final Aliquot: 1.08 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.017 +/- 0.018</td>
<td>0.029</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.098</td>
<td>1.68</td>
<td>pCi/g</td>
<td>80.1</td>
<td>30 - 110 %</td>
<td></td>
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</table>

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: AM1906661-1
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-1
Final Aliquot: 1.00 g
QCBatchID: AS190723-1-1
Prep Basis: Dry Weight
Run ID: AS190723-1AM
Count Time: 600 minutes
Report Basis: Dry Weight
File Name: Spectrum #1

Field ID: SB-5-0-2-01
Lab ID: 1906661-9
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 08-Aug-19

CASNO  Target Nuclide  Result +/- 2 s TPU  MDC  Requested MDC  DL  Lab Qualifier
14596-10-2  Am-241  0.007 +/- 0.020  0.041  0.1  NA  U

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
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<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.270</td>
<td>1.60</td>
<td>pCi/g</td>
<td>70.3</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
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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: AM1906661-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

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<th>Field ID:</th>
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<tbody>
<tr>
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<td>1906661-11</td>
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</table>

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 08-Aug-19

Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1AM
Count Time: 600 minutes
Report Basis: Dry Weight

Final Aliquot: 1.04 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.003 +/- 0.015</td>
<td>0.034</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.181</td>
<td>1.63</td>
<td>pCi/g</td>
<td>74.5</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: AM1906661-1
### Isotopic Americium by Alpha Spectroscopy

#### PAI 714 Rev 14

**Sample Results**

<table>
<thead>
<tr>
<th>Field ID: SB-7-0-2-01</th>
<th>Lab ID: 1906661-13</th>
</tr>
</thead>
</table>

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 26-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 08-Aug-19  
**Prep Batch:** AS190723-1  
**QCBatchID:** AS190723-1-1  
**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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.010 +/- 0.020</td>
<td>0.040</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

#### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.202</td>
<td>1.60</td>
<td>pCi/g</td>
<td>72.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

**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:** AM1906661-1

**Date Printed:** Tuesday, August 13, 2019

---

**ALS -- Fort Collins**

**LIMS Version:** 6.906

---

**Page 7 of 17**
Sample Matrix: SOIL  
Prep SOP: PAI 778 Rev 16  
Date Collected: 26-Jun-19  
Date Prepared: 23-Jul-19  
Date Analyzed: 08-Aug-19  
Prep Batch: AS190723-1  
QC Batch ID: AS190723-1-1  
Run ID: AS190723-1AM  
Count Time: 600 minutes  
Report Basis: Dry Weight  
Final Aliquot: 1.05 g  
Prep Basis: Dry Weight  
Moisture(%): NA  
Result Units: pCi/g  
File Name: Spectrum #1

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.009 +/- 0.018</td>
<td>0.034</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

#### 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:** AM1906661-1
Isotopic Americium by Alpha Spectroscopy  
PAI 714 Rev 14  
Sample Results  

Lab Name: ALS -- Fort Collins  
Work Order Number: 1906661  
Client Name: Engineering Analytics  
ClientProject ID: Rocky Flats Trails (FWS) 110876  

Sample Matrix: SOIL  
Prep SOP: PAI 778 Rev 16  
Date Collected: 26-Jun-19  
Date Prepared: 23-Jul-19  
Date Analyzed: 08-Aug-19  

Prep Batch: AS190723-1  
QCBatchID: AS190723-1-1  
Run ID: AS190723-1AM  
Count Time: 600 minutes  
Report Basis: Dry Weight  

Final Aliquot: 1.05 g  
Prep Basis: Dry Weight  
Moisture(%): NA  
Result Units: pCi/g  
File Name: Spectrum #1  

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.010 +/- 0.022</td>
<td>0.042</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Chemical Yield Summary  

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.158</td>
<td>1.94</td>
<td>pCi/g</td>
<td>90.0</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: AM1906661-1
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 08-Aug-19

Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1AM
Count Time: 600 minutes
Report Basis: Dry Weight

Final Aliquot: 1.08 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.002 +/- 0.016</td>
<td>0.037</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.098</td>
<td>1.42</td>
<td>pCi/g</td>
<td>67.8</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: AM1906661-1

Date Printed: Tuesday, August 13, 2019
Sample Results

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 08-Aug-19

Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1AM
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

Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.006 +/- 0.018</td>
<td>0.038</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

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.
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- 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: AM1906661-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Americium by Alpha Spectroscopy

Sample Results

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Final Aliquot: 1000 ml
Count Time: 1000 minutes
Report Basis: Unfiltered

Prep Batch: AS190717-1
QCBatchID: AS190717-1-1
Run ID: AS190717-1AM

Result Units: pCi/l
File Name: Spectrum #1

Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>-0.008 +/- 0.013</td>
<td>0.029</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Comments:

**Qualifiers/Flags:**

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- **Y2** - Chemical Yield outside default limits.
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- **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:** AM1906661-1
**Isotopic Americium by Alpha Spectroscopy**

**PAI 714 Rev 14**

**Sample Results**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906661  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

| Field ID: | SB-11-0-2-01  
| Lab ID: | 1906661-24  

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 26-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 08-Aug-19  

**Prep Batch:** AS190723-1  
**QC Batch ID:** AS190723-1-1  
**Run ID:** AS190723-1AM  
**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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>-0.007 +/- 0.012</td>
<td>0.034</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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</table>

**Chemical Yield Summary**

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.128</td>
<td>1.76</td>
<td>pCi/g</td>
<td>82.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

**Comments:**

- **Qualifiers/Flags:**
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  - 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:** AM1906661-1
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 08-Aug-19

Prep Batch: AS190723-1
Run ID: AS190723-1AM
Count Time: 600 minutes
Report Basis: Dry Weight

Final Aliquot: 1.04 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>-0.007 +/- 0.015</td>
<td>0.039</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.177</td>
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<td>pCi/g</td>
<td>85.1</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

Qualifiers/Flags:

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M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.
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MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit
DL - Decision Level

Data Package ID: AM1906661-1

Date Printed: Tuesday, August 13, 2019

ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-20-0-2-01
Lab ID: 1906661-28

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 08-Aug-19
Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1AM
Count Time: 600 minutes
Report Basis: Dry Weight
Final Aliquot: 1.05 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>-0.001 +/- 0.015</td>
<td>0.035</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

<table>
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<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.162</td>
<td>1.75</td>
<td>pCi/g</td>
<td>81.0</td>
<td>30 - 110 %</td>
<td></td>
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Comments:

Qualifiers/Flags:
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Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
Y2 - Chemical Yield outside default limits.
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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: AM1906661-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906
**Isotopic Americium by Alpha Spectroscopy**

**PAI 714 Rev 14**

**Sample Results**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906661  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

<table>
<thead>
<tr>
<th>Field ID:</th>
<th>Lab ID:</th>
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</thead>
<tbody>
<tr>
<td>SB-19-0-2-01</td>
<td>1906661-30</td>
</tr>
</tbody>
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- **Sample Matrix:** SOIL  
- **Prep SOP:** PAI 778 Rev 16  
- **Date Collected:** 26-Jun-19  
- **Date Prepared:** 23-Jul-19  
- **Date Analyzed:** 08-Aug-19  
- **Prep Batch:** AS190723-1  
- **Run ID:** AS190723-1AM  
- **Final Aliquot:** 1.01g  
- **Count Time:** 600 minutes  
- **Report Basis:** Dry Weight  
- **Lab Name:** Engineering Analytics  
- **Client Name:** Engineering Analytics  
- **Client Project ID:** Rocky Flats Trails (FWS) 110876  
- **Work Order Number:** 1906661  
- **Field ID:** SB-19-0-2-01  
- **Lab ID:** 1906661-30  
- **Date Analyzed:** 08-Aug-19  
- **Date Collected:** 26-Jun-19  
- **Sample Matrix:** SOIL  
- **Report Basis:** Dry Weight  
- **Date Prepared:** 23-Jul-19  
- **Date Analyzed:** 08-Aug-19  
- **Prep Batch:** AS190723-1  
- **Run ID:** AS190723-1AM  
- **Final Aliquot:** 1.01g  
- **Count Time:** 600 minutes  
- **Report Basis:** Dry Weight  
- **File Name:** Spectrum #1

**CASNO** | **Target Nuclide** | **Result +/- 2 s TPU** | **MDC** | **Requested MDC** | **DL** | **Lab Qualifier** |
<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.013 +/- 0.020</td>
<td>0.036</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
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</table>

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.259</td>
<td>1.77</td>
<td>pCi/g</td>
<td>78.4</td>
<td>30 - 110 %</td>
<td>U</td>
</tr>
</tbody>
</table>

**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:** AM1906661-1

**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: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19
Final Aliquot: 1.00 g
Count Time: 600 minutes
Report Basis: Dry Weight

Field ID: SB-19-0-2-02
Lab ID: 1906661-32
Prep Batch: AS190723-1
Run ID: AS190723-1AM
QCBatchID: AS190723-1-1
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 | 0.004 +/- 0.019 | 0.040 | 0.1 | NA | U

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.261</td>
<td>1.81</td>
<td>pCi/g</td>
<td>79.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: AM1906661-1
Isotopic Plutonium
Case Narrative

Engineering Analytics
Rocky Flats Trails (FWS) -- 110876

Work Order Number: 1906661

1. This report consists of the analytical results for sixteen soil samples and one water sample received by ALS on 06/26/2019.

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, 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 08/07/2019.

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. Plutonium-239/240 activity is reported in method blank AS190723-1MB 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.

9. 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  
8/12/19  
Date

Radiochemistry Final Data Reviewer  
8/14/19  
Date
# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

**OrderNum:** 1906661  
**Client Name:** Engineering Analytics  
**Client Project Name:** Rocky Flats Trails (FWS)  
**Client Project Number:** 110876  
**Client PO Number:**

<table>
<thead>
<tr>
<th>Client Sample Number</th>
<th>Lab Sample Number</th>
<th>COC Number</th>
<th>Matrix</th>
<th>Date Collected</th>
<th>Time Collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-1-0-2-01</td>
<td>1906661-1</td>
<td></td>
<td>SOIL</td>
<td>26-Jun-19</td>
<td>7:45</td>
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<tr>
<td>SB-1-0-2-99</td>
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</table>
### Sample Number(s) Cross-Reference Table

**OrderNum:** 1906661  
**Client Name:** Engineering Analytics  
**Client Project Name:** Rocky Flats Trails (FWS)  
**Client Project Number:** 110876  
**Client PO Number:**

<table>
<thead>
<tr>
<th>Client Sample Number</th>
<th>Lab Sample Number</th>
<th>COC Number</th>
<th>Matrix</th>
<th>Date Collected</th>
<th>Time Collected</th>
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</thead>
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**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.

<table>
<thead>
<tr>
<th>PROJECT NAME</th>
<th>SITE ID</th>
<th>EDD FORMAT</th>
<th>PURCHASE ORDER</th>
<th>BILL TO COMPANY</th>
<th>INVOICE ATTN TO</th>
<th>ADDRESS</th>
<th>ADDRESS</th>
<th>CITY/STATE/ZIP</th>
<th>PHONE</th>
<th>PHONE</th>
<th>FAX</th>
<th>E-MAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rocky Flats Trails (EWS)</td>
<td>N/A</td>
<td>N/A</td>
<td>A</td>
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</table>

| LAB ID | FIELD ID | MATRIX | SAMPLE DATE | SAMPLE TIME | # OF BOTTLES | PRESERVATIVE | GC | A | B | C | D | E | F | G | H | I | J | SEE NOTES |
|--------|----------|--------|-------------|-------------|--------------|--------------|----|----|----|----|----|----|----|----|----|----|----------------------|
| 1      | 1B-1-0-2-01 | 99     | 6/24/19     | 0945        | 1             | None         | K  | K  | K  |    |    |    |    |    |    | Hold                  |
| 2      | 3B-2-0-2-01 | 99     | 08/15       | 0940        | K  | K  | K  |    |    |    |    |    |    |    |    | Hold                  |
| 3      | 3B-3-0-2-01 | 99     | 08/40       | 0840        | K  | K  | K  |    |    |    |    |    |    |    |    | Hold                  |
| 4      | 3B-4-0-2-01 | 99     | 09/00       | 0900        | K  | K  | K  |    |    |    |    |    |    |    |    | Hold                  |
| 5      | 3B-5-0-2-01 | 99     | 09/25       | 0925        | K  | K  | K  |    |    |    |    |    |    |    |    | Hold                  |
| 6      | 3B-6-0-2-01 | 99     | 09/45       | 0945        | K  | K  | K  |    |    |    |    |    |    |    |    | Hold                  |

**NOTES**

No Carbohydrate
Fusion Testing
Samples for archive

**REPORT LEVEL/QC REQUIRED**

<table>
<thead>
<tr>
<th>Summary</th>
<th>Standard QC</th>
<th>LEVEL I</th>
<th>Standard QC</th>
<th>LEVEL III</th>
<th>Standard QC</th>
<th>LEVEL IV</th>
<th>Standard QC</th>
</tr>
</thead>
</table>

1-10

**RELIQUISHED BY**

EMI McCaul

Megan Carnl

06/24/19 1630

RELIQUISHED BY

EMI McCaul

Emily Lyons

06/24/19 1630
**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.

<table>
<thead>
<tr>
<th>PROJECT NAME</th>
<th>SITE ID</th>
<th>SAMPLER</th>
<th>SK_Mc</th>
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<tbody>
<tr>
<td>Rocky Flats Trails</td>
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<td>(Fws)</td>
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</table>

**PARAMETER/METHOD REQUEST FOR ANALYSIS**

- A: Am-241  ALS SOF714
- B: Pu-238,239,240  ALS SOF714
- C: U-234, 235, 238  ALS SOF714
- D: Am-241  ALS SOF714
- E: Pu-238,239,240  ALS SOF714
- F: U-234, 235, 238  ALS SOF714

**LAB ID**

<table>
<thead>
<tr>
<th>LAB ID</th>
<th>FIELD ID</th>
<th>MATRIX</th>
<th>SAMPLE DATE</th>
<th>SAMPLE TIME</th>
<th># OF BOTTLES</th>
<th>PRESERVATIVE</th>
<th>QC</th>
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<td>3 HNO3</td>
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</table>

**Notes**

- Do not test carbonate fusion
- Samples for archive
- Report Level / QC Required
  - Summary (Standard QC)
  - Level I (Standard QC)
  - Level II (Std QC + forms)
  - Level III (Std QC + forms + raw)
- Preservation Key
  - HCl 2HNO3 3HCO3 4NaOH 5NaOH2CO2acetate 6NaHCO3 7-8°C 8 Other

**Signature**

- Received By: Emily Lyons
- Received Date: 06.26.19
- Received Time: 1630
### ALS Environmental - Fort Collins

**CONDITION OF SAMPLE UPON RECEIPT FORM**

**Project Manager:**

**Initials:**

**Date:** 06/26/19

---

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are airbills / shipping documents present and/or removable?</td>
<td>NO</td>
</tr>
<tr>
<td>Are custody seals on shipping containers intact?</td>
<td>NO</td>
</tr>
<tr>
<td>Are custody seals on sample containers intact?</td>
<td>NO</td>
</tr>
<tr>
<td>Is there a COC (chain-of-custody) present?</td>
<td>NO</td>
</tr>
<tr>
<td>Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)</td>
<td>NO</td>
</tr>
<tr>
<td>Are short-hold samples present?</td>
<td>NO</td>
</tr>
<tr>
<td>Are all samples within holding times for the requested analyses?</td>
<td>NO</td>
</tr>
<tr>
<td>Were all sample containers received intact? (not broken or leaking)</td>
<td>NO</td>
</tr>
<tr>
<td>Is there sufficient sample for the requested analyses?</td>
<td>NO</td>
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<tr>
<td>Are all samples in the proper containers for the requested analyses?</td>
<td>NO</td>
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<tr>
<td>Are all aqueous samples preserved correctly, if required? (excluding volatiles)</td>
<td>NO</td>
</tr>
<tr>
<td>Are all aqueous non-preserved samples pH 4-9?</td>
<td>NO</td>
</tr>
<tr>
<td>Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles &gt; 6 mm (1/4 inch) diameter? (i.e. size of green pea)</td>
<td>NO</td>
</tr>
<tr>
<td>Were the samples shipped on ice?</td>
<td>NO</td>
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**Were cooler temperatures measured at 0.1-6.0°C?**

<table>
<thead>
<tr>
<th>Cooler #</th>
<th>IR gun used</th>
<th>#1</th>
<th>#3</th>
<th>#4</th>
<th>AD ONLY</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DOT Survey Acceptance Information**

- Temperature (°C): Amb.
- No. of custody seals on cooler: N/A
- External µR/hr reading: 10
- Background µR/hr reading: 10

*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:

If applicable, was the client contacted? YES / NO / NA Contact: Date/Time:

**Project Manager Signature / Date:**

---

Form 201r27.xls
(02/11/2019)

*IR Gun #1, VWR SN 170560549*  
*IR Gun #3, VWR SN 170647571*  
*IR Gun #4, Oakton, SN 2372220101-0002*
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190717-1
QCBatchID: AS190717-1-1
Final Aliquot: 1000 ml
Result Units: pCi/l
File Name: Spectrum #1

Count Time: 420 minutes
Date Analyzed: 22-Jul-19
Date Collected: 17-Jul-19
Date Prepared: 17-Jul-19
Date Analyzed: 22-Jul-19

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
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<td>0.059</td>
<td>0.15</td>
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<td>10-12-8</td>
<td>Pu-239/240</td>
<td>-0.003 +/- 0.023</td>
<td>0.036</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tbody>
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<td>4.133</td>
<td>2.10</td>
<td>pCi/l</td>
<td>50.8</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 - Requested MDC not met.
B - Analyte concentration greater than MDC.
B3 - Analyte concentration greater than MDC but less than Requested MDC.
DL - Decision Level

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-1
Final Aliquot: 2.00 g
Count Time: 480 minutes
Lab ID: AS190723-1MB
Date Analyzed: 07-Aug-19
Date Collected: 23-Jul-19
Date Prepared: 23-Jul-19
Date Analyzed: 07-Aug-19

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.006 +/- 0.011</td>
<td>0.021</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.0081 +/- 0.0082</td>
<td>0.0055</td>
<td>0.1</td>
<td>NA</td>
<td>B3</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>2.304</td>
<td>1.67</td>
<td>pCi/g</td>
<td>72.6</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 - Requested MDC not met.
B - Analyte concentration greater than MDC.
B3 - Analyte concentration greater than MDC but less than Requested MDC.
DL - Decision Level

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit

Data Package ID: PU1906661-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Lab ID: AS190717-1LCS
Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190717-1
QCBatchID: AS190717-1-1
Final Aliquot: 1000 ml
Result Units: pCi/l
Run ID: AS190717-1PU
Count Time: 420 minutes
File Name: Spectrum #1

Date Collected: 17-Jul-19
Date Prepared: 17-Jul-19
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  4.74 +/- 0.83  0.03  4.553  104  82 - 118  P

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.133</td>
<td>2.71</td>
<td>pCi/l</td>
<td>65.5</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 the reported activity is greater than the reported MDC.

Abbreviations:
- TPU - Total Propagated Uncertainty
- MDC - Minimum Detectable Concentration

Data Package ID: PU1906661-1
**Isotopic Plutonium by Alpha Spectroscopy**

**PAI 714 Rev 14**

**Laboratory Control Sample(s)**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906661  
**Client Name:** Engineering Analytics  
**ClientProject ID:** Rocky Flats Trails (FWS) 110876

---

**Sample Matrix:** WATER  
**Prep SOP:** PAI 778 Rev 16  
**Prep Batch:** AS190717-1  
**QCBatchID:** AS190717-1-1  
**Final Aliquot:** 1000 ml  
**Result Units:** pCi/l  
**Count Time:** 420 minutes  
**Run ID:** AS190717-1PU  
**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 the reported activity is greater than the reported MDC.

**Abbreviations:**  
- **TPU** - Total Propagated Uncertainty  
- **MDC** - Minimum Detectable Concentration

**Data Package ID:** PU1906661-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

<table>
<thead>
<tr>
<th>Sample Matrix: SOIL</th>
<th>Prep SOP: PAI 778 Rev 16</th>
<th>Prep Batch: AS190723-1</th>
<th>Final Aliquot: 2.00 g</th>
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</thead>
<tbody>
<tr>
<td>Date Collected: 23-Jul-19</td>
<td>QCBatchID: AS190723-1-1</td>
<td>Run ID: AS190723-1PU</td>
<td>Result Units: pCi/g</td>
</tr>
<tr>
<td>Date Prepared: 23-Jul-19</td>
<td>Count Time: 480 minutes</td>
<td>File Name: Spectrum #1</td>
<td></td>
</tr>
<tr>
<td>Date Analyzed: 07-Aug-19</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>2.53 +/- 0.44</td>
<td>0.01</td>
<td>2.277</td>
<td>111</td>
<td>82 - 118</td>
<td>P</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>2.304</td>
<td>1.34</td>
<td>pCi/g</td>
<td>58.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

Modifiers/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 the reported activity is greater than the reported MDC.

Data Package ID: PU1906661-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901

Page 3 of 3

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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:** 1906661  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876  
**Field ID:** AS190717-1LCSD  
**Lab ID:** AS190717-1LCSD  
**Date Analyzed:** 22-Jul-19  
**Date Collected:** 17-Jul-19  
**Sample Matrix:** WATER  
**Prep Batch:** AS190717-1  
**Final Aliquot:** 1000 ml  
**Prep SOP:** PAI 778 Rev 16  
**Count Time:** 420 minutes  
**QCBatchID:** AS190717-1-1  
**Lab ID:** AS190717-1LCSD  
**Run ID:** AS190717-1PU  
**Result Units:** pCi/l  
**Result:** 4.74 +/- 0.83  
**Sample:** Pu-239/240  
**Flags:** P  
**Duplicate:** 5.32 +/- 0.94  
**Result:** 0.03  
**MDC:** 0.02  
**DER:** 0.454  
**DER Lim:** 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  

**Data Package ID:** PU1906661-1  
**Date Printed:** Monday, August 12, 2019  
**LIMS Version:** 6.901
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1PU
Count Time: 480 minutes
Report Basis: Dry Weight

Field ID: SB-1-0-2-01
Lab ID: 1906661-1
Final Aliquot: 1.02 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #2

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.004 +/- 0.017</td>
<td>0.012</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.013 +/- 0.017</td>
<td>0.012</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.517</td>
<td>2.75</td>
<td>pCi/g</td>
<td>60.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906661-1

Date Printed: Monday, August 12, 2019
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1PU
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 #2

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.008 +/- 0.019</td>
<td>0.030</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.013 +/- 0.022</td>
<td>0.041</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.515</td>
<td>2.50</td>
<td>pCi/g</td>
<td>55.3</td>
<td>30 - 110 %</td>
<td></td>
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</tbody>
</table>

Data Package ID: PU1906661-1

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

Comments:

Data Package ID: PU1906661-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-3-0-2-01
Lab ID: 1906661-5

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1PU
Count Time: 480 minutes
Report Basis: Dry Weight

Final Aliquot: 1.04 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #2

CASNO | Target Nuclide | Result +/- 2 s TPU | MDC | Requested MDC | DL | Lab Qualifier
--- | --- | --- | --- | --- | --- | ---
13981-16-3 | Pu-238 | 0.004 +/- 0.014 | 0.010 | 0.15 | NA | U
10-12-8 | Pu-239/240 | 0.048 +/- 0.029 | 0.027 | 0.1 | NA | NA

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.415</td>
<td>3.15</td>
<td>pCi/g</td>
<td>71.4</td>
<td>30 - 110 %</td>
<td></td>
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</tbody>
</table>

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: PU1906661-1

Date Printed: Monday, August 12, 2019
**Isotopic Plutonium by Alpha Spectroscopy**

**PAI 714 Rev 14**

**Sample Results**

<table>
<thead>
<tr>
<th>Field ID</th>
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<tbody>
<tr>
<td>SB-4-0-2-01</td>
<td>1906661-7</td>
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**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 26-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 06-Aug-19

**Prep Batch:** AS190723-1  
**QCBatchID:** AS190723-1-1  
**Run ID:** AS190723-1PU  
**Count Time:** 480 minutes  
**Report Basis:** Dry Weight

**Final Aliquot:** 1.08 g  
**Prep Basis:** Dry Weight  
**Moisture(%):** NA  
**Result Units:** pCi/g

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0 +/- 0.015</td>
<td>0.010</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
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<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.048 +/- 0.030</td>
<td>0.031</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

**Chemical Yield Summary**

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.258</td>
<td>2.90</td>
<td>pCi/g</td>
<td>68.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

**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:** PU1906661-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19
Final Aliquot: 1.00 g
Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1PU
Count Time: 480 minutes
Report Basis: Dry Weight

Field ID: SB-5-0-2-01
Lab ID: 1906661-9
Lab Name: ALS -- Fort Collins
Lab ID: 1906661-9

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.010 +/- 0.018</td>
<td>0.034</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.017 +/- 0.019</td>
<td>0.030</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.608</td>
<td>3.18</td>
<td>pCi/g</td>
<td>69.0</td>
<td>30 - 110 %</td>
<td></td>
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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: PU1906661-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1PU
Count Time: 480 minutes
Report Basis: Dry Weight

Final Alquot: 1.04 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #2

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.005 +/- 0.019</td>
<td>0.035</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.056 +/- 0.035</td>
<td>0.029</td>
<td>0.1</td>
<td>NA</td>
<td></td>
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</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.427</td>
<td>2.43</td>
<td>pCi/g</td>
<td>54.8</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906661-1

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**

**Sample Results**

<table>
<thead>
<tr>
<th>Field ID: SB-7-0-2-01</th>
<th>Lab ID: 1906661-13</th>
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**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 26-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 06-Aug-19

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.002 +/- 0.016</td>
<td>0.036</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.030 +/- 0.027</td>
<td>0.039</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

**Chemical Yield Summary**

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tbody>
<tr>
<td>Pu-242</td>
<td>4.469</td>
<td>3.13</td>
<td>pCi/g</td>
<td>69.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

**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:** PU1906661-1
Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

Sample Results

Prep SOP: PAI 778 Rev 16

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Final Aliquot: 1.05 g
Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Count Time: 480 minutes
Run ID: AS190723-1PU
Report Basis: Dry Weight
File Name: Spectrum #2

Sample Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876
Field ID: SB-8-0-2-01
Lab ID: 1906661-15

CASNO | Target Nuclide | Result +/- 2 s TPU | MDC | Requested MDC | DL | Lab Qualifier
---|---|---|---|---|---|---
13981-16-3 | Pu-238 | 0.005 +/- 0.017 | 0.032 | 0.15 | NA | U
10-12-8 | Pu-239/240 | 0.078 +/- 0.042 | 0.040 | 0.1 | NA | 

Chemical Yield Summary

| Carrier/Tracer | Amount Added | Result | Units | Yield | Control Limits | Flag |
---|---|---|---|---|---|---
Pu-242 | 4.374 | 2.91 | 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.
- **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: **PU1906661-1**
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1PU
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 #2

<table>
<thead>
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<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>-0.024 +/- 0.020</td>
<td>0.065</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.058 +/- 0.036</td>
<td>0.030</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.379</td>
<td>2.48</td>
<td>pCi/g</td>
<td>56.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906661-1

Date Printed: Monday, August 12, 2019
## Isotopic Plutonium by Alpha Spectroscopy

**PAI 714 Rev 14**  
**Sample Results**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906661  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

### Sample Matrix: SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 26-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 06-Aug-19  
**Field ID:** SB-9-0-2-01  
**Lab ID:** 1906661-19

<table>
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<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.008 +/- 0.015</td>
<td>0.029</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.026 +/- 0.024</td>
<td>0.033</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.259</td>
<td>3.01</td>
<td>pCi/g</td>
<td>70.6</td>
<td>30 - 110 %</td>
<td></td>
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</tbody>
</table>

#### 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:** PU1906661-1
Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.018 +/- 0.024</td>
<td>0.041</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.022 +/- 0.023</td>
<td>0.029</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Data Package ID: PU1906661-1

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: PU1906661-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Sample Results
Prep Batch: AS190717-1
QCBatchID: AS190717-1-1
Final Aliquot: 1000 ml
Run ID: AS190717-1PU
Prep Basis: Unfiltered
Count Time: 420 minutes
Report Basis: Unfiltered
Lab Name: Client Name: Engineering Analytics

Date Collected: 26-Jun-19
Date Prepared: 17-Jul-19
Date Analyzed: 22-Jul-19

Moisture(%): NA
Lab ID: 1906661-23
Date Prepared: 17-Jul-19
Prep Batch: AS190717-1
Run ID: AS190717-1PU
Result Units: pCi/l
File Name: Spectrum #1

Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.002 +/- 0.018</td>
<td>0.043</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.011 +/- 0.018</td>
<td>0.034</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Carrier/Tracer | Amount Added | Result | Units | Yield | Control Limits | Flag |
---|---|---|---|---|---|---|
Pu-242  | 4.133 | 2.71 | pCi/l | 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: PU1906661-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1PU
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 #2

<table>
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<th>CASNO</th>
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<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.002 +/- 0.015</td>
<td>0.023</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.031 +/- 0.024</td>
<td>0.028</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.320</td>
<td>3.15</td>
<td>pCi/g</td>
<td>73.0</td>
<td>30 - 110 %</td>
<td></td>
</tr>
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</table>

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: PU1906661-1

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
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Final Aliquot: 1.04 g
Count Time: 480 minutes
Lab Name: Engineering Analytics
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876
Work Order Number: 1906661
Field ID: SB-12-0-2-01
Lab ID: 1906661-26
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1PU
Report Basis: Dry Weight
File Name: Spectrum #2

<table>
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<tr>
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<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>-0.004 +/- 0.017</td>
<td>0.032</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.033 +/- 0.026</td>
<td>0.026</td>
<td>0.1</td>
<td>NA</td>
<td></td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.419</td>
<td>2.81</td>
<td>pCi/g</td>
<td>63.6</td>
<td>30 - 110 %</td>
<td></td>
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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: PU1906661-1

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**

**Sample Results**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906661  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

---

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 26-Jun-19  
**Date Prepared:** 23-Jul-19  
**Count Time:** 480 minutes  
**Date Analyzed:** 06-Aug-19

**Prep Batch:** AS190723-1  
**Run ID:** AS190723-1PU  
**Final Aliquot:** 1.05 g  
**Report Basis:** Dry Weight

---

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.001 +/- 0.018</td>
<td>0.045</td>
<td>0.15</td>
<td>NA</td>
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<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.042 +/- 0.027</td>
<td>0.011</td>
<td>0.1</td>
<td>NA</td>
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### Chemical Yield Summary

<table>
<thead>
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<th>Carrier/Tracer</th>
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<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
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<tr>
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<td>4.388</td>
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<td>pCi/g</td>
<td>67.1</td>
<td>30 - 110 %</td>
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### 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:** PU1906661-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1PU
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 #2

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<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.004 +/- 0.016</td>
<td>0.030</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
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<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.017 +/- 0.019</td>
<td>0.030</td>
<td>0.1</td>
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Chemical Yield Summary

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<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.585</td>
<td>3.33</td>
<td>pCi/g</td>
<td>72.7</td>
<td>30 - 110 %</td>
<td></td>
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</tbody>
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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: PU1906661-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-19-0-2-02
Lab ID: 1906661-32

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1PU
Count Time: 480 minutes
Report Basis: Dry Weight

Final Aliquot: 1.00 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #2

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<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.007 +/- 0.017</td>
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<td>0.032 +/- 0.025</td>
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Chemical Yield Summary

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<th>Carrier/Tracer</th>
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<th>Result</th>
<th>Units</th>
<th>Yield</th>
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<th>Flag</th>
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<td>Pu-242</td>
<td>4.590</td>
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<td>pCi/g</td>
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<td>30 - 110 %</td>
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Comments:

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<td>Result is less than the sample specific MDC.</td>
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<tr>
<td>Y1</td>
<td>Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.</td>
</tr>
<tr>
<td>Y2</td>
<td>Chemical Yield outside default limits.</td>
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<tr>
<td>M3</td>
<td>The requested MDC was not met, but the reported activity is greater than the reported MDC.</td>
</tr>
<tr>
<td>M</td>
<td>The requested MDC was not met.</td>
</tr>
</tbody>
</table>

Abbreviations:
- TPU - Total Propagated Uncertainty
- MDC - Sample specific Minimum Detectable Concentration
- BDL - Below Detection Limit
- DL - Decision Level

Data Package ID: PU1906661-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
Isotopic Uranium
Case Narrative

Engineering Analytics
Rocky Flats Trails (FWS) -- 110876

Work Order Number: 1906661

1. This report consists of the analytical results for sixteen soil samples and one water sample received by ALS on 06/26/2019.

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, 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 08/05/2019.

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. Uranium-234 activity is reported in method blank AS190723-1MB 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.

9. 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

8/12/19
Date

Radiochemistry Final Data Reviewer

8/14/19
Date
# Sample Number(s) Cross-Reference Table

**OrderNum:** 1906661  
**Client Name:** Engineering Analytics  
**Client Project Name:** Rocky Flats Trails (FWS)  
**Client Project Number:** 110876  
**Client PO Number:**

<table>
<thead>
<tr>
<th>Client Sample Number</th>
<th>Lab Sample Number</th>
<th>COC Number</th>
<th>Matrix</th>
<th>Date Collected</th>
<th>Time Collected</th>
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## Sample Number(s) Cross-Reference Table

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<th>Client Sample Number</th>
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<th>COC Number</th>
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**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.

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<th>PROJECT NAME</th>
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<th>PARAMETER/METHOD REQUEST FOR ANALYSIS</th>
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<td>Am-241 ALS SOL 714</td>
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<table>
<thead>
<tr>
<th>COMPANY NAME</th>
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<th>INVOICE ATTN TO</th>
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<tbody>
<tr>
<td>Engineering Analytics</td>
<td>Same</td>
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<table>
<thead>
<tr>
<th>ADDRESS</th>
<th>CITY/STATE/ZIP</th>
<th>PHONE</th>
<th>FAX</th>
<th>E-MAIL</th>
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<tbody>
<tr>
<td>1800 Specht Point Rd # 209</td>
<td>Fort Collins, CO 80525</td>
<td>970 485 3111</td>
<td></td>
<td><a href="mailto:JAndews@enganalytics.com">JAndews@enganalytics.com</a></td>
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<thead>
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**NOTES**

- No Carbohydrate fusion testing
- Hold all -99 fusion testing
- Samples for archive

**REPORT LEVEL/QC REQUIRED**

<table>
<thead>
<tr>
<th>REPORT LEVEL/QC REQUIRED</th>
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**SIGNATURE**

- RELINQUISHED BY: McCall
- RECEIVED BY: John
- PRINTED NAME: Megan Conn
- DATE: 6/26/19
- TIME: 16:30

**RECEIVED BY**

- RELINQUISHED BY: Lyons
- RECEIVED BY: Monica
- RELINQUISHED BY: Lyons
- RECEIVED BY: Monica

**PRESERVATION KEY**

- 1HCL 2-HNOS 3-HNO3 4-HNO4 5-H2O 6-NaOH 7-Formic acid 8-NaCl 9-TCE 10-Other
**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.

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<th>Turner Around Time</th>
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<td>BILL TO COMPANY</td>
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</tr>
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</table>

| LAB ID | FIELD ID | MATRIX | SAMPLE DATE | SAMPLE TIME | # OF BOTTLES | PRESERVATIVE | QC | SEE NOTES |
|--------|----------|--------|-------------|-------------|--------------|--------------|    | SECTION  |
| 13     | SB-7-0-2-01 | S      | 6/20/91 | 1010        | None         | X X X        |    | Hold     |
| 14     |          |        |       | 1010        |              | X X X        |    | Hold     |
| 15     | SB-8-0-2-01 | S      | 1025     |             |              | X X X        |    | Hold     |
| 16     |          |        | 1025     |             |              | X X X        |    | Hold     |
| 17     | SB-13-0-2-01 | S      | 1050     |             |              | X X X        |    | Hold     |
| 18     |          |        | 1050     |             |              | X X X        |    | Hold     |
| 19     | SB-9-0-2-01 | S      | 1110     |             |              | X X X        |    | Hold     |
| 20     |          |        | 1110     |             |              | X X X        |    | Hold     |
| 21     | SB-10-0-2-01 | S    | 1300     |             |              | X X X        |    | Hold     |
| 22     |          |        | 1300     |             |              | X X X        |    | Hold     |
| 23     | SB-9-0-2-02 | W      | 6/20/91 | 1120        | 3 HNO3       | X X X        |    | Hold     |

*Time Zone (Circle): EST CST MDT PST  Matrix: O = oil  S = soil  NS = non-soil solid  W = water  L = liquid  E = extract  F = filter*

**NOTES**

- Do not test carbonate fusion
- Samples for archive

**REPORT LEVEL / QC REQUIRED**

- Summary (Standard QC)
- LEVEL I (Standard QC)
- LEVEL II (Stat QC + forms)
- LEVEL III (Stat QC + forms = raw)

**PRESERVATION KEY**

- 1+HCl 2+NO3 3+GBD 4+NaOH 5+NaOH/H2O/acetate 6+NaOH/so4 7+4C 8=Other

**SIGNATURE**

- RELINQUISHED BY: Megan Carroll  6-26-19 1630
- RECEIVED BY: Emily Lyons  6-26-19 1630
**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.

<table>
<thead>
<tr>
<th>TURNAROUND TIME</th>
<th>SITE ID</th>
<th>SAMPLER</th>
<th>MC/SC</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Std</td>
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**PARAMETER/METHOD REQUEST FOR ANALYSIS**

<table>
<thead>
<tr>
<th>Parameter/Method Request for Analysis</th>
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</thead>
<tbody>
<tr>
<td>ALS SOP 719</td>
</tr>
<tr>
<td>40-238, 239, 240 ALS SOP 714</td>
</tr>
<tr>
<td>muss p. 714</td>
</tr>
<tr>
<td>ALS SOP 714</td>
</tr>
</tbody>
</table>

**SEND REPORT TO**

<table>
<thead>
<tr>
<th><em>Send Report To</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Jason Andrews</td>
</tr>
</tbody>
</table>

**ADDRESS**

<table>
<thead>
<tr>
<th>Address</th>
</tr>
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<tbody>
<tr>
<td>1600 Spade Pointe Station</td>
</tr>
<tr>
<td>Fort Collins CO 80524</td>
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**PHONE**

<table>
<thead>
<tr>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>970 488 3111</td>
</tr>
</tbody>
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**E-MAIL**

<table>
<thead>
<tr>
<th>E-mail</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="mailto:JAndrews@enganalytics.com">JAndrews@enganalytics.com</a></td>
</tr>
</tbody>
</table>

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**LAB ID**

<table>
<thead>
<tr>
<th>Field ID</th>
<th>Sample Date</th>
<th>Sample Time</th>
<th># of Bottles</th>
<th>Preservative</th>
<th>QC</th>
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<tbody>
<tr>
<td>24</td>
<td>SB-11-0-2-01</td>
<td>6/26/19</td>
<td>1330</td>
<td>None</td>
<td>X</td>
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<tr>
<td>25</td>
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<tr>
<td>26</td>
<td>SB-18-0-2-01</td>
<td>1350</td>
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<td>27</td>
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<td>1350</td>
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<td>28</td>
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<td>SB-19-0-2-01</td>
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<tr>
<td>32</td>
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</tbody>
</table>

**NOTES**

- Time Zone (Circle): EST CST MST PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

- No carbonate fusion testing
- Hold all -99
- Samples for archive

---

**SIGNATURE**

<table>
<thead>
<tr>
<th>Relinquished By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yvonne</td>
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**PRINTED NAME**

<table>
<thead>
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<th>Printed Name</th>
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<tbody>
<tr>
<td>Emily Lyons</td>
</tr>
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</table>

**DATE**

<table>
<thead>
<tr>
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<tbody>
<tr>
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</tbody>
</table>

**TIME**

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<th>Time</th>
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</thead>
<tbody>
<tr>
<td>11:30</td>
</tr>
</tbody>
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**PRESERVATION KEY**

- 1-HCl 2-HNO3 3-H2SO4 4-H2O 5-NaOH 6-Na2CO3 Acetate 8-NaOH 9-H2SO4 10- Other
### ALS Environmental - Fort Collins

**CONDITION OF SAMPLE UPON RECEIPT FORM**

**Engineering Analysis**

**Client:** [Handwritten Name]

**Workorder No:** 19061661

**Project Manager:** [Handwritten Name]

**Initials:** [Handwritten Initials]

**Date:** 06-26-19

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Prop. OFF</th>
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</thead>
<tbody>
<tr>
<td>Are airbills / shipping documents present and/or removable?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are custody seals on shipping containers intact?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are custody seals on sample containers intact?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is there a COC (chain-of-custody) present?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are short-hold samples present?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are all samples within holding times for the requested analyses?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Were all sample containers received intact? (not broken or leaking)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is there sufficient sample for the requested analyses?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are all samples in the proper containers for the requested analyses?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are all aqueous samples preserved correctly, if required? (excluding volatiles)</td>
<td>N/A</td>
<td>YES</td>
<td>NO *</td>
</tr>
<tr>
<td>Are all aqueous non-preserved samples pH 4-9?</td>
<td>N/A</td>
<td>YES</td>
<td>NO *</td>
</tr>
<tr>
<td>Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles &gt; 6 mm (1/4 inch) diameter? (i.e. size of green pea)</td>
<td>N/A</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Were the samples shipped on ice?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Were cooler temperatures measured at 0.1-6.0°C?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cooler #:**

- **Temperature (°C):** Amb.
- **No. of custody seals on cooler:** N/A
- **External μR/hr reading:** 10
- **Background μR/hr reading:**

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: [Handwritten Signature]

If applicable, was the client contacted? **YES / NO / NA** Contact:

[Handwritten Name] 6/27/15

**Project Manager Signature / Date:**

---

Form 201127.xls  
(02/11/2019)

*IR Gun #1, VWR SN 170560549*  
*IR Gun #3, VWR SN 170647571*  
*IR Gun #4, Oakton, SN 2372220101-0002*

---

Page 1 of --8 of 31
# Isotopic Uranium by Alpha Spectroscopy

**PAI 714 Rev 14**  
**Method Blank Results**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906661  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

---

**Sample Matrix:** WATER  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 17-Jul-19  
**Date Prepared:** 17-Jul-19  
**Count Time:** 420 minutes

**Prep Batch:** AS190717-1  
**QCBatchID:** AS190717-1-1  
**Run ID:** AS190717-1UD  
**Date Analyzed:** 23-Jul-19  
**Date Collected:** 17-Jul-19  
**Final Alquot:** 1000 ml  
**Result Units:** pCi/l  
**File Name:** Spectrum #1

---

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.009 +/- 0.018</td>
<td>0.035</td>
<td>0.2</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>-0.002 +/- 0.018</td>
<td>0.027</td>
<td>0.2</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>-0.002 +/- 0.015</td>
<td>0.023</td>
<td>0.2</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

---

**Chemical Yield Summary**

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.429</td>
<td>3.48</td>
<td>pCi/l</td>
<td>78.6</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

---

**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** - Requested MDC not met.
- **B** - Analyte concentration greater than MDC.
- **B3** - Analyte concentration greater than MDC but less than Requested MDC.
- **DL** - Decision Level

**Abbreviations:**

- **TPU** - Total Propagated Uncertainty
- **MDC** - Sample specific Minimum Detectable Concentration
- **BDL** - Below Detection Limit

---

**Data Package ID:** UR1906661-1

---

**Date Printed:** Monday, August 12, 2019  
**ALS -- Fort Collins**  
**LIMS Version:** 6.901  
**Page 1 of 2**
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 23-Jul-19
Prep Batch: AS190723-1
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Final Aliquot: 2.00 g
Run ID: AS190723-1UD
Count Time: 420 minutes
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.016 +/- 0.013</td>
<td>0.016</td>
<td>0.1</td>
<td>NA</td>
<td>B3</td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.003 +/- 0.010</td>
<td>0.007</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.0082 +/- 0.0094</td>
<td>0.0131</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>2.287</td>
<td>1.74</td>
<td>pCi/g</td>
<td>75.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 - Requested MDC not met.
B - Analyte concentration greater than MDC.
B3 - Analyte concentration greater than MDC but less than Requested MDC.
DL - Decision Level

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit

Data Package ID: UR1906661-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

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
Run ID: AS190717-1UD
Count Time: 420 minutes
Final Aliquot: 1000 ml
Result Units: pCi/l
File Name: Spectrum #1

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<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
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<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
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</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>4.86 +/- 0.82</td>
<td>0.04</td>
<td>4.220</td>
<td>115</td>
<td>82 - 122</td>
<td>P</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>5.08 +/- 0.86</td>
<td>0.03</td>
<td>4.382</td>
<td>116</td>
<td>78 - 126</td>
<td>P</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.429</td>
<td>3.56</td>
<td>pCi/l</td>
<td>80.4</td>
<td>30 - 110 %</td>
<td></td>
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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 the reported activity is greater than the reported MDC.

Abbreviations:
- TPU - Total Propagated Uncertainty
- MDC - Minimum Detectable Concentration

Data Package ID: UR1906661-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190717-1
Prep ID: AS190717-1-1
Final Aliquot: 1000 ml
Result Units: pCi/l
File Name: Spectrum #1

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<th>Spike Added</th>
<th>% Rec</th>
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<th>Lab Qualifier</th>
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<td>13966-29-5</td>
<td>U-234</td>
<td>4.43 +/- 0.75</td>
<td>0.03</td>
<td>4.220</td>
<td>105</td>
<td>82 - 122</td>
<td>P</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>4.67 +/- 0.79</td>
<td>0.02</td>
<td>4.382</td>
<td>107</td>
<td>78 - 126</td>
<td>P</td>
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</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.429</td>
<td>4.02</td>
<td>pCi/l</td>
<td>90.8</td>
<td>30 - 110 %</td>
<td></td>
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</tbody>
</table>

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 the reported activity is greater than the reported MDC.

Data Package ID: UR1906661-1

Date Printed: Monday, August 12, 2019
LIMS Version: 6.901
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

---

<table>
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<tbody>
<tr>
<td>Date Collected: 23-Jul-19</td>
<td>QC Batch ID: AS190723-1-1</td>
<td>Run ID: AS190723-1UD</td>
</tr>
<tr>
<td>Date Prepared: 23-Jul-19</td>
<td>Final Aliquot: 2.00 g</td>
<td>Count Time: 420 minutes</td>
</tr>
<tr>
<td>Date Analyzed: 05-Aug-19</td>
<td>Result Units: pCi/g</td>
<td>File Name: Spectrum #1</td>
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<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>2.13 +/- 0.37</td>
<td>0.02</td>
<td>2.110</td>
<td>101</td>
<td>82 - 122</td>
<td>P</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>2.38 +/- 0.41</td>
<td>0.02</td>
<td>2.191</td>
<td>109</td>
<td>82 - 122</td>
<td>P</td>
</tr>
</tbody>
</table>

---

**Chemical Yield Summary**

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>2.287</td>
<td>1.84</td>
<td>pCi/g</td>
<td>80.4</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

---

**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 the reported activity is greater than the reported MDC.

**Abbreviations:**
- TPU - Total Propagated Uncertainty
- MDC - Minimum Detectable Concentration

**Data Package ID:** UR1906661-1
# Isotopic Uranium by Alpha Spectroscopy

**PAI 714 Rev 14**

**Duplicate Sample Results (DER)**

**Lab Name:** ALS -- Fort Collins

**Work Order Number:** 1906661

**Client Name:** Engineering Analytics

**Client Project ID:** Rocky Flats Trails (FWS) 110876

**Sample Matrix:** WATER

**Prep SOP:** PAI 778 Rev 16

**Date Collected:** 17-Jul-19

**Date Prepared:** 17-Jul-19

**Date Analyzed:** 23-Jul-19

**Final Aliquot:** 1000 ml

**Prep Batch:** AS190717-1

**QCBatchID:** AS190717-1-1

**Run ID:** AS190717-1UD

**Count Time:** 420 minutes

**Lab ID:** AS190717-1LCSD

**Date Analyzed:** 23-Jul-19

**Date Collected:** 17-Jul-19

**Sample Matrix:** WATER

**Prep SOP:** PAI 778 Rev 16

**Date Collected:** 17-Jul-19

**Date Prepared:** 17-Jul-19

**Date Analyzed:** 23-Jul-19

**Final Aliquot:** 1000 ml

**Prep Basis:** Unfiltered

**Moisture (%):** NA

**Result Units:** pCi/l

**File Name:** Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Analyte</th>
<th>Sample</th>
<th>Duplicate</th>
<th>DER</th>
<th>DER Lim</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>4.86 +/- 0.82</td>
<td>0.04</td>
<td>P</td>
<td>4.43 +/- 0.75</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>5.08 +/- 0.86</td>
<td>0.03</td>
<td>P</td>
<td>4.67 +/- 0.79</td>
</tr>
</tbody>
</table>

**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
- **BLD**: Below Detection Limit
- **NR**: Not Reported

**Data Package ID:** UR1906661-1

**Date Printed:** Monday, August 12, 2019
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1UD
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.79 +/- 0.17</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.020 +/- 0.020</td>
<td>0.014</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.73 +/- 0.16</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.483</td>
<td>3.32</td>
<td>pCi/g</td>
<td>74.0</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906661-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19

Final Aliquot: 1.02 g
Count Time: 420 minutes
Report Basis: Dry Weight

Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1UD

Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g

Field ID: SB-2-0-2-01
Lab ID: 1906661-3

<table>
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<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.59 +/- 0.14</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.048 +/- 0.033</td>
<td>0.029</td>
<td>0.1</td>
<td>NA</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.57 +/- 0.13</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.481</td>
<td>3.29</td>
<td>pCi/g</td>
<td>73.4</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

Qualifier/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: UR1906661-1
Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

Sample Results

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19

Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1UD
Count Time: 420 minutes
Report Basis: Dry Weight

Final Aliquot: 1.04 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g

Field ID: SB-3-0-2-01
Lab ID: 1906661-5

CASNO | Target Nuclide | Result +/- 2 s TPU | MDC | Requested MDC | DL | Lab Qualifier
--- | --- | --- | --- | --- | --- | ---
13966-29-5 | U-234 | 0.76 +/- 0.17 | 0.03 | 0.1 | NA | |
15117-96-1 | U-235 | 0.055 +/- 0.036 | 0.030 | 0.1 | NA | |
7440-61-1 | U-238 | 0.81 +/- 0.18 | 0.03 | 0.1 | NA | |

Chemical Yield Summary

| Carrier/Tracer | Amount Added | Result | Units | Yield | Control Limits | Flag |
| --- | --- | --- | --- | --- | --- | ---
| U-232 | 4.382 | 3.05 | pCi/g | 69.5 | 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: UR1906661-1

Date Printed: Monday, August 12, 2019

ALS -- Fort Collins

Page 3 of 17
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19

Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1UD
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.72 +/- 0.16</td>
<td>0.02</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.060 +/- 0.036</td>
<td>0.013</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.77 +/- 0.17</td>
<td>0.01</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.227</td>
<td>2.95</td>
<td>pCi/g</td>
<td>69.8</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906661-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
Sample Results

Prep SOP: PAI 778 Rev 16

Final Aliquot: 1.00 g

Count Time: 420 minutes

Count Time: 420 minutes

Report Basis: Dry Weight

Result Units: pCi/g

File Name: Spectrum #1

Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.81 +/- 0.18</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-86-1</td>
<td>U-235</td>
<td>0.062 +/- 0.039</td>
<td>0.015</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.82 +/- 0.18</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Carriers/Tracers | Amount Added | Result | Units | Yield | Control Limits | Flag |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.574</td>
<td>3.00</td>
<td>pCi/g</td>
<td>65.6</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906661-1
Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1UD
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.70 +/- 0.16</td>
<td>0.05</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.032 +/- 0.029</td>
<td>0.036</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.71 +/- 0.16</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.395</td>
<td>2.98</td>
<td>pCi/g</td>
<td>67.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906661-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19

Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1UD
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.77 +/- 0.17</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.039 +/- 0.032</td>
<td>0.038</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.77 +/- 0.17</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
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<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.436</td>
<td>3.04</td>
<td>pCi/g</td>
<td>68.6</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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:** UR1906661-1
### Isotopic Uranium by Alpha Spectroscopy

**PAI 714 Rev 14**

**Sample Results**

- **Lab Name:** ALS -- Fort Collins
- **Work Order Number:** 1906661
- **Client Name:** Engineering Analytics
- **ClientProject ID:** Rocky Flats Trails (FWS) 110876

#### Sample Matrix: SOIL
- **Prep SOP:** PAI 778 Rev 16
- **Date Collected:** 26-Jun-19
- **Date Prepared:** 23-Jul-19
- **Date Analyzed:** 05-Aug-19

- **Final Aliquot:** 1.05 g
- **Count Time:** 420 minutes
- **Lab Name:** Client Name: Engineering Analytics
- **Report Basis:** Dry Weight
- **Report Basis:** Dry Weight
- **File Name:** Spectrum #1

#### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.342</td>
<td>3.17</td>
<td>pCi/g</td>
<td>73.1</td>
<td>30 - 110 %</td>
<td></td>
</tr>
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</table>

#### Target Nuclide Table

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.74 +/- 0.16</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
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</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.004 +/- 0.018</td>
<td>0.038</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.60 +/- 0.14</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

#### 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:** UR1906661-1

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**Date Printed:** Monday, August 12, 2019

**ALS -- Fort Collins**

**LIMS Version:** 6.901

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22 of 31
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
QCBatchID: AS190723-1-1
Run ID: AS190723-1UD
Count Time: 420 minutes
Report Basis: Dry Weight
Final Aliquot: 1.05 g
Prep Basis: Dry Weight
Field ID: SB-13-0-2-01
Lab ID: 1906661-17
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.63 +/- 0.14</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.028 +/- 0.028</td>
<td>0.044</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.63 +/- 0.14</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.347</td>
<td>3.27</td>
<td>pCi/g</td>
<td>75.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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:
TUU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit
DL - Decision Level

Data Package ID: UR1906661-1

Date Printed: Monday, August 12, 2019
LIMS Version: 6.901
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Count Time: 420 minutes
Report Basis: Dry Weight
Field ID: SB-9-0-2-01
Lab ID: 1906661-19

Final Aliquot: 1.08 g
Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1UD
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g

Reported Result:

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.73 +/- 0.16</td>
<td>0.02</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.056 +/- 0.035</td>
<td>0.028</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.69 +/- 0.16</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.228</td>
<td>3.01</td>
<td>pCi/g</td>
<td>71.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906661-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Final Aliquot: 1.07 g
Count Time: 420 minutes
Report Basis: Dry Weight
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5 U-234</td>
<td>0.79 +/- 0.18</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
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</tr>
<tr>
<td>15117-96-1 U-235</td>
<td>0.041 +/- 0.031</td>
<td>0.031</td>
<td>0.1</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7440-61-1 U-238</td>
<td>0.89 +/- 0.19</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
<td></td>
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</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.268</td>
<td>2.71</td>
<td>pCi/g</td>
<td>63.5</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906661-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins  LIMS Version: 6.901
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 17-Jul-19
Date Analyzed: 23-Jul-19

Prep Batch: AS190717-1
QC Batch ID: 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

Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.022 +/- 0.022</td>
<td>0.027</td>
<td>0.2</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>-0.002 +/- 0.021</td>
<td>0.032</td>
<td>0.2</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.011 +/- 0.020</td>
<td>0.041</td>
<td>0.2</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

carrier/Tracer | Amount Added | Result | Units | Yield | Control Limits | Flag |
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.429</td>
<td>3.00</td>
<td>pCi/l</td>
<td>67.8</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906661-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-11-0-2-01
Lab ID: 1906661-24
Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1UD
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.70 +/- 0.16</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.046 +/- 0.032</td>
<td>0.014</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.71 +/- 0.16</td>
<td>0.05</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.288</td>
<td>3.20</td>
<td>pCi/g</td>
<td>74.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906661-1
Isotopic Uranium by Alpha Spectroscopy

Sample Results

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Final Aliquot: 1.04 g
Date Collected: 26-Jun-19
Prep Batch: AS190723-1
Date Prepared: 23-Jul-19
QCBatchID: AS190723-1-1
Date Analyzed: 05-Aug-19
Run ID: AS190723-1UD
Sample Results

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>1.04 +/- 0.22</td>
<td>0.01</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.055 +/- 0.040</td>
<td>0.042</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.95 +/- 0.21</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.387</td>
<td>2.81</td>
<td>pCi/g</td>
<td>64.0</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

Qualifiers/Flags:
U - Result is less than the sample specific MDC.
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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: UR1906661-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Final Aliquot: 1.05 g
Count Time: 420 minutes
Lab ID: 1906661-28
Date Prepared: 23-Jul-19
Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1UD
Report Basis: Dry Weight
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.64 +/- 0.15</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.040 +/- 0.031</td>
<td>0.034</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.67 +/- 0.15</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.355</td>
<td>3.39</td>
<td>pCi/g</td>
<td>77.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
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</table>

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: UR1906661-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906661
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 26-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1UD
Count Time: 420 minutes
Report Basis: Dry Weight
Final Aliquot: 1.01 g
Prep Basis: Dry Weight
Field ID: SB-19-0-2-01
Lab ID: 1906661-30
Lab Name: ALS -- Fort Collins
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.73 +/- 0.17</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.028 +/- 0.028</td>
<td>0.038</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.55 +/- 0.13</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.551</td>
<td>3.42</td>
<td>pCi/g</td>
<td>75.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906661-1

Date Printed: Monday, August 12, 2019
LIMS Version: 6.901
**Sample Results**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906661  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

---

**Field ID:** SB-19-0-2-02  
**Lab ID:** 1906661-32

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 26-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 05-Aug-19

**Prep Batch:** AS190723-1  
**QCBatchID:** AS190723-1-1  
**Run ID:** AS190723-1UD  
**Count Time:** 420 minutes  
**Report Basis:** Dry Weight

**Final Aliquot:** 1.00 g  
**Prep Basis:** Dry Weight  
**Moisture:** NA  
**Result Units:** pCi/g  
**File Name:** Spectrum #1

---

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<td>U-232</td>
<td>4.556</td>
<td>3.41</td>
<td>pCi/g</td>
<td>74.9</td>
<td>30 - 110 %</td>
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**Target Nuclide**  
**Result +/- 2 s TPU**  
**MDC**  
**Requested MDC**  
**DL**  
**Lab Qualifier**

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<td>13966-29-5</td>
<td>U-234</td>
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<td>NA</td>
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</tbody>
</table>

---

**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:** UR1906661-1
APPENDIX B.3
ALS LABORATORY REPORTS
WORK ORDER NUMBER: 1906738
1. This report consists of the analytical results for nineteen soil samples and one water sample received by ALS on 06/28/2019.

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, SOP 768.

3. The samples were analyzed for the presence of $^{241}$Am 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. 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

**OrderNum:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project Name:** Rocky Flats Trails (FWS)  
**Client Project Number:** 110876  
**Client PO Number:**

<table>
<thead>
<tr>
<th>Client Sample Number</th>
<th>Lab Sample Number</th>
<th>COC Number</th>
<th>Matrix</th>
<th>Date Collected</th>
<th>Time Collected</th>
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<tbody>
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<td>1906738-1</td>
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<td>SOIL</td>
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</table>
# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

**OrderNum:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project Name:** Rocky Flats Trails (FWS)  
**Client Project Number:** 110876  
**Client PO Number:**

<table>
<thead>
<tr>
<th>Client Sample Number</th>
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<th>COC Number</th>
<th>Matrix</th>
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</tbody>
</table>
# 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.

| LAB ID | FIELD ID | MATRIX | SAMPLE DATE | SAMPLE TIME | # OF BOTTLES | PRESERVATIVE | GC | A | B | C | D | E | F | G | H | I | J | SEE NOTES SECTION |
|--------|----------|--------|-------------|-------------|--------------|--------------|----|---|---|---|---|---|---|---|---|---|------------------|
| 1      | SB-14-0-2-01 | 5     | 6/27/19    | 0910        | 1            | None         | X  | X | X |   |    |    |    |    |    |    | Hold             |
| 2      | SB-15-0-2-01 | 99    |             | 0910        |              |              |    |   |   |   |    |    |    |    |    |    | Hold             |
| 3      | SB-16-0-2-01 | 99    |             | 0925        |              |              |    |   |   |   |    |    |    |    |    |    | Hold             |
| 4      | SB-16-0-2-01 | 99    |             | 0950        |              |              |    |   |   |   |    |    |    |    |    |    | Hold             |
| 5      | SB-17-0-2-01 | 99    |             | 0950        |              |              |    |   |   |   |    |    |    |    |    |    | Hold             |
| 6      | SB-17-0-2-01 | 99    |             | 1015        |              |              |    |   |   |   |    |    |    |    |    |    | Hold             |
| 7      | SB-18-0-2-01 | 99    |             | 1015        |              |              |    |   |   |   |    |    |    |    |    |    | Hold             |
| 8      | SB-18-0-2-01 | 99    |             | 1040        |              |              |    |   |   |   |    |    |    |    |    |    | Hold             |
| 9      | SB-21-0-2-01 | 99    |             | 1120        |              |              |    |   |   |   |    |    |    |    |    |    | Hold             |
| 10     | SB-21-0-2-01 | 99    |             | 1120        |              |              |    |   |   |   |    |    |    |    |    |    | Hold             |

*Time Zone (Circle): EST CST MST PST Matric: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

**NOTES**
- No carbonate
- Fission testing
- Hold all \(-99\) samples for archive

**PRESERVATION KEY**
- 1 HCO 2 HNO3 3 H2SO4 4 NaOH 5 NaOH/2/acetate 6 NaHISO4 7 4°C 8 Other
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<th>BOTTLE ID</th>
<th>FIELD ID</th>
<th>MATRIX</th>
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<td>12320</td>
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<td>I</td>
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<td>6/14/97</td>
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Notes: All samples for Phase 1 have been received and analyzed. No carbonate fusion testing required.
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<tr>
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<th>Hold</th>
<th>Hold</th>
<th>Hold</th>
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<td>U-234, 235, 238</td>
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<td>1350</td>
<td>1410</td>
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<td>1500</td>
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</table>

**Turnaround Time**
- Time Zone: EST CST MST PST
- Level 1: 0 to 20,000
- Level 2: 20,001 to 49,999
- Level 3: 50,000 to 199,999
- Level 4: 200,000 or more

**Notes**
- Hold all - 
- No Carbonate
- Division testing, samples for

**Preservation Key**

**Reference:**
- PW-234, 239/240, 235/238, 234, 235, 238
- PW-234, 235/238, 234, 235, 238
- PW-234, 235/238, 234, 235, 238
- PW-234, 235/238, 234, 235, 238
- PW-234, 235/238, 234, 235, 238
1. Are airbills / shipping documents present and/or removable? [DROP OFF] YES NO

2. Are custody seals on shipping containers intact? [NONE] YES NO

3. Are custody seals on sample containers intact? [NONE] YES NO

4. Is there a COC (chain-of-custody) present? YES NO

5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.) YES NO

6. Are short-hold samples present? YES NO

7. Are all samples within holding times for the requested analyses? YES NO

8. Were all sample containers received intact? (not broken or leaking) YES NO

9. Is there sufficient sample for the requested analyses? YES NO

10. Are all samples in the proper containers for the requested analyses? YES NO

11. Are all aqueous samples preserved correctly, if required? (excluding volatiles) YES NO

12. Are all aqueous non-preserved samples pH 4-9? 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) N/A YES NO

14. Were the samples shipped on ice? YES NO

15. Were cooler temperatures measured at 0.1-6.0°C? IR gun used* #1 #3 #4 YES NO

   Cooler #: 1_2

   Temperature (°C): AMB AMB

   No. of custody seals on cooler: O N/A

   External μR/hr reading: 9

   Background μR/hr reading: 9

   Were external μR/hr readings ≤ two times background and within DOT acceptance criteria? YES NO N/A (N/A, 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.

- 01 Samples in 407 Soil
- 02 Samples in 807 Soil

All client bottle ID's vs ALS lab ID's double-checked by:

If applicable, was the client contacted? YES / NO / NA

Contact:

Project Manager Signature / Date: 6/29/19
Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190717-1
Final Aliquot: 1000 ml
QCBatchID: AS190717-1-1
Count Time: 1000 minutes
Result Units: pCi/l
File Name: Spectrum #1

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<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tbody>
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<td>Am-241</td>
<td>0.005 +/- 0.013</td>
<td>0.024</td>
<td>0.1</td>
<td>NA</td>
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Chemical Yield Summary

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<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
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<td>2.271</td>
<td>2.07</td>
<td>pCi/l</td>
<td>91.2</td>
<td>30 - 110 %</td>
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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 - Requested MDC not met.
- B - Analyte concentration greater than MDC.
- B3 - Analyte concentration greater than MDC but less than Requested MDC.
- DL - Decision Level

Abbreviations:
- TPU - Total Propagated Uncertainty
- MDC - Sample specific Minimum Detectable Concentration
- BDL - Below Detection Limit

Data Package ID: AM1906738-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Final Aliquot: 2.00 g
Run ID: AS190723-1AM
Count Time: 600 minutes
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  -0.0019 +/- 0.0071  0.0179  0.1  NA  U

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
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<td>1.135</td>
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<td>pCi/g</td>
<td>85.4</td>
<td>30 - 110 %</td>
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Comments:

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U - Result is less than the sample specific MDC.
Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
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B - Analyte concentration greater than MDC.
B3 - Analyte concentration greater than MDC but less than Requested MDC.
DL - Decision Level

Data Package ID: AM1906738-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Final Aliquot: 2.00 g
Count Time: 600 minutes
File Name: Spectrum #1

Count Time: 600 minutes

Lab ID: AS190723-2MB
Date Collected: 23-Jul-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19

CASNO  Target Nuclide  Result +/- 2 s TPU  MDC  Requested MDC  DL  Lab Qualifier
14596-10-2  Am-241  -0.0037 +/- 0.0060  0.0175  0.1  NA  U

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
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<tbody>
<tr>
<td>Am-243</td>
<td>1.135</td>
<td>1.00</td>
<td>pCi/g</td>
<td>87.8</td>
<td>30 - 110 %</td>
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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 - Requested MDC not met.
B - Analyte concentration greater than MDC.
B3 - Analyte concentration greater than MDC but less than Requested MDC.
DL - Decision Level

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit

Data Package ID: AM1906738-1

Date Printed: Tuesday, August 13, 2019
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

<table>
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<th>Prep Batch: AS190717-1</th>
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<td>Date Collected: 17-Jul-19</td>
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Lab ID: AS190717-1-LCS

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<th>Lab Qualifier</th>
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<td>14596-10-2</td>
<td>Am-241</td>
<td>4.52 +/- 0.73</td>
<td>0.02</td>
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<td>79 - 118</td>
<td>P,Y1</td>
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Chemical Yield Summary

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<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<td>pCi/l</td>
<td>101</td>
<td>30 - 110 %</td>
<td>Y1</td>
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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 the reported activity is greater than the reported MDC.

Abbreviations:
- TPU - Total Propagated Uncertainty
- MDC - Minimum Detectable Concentration

Data Package ID: AM1906738-1

Date Printed: Tuesday, August 13, 2019
## Isotopic Americium by Alpha Spectroscopy

**PAI 714 Rev 14**  
**Laboratory Control Sample(s)**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

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<td>1000 ml</td>
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<td>17-Jul-19</td>
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<tr>
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<td>AS190717-1-1</td>
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<td>1000 minutes</td>
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<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
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<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>4.53 +/- 0.73</td>
<td>0.02</td>
<td>4.935</td>
<td>91.9</td>
<td>79 - 118</td>
<td>P</td>
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</tbody>
</table>

### Chemical Yield Summary

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<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.271</td>
<td>2.19</td>
<td>pCi/l</td>
<td>96.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

---

**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.
- **M1** - The requested MDC was not met.
- **M3** - The requested MDC was not met, but the reported activity is greater than the reported MDC.

Abbreviations:
- **TPU** - Total Propagated Uncertainty
- **MDC** - Minimum Detectable Concentration

---

**Data Package ID:** AM1906738-1
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Final Aliquot: 2.00 g
Result Units: pCi/g
Run ID: AS190723-1AM
File Name: Spectrum #1

Count Time: 600 minutes

Lab ID: AS190723-1-LCS
Date Collected: 23-Jul-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19

Date Analyzed: 09-Aug-19
Date Collected: 23-Jul-19
Date Prepared: 23-Jul-19

Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
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</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>2.11 +/- 0.36</td>
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<td>2.467</td>
<td>85.5</td>
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<td>P</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tbody>
<tr>
<td>Am-243</td>
<td>1.135</td>
<td>1.03</td>
<td>pCi/g</td>
<td>90.9</td>
<td>30 - 110 %</td>
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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 the reported activity is greater than the reported MDC.

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Minimum Detectable Concentration

Data Package ID: AM1906738-1

Date Printed: Tuesday, August 13, 2019
**Isotopic Americium by Alpha Spectroscopy**

*PAI 714 Rev 14*

**Laboratory Control Sample(s)**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906738  
**Client Name:** Engineering Analytics  
**ClientProject ID:** Rocky Flats Trails (FWS) 110876

<table>
<thead>
<tr>
<th>Lab ID:</th>
<th>AS190723-2-LCS</th>
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<tr>
<td>Sample Matrix:</td>
<td>SOIL</td>
</tr>
<tr>
<td>Prep SOP:</td>
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<td>Prep Batch:</td>
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<tr>
<td>Final Aliquot:</td>
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<td>Result Units:</td>
<td>pCi/g</td>
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<tr>
<td>File Name:</td>
<td>Spectrum #1</td>
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<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
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<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>2.13 +/- 0.36</td>
<td>0.02</td>
<td>2.467</td>
<td>86.5</td>
<td>67 - 111</td>
<td>P</td>
</tr>
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**Chemical Yield Summary**

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>1.135</td>
<td>1.08</td>
<td>pCi/g</td>
<td>94.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

**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 the reported activity is greater than the reported MDC.

**Abbreviations:**

- **TPU** - Total Propagated Uncertainty
- **MDC** - Minimum Detectable Concentration

**Data Package ID:** AM1906738-1
**Isotopic Americium by Alpha Spectroscopy**

**PAI 714 Rev 14**

**Duplicate Sample Results (DER)**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

---

| Field ID: | SB-14-0-2-01  
| Lab ID: | 1906738-1DUP  

| Sample Matrix: | SOIL  
| Prep SOP: | PAI 778 Rev 16  
| Date Collected: | 27-Jun-19  
| Date Prepared: | 23-Jul-19  
| Date Analyzed: | 08-Aug-19  

| Prep Batch: | AS190723-1  
| QCBatchID: | AS190723-1-1  
| Run ID: | AS190723-1AM  
| Count Time: | 600 minutes  

| Final Aliquot: | 1.08 g  
| Prep Basis: | Dry Weight  
| Moisture(%): | NA  
| Result Units: | pCi/g  
| File Name: | Spectrum #1  

---

### CASNO               | Analyte | Sample Result +/- 2 s TPU | MDC | Flags | Duplicate Result +/- 2 s TPU | MDC | Flags | DER | DER Lim |
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
14596-10-2 | Am-241 | 0.005 +/- 0.016 | 0.033 | U | 0.007 +/- 0.017 | 0.034 | U | 0.0696 | 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:** AM1906738-1
### Isotopic Americium by Alpha Spectroscopy

**PAI 714 Rev 14**  
**Duplicate Sample Results (DER)**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Prep Batch:** AS190723-2  
**Final Aliquot:** 1.01 g  
**Prep Basis:** Dry Weight  
**Date Collected:** 27-Jun-19  
**Count Time:** 600 minutes  
**Moisture(%):** NA  
**Date Prepared:** 23-Jul-19  
**Run ID:** AS190723-2AM  
**Result Units:** pCi/g  
**Date Analyzed:** 09-Aug-19  
**File Name:** Spectrum #1

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<th>MDC</th>
<th>Duplicate Result +/- 2 s TPU</th>
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<th>DER</th>
<th>DER LIM</th>
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<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.221 +/- 0.065</td>
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<td>2.13</td>
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**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

**Data Package ID:** AM1906738-1  
**Date Printed:** Tuesday, August 13, 2019
### Isotopic Americium by Alpha Spectroscopy
#### PAI 714 Rev 14
#### Duplicate Sample Results (DER)

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

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#### CASNO 14596-10-2

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<tr>
<td>Am-241</td>
<td>4.52 +/- 0.73</td>
<td>4.53 +/- 0.73</td>
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<tr>
<th>MDC</th>
<th>Flags</th>
<th>MDC</th>
<th>Flags</th>
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<tr>
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#### Comments:

**Duplicate Qualifiers/Flags:**
- **U** - Result is less than the sample specific MDC.
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- **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:** AM1906738-1

**Date Printed:** Tuesday, August 13, 2019
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 08-Aug-19
Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1AM
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

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<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.005 +/- 0.016</td>
<td>0.033</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

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<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tbody>
<tr>
<td>Am-243</td>
<td>2.208</td>
<td>1.96</td>
<td>pCi/g</td>
<td>88.8</td>
<td>30 - 110 %</td>
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</tbody>
</table>

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: AM1906738-1
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Duplicate Results

Lab Name: ALS -- Fort Collins
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Final Aliquot: 1.08 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.007 +/- 0.017</td>
<td>0.034</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.110</td>
<td>1.93</td>
<td>pCi/g</td>
<td>91.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
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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 the reported 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: AM1906738-1
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19
Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1AM
Count Time: 600 minutes
Report Basis: Dry Weight
Final Aliquot: 1.04 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.011 +/- 0.018</td>
<td>0.033</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.177</td>
<td>1.77</td>
<td>pCi/g</td>
<td>81.3</td>
<td>30 - 110 %</td>
<td></td>
</tr>
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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: AM1906738-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Sample Results

Prep SOP: PAI 778 Rev 16
Count Time: 600 minutes
Sample Matrix: SOIL
Prep Basis: Dry Weight
Report Basis: Dry Weight
Final Aliquot: 1.04 g
Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1AM
Result Units: pCi/g
File Name: Spectrum #1

Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>-0.008 +/- 0.010</td>
<td>0.031</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
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<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.192</td>
<td>1.87</td>
<td>pCi/g</td>
<td>85.1</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

Qualifiers/Flags:
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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: AM1906738-1
Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-1
Final Aliquot: 1.03 g
QCBatchID: AS190723-1-1
Run ID: AS190723-1AM
Count Time: 600 minutes
Report Basis: Dry Weight
File Name: Spectrum #1

Field ID: SB-17-0-2-01
Lab ID: 1906738-7
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19

CASNO  Target Nuclide  Result +/- 2 s TPU  MDC  Requested MDC  DL  Lab Qualifier
14596-10-2  Am-241  -0.005 +/- 0.018  0.044  0.1  NA  U

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.210</td>
<td>1.71</td>
<td>pCi/g</td>
<td>77.6</td>
<td>30 - 110 %</td>
<td></td>
</tr>
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</table>

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:

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MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit
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Data Package ID: AM1906738-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Page 4 of 20
**Isotopic Americium by Alpha Spectroscopy**

**PAI 714 Rev 14**

**Sample Results**

<table>
<thead>
<tr>
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<tr>
<td>Lab ID:</td>
<td>1906738-9</td>
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**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 27-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 09-Aug-19  
**Prep Batch:** AS190723-2  
**QC Batch ID:** AS190723-2-1  
**Run ID:** AS190723-2AM  
**Count Time:** 600 minutes  
**Report Basis:** Dry Weight  
**Final Aliquot:** 1.05 g  
**Prep Basis:** Dry Weight  
**Moisture (%):** NA  
**Result Units:** pCi/g  
**File Name:** Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
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<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>-0.012 +/- 0.015</td>
<td>0.043</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.169</td>
<td>1.50</td>
<td>pCi/g</td>
<td>69.3</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

### 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:**

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- **BDL** - Below Detection Limit
- **DL** - Decision Level

**Data Package ID:** AM1906738-1

---

**Date Printed:** Tuesday, August 13, 2019

**ALS -- Fort Collins**

**LIMS Version:** 6.906
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19

Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2AM
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.221 +/- 0.065</td>
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<td>NA</td>
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Chemical Yield Summary

<table>
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<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.202</td>
<td>1.61</td>
<td>pCi/g</td>
<td>72.9</td>
<td>30 - 110 %</td>
<td></td>
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Comments:
Qualifiers/Flags:
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Y2 - Chemical Yield outside default limits.
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M - The requested MDC was not met.

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MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit
DL - Decision Level

Data Package ID: AM1906738-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Duplicate Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-21-0-2-01
Lab ID: 1906738-11DUP

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19
Prep Batch: AS190723-2
QC Batch ID: AS190723-2-1
Run ID: AS190723-2AM
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

<table>
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<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.192 +/- 0.060</td>
<td>0.036</td>
<td>0.1</td>
<td>NA</td>
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Chemical Yield Summary

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<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tbody>
<tr>
<td>Am-243</td>
<td>2.257</td>
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<td>pCi/g</td>
<td>73.4</td>
<td>30 - 110 %</td>
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Comments:

Qualifiers/Flags:
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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 the reported 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: AM1906738-1

Date Printed: Tuesday, August 13, 2019
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19

Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2AM
Count Time: 600 minutes
Report Basis: Dry Weight

Final Aliquot: 1.02 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tbody>
<tr>
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<td>0.358 +/- 0.087</td>
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Chemical Yield Summary

<table>
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<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tr>
<td>Am-243</td>
<td>2.225</td>
<td>1.92</td>
<td>pCi/g</td>
<td>86.3</td>
<td>30 - 110 %</td>
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Comments:

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Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
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M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.
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Abbreviations:
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MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit
DL - Decision Level

Data Package ID: AM1906738-1

Date Printed: Tuesday, August 13, 2019

ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-23-0-2-01
Lab ID: 1906738-15

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19

Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2AM
Count Time: 600 minutes
Report Basis: Dry Weight

Final Aliquot: 1.02 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.66 +/- 0.14</td>
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<td>0.1</td>
<td>NA</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.234</td>
<td>1.80</td>
<td>pCi/g</td>
<td>80.6</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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.
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Abbreviations:
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- MDC - Sample specific Minimum Detectable Concentration
- BDL - Below Detection Limit
- DL - Decision Level

Data Package ID: AM1906738-1

Date Printed: Tuesday, August 13, 2019
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19

Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2AM
Count Time: 600 minutes
Report Basis: Dry Weight

Final Aliquot: 1.02 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.63 +/- 0.13</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
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<tr>
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<td>2.226</td>
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<td>pCi/g</td>
<td>76.0</td>
<td>30 - 110 %</td>
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Comments:

Qualifiers/Flags:
U - Result is less than the sample specific MDC.
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Abbreviations:
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MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit
DL - Decision Level

Data Package ID: AM1906738-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2AM
Count Time: 600 minutes
Report Basis: Dry Weight
Final Aliquot: 1.08 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.56 +/- 0.12</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.100</td>
<td>1.85</td>
<td>pCi/g</td>
<td>88.1</td>
<td>30 - 110 %</td>
<td>Y2</td>
</tr>
</tbody>
</table>

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: AM1906738-1
Isotopic Americium by Alpha Spectroscopy

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-26-0-2-01
Lab ID: 1906738-21

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19

Prep Batch: AS190723-2
QC Batch ID: AS190723-2-1
Run ID: AS190723-2AM
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 | 0.45 +/- 0.10 | 0.03 | 0.1 | NA |

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.126</td>
<td>1.77</td>
<td>pCi/g</td>
<td>83.0</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: AM1906738-1

Date Printed: Tuesday, August 13, 2019
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19

Prep Batch: AS190723-2
QC Batch ID: AS190723-2-1
Run ID: AS190723-2AM
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.76 +/- 0.16</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.118</td>
<td>1.55</td>
<td>pCi/g</td>
<td>73.4</td>
<td>30 - 110 %</td>
<td></td>
</tr>
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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: AM1906738-1

Date Printed: Tuesday, August 13, 2019
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190717-1
QCBatchID: AS190717-1-1
Run ID: AS190717-1AM
Count Time: 1000 minutes
Report Basis: Unfiltered
Final Aliquot: 1000 ml
Prep Basis: Unfiltered
Moisture(%): NA
Result Units: pCi/l
File Name: Spectrum #1

Field ID: SB-26-0-2-03
Lab ID: 1906738-24

Date Collected: 27-Jun-19
Date Prepared: 17-Jul-19
Date Analyzed: 23-Jul-19

CASNO | Target Nuclide | Result +/- 2 s TPU | MDC | Requested MDC | DL | Lab Qualifier
--- | --- | --- | --- | --- | --- | ---
14596-10-2 | Am-241 | 0 +/- 0.011 | 0.023 | 0.1 | NA | U

Chemical Yield Summary

| Carrier/Tracer | Amount Added | Result | Units | Yield | Control Limits | Flag |
|--- | --- | --- | --- | --- | --- | ---
| Am-243 | 2.271 | 1.83 | pCi/l | 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: AM1906738-1

Date Printed: Tuesday, August 13, 2019
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19
Prep Batch: AS190723-2
 QBatchID: AS190723-2-1
 Run ID: AS190723-2AM
Count Time: 600 minutes
Report Basis: Dry Weight
Final Aliquot: 1.02 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.334 +/- 0.090</td>
<td>0.039</td>
<td>0.1</td>
<td>NA</td>
<td></td>
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</tbody>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.226</td>
<td>1.38</td>
<td>pCi/g</td>
<td>62.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: AM1906738-1

Date Printed: Tuesday, August 13, 2019
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19
Field ID: SB-28-0-2-01
Lab ID: 1906738-27

Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2AM
Count Time: 600 minutes
Report Basis: Dry Weight
Final Aliquot: 1.09 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

---

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.152 +/- 0.053</td>
<td>0.033</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.083</td>
<td>1.33</td>
<td>pCi/g</td>
<td>64.0</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

---

**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:** AM1906738-1
Sample Results

Prep SOP: PAI 778 Rev 16

Final Aliquot: 1.04 g

Count Time: 600 minutes

Report Basis: Dry Weight

Prep Basis: Dry Weight

Date Analyzed: 09-Aug-19

CASNO  Target Nuclide  Result +/- 2 s TPU  MDC  Requested MDC  DL  Lab Qualifier
14596-10-2  Am-241  0.354 +/- 0.090  0.034  0.1  NA

Chemical Yield Summary

<table>
<thead>
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<th>Carrier/Tracer</th>
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<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.175</td>
<td>1.46</td>
<td>pCi/g</td>
<td>67.3</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: AM1906738-1

Date Printed: Tuesday, August 13, 2019

ALS -- Fort Collins

LIMS Version: 6.906
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Count Time: 600 minutes
Run ID: AS190723-2AM
Final Aliquot: 1.03 g
Report Basis: Dry Weight
File Name: Spectrum #1

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.143 +/- 0.047</td>
<td>0.034</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

### 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:** AM1906738-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-33-0-2-01
Lab ID: 1906738-33

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19

Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2AM
Count Time: 600 minutes
Report Basis: Dry Weight

Final Aliquot: 1.02 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.219 +/- 0.063</td>
<td>0.034</td>
<td>0.1</td>
<td>NA</td>
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</tbody>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.231</td>
<td>1.73</td>
<td>pCi/g</td>
<td>77.5</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
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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: AM1906738-1
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Lab ID:</td>
<td>1906738-35</td>
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Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2AM
Count Time: 600 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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.249 +/- 0.068</td>
<td>0.035</td>
<td>0.1</td>
<td>NA</td>
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</tr>
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#### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.143</td>
<td>1.82</td>
<td>pCi/g</td>
<td>84.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

#### 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:** AM1906738-1

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: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-31-0-2-01
Lab ID: 1906738-37

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19

Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2AM
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

<table>
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<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.110 +/- 0.041</td>
<td>0.034</td>
<td>0.1</td>
<td>NA</td>
<td></td>
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</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.130</td>
<td>1.83</td>
<td>pCi/g</td>
<td>86.0</td>
<td>30 - 110 %</td>
<td></td>
</tr>
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</table>

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: AM1906738-1

Date Printed: Tuesday, August 13, 2019
LIMS Version: 6.906
1. This report consists of the analytical results for nineteen soil samples and one water sample received by ALS on 06/28/2019.

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, 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 08/07/2019.

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. Plutonium-239/240 activity is reported in method blank AS190723-1MB 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.
9. 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.

10. 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

Date

Jean Anderson
Radiochemistry Final Data Reviewer

Date
# ALS -- Fort Collins

**Sample Number(s) Cross-Reference Table**

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## Sample Number(s) Cross-Reference Table

**OrderNum:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project Name:** Rocky Flats Trails (FWS)  
**Client Project Number:** 110876

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## 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 Information
- **Project Name:** Rocky Flats Trails (FS)
- **Project No.:** 110876
- **Company Name:** Engineering Analytics
- **Send Report To:** Jason Andrews
- **Address:** 1600 Specht Point Rd, STE 209
  Fort Collins, CO 80525
- **Phone:** (970) 488-3111
- **E-mail:** J Andrews @ enganalytics.com

### Laboratory Information

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### Notes
- No carbonate fission testing
- Hold all -99 samples for archive

### Signature
- **Signature:** Emmett Nite
- **Printed Name:** Emmett Nite
- **Date:** 6/27/19
- **Time:** 17:35
- **RELINQUISHED BY:** M Canell
- **RECEIVED BY:** M Canell
- **Date:** 6/28/19
- **Time:** 10:00
- **RELINQUISHED BY:** E Evans
- **RECEIVED BY:** E Evans

### Preservation Key
- 1:HO 2:HO3 3:HO5 4:Acetate 5:Acetate 6:NaOH 7:4°C 8:Other
### 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.

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- B: PU-238, 239/240, ALSDSOP714
- C: U-234, 235, 238, ALSDSOP714
- D: Am-841, ALSDSOP714
- E: PU-238, 239/240, ALSDSOP714
- F: U-234, 235, 238, ALSDSOP714

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**Notes:**
- No carbonate fusion testing. All samples for archive.

**Preservation Key:**
- 1-HCl, 2-HNO3, 3-H2SO4, 4-NaOH, 5-NaOH/OA, 6-NaI, 7-4°C, 8-Other

**Signatures:**
- Relinquished by: Emmett Hite
- Received by: Megan Casso
- Relinquished by: Frank Evans
- Received by: Frank Evans

**Printed Name:**
- Emmett Hite
- Megan Casso
- Frank Evans

**Date:**
- 6/27/19
- 6/28/19

**Time:**
- 17:25
- 10:00
### 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.

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<tr>
<td>30</td>
<td>SB-32-0-2-01</td>
<td></td>
<td></td>
<td>1425</td>
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<tr>
<td>31</td>
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<tr>
<td>34</td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

*Time Zone (Circle): EST CST MST PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

### NOTES

No Carbone fusion testing. Hold all -99 samples for archive.

### PRESERVATION KEY

1-H2O 2-HNO3 3-H2SO4 4-HCl 5-NaOH 6-H2O/NaBH4Acetate 7-Nonoate 8-Other

### FORM 2022 & SIGNATURES

<table>
<thead>
<tr>
<th>RELINQUISHED BY</th>
<th>RECEIVED BY</th>
<th>RECEIVED BY</th>
<th>RECEIVED BY</th>
<th>RECEIVED BY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emmett Hite</td>
<td>EA Storage</td>
<td>EA Storage</td>
<td>EA Storage</td>
<td>EA Storage</td>
</tr>
<tr>
<td>6/27/19</td>
<td>6/27/19</td>
<td>6/28/19</td>
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<td>17:25</td>
<td>17:25</td>
<td>10:00</td>
<td>10:00</td>
<td></td>
</tr>
</tbody>
</table>

### PRINTED NAME & DATE

Emmett Hite 6/27/19 17:25

### REINVESTIGATION

Signatures and dates indicate the chain of custody for the samples processed and sent for analysis.
### Chain-of-Custody

Turning around time for samples received after 2 p.m. will be calculated beginning from the next business day.

Turning around time for samples received Saturday will be calculated beginning from the next business day.

<table>
<thead>
<tr>
<th>PROJECT NAME</th>
<th>SITE ID</th>
<th>SAMPLER</th>
<th>EDD FORMAT</th>
<th>PURCHASE ORDER</th>
<th>BILL TO COMPANY</th>
<th>INVOICE ATTN TO</th>
<th>ADDRESS</th>
<th>CITY / STATE / ZIP</th>
<th>PHONE</th>
<th>PHONE FAX</th>
<th>E-MAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rocky Flats Tail (EWS)</td>
<td>STD</td>
<td>EH, SK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>80524</td>
<td>(970)</td>
<td></td>
<td><a href="mailto:JAndrews@mganalytics.com">JAndrews@mganalytics.com</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PARAMETER/METHOD REQUEST FOR ANALYSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LAB ID</th>
<th>FIELD ID</th>
<th>MATRIX</th>
<th>SAMPLE DATE</th>
<th>SAMPLE TIME</th>
<th># OF BOTTLES</th>
<th>PRESERVATIVE</th>
<th>QC</th>
<th>SEE NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>58-31-0-2-01</td>
<td>S</td>
<td>6/27/19</td>
<td>1540</td>
<td>1</td>
<td>-</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>38</td>
<td>&quot; &quot; &quot; &quot; -99</td>
<td>I</td>
<td>1</td>
<td>1540</td>
<td>1</td>
<td>-</td>
<td>Hold</td>
<td></td>
</tr>
</tbody>
</table>

---

**NOTES**

No Carbonate fusion testing

Hold all -99

Samples for archive

**PRESERVATION KEY**

1+H2O 24HNO3 3H2SO4 4HNO3 5NaOH 5NaOH2Znacetate 6NaHCO3 7-4°C 8-Other

---

**REPORT LEVEL / QC REQUIRED**

- Summary (Standard QC)
- Level II (Standard QC)
- Level III (SPE QC = flume)
- Level IV (SPE QC = flume)
<table>
<thead>
<tr>
<th>Question</th>
<th>YES</th>
<th>NO</th>
<th>*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are airbills / shipping documents present and/or removable?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are custody seals on shipping containers intact?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are custody seals on sample containers intact?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is there a COC (chain-of-custody) present?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)</td>
<td></td>
<td></td>
<td>NO*</td>
</tr>
<tr>
<td>Are short-hold samples present?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are all samples within holding times for the requested analyses?</td>
<td></td>
<td></td>
<td>NO*</td>
</tr>
<tr>
<td>Were all sample containers received intact? (not broken or leaking)</td>
<td></td>
<td></td>
<td>NO*</td>
</tr>
<tr>
<td>Is there sufficient sample for the requested analyses?</td>
<td></td>
<td></td>
<td>NO*</td>
</tr>
<tr>
<td>Are all samples in the proper containers for the requested analyses?</td>
<td></td>
<td></td>
<td>NO*</td>
</tr>
<tr>
<td>Are all aqueous samples preserved correctly, if required? (excluding volatiles)</td>
<td></td>
<td></td>
<td>NO*</td>
</tr>
<tr>
<td>Are all aqueous non-preserved samples pH 4-9?</td>
<td>N/A</td>
<td>YES</td>
<td>NO*</td>
</tr>
<tr>
<td>Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles &gt; 6 mm (1/4 inch) diameter? (i.e. size of green pea)</td>
<td>N/A</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Were the samples shipped on ice?</td>
<td></td>
<td></td>
<td>NO</td>
</tr>
<tr>
<td>Were cooler temperatures measured at 0.1-6.0°C?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cooler #</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOT Survey Acceptance Information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of custody seals on cooler</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>External μR/hr reading</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Background μR/hr reading</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

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.

- [ ] 01 Samples in 4 oz soil
- [ ] 993 Samples in 8 oz soil
- [ ] 02

All client bottle ID's vs ALS lab ID's double-checked by: [Signature]

If applicable, was the client contacted? YES / NO / NA

Project Manager Signature / Date: [Signature] 6/29/19

Form 2017-27.xlsx
(02/11/2019)

*IR Gun #1, VWR SN 170560549
*IR Gun #3, VWR SN 170647571
*IR Gun #4, Oakton, SN 2372220101-0002
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190717-1
 QCBatchID: AS190717-1-1
 Run ID: AS190717-1PU
 Final Aliquot: 1000 ml
 Count Time: 420 minutes

Final Aliquot: 1000 ml
Result Units: pCi/l
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>-0.013 +/- 0.023</td>
<td>0.059</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>-0.003 +/- 0.023</td>
<td>0.036</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.133</td>
<td>2.10</td>
<td>pCi/l</td>
<td>50.8</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 - Requested MDC not met.
B - Analyte concentration greater than MDC.
B3 - Analyte concentration greater than MDC but less than Requested MDC.
DL - Decision Level

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Final Aliquot: 2.00 g
Result Units: pCi/g
File Name: Spectrum #1

Count Time: 480 minutes

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.006 +/- 0.011</td>
<td>0.021</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.0081 +/- 0.0082</td>
<td>0.0055</td>
<td>0.1</td>
<td>NA</td>
<td>B3</td>
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</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>2.304</td>
<td>1.67</td>
<td>pCi/g</td>
<td>72.6</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
Y2 - Chemical Yield outside default limits.

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: PU1906738-1

Date Printed: Wednesday, August 14, 2019
LIMS Version: 6.906
# Isotopic Plutonium by Alpha Spectroscopy

## PAI 714 Rev 14

### Method Blank Results

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

<table>
<thead>
<tr>
<th>Lab ID</th>
<th>AS190723-2MB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Matrix</td>
<td>SOIL</td>
</tr>
<tr>
<td>Prep SOP</td>
<td>PAI 778 Rev 16</td>
</tr>
<tr>
<td>Final Aliquot</td>
<td>2.00 g</td>
</tr>
<tr>
<td>Prep Batch</td>
<td>AS190723-2</td>
</tr>
<tr>
<td>QCBatchID</td>
<td>AS190723-2-1</td>
</tr>
<tr>
<td>Run ID</td>
<td>AS190723-2PU</td>
</tr>
<tr>
<td>Count Time</td>
<td>480 minutes</td>
</tr>
<tr>
<td>Lab ID</td>
<td>AS190723-2MB</td>
</tr>
<tr>
<td>Data Collected</td>
<td>23-Jul-19</td>
</tr>
<tr>
<td>Date Prepared</td>
<td>23-Jul-19</td>
</tr>
<tr>
<td>Date Analyzed</td>
<td>05-Aug-19</td>
</tr>
<tr>
<td>Date Prepared</td>
<td>23-Jul-19</td>
</tr>
<tr>
<td>Prep Batch</td>
<td>AS190723-2</td>
</tr>
<tr>
<td>QCBatchID</td>
<td>AS190723-2-1</td>
</tr>
<tr>
<td>Run ID</td>
<td>AS190723-2PU</td>
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<tr>
<td>Count Time</td>
<td>480 minutes</td>
</tr>
<tr>
<td>File Name</td>
<td>Spectrum #1</td>
</tr>
</tbody>
</table>

## CASNO Target Nuclide | Result +/- 2 s TPU | MDC | Requested MDC | DL | Lab Qualifier
--- | --- | --- | --- | --- | ---
13981-16-3 Pu-238 | 0 +/- 0.010 | 0.019 | 0.15 | NA | U
10-12-8 Pu-239/240 | 0.001 +/- 0.010 | 0.022 | 0.1 | NA | U

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>2.304</td>
<td>1.34</td>
<td>pCi/g</td>
<td>58.3</td>
<td>30 - 110%</td>
<td></td>
</tr>
</tbody>
</table>

### 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 - Requested MDC not met.
B - Analyte concentration greater than MDC.
B3 - Analyte concentration greater than MDC but less than Requested MDC.
DL - Decision Level

**Abbreviations:**

TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit

---

**Data Package ID:** PU1906738-1

**Date Printed:** Wednesday, August 14, 2019

**ALS -- Fort Collins**

**LIMS Version:** 6.906

---

12 of 41
Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Lab ID: AS190717-1-LCS
Sample Matrix: WATER
Prep SOP: PAI 747 Rev 16
Date Collected: 17-Jul-19
Prep Batch: AS190717-1
Date Prepared: 17-Jul-19
Final Aliquot: 1000 ml
Prep Batch: AS190717-1-1
Result Units: pCi/l
QCBatchID: AS190717-1-1
File Name: Spectrum #1
Run ID: AS190717-1PU
Count Time: 420 minutes

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>4.74 +/- 0.83</td>
<td>0.03</td>
<td>4.553</td>
<td>104</td>
<td>82 - 118</td>
<td>P</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.133</td>
<td>2.71</td>
<td>pCi/l</td>
<td>65.5</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 the reported activity is greater than the reported MDC.

Abbreviations:
- **TPU**: Total Propagated Uncertainty
- **MDC**: Minimum Detectable Concentration

Data Package ID: PU1906738-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

<table>
<thead>
<tr>
<th>Lab ID:</th>
<th>AS190717-1LCSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Matrix:</td>
<td>WATER</td>
</tr>
<tr>
<td>Prep SOP:</td>
<td>PAI 778 Rev 16</td>
</tr>
<tr>
<td>Prep Batch:</td>
<td>AS190717-1</td>
</tr>
<tr>
<td>QCBatchID:</td>
<td>AS190717-1-1</td>
</tr>
<tr>
<td>Final Aliquot:</td>
<td>1000 ml</td>
</tr>
<tr>
<td>Count Time:</td>
<td>420 minutes</td>
</tr>
<tr>
<td>Result Units:</td>
<td>pCi/l</td>
</tr>
<tr>
<td>File Name:</td>
<td>Spectrum #1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>5.32 +/- 0.94</td>
<td>0.02</td>
<td>4.553</td>
<td>117</td>
<td>82 - 118</td>
<td>P</td>
</tr>
</tbody>
</table>

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.133</td>
<td>2.47</td>
<td>pCi/l</td>
<td>59.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

**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 the reported activity is greater than the reported MDC.

**Abbreviations:**
- TPU - Total Propagated Uncertainty
- MDC - Minimum Detectable Concentration

**Data Package ID:** PU1906738-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 23-Jul-19
Date Prepared: 23-Jul-19
Date Analyzed: 07-Aug-19
Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1PU
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
10-12-8  Pu-239/240  2.53 +/- 0.44  0.01  2.277  111  82 - 118  P

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>2.304</td>
<td>1.34</td>
<td>pCi/g</td>
<td>58.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 the reported activity is greater than the reported MDC.

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Minimum Detectable Concentration

Data Package ID: PU1906738-1
Isotopic Plutonium by Alpha Spectroscopy

Laboratory Control Sample(s)

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Lab ID: AS190723-2LCS
Prep Batch: AS190723-2
Final Aliquot: 2.00 g
QC Batch ID: AS190723-2-1
Result Units: pCi/g
Run ID: AS190723-2PU
File Name: Spectrum #1
Count Time: 480 minutes

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>2.33 +/- 0.39</td>
<td>0</td>
<td>2.277</td>
<td>103</td>
<td>82 - 118</td>
<td>P</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>2.304</td>
<td>2.08</td>
<td>pCi/g</td>
<td>90.1</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 the reported activity is greater than the reported MDC.

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Minimum Detectable Concentration

Data Package ID: PU1906738-1
**Isotopic Plutonium by Alpha Spectroscopy**
**PAI 714 Rev 14**
**Duplicate Sample Results (DER)**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906738  
**Client Name:** Engineering Analytics  
**ClientProject ID:** Rocky Flats Trails (FWS) 110876

<table>
<thead>
<tr>
<th>Field ID</th>
<th>SB-14-0-2-01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab ID</td>
<td>1906738-1DUP</td>
</tr>
</tbody>
</table>

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 27-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 06-Aug-19  
**Final Aliquot:** 1.08 g  
**Count Time:** 480 minutes  
**Prep Batch:** AS190723-1  
**Run ID:** AS190723-1PU  
**QCBatchID:** AS190723-1-1  
**Prep Basis:** Dry Weight  
**Moisture(%):** NA  
**Result Units:** pCi/g  
**File Name:** Spectrum #2

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Analyte</th>
<th>Sample Result +/- 2 s TPU</th>
<th>Sample MDC</th>
<th>Sample Flags</th>
<th>Duplicate Result +/- 2 s TPU</th>
<th>Duplicate MDC</th>
<th>Duplicate Flags</th>
<th>DER</th>
<th>DER Lim</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>-0.005 +/- 0.021</td>
<td>0.040</td>
<td>U</td>
<td>-0.009 +/- 0.015</td>
<td>0.038</td>
<td>U</td>
<td>0.15</td>
<td>2.13</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.031 +/- 0.031</td>
<td>0.046</td>
<td>U</td>
<td>0.034 +/- 0.024</td>
<td>0.010</td>
<td>U</td>
<td>0.096</td>
<td>2.13</td>
</tr>
</tbody>
</table>

**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

**Data Package ID:** PU1906738-1

**Date Printed:** Wednesday, August 14, 2019  
**ALS -- Fort Collins**  
**LIMS Version:** 6.906

---

**Abbreviations:**
- **TPU** - Total Propagated Uncertainty  
- **DER** - Duplicate Error Ratio  
- **BDL** - Below Detection Limit  
- **NR** - Not Reported  
- **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  

**Date Printed:** Wednesday, August 14, 2019  
**ALS -- Fort Collins**  
**LIMS Version:** 6.906  
**Page 1 of 3**
## Isotopic Plutonium by Alpha Spectroscopy

**PAI 714 Rev 14**

**Duplicate Sample Results (DER)**

- **Lab Name:** ALS -- Fort Collins
- **Work Order Number:** 1906738
- **Client Name:** Engineering Analytics
- **Client Project ID:** Rocky Flats Trails (FWS) 110876

### Sample Details

- **Sample Matrix:** SOIL
- **Final Aliquot:** 1.01 g
- **Count Time:** 480 minutes
- **Prep SOP:** PAI 778 Rev 16
- **Prep Batch:** AS190723-2
- **QCBatchID:** AS190723-2-1
- **Run ID:** AS190723-2PU
- **Prep Basis:** Dry Weight
- **Sample ID:** AS190723-2
- **QCBatchID:** AS190723-2-1
- **Run ID:** AS190723-2PU
- **Result Units:** pCi/g
- **File Name:** Spectrum #1

### Analyte Results

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Analyte</th>
<th>Sample Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>Duplicate Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>DER</th>
<th>DER Lim</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.029 +/- 0.022</td>
<td>0.022</td>
<td></td>
<td>0.031 +/- 0.024</td>
<td>0.012</td>
<td></td>
<td>0.0639</td>
<td>2.13</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>1.27 +/- 0.25</td>
<td>0.03</td>
<td></td>
<td>1.05 +/- 0.22</td>
<td>0.01</td>
<td></td>
<td>0.669</td>
<td>2.13</td>
</tr>
</tbody>
</table>

### 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:

**PU1906738-1**

---

**Date Printed:** Wednesday, August 14, 2019

**ALS -- Fort Collins**

**LIMS Version:** 6.906
Isotopic Plutonium by Alpha Spectroscopy

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16

Final Aliquot: 1000 ml
Prep Batch: AS190717-1

Date Collected: 17-Jul-19
Prep Basis: Unfiltered

Date Prepared: 17-Jul-19
Run ID: AS190717-1PU

Date Analyzed: 22-Jul-19
Count Time: 420 minutes

Lab Name: ALS -- Fort Collins
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

### CASNO | Analyte     | Sample Result +/- 2 s TPU | MDC | Flags | Duplicate Result +/- 2 s TPU | MDC | Flags | DER | DER Lim
--- | --- | --- | --- | --- | --- | --- | --- | --- | ---
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:** PU1906738-1

---

**Date Printed:** Wednesday, August 14, 2019
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19
Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1PU
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 #2

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>-0.005 +/- 0.021</td>
<td>0.040</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.031 +/- 0.031</td>
<td>0.046</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.482</td>
<td>2.42</td>
<td>pCi/g</td>
<td>53.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906738-1

Date Printed: Wednesday, August 14, 2019
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Duplicate Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Prep Batch: AS190723-1
Count Time: 480 minutes
Report Basis: Dry Weight

Final Aliquot: 1.08 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #2

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>-0.009 +/- 0.015</td>
<td>0.038</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
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<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.034 +/- 0.024</td>
<td>0.010</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.283</td>
<td>3.22</td>
<td>pCi/g</td>
<td>75.3</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 the reported 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: PU1906738-1
**Isotopic Plutonium by Alpha Spectroscopy**

**PAI 714 Rev 14**

**Sample Results**

- **Lab Name:** ALS -- Fort Collins
- **Work Order Number:** 1906738
- **Client Name:** Engineering Analytics
- **Client Project ID:** Rocky Flats Trails (FWS) 110876

---

**Sample Matrix:** SOIL

<table>
<thead>
<tr>
<th>Field ID</th>
<th>Lab ID</th>
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<tbody>
<tr>
<td>SB-15-0-2-01</td>
<td>1906738-3</td>
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</table>

**Prep SOP:** PAI 778 Rev 16

**Date Collected:** 27-Jun-19

**Date Prepared:** 23-Jul-19

**Date Analyzed:** 07-Aug-19

**Final Aliquot:** 1.04 g

**Count Time:** 480 minutes

**Report Basis:** Dry Weight

---

**CASNO** | **Target Nuclide** | **Result +/- 2 s TPU** | **MDC** | **Requested MDC** | **DL** | **Lab Qualifier** |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.006 +/- 0.017</td>
<td>0.038</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.019 +/- 0.022</td>
<td>0.035</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

**Chemical Yield Summary**

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.420</td>
<td>3.11</td>
<td>pCi/g</td>
<td>70.4</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

**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:** PU1906738-1

---

**Date Printed:** Wednesday, August 14, 2019
Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 07-Aug-19

Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1PU
Count Time: 480 minutes
Report Basis: Dry Weight

Final Aliquot: 1.04 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

Field ID: SB-16-0-2-01
Lab ID: 1906738-5

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0 +/- 0.016</td>
<td>0.029</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
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<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.010 +/- 0.016</td>
<td>0.024</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.449</td>
<td>3.06</td>
<td>pCi/g</td>
<td>68.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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

Data Package ID: PU1906738-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 07-Aug-19

Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1PU
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.003 +/- 0.020</td>
<td>0.031</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
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<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.010 +/- 0.020</td>
<td>0.037</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.486</td>
<td>2.38</td>
<td>pCi/g</td>
<td>53.0</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906738-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

| Field ID: | SB-18-0-2-01 |
| Lab ID:   | 1906738-9    |

- **Sample Matrix:** SOIL
- **Prep SOP:** PAI 778 Rev 16
- **Date Collected:** 27-Jun-19
- **Date Prepared:** 23-Jul-19
- **Date Analyzed:** 05-Aug-19
- **Prep Batch:** AS190723-2
- **QC Batch ID:** AS190723-2-1
- **Run ID:** AS190723-2PU
- **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

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.004 +/- 0.016</td>
<td>0.011</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.023 +/- 0.021</td>
<td>0.024</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

### 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:** PU1906738-1
Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2PU
Count Time: 480 minutes
Final Aliquot: 1.03 g
Prep Basis: Dry Weight
Report Basis: Dry Weight
Lab ID: 1906738-11
Date Prepared: 23-Jul-19
Prep Batch: AS190723-2
Run ID: AS190723-2PU
QCBatchID: AS190723-2-1
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.029 +/- 0.022</td>
<td>0.022</td>
<td>0.15</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>1.27 +/- 0.25</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.470</td>
<td>3.16</td>
<td>pCi/g</td>
<td>70.6</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906738-1
Isotopic Plutonium by Alpha Spectroscopy  
PAI 714 Rev 14  
Sample Duplicate Results

*Lab Name:* ALS -- Fort Collins  
*Work Order Number:* 1906738  
*Client Name:* Engineering Analytics  
*Client Project ID:* Rocky Flats Trails (FWS) 110876

---

**Field ID:** SB-21-0-2-01  
**Lab ID:** 1906738-11DUP

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Prep Batch:** AS190723-2  
**Date Collected:** 27-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 05-Aug-19  
**Final Aliquot:** 1.01 g  
**Count Time:** 480 minutes  
**Run ID:** AS190723-2PU  
**Report Basis:** Dry Weight

**CASNO** | **Target Nuclide** | **Result +/- 2 s TPU** | **MDC** | **Requested MDC** | **DL** | **Lab Qualifier**
--- | --- | --- | --- | --- | --- | ---
13981-16-3 | Pu-238 | 0.031 +/- 0.024 | 0.012 | 0.15 | NA | NA
10-12-8 | Pu-239/240 | 1.05 +/- 0.22 | 0.01 | 0.1 | NA | NA

**Chemical Yield Summary**

| Carrier/Tracer | Amount Added | Result | Units | Yield | Control Limits | Flag |
--- | --- | --- | --- | --- | --- | ---
Pu-242 | 4.581 | 2.94 | pCi/g | 64.2 | 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.  
  - **M** - The requested MDC was not met.  
  - **M3** - The requested MDC was not met, but the reported 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:** PU1906738-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19

Prep Batch: AS190723-2
QC Batch ID: AS190723-2-1
Run ID: AS190723-2PU
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

Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.027 +/- 0.023</td>
<td>0.024</td>
<td>0.15</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>1.50 +/- 0.29</td>
<td>0.01</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Carrier/Tracer | Amount Added | Result | Units | Yield | Control Limits | Flag |
--- | --- | --- | --- | --- | --- | --- |
Pu-242 | 4.517 | 3.11 | pCi/g | 68.9 | 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: PU1906738-1
## Isotopic Plutonium by Alpha Spectroscopy

**PAI 714 Rev 14**

### Sample Results

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876  

<table>
<thead>
<tr>
<th>Field ID</th>
<th>Lab ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-23-0-2-01</td>
<td>1906738-15</td>
</tr>
</tbody>
</table>

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 27-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 05-Aug-19  

**Final Aliquot:** 1.02 g  
**Count Time:** 480 minutes  
**Lab Name:** Engineering Analytics  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876  
**Work Order Number:** 1906738  
**Field ID:** SB-23-0-2-01  
**Lab ID:** 1906738-15  
**Date Analyzed:** 05-Aug-19  
**Date Collected:** 27-Jun-19  
**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Prep Batch:** AS190723-2  
**QC Batch ID:** AS190723-2-1  
**Run ID:** AS190723-2PU  
**Report Basis:** Dry Weight  
**Result Units:** pCi/g  
**File Name:** Spectrum #1  

### Table: Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.057 +/- 0.030</td>
<td>0.010</td>
<td>0.15</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>3.15 +/- 0.54</td>
<td>0.01</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

### 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:** **PU1906738-1**
Isotopic Plutonium by Alpha Spectroscopy

PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19

Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2PU
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.072 +/- 0.038</td>
<td>0.026</td>
<td>0.15</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>2.84 +/- 0.51</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.519</td>
<td>2.89</td>
<td>pCi/g</td>
<td>64.0</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906738-1
### Sample Results

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Prep Batch:** AS190723-2  
**QCBatchID:** AS190723-2-1  
**Final Aliquot:** 1.08 g  
**Prep Basis:** Dry Weight  
**Count Time:** 480 minutes  
**Report Basis:** Dry Weight  
**File Name:** Spectrum #1

**Field ID:** SB-25-0-2-01  
**Lab ID:** 1906738-19  
**Sample Prepared:** 27-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 05-Aug-19  
**Result Units:** pCi/g

<table>
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<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.035 +/- 0.024</td>
<td>0.011</td>
<td>0.15</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>3.51 +/- 0.61</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

**Chemical Yield Summary**

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.263</td>
<td>2.76</td>
<td>pCi/g</td>
<td>64.8</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

### 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:** PU1906738-1

---

**Date Printed:** Wednesday, August 14, 2019  
**ALS -- Fort Collins**  
**LIMS Version:** 6.906
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-26-0-2-01
Lab ID: 1906738-21

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2PU
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.040 +/- 0.026</td>
<td>0.011</td>
<td>0.15</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>2.19 +/- 0.40</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
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</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.316</td>
<td>2.82</td>
<td>pCi/g</td>
<td>65.4</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906738-1

Date Printed: Wednesday, August 14, 2019
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2PU
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.068 +/- 0.036</td>
<td>0.032</td>
<td>0.15</td>
<td>NA</td>
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<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>3.31 +/- 0.58</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.300</td>
<td>2.94</td>
<td>pCi/g</td>
<td>68.3</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906738-1

Date Printed: Wednesday, August 14, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.003 +/- 0.019</td>
<td>0.029</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.011 +/- 0.019</td>
<td>0.036</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.133</td>
<td>2.65</td>
<td>pCi/l</td>
<td>64.1</td>
<td>30 - 110 %</td>
<td></td>
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</tbody>
</table>

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: PU1906738-1

Date Printed: Wednesday, August 14, 2019
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Prep Batch: AS190723-2
QC Batch ID: AS190723-2-1
Run ID: AS190723-2PU
Count Time: 480 minutes
Report Basis: Dry Weight
Final Aliquot: 1.02 g
Lab ID: 1906738-25
Lab Name: ALS -- Fort Collins
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876
Work Order Number: 1906738
Field ID: SB-27-0-2-01
Lab ID: 1906738-25

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<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
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<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.024 +/- 0.034</td>
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<td>NA</td>
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<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>2.15 +/- 0.45</td>
<td>0.05</td>
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Chemical Yield Summary

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<thead>
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<th>Carrier/Tracer</th>
<th>Amount Added</th>
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<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<td>Pu-242</td>
<td>4.518</td>
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<td>pCi/g</td>
<td>34.2</td>
<td>30 - 110 %</td>
<td></td>
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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: PU1906738-1

Data Package ID: PU1906738-1

Date Printed: Wednesday, August 14, 2019
Page 14 of 20

ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19

Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2PU
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

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<th>MDC</th>
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<th>DL</th>
<th>Lab Qualifier</th>
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</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.006 +/- 0.014</td>
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<td>0.15</td>
<td>NA</td>
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<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.73 +/- 0.16</td>
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<td>0.1</td>
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Chemical Yield Summary

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<th>Carrier/Tracer</th>
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<tr>
<td>Pu-242</td>
<td>4.229</td>
<td>3.21</td>
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<td>75.8</td>
<td>30 - 110 %</td>
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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: PU1906738-1

Date Printed: Wednesday, August 14, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19

Prep Batch: AS190723-2
QC Batch ID: AS190723-2-1
Run ID: AS190723-2
Count Time: 480 minutes
Report Basis: Dry Weight
Final Alquot: 1.04 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

Field ID: SB-29-0-2-01
Lab ID: 1906738-29

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<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.032 +/- 0.027</td>
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<td>0.15</td>
<td>NA</td>
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<td>10-12-8</td>
<td>Pu-239/240</td>
<td>1.90 +/- 0.36</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tbody>
<tr>
<td>Pu-242</td>
<td>4.415</td>
<td>2.82</td>
<td>pCi/g</td>
<td>63.9</td>
<td>30 - 110 %</td>
<td></td>
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</table>

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: PU1906738-1
### Chemical Yield Summary

<table>
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<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.472</td>
<td>3.65</td>
<td>pCi/g</td>
<td>81.6</td>
<td>30 - 110 %</td>
<td></td>
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</table>

**Comments:**

- **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:** PU1906738-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2PU
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.041 +/- 0.027</td>
<td>0.027</td>
<td>0.15</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>1.10 +/- 0.22</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
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</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tbody>
<tr>
<td>Pu-242</td>
<td>4.529</td>
<td>3.61</td>
<td>pCi/g</td>
<td>79.6</td>
<td>30 - 110 %</td>
<td></td>
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</table>

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: PU1906738-1
## Isotopic Plutonium by Alpha Spectroscopy

**PAI 714 Rev 14**

### Sample Results

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906738  
**Client Name:** Engineering Analytics  
**ClientProject ID:** Rocky Flats Trails (FWS) 110876

| Field ID: | SB-32-0-2-01  
| Lab ID: | 1906738-35 |

- **Sample Matrix:** SOIL  
- **Prep SOP:** PAI 778 Rev 16  
- **Date Collected:** 27-Jun-19  
- **Date Prepared:** 23-Jul-19  
- **Date Analyzed:** 05-Aug-19

- **Prep Batch:** AS190723-2  
- **QCBatchID:** AS190723-2-1  
- **Run ID:** AS190723-2PU  
- **Count Time:** 480 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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.013 +/- 0.018</td>
<td>0.031</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-128</td>
<td>Pu-239/240</td>
<td>1.20 +/- 0.23</td>
<td>0.02</td>
<td>0.1</td>
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### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
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<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tbody>
<tr>
<td>Pu-242</td>
<td>4.350</td>
<td>3.36</td>
<td>pCi/g</td>
<td>77.2</td>
<td>30 - 110 %</td>
<td></td>
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### 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:** PU1906738-1

---

**Date Printed:** Wednesday, August 14, 2019  
**ALS -- Fort Collins**  
**LIMS Version:** 6.906
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Prep Batch: AS190723-2
QC Batch ID: AS190723-2-1
Run ID: AS190723-2PU
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
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<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.023 +/- 0.021</td>
<td>0.028</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
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<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.71 +/- 0.15</td>
<td>0.02</td>
<td>0.1</td>
<td>NA</td>
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Chemical Yield Summary

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<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
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<th>Units</th>
<th>Yield</th>
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<th>Flag</th>
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<tbody>
<tr>
<td>Pu-242</td>
<td>4.324</td>
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<td>pCi/g</td>
<td>69.7</td>
<td>30 - 110 %</td>
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Comments:

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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: PU1906738-1
1. This report consists of the analytical results for nineteen soil samples and one water sample received by ALS on 06/28/2019.

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, 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 08/06/2019.

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. Uranium-234 activity is reported in method blanks AS190723-1MB and -2MB 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.

9. 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                         8/14/19
Radiochemistry Primary Data Reviewer

Radiochemistry Final Data Reviewer    8/14/19
## Sample Number(s) Cross-Reference Table

**OrderNum:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project Name:** Rocky Flats Trails (FWS)  
**Client Project Number:** 110876  
**Client PO Number:**

<table>
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<th>Time Collected</th>
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## ALS -- Fort Collins

Sample Number(s) Cross-Reference Table

**OrderNum:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project Name:** Rocky Flats Trails (FWS)  
**Client Project Number:** 110876  
**Client PO Number:**

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**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.

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*Time Zone (Circle): EST CST MST PST  Matrix: O = oil  S = soil NS = non-soil solid W = water L = liquid E = extract F = filler

**NOTES**

No carbonate

Fission testing

Hold all -99

Refrigerate samples for archive

**REPORT LEVELS/ QC REQUIRED**

- **Summary** (Standard QC)
- **LEVEL II** (Standard QC)
- **LEVEL III** (Standard QC + forms)
- **LEVEL IV** (Standard QC + forms + forms)

**RELINQUISHED BY**

- Emmett Nite
- Megan Canell
- Erik Evans

**RECEIVED BY**

- M. Canell
- E. Canell
- E. Evans

**SIGNATURE**

- Emmett Nite
- Megan Canell
- Erik Evans

**PRINTED NAME**

- Emmett Nite
- Megan Canell
- Erik Evans

**DATE**

- 6/27/19
- 6/27/19
- 6/28/19

**TIME**

- 17:25
- 17:25
- 10:00
### Chain-of-Custody

**Turnaround Time:**
- Samples received after 2 p.m. will be calculated beginning from the next business day.
- Samples received Saturday will be calculated beginning from the next business day.

**Project Name:** Rocky Flats Trails (FWS)
**SITE ID:** STD
**Sampler:** EH, SK

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*Time Zone (Circle): EST CST MST PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

**Preservation Key:**
- 1-HCl 2-HNO₃ 3-H₂SO₄ 4-H₂O 5-NaOH 6-ZnAcetate 7-NaHSO₄ 8-Other

**Notes:**
- No carbonate fusion testing.
- Hold all -99
- Samples for archive.

**Form 2020**

**Signature:**
- Relinquished by: Emily Hite
- Received by: Megan Carlson
- Relinquished by: Eric Evans

**Printed Name:**
- Emily Hite
- Megan Carlson
- Eric Evans

**Date:**
- 6/27/19
- 6/28/19
- 6/28/19

**Time:**
- 1725
- 1725
- 1000

**Preservation Key:**
- 1-HCl 2-HNO₃ 3-H₂SO₄ 4-H₂O 5-NaOH 6-ZnAcetate 7-NaHSO₄ 8-Other
# 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.

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<th>PROJECT NAME</th>
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<tr>
<td>1000 Specht Point Rd, ste 209</td>
<td>Fort Collins, CO 80525</td>
<td>(970) 488-3111</td>
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<td><a href="mailto:JAAndrews@enganalytics.com">JAAndrews@enganalytics.com</a></td>
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## LAB ID | FIELD ID | MATRIX | SAMPLE DATE | SAMPLE TIME | # OF BOTTLES | PRESERVATIVE | QC |
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**NOTES**

- No Carbonate fusion testing
- Hold all -99 samples for archival

**REPORT LEVEL/QC REQUIRED**

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<th>LEVEL I (Standard QC)</th>
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**RECALIBRATION**

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<td>Emmett Hite</td>
<td>EA Storage</td>
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**PROPERTIES**

- Form 282/9
- Signature
- Printed Name: Emmett Hite
- Date: 6/27/19
- Time: 17:25

**REUNION OF SAMPLES**

- Relinquished by: Emmett Hite
- Received by: EA Storage
- Date: 6/27/19
- Time: 17:25

**RECALIBRATION**

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<th>RELINQUISHED BY</th>
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<td>Megan Carroll</td>
<td>Emily Evans</td>
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**PROPERTIES**

- Form 282/9
- Signature
- Printed Name: Megan Carroll
- Date: 6/28/19
- Time: 10:00
# 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
Rocky Flats Trail (FWS)

## SITE ID
STD

## SAMPLER
EH, SK

## PARAMETER/METHOD REQUEST FOR ANALYSIS
- **A:** AM-241
- **B:** PV-238, 239/240
- **C:** U-234, 235, 238
- **D:** ALS SOP 714

## COMPANY NAME
Engineering Analytics

## SEND REPORT TO
Jason Andrews

## CITY/STATE/ZIP
1600 Specht Point Rd, Ste 809
Fort Collins, CO 80525

## PHONE
(970) 488-3111

## E-MAIL
JAndrews@mganalytics.com

## LAB ID
FIELD ID

<table>
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<th>LAB ID</th>
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<th>SAMPLE DATE</th>
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*Time Zone (Circle): EST  CST  MST  PST
Matrix: O = oil  S = solid  NS = non-solvent solid  W = water  L = liquid  E = extract  F = filter

---

**NOTES**

- No Carbonate fusion testing
- Hold all -99 samples for archive

---

**REPRESENTATIVE**

**SIGNATURE**

**PRINTED NAME**

**DATE**

**TIME**

- RELINQUISHED BY: Emmett Hite
  - RECEIVED BY: M. Camill
  - RELINQUISHED BY: M. Camill
  - RECEIVED BY: E. Evans

- RELINQUISHED BY: Emmett Hite
  - RECEIVED BY: M. Camill
  - RELINQUISHED BY: M. Camill
  - RECEIVED BY: E. Evans

**PRESERVATION KEY**

- 1+H2O 2+NaOH 3+H2SO4 4+Na2O7 5+Na2O2V2O5acetate 6+NaH8O4 7+TC 8+Other
ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: EA
Workorder No: 1900738
Initials: 8
Date: 6.28.19

1. Are airbills / shipping documents present and/or removable? DROP OFF
2. Are custody seals on shipping containers intact? NONE
3. Are custody seals on sample containers intact? NONE
4. Is there a COC (chain-of-custody) present? YES
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.) YES
6. Are short-hold samples present? NO
7. Are all samples within holding times for the requested analyses? NO
8. Were all sample containers received intact? (not broken or leaking) NO
9. Is there sufficient sample for the requested analyses? NO
10. Are all samples in the proper containers for the requested analyses? NO
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles) NO
12. Are all aqueous non-preserved samples pH 4-9? 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) NO
14. Were the samples shipped on ice? NO
15. Were cooler temperatures measured at 0.1-6.0°C? YES

<table>
<thead>
<tr>
<th>Cooler #</th>
<th>#1</th>
<th>#3</th>
<th>#4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature (°C):</td>
<td>AMB</td>
<td>AMB</td>
<td></td>
</tr>
<tr>
<td>No. of custody seals on cooler:</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>External μR/hr reading:</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Background μR/hr reading:</td>
<td>9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Were external μR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / NA

* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

- 01 Samples in 4 oz soil
- 02 Samples in 8 oz soil
- 03 Samples in 4 oz soil

Form 201r27.xls (02/11/2019)

*IR Gun #1, WVR SN 170560549
*IR Gun #3, WVR SN 170647571
*IR Gun #4, Oakton, VA 2372220101-0002

All client bottle ID's vs ALS lab ID's double-checked by: [Signature]

If applicable, was the client contacted? YES / NO / NA

Project Manager Signature / Date: [Signature] 6/29/19
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190717-1
QC Batch ID: AS190717-1-1
Final Aliquot: 1000 ml
Result Units: pCi/l
File Name: Spectrum #1

Count Time: 420 minutes

Lab ID: AS190717-1MB
Date Analyzed: 23-Jul-19
Date Collected: 17-Jul-19
Date Prepared: 17-Jul-19
Date Analyzed: 23-Jul-19

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

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.429</td>
<td>3.48</td>
<td>pCi/l</td>
<td>78.6</td>
<td>30 - 110 %</td>
</tr>
</tbody>
</table>

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**: Requested MDC not met.
- **B**: Analyte concentration greater than MDC.
- **B3**: Analyte concentration greater than MDC but less than Requested MDC.
- **DL**: Decision Level

Abbreviations:
- **TPU**: Total Propagated Uncertainty
- **MDC**: Sample specific Minimum Detectable Concentration
- **BDL**: Below Detection Limit

Data Package ID: UR1906738-1
### Isotopic Uranium by Alpha Spectroscopy

**PAI 714 Rev 14**

**Method Blank Results**

- **Lab Name:** ALS -- Fort Collins
- **Work Order Number:** 1906738
- **Client Name:** Engineering Analytics
- **ClientProject ID:** Rocky Flats Trails (FWS) 110876

---

<table>
<thead>
<tr>
<th>Lab ID:</th>
<th>AS190723-1MB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Matrix:</td>
<td>SOIL</td>
</tr>
<tr>
<td>Prep SOP:</td>
<td>PAI 778 Rev 16</td>
</tr>
<tr>
<td>Date Collected:</td>
<td>23-Jul-19</td>
</tr>
<tr>
<td>Date Prepared:</td>
<td>23-Jul-19</td>
</tr>
<tr>
<td>Date Analyzed:</td>
<td>05-Aug-19</td>
</tr>
<tr>
<td>Prep Batch:</td>
<td>AS190723-1</td>
</tr>
<tr>
<td>QCBatchID:</td>
<td>AS190723-1-1</td>
</tr>
<tr>
<td>Final Aliquot:</td>
<td>2.00 g</td>
</tr>
<tr>
<td>Run ID:</td>
<td>AS190723-1UD</td>
</tr>
<tr>
<td>Count Time:</td>
<td>420 minutes</td>
</tr>
<tr>
<td>Result Units:</td>
<td>pCi/g</td>
</tr>
<tr>
<td>File Name:</td>
<td>Spectrum #1</td>
</tr>
</tbody>
</table>

---

#### CASNO Target Nuclide Result +/- 2 s TPU MDC Requested MDC DL Lab Qualifier

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.016 +/- 0.013</td>
<td>0.016</td>
<td>0.1</td>
<td>NA</td>
<td>B3</td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.003 +/- 0.010</td>
<td>0.007</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.0082 +/- 0.0094</td>
<td>0.0131</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

---

#### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>2.287</td>
<td>1.74</td>
<td>pCi/g</td>
<td>75.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

---

**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:** UR1906738-1

---

**Date Printed:** Monday, August 12, 2019

**ALS -- Fort Collins**

**LIMS Version:** 6.901
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Final Aliquot: 2.00 g
Count Time: 480 minutes
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  0.018 +/- 0.013  0.016  0.1  NA  B3
15117-96-1  U-235  -0.0011 +/- 0.0086  0.0133  0.1  NA  U
7440-61-1  U-238  -0.0027 +/- 0.0073  0.0158  0.1  NA  U

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>2.287</td>
<td>1.85</td>
<td>pCi/g</td>
<td>80.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 - Requested MDC not met.
- B - Analyte concentration greater than MDC.
- B3 - Analyte concentration greater than MDC but less than Requested MDC.
- DL - Decision Level

Abbreviations:
- TPU - Total Propagated Uncertainty
- MDC - Sample specific Minimum Detectable Concentration
- BDL - Below Detection Limit

Data Package ID: UR1906738-1
Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Sample SOP: PAI 778 Rev 16
Final Aliquot: 1000 ml

Prep SOP: PAI 778 Rev 16
Prep Batch: AS190717-1
QCBatchID: AS190717-1-1
Run ID: AS190717-1UD
Count Time: 420 minutes

Lab ID: AS190717-1-LCS
Date Collected: 17-Jul-19
Date Prepared: 17-Jul-19
Date Analyzed: 23-Jul-19

Result Units: pCi/l
File Name: Spectrum #1

Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Contro l Limits</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>4.86 +/- 0.82</td>
<td>0.04</td>
<td>4.220</td>
<td>115</td>
<td>82 - 122</td>
<td>P</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>5.08 +/- 0.86</td>
<td>0.03</td>
<td>4.382</td>
<td>116</td>
<td>78 - 126</td>
<td>P</td>
</tr>
</tbody>
</table>

Carrier/Tracer | Amount Added | Result | Units | Yield | Control Limits | Flag
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.429</td>
<td>3.56</td>
<td>pCi/l</td>
<td>80.4</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 the reported activity is greater than the reported MDC.

Abbreviations:

TPU - Total Propagated Uncertainty
MDC - Minimum Detectable Concentration

Data Package ID: UR1906738-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190717-1
Final Aliquot: 1000 ml
QCBatchID: AS190717-1-1
Run ID: AS190717-1UD
Count Time: 420 minutes

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

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.429</td>
<td>4.02</td>
<td>pCi/l</td>
<td>90.8</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

### 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 the reported activity is greater than the reported MDC.

Abbreviations:
- TPU - Total Propagated Uncertainty
- MDC - Minimum Detectable Concentration

Data Package ID: UR1906738-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Final Alquot: 2.00 g
Result Units: pCi/g
Count Time: 420 minutes
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>2.13 +/- 0.37</td>
<td>0.02</td>
<td>2.110</td>
<td>101</td>
<td>82 - 122</td>
<td>P</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>2.38 +/- 0.41</td>
<td>0.02</td>
<td>2.191</td>
<td>109</td>
<td>82 - 122</td>
<td>P</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>2.287</td>
<td>1.84</td>
<td>pCi/g</td>
<td>80.4</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 the reported activity is greater than the reported MDC.

Data Package ID: UR1906738-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2UR
Final Aliquot: 2.00 g
Count Time: 480 minutes

Date Collected: 23-Jul-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19
Date Collected: 23-Jul-19
Prep Batch: AS190723-2
Run ID: AS190723-2UR
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>2.17 +/- 0.37</td>
<td>0.01</td>
<td>2.110</td>
<td>103</td>
<td>82 - 122</td>
<td>P</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>2.40 +/- 0.40</td>
<td>0.02</td>
<td>2.191</td>
<td>109</td>
<td>82 - 122</td>
<td>P</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>2.287</td>
<td>1.80</td>
<td>pCi/g</td>
<td>78.5</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

Modifiers/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 the reported activity is greater than the reported MDC.

Abbreviations:
- TPU - Total Propagated Uncertainty
- MDC - Minimum Detectable Concentration

Data Package ID: UR1906738-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
# Isotopic Uranium by Alpha Spectroscopy

**PAI 714 Rev 14**  
**Duplicate Sample Results (DER)**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

**Final Aliquot:** 1.08 g  
**Count Time:** 420 minutes

---

### Sample Details
- **Field ID:** SB-14-0-2-01  
- **Lab ID:** 1906738-1DUP
- **Sample Matrix:** SOIL  
- **Prep SOP:** PAI 778 Rev 16  
- **Prep Batch:** AS190723-1
- **Final Aliquot:** 1.08 g  
- **Run ID:** AS190723-1UD
- **QCBatchID:** AS190723-1-1
- **Result Units:** pCi/g  
- **Lab ID:** 1906738-1DUP  
- **Date Analyzed:** 05-Aug-19
- **Date Collected:** 27-Jun-19
- **Date Prepared:** 23-Jul-19
- **Prep Batch:** AS190723-1
- **Run ID:** AS190723-1UD
- **QCBatchID:** AS190723-1-1

### CASNO Table

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Analyte</th>
<th>Sample Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>Duplicate Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>DER</th>
<th>DER Lim</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.58 +/- 0.15</td>
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<td></td>
<td>0.52 +/- 0.13</td>
<td>0.02</td>
<td></td>
<td>0.316</td>
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</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.017 +/- 0.025</td>
<td>0.038</td>
<td>U</td>
<td>0.003 +/- 0.019</td>
<td>0.029</td>
<td>U</td>
<td>0.447</td>
<td>2.13</td>
</tr>
<tr>
<td>7440-81-1</td>
<td>U-238</td>
<td>0.54 +/- 0.14</td>
<td>0.04</td>
<td></td>
<td>0.60 +/- 0.14</td>
<td>0.04</td>
<td></td>
<td>0.328</td>
<td>2.13</td>
</tr>
</tbody>
</table>

---

**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

**Data Package ID:** UR1906738-1

---

**Date Printed:** Monday, August 12, 2019  
**Date Printed:** Monday, August 12, 2019  
**LIMS Version:** 6.901  
**Page:** 1 of 3  
**Date Printed:** Monday, August 12, 2019  
**LIMS Version:** 6.901  
**Page:** 1 of 3
**Isotopic Uranium by Alpha Spectroscopy**  
**PAI 714 Rev 14**  
**Duplicate Sample Results (DER)**

**Prep SOP:** PAI 778 Rev 16  
**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

### Sample Matrix: SOIL  
### Prep Batch: AS190723-2  
### Final Aliquot: 1.01 g  
### Prep Basis: Dry Weight  
### Date Collected: 27-Jun-19  
### Date Prepared: 23-Jul-19  
### Date Analyzed: 06-Aug-19  
### Run ID: AS190723-2UR  
### QCBatchID: AS190723-2-1  
### Count Time: 480 minutes  
### Result Units: pCi/g  
### File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Analyte</th>
<th>Sample Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>Duplicate Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>DER</th>
<th>DER Lim</th>
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</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.76 +/- 0.17</td>
<td>0.03</td>
<td></td>
<td>0.95 +/- 0.23</td>
<td>0.05</td>
<td></td>
<td>0.68</td>
<td>2.13</td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.034 +/- 0.029</td>
<td>0.035</td>
<td>U</td>
<td>0.062 +/- 0.049</td>
<td>0.056</td>
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<td>0.494</td>
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<tr>
<td>7440-81-1</td>
<td>U-238</td>
<td>0.68 +/- 0.15</td>
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<td>0.84 +/- 0.21</td>
<td>0.04</td>
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<td>0.623</td>
<td>2.13</td>
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**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

**Data Package ID:** **UR1906738-1**

**Duplicate Error Ratio**

**Below Detection Limit (BDL)**

**Not Reported (NR)**

**Total Propagated Uncertainty (TPU)**

**Duplicate Error Ratio (DER)**

**Request MDC**

**Warning Limit (LT)**

**LCS Recovery (L)**

**U** - Result is less than the sample specific MDC.
### Duplicate Sample Results (DER)

**Sample Matrix:** WATER  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 17-Jul-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 23-Jul-19  
**Final Aliquot:** 1000 ml  
**Prep Batch:** AS190717-1  
**QCBatchID:** AS190717-1-1  
**Run ID:** AS190717-1UD  
**Count Time:** 420 minutes  
**Result Units:** pCi/l  
**File Name:** Spectrum #1  

<table>
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<th>Flags</th>
<th>Duplicate</th>
<th>DER</th>
<th>DER Lim</th>
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</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>4.66 +/- 0.82</td>
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<td>7440-61-1</td>
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<td>5.08 +/- 0.86</td>
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<td>P</td>
<td>4.67 +/- 0.79</td>
<td>0.354</td>
<td>2.13</td>
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</table>

**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

**Data Package ID:** UR1906738-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19

Final Aliquot: 1.03 g
Prep Batch: AS190723-1
QC Batch ID: AS190723-1-1
Run ID: AS190723-1UD
Count Time: 420 minutes
Report Basis: Dry Weight

Result Units: pCi/g
File Name: Spectrum #1

Field ID: SB-14-0-2-01
Lab ID: 1906738-1

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<tr>
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<th>Requested MDC</th>
<th>DL</th>
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<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.58 +/- 0.15</td>
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<td>0.1</td>
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<td>NA</td>
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<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.017 +/- 0.025</td>
<td>0.038</td>
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<td>NA</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.54 +/- 0.14</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td>NA</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.449</td>
<td>2.71</td>
<td>pCi/g</td>
<td>60.8</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906738-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Prep Batch: AS190723-1
 QC Batch ID: AS190723-1-1
 Run ID: AS190723-1UD
 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

Field ID: SB-15-0-2-01
Lab ID: 1906738-3

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<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>1.02 +/- 0.22</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
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<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.076 +/- 0.044</td>
<td>0.032</td>
<td>0.1</td>
<td>NA</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.98 +/- 0.21</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
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Chemical Yield Summary

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<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.387</td>
<td>3.16</td>
<td>pCi/g</td>
<td>72.1</td>
<td>30 - 110 %</td>
<td></td>
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</table>

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: UR1906738-1

Date Printed: Monday, August 12, 2019
Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14
Sample Results

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19

Final Aliquot: 1.04 g
Count Time: 420 minutes
Report Basis: Dry Weight

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876
Field ID: SB-16-0-2-01
Lab ID: 1906738-5

CASNO  Target Nuclide  Result +/- 2 s TPU  MDC  Requested MDC  DL  Lab Qualifier
13966-29-5  U-234  0.74 +/- 0.17  0.04  0.1  NA
15117-96-1  U-235  0.034 +/- 0.028  0.015  0.1  NA
7440-61-1  U-238  0.75 +/- 0.17  0.04  0.1  NA

Chemical Yield Summary

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<th>Carrier/Tracer</th>
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<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.416</td>
<td>3.04</td>
<td>pCi/g</td>
<td>69.0</td>
<td>30 - 110 %</td>
<td></td>
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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: UR1906738-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19

Prep Batch: AS190723-1
QCBatchID: AS190723-1-1
Run ID: AS190723-1UD
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 0.71 +/- 0.16 0.04 0.1 NA
15117-96-1 U-235 0.041 +/- 0.032 0.031 0.1 NA
7440-61-1 U-238 0.80 +/- 0.18 0.04 0.1 NA

### Chemical Yield Summary

<table>
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<th>Carrier/Tracer</th>
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<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tbody>
<tr>
<td>U-232</td>
<td>4.453</td>
<td>3.18</td>
<td>pCi/g</td>
<td>71.3</td>
<td>30 - 110 %</td>
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</tbody>
</table>

### 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:** UR1906738-1
Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

Sample Results

Prep SOP: PAI 778 Rev 16

Final Aliquot: 1.05 g

Count Time: 480 minutes

Lab Name: ALS -- Fort Collins

Client Name: Engineering Analytics

Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL

Prep Batch: AS190723-2

QCBatchID: AS190723-2-1

Run ID: AS190723-2UR

Count Time: 480 minutes

Report Basis: Dry Weight

Field ID: SB-18-0-2-01

Lab ID: 1906738-9

Date Analyzed: 06-Aug-19

Date Collected: 27-Jun-19

Date Prepared: 23-Jul-19

Date Analyzed: 06-Aug-19

Sample Matrix: SOIL

Prep SOP: PAI 778 Rev 16

Final Aliquot: 1.05 g

Count Time: 480 minutes

Report Basis: Dry Weight

Field ID: SB-18-0-2-01

Lab ID: 1906738-9

Date Analyzed: 06-Aug-19

Date Collected: 27-Jun-19

Date Prepared: 23-Jul-19

Prep Batch: AS190723-2

QCBatchID: AS190723-2-1

Run ID: AS190723-2UR

Result Units: pCi/g

File Name: Spectrum #1

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<th>CASNO</th>
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<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.64 +/- 0.14</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
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<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.042 +/- 0.029</td>
<td>0.013</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.82 +/- 0.17</td>
<td>0.04</td>
<td>0.1</td>
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Chemical Yield Summary

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<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tr>
<td>U-232</td>
<td>4.369</td>
<td>2.96</td>
<td>pCi/g</td>
<td>67.8</td>
<td>30 - 110 %</td>
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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: UR1906738-1

Date Printed: Monday, August 12, 2019
### Isotopic Uranium by Alpha Spectroscopy

**PAI 714 Rev 14**  
**Sample Results**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

| Field ID: | SB-21-0-2-01  
| Lab ID:   | 1906738-11 |

#### Sample Results

- **Prep SOP:** PAI 778 Rev 16  
- **Final Aliquot:** 1.03 g  
- **Count Time:** 480 minutes

**Lab Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

| Final Aliquot: | 1.03 g |

**Lab ID:** 1906738-11  
**Date Analyzed:** 06-Aug-19

**Sample Matrix:** SOIL  
**Date Collected:** 27-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 06-Aug-19  
**Lab ID:** 1906738-11

**Prep Batch:** AS190723-2  
**QCBatchID:** AS190723-2-1  
**Run ID:** AS190723-2UR

- **Report Basis:** Dry Weight

**Field ID:** SB-21-0-2-01  
**Lab ID:** 1906738-11

#### Chemical Yield Summary

<table>
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<th>CASNO</th>
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<th>MDC</th>
<th>Requested MDC</th>
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<th>Lab Qualifier</th>
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<tr>
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<td>U-234</td>
<td>0.76 +/- 0.17</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
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<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.034 +/- 0.029</td>
<td>0.035</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.68 +/- 0.15</td>
<td>0.02</td>
<td>0.1</td>
<td>NA</td>
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**Chemical Yield Summary**

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<td>4.436</td>
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<td>pCi/g</td>
<td>65.3</td>
<td>30 - 110 %</td>
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#### 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:** UR1906738-1
### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
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<th>Units</th>
<th>Yield</th>
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### 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 the reported 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:** UR1906738-1

---

**Date Printed:**

Monday, August 12, 2019
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2UR
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

<table>
<thead>
<tr>
<th>CASNO</th>
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<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.61 +/- 0.14</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.016 +/- 0.018</td>
<td>0.026</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.55 +/- 0.13</td>
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<td>0.1</td>
<td>NA</td>
<td>NA</td>
</tr>
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</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.483</td>
<td>3.30</td>
<td>pCi/g</td>
<td>73.5</td>
<td>30 - 110 %</td>
<td>-</td>
</tr>
</tbody>
</table>

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: UR1906738-1
### Sample Results

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Prep Batch:** AS190723-2  
**QCBatchID:** AS190723-2-1  
**Run ID:** AS190723-2UR  
**Final Aliquot:** 1.02 g  
**Count Time:** 480 minutes  
**Report Basis:** Dry Weight  
**File Name:** Spectrum #1

### Target Nuclides

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.82 +/- 0.18</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.039 +/- 0.028</td>
<td>0.013</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.75 +/- 0.16</td>
<td>0.02</td>
<td>0.1</td>
<td>NA</td>
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### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.501</td>
<td>3.00</td>
<td>pCi/g</td>
<td>66.6</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

### 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:** UR1906738-1  

**Date Printed:** Monday, August 12, 2019
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Final Aliquot: 1.02 g
Count Time: 480 minutes
Lab ID: 1906738-17
Date Analyzed: 06-Aug-19

Sample Results

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<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.86 +/- 0.18</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.046 +/- 0.031</td>
<td>0.014</td>
<td>0.1</td>
<td>NA</td>
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</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.83 +/- 0.18</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
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</tbody>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.485</td>
<td>2.86</td>
<td>pCi/g</td>
<td>63.8</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906738-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
### Isotopic Uranium by Alpha Spectroscopy

#### PAI 714 Rev 14

#### Sample Results

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

#### Sample Matrix: SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 27-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 06-Aug-19  
**Final Aliquot:** 1.08 g  
**Count Time:** 480 minutes  
**Report Basis:** Dry Weight  
**Sample Results**

<table>
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<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.73 +/- 0.16</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.045 +/- 0.031</td>
<td>0.028</td>
<td>0.1</td>
<td>NA</td>
<td></td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.77 +/- 0.17</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
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</table>

#### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.231</td>
<td>2.74</td>
<td>pCi/g</td>
<td>64.8</td>
<td>30 - 110 %</td>
<td></td>
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</tbody>
</table>

#### 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:** UR1906738-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Final Aliquot: 1.07 g
Count Time: 480 minutes
Report Basis: Dry Weight

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.284</td>
<td>2.81</td>
<td>pCi/g</td>
<td>65.5</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906738-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19
Prep Batch: AS190723-2
QC Batch ID: AS190723-2-1
Run ID: AS190723-2UR
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
---|---|---|---|---|---|---
13966-29-5 | U-234 | 0.82 +/- 0.19 | 0.03 | 0.1 | NA |
15117-96-1 | U-235 | 0.040 +/- 0.033 | 0.018 | 0.1 | NA |
7440-61-1 | U-238 | 0.68 +/- 0.17 | 0.02 | 0.1 | NA |

Chemical Yield Summary

| Carrier/Tracer | Amount Added | Result | Units | Yield | Control Limits | Flag |
---|---|---|---|---|---|---|
U-232 | 4.268 | 1.98 | pCi/g | 46.4 | 30 - 110 % | |

Comments:

Qualifiers/Flags:
U - Result is less than the sample specific MDC.
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Y2 - Chemical Yield outside default limits.
M3 - The reported 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: UR1906738-1

Date Printed: Monday, August 12, 2019
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-26-0-2-03
Lab ID: 1906738-24

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.025 +/- 0.026</td>
<td>0.041</td>
<td>0.2</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.010 +/- 0.019</td>
<td>0.014</td>
<td>0.2</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0 +/- 0.016</td>
<td>0.041</td>
<td>0.2</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.429</td>
<td>3.23</td>
<td>pCi/l</td>
<td>73.0</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

Qualifiers/Flags:
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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: UR1906738-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Prep Batch: AS190723-2
Run ID: AS190723-2UR
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.82 +/- 0.17</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.044 +/- 0.029</td>
<td>0.012</td>
<td>0.1</td>
<td>NA</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.87 +/- 0.18</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.484</td>
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<td>pCi/g</td>
<td>71.7</td>
<td>30 - 110 %</td>
<td></td>
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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: UR1906738-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
### Sample Results

#### Prep SOP:
PAI 778 Rev 16

#### Final Aliquot:
1.09 g

#### Count Time:
480 minutes

#### Lab Name:
Engineering Analytics

#### Client Name:
Engineering Analytics

#### Client Project ID:
Rocky Flats Trails (FWS) 110876

#### Work Order Number:
1906738

#### Field ID:
SB-28-0-2-01

#### Lab ID:
1906738-27

#### Date Analyzed:
06-Aug-19

#### Date Collected:
27-Jun-19

#### Sample Matrix:
SOIL

#### Prep Lot:
PAI 778 Rev 16

#### Prep Batch:
AS190723-2

#### QC Batch ID:
AS190723-2-1

#### Run ID:
AS190723-2UR

#### Count Time:
480 minutes

#### Report Basis:
Dry Weight

#### Date Prepared:
23-Jul-19

#### Prep Batch:
AS190723-2

#### QCBatchID:
AS190723-2-1

#### Result Units:
pCi/g

#### File Name:
Spectrum #1

#### Target Nuclide

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>1.00 +/- 0.20</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.038 +/- 0.028</td>
<td>0.030</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.98 +/- 0.20</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
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</table>

#### Chemical Yield Summary

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<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
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<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
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<tbody>
<tr>
<td>U-232</td>
<td>4.197</td>
<td>2.96</td>
<td>pCi/g</td>
<td>70.5</td>
<td>30 - 110%</td>
<td></td>
</tr>
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</table>

#### 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

#### Comments:

**Data Package ID:** UR1906738-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2UR
Count Time: 480 minutes
Report Basis: Dry Weight
Final Aliquot: 1.04 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>1.10 +/- 0.22</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
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</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.090 +/- 0.046</td>
<td>0.036</td>
<td>0.1</td>
<td>NA</td>
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</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>1.05 +/- 0.22</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
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<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.382</td>
<td>2.81</td>
<td>pCi/g</td>
<td>64.1</td>
<td>30 - 110%</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906738-1
Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Final Aliquot: 1.03 g
Count Time: 480 minutes
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2UR
Report Basis: Dry Weight
Date Analyzed: 06-Aug-19
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Lab ID: 1906738-31
Field ID: SB-30-0-2-01

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Final Aliquot: 1.03 g
Count Time: 480 minutes
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2UR
Report Basis: Dry Weight
Date Analyzed: 06-Aug-19
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Lab ID: 1906738-31
Field ID: SB-30-0-2-01

CASNO Target Nuclide Result +/- 2 s TPU MDC Requested MDC DL Lab Qualifier
13966-29-5 U-234 0.83 +/- 0.18 0.04 0.1 NA
15117-96-1 U-235 0.046 +/- 0.034 0.040 0.1 NA
7440-61-1 U-238 0.84 +/- 0.18 0.03 0.1 NA

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
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<tr>
<td>U-232</td>
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<td>pCi/g</td>
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<td>30 - 110 %</td>
<td></td>
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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: UR1906738-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2UR
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

Field ID: SB-33-0-2-01
Lab ID: 1906738-33

<table>
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<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
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<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.77 +/- 0.16</td>
<td>0.03</td>
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<td>NA</td>
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<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.033 +/- 0.029</td>
<td>0.043</td>
<td>0.1</td>
<td>NA</td>
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</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.71 +/- 0.15</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.495</td>
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<td>pCi/g</td>
<td>73.5</td>
<td>30 - 110 %</td>
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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: UR1906738-1

Date Printed: Monday, August 12, 2019
## Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

### Sample Results

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906738  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

<table>
<thead>
<tr>
<th>Field ID</th>
<th>Lab ID</th>
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<tbody>
<tr>
<td>SB-32-0-2-01</td>
<td>1906738-35</td>
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**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 27-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 06-Aug-19

**Prep Batch:** AS190723-2  
**QC Batch ID:** AS190723-2-1  
**Run ID:** AS190723-2UR  
**Count Time:** 480 minutes  
**Report Basis:** Dry Weight

**Final Aliquot:** 1.06 g  
**Lab Name:** Client Name: Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

**Work Order Number:** 1906738  
**Field ID:** SB-32-0-2-01  
**Lab ID:** 1906738-35

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.78 +/- 0.16</td>
<td>0.02</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.046 +/- 0.030</td>
<td>0.026</td>
<td>0.1</td>
<td>NA</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.67 +/- 0.15</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
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**Chemical Yield Summary**

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.318</td>
<td>3.06</td>
<td>pCi/g</td>
<td>70.8</td>
<td>30-110%</td>
<td></td>
</tr>
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</table>

**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.
- Y3 - 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:** UR1906738-1

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*Date Printed: Monday, August 12, 2019*  
*ALS -- Fort Collins*  
*LIMS Version: 6.901*  
*Page 19 of 20*  
*39 of 41*
Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 14

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Final Aliquot: 1.07 g
Count Time: 480 minutes
Report Basis: Dry Weight

Lab ID: 1906738-37
Field ID: SB-31-0-2-01

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<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.74 +/- 0.16</td>
<td>0.02</td>
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<td>NA</td>
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<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.029 +/- 0.024</td>
<td>0.027</td>
<td>0.1</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.84 +/- 0.18</td>
<td>0.02</td>
<td>0.1</td>
<td>NA</td>
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Chemical Yield Summary

<table>
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<th>Result</th>
<th>Units</th>
<th>Yield</th>
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<tr>
<td>U-232</td>
<td>4.292</td>
<td>2.89</td>
<td>pCi/g</td>
<td>67.3</td>
<td>30 - 110 %</td>
<td></td>
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</table>

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: UR1906738-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901

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Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Duplicate Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906738
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 27-Jun-19
Prep Batch: AS190723-1
Date Prepared: 23-Jul-19
OCBatchID: AS190723-1-1
Date Analyzed: 05-Aug-19
Run ID: AS190723-1UD
Report Basis: Dry Weight
File Name: Spectrum #1

Final Aliquot: 1.08 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g

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<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
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<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.52 +/- 0.13</td>
<td>0.02</td>
<td>0.1</td>
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<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.003 +/- 0.019</td>
<td>0.029</td>
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<td>NA</td>
<td>U</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.60 +/- 0.14</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
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</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
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<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
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<tr>
<td>U-232</td>
<td>4.251</td>
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<td>pCi/g</td>
<td>72.8</td>
<td>30 - 110 %</td>
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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 the reported 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: UR1906738-1
APPENDIX B.4
ALS LABORATORY REPORTS
WORK ORDER NUMBER: 190768
1. This report consists of the analytical results for sixteen soil samples and one water sample received by ALS on 06/28/2019.

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, 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 08/10/2019.

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

8/14/19
Date

Radiochemistry Final Data Reviewer
## Sample Number(s) Cross-Reference Table

**OrderNum:** 1906768  
**Client Name:** Engineering Analytics  
**Client Project Name:** Rocky Flats Trails (FWS)  
**Client Project Number:** 110876  
**Client PO Number:**

<table>
<thead>
<tr>
<th>Client Sample Number</th>
<th>Lab Sample Number</th>
<th>COC Number</th>
<th>Matrix</th>
<th>Date Collected</th>
<th>Time Collected</th>
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<td>WATER</td>
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</table>
# ALS -- Fort Collins

Sample Number(s) Cross-Reference Table

**OrderNum:** 1906768  
**Client Name:** Engineering Analytics  
**Client Project Name:** Rocky Flats Trails (FWS)  
**Client Project Number:** 110876  
**Client PO Number:**

<table>
<thead>
<tr>
<th>Client Sample Number</th>
<th>Lab Sample Number</th>
<th>COC Number</th>
<th>Matrix</th>
<th>Date Collected</th>
<th>Time Collected</th>
</tr>
</thead>
</table>
# 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.

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<thead>
<tr>
<th>PROJECT NAME: Rocky Flats Trails (FWS)</th>
<th>SITE ID</th>
<th>SAMPLER</th>
<th>EH, SK</th>
<th>TURNAROUND TIME</th>
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<th>BY LAB or RETURN</th>
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<td>COMPANY NAME: Engineering Analytics</td>
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<tr>
<td>SEND REPORT TO: Jason Andrews</td>
<td></td>
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</tr>
<tr>
<td>ADDRESS: 1600 Specht Blvd, Ste 209</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHONE: (970) 468-311</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-MAIL: <a href="mailto:JAndreas@enganalytics.com">JAndreas@enganalytics.com</a></td>
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## LAB ID - FIELD ID

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<th>FIELD ID</th>
<th>MATRIX</th>
<th>SAMPLE DATE</th>
<th>SAMPLE TIME</th>
<th># OF BOTTLES</th>
<th>PRESERVATIVE</th>
<th>QC A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>SEE NOTES</th>
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<tr>
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</tbody>
</table>

*Time Zone (Circle): EST CST MST PST  Metric: O = oil  S = soil  NS = non-soil solids  W = water  L = liquid  E = extract  F = filter

### NOTES
- Do not test for carbonate ion.
- Hold all 99 samples for 3 years.
- Preservation Key:

### SIGNATURE
- RELINQUISHED BY: [Signature]
- RECEIVED BY: [Signature]
- RELINQUISHED BY: [Signature]
- RECEIVED BY: [Signature]

### PRINTED NAME
- Stew Becker
- Emily Lyons

### DATE
- 06/28/19

### TIME
- 1600
| 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 |
|--------|------------|--------|-------------|-------------|--------------|--------------|---------------|----|----|----|----|----|----|----|----|----|----|-----|----------|----------|
| 3      | SB-41-0-2-01 | S      | 6/28/11     | 1120        | 1            | None         | XXX           |   |    |    |    |    |    |    |    |    |    | Hold    |          |
| 14     | "          | "      | 1120        |             |              |              |               |   |    |    |    |    |    |    |    |    |    | Hold    |          |
| 15     | SB-42-0-2-01 | "      | 1055        |             |              |              | X             |   |    |    |    |    |    |    |    |    |    | Hold    |          |
| 16     | "          | "      | 1055        |             |              |              |               |   |    |    |    |    |    |    |    |    |    | Hold    |          |
| 17     | SB-43-0-2-01 | "      | 1020        |             |              |              |               |   |    |    |    |    |    |    |    |    |    | Hold    |          |
| 18     | "          | "      | 1040        |             |              |              |               |   |    |    |    |    |    |    |    |    |    | Hold    |          |
| 19     | SB-44-0-2-01 | "      | 1025        |             |              |              |               |   |    |    |    |    |    |    |    |    |    | Hold    |          |
| 20     | "          | "      | 1025        |             |              |              |               |   |    |    |    |    |    |    |    |    |    | Hold    |          |
| 21     | SB-45-0-2-01 | "      | 1005        |             |              |              |               |   |    |    |    |    |    |    |    |    |    | Hold    |          |
| 22     | "          | "      | 1005        |             |              |              |               |   |    |    |    |    |    |    |    |    |    | Hold    |          |
| 23     | SB-46-0-2-01 | "      | 0955        |             |              |              |               |   |    |    |    |    |    |    |    |    |    | Hold    |          |
| 24     | "          | "      | 0955        |             |              |              |               |   |    |    |    |    |    |    |    |    |    | Hold    |          |

*Time Zone (Circle): EST CST MST PST Metes: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

Do not test for carbonate fusion. Hold all. Samples for archive.

**Preservation Key:**
1-H2O 2-NO3 3-H2SO4 4-NaOH 5-NaOH/2vAcetate 6-NaHISO4 7-4°C 8-Other
**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.

<table>
<thead>
<tr>
<th>PROJECT NAME</th>
<th>SITE ID</th>
<th>PARAMETER/METHOD REQUEST FOR ANALYSIS</th>
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<tbody>
<tr>
<td>Rocky Flats Trails (FWS)</td>
<td>STD</td>
<td>-</td>
</tr>
<tr>
<td>110876</td>
<td></td>
<td>A: AM-241 - ALS SOP 714</td>
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<tr>
<td>COMPANY NAME</td>
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<td>PURCHASE ORDER</td>
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<td>Engineering Analytics</td>
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<td>SEND REPORT TO</td>
<td>INVOICE ATTN TO</td>
<td>C: U-234, 235, 236 - ALS SOP 714</td>
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<td>Jason Andrews</td>
<td>Same</td>
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<tr>
<td>ADDRESS</td>
<td>ADDRESS</td>
<td>D: AM-241 - ALS SOP 714</td>
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<tr>
<td>1600 South Point Rd, Suite 209</td>
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<td>E: PV-238, 239/240 - ALS SOP 714</td>
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<td>Fort Collins, CO 80525</td>
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<tr>
<td>PHONE</td>
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<tr>
<td>(970) 488-3111</td>
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<tr>
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<th>SAMPLE TIME</th>
<th># OF BOTTLES</th>
<th>PRESERVATIVE</th>
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<th>B</th>
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<th>G</th>
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<th>J</th>
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</tbody>
</table>

**NOTES**

- Do not test for carbonate
- Hold all 99 samples for archive

**PRESCRIPTION KEY**

- 1-HCl 2-HNO3 3-H2SO4 4-H2O 5-NaOH 6-NaOH/2%Acetic 7-NaHSO4 74°C 8-Other
**ALS Environmental - Fort Collins**

**CONDITION OF SAMPLE UPON RECEIPT FORM**

<table>
<thead>
<tr>
<th>Client:</th>
<th>8A</th>
<th>Workorder No:</th>
<th>904708</th>
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<tr>
<td>Project Manager:</td>
<td>1FS</td>
<td>Initials:</td>
<td>8z</td>
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<tr>
<td>Date:</td>
<td>4.29.19</td>
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</tr>
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</table>

1. Are airbills / shipping documents present and/or removable? **YES**
2. Are custody seals on shipping containers intact? **NONE**
3. Are custody seals on sample containers intact? **NONE**
4. Is there a COC (chain-of-custody) present? **YES**
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.) **NO**
6. Are short-hold samples present? **NO**
7. Are all samples within holding times for the requested analyses? **NO**
8. Were all sample containers received intact? (not broken or leaking) **NO**
9. Is there sufficient sample for the requested analyses? **NO**
10. Are all samples in the proper containers for the requested analyses? **NO**
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles) **NO**
12. Are all aqueous non-preserved samples pH 4-9? **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) **NO**
14. Were the samples shipped on ice? **NO**
15. Were cooler temperatures measured at 0.1-6.0°C? **NO**

<table>
<thead>
<tr>
<th>Cooler #</th>
<th>#1</th>
<th>#3</th>
<th>#4</th>
<th>RAD ONLY</th>
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<tbody>
<tr>
<td>IR gun used*</td>
<td>YES</td>
<td>NO</td>
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</table>

DOT Survey Acceptance Information

- Temperature (°C): A/M/B
- No. of custody seals on cooler: N/A
- External μR/hr reading: N/A
- Background μR/hr reading: N/A

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.

The Dot jars all are -88 samples and the 405 are 01-02

All client bottle ID's vs ALS lab ID's double-checked by: [Signature]

If applicable, was the client contacted? **YES / NO / NA**

Contact Date/Time: [6/29/19]

Project Manager Signature / Date: [Signature] 6/29/19

---

*IR Gun #1, VWR SN 170560549
*IR Gun #3, VWR SN 170647571
*IR Gun #4, Oakton, NV, 2372220101-0002

Form 201r27.xls
(02/11/2019)
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190717-1
QCBatchID: AS190717-1-1
NCB Batch: AS190717-1-1
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

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.271</td>
<td>2.07</td>
<td>pCi/l</td>
<td>91.2</td>
<td>30 - 110 %</td>
<td>Y2</td>
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</tbody>
</table>

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

Data Package ID: AM1906768-1
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date SOP: 23-Jul-19
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Date Prepared: 23-Jul-19
Run ID: AS190723-2AM
Date Analyzed: 09-Aug-19
Count Time: 600 minutes

CASNO Target Nuclide Result +/- 2 s TPU MDC Requested MDC DL Qualifier
14596-10-2 Am-241 -0.0037 +/- 0.0060 0.0175 0.1 NA U

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>1.135</td>
<td>1.00</td>
<td>pCi/g</td>
<td>87.8</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 - Requested MDC not met.
B - Analyte concentration greater than MDC.
B3 - Analyte concentration greater than MDC but less than Requested MDC.
DL - Decision Level

Abbreviations:

TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit

Data Package ID: AM1906768-1
Isotopic Americium by Alpha Spectroscopy

Method Blank Results

Lab Name:  ALS -- Fort Collins
Work Order Number:  1906768
Client Name:  Engineering Analytics
Client Project ID:  Rocky Flats Trails (FWS) 110876

Prep SOP:  PAI 778 Rev 16
Prep Batch:  AS190723-3
QCBatchID:  AS190723-3-1
Run ID:  AS190723-3AM
Final Aliquot:  2.00 g
Result Units:  pCi/g
File Name:  Spectrum #1

Sample Matrix:  SOIL
Count Time:  600 minutes
Date Collected:  23-Jul-19
Date Prepared:  23-Jul-19
Date Analyzed:  10-Aug-19
Prep Batch:  AS190723-3
QCBatchID:  AS190723-3-1
Run ID:  AS190723-3AM
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  -0.0017 +/- 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:  AM1906768-1

Date Printed:  Tuesday, August 13, 2019
ALS -- Fort Collins
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: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
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<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>4.52 +/- 0.73</td>
<td>0.02</td>
<td>4.935</td>
<td>91.7</td>
<td>79 - 118</td>
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Chemical Yield Summary

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<th>Carrier/Tracer</th>
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Comments:

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<th>Qualifiers/Flags:</th>
<th>Abbreviations:</th>
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<tr>
<td>U</td>
<td>TPU - Total Propagated Uncertainty</td>
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<td>Y1</td>
<td>MDC - Minimum Detectable Concentration</td>
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Data Package ID: AM1906768-1
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14

Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190717-1
Final Aliquot: 1000 ml
Count Time: 1000 minutes

Lab ID: AS190717-1LCSD
Date Collected: 17-Jul-19
Date Prepared: 17-Jul-19
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:

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 the reported activity is greater than the reported MDC.

Data Package ID: AM1906768-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906

Page 2 of 4
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 23-Jul-19
Prep Batch: AS190723-2
Date Prepared: 23-Jul-19
 QC Batch ID: AS190723-2-1
Final Aliquot: 2.00 g
 Run ID: AS190723-2AM
Count Time: 600 minutes
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>2.13 +/- 0.36</td>
<td>0.02</td>
<td>2.467</td>
<td>86.5</td>
<td>67 - 111</td>
<td>P</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>1.135</td>
<td>1.08</td>
<td>pCi/g</td>
<td>94.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 the reported activity is greater than the reported MDC.

Abbreviations:
- TPU - Total Propagated Uncertainty
- MDC - Minimum Detectable Concentration

Data Package ID: AM1906768-1
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-3
QCBatchID: AS190723-3-1
Final Aliquot: 2.00 g
Result Units: pCi/g
File Name: Spectrum #1

Count Time: 600 minutes
File Name: Spectrum #1

Lab ID: AS190723-3-LCS
Date Collected: 23-Jul-19
Date Prepared: 23-Jul-19
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

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>1.135</td>
<td>1.00</td>
<td>pCi/g</td>
<td>88.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 the reported activity is greater than the reported MDC.

Abbreviations:

TPU - Total Propagated Uncertainty
MDC - Minimum Detectable Concentration

Data Package ID: AM1906768-1
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
Client Project 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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Analyte</th>
<th>Sample Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>Duplicate Result +/- 2 s TPU</th>
<th>MDC</th>
<th>DER</th>
<th>DER Lim</th>
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</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.012 +/- 0.017</td>
<td>0.030</td>
<td>U</td>
<td>0.002 +/- 0.016</td>
<td>0.034</td>
<td>U</td>
<td>0.456</td>
</tr>
</tbody>
</table>

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

Date Printed: Tuesday, August 13, 2019
## 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  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

<table>
<thead>
<tr>
<th>Field ID:</th>
<th>AS190717-1LCSD</th>
<th>Prep SOP:</th>
<th>PAI 778 Rev 16</th>
<th>Prep Batch:</th>
<th>AS190717-1</th>
<th>Final Aliquot:</th>
<th>1000 ml</th>
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</thead>
<tbody>
<tr>
<td>Lab ID:</td>
<td>AS190717-1-1</td>
<td>QC Batch ID:</td>
<td>AS190717-1-1</td>
<td>Run ID:</td>
<td>AS190717-1AM</td>
<td>Moisture(%):</td>
<td>NA</td>
</tr>
<tr>
<td>Date Collected:</td>
<td>17-Jul-19</td>
<td>Date Prepared:</td>
<td>17-Jul-19</td>
<td>Date Analyzed:</td>
<td>23-Jul-19</td>
<td>Count Time:</td>
<td>1000 minutes</td>
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<tr>
<td>Sample Matrix:</td>
<td>WATER</td>
<td>Prep Basis:</td>
<td>Unfiltered</td>
<td></td>
<td></td>
<td>Result Units:</td>
<td>pCi/l</td>
</tr>
<tr>
<td>Date Prepared:</td>
<td>17-Jul-19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>File Name:</td>
<td>Spectrum #1</td>
</tr>
<tr>
<td>Date Analyzed:</td>
<td>23-Jul-19</td>
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<td></td>
<td></td>
<td></td>
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</tbody>
</table>

**Sample Matrix:** WATER  
**Prep SOP:** PAI 778 Rev 16  
**Final Aliquot:** 1000 ml  
**Prep Batch:** AS190717-1  
**QC Batch ID:** AS190717-1-1  
**Run ID:** AS190717-1AM  
**Moisture(%):** NA  
**Result Units:** pCi/l  
**File Name:** Spectrum #1

### CASNO 14596-10-2: Am-241

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Sample Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>Duplicate Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>DER</th>
<th>DER Lim</th>
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</thead>
<tbody>
<tr>
<td>Am-241</td>
<td>4.52 +/- 0.73</td>
<td>0.02</td>
<td>P,Y1</td>
<td>4.53 +/- 0.73</td>
<td>0.02</td>
<td>P</td>
<td>0.011</td>
<td>2.13</td>
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</tbody>
</table>

**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

**Date Printed:** Tuesday, August 13, 2019  
**ALS -- Fort Collins**  
**LIMS Version:** 6.906

Page 2 of 2
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

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: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2AM
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>-0.005 +/- 0.020</td>
<td>0.047</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.208</td>
<td>1.81</td>
<td>pCi/g</td>
<td>81.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: AM1906768-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

**Field ID:** SB-36-0-2-01  
**Lab ID:** 1906768-3

<table>
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<th>Prep Batch:</th>
<th>QCBatchID:</th>
<th>Final Aliquot:</th>
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<tbody>
<tr>
<td>SOIL</td>
<td>PAI 778 Rev 16</td>
<td>AS190723-2</td>
<td>AS190723-2-1</td>
<td>1.01 g</td>
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<tr>
<td>Date Collected:</td>
<td>Date Prepared:</td>
<td>Run ID:</td>
<td>Count Time:</td>
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<tr>
<td>28-Jun-19</td>
<td>23-Jul-19</td>
<td>AS190723-2AM</td>
<td>600 minutes</td>
<td>Dry Weight</td>
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<tr>
<td>Date Analyzed:</td>
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<tr>
<td>09-Aug-19</td>
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<table>
<thead>
<tr>
<th>Lab Name:</th>
<th>Client Name:</th>
<th>ClientProject ID:</th>
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<tbody>
<tr>
<td>ALS -- Fort Collins</td>
<td>Engineering Analytics</td>
<td>Rocky Flats Trails (FWS) 110876</td>
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<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.035 +/- 0.025</td>
<td>0.033</td>
<td>0.1</td>
<td>NA</td>
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</table>

**Chemical Yield Summary**

<table>
<thead>
<tr>
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<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.246</td>
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<td>pCi/g</td>
<td>88.0</td>
<td>30 - 110 %</td>
<td>Y1</td>
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**Comments:**

**Qualifiers/Flags:**

- **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:** AM1906768-1

**Date Printed:** Tuesday, August 13, 2019

**ALS -- Fort Collins**

**LIMS Version:** 6.906
Sample Results

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: AS190723-2
QC Batch ID: AS190723-2-1
Run ID: AS190723-2AM
Count Time: 600 minutes
Report Basis: Dry Weight
Final Aliquot: 1.05 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.007 +/- 0.020</td>
<td>0.041</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.173</td>
<td>1.58</td>
<td>pCi/g</td>
<td>72.6</td>
<td>30 - 110 %</td>
<td></td>
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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: AM1906768-1
Isotopic Americium by Alpha Spectroscopy

PAI 714 Rev 14

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

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: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2AM
Count Time: 600 minutes
Report Basis: Dry Weight

Final Aliquot: 1.02 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>-0.005 +/- 0.013</td>
<td>0.034</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

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<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tbody>
<tr>
<td>Am-243</td>
<td>2.219</td>
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<td>pCi/g</td>
<td>84.6</td>
<td>30 - 110 %</td>
<td>Y2</td>
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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: AM1906768-1
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Prep SOP: PAI 778 Rev 16
Sample Matrix: SOIL
Date Collected: 28-Jun-19
Prep Batch: AS190723-2
Lab ID: 1906768-9
Date Prepared: 23-Jul-19
Run ID: AS190723-2AM
Count Time: 600 minutes
Report Basis: Dry Weight
Field ID: SB-39-0-2-01
Final Aliquot: 1.07 g
Prep Basis: Dry Weight
Client Name: Engineering Analytics
Lab Name: ALS -- Fort Collins
Client Project ID: Rocky Flats Trails (FWS) 110876
Work Order Number: 1906768
Date Analyzed: 09-Aug-19
Report Units: pCi/g
Date Collected: 28-Jun-19
Sample Results

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<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
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<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>-0.004 +/- 0.016</td>
<td>0.039</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

<table>
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<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<td>Am-243</td>
<td>2.118</td>
<td>1.75</td>
<td>pCi/g</td>
<td>82.5</td>
<td>30 - 110 %</td>
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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: AM1906768-1
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Final Aliquot: 1.07 g
Count Time: 600 minutes
Prep Batch: AS190723-3
QCBatchID: AS190723-3-1
Run ID: AS190723-3AM
Report Basis: Dry Weight
File Name: Spectrum #1

Date Collected: 28-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19
Prep Batch: AS190723-3
Field ID: SB-40-0-2-01
Lab ID: 1906768-11
Lab Name: ALS -- Fort Collins
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

CASNO Target Nuclide Result +/- 2 s TPU MDC Requested MDC DL Lab Qualifier
14596-10-2 Am-241 0.006 +/- 0.014 0.029 0.1 NA U

Chemical Yield Summary

Carrier/Tracer Amount Added Result Units Yield Control Limits Flag
Am-243 2.121 1.75 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: AM1906768-1
## Isotopic Americium by Alpha Spectroscopy

**PAI 714 Rev 14**  
**Sample Results**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906768  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

<table>
<thead>
<tr>
<th>Field ID:</th>
<th>Lab ID:</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-41-0-2-01</td>
<td>1906768-13</td>
</tr>
</tbody>
</table>

**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  
**QC Batch ID:** AS190723-3-1  
**Run ID:** AS190723-3AM  
**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

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>-0.002 +/- 0.014</td>
<td>0.037</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

#### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.249</td>
<td>1.55</td>
<td>pCi/g</td>
<td>68.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

**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:** AM1906768-1
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

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
Report Basis: Dry Weight

Final Aliquot: 1.08 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.002 +/- 0.013</td>
<td>0.030</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.099</td>
<td>1.66</td>
<td>pCi/g</td>
<td>79.0</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: AM1906768-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 28-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19
Final Aliquot: 1.07 g
Count Time: 600 minutes
Report Basis: Dry Weight
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.021 +/- 0.020</td>
<td>0.030</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.118</td>
<td>1.68</td>
<td>pCi/g</td>
<td>79.3</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: AM1906768-1

Date Printed: Tuesday, August 13, 2019
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-44-0-2-01
Lab ID: 1906768-19

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
QC Batch ID: AS190723-3-1
Run ID: AS190723-3AM
Count Time: 600 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
14596-10-2  Am-241  0.016 +/- 0.018  0.031  0.1  NA  U

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.187</td>
<td>1.69</td>
<td>pCi/g</td>
<td>77.4</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: AM1906768-1

Date Printed: Tuesday, August 13, 2019
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 28-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 09-Aug-19
Field ID: SB-45-0-2-01
Lab ID: 1906768-21

Prep Batch: AS190723-3
QCBatchID: AS190723-3-1
Run ID: AS190723-3AM
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.003 +/- 0.015</td>
<td>0.033</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.210</td>
<td>1.77</td>
<td>pCi/g</td>
<td>80.0</td>
<td>30 - 110 %</td>
<td></td>
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</tbody>
</table>

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: AM1906768-1

Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

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
Report Basis: Dry Weight

Final Aliquot: 1.02 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.003 +/- 0.015</td>
<td>0.033</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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</tbody>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.232</td>
<td>1.61</td>
<td>pCi/g</td>
<td>72.1</td>
<td>30 - 110 %</td>
<td></td>
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</table>

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.
Y3 - 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: AM1906768-1

Date Printed: Tuesday, August 13, 2019
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-3
QC Batch ID: AS190723-3-1
Run ID: AS190723-3AM
Count Time: 600 minutes
Report Basis: Dry Weight

Field ID: SB-47-0-2-01
Lab ID: 1906768-25

Sample Results

Final Aliquot: 1.07 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.012 +/- 0.017</td>
<td>0.030</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.117</td>
<td>1.66</td>
<td>pCi/g</td>
<td>78.5</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

<table>
<thead>
<tr>
<th>Qualifiers/Flags:</th>
</tr>
</thead>
<tbody>
<tr>
<td>U - Result is less than the sample specific MDC.</td>
</tr>
<tr>
<td>Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.</td>
</tr>
<tr>
<td>Y2 - Chemical Yield outside default limits.</td>
</tr>
<tr>
<td>M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.</td>
</tr>
<tr>
<td>M - The requested MDC was not met.</td>
</tr>
</tbody>
</table>

Abbreviations:

| TPU - Total Propagated Uncertainty |
| MDC - Sample specific Minimum Detectable Concentration |
| BDL - Below Detection Limit |
| DL - Decision Level |

Data Package ID: AM1906768-1
## Isotopic Americium by Alpha Spectroscopy

### PAI 714 Rev 14

#### Sample Duplicate Results

<table>
<thead>
<tr>
<th>Field ID: SB-47-0-2-01</th>
<th>Prep SOP: PAI 778 Rev 16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab ID: 1906768-25DUP</td>
<td></td>
</tr>
</tbody>
</table>

- **Sample Matrix:** SOIL
- **Date Collected:** 28-Jun-19
- **Date Prepared:** 23-Jul-19
- **Date Analyzed:** 09-Aug-19
- **Final Aliquot:** 1.07 g
- **Lab ID:** 1906768-25DUP
- **Prep Basis:** Dry Weight
- **Report Basis:** Dry Weight

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.002 +/- 0.016</td>
<td>0.034</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

#### Carrier/Tracer | Amount Added | Result | Units | Yield | Control Limits | Flag |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.120</td>
<td>1.74</td>
<td>pCi/g</td>
<td>82.1</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

### 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 the reported 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: AM1906768-1

- **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: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

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
QC Batch ID: AS190723-3-1
Run ID: AS190723-3AM
Count Time: 600 minutes
Report Basis: Dry Weight

Field ID: SB-48-0-2-01
Lab ID: 1906768-27

Final Aliquot: 1.06 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g

File Name: Spectrum #1

Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.003 +/- 0.015</td>
<td>0.032</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Carrier/Tracer | Amount Added | Result | Units | Yield | Control Limits | Flag |
---------------|--------------|--------|-------|-------|----------------|------|
Am-243         | 2.145        | 1.67   | pCi/g | 78.0  | 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: AM1906768-1

Date Printed: Tuesday, August 13, 2019
### Isotopic Americium by Alpha Spectroscopy

**PAI 714 Rev 14**

**Sample Results**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906768  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

| Field ID: | SB-38-0-2-02  
| Lab ID: | 1906768-29

| Sample Matrix: | SOIL  
| Prep SOP: | PAI 778 Rev 16

| 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

| Client Name: | Engineering Analytics
| Work Order Number: | 1906768
| Field ID: | SB-38-0-2-02
| Lab ID: | 1906768-29
| Date Analyzed: | 09-Aug-19
| Date Collected: | 28-Jun-19
| Date Prepared: | 23-Jul-19

| Field ID: | SB-38-0-2-02  
| Lab ID: | 1906768-29

### Chemical Yield Summary

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<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.012 +/- 0.018</td>
<td>0.032</td>
<td>0.1</td>
<td>NA</td>
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</tbody>
</table>

#### 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:** AM1906768-1

**Date Printed:** Tuesday, August 13, 2019
### Sample Results

**Prep SOP:** PAI 778 Rev 16  
**Final Aliquot:** 1000 ml  
**Count Time:** 1000 minutes  
**Lab Name:** Engineering Analytics  
**Client Name:** Engineering Analytics  
**ClientProject ID:** Rocky Flats Trails (FWS) 110876  
**Work Order Number:** 1906768  
**Field ID:** SB-34-0-2-03  
**Lab ID:** 1906768-30  
**Date Analyzed:** 23-Jul-19  
**Date Collected:** 28-Jun-19  
**Sample Matrix:** WATER  
**Report Basis:** Unfiltered  
**Date Prepared:** 17-Jul-19  
**Prep Batch:** AS190717-1  
**Run ID:** AS190717-1AM  
**Lab ID:** 1906768-30  
**Date Prepared:** 17-Jul-19  
**Run ID:** AS190717-1AM  
**Result Units:** pCi/l  
**File Name:** Spectrum #1

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tbody>
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<td>14596-10-2</td>
<td>Am-241</td>
<td>-0.002 +/- 0.011</td>
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<td>0.1</td>
<td>NA</td>
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- **Carrier/Tracer**: Am-243  
- **Amount Added**: 2.271  
- **Result**: 2.20  
- **Units**: pCi/l  
- **Yield**: 96.7  
- **Control Limits**: 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:** AM1906768-1

---

**Date Printed:** Tuesday, August 13, 2019
Isotopic Americium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

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
Report Basis: Dry Weight

Final Aliquot: 1.03 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
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<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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</thead>
<tbody>
<tr>
<td>14596-10-2</td>
<td>Am-241</td>
<td>0.020 +/- 0.024</td>
<td>0.040</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-243</td>
<td>2.209</td>
<td>1.56</td>
<td>pCi/g</td>
<td>70.7</td>
<td>30 - 110 %</td>
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</tbody>
</table>

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: AM1906768-1

Date Printed: Tuesday, August 13, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Plutonium
Case Narrative

Engineering Analytics
Rocky Flats Trails (FWS) -- 110876

Work Order Number: 1906768

1. This report consists of the analytical results for sixteen soil samples and one water sample received by ALS on 06/28/2019.

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, 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 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 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

_______________________________   __8/12/19
Date

_______________________________   ___________
Radiochemistry Final Data Reviewer

8/14/19
Date
## Sample Number(s) Cross-Reference Table

**OrderNum:** 1906768  
**Client Name:** Engineering Analytics  
**Client Project Name:** Rocky Flats Trails (FWS)  
**Client Project Number:** 110876  
**Client PO Number:**  

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<th>Matrix</th>
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<th>Time Collected</th>
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### 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.

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<th>LAB ID</th>
<th>FIELD ID</th>
<th>MATRIX</th>
<th>SAMPLE DATE</th>
<th>SAMPLE TIME</th>
<th># OF BOTTLES</th>
<th>PRESERVATIVE</th>
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<th>B</th>
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<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
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**NOTES**

*Do not test for carbonate & oxygen.*

*Hold all -99 for archive.*

**SIGNATURE**

Stevie Keller  6/28/19  1600

Emily Lyons  06/28/19  1600
**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.

<table>
<thead>
<tr>
<th>TURNAROUND TIME</th>
<th>SAMPLER</th>
<th>SITE ID</th>
<th>PARAMETER/METHOD REQUEST FOR ANALYSIS</th>
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<tbody>
<tr>
<td>STD</td>
<td>EH, SK</td>
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<tr>
<th>PROJECT NAME</th>
<th>SITE ID</th>
<th>SAMPLER</th>
<th>PARAMETER/METHOD REQUEST FOR ANALYSIS</th>
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<tbody>
<tr>
<td>Rocky Flats Trails (FW5)</td>
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<th>INVOICE ATTN TO</th>
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<th>CITY / STATE / ZIP</th>
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<tbody>
<tr>
<td>Engineering Analytics</td>
<td>Jason Andrews</td>
<td>1600 Specht Point Rd., Ste. 209</td>
<td>Fort Collins, CO 80525</td>
<td>(970) 489-3111</td>
<td></td>
<td><a href="mailto:JAndrews@Engmanalytics.com">JAndrews@Engmanalytics.com</a></td>
</tr>
</tbody>
</table>

| 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 |
|--------|----------|--------|-------------|-------------|--------------|--------------|----|---|---|---|---|---|---|---|---|---|-----------------|
| B      | SB-41-0-2-01 | 99     | 6/28/19   | 11:20       | 1            | None         | X  | X | X |   |    |    |    |    |   |    | Hold            |
| 14     | "         | "      | "          | "           | "            | "            | "  | " | " | " | " | " | " | " | " | " | " | Hold            |
| 15     | SB-42-0-2-01 | 99     | 10:55      |             |              |              | "  | " | " | " | " | " | " | " | " | " | " | Hold            |
| 16     | SB-43-0-2-01 | 99     | 10:40      |             |              |              | "  | " | " | " | " | " | " | " | " | " | " | Hold            |
| 17     | SB-44-0-2-01 | 99     | 10:40      |             |              |              | "  | " | " | " | " | " | " | " | " | " | " | Hold            |
| 18     | SB-44-0-2-01 | 99     | 10:25      |             |              |              | "  | " | " | " | " | " | " | " | " | " | " | Hold            |
| 19     | SB-45-0-2-01 | 99     | 10:05      |             |              |              | "  | " | " | " | " | " | " | " | " | " | " | Hold            |
| 20     | SB-45-0-2-01 | 99     | 10:05      |             |              |              | "  | " | " | " | " | " | " | " | " | " | " | Hold            |
| 21     | SB-46-0-2-01 | 99     | 09:55      |             |              |              | "  | " | " | " | " | " | " | " | " | " | " | Hold            |

*Time Zone (Circle): EST CST MST PST  Marks: D = drill S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

**NOTES**

Do not test for carbonate fusion. Hold all 99 for carbonate samples for archive.
### Chain-of-Custody

**Project Name:** Rocky Flats Trails (FW5)

**SITE ID:** STD

**PARAMETER/METHOD REQUEST FOR ANALYSIS**

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<th>B</th>
<th>C</th>
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<tbody>
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<td>U-239, 235, 238</td>
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**PROJECT NO.:** 110876

**COMPANY NAME:** Engineering Analytics

**SEND REPORT TO:** Jason Andrews, 600 Spectra Point Dr., Ste 209, Fort Collins, CO 80525

**PHONE:** (970) 428-3111

**E-MAIL:** jandrews@organalytix.com

**PURCHASE ORDER:** A

**ADDRESS:** 600 Spectra Point Dr., Ste 209, Fort Collins, CO 80525

**INVOICE ATTN TO:** Same

**FAX:**

**LAB ID** | **FIELD ID** | **MATRIX** | **SAMPLE DATE** | **SAMPLE TIME** | **# OF BOTTLES** | **PRESERVATIVE** | **QC** |
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<td>1</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>29</td>
<td>SB-38-0-2-02</td>
<td>&quot;</td>
<td>6/28/19</td>
<td>1215</td>
<td>1</td>
<td>&quot;</td>
<td>XXXX</td>
</tr>
<tr>
<td>30</td>
<td>SB-34-0-2-03</td>
<td>W</td>
<td>6/28/19</td>
<td>1505</td>
<td>3</td>
<td>HNO3</td>
<td>XXXX</td>
</tr>
<tr>
<td>31</td>
<td>SB-34-0-2-01</td>
<td>S</td>
<td>6/28/19</td>
<td>1320</td>
<td>1</td>
<td>None</td>
<td>XXXX</td>
</tr>
<tr>
<td>32</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>6/28/19</td>
<td>1</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

**NOTES:**

- Do not test for carbonate fusion.
- Hold all 99 samples for archive.

**SIGNATURE:**

**PRINTED NAME:**

**DATE:** 6/28/19

**TIME:** 16:00
**CONDITION OF SAMPLE UPON RECEIPT FORM**

Client: [blank]  
Workorder No: 1904708  
Initials: [blank]  
Date: 6.29.19

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are airbills / shipping documents present and/or removable?</td>
<td>Present</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Are custody seals on shipping containers intact?</td>
<td>None</td>
<td>YES</td>
<td>NO *</td>
</tr>
<tr>
<td>Are custody seals on sample containers intact?</td>
<td>None</td>
<td>YES</td>
<td>NO *</td>
</tr>
<tr>
<td>Is there a COC (chain-of-custody) present?</td>
<td>YES</td>
<td></td>
<td>NO *</td>
</tr>
<tr>
<td>Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)</td>
<td>YES</td>
<td></td>
<td>NO *</td>
</tr>
<tr>
<td>Are short-hold samples present?</td>
<td>YES</td>
<td></td>
<td>NO</td>
</tr>
<tr>
<td>Are all samples within holding times for the requested analyses?</td>
<td>YES</td>
<td></td>
<td>NO *</td>
</tr>
<tr>
<td>Were all sample containers received intact? (not broken or leaking)</td>
<td>YES</td>
<td></td>
<td>NO *</td>
</tr>
<tr>
<td>Is there sufficient sample for the requested analyses?</td>
<td>YES</td>
<td></td>
<td>NO *</td>
</tr>
<tr>
<td>Are all samples in the proper containers for the requested analyses?</td>
<td>YES</td>
<td></td>
<td>NO *</td>
</tr>
<tr>
<td>Are all aqueous samples preserved correctly, if required? (excluding volatiles)</td>
<td>N/A</td>
<td>YES</td>
<td>NO *</td>
</tr>
<tr>
<td>Are all aqueous non-preserved samples pH 4-9?</td>
<td>N/A</td>
<td>YES</td>
<td>NO *</td>
</tr>
<tr>
<td>Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles &gt; 6 mm (1/4 inch) diameter (i.e. size of green pea)</td>
<td>N/A</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Were the samples shipped on ice?</td>
<td>YES</td>
<td></td>
<td>NO</td>
</tr>
<tr>
<td>Were cooler temperatures measured at 0.1-6.0°C?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooler #:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature (°C):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOT Survey Acceptance Information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of custody seals on cooler:</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External μR/hr reading:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Background μR/hr reading:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Were external μR/hr readings ≤ two times background and within DOT acceptance criteria?</td>
<td>YES / NO / NA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

* The dot bars all are -88 sampling and the dots are -01, -02

All client bottle ID's vs ALS lab ID's double-checked by: [signature]  
Date/Time: 6/29/15

---

Form 201r27.xls  
(02/11/2019)

---

*IR Gun #1, VWR SN 170560549
*IR Gun #3, VWR SN 170647571
*IR Gun #4, Oakton, VA: 2372220101-0002

Page 1 of 8 of 35
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Lab ID: AS190717-1MB
Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190717-1
QCBatchID: AS190717-1-1
Final Aliquot: 1000 ml
Result Units: pCi/l
Run ID: AS190717-1PU
File Name: Spectrum #1
Count Time: 420 minutes
Prep Batch: AS190717-1
Date Collected: 17-Jul-19
Date Prepared: 17-Jul-19
Date Analyzed: 22-Jul-19

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>-0.013 +/- 0.023</td>
<td>0.059</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>-0.003 +/- 0.023</td>
<td>0.036</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.133</td>
<td>2.10</td>
<td>pCi/l</td>
<td>50.8</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 - Requested MDC not met.
B - Analyte concentration greater than MDC.
B3 - Analyte concentration greater than MDC but less than Requested MDC.
DL - Decision Level

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit

Data Package ID: PU1906768-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-2
QC Batch ID: AS190723-2-1
Run ID: AS190723-2PU
Count Time: 480 minutes
Final Alas: 2.00 g
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0 +/- 0.010</td>
<td>0.019</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.001 +/- 0.010</td>
<td>0.022</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>2.304</td>
<td>1.34</td>
<td>pCi/g</td>
<td>58.3</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 - Requested MDC not met.
B - Analyte concentration greater than MDC.
B3 - Analyte concentration greater than MDC but less than Requested MDC.
DL - Decision Level

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit

Data Package ID: PU1906768-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-3
QC Batch ID: AS190723-3-1
Run ID: AS190723-3PU
Count Time: 360 minutes
Final Alquot: 2.00 g
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.004 +/- 0.010</td>
<td>0.022</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0 +/- 0.0086</td>
<td>0.0063</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>2.304</td>
<td>1.94</td>
<td>pCi/g</td>
<td>84.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

Qualifiers/Flags:
- U - Result is less than the sample specific MDC.
- Y1 - Chemical Yield is in control at 100-110%.
- Y2 - Chemical Yield outside default limits.
- 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

Abbreviations:
- TPU - Total Propagated Uncertainty
- MDC - Sample specific Minimum Detectable Concentration
- BDL - Below Detection Limit

Data Package ID: PU1906768-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190717-1
QCBatchID: AS190717-1-1
Final Aliquot: 1000 ml
Result Units: pCi/l
File Name: Spectrum #1

Prep Batch: AS190717-1
QCBatchID: AS190717-1-1
Run ID: AS190717-1PU
Count Time: 420 minutes

Lab ID: AS190717-1LCS
Date Analyzed: 22-Jul-19
Date Collected: 17-Jul-19
Sample Matrix: WATER
Prep Batch: AS190717-1
QCBatchID: AS190717-1-1
Final Aliquot: 1000 ml
Result Units: pCi/l
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>4.74 +/- 0.83</td>
<td>0.03</td>
<td>4.553</td>
<td>104</td>
<td>82 - 118</td>
<td>P</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-239/240</td>
<td>4.133</td>
<td>2.71</td>
<td>pCi/l</td>
<td>65.5</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 the reported activity is greater than the reported MDC.

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Minimum Detectable Concentration

Data Package ID: PU1906768-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>5.32 +/- 0.94</td>
<td>0.02</td>
<td>4.553</td>
<td>117</td>
<td>82 - 118</td>
<td>P</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.133</td>
<td>2.47</td>
<td>pCi/l</td>
<td>59.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

Qualifiers/Flags:

- **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 the reported activity is greater than the reported MDC.

Abbreviations:

- **TPU** - Total Propagated Uncertainty
- **MDC** - Minimum Detectable Concentration

Data Package ID: **PU1906768-1**
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 23-Jul-19
Prep Batch: AS190723-2
QC Batch ID: AS190723-2-1
Final Aliquot: 2.00 g
Run ID: AS190723-2PU
Count Time: 480 minutes
File Name: Spectrum #1

CASNO | Target Nuclide | Results +/- 2s TPU | MDC | Spike Added | % Rec | Control Limits | Lab Qualifier
--- | --- | --- | --- | --- | --- | --- | ---
10-12-8 | Pu-239/240 | 2.33 +/- 0.39 | 0 | 2.277 | 103 | 82 - 118 | P

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>2.304</td>
<td>2.08</td>
<td>pCi/g</td>
<td>90.1</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 the reported activity is greater than the reported MDC.

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Minimum Detectable Concentration

Data Package ID: PU1906768-1

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: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-3
QCBatchID: AS190723-3-1
Final Aliquot: 2.00 g
Result Units: pCi/g
File Name: Spectrum #1

Count Time: 360 minutes

Lab ID: AS190723-3LCS
Date Collected: 23-Jul-19
Date Prepared: 23-Jul-19
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  2.43 +/- 0.43  0.02   2.277       107  82 - 118      P

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>2.304</td>
<td>1.67</td>
<td>pCi/g</td>
<td>72.6</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 the reported activity is greater than the reported MDC.

Abbreviations:

- TPU - Total Propagated Uncertainty
- MDC - Minimum Detectable Concentration

Data Package ID: PU1906768-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901

Page 4 of 4
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
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 28-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 07-Aug-19
Final Aliquot: 1.07 g
Count Time: 360 minutes
Prep Batch: AS190723-3
Run ID: AS190723-3PU
QC Batch ID: AS190723-3-1
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Analyte</th>
<th>Sample Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>Duplicate Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>DER</th>
<th>DER Lim</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>238</td>
<td>0.002 +/- 0.030</td>
<td>0.055</td>
<td>U</td>
<td>-0.005 +/- 0.018</td>
<td>0.036</td>
<td>U</td>
<td>0.213</td>
<td>2.13</td>
</tr>
<tr>
<td>10-128</td>
<td>239/240</td>
<td>0.054 +/- 0.045</td>
<td>0.045</td>
<td></td>
<td>0.031 +/- 0.028</td>
<td>0.040</td>
<td>U</td>
<td>0.436</td>
<td>2.13</td>
</tr>
</tbody>
</table>

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.
L3 - 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

Data Package ID: PU1906768-1

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Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Duplicate Sample Results (DER)

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Final Aliquot: 1000 ml
Prep Batch: AS190717-1
QCBatchID: AS190717-1-1
Run ID: AS190717-1PU
Count Time: 420 minutes
Result Units: pCi/l
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Analyte</th>
<th>Sample Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>Duplicate Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>DER</th>
<th>DER Lim</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>4.74 +/- 0.83</td>
<td>0.03</td>
<td>P</td>
<td>5.32 +/- 0.94</td>
<td>0.02</td>
<td>P</td>
<td>0.454</td>
<td>2.13</td>
</tr>
</tbody>
</table>

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

Data Package ID: PU1906768-1

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Date Printed: Monday, August 12, 2019

ALS -- Fort Collins
LIMS Version: 6.901
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 28-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19

Field ID: SB-35-0-2-01
Lab ID: 1906768-1

Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2PU
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.002 +/- 0.016</td>
<td>0.024</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.057 +/- 0.033</td>
<td>0.030</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.483</td>
<td>3.18</td>
<td>pCi/g</td>
<td>71.0</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906768-1
Isotopic Plutonium by Alpha Spectroscopy

Sample Results

Prep SOP: PAI 778 Rev 16
Final Aliquot: 1.01 g
Count Time: 480 minutes
Lab Name: Engineering Analytics
Client Name: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Report Basis: Dry Weight
File Name: Spectrum #1

Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g

Field ID: SB-36-0-2-01
Lab ID: 1906768-3
Date Analyzed: 05-Aug-19
Date Collected: 28-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19

CASNO  Target Nuclide  Result +/- 2 s TPU  MDC  Requested MDC  DL  Lab Qualifier
13981-16-3  Pu-238  0.015 +/- 0.018  0.028  0.15  NA  U
10-12-8  Pu-239/240  0.070 +/- 0.035  0.022  0.1  NA

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.559</td>
<td>3.47</td>
<td>pCi/g</td>
<td>76.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906768-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
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Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 28-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2PU
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0 +/- 0.017</td>
<td>0.042</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.044 +/- 0.027</td>
<td>0.011</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.410</td>
<td>3.15</td>
<td>pCi/g</td>
<td>71.5</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906768-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14

Sample Results

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 28-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 05-Aug-19

Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2PU
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

Field ID: SB-38-0-2-01
Lab ID: 1906768-7

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.012 +/- 0.016</td>
<td>0.028</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.039 +/- 0.027</td>
<td>0.028</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.505</td>
<td>3.41</td>
<td>pCi/g</td>
<td>75.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

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: PU1906768-1
## Isotopic Plutonium by Alpha Spectroscopy

### Sample Results

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Sample Prepared:** 28-Jun-19  
**Sample Prepared:** 23-Jul-19  
**Date Analyzed:** 05-Aug-19  
**Report Basis:** Dry Weight

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>-0.002 +/- 0.014</td>
<td>0.022</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.028 +/- 0.022</td>
<td>0.022</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

### 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:** PU1906768-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-40-0-2-01
Lab ID: 1906768-11
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
Report Basis: Dry Weight
Final Aliquot: 1.07 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.019 +/- 0.019</td>
<td>0.013</td>
<td>0.15</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.032 +/- 0.025</td>
<td>0.013</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.306</td>
<td>3.26</td>
<td>pCi/g</td>
<td>75.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906768-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
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Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

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
Report Basis: Dry Weight

Final Aliquot: 1.01 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

Prep Basis:

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.564</td>
<td>3.77</td>
<td>pCi/g</td>
<td>82.5</td>
<td>30 - 110 %</td>
</tr>
</tbody>
</table>

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: PU1906768-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
Isotopic Plutonium by Alpha Spectroscopy

Sample Results

Prep SOP: PAI 778 Rev 16

Sample Matrix: SOIL

Field ID: SB-42-0-2-01
Lab ID: 1906768-15

Date Collected: 28-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 07-Aug-19

Prep Batch: AS190723-3
QC Batch ID: AS190723-3-1
Run ID: AS190723-3PU
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 +/- 0.016 | 0.012 | 0.15 | NA | U
10-12-8 | Pu-239/240 | 0.009 +/- 0.016 | 0.012 | 0.1 | NA | U

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.260</td>
<td>3.27</td>
<td>pCi/g</td>
<td>76.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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:** PU1906768-1

---

**Date Printed:** Monday, August 12, 2019
Isotopic Plutonium by Alpha Spectroscopy  
PAI 714 Rev 14  
Sample Results

Lab Name: ALS -- Fort Collins  
Work Order Number: 1906768  
Client Name: Engineering Analytics  
ClientProject ID: Rocky Flats Trails (FWS) 110876

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  
Report Basis: Dry Weight

Final Aliquot: 1.07 g  
Prep Basis: Dry Weight  
Moisture(%): NA  
Result Units: pCi/g  
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.004 +/- 0.021</td>
<td>0.031</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.045 +/- 0.035</td>
<td>0.042</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.300</td>
<td>2.69</td>
<td>pCi/g</td>
<td>62.5</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906768-1

Date Printed: Monday, August 12, 2019  
ALS -- Fort Collins  
LIMS Version: 6.901
## Isotopic Plutonium by Alpha Spectroscopy

**PAI 714 Rev 14**  
**Sample Results**

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 28-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 07-Aug-19  
**Final Aliquot:** 1.04 g  
**Count Time:** 360 minutes  
**Report Basis:** Dry Weight

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.439</td>
<td>3.19</td>
<td>pCi/g</td>
<td>72.0</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

**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:** PU1906768-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

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
QC Batch ID: 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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.005 +/- 0.019</td>
<td>0.014</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.045 +/- 0.034</td>
<td>0.038</td>
<td>0.1</td>
<td>NA</td>
<td></td>
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</tbody>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.485</td>
<td>3.21</td>
<td>pCi/g</td>
<td>71.5</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906768-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

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
Report Basis: Dry Weight

Final Aliquot: 1.02 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

Field ID: SB-46-0-2-01
Lab ID: 1906768-23

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<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>-0.006 +/- 0.020</td>
<td>0.040</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>11-12-8</td>
<td>Pu-239/240</td>
<td>0.023 +/- 0.025</td>
<td>0.035</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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</tbody>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.531</td>
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<td>pCi/g</td>
<td>69.7</td>
<td>30 - 110 %</td>
<td></td>
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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: PU1906768-1

Date Printed: Monday, August 12, 2019
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

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: 1906768-25

Sample Results
Prep SOP: PAI 778 Rev 16
Sample Matrix: SOIL
Prep Batch: AS190723-3
Date Collected: 28-Jun-19
QCBatchID: AS190723-3-1
Date Prepared: 23-Jul-19
Run ID: AS190723-3PU
Date Analyzed: 07-Aug-19
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  0.002 +/- 0.030  0.055  0.15  NA  U
10-12-8  Pu-239/240  0.054 +/- 0.045  0.045  0.1  NA

Chemical Yield Summary

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<tr>
<th>Carrier/Tracer</th>
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<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tbody>
<tr>
<td>Pu-242</td>
<td>4.297</td>
<td>1.80</td>
<td>pCi/g</td>
<td>41.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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.
Y3 - 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: PU1906768-1

Date Printed: Monday, August 12, 2019  ALS -- Fort Collins  Page 13 of 17
LIMS Version: 6.901
Isotopic Plutonium by Alpha Spectroscopy

Sample Duplicate Results

Lab Name: ALS - Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep Batch: AS190723-3
Prep SOP: PAI 778 Rev 16
OCBatchID: AS190723-3-1
Run ID: AS190723-3PU
Final Aliquot: 1.07 g
Prep Basis: Dry Weight
Report Basis: Dry Weight
Field ID: SB-47-0-2-01
Lab ID: 1906768-25DUP
Date Analyzed: 07-Aug-19
Date Collected: 28-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 07-Aug-19
Count Time: 360 minutes
Report Basis: Dry Weight

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
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<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.303</td>
<td>3.46</td>
<td>pCi/g</td>
<td>80.3</td>
<td>30 - 110 %</td>
<td></td>
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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 the reported 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: PU1906768-1

Date Printed: Monday, August 12, 2019
LIMS Version: 6.901
### Isotopic Plutonium by Alpha Spectroscopy
#### PAI 714 Rev 14

**Sample Results**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906768  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

---

**Field ID:** SB-48-0-2-01  
**Lab ID:** 1906768-27

**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  
**QC Batch ID:** AS190723-3-1  
**Run ID:** AS190723-3PU  
**Count Time:** 360 minutes  
**Report Basis:** Dry Weight

**Final Aliquot:** 1.06 g

**Lab ID:** 1906768-27

**Date Analyzed:** 07-Aug-19  
**Date Collected:** 28-Jun-19  
**Sample Matrix:** SOIL  
**Report Basis:** Dry Weight  
**Date Prepared:** 23-Jul-19

**Prep Batch:** AS190723-3  
**QC Batch ID:** AS190723-3-1

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<table>
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<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifer</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.007 +/- 0.019</td>
<td>0.034</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.018 +/- 0.024</td>
<td>0.042</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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</tbody>
</table>

**Chemical Yield Summary**

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tbody>
<tr>
<td>Pu-242</td>
<td>4.353</td>
<td>3.27</td>
<td>pCi/g</td>
<td>75.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

**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:** PU1906768-1
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

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
QC BatcId: 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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>-0.008 +/- 0.019</td>
<td>0.058</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
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<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.038 +/- 0.029</td>
<td>0.028</td>
<td>0.1</td>
<td>NA</td>
<td></td>
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</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.291</td>
<td>3.17</td>
<td>pCi/g</td>
<td>73.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906768-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
Isotopic Plutonium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-34-0-2-03
Lab ID: 1906768-30

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Date Collected: 28-Jun-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

<table>
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<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tbody>
<tr>
<td>13981-16-3</td>
<td>Pu-238</td>
<td>0.004 +/- 0.027</td>
<td>0.041</td>
<td>0.15</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>10-12-8</td>
<td>Pu-239/240</td>
<td>0.011 +/- 0.027</td>
<td>0.041</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.133</td>
<td>1.86</td>
<td>pCi/l</td>
<td>44.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906768-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
Sample Results

Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-3

Field ID: SB-34-0-2-01
Lab ID: 1906768-31
Sample Matrix: SOIL
Date Collected: 28-Jun-19
Prep Basis: Dry Weight

Lab Name: ALS -- Fort Collins
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876
Lab ID: 1906768-31
Work Order Number: 1906768

Date Prepared: 23-Jul-19
Date Analyzed: 07-Aug-19
Report Basis: Dry Weight

Sample Results

Target Nuclide | Result +/- 2 s TPU | MDC | Requested MDC | DL | Lab Qualifier
---|---|---|---|---|---
Pu-238 | 0.006 +/- 0.016 | 0.029 | 0.15 | NA | U
Pu-239/240 | 0.035 +/- 0.027 | 0.033 | 0.1 | NA | NA

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-242</td>
<td>4.485</td>
<td>4.02</td>
<td>pCi/g</td>
<td>89.6</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: PU1906768-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.901
Isotopic Uranium
Case Narrative

Engineering Analytics
Rocky Flats Trails (FWS) -- 110876

Work Order Number: 1906768

1. This report consists of the analytical results for sixteen soil samples and one water sample received by ALS on 06/28/2019.

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, 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 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. Uranium-234 activity is reported in method blank AS190723-2MB 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.

9. 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

<table>
<thead>
<tr>
<th>Client Sample Number</th>
<th>Lab Sample Number</th>
<th>COC Number</th>
<th>Matrix</th>
<th>Date Collected</th>
<th>Time Collected</th>
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<tbody>
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<td>SB-35-0-2-01</td>
<td>1906768-1</td>
<td>SOIL</td>
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<td>SB-41-0-2-01</td>
<td>1906768-13</td>
<td>SOIL</td>
<td>28-Jun-19</td>
<td>11:20</td>
<td></td>
</tr>
<tr>
<td>SB-43-0-2-01</td>
<td>1906768-17</td>
<td>SOIL</td>
<td>28-Jun-19</td>
<td>10:40</td>
<td></td>
</tr>
<tr>
<td>SB-43-0-2-99</td>
<td>1906768-18</td>
<td>SOIL</td>
<td>28-Jun-19</td>
<td>10:40</td>
<td></td>
</tr>
<tr>
<td>SB-44-0-2-01</td>
<td>1906768-19</td>
<td>SOIL</td>
<td>28-Jun-19</td>
<td>10:25</td>
<td></td>
</tr>
<tr>
<td>SB-44-0-2-99</td>
<td>1906768-20</td>
<td>SOIL</td>
<td>28-Jun-19</td>
<td>10:25</td>
<td></td>
</tr>
<tr>
<td>SB-45-0-2-01</td>
<td>1906768-21</td>
<td>SOIL</td>
<td>28-Jun-19</td>
<td>10:05</td>
<td></td>
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<tr>
<td>SB-45-0-2-99</td>
<td>1906768-22</td>
<td>SOIL</td>
<td>28-Jun-19</td>
<td>10:05</td>
<td></td>
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<tr>
<td>SB-47-0-2-01</td>
<td>1906768-25</td>
<td>SOIL</td>
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<td>9:30</td>
<td></td>
</tr>
<tr>
<td>SB-48-0-2-01</td>
<td>1906768-27</td>
<td>SOIL</td>
<td>28-Jun-19</td>
<td>9:05</td>
<td></td>
</tr>
<tr>
<td>SB-38-0-2-02</td>
<td>1906768-29</td>
<td>SOIL</td>
<td>28-Jun-19</td>
<td>12:15</td>
<td></td>
</tr>
<tr>
<td>SB-34-0-2-03</td>
<td>1906768-30</td>
<td>WATER</td>
<td>28-Jun-19</td>
<td>15:05</td>
<td></td>
</tr>
</tbody>
</table>
ALS -- Fort Collins

Sample Number(s) Cross-Reference Table

<table>
<thead>
<tr>
<th>Client Sample Number</th>
<th>Lab Sample Number</th>
<th>COC Number</th>
<th>Matrix</th>
<th>Date Collected</th>
<th>Time Collected</th>
</tr>
</thead>
</table>
| LAB ID | FIELD ID | MATRIX | SAMPLE DATE | SAMPLE TIME | OF BOTTLE | PRESERVATIVE | QC | SEE NOTES
|--------|----------|--------|-------------|-------------|-----------|--------------|----|-----------
| 1      | SB-35-0-2-01 | 5      | 6/28/19     | 12:05       | 1         | None         | X  | X         | X   | Hold     |
| 2      | SB-36-0-2-01 |        |             |             | 12:45     |             | X  | X         | X   | Hold     |
| 3      | SB-37-0-2-01 |        |             |             | 12:35     |             | X  | X         | X   | Hold     |
| 4      |             |        |             |             | 12:15     |             | X  | X         | X   | Hold     |
| 5      | SB-38-0-2-01 | 4      |             |             | 12:15     |             | X  | X         | X   | Hold     |
| 6      | SB-39-0-2-01 |        |             |             | 12:00     |             | X  | X         | X   | Hold     |
| 7      | SB-40-0-2-01 | 11     |             |             | 11:35     |             | X  | X         | X   | Hold     |

*Time Zone (Circle): EST CST MST PST Metric: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

**REPORT LEVEL / QC REQUIRED**

- Summary
- Standard QC
- Level II
- Standard QC
- Level III
- Standard QC + forms
- Level IV
- Standard QC + forms + raw

**PRESERVATION KEY**

- HO
- HNO3
- H2SO4
- HCl
- NaOH
- NaOH
- Acetate
- Na2SO4
- 7°C
- Other

**NOTES**

- Do not test for carbonate
- Samples for archive.
### 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.

<table>
<thead>
<tr>
<th>PROJECT NAME</th>
<th>SITE ID</th>
<th>SAMPLER</th>
<th>TURNAROUND TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rocky Flats Trails (FW5)</td>
<td>STD</td>
<td>EH, SK</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COMPANY NAME</th>
<th>BILL TO COMPANY</th>
<th>INVOICE ATTN TO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Analytics</td>
<td></td>
<td>Same</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ADDRESS</th>
<th>PHONE</th>
<th>FAX</th>
<th>E-MAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1600 Specht Point Rd., Ste. 209 Fort Collins, CO 80525</td>
<td>(970) 489-3111</td>
<td></td>
<td><a href="mailto:JAndrews@Enganalytics.com">JAndrews@Enganalytics.com</a></td>
</tr>
</tbody>
</table>

| LAB ID | FIELD ID | MATRIX | SAMPLE DATE | SAMPLE TIME | # OF BOTTLES | PRESERVATIVE | GC | A | B | C | D | E | F | G | H | I | J | SEE NOTES |
|--------|----------|--------|-------------|-------------|--------------|--------------|----|---|---|---|---|---|---|---|---|---|------------|
| 13     | SB-41-0-2-01  | 5      | 6/28/11    | 120         | 1            | None         | XXX|   |   |   |   |   |   |   |   |   | Hold      |
| 14     | SB-42-0-2-01  | 5      | 10/55       | 120         | 1            | None         | XXX|   |   |   |   |   |   |   |   |   | Hold      |
| 15     | SB-43-0-2-01  | 5      | 10/55       | 120         | 1            | None         | XXX|   |   |   |   |   |   |   |   |   | Hold      |
| 16     | SB-44-0-2-01  | 5      | 10/55       | 120         | 1            | None         | XXX|   |   |   |   |   |   |   |   |   | Hold      |
| 17     | SB-45-0-2-01  | 5      | 10/25       | 120         | 1            | None         | XXX|   |   |   |   |   |   |   |   |   | Hold      |
| 18     | SB-46-0-2-01  | 5      | 10/55       | 120         | 1            | None         | XXX|   |   |   |   |   |   |   |   |   | Hold      |

*Time Zone (Circle): EST CST MST PST  Marks: O = oil  S = soil  NS = non-soil solid  W = water  L = liquid  E = extract  F = filter

**Notes**

- Do not test for carbonate fusion.
- Hold all for archive.

**Preservation Key**

1-H2O 2-HNO3 3-H2SO4 4-NaCl 5-NaOH 6-Acetate 7-NaHCO3 7-4°C 8-Other

**Form 2029**

**Signature**

- Emily Lyons
- Steven Keller

**Printed Name**

- Emily Lyons
- Steven Keller

**Date**

- 06/28/19
- 06/30/19

**Time**

- 1600
**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.

<table>
<thead>
<tr>
<th><strong>PROJECT NAME</strong></th>
<th><strong>SITE ID</strong></th>
<th><strong>PARAMETER/METHOD REQUEST FOR ANALYSIS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rocky Flats Trails (FWS)</td>
<td>STD</td>
<td>AM-241, V-234, 235, 238, ALS SOP 714</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>COMPANY NAME</strong></th>
<th><strong>BILL TO COMPANY</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Analyti</td>
<td>Same</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>ADDRESS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>600 Special Visit Rd.</td>
</tr>
<tr>
<td>Fort Collins, CO 80525</td>
</tr>
</tbody>
</table>

| **PHONE** | | **FAX** | | **E-MAIL** |
|-----------|------------|----------|----------------|
| (970) 488-3111 | | | JAndrews@enganalytix.com |

<table>
<thead>
<tr>
<th><strong>LAB ID</strong></th>
<th><strong>FIELD ID</strong></th>
<th><strong>MATRIX</strong></th>
<th><strong>SAMPLE DATE</strong></th>
<th><strong>SAMPLE TIME</strong></th>
<th><strong># OF BOTTLES</strong></th>
<th><strong>PRESERVATIVE</strong></th>
<th><strong>QC</strong></th>
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</thead>
<tbody>
<tr>
<td>25</td>
<td>SB-47-0-2-01</td>
<td>S</td>
<td>6/28/19</td>
<td>0930</td>
<td>1</td>
<td>None</td>
<td>XXX</td>
</tr>
<tr>
<td>26</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot; -99</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>SB-48-0-2-01</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot; -99</td>
<td></td>
<td>0930</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>&quot; &quot; &quot; &quot; &quot; &quot; -99</td>
<td></td>
<td></td>
<td>0905</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>SB-38-0-2-02</td>
<td></td>
<td></td>
<td>1205</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>SB-34-0-2-03</td>
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<td></td>
<td>1505</td>
<td>3</td>
<td>HNO₃</td>
<td>XXX</td>
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<td>31</td>
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<td>6/28/19</td>
<td>1320</td>
<td>1</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

*Time Zone (Circle): EST CST MST PST Metric: O = oil, S = soil, NS = non-soil solid, W = liquid, E = extract, F = filter

**NOTES**

Do not test for carbonate. For carbonate samples for archiving.

**PRESERVATION KEY**

1 = HCl, 2 = HNO₃, 3 = H₂SO₄, 4 = NaOH, 5 = NaOH/Zn/acetate, 6 = NaH₂SO₄, 7-9 = Other
<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are airbills / shipping documents present and/or removable?</td>
<td>YES</td>
</tr>
<tr>
<td>Are custody seals on <strong>shipping</strong> containers intact?</td>
<td></td>
</tr>
<tr>
<td>Are custody seals on <strong>sample</strong> containers intact?</td>
<td></td>
</tr>
<tr>
<td>Is there a COC (chain-of-custody) present?</td>
<td>YES</td>
</tr>
<tr>
<td>Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)</td>
<td>YES</td>
</tr>
<tr>
<td>Are short-hold samples present?</td>
<td></td>
</tr>
<tr>
<td>Are all samples within holding times for the requested analyses?</td>
<td>NO</td>
</tr>
<tr>
<td>Were all sample containers received intact? (not broken or leaking)</td>
<td>NO</td>
</tr>
<tr>
<td>Is there sufficient sample for the requested analyses?</td>
<td>NO</td>
</tr>
<tr>
<td>Are all samples in the proper containers for the requested analyses?</td>
<td></td>
</tr>
<tr>
<td>Are all aqueous samples preserved correctly, if required? (excluding volatiles)</td>
<td>NO</td>
</tr>
<tr>
<td>Are all aqueous non-preserved samples pH 4-9?</td>
<td>NO</td>
</tr>
<tr>
<td>Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles &gt; 6 mm (1/4 inch) diameter? (i.e. size of green pea)</td>
<td>NO</td>
</tr>
<tr>
<td>Were the samples shipped on ice?</td>
<td>NO</td>
</tr>
<tr>
<td>Were cooler temperatures measured at 0.1-6.0°C?</td>
<td></td>
</tr>
</tbody>
</table>

**Cooler #:**

**Temperature (°C):**

**DOT Survey Acceptance Information**

**No. of custody seals on cooler:**

**External µR/hr reading:**

**Background µR/hr reading:**

Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? **YES / NO / NA**

* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/login.

The 507 jars all are -88 samples and the 40 are -01, -02

All client bottle ID's vs ALS lab ID's double-checked by: [Signature]

If applicable, was the client contacted? **YES / NO / NA** Contact: [Signature]

Project Manager Signature / Date: [Signature] 4/29/19

*IR Gun #1, VWR SN 170560549
*IR Gun #3, VWR SN 170647571
*IR Gun #4, Oakton, SN 2372220101-0002
# Isotopic Uranium by Alpha Spectroscopy

**PAI 714 Rev 14**

**Method Blank Results**

---

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906768  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

---

**Sample Matrix:** WATER  
**Prep SOP:** PAI 778 Rev 16  
**Prep Batch:** AS190717-1  
**QC Batch ID:** AS190717-1-1  
**Final Alquot:** 1000 ml  
**Run ID:** AS190717-1UD  
**Result Units:** pCi/l

**Count Time:** 420 minutes  
**Date Analyzed:** 23-Jul-19  
**Date Collected:** 17-Jul-19  
**Sample Matrix:** WATER  
**Date Prepared:** 17-Jul-19  
**Prep Batch:** AS190717-1  
**Run ID:** AS190717-1UD  
**Result Units:** pCi/l  
**File Name:** Spectrum #1

## Target Nuclide Results

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.009 +/- 0.018</td>
<td>0.035</td>
<td>0.2</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>-0.002 +/- 0.018</td>
<td>0.027</td>
<td>0.2</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>-0.002 +/- 0.015</td>
<td>0.023</td>
<td>0.2</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

## Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.429</td>
<td>3.48</td>
<td>pCi/l</td>
<td>78.6</td>
<td>30 - 110 %</td>
</tr>
</tbody>
</table>

---

**Chemical Yield Summary**

**Control Limits:** 30 - 110 %

**Flag:** 

**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:** UR1906768-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
QCBatchID: AS190723-2
Run ID: AS190723-2UR
Result Units: pCi/g
File Name: Spectrum #1

Final Aliquot: 2.00 g
Count Time: 480 minutes

Prep Batch: AS190723-2
Prep SOP: PAI 778 Rev 16
Date Collected: 23-Jul-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

CASNO  Target Nuclide  Result +/- 2 s TPU  MDC  Requested MDC  DL  Lab Qualifier
13966-29-5  U-234  0.018 +/- 0.013  0.016  0.1  NA  B3
15117-96-1  U-235  -0.0011 +/- 0.0086  0.0133  0.1  NA  U
7440-61-1  U-238  -0.0027 +/- 0.0073  0.0158  0.1  NA  U

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>2.287</td>
<td>1.85</td>
<td>pCi/g</td>
<td>80.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906768-1
**Isotopic Uranium by Alpha Spectroscopy**

**PAI 714 Rev 14**

**Method Blank Results**

---

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906768  
**Client Name:** Engineering Analytics  
**ClientProject ID:** Rocky Flats Trails (FWS) 110876

---

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Prep Batch:** AS190723-3  
**QCBatchID:** AS190723-3-1  
**Final Aliquot:** 2.00 g  
**Count Time:** 420 minutes  
**Result Units:** pCi/g  
**File Name:** Spectrum #1

---

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.0075 +/- 0.0087</td>
<td>0.0121</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.0025 +/- 0.0093</td>
<td>0.0067</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.0042 +/- 0.0079</td>
<td>0.0057</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

---

**Chemical Yield Summary**

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>2.287</td>
<td>1.73</td>
<td>pCi/g</td>
<td>75.6</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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**Comments:**

<table>
<thead>
<tr>
<th>Qualifiers/Flags:</th>
<th>Abbreviations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>TPU - Total Propagated Uncertainty</td>
</tr>
<tr>
<td>Y1</td>
<td>MDC - Sample specific Minimum Detectable Concentration</td>
</tr>
<tr>
<td>Y2</td>
<td>BDL - Below Detection Limit</td>
</tr>
<tr>
<td>M</td>
<td>Requested MDC not met.</td>
</tr>
<tr>
<td>B</td>
<td>Analyte concentration greater than MDC.</td>
</tr>
<tr>
<td>B3</td>
<td>Analyte concentration greater than MDC but less than Requested MDC.</td>
</tr>
<tr>
<td>DL</td>
<td>Decision Level</td>
</tr>
</tbody>
</table>

**Data Package ID:** UR1906768-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Lab ID: AS190717-1-LCS
Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190717-1
Final Aliquot: 1000 ml
QC Batch ID: AS190717-1-1
Run ID: AS190717-1UD
Count Time: 420 minutes
File Name: Spectrum #1

Date Analyzed: 23-Jul-19
Date Collected: 17-Jul-19
Date Prepared: 17-Jul-19
Date Analyzed: 23-Jul-19
Prep Batch: AS190717-1
Run ID: AS190717-1UD
Count Time: 420 minutes
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

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.429</td>
<td>3.56</td>
<td>pCi/l</td>
<td>80.4</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 the reported activity is greater than the reported MDC.

Abbreviations:
- TPU - Total Propagated Uncertainty
- MDC - Minimum Detectable Concentration

Data Package ID: UR1906768-1

Date Printed: Monday, August 12, 2019
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Lab ID: AS190717-1LCSD
Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Date Collected: 17-Jul-19
Prep Batch: AS190717-1
Date Prepared: 17-Jul-19
QC Batch ID: AS190717-1-1
Date Analyzed: 23-Jul-19
Run ID: AS190717-1UD
Final Aliquot: 1000 ml
Count Time: 420 minutes
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>4.43 +/- 0.75</td>
<td>0.03</td>
<td>4.220</td>
<td>105</td>
<td>82 - 122</td>
<td>P</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>4.67 +/- 0.79</td>
<td>0.02</td>
<td>4.382</td>
<td>107</td>
<td>78 - 126</td>
<td>P</td>
</tr>
</tbody>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.429</td>
<td>4.02</td>
<td>pCi/l</td>
<td>90.8</td>
<td>30 - 110 %</td>
<td></td>
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</table>

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 the reported activity is greater than the reported MDC.

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Minimum Detectable Concentration

Data Package ID: UR1906768-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Final Aliquot: 2.00 g
Count Time: 480 minutes
File Name: Spectrum #1

Date Analyzed: 06-Aug-19
Date Collected: 23-Jul-19
Date Prepared: 23-Jul-19
Date Analyzed: 23-Jul-19
Prep Batch: AS190723-2
Run ID: AS190723-2UR
Result Units: pCi/g

Chemical Yield Summary

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Results +/- 2s TPU</th>
<th>MDC</th>
<th>Spike Added</th>
<th>% Rec</th>
<th>Control Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>2.17 +/- 0.37</td>
<td>0.01</td>
<td>2.110</td>
<td>103</td>
<td>82 - 122</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>2.40 +/- 0.40</td>
<td>0.02</td>
<td>2.191</td>
<td>109</td>
<td>82 - 122</td>
</tr>
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</table>

Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>2.287</td>
<td>1.80</td>
<td>pCi/g</td>
<td>78.5</td>
<td>30 - 110 %</td>
</tr>
</tbody>
</table>

Qualifiers/Flags:

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 the reported activity is greater than the reported MDC.

Abbreviations:

TPU - Total Propagated Uncertainty
MDC - Minimum Detectable Concentration

Data Package ID: UR1906768-1
## Isotopic Uranium by Alpha Spectroscopy

**PAI 714 Rev 14**  
**Laboratory Control Sample(s)**

| Lab Name: | ALS -- Fort Collins |
| Work Order Number: | 1906768 |
| Client Name: | Engineering Analytics |
| Client Project ID: | Rocky Flats Trails (FWS) 110876 |

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 23-Jul-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 08-Aug-19  
**Final Aliquot:** 2.00 g  
**Count Time:** 360 minutes  
**Result Units:** pCi/g  
**File Name:** Spectrum #1

### CASNO | Target Nuclide | Results +/- 2s TPU | MDC | Spike Added | % Rec | Control Limits | Lab Qualifier |
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>2.15 +/- 0.38</td>
<td>0.02</td>
<td>2.110</td>
<td>102</td>
<td>82 - 122</td>
<td>P</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>2.26 +/- 0.40</td>
<td>0.02</td>
<td>2.191</td>
<td>103</td>
<td>82 - 122</td>
<td>P</td>
</tr>
</tbody>
</table>

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>2.287</td>
<td>1.72</td>
<td>pCi/g</td>
<td>75.1</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

### Comments:

<table>
<thead>
<tr>
<th>Qualifiers/Flags:</th>
<th>Abbreviations:</th>
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</thead>
<tbody>
<tr>
<td>U - Result is less than the sample specific MDC.</td>
<td>TPU - Total Propagated Uncertainty</td>
</tr>
<tr>
<td>Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.</td>
<td>MDC - Minimum Detectable Concentration</td>
</tr>
<tr>
<td>Y2 - Chemical Yield outside default limits.</td>
<td></td>
</tr>
<tr>
<td>L - LCS Recovery below lower control limit.</td>
<td></td>
</tr>
<tr>
<td>H - LCS Recovery above upper control limit.</td>
<td></td>
</tr>
<tr>
<td>P - LCS Recovery within control limits.</td>
<td></td>
</tr>
<tr>
<td>M - The requested MDC was not met.</td>
<td></td>
</tr>
<tr>
<td>M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.</td>
<td></td>
</tr>
</tbody>
</table>

**Data Package ID:** UR1906768-1
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
Client Project ID: Rocky Flats Trails (FWS) 110876

---

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Analyte</th>
<th>Sample Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>Duplicate Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>DER</th>
<th>DER Lim</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>1.14 +/- 0.25</td>
<td>0.05</td>
<td></td>
<td>0.97 +/- 0.21</td>
<td>0.04</td>
<td></td>
<td>0.518</td>
<td>2.13</td>
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<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.040 +/- 0.034</td>
<td>0.018</td>
<td></td>
<td>0.071 +/- 0.041</td>
<td>0.030</td>
<td></td>
<td>0.58</td>
<td>2.13</td>
</tr>
<tr>
<td>7440-81-1</td>
<td>U-238</td>
<td>1.20 +/- 0.26</td>
<td>0.05</td>
<td></td>
<td>0.91 +/- 0.19</td>
<td>0.04</td>
<td></td>
<td>0.9</td>
<td>2.13</td>
</tr>
</tbody>
</table>

---

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
### Duplicate Sample Results (DER)

**Sample Matrix:** WATER  
**Prep SOP:** PAI 778 Rev 16  
**Final Aliquot:** 1000 ml  
**Prep Batch:** AS190717-1  
**Count Time:** 420 minutes  
**Prep Basis:** Unfiltered  
**Moisture(%):** NA  
**Result Units:** pCi/l  
**File Name:** Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Analyte</th>
<th>Sample Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>Duplicate Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Flags</th>
<th>DER</th>
<th>DER Lim</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>4.86 +/- 0.82</td>
<td>0.04</td>
<td>P</td>
<td>4.43 +/- 0.75</td>
<td>0.03</td>
<td>P</td>
<td>0.389</td>
<td>2.13</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>5.08 +/- 0.86</td>
<td>0.03</td>
<td>P</td>
<td>4.67 +/- 0.79</td>
<td>0.02</td>
<td>P</td>
<td>0.354</td>
<td>2.13</td>
</tr>
</tbody>
</table>

**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

**Data Package ID:** UR1906768-1

---

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906768  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Field ID: SB-35-0-2-01
Lab ID: 1906768-1

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 28-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Prep Batch: AS190723-2
QC Batch ID: AS190723-2-1
Run ID: AS190723-2UR
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.72 +/- 0.16</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.028 +/- 0.023</td>
<td>0.013</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.71 +/- 0.16</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.449</td>
<td>3.35</td>
<td>pCi/g</td>
<td>75.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906768-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

<table>
<thead>
<tr>
<th>Field ID:</th>
<th>SB-36-0-2-01</th>
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</thead>
<tbody>
<tr>
<td>Lab ID:</td>
<td>1906768-3</td>
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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: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2UR
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.90 +/- 0.20</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
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<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.061 +/- 0.038</td>
<td>0.015</td>
<td>0.1</td>
<td>NA</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.88 +/- 0.19</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
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Chemical Yield Summary

<table>
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<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.525</td>
<td>2.63</td>
<td>pCi/g</td>
<td>58.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
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</table>

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: UR1906768-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.906
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Prep Batch: AS190723-2
QCBatchID: AS190723-2-1
Run ID: AS190723-2UR
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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
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</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.89 +/- 0.20</td>
<td>0.05</td>
<td>0.1</td>
<td>NA</td>
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</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.064 +/- 0.043</td>
<td>0.042</td>
<td>0.1</td>
<td>NA</td>
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</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.82 +/- 0.19</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
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<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.377</td>
<td>2.54</td>
<td>pCi/g</td>
<td>58.0</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906768-1
Isotopic Uranium by Alpha Spectroscopy

Sample Results

Prep SOP: PAI 778 Rev 16
Final Aliquot: 1.02 g
Prep Batch: AS190723-2
Final Aliquot: 1.02 g
Prep Basis: Dry Weight
Final Aliquot: 1.02 g
Moisture(%): NA
Prep Basis: Dry Weight
Prep Basis: Dry Weight
Result Units: pCi/g
Result Units: pCi/g
File Name: Spectrum #1
Result Units: pCi/g

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.83 +/- 0.19</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.012 +/- 0.023</td>
<td>0.044</td>
<td>0.1</td>
<td>NA</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.76 +/- 0.18</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
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</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.471</td>
<td>2.60</td>
<td>pCi/g</td>
<td>58.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906768-1
## Isotopic Uranium by Alpha Spectroscopy

### PAI 714 Rev 14

### Sample Results

Lab Name: ALS -- Fort Collins  
Work Order Number: 1906768  
Client Name: Engineering Analytics  
Client Project ID: Rocky Flats Trails (FWS) 110876

<table>
<thead>
<tr>
<th>Field ID</th>
<th>Lab ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-39-0-2-01</td>
<td>1906768-9</td>
</tr>
</tbody>
</table>

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 28-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 06-Aug-19  
**Final Aliquot:** 1.07 g  
**Count Time:** 480 minutes  
**Report Basis:** Dry Weight

### Target Nuclide Results

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/− 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.98 +/− 0.21</td>
<td>0.05</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.024 +/− 0.025</td>
<td>0.032</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.99 +/− 0.21</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.268</td>
<td>2.68</td>
<td>pCi/g</td>
<td>62.9</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

### 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: **UR1906768-1**
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 28-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Prep Batch: AS190723-3
QC Batch ID: 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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.73 +/- 0.17</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.051 +/- 0.037</td>
<td>0.034</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.70 +/- 0.17</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.274</td>
<td>2.86</td>
<td>pCi/g</td>
<td>66.8</td>
<td>30 - 110%</td>
<td></td>
</tr>
</tbody>
</table>

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:** UR1906768-1
### Isotopic Uranium by Alpha Spectroscopy

**PAI 714 Rev 14**  
**Sample Results**

**Lab Name:** ALS -- Fort Collins  
**Work Order Number:** 1906768  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

---

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 28-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 06-Aug-19  
**Field ID:** SB-41-0-2-01  
**Lab ID:** 1906768-13

**Prep Batch:** AS190723-3  
**QC Batch ID:** AS190723-3-1  
**Run ID:** AS190723-3UD  
**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

---

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.73 +/- 0.17</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.043 +/- 0.033</td>
<td>0.017</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.78 +/- 0.18</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.530</td>
<td>2.96</td>
<td>pCi/g</td>
<td>65.3</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

---

### 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:** UR1906768-1

---

**Date Printed:** Monday, August 12, 2019  
**ALS -- Fort Collins**  
**LIMS Version:** 6.906
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 28-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19
Prep Batch: AS190723-3
QC Batch ID: AS190723-3-1
Run ID: AS190723-3-1D
Count Time: 420 minutes
Report Basis: Dry Weight
Final Alquot: 1.08 g
Prep Basis: Dry Weight
Moisture (%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.62 +/- 0.16</td>
<td>0.05</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.052 +/- 0.040</td>
<td>0.039</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.76 +/- 0.18</td>
<td>0.05</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.228</td>
<td>2.28</td>
<td>pCi/g</td>
<td>53.8</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906768-1
Isotopic Uranium by Alpha Spectroscopy

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Field ID: SB-43-0-2-01
Lab ID: 1906768-17
Prep Batch: AS190723-3
QCBatchID: AS190723-3-1
Date Collected: 28-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19
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 | 1.02 +/- 0.22 | 0.03 | 0.1 | NA | 
15117-96-1 | U-235 | 0.018 +/- 0.022 | 0.016 | 0.1 | NA | 
7440-61-1 | U-238 | 0.91 +/- 0.20 | 0.03 | 0.1 | NA | 

Chemical Yield Summary

| Carrier/Tracer | Amount Added | Result | Units | Yield | Control Limits | Flag |
|--- | --- | --- | --- | --- | --- | ---
| U-232 | 4.268 | 2.78 | pCi/g | 65.0 | 30 - 110 % | 

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC.
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Y2 - Chemical Yield outside default limits.
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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: UR1906768-1

Date Printed: Monday, August 12, 2019
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-44-0-2-01
Lab ID: 1906768-19

Sample Matrix: SOIL
Prep SOP: PAI 778 Rev 16
Date Collected: 28-Jun-19
Date Prepared: 23-Jul-19
Date Analyzed: 06-Aug-19

Prep Batch: AS190723-3
QCBatchID: AS190723-3-1
Run ID: AS190723-3UD
Count Time: 420 minutes
Report Basis: Dry Weight

Final Aliquot: 1.04 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.85 +/- 0.18</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
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<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.040 +/- 0.029</td>
<td>0.013</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.86 +/- 0.18</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
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</tbody>
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Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.406</td>
<td>3.45</td>
<td>pCi/g</td>
<td>78.3</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906768-1

Date Printed: Monday, August 12, 2019
## Isotopic Uranium by Alpha Spectroscopy

**Self Name:** ALS -- Fort Collins  
**Work Order Number:** 1906768  
**Client Name:** Engineering Analytics  
**Client Project ID:** Rocky Flats Trails (FWS) 110876

### Sample Results

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 28-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 06-Aug-19

**Final Aliquot:** 1.03 g  
**Count Time:** 420 minutes  
**Report Basis:** Dry Weight  
**File Name:** Spectrum #1

### Target Nuclides

<table>
<thead>
<tr>
<th>CASNO</th>
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<th>Result +/− 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.91 +/- 0.20</td>
<td>0.05</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.071 +/- 0.044</td>
<td>0.041</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.76 +/- 0.17</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

### Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.452</td>
<td>2.88</td>
<td>pCi/g</td>
<td>64.7</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

### 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:** UR1906768-1

---

**Date Printed:** Monday, August 12, 2019  
**LIMS Version:** 6.906
**Isotopic Uranium by Alpha Spectroscopy**

PAI 714 Rev 14

**Sample Results**

**Field ID:** SB-46-0-2-01  
**Lab ID:** 1906768-23

**Sample Matrix:** SOIL  
**Prep SOP:** PAI 778 Rev 16  
**Date Collected:** 28-Jun-19  
**Date Prepared:** 23-Jul-19  
**Date Analyzed:** 06-Aug-19

**Final Aliquot:** 1.02 g  
**Count Time:** 420 minutes  
**Lab Name:** Engineering Analytics  
**Client Name:** Rocky Flats Trails (FWS) 110876

**Prep Basis:** Dry Weight  
**Report Basis:** Dry Weight  
**File Name:** Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.88 +/- 0.23</td>
<td>0.05</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.055 +/- 0.050</td>
<td>0.056</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.78 +/- 0.21</td>
<td>0.08</td>
<td>0.1</td>
<td>NA</td>
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**Chemical Yield Summary**

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
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<tr>
<td>U-232</td>
<td>4.498</td>
<td>1.78</td>
<td>pCi/g</td>
<td>39.5</td>
<td>30 - 110 %</td>
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**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:** UR1906768-1

**Date Printed:** Monday, August 12, 2019  
**LIMS Version:** 6.906
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

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
QC Batch ID: AS190723-3-1
Run ID: AS190723-3UD
Count Time: 420 minutes
Report Basis: Dry Weight

Final Aliquot: 1.07 g
Lab Name: Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876
Work Order Number: 1906768
Field ID: SB-47-0-2-01
Lab ID: 1906768-25

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>1.14 +/- 0.25</td>
<td>0.05</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.040 +/- 0.034</td>
<td>0.018</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>1.20 +/- 0.26</td>
<td>0.05</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.265</td>
<td>2.40</td>
<td>pCi/g</td>
<td>56.2</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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: UR1906768-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Duplicate Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

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
OCBatchID: 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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.97 +/- 0.21</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.071 +/- 0.041</td>
<td>0.030</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.91 +/- 0.19</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.271</td>
<td>3.05</td>
<td>pCi/g</td>
<td>71.5</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

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 the reported 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: UR1906768-1

Date Printed: Monday, August 12, 2019
ALS -- Fort Collins
LIMS Version: 6.906
**Chemical Yield Summary**

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
<th>Amount Added</th>
<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.320</td>
<td>3.45</td>
<td>pCi/g</td>
<td>80.0</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

**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
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
Client Project ID: Rocky Flats Trails (FWS) 110876

Field ID: SB-38-0-2-02
Lab ID: 1906768-29

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
Report Basis: Dry Weight

Final Aliquot: 1.07 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.82 +/- 0.18</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.034 +/- 0.028</td>
<td>0.015</td>
<td>0.1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.85 +/- 0.19</td>
<td>0.05</td>
<td>0.1</td>
<td>NA</td>
<td></td>
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</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
<th>Carrier/Tracer</th>
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<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.258</td>
<td>2.84</td>
<td>pCi/g</td>
<td>66.8</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

Qualifiers/Flags:
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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:
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MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit
DL - Decision Level

Data Package ID: UR1906768-1
Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Sample Matrix: WATER
Prep SOP: PAI 778 Rev 16
Date Collected: 28-Jun-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

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.026 +/- 0.022</td>
<td>0.030</td>
<td>0.2</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>-0.002 +/- 0.017</td>
<td>0.026</td>
<td>0.2</td>
<td>NA</td>
<td>U</td>
</tr>
<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.004 +/- 0.014</td>
<td>0.010</td>
<td>0.2</td>
<td>NA</td>
<td>U</td>
</tr>
</tbody>
</table>

Chemical Yield Summary

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<tr>
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<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.429</td>
<td>3.66</td>
<td>pCi/l</td>
<td>82.6</td>
<td>30 - 110 %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

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Data Package ID: UR1906768-1

Date Printed: Monday, August 12, 2019
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 ALS -- Fort Collins

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Isotopic Uranium by Alpha Spectroscopy
PAI 714 Rev 14
Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1906768
Client Name: Engineering Analytics
ClientProject ID: Rocky Flats Trails (FWS) 110876

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
Report Basis: Dry Weight
Prep Basis: Dry Weight
Final Alquot: 1.03 g
Moisture(%): NA
Result Units: pCi/g
File Name: Spectrum #1

<table>
<thead>
<tr>
<th>CASNO</th>
<th>Target Nuclide</th>
<th>Result +/- 2 s TPU</th>
<th>MDC</th>
<th>Requested MDC</th>
<th>DL</th>
<th>Lab Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>13966-29-5</td>
<td>U-234</td>
<td>0.67 +/- 0.15</td>
<td>0.04</td>
<td>0.1</td>
<td>NA</td>
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<tr>
<td>15117-96-1</td>
<td>U-235</td>
<td>0.021 +/- 0.023</td>
<td>0.034</td>
<td>0.1</td>
<td>NA</td>
<td>U</td>
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<tr>
<td>7440-61-1</td>
<td>U-238</td>
<td>0.69 +/- 0.15</td>
<td>0.03</td>
<td>0.1</td>
<td>NA</td>
<td></td>
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</tbody>
</table>

Chemical Yield Summary

<table>
<thead>
<tr>
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<th>Result</th>
<th>Units</th>
<th>Yield</th>
<th>Control Limits</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-232</td>
<td>4.451</td>
<td>3.40</td>
<td>pCi/g</td>
<td>76.3</td>
<td>30 - 110 %</td>
<td></td>
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