# ZION STATION RESTORATION PROJECT
# FINAL STATUS SURVEY RELEASE RECORD

## NORTH HALF OF UNIT 2 CONTAINMENT

## SURVEY UNIT 12104

## REVISION 1

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## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ALARA | As Low As Reasonably Achievable |
| AMCG | Average Member of the Critical Group |
| BcDCGL | Base Case Soil Derived Concentration Guideline Level |
| CAD | Computer Assisted Design |
| CCDD | Clean Concrete Demolition Debris |
| C/LT | Characterization/License Termination |
| cpm | Counts per minute |
| DCGL | Derived Concentration Guideline Level |
| dpm | Disintegrations per minute |
| DQA | Data Quality Assessment |
| DQO | Data Quality Objective |
| EMC | Elevated Measurement Comparison |
| FSS | Final Status Survey |
| GPS | Global Positioning System |
| HTD | Hard-to-Detect |
| HSA | Historical Site Assessment |
| IC | Insignificant Contributor |
| LBGR | Lower Bound of the Gray Region |
| LTP | License Termination Plan |
| MARSSIM | Multi-Agency Radiation Survey and Site Investigation Manual |
| MDC | Minimum Detectable Concentration |
| MDCR | Minimum Detectable Count Rate |
| NAD | North American Datum |
| NaI | Sodium Iodide |
| OpDCGL | Operational Derived Concentration Guideline Level |
| OpSOF | Operational Sum of Fractions |
| ORISE | Oak Ridge Institute for Science and Education |
| QAPP | Quality Assurance Project Plan |

| | |
|---|---|
| QC | Quality Control |
| RE | Radiological Engineer |
| ROC | Radionuclides of Concern |
| SOF | Sum of Fractions |
| TEDE | Total Effective Dose Equivalent |
| TSD | Technical Support Document |
| UBGR | Upper Bound of the Gray Region |
| VSP | Visual Sample Plan |
| ZNPS | Zion Nuclear Power Station |
| ZSRP | Zion Station Restoration Project |

## 1. EXECUTIVE SUMMARY

This Final Status Survey (FSS) Release Record for Survey Unit 12104, the "North Half of Unit 2 Containment," has been generated for the Zion Station Restoration Project (ZSRP) in accordance with Zion*Solutions* procedure ZS-LT-300-001-005, *"Final Status Survey Data Reporting"* (Reference 1) and satisfies the requirements of Section 5.11 of the *"Zion Station Restoration Project License Termination Plan"* (LTP) (Reference 2).

An FSS package (L1-12104A-F) was developed in accordance with Zion*Solutions* procedure ZS-LT-300-001-001, *"Final Status Survey Package Development"* (Reference 3), the ZSRP LTP, and guidance from NUREG-1575, "*Multi-Agency Radiation Survey and Site Investigation Manual"* (MARSSIM) (Reference 4).

This open land survey unit has a MARSSIM classification of one. A survey plan was designed based upon use of the Sign Test as the nonparametric statistical test for compliance. Both the Type I (α) and Type II (β) decision error rates were set at 0.05. Seventeen (17) systematic surface soil samples were acquired from the survey unit. In addition, surface scanning was performed on 100% of the total surface area in the survey unit. No areas of elevated activity were detected during the scans. The analytical results for all soil samples taken in survey unit 12104 indicated that the Sum of Fractions (SOF) for each sample, when compared to the Operational Derived Concentration Guideline Levels (OpDCGL), was less than 1.0. The maximum Operational SOF (OpSOF) was 0.068. The mean OpSOF for the systematic samples was 0.034. The mean SOF (BcSOF), when the analytical results were compared to the Base Case DCGLs (BcDCGL), was 0.009, which results in a dose assigned to the survey unit of 0.215 mrem/year Total Effective Dose Equivalent (TEDE). Therefore, the null hypothesis is rejected and survey unit 12104 is acceptable for unrestricted release.

## 2. SURVEY UNIT DESCRIPTION

Survey unit 12104, described as "North Half of Unit 2 Containment," is a Class 1 open land survey unit and is 1,940m$^2$ in size. It is bounded on the west by survey unit 12202A, the south by survey unit 12105, the east by survey unit 12205A, and the north by survey units 12201A through 12201C.

The topography of the survey unit is mainly flat with some small dips and depressions. The soil is mostly sand.

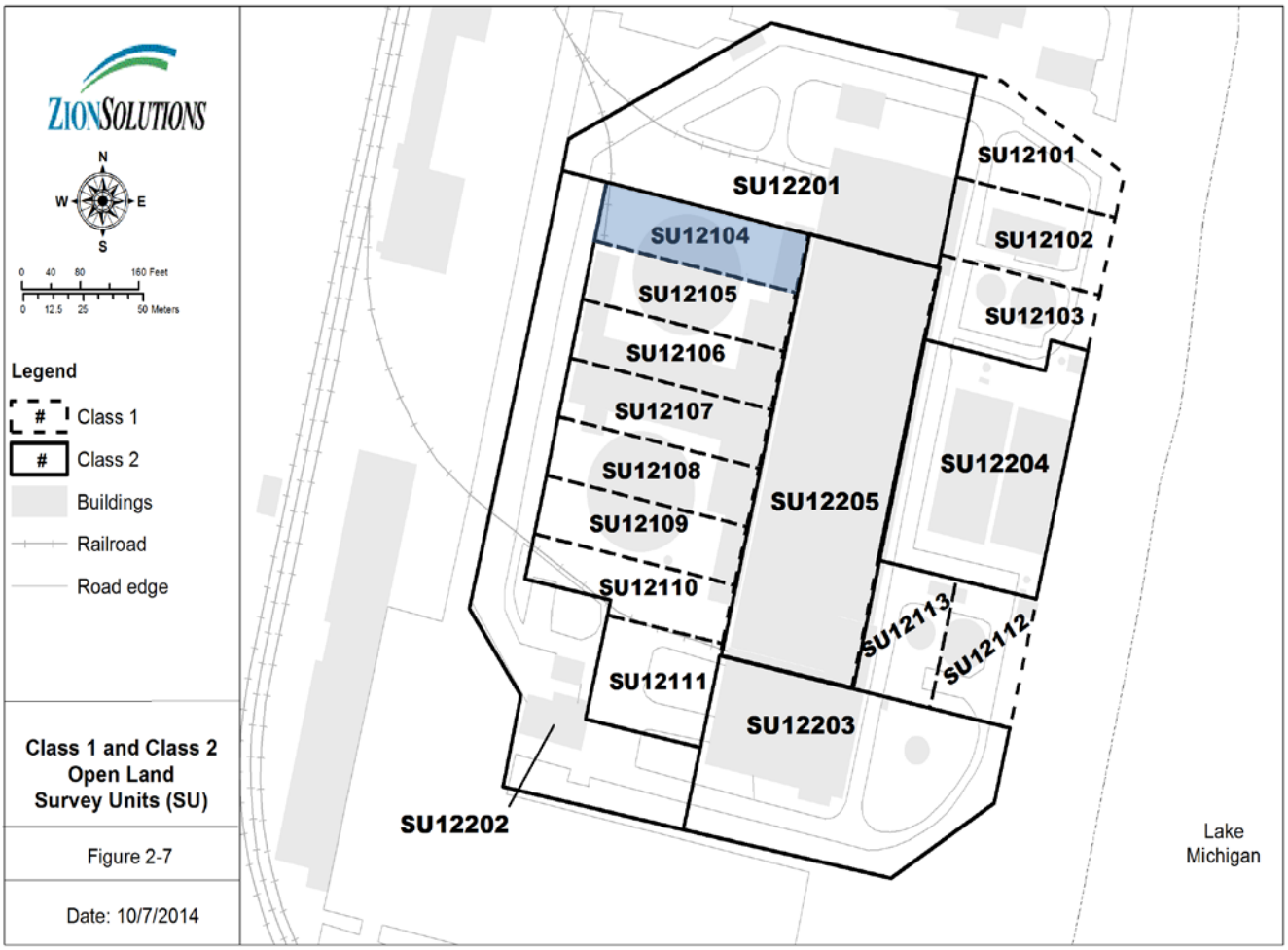
The boundary of the survey unit was defined using a Global Positioning System (GPS) based on the Illinois State Plane System North American Datum (NAD) 1983 East. The reference coordinates associated with the sample locations in this survey unit are presented in Table 8.

## 3. CLASSIFICATION BASIS

Survey unit 12104 was classified in accordance with Zion*Solutions* procedure ZS-LT-300-001-002, "*Survey Unit Classification*" (Reference 5).

The area encompassing this survey unit is made up of the southern halves of survey units 10103 and 10104 as identified in Figure 3 of the *"Zion Station Historical Site Assessment"* (HSA) (Reference 6). Subsequently, this area was designated by the LTP as survey unit 12104, a Class 1 open land survey unit, and described as the "Area Under and North of Unit 2 CTMT" in Table 2-31 of the LTP as represented in Figure 2-7 of the LTP; the figure is replicated below as Figure 1.

**Figure 1 - Class 1 and 2 Open Land Survey Units from Figure 2-7 of the LTP**




The HSA states that this area contained the footprint of the North Half of Unit 2 Containment, the East and West Main Power Transformers and the Diesel Fuel Tank – Tanker Connection Point. Also, the area between the FHB and Unit 2 Containment was a storage area for radwaste containers awaiting shipment. The HSA also notes that there were several instances of

contaminated materials being found in the area. The most significant occurrence was in 1979 when a contaminated trailer was found parked outside the Fuel Handling Building trackway door with contamination levels up to 300,000 disintegrations per minute (dpm) and a hot spot of 120 mrem/hr. The HSA also mentions that there were some spills of contaminated laundry water by the Auxiliary Building missile doors.

Characterization surveys of survey unit 12104 were performed in April of 2014. Sampling locations were limited as the majority of the ground surface in this survey unit was occupied by an above-grade structure (Unit 2 Containment and other miscellaneous structures) or covered by concrete or asphalt. The following data was obtained:

- One (1) judgmental surface sample.
- Nine (9) judgmental subsurface samples taken at three (3) locations to a depth of 3 meters composited over 1-meter increments.

Sodium Iodide (NaI) walkover scans were not performed as the background in the area was prohibitive due to the presence of radioactive materials in adjacent systems and stored packages.

The results of the characterization survey were:

- Cs-137 was positively detected in the surface soil sample at a concentration greater than the Minimum Detectable Concentration (MDC).
- The analysis of the nine (9) subsurface samples showed that the concentrations were less than MDC for the Radionuclides of Concern (ROC).

In August of 2018, ZSRP completed the demolition and backfill of the Auxiliary Building basement and Spent Fuel Pool. The next buildings that were slated for demolition were the Unit 1 and Unit 2 Containment domes. It was the intention of ZSRP to use the exterior concrete of the Unit 1 and Unit 2 Containment domes as Clean Concrete Demolition Debris (CCDD). However, for the concrete to be considered for use as CCDD, it was important to maintain the unrestricted release pedigree of the concrete. The 588-foot grade surface soils surrounding the two containments were identified as contaminated. While it was necessary to remediate the soils surrounding the Containments, the timeframe required was prohibitive at the time. Therefore, in lieu of remediating the exposed soil, a sacrificial layer of clean soil from off-site was placed over the contaminated indigenous surface soil with up to 1-½ feet of clean fill. Once the sacrificial layer was in place, the Containment dome structures were demolished without having to wait for the remediation to be completed. From August 2018 through December 2018, both Unit 1 and Unit 2 Containments were demolished and the resultant CCDD was removed from the area. After removal of the CCDD, the sacrificial soil was removed and the exposed 588-foot indigenous soils were scanned. The survey was performed under a Radiological Assessment, which required "100% scan of the soils exposed by the removal of the sacrificial layer" with an alarm set-point set at the Minimum Detectable Count Rate (MDCR) of the instrument plus background. Any

indication of elevated activity greater than the MDCR would then prompt investigation and remediation, as necessary.

From February 26, 2019, through June 18, 2019, scanning and remediation commenced south of Unit 1 and progressed to the north and west of the Containment footprints. Large areas of elevated activity were identified by scan and verified by soil sample analysis. The areas were marked. All soil identified as exceeding the OpDCGLs for subsurface soil was excavated and removed from the site as radioactive waste. Following excavation, post-remediation surveys were performed by scan and media sampling. The analysis of all post-remediation soil samples showed an OpSOF less than one when sample results were directly compared against the OpDCGLs for subsurface soils. However, all excavations remained open to allow the Oak Ridge Institute for Science and Education (ORISE) to perform confirmatory surveys of the exposed remediated soil.

ORISE performed confirmatory surveys of the exposed subsurface soils surrounding the Containments in August of 2019. Shortly thereafter, clean fill was acquired from an off-site source and used to increase the grade of all survey units surrounding any end-state basement to the 591-foot elevation. In accordance with LTP, Section 6.4.1, the end-state basements will be covered by at least three feet of clean soil and physically altered to a condition which would not realistically allow the remaining structures, if excavated, to be occupied.

A Radiological Engineer (RE) and a Characterization/License Termination (C/LT) Supervisor performed a visual inspection and walk-down of the survey unit on September 24, 2019, prior to performing FSS. The purpose of the walk-down was to assess the physical condition of the survey unit, evaluate access points and travel paths and identify potentially hazardous conditions. A final classification assessment was performed in accordance with procedure ZS-LT-300-001-002, "*Survey Unit Classification*" as part of the survey design for FSS. The assessment confirmed that survey unit 12104 was correctly classified as Class 1.

## 4. DATA QUALITY OBJECTIVES

FSS planning and design hinges on coherence with the Data Quality Objective (DQO) process to ensure, through compliance with explicitly defined inputs and boundaries, that the primary objective of the survey is satisfied. The DQO process, utilized in accordance with MARSSIM, is described in the ZSRP LTP. The appropriate design for a given survey is developed using the DQO process as outlined in Appendix D of MARSSIM.

The DQO process incorporated hypothesis testing and probabilistic sampling distributions to control decision errors during data analysis. Hypothesis testing is a process based on the scientific method that compares a baseline condition to an alternate condition. The baseline condition is technically known as the null hypothesis. Hypothesis testing rests on the premise that the null hypothesis is true and that sufficient evidence must be provided for rejection. In designing the survey plan, the underlying assumption, or null hypothesis, was that residual activity in the survey unit exceeded the release criteria. Rejection of the null hypothesis would indicate that

residual activity within the survey unit does not exceed the release criteria. Therefore, the survey unit would satisfy the primary objective of the FSS sample plan.

The primary objective of the FSS sample plan is to demonstrate that the level of residual radioactivity in survey unit 12104 does not exceed the release criteria specified in the LTP and that the potential dose from residual radioactivity is As Low As Reasonably Achievable (ALARA).

Zion*Solutions* Technical Support Document (TSD) 11-001, *"Technical Support Document for Potential Radionuclides of Concern During the Decommissioning of the Zion Station"* (Reference 7), established the basis for an initial suite of potential ROC for the decommissioning of the Zion Nuclear Power Station (ZNPS).

Zion*Solutions* TSD 14-019, *"Radionuclides of Concern for Soil and Basement Fill Model Source Terms"* (Reference 8), was written to refine the initial selection of ROC for decommissioning at the ZSRP. The list of ROC was evaluated using Containment and Auxiliary Building concrete core analysis data to evaluate the dose significance of each radionuclide in the end state model. Section 4.4 of TSD 14-019 evaluated the results of the characterization data of surveys taken of soils. The following conclusion was reached: *"The results of surface and subsurface soil characterization in the impacted area surrounding Zion indicate that there is minimal residual radioactivity in soil. Essentially all of the soil results were reported as non-detectable. Other than Cs-137 at very low levels, and Co-60 at a concentration of 0.24 pCi/g in one sample, the results for all radionuclides were less than MDC. Therefore, the direct determination of radionuclide mixture fractions for initial suite radionuclides in soil is not technically feasible due to the MDC biasing issues discussed above. Based on a generalized assumption that the contaminated water that caused concrete contamination would be similar to the source of soil contamination, the ROC and radionuclide mixture derived for the Auxiliary Building concrete was considered to be reasonably representative of soils for FSS planning and implementation.*"

The ROC for surface soils are listed in Table 1 below (from Table 5-2 of the LTP):

**Table 1 - Dose Significant Radionuclides and Mixture**

| Radionuclide | Auxiliary Building % of Total Activity (normalized)(1)(2) |
|---|---|
| Co-60 | 0.92% |
| Ni-63 | 23.71% |
| Sr-90 | 0.05% |
| Cs-134 | 0.01% |
| Cs-137 | 75.32% |

(1) Based on maximum percent of total activity from Table 20 of TSD 14-019, normalized to one for the dose significant radionuclides
(2) Does not include dose significant radionuclides for activated concrete (H-3, Eu-152, Eu-154).

A fundamental precursor to survey design is to establish a relationship between the release criteria and some measurable quantity. This is done through the development of DCGLs. The DCGLs represent average levels of radioactivity above background levels and are presented in terms of surface or mass activity concentrations. Chapter 6 of the LTP describes in detail the modeling used to develop the DCGLs for soils.

Surface soil is defined as soil residing in the first 0.15 m (6 inches) layer of soil. A subsurface soil category, which is defined as a layer of soil beginning at the surface but extending to a depth of 1 m, is also assessed to allow for flexibility in compliance demonstration if contamination deeper than 0.15 m is encountered. Site-specific DCGLs for soil were calculated for both the 0.15 m and 1 m thicknesses. Based on characterization data and historical information, there are no expectations of encountering a source term geometry that is comprised of a clean surface layer of soil over a contaminated subsurface soil layer. Zion*Solutions* TSD 14-011, *"Soil Area Factors"* (Reference 9) and LTP, Section 6.8 provide the exposure scenarios and modeling parameters that were used to calculate the site-specific DCGLs for soils (referred to as BcDCGL in this Release Record).

At ZNPS, compliance is demonstrated through the summation of dose from four distinct source terms (basements, soils, buried pipe and groundwater) for the end-state. Basements are comprised of the summation of four structural source terms (surfaces, embedded pipe, penetrations and fill). When applied to soil, the DCGLs are expressed in units of activity per unit of mass (pCi/g). The "unity rule" is applied when there is more than one ROC. The measurement results for each singular ROC present in the mixture are compared against their respective DCGL to derive a dose fraction.

The surface and subsurface soil BcDCGLs for the unrestricted release of open land survey units are listed in Tables 5-5 and 5-6 of the LTP and are provided in Table 2 and Table 3, respectively. The Insignificant Contributor (IC) dose percentage of 10% was used to adjust the DCGLs in soils to account for the dose from the eliminated IC radionuclides.

**Table 2 - Base Case DCGLs for Surface Soils ($BcDCGL_{SS}$)**

| Radionuclide | Surface Soil DCGL (pCi/g) |
|---|---|
| Co-60 | 4.26 |
| Cs-134 | 6.77 |
| Cs-137 | 14.18 |
| Ni-63 | 3,572.10 |
| Sr-90 | 12.09 |

**Table 3 - Base Case DCGLs for Subsurface Soils ($BcDCGL_{SB}$)**

| Radionuclide | Subsurface Soil DCGL (pCi/g) |
|---|---|
| Co-60 | 3.44 |
| Cs-134 | 4.44 |
| Cs-137 | 7.75 |
| Ni-63 | 763.02 |
| Sr-90 | 1.66 |

Each radionuclide-specific BcDCGL is equivalent to the level of residual radioactivity (above background levels) that could, when considered independently, result in a TEDE of 25 mrem/year to an Average Member of the Critical Group (AMCG). To ensure that the summation of dose from each source term is 25 mrem/year or less after all FSS is completed, the BcDCGLs are reduced based on an expected, or *a priori*, fraction of the 25 mrem/year dose limit from each source term. The reduced DCGLs, or "Operational" DCGLs, can be related to the BcDCGLs as an expected fraction of dose based on an *a priori* assessment of what the expected dose should be based on the results of site characterization, process knowledge and the extent of planned remediation. The OpDCGL is then used as the DCGL for the FSS design of the survey unit (calculation of surrogate DCGLs, investigations levels, etc.). Details of the OpDCGLs derived for each dose component and the basis for the applied *a priori* dose fractions are provided in Zion*Solutions* TSD 17-004, *"Operational Derived Concentration Guideline Levels for Final Status Survey"* (Reference 10).

The OpDCGLs for the FSS of surface and subsurface soils are listed in Tables 5-7 and 5-8 of the LTP and are presented in Table 4 and Table 5, respectively.

**Table 4 - Operational DCGLs for Surface Soils ($OpDCGL_{SS}$)**

| Radionuclide | Surface Soil DCGL (pCi/g) |
|---|---|
| Co-60 | 1.091 |
| Cs-134 | 1.733 |
| Cs-137 | 3.630 |
| Ni-63 | 914.458 |
| Sr-90 | 3.095 |

**Table 5 - Operational DCGLs for Subsurface Soils ($OpDCGL_{SB}$)**

| Radionuclide | Subsurface Soil DCGL (pCi/g) |
|---|---|
| Co-60 | 0.881 |
| Cs-134 | 1.137 |
| Cs-137 | 1.984 |
| Ni-63 | 195.333 |
| Sr-90 | 0.425 |

In accordance with NUREG-1757, Appendix G, if the HSA indicates that there is no likelihood of substantial subsurface residual radioactivity, subsurface surveys are not necessary. The HSA, as well as the results of the extensive characterization of subsurface soils in the impacted area surrounding the Zion facility have shown that there is minimal residual radioactivity in subsurface soil. Consequently, the ZSRP performed minimal subsurface sampling during FSS.

Instrument DQOs included a verification of the ability of the survey instrument to detect the radiation(s) of interest at the required scan MDC, which for Class 1 open land survey units, is the *a priori* Elevated Measurement Comparison DCGL ($DCGL_{EMC}$). Survey instrument response checks were required prior to issuance and after the instrument had been used. Control and accountability of survey instruments was required to ensure the quality and prevent the loss of data.

As part of the DQOs applied to laboratory processes, analysis results were reported as actual calculated results. The actual recorded value was used as the recorded FSS result for measurement and/or sample values that are less than MDC. Negative values were recorded as "zero." For radionuclides less than MDC, the value representing the highest abundance was

selected. Results were not reported as "less than MDC." Sample report summaries included unique sample identification, analytical method, radionuclide, result, uncertainty, laboratory data qualifiers, units, and the observed MDC.

In accordance with the LTP, for laboratory analysis, MDCs less than 10% of the OpDCGL were preferable while MDCs up to 50% of the OpDCGL were acceptable. The maximum acceptable MDC for measurements obtained using field instruments was the *a priori* $DCGL_{EMC}$, which was calculated using the methodology described in the LTP, Section 5.6.4.3.

## 5. SURVEY DESIGN

The level of effort associated with planning a survey is based on the complexity of the survey and nature of the hazards. Guidance for preparing FSS plans is provided in procedure ZS-LT-300-001-001, *"Final Status Survey Package Development."*

The DQO process determined that Co-60, Ni-63, Sr-90, Cs-134 and Cs-137 would be the ROC in survey unit 12104. During FSS, concentrations for Hard-to-Detect (HTD) ROC Ni-63 and Sr-90 are inferred using a surrogate approach. Cs-137 is the principle surrogate radionuclide for Sr-90 and Co-60 is the principle surrogate radionuclide for Ni-63. The mean, maximum and 95% Upper Confidence Level (UCL) of the surrogate ratios for concrete core samples taken in the Auxiliary Building basement were calculated in Zion*Solutions* TSD 14-019, *"Radionuclides of Concern for Soil and Basement Fill Model Source Terms,"* and are presented in Table 6. The maximum ratios were used in the surrogate calculations during FSS unless area specific ratios are determined by continuing characterization.

**Table 6 - Surrogate Ratios**

| Ratios | Auxiliary Building | | |
|---|---|---|---|
| | Mean | Max | 95%UCL |
| Ni-63/Co-60 | 44.143 | 180.450 | 154.632 |
| Sr-90/Cs-137 | 0.001 | 0.002 | 0.002 |

For the FSS of survey unit 12104, the surrogate OpDCGLs for Co-60 and Cs-137 were computed based on the maximum ratios from Table 6.

The equation for calculating a surrogate DCGL is as follows:

**Equation 1**

$$Surrogate_{DCGL} = \frac{1}{\left[\left(\frac{1}{DCGL_{Sur}}\right) + \left(\frac{R_2}{DCGL_2}\right) + \left(\frac{R_3}{DCGL_3}\right) + \cdots \left(\frac{R_n}{DCGL_n}\right)\right]}$$

Where: $DCGL_{Sur}$ = Surrogate radionuclide DCGL

| | | |
|---|---|---|
| $DCGL_{2,3...n}$ | = | DCGL for radionuclides to be represented by the surrogate |
| $R_n$ | = | Ratio of concentration (or nuclide mixture fraction) of radionuclide "n" to surrogate radionuclide |

Using the OpDCGLs for surface soils presented in Table 4 and the maximum ratios from Table 6, the following surrogate calculations for surface soils were performed:

**Equation 2**

$$Surrogate_{OpDCGL\ (Cs-137)} = \frac{1}{\left[\left(\frac{1}{3.630_{(Cs-137)}}\right) + \left(\frac{0.002}{3.095_{(Sr-90)}}\right)\right]} = 3.622\ pCi/g$$

The surrogate OpDCGL for surface soils that was used for Cs-137 in this survey unit for direct comparison of surface soil sample results to demonstrate compliance is 3.622 pCi/g.

**Equation 3**

$$Surrogate_{OpDCGL\ (Co-60)} = \frac{1}{\left[\left(\frac{1}{1.091_{(Co-60)}}\right) + \left(\frac{180.45}{914.458_{(Ni-63)}}\right)\right]} = 0.898\ pCi/g$$

The surrogate OpDCGL for surface soils that was used for Co-60 in this survey unit for direct comparison of surface soil sample results to demonstrate compliance is 0.898 pCi/g.

Using the BcDCGLs presented in Table 2 and the maximum ratios from Table 6, the following surrogate calculations were performed:

**Equation 4**

$$Surrogate_{BcDCGL\ (Cs-137)} = \frac{1}{\left[\left(\frac{1}{14.18_{(Cs-137)}}\right) + \left(\frac{0.002}{12.09_{(Sr-90)}}\right)\right]} = 14.15\ pCi/g$$

The surrogate BcDCGL for surface soils that was used for Cs-137 in this survey unit for calculating the $DCGL_{EMC}$ is 14.15 pCi/g.

**Equation 5**

$$Surrogate_{BcDCGL\ (Co-60)} = \frac{1}{\left[\left(\frac{1}{4.26_{(Co-60)}}\right) + \left(\frac{180.45}{3572.10_{(Ni-63)}}\right)\right]} = 3.51\ pCi/g$$

The surrogate BcDCGL for surface soils that was used for Co-60 in this survey unit for calculating the $DCGL_{EMC}$ is 3.51 pCi/g.

For this Class 1 open land survey unit, the "Investigation Levels" for area scanning and soil sample measurement results are those levels specified in LTP, Table 5-25, and are reproduced below in Table 7.

**Table 7 - Investigation Levels**

| Classification | Scan Investigation Levels | Direct Investigation Levels |
|---|---|---|
| Class 1 | >Operational DCGL or >$MDC_{scan}$ if $MDC_{scan}$ is greater than Operational DCGL | > Operational DCGL |

The $MDC_{scan}$ for the 2350-1/44-10 was calculated using the methodology of TSD-11-004, *"Ludlum Model 44-10 Detector Sensitivity"* (Reference 11) with the following parameters:

- background count rate of 5,000 counts per minute (cpm)
- scan speed of 0.5 m/sec
- distance from detector to surface of 2 inches
- isotopic mix of 95% Cs-137 and 5% Co-60

The calculated $MDC_{scan}$ value was 3.75 pCi/g, which was greater than the calculated Surrogate DCGLs, therefore the scan investigation level was set at the $MDC_{scan}$ of the 2350-1/44-10. The collimator was used during the scan surveys to lower the background count rate.

The Sign Test was selected as the non-parametric statistical test. The use of the Sign Test did not require the selection or use of a background reference area, which simplified survey design and implementation. This approach was conservative since it included background Cs-137 as part of the sample set.

The number of soil samples for FSS was determined in accordance with procedure ZS-LT-300-001-001 "*Final Status Survey Package Development*." The relative shift ($\Delta/\sigma$) for the survey unit data set is defined as shift ($\Delta$), which is the Upper Bound of the Gray Region (UBGR), or the DCGL (SOF of 1), minus the Lower Bound of the Gray Region (LBGR) (SOF of 0.5), divided by sigma ($\sigma$), which is the standard deviation of the data set used for survey design. The optimal value for $\Delta/\sigma$ should range between one and three. The largest value the $\Delta/\sigma$ can have is three. If the $\Delta/\sigma$ exceeds three, then the value of three will be used for $\Delta/\sigma$. For this survey design, a conservative estimate of the sample variability of 0.30 was used as the coefficient of variation to calculate $\Delta/\sigma$.

The calculated relative shift was 1.67. Both the Type I error, or $\alpha$ value and the Type II error, or $\beta$ value was set at 0.05. The sample size from Table 5.5 of MARSSIM that equates to the Type I and Type II error of 0.05 for use with the Sign Test is an N value of 17.

The computer program Visual Sample Plan (VSP) was used to generate the sample map, in accordance with ZS-LT-300-001-001. The map used was provided by the Survey

Mapping/Computer Assisted Design Specialist, with coordinates based on the Illinois State Plane NAD 1983 standard topographical grid coordinate system. The number of samples generated by VSP for a systematic triangular grid was 17. The Prospective Power Curve generated by VSP showed adequate power for the survey design.

In accordance with Section 5.6.4.3 of the LTP, the *a priori* $DCGL_{EMC}$ values were calculated for the gamma-emitting ROC to ensure that the $MDC_{scan}$ of the selected instrument was sufficient to detect small areas of elevated activity in the survey unit. The calculations were:

- To calculate the area bounded by the systematic samples: $A = \frac{A_{SU}}{N} = \frac{1940}{17} = 114.1\ m^2$
- From the LTP, Table 5-16, the Area Factors for the next larger area (300 $m^2$) were used:
  - Cs-137 - 1.46
  - Cs-134 - 1.30
  - Co-60 - 1.16
- The $DCGL_{EMC}$ is the Surrogate Base Case DCGL times the Area Factor:
  - The $DCGL_{EMC}$ for Cs-137 = $1.46 * 14.15 = 20.66\ pCi/g$
  - The $DCGL_{EMC}$ for Cs-134 = $1.30 * 6.77 = 8.80\ pCi/g$
  - The $DCGL_{EMC}$ for Co-60 = $1.16 * 3.51 = 4.07\ pCi/g$

The calculated $MDC_{scan}$, 3.75 pCi/g, is less than the $DCGL_{EMC}$ values calculated above; therefore, the spacing of the statistical systematic sampling and measurement locations was adequate to detect small areas of elevated radioactivity. No adjustment to the sample number was required.

The implementation of quality control measures as referenced by LTP, Section 5.9 and Zion*Solutions* ZS-LT-01, "*Quality Assurance Project Plan (for Characterization and FSS)*" (QAPP) (Reference 12) includes the collection of a soil sample for "split sample" analysis on 5% of the soil samples taken in a survey unit with the locations selected at random. One (1) surface soil sample (L1-12104A-FQGS-013-SS) was selected randomly for split sample analysis for the FSS of this survey unit.

In accordance with Section 5.7.1.6.2 of the LTP, a subsurface soil sample was taken at 10% of the systematic surface soil sample locations in the survey unit with the location(s) selected at random. Locations L1-12104A-FSGS-003-SB and L1-12104A-FSGS-007-SB were selected for this survey unit.

Section 5.3.4.4 of LTP Chapter 5 states that attempts shall be made to acquire subsurface soil samples from beneath each Containment basement foundation and the Auxiliary Building basement floor slab. The objective is to assess the radiological contamination of subsurface soils adjacent to and below these basement slabs. The LTP states that attempts shall be made to acquire a minimum of 2 subsurface soil samples from beneath each Containment basement foundation and the Auxiliary Building basement floor slab and, a minimum of 4 subsurface soil samples will be taken around each foundation from grade to the depth of approximately

55 feet or refusal, whichever is less. As part of this effort, two subsurface soil samples were taken in survey unit 12104 along the north side of Unit 2 Containment to a depth of 32 feet below grade, where refusal was met. Several attempts were made to acquire samples at a deeper depth and below the basement slab in survey unit 12104 however, the "mud-mat" placed around the Containment basement exterior during construction obstructed the Geoprobe® from acquiring samples at a deeper depth. Therefore, the required samples were acquired at the depth of refusal (32 feet below grade).

The locations of the seventeen (17) systematic samples and two (2) subsurface samples are listed in Table 8. Also included are the locations of the two (2) continuing characterization subsurface samples taken to assess the soils at depth (L1-12104L-CJGS-001-SB and L1-12104L-CJGS-002-SB, results in Table 13). A map of the systematic sample locations is included in Attachment 1.

**Table 8 - Systematic Sample Measurement Locations**

| MEASUREMENT ID | NORTHING (meters) | EASTING (meters) |
|---|---|---|
| L1-12104A-FSGS-001-SS | 641831.23 | 343654.29 |
| L1-12104A-FSGS-002-SS | 641831.23 | 343665.77 |
| L1-12104A-FSGS-003-SS | 641831.23 | 343677.25 |
| L1-12104A-FSGS-004-SS | 641831.23 | 343688.73 |
| L1-12104A-FSGS-005-SS | 641841.17 | 343614.11 |
| L1-12104A-FSGS-006-SS | 641841.17 | 343625.59 |
| L1-12104A-FSGS-007-SS | 641841.17 | 343637.07 |
| L1-12104A-FSGS-008-SS | 641841.17 | 343648.55 |
| L1-12104A-FSGS-009-SS | 641841.17 | 343660.03 |
| L1-12104A-FSGS-010-SS | 641841.17 | 343671.51 |
| L1-12104A-FSGS-011-SS | 641841.17 | 343682.99 |
| L1-12104A-FSGS-012-SS | 641851.11 | 343608.37 |
| L1-12104A-FSGS-013-SS | 641851.11 | 343619.85 |
| L1-12104A-FSGS-014-SS | 641851.11 | 343631.33 |
| L1-12104A-FSGS-015-SS | 641851.11 | 343642.81 |
| L1-12104A-FSGS-016-SS | 641851.11 | 343654.29 |
| L1-12104A-FSGS-017-SS | 641861.06 | 343614.11 |
| L1-12104A-FSGS-003-SB | 641831.23 | 343677.25 |
| L1-12104A-FSGS-007-SB | 641841.17 | 343637.07 |
| L1-12104L-CJGS-001-SB | 641851.56 | 343635.67 |
| L1-12104L-CJGS-002-SB | 641844.91 | 343660.99 |

ZSRP LTP, Section 5.1 states that soil samples will be collected during FSS to confirm the HTD to surrogate radionuclide ratios (provided in Table 6). Ten percent (10%) of the FSS samples collected from open land survey units will be analyzed for HTD ROC. Only HTD

radionuclides included as ROC (Ni-63 and Sr-90 for soils) will be analyzed in the FSS confirmatory samples. For soil samples with positive results for both a HTD ROC and the corresponding surrogate radionuclide (Cs-137 or Co-60), the HTD surrogate ratio will be derived and compared against the maximum ratio. The maximum ratios will be used unless specific survey information supports the use of a surrogate ratio that is specific to the area. In these cases, the survey unit-specific radiological data and the derived surrogate ratios will be submitted to the NRC for approval. If approved, then the survey unit-specific ratios used and the survey data serving as the basis for the surrogate ratios will be documented in the release record for the survey unit.

In addition, LTP, Section 5.1 states that if levels of residual gamma radioactivity in an individual soil sample exceed an OpSOF of 0.1, then the sample(s) will be analyzed for HTD ROC. None of the systematic samples or the subsurface samples taken at random exceeded an OpSOF of 0.1. For both subsurface soil samples taken at depth, no ROC were positively detected at concentrations greater than the instrument MDC. Higher MDC values resulted in an OpSOF greater than 0.1 when the MDC values were compared against the subsurface soil OpDCGLs. As no radioactive material was positively detected in the sample, no further actions were deemed necessary.

Two (2) soil samples, L1-12104A-FSGS-011-SS and L1-12104A-FSGS-013-SS, were selected to meet the requirement that 10% of the samples collected for the FSS of survey unit 12104 be analyzed for HTD ROC. These samples were selected based on exhibiting the highest OpSOF. Each sample was sent off-site (Eberline Analytical) for analysis of the HTD ROC as specified in LTP, Section 5.1. Eberline analytical reports are provided in Attachment 8.

Table 9 provides a synopsis of the survey design for survey unit 12104.

**Table 9 - Synopsis of Survey Design**

| FEATURE | DESIGN CRITERIA | BASIS |
|---|---|---|
| Survey Unit Area | 1,940 $m^2$ | GPS measurements of area |
| Number of Surface Soil Samples | 17 (Systematic) | • $\sigma = 0.30$<br>• UBGR = SOF of 1<br>• LBGR = SOF of 0.5<br>• Type I error = 0.05<br>• Type II error = 0.05<br>• $\Delta/\sigma = 1.67$<br>(MARSSIM Table 5.5) |
| Grid Spacing | 11.5 m | (LTP, Section 5.6.4.5.2) |
| DCGLs | • Co-60 – 1.091 pCi/g<br>• Cs-134 – 1.733 pCi/g<br>• Cs-137 – 3.630 pCi/g<br>• Ni-63 – 914.458 pCi/g<br>• Sr-90 – 3.095 pCi/g | Operational DCGLs for Surface Soils, (LTP, Table 5-7) |
| HTD ROC Analysis | A minimum of two (2) soil samples selected for HTD ROC analysis | (LTP, Section 5.1) |
| Measurement Investigation Level | Operational DCGL | (LTP, Table 5-25) |
| Scan Survey Area Coverage | 100% | (LTP, Table 5-24) |
| QC | One (1) systematic sample selected randomly for split sample analysis | (LTP, Section 5.9) |
| Number of Subsurface Soil Samples | Two (2) systematic surface soil sample locations 3 and 7 | (LTP, Section 5.7.1.6.2) |

## 6. SURVEY IMPLEMENTATION

Survey instructions for this FSS were incorporated into and performed in accordance with FSS sample plan L1-12104A-F, which was developed in accordance with Zion*Solutions* procedure ZS-LT-300-001-001, "*Final Status Survey Package Development*." The FSS unit was inspected and controlled in accordance with Zion*Solutions* procedure ZS-LT-300-001-003, "*Isolation and Control for Final Status Survey*" (Reference 13).

For survey unit 12104, compliance with the unrestricted release criteria was demonstrated through a combination of surface scanning with a Ludlum Model 44-10 gamma detector and the sampling of surface soil for isotopic analysis. In accordance with the LTP Chapter 5, two (2) subsurface samples were obtained and analyzed. Also, if during the performance of FSS, the analysis of a surface soil sample, or the results of a surface gamma scan indicated the potential presence of residual radioactivity at a concentration of 75% of the subsurface Operational DCGL, then a biased subsurface soil sample(s) would have been taken to the appropriate depth within the area of concern as part of the investigation. This threshold was not encountered during the FSS of survey unit 12104.

FSS field activities were conducted under FSS sample plan L1-12104A-F. A "Field Log" (ZS-LT-300-001-001, Attachment 14) was used to document field activities and other information pertaining to the performance of the FSS.

FSS field activities were projected to take four (4) working days to complete. Daily briefings were conducted to discuss the expectations for job performance and to review safety aspects of the job. The survey required field activities were performed during normal working hours starting on September 27, 2019, and concluding on October 1, 2019. The acquisition of the deep subsurface soil samples occurred between August 19, 2019 and August 23, 2019.

The seventeen (17) systematic surface soil sample locations were marked with flags based on GPS coordinates provided by VSP.

Gamma scans were performed on 100% of the surface area of the survey unit using a Ludlum 2350-1 paired with a Model 44-10 (2-inch x 2-inch) NaI detector operated in the rate-meter mode and using audio response. The probe was positioned within 2 inches of the ground and was moved at a scan speed of approximately 0.5 meters per second. No areas of elevated activity were detected on the scans. Daily, prior to and following use, each detector was subjected to an Operational Response Check in accordance with procedure ZS-RP-108-004-011, *"Operation of the Ludlum Model 2350-1 Data Logger"* (Reference 14). The daily Operational Response Check compared the background response and the response to a check source to ranges established for normal background and detector source response to ensure that the detector was working properly.

The instruments and detectors used for this survey are presented in Table 10. The instruments and detectors were verified to be properly calibrated prior to use.

**Table 10 - Instruments and Detectors**

| Instrument/Detector Type | Serial # | Calibration Due Date |
|---|---|---|
| Ludlum 2350-1/Ludlum 44-10 | 304708/PR321892 | 9/4/2020 |
| Ludlum 2350-1/Ludlum 44-10 | 304711/PR321902 | 1/18/2020 |
| Ludlum 2350-1/Ludlum 44-10 | 304726/PR363452 | 8/28/2020 |
| Ludlum 2350-1/Ludlum 44-10 | 304712/PR372143 | 9/9/2020 |

In accordance with the survey design, seventeen (17) surface soil samples were collected at the designated systematic sample points. Two (2) subsurface samples were collected at randomly selected sample locations. In addition, (2) subsurface soil samples were acquired at the maximum achievable depth of 32 feet below grade along the north exterior of Unit 2 Containment basement.

Two (2) samples (L1-12104A-FSGS-011-SS, and L1-12104A-FSGS-013-SS) were selected for HTD radionuclide analysis. One (1) surface soil sample (L1-12104A-FQGS-013-SS) was selected randomly for QC sample analysis.

## 7. SURVEY RESULTS

One hundred percent (100%) of the surface of the survey unit was scanned for elevated radiation levels. Eighty-six (86) 1-meter wide scan rows, as shown on the map in Attachment 1, were marked in the field and scanned with the 2350-1/44-10 using latching mode. Readings were recorded at approximately 10-meter intervals during the scans. No elevated measurement locations were identified by surface scan. Table 11 provides an overview of the scan results. Complete scan results are provided in Attachment 2.

**Table 11 - Synopsis of Scan Results**

| Scan Area | Highest Logged Reading (cpm) | Action Level(1) (cpm) | # of Scan Alarms | Investigation Samples |
|---|---|---|---|---|
| Row 1 | 2182 | 2760 | None | None |
| Row 2 | 2174 | 2760 | None | None |
| Row 3 | 2135 | 2760 | None | None |
| Row 4 | 2115 | 2760 | None | None |
| Row 5 | 2180 | 2760 | None | None |
| Row 6 | 2217 | 2760 | None | None |
| Row 7 | 2118 | 2760 | None | None |
| Row 8 | 2151 | 2760 | None | None |
| Row 9 | 2130 | 2760 | None | None |
| Row 10 | 2171 | 2760 | None | None |
| Row 11 | 2145 | 2760 | None | None |
| Row 12 | 2123 | 2760 | None | None |
| Row 13 | 2149 | 2760 | None | None |
| Row 14 | 2142 | 2760 | None | None |

**Table 11 (continued) - Synopsis of Scan Results**

| Scan Area | Highest Logged Reading (cpm) | Action Level[1] (cpm) | # of Scan Alarms | Investigation Samples |
|---|---|---|---|---|
| Row 15 | 2117 | 2760 | None | None |
| Row 16 | 2105 | 2760 | None | None |
| Row 17 | 2167 | 2760 | None | None |
| Row 18 | 2247 | 2834 | None | None |
| Row 19 | 2316 | 2834 | None | None |
| Row 20 | 2310 | 2834 | None | None |
| Row 21 | 2301 | 2834 | None | None |
| Row 22 | 2221 | 2834 | None | None |
| Row 23 | 2443 | 2837 | None | None |
| Row 24 | 2432 | 2837 | None | None |
| Row 25 | 2481 | 2837 | None | None |
| Row 26 | 2397 | 2837 | None | None |
| Row 27 | 2444 | 2837 | None | None |
| Row 28 | 2394 | 2837 | None | None |
| Row 29 | 2444 | 2837 | None | None |
| Row 30 | 2374 | 2837 | None | None |
| Row 31 | 2530 | 2837 | None | None |
| Row 32 | 2345 | 2837 | None | None |
| Row 33 | 2447 | 2837 | None | None |
| Row 34 | 2412 | 2837 | None | None |
| Row 35 | 2394 | 2837 | None | None |
| Row 36 | 2454 | 2837 | None | None |
| Row 37 | 2344 | 2837 | None | None |
| Row 38 | 2485 | 2837 | None | None |
| Row 39 | 2409 | 2837 | None | None |
| Row 40 | 2627 | 2883 | None | None |
| Row 41 | 2492 | 2883 | None | None |
| Row 42 | 2447 | 2883 | None | None |
| Row 43 | 2523 | 2883 | None | None |
| Row 44 | 2523 | 2883 | None | None |
| Row 45 | 2477 | 2873 | None | None |
| Row 46 | 2413 | 2873 | None | None |
| Row 47 | 2552 | 2873 | None | None |
| Row 48 | 2407 | 2873 | None | None |
| Row 49 | 2390 | 2873 | None | None |
| Row 50 | 2546 | 2873 | None | None |
| Row 51 | 2479 | 2873 | None | None |
| Row 52 | 2408 | 2873 | None | None |
| Row 53 | 2486 | 2873 | None | None |

**Table 11 (continued) - Synopsis of Scan Results**

| Scan Area | Highest Logged Reading (cpm) | Action Level(1) (cpm) | # of Scan Alarms | Investigation Samples |
|---|---|---|---|---|
| Row 54 | 2508 | 2873 | None | None |
| Row 55 | 2456 | 2873 | None | None |
| Row 56 | 2379 | 2873 | None | None |
| Row 57 | 2435 | 2873 | None | None |
| Row 58 | 2461 | 2873 | None | None |
| Row 59 | 2594 | 2873 | None | None |
| Row 60 | 2367 | 2873 | None | None |
| Row 61 | 2471 | 2909 | None | None |
| Row 62 | 2282 | 2753 | None | None |
| Row 63 | 2261 | 2753 | None | None |
| Row 64 | 2304 | 2753 | None | None |
| Row 65 | 2295 | 2753 | None | None |
| Row 66 | 2227 | 2753 | None | None |
| Row 67 | 2446 | 2753 | None | None |
| Row 68 | 2339 | 2753 | None | None |
| Row 69 | 2370 | 2753 | None | None |
| Row 70 | 2347 | 2753 | None | None |
| Row 71 | 2352 | 2753 | None | None |
| Row 72 | 2299 | 2753 | None | None |
| Row 73 | 2320 | 2753 | None | None |
| Row 74 | 2263 | 2753 | None | None |
| Row 75 | 2172 | 2753 | None | None |
| Row 76 | 2267 | 2753 | None | None |
| Row 77 | 2300 | 2753 | None | None |
| Row 78 | 2305 | 2753 | None | None |
| Row 79 | 2363 | 2753 | None | None |
| Row 80 | 2215 | 2753 | None | None |
| Row 81 | 2216 | 2753 | None | None |
| Row 82 | 2381 | 2753 | None | None |
| Row 83 | 2355 | 2753 | None | None |
| Row 84 | 2273 | 2753 | None | None |
| Row 85 | 2253 | 2753 | None | None |
| Row 86 | 2185 | 2753 | None | None |

1) The action level is based on the measurement Minimum Detectable Count Rate (MDCR) plus background in accordance with the FSS plan

The seventeen (17) soil samples taken for non-parametric statistical testing, the two (2) subsurface soil samples selected at random, and the two (2) subsurface soil samples taken at depth were analyzed using the on-site gamma spectroscopy system. Summaries of the sample analysis results are provided in Tables 12 and 13, respectively. The basic statistics for the

systematic sample population are summarized in Table 19. The gamma spectroscopy results revealed no samples with activity level above MDC for Cs-137, Co-60 or Cs-134. The concentrations for Ni-63 and Sr-90 were inferred based on the maximum ratios as specified in Table 6. The mean of the gamma spectroscopic analysis results for the sample population indicated that Cs-137 was present at levels lower than the concentrations of Cs-137 expected to be found in off-site soil in the vicinity of the ZNPS as presented in Zion*Solutions* TSD 13-004, "*Examination of Cs-137 Global Fallout In Soils At Zion Station*" (Reference 15). The complete gamma spectroscopy reports are presented in Attachment 7.

**Table 12 - Summary of Gamma Spectroscopy Results for Surface Soil Samples Comprising the Statistical Sample Population**

| MEASUREMENT ID | Co-60(1) (pCi/g) | Cs-134(1) (pCi/g) | Cs-137(1) (pCi/g) | Ni-63(2) (pCi/g) | Sr-90(2) (pCi/g) |
|---|---|---|---|---|---|
| L1-12104A-FSGS-001-SS | 0.00E+00 | 3.98E-02 | 7.66E-03 | 0.00E+00 | 1.53E-05 |
| L1-12104A-FSGS-002-SS | 1.05E-02 | 2.01E-02 | 0.00E+00 | 1.89E+00 | 0.00E+00 |
| L1-12104A-FSGS-003-SS | 4.35E-02 | 0.00E+00 | 4.36E-02 | 7.85E+00 | 8.72E-05 |
| L1-12104A-FSGS-004-SS | 0.00E+00 | 4.14E-02 | 2.06E-02 | 0.00E+00 | 4.12E-05 |
| L1-12104A-FSGS-005-SS | 0.00E+00 | 2.17E-02 | 4.02E-02 | 0.00E+00 | 8.04E-05 |
| L1-12104A-FSGS-006-SS | 2.70E-02 | 1.23E-02 | 0.00E+00 | 4.87E+00 | 0.00E+00 |
| L1-12104A-FSGS-007-SS | 4.24E-02 | 1.79E-03 | 0.00E+00 | 7.65E+00 | 0.00E+00 |
| L1-12104A-FSGS-008-SS | 3.50E-02 | 1.51E-02 | 3.02E-02 | 6.32E+00 | 6.04E-05 |
| L1-12104A-FSGS-009-SS | 3.72E-03 | 1.98E-02 | 6.19E-03 | 6.71E-01 | 1.24E-05 |
| L1-12104A-FSGS-010-SS | 2.49E-02 | 0.00E+00 | 0.00E+00 | 4.49E+00 | 0.00E+00 |
| L1-12104A-FSGS-011-SS | 5.14E-02 | 4.99E-03 | 1.60E-02 | 9.28E+00 | 3.20E-05 |
| L1-12104A-FSGS-012-SS | 1.94E-02 | 2.50E-03 | 0.00E+00 | 3.50E+00 | 0.00E+00 |
| L1-12104A-FSGS-013-SS | 4.29E-02 | 2.77E-02 | 1.71E-02 | 7.74E+00 | 3.42E-05 |
| L1-12104A-FSGS-014-SS | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| L1-12104A-FSGS-015-SS | 5.30E-03 | 2.44E-02 | 3.69E-02 | 9.56E-01 | 7.38E-05 |
| L1-12104A-FSGS-016-SS | 0.00E+00 | 9.98E-03 | 3.31E-02 | 0.00E+00 | 6.62E-05 |
| L1-12104A-FSGS-017-SS | 1.58E-02 | 1.36E-03 | 1.25E-02 | 2.85E+00 | 2.50E-05 |

Note: (1) Bold font indicates ROC positively detected at concentration greater than MDC.
(2) Ni-63 and Sr-90 are inferred concentrations using the maximum HTD ratio.

**Table 13 - Summary of Gamma Spectroscopy Results for Subsurface Soil Samples**

| MEASUREMENT ID | Co-60(1) (pCi/g) | Cs-134(1) (pCi/g) | Cs-137(1) (pCi/g) | Ni-63(2) (pCi/g) | Sr-90(2) (pCi/g) |
|---|---|---|---|---|---|
| L1-12104A-FSGS-003-SB | 1.15E-02 | 3.81E-02 | 1.55E-02 | 2.08E+00 | 3.10E-05 |
| L1-12104A-FSGS-007-SB | 2.91E-02 | 5.06E-04 | 0.00E+00 | 5.25E+00 | 0.00E+00 |
| L1-12104L-CJGS-001-SB | 6.47E-02 | 6.77E-02 | 5.98E-02 | 1.17E+01 | 1.20E-04 |
| L1-12104L-CJGS-002-SB | 7.64E-02 | 1.06E-01 | 9.96E-02 | 1.38E+01 | 1.99E-04 |

Note: (1) Bold font indicates ROC positively detected at concentration greater than MDC.
(2) Ni-63 and Sr-90 are inferred concentrations using the maximum HTD ratio.

The off-site laboratory, Eberline Analytical, processed the two (2) samples selected for HTD ROC analysis. Samples L1-12104A-FSGS-011-SS-A and L1-12104A-FSGS-013-SS-A were selected. Only HTD radionuclides included as ROC (Ni-63 and Sr-90 for soils) were included in the analysis. All analyses met the required MDC. No activity was positively detected in either of the samples at a concentration greater than MDC. Consequently, comparison of existing ratios versus the maximum ratios from Table 6 was not required. The off-site analysis results are provided in Table 14.

**Table 14 - Off-Site Analysis Results**

**Sample # L1-12104A-FSGS-011-SS-A**

| ROC | Result (pCi/g) | Uncertainty (pCi/g) | MDC (pCi/g) | >MDC |
|---|---|---|---|---|
| Co-60 | -1.09E-03 | 5.32E-03 | 5.49E-03 | No |
| Cs-134 | 1.49E-04 | 1.29E-03 | 5.78E-03 | No |
| Cs-137 | 2.17E-03 | 3.38E-03 | 5.82E-03 | No |
| Ni-63 | 9.68E-01 | 1.85E+00 | 3.14E+00 | No |
| Sr-90 | 3.74E-01 | 2.89E-01 | 5.72E-01 | No |

**Sample # L1-12104A-FSGS-013-SS-A**

| ROC | Result (pCi/g) | Uncertainty (pCi/g) | MDC (pCi/g) | >MDC |
|---|---|---|---|---|
| Co-60 | -7.45E-03 | 4.03E-02 | 5.08E-02 | No |
| Cs-134 | 1.05E-02 | 1.76E-02 | 5.26E-02 | No |
| Cs-137 | 1.25E-02 | 3.38E-02 | 5.08E-02 | No |
| Ni-63 | -6.24E-01 | 2.13E+00 | 3.71E+00 | No |
| Sr-90 | 2.44E-01 | 3.04E-01 | 6.22E-01 | No |

The implementation of survey specific QC measures included the collection of one (1) systematic sample (L1-12104A-FQGS-013-SS) for "split sample" analysis. The on-site laboratory analyzed the designated QC sample using the on-site gamma spectroscopy system. Gamma spectroscopy results (summarized in Table 15) indicate that concentrations for Cs-137, Co-60 and Cs-134 were

less than MDC in the sample. The concentration for Ni-63 and Sr-90 are inferred based on the maximum ratios as specified in Table 6.

**Table 15 - Summary of Gamma Spectroscopy Results for QC Surface Soil Sample**

| MEASUREMENT ID | Co-60(1) (pCi/g) | Cs-134(1) (pCi/g) | Cs-137(1) (pCi/g) | Ni-63(2) (pCi/g) | Sr-90(2) (pCi/g) |
|---|---|---|---|---|---|
| L1-12104A-FQGS-013-SS | 5.03E-03 | 1.30E-03 | 3.77E-02 | 9.08E-01 | 7.54E-05 |

Note: (1) Bold font indicates ROC positively detected at concentration greater than MDC.
(2) Ni-63 and Sr-90 are inferred concentrations using the maximum HTD ratio.

The SOF or "unity rule" is the mathematical test used to evaluate compliance with radiological criteria for license termination when more than one radionuclide has been determined to be potentially present. The equation for the unity rule is:

**Equation 6**

$$\frac{C_1}{DCGL_1} + \frac{C_2}{DCGL_2} + \ldots\ldots \frac{C_n}{DCGL_n} \leq 1$$

Where: $C_n$ = concentration of radionuclide $n$

$DCGL_n$ = DCGL of radionuclide $n$.

The results of the unity rule calculations for the ROC in the systematic sample population when compared against the OpDCGLs for surface soils for survey unit 12104 are provided in Table 16. The results of the unity rule calculations for the ROC for the subsurface samples are provided in Table 17, and the results for the QC samples are presented in Table 18.

**Table 16 - Sum of Fractions for Systematic Surface Soil Samples compared to the OpDCGLs**

| MEASUREMENT ID | Fraction of the OpDCGLs for Surface Soils | | | | | OpSOF |
|---|---|---|---|---|---|---|
| | Co-60 | Cs-134 | Cs-137 | Ni-63 | Sr-90 | |
| L1-12104A-FSGS-001-SS | 0.00E+00 | 2.30E-02 | 2.11E-03 | 0.00E+00 | 4.95E-06 | 0.025 |
| L1-12104A-FSGS-002-SS | 9.62E-03 | 1.16E-02 | 0.00E+00 | 2.07E-03 | 0.00E+00 | 0.023 |
| L1-12104A-FSGS-003-SS | 3.99E-02 | 0.00E+00 | 1.20E-02 | 8.58E-03 | 2.82E-05 | 0.060 |
| L1-12104A-FSGS-004-SS | 0.00E+00 | 2.39E-02 | 5.67E-03 | 0.00E+00 | 1.33E-05 | 0.030 |
| L1-12104A-FSGS-005-SS | 0.00E+00 | 1.25E-02 | 1.11E-02 | 0.00E+00 | 2.60E-05 | 0.024 |
| L1-12104A-FSGS-006-SS | 2.47E-02 | 7.10E-03 | 0.00E+00 | 5.33E-03 | 0.00E+00 | 0.037 |
| L1-12104A-FSGS-007-SS | 3.89E-02 | 1.03E-03 | 0.00E+00 | 8.37E-03 | 0.00E+00 | 0.048 |
| L1-12104A-FSGS-008-SS | 3.21E-02 | 8.71E-03 | 8.32E-03 | 6.91E-03 | 1.95E-05 | 0.056 |
| L1-12104A-FSGS-009-SS | 3.41E-03 | 1.14E-02 | 1.71E-03 | 7.34E-04 | 4.00E-06 | 0.017 |
| L1-12104A-FSGS-010-SS | 2.28E-02 | 0.00E+00 | 0.00E+00 | 4.91E-03 | 0.00E+00 | 0.028 |
| L1-12104A-FSGS-011-SS | 4.71E-02 | 2.88E-03 | 4.41E-03 | 1.01E-02 | 1.03E-05 | 0.065 |
| L1-12104A-FSGS-012-SS | 1.78E-02 | 1.44E-03 | 0.00E+00 | 3.83E-03 | 0.00E+00 | 0.023 |
| L1-12104A-FSGS-013-SS | 3.93E-02 | 1.60E-02 | 4.71E-03 | 8.47E-03 | 1.11E-05 | 0.068 |
| L1-12104A-FSGS-014-SS | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.000 |
| L1-12104A-FSGS-015-SS | 4.86E-03 | 1.41E-02 | 1.02E-02 | 1.05E-03 | 2.38E-05 | 0.030 |
| L1-12104A-FSGS-016-SS | 0.00E+00 | 5.76E-03 | 9.12E-03 | 0.00E+00 | 2.14E-05 | 0.015 |
| L1-12104A-FSGS-017-SS | 1.45E-02 | 7.85E-04 | 3.44E-03 | 3.12E-03 | 8.08E-06 | 0.022 |

**Systematic Measurements**

| | |
|---|---|
| Number of Systematic Measurements = | 17 |
| # of Systematic Measurements with OpSOF $\geq$ 1 = | 0 |
| # of Systematic Measurements with OpSOF > 0.1 (HTD Assessment) = | 0 |
| Max Individual Systematic Measurement OpSOF = | 0.068 |
| Mean Systematic Measurement OpSOF = | 0.034 |

**Table 17 - Sum of Fractions for Subsurface Soil Samples compared to the OpDCGLs**

| MEASUREMENT ID | Fraction of the OpDCGLs for Subsurface Soils | | | | | OpSOF |
|---|---|---|---|---|---|---|
| | Co-60 | Cs-134 | Cs-137 | Ni-63 | Sr-90 | |
| L1-12104A-FSGS-003-SB | 1.31E-02 | 3.35E-02 | 7.81E-03 | 1.06E-02 | 7.29E-05 | 0.065 |
| L1-12104A-FSGS-007-SB | 3.30E-02 | 4.45E-04 | 0.00E+00 | 2.69E-02 | 0.00E+00 | 0.060 |
| L1-12104L-CJGS-001-SB | 7.34E-02 | 5.95E-02 | 3.01E-02 | 5.98E-02 | 2.81E-04 | 0.220(1) |
| L1-12104L-CJGS-002-SB | 8.67E-02 | 9.32E-02 | 5.02E-02 | 7.06E-02 | 4.69E-04 | 0.300(1) |

**Table 18 - Sum of Fractions for QC Soil Samples compared to the OpDCGLs**

| MEASUREMENT ID | Fraction of the OpDCGLs for Surface Soils | | | | | OpSOF |
|---|---|---|---|---|---|---|
| | Co-60 | Cs-134 | Cs-137 | Ni-63 | Sr-90 | |
| L1-12104A-FQGS-013-SS | 4.61E-03 | 7.50E-04 | 1.04E-02 | 9.93E-04 | 2.44E-05 | 0.017 |

**Table 19 - Basic Statistical Properties of Systematic Sample Population**

| ROC | Mean (pCi/g) | Median (pCi/g) | Max (pCi/g) | Min (pCi/g) | Std. Dev. (pCi/g) | BcDCGL (pCi/g) | Avg. SOF per ROC | Avg. Dose Per ROC |
|---|---|---|---|---|---|---|---|---|
| Co-60 | 1.89E-02 | 1.58E-02 | 5.14E-02 | 0.00E+00 | 0.018 | 4.26 | 4.44E-03 | 1.11E-01 |
| Cs-134 | 1.43E-02 | 1.23E-02 | 4.14E-02 | 0.00E+00 | 0.014 | 6.77 | 2.11E-03 | 5.28E-02 |
| Cs-137 | 1.55E-02 | 1.25E-02 | 4.36E-02 | 0.00E+00 | 0.016 | 14.18 | 1.10E-03 | 2.74E-02 |
| Ni-63 | 3.42E+00 | 2.85E+00 | 9.28E+00 | 0.00E+00 | 3.325 | 3572.1 | 9.56E-04 | 2.39E-02 |
| Sr-90 | 3.11E-05 | 2.50E-05 | 8.72E-05 | 0.00E+00 | 0.000 | 12.09 | 2.57E-06 | 6.42E-05 |

The mean BcSOF for survey unit 12104 is 0.009, which equates to a dose of 0.215 mrem/year TEDE.

The mean of all identified isotopes are less than the Consultation Triggers for Residential and Commercial/Industrial Soil Contamination depicted in Table H.1 of NUREG 1757, Vol. 1, (MOU Table 1). The full table is included in Attachment 3 of this Release Record.

## 8. QUALITY CONTROL

The on-site laboratory processed one (1) split sample, L1-12104A-FQGS-013-SS, using gamma spectroscopy analysis. The data was evaluated using acceptance criteria specified in Zion*Solutions* procedure ZS-LT-01, "*Quality Assurance Project Plan (for Characterization and FSS).*" For the sample, the standard sample and QC sample did not both have a positive result for a gamma-emitting ROC, therefore K-40 was used in the QC comparison. There was acceptable agreement between standard and comparison results. Refer to Attachment 5 for data and quality control analysis results.

## 9. INVESTIGATIONS AND RESULTS

No investigations were performed in survey unit 12104.

## 10. REMEDIATION AND RESULTS

No remediation was performed in this survey unit.

## 11. CHANGES FROM THE SURVEY PLAN

There were no addendums to the FSS plan.

## 12. DATA QUALITY ASSESSMENT

The DQO sample design and data were reviewed in accordance with Zion*Solutions* procedure ZS-LT-300-001-004, *"Final Status Survey Data Assessment"* (Reference 16) for completeness and consistency. Documentation was complete and legible. Surveys and sample collection were

consistent with the DQOs. The sampling design had adequate power as indicated by the Retrospective Power Curve.

The analytical results of all samples were less than an OpSOF of one when compared to the OpDCGLs.

Although MARSSIM states that the Sign Test need not be performed in the instance that no measurements surpass the DCGL, the test was conducted to demonstrate coherence to the statistical principles of the DQO process. The Sign Test was performed on the data and compared to the original assumptions of the DQOs. The evaluation of the Sign Test results clearly demonstrates that the survey unit passes the unrestricted release criteria, thus, the null hypothesis is rejected. The Sign Test is included in Attachment 4.

The preliminary data review consisted of calculating basic statistical quantities (e.g., mean, median, standard deviation). All data was considered valid including negative values, zeros, values reported below the MDC, and values with uncertainties greater than two standard deviations. The mean and median values for each ROC were well below the respective OpDCGLs. Also, the retrospective power curve shows that a sufficient number of samples were collected to achieve the desired power. Therefore, the survey unit meets the unrestricted release criteria with adequate power as required by the DQOs.

The data for Co-60 and Cs-137 is represented graphically through a frequency plot and a quantile plot. All graphical representations are provided in Attachment 6.

## 13. ANOMALIES

No anomalies were observed during the performance or analyses of the survey.

## 14. CONCLUSION

Survey unit 12104 has met the DQOs of the FSS plan. The ALARA criteria for soils as specified in Chapter 4 of the LTP were achieved. The EMC for soils was not needed for this survey unit.

All identified ROC were used for statistical testing to determine the adequacy of the survey unit for FSS. Evaluation of the data shows that none of the ROC concentration values exceed the OpDCGL or any investigational levels; therefore, in accordance with the LTP Section 5.10, the survey unit meets the release criterion.

The sample data passed the Sign Test. The null hypothesis was rejected. The Retrospective Power Curve showed that adequate power was achieved.

The mean BcSOF, when the analytical results were compared to the BcDCGLs, was 0.009, which results in a dose contribution from soil in survey unit 12104 of 0.215 mrem/year TEDE, based on the average concentration of the ROC in samples used for non-parametric statistical sampling.

The conclusion of this Release Record is that survey unit 12104 is acceptable for unrestricted release.

## 15. REFERENCES

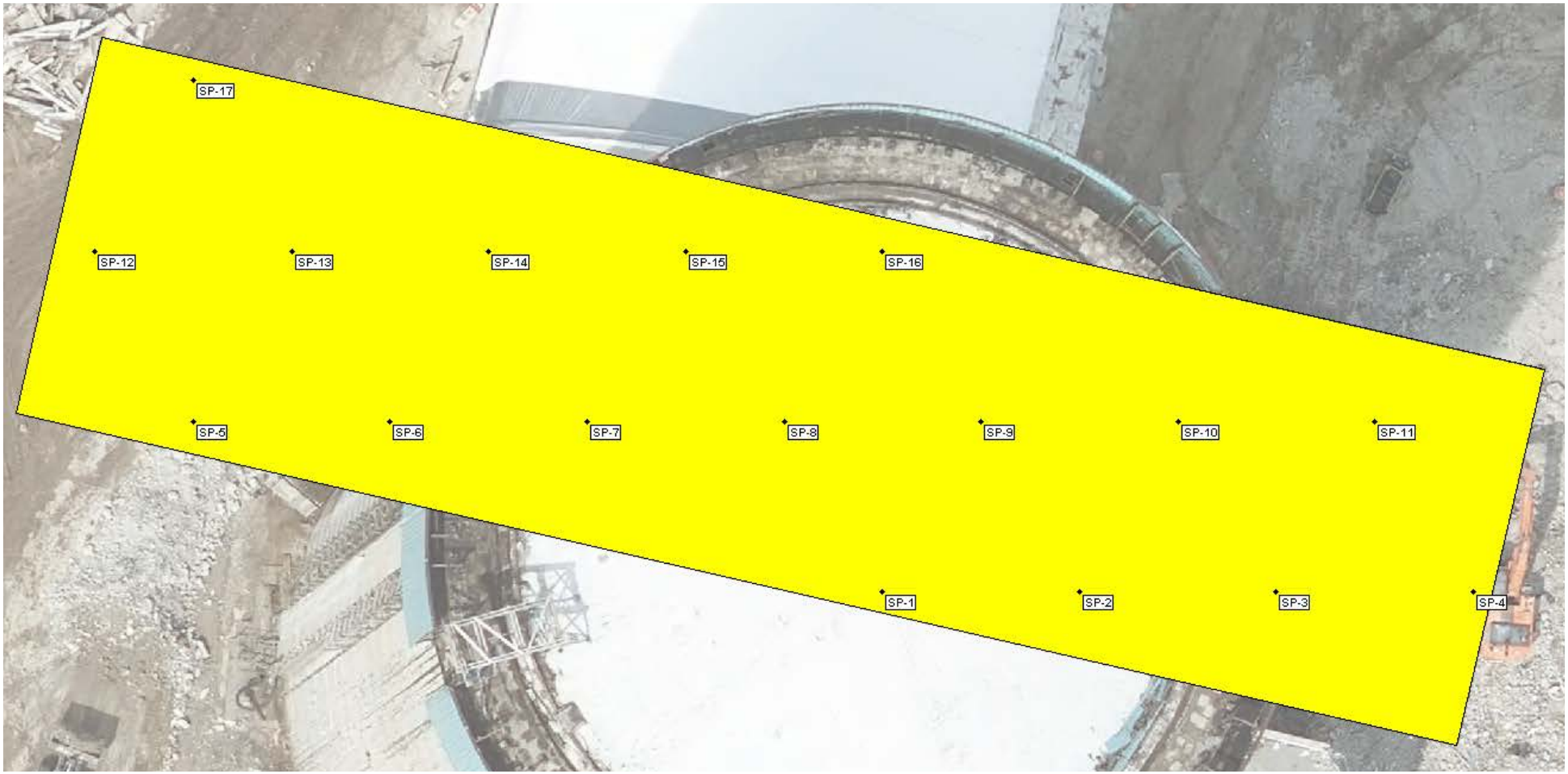
1. Zion*Solutions* procedure ZS-LT-300-001-005, "Final Status Survey Data Reporting"
2. Zion Station Restoration Project License Termination Plan
3. Zion*Solutions* procedure ZS-LT-300-001-001, "Final Status Survey Package Development"
4. NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual"
5. Zion*Solutions* procedure ZS-LT-300-001-002, "Survey Unit Classification"
6. "Zion Station Historical Site Assessment"
7. Zion*Solutions* TSD 11-001, "Technical Support Document for Potential Radionuclides of Concern During the Decommissioning of the Zion Station"
8. Zion*Solutions* TSD 14-019, "Radionuclides of Concern for Soil and Basement Fill Model Source Terms"
9. Zion*Solutions* TSD 14-011, "Soil Area Factors"
10. Zion*Solutions* TSD 17-004, "Operational Derived Concentration Guideline Levels for Final Status Survey"
11. Zion*Solutions* TSD 11-004, "Ludlum Model 44-10 Detector Sensitivity"
12. Zion*Solutions* procedure ZS-LT-01, "Quality Assurance Project Plan (for Characterization and FSS)"
13. Zion*Solutions* procedure ZS-LT-300-001-003, "Isolation and Control for Final Status Survey"
14. Zion*Solutions* procedure ZS-RP-108-004-011, "Operation of the Ludlum Model 2350-1 Data Logger"
15. Zion*Solutions* TSD 13-004, "Examination of Cs-137 Global Fallout In Soils At Zion Station"
16. Zion*Solutions* procedure ZS-LT-300-001-004, "Final Status Survey Data Assessment"

## 16. ATTACHMENTS

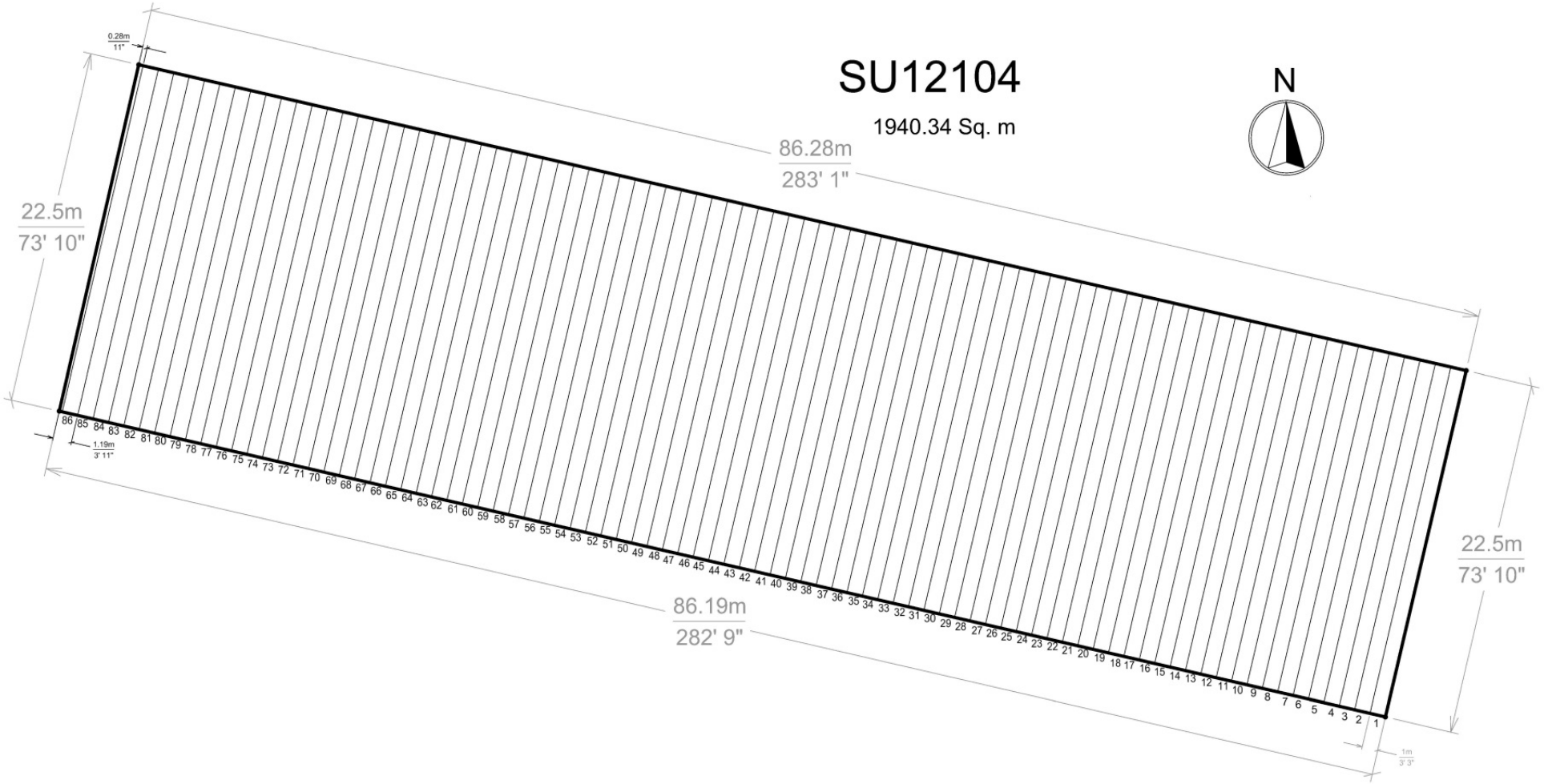
1. Attachment 1 - Figure and Map
2. Attachment 2 - Scan Data
3. Attachment 3 - Consultation Triggers for Residential and Commercial/Industrial Soil Contamination
4. Attachment 4 - Sign Test
5. Attachment 5 - QC Sample Assessment
6. Attachment 6 - Graphical Presentations
7. Attachment 7 - Sample Analytical Reports
8. Attachment 8 - Eberline Analytical Reports

**ATTACHMENT 1**
FIGURE AND MAP

## Survey Unit 12104 Final Status Survey Boundaries and Systematic Sample Points



## Survey Unit 12104 Final Status Survey Scan Rows



# ATTACHMENT 2
SCAN DATA

| Detector Type | Detector ID | M2350-1 ID | Survey Unit | Location | Date/Time | Scan Logged Result (cpm) | Avg Background (cpm) | Action Level (cpm) | Scan Alarms |
|---|---|---|---|---|---|---|---|---|---|
| 44-10 | PR321902 | 304711 | 12104 | GS001 | 9/27/2019 7:59 | 2182 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS001 | 9/27/2019 8:01 | 2166 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS001 | 9/27/2019 8:03 | 2105 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS002 | 9/27/2019 8:05 | 2174 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS002 | 9/27/2019 8:07 | 2111 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS002 | 9/27/2019 8:08 | 2117 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS003 | 9/27/2019 8:10 | 2036 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS003 | 9/27/2019 8:12 | 2135 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS003 | 9/27/2019 8:14 | 2095 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS004 | 9/27/2019 8:28 | 2115 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS004 | 9/27/2019 8:30 | 2076 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS004 | 9/27/2019 8:31 | 2080 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS005 | 9/27/2019 8:33 | 2180 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS005 | 9/27/2019 8:36 | 2104 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS005 | 9/27/2019 8:37 | 2093 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS006 | 9/27/2019 8:39 | 2217 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS006 | 9/27/2019 8:42 | 2116 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS006 | 9/27/2019 8:44 | 2152 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS007 | 9/27/2019 8:47 | 2118 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS007 | 9/27/2019 8:49 | 2075 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS007 | 9/27/2019 8:50 | 2112 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS008 | 9/27/2019 8:53 | 2151 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS008 | 9/27/2019 8:55 | 2118 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS008 | 9/27/2019 8:59 | 2097 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS009 | 9/27/2019 9:02 | 2130 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS009 | 9/27/2019 9:06 | 2084 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS009 | 9/27/2019 9:08 | 2079 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS010 | 9/27/2019 9:10 | 2171 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS010 | 9/27/2019 9:14 | 2087 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS010 | 9/27/2019 9:17 | 2080 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS011 | 9/27/2019 9:20 | 2145 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS011 | 9/27/2019 9:22 | 2131 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS011 | 9/27/2019 9:24 | 2130 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS012 | 9/27/2019 9:30 | 2123 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS012 | 9/27/2019 9:32 | 2100 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS012 | 9/27/2019 9:35 | 2100 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS013 | 9/27/2019 9:38 | 2115 | 2071 | 2760 | No |

| Detector Type | Detector ID | M2350-1 ID | Survey Unit | Location | Date/Time | Scan Logged Result (cpm) | Avg Background (cpm) | Action Level (cpm) | Scan Alarms |
|---|---|---|---|---|---|---|---|---|---|
| 44-10 | PR321902 | 304711 | 12104 | GS013 | 9/27/2019 9:40 | 2149 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS013 | 9/27/2019 9:42 | 2128 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS014 | 9/27/2019 9:44 | 2095 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS014 | 9/27/2019 9:46 | 2142 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS014 | 9/27/2019 9:48 | 2107 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS015 | 9/27/2019 9:50 | 2117 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS015 | 9/27/2019 9:52 | 2070 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS015 | 9/27/2019 9:57 | 2085 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS016 | 9/27/2019 10:06 | 2078 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS016 | 9/27/2019 10:08 | 2087 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS016 | 9/27/2019 10:09 | 2105 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS017 | 9/27/2019 10:12 | 2167 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS017 | 9/27/2019 10:15 | 2146 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS017 | 9/27/2019 10:20 | 2065 | 2071 | 2760 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS018 | 9/30/2019 7:35 | 2237 | 2135 | 2834 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS018 | 9/30/2019 7:38 | 2247 | 2135 | 2834 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS019 | 9/30/2019 7:44 | 2316 | 2135 | 2834 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS019 | 9/30/2019 7:46 | 2188 | 2135 | 2834 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS019 | 9/30/2019 7:48 | 2213 | 2135 | 2834 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS020 | 9/30/2019 7:51 | 2221 | 2135 | 2834 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS020 | 9/30/2019 7:53 | 2310 | 2135 | 2834 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS020 | 9/30/2019 7:55 | 2221 | 2135 | 2834 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS021 | 9/30/2019 7:58 | 2262 | 2135 | 2834 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS021 | 9/30/2019 8:00 | 2229 | 2135 | 2834 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS021 | 9/30/2019 8:01 | 2301 | 2135 | 2834 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS022 | 9/30/2019 8:04 | 2217 | 2135 | 2834 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS022 | 9/30/2019 8:06 | 2221 | 2135 | 2834 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS022 | 9/30/2019 8:08 | 2214 | 2135 | 2834 | No |
| 44-10 | PR321902 | 304711 | 12104 | GS018 | 9/30/2019 13:37 | 2218 | 2135 | 2834 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS023 | 9/27/2019 7:57 | 2394 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS023 | 9/27/2019 8:00 | 2341 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS023 | 9/27/2019 8:02 | 2443 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS024 | 9/27/2019 8:05 | 2432 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS024 | 9/27/2019 8:07 | 2327 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS024 | 9/27/2019 8:09 | 2293 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS025 | 9/27/2019 8:12 | 2325 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS025 | 9/27/2019 8:14 | 2405 | 2138 | 2837 | No |

| Detector Type | Detector ID | M2350-1 ID | Survey Unit | Location | Date/Time | Scan Logged Result (cpm) | Avg Background (cpm) | Action Level (cpm) | Scan Alarms |
|---|---|---|---|---|---|---|---|---|---|
| 44-10 | PR363452 | 304726 | 12104 | GS025 | 9/27/2019 8:17 | 2481 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS026 | 9/27/2019 8:19 | 2390 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS026 | 9/27/2019 8:22 | 2397 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS026 | 9/27/2019 8:24 | 2284 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS027 | 9/27/2019 8:27 | 2433 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS027 | 9/27/2019 8:29 | 2400 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS027 | 9/27/2019 8:31 | 2444 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS028 | 9/27/2019 8:34 | 2394 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS028 | 9/27/2019 8:36 | 2332 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS028 | 9/27/2019 8:39 | 2322 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS029 | 9/27/2019 8:45 | 2444 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS029 | 9/27/2019 8:47 | 2371 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS029 | 9/27/2019 8:49 | 2341 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS030 | 9/27/2019 8:52 | 2273 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS030 | 9/27/2019 8:56 | 2296 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS030 | 9/27/2019 8:58 | 2374 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS031 | 9/27/2019 9:01 | 2530 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS031 | 9/27/2019 9:03 | 2362 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS031 | 9/27/2019 9:05 | 2454 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS032 | 9/27/2019 9:15 | 2303 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS032 | 9/27/2019 9:17 | 2306 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS032 | 9/27/2019 9:20 | 2345 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS033 | 9/27/2019 9:23 | 2422 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS033 | 9/27/2019 9:25 | 2294 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS033 | 9/27/2019 9:27 | 2447 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS034 | 9/27/2019 9:30 | 2412 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS034 | 9/27/2019 9:32 | 2352 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS034 | 9/27/2019 9:34 | 2345 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS035 | 9/27/2019 9:37 | 2337 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS035 | 9/27/2019 9:39 | 2394 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS035 | 9/27/2019 9:42 | 2300 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS036 | 9/27/2019 9:44 | 2349 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS036 | 9/27/2019 9:47 | 2323 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS036 | 9/27/2019 9:49 | 2454 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS037 | 9/27/2019 9:51 | 2311 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS037 | 9/27/2019 9:54 | 2291 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS037 | 9/27/2019 9:56 | 2344 | 2138 | 2837 | No |

| Detector Type | Detector ID | M2350-1 ID | Survey Unit | Location | Date/Time | Scan Logged Result (cpm) | Avg Background (cpm) | Action Level (cpm) | Scan Alarms |
|---|---|---|---|---|---|---|---|---|---|
| 44-10 | PR363452 | 304726 | 12104 | GS038 | 9/27/2019 9:59 | 2485 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS038 | 9/27/2019 10:01 | 2351 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS038 | 9/27/2019 10:03 | 2318 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS039 | 9/27/2019 10:06 | 2409 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS039 | 9/27/2019 10:08 | 2338 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS039 | 9/27/2019 10:10 | 2304 | 2138 | 2837 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS040 | 9/30/2019 7:47 | 2453 | 2178 | 2883 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS040 | 9/30/2019 7:49 | 2627 | 2178 | 2883 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS040 | 9/30/2019 7:52 | 2587 | 2178 | 2883 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS041 | 9/30/2019 7:54 | 2492 | 2178 | 2883 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS041 | 9/30/2019 7:57 | 2449 | 2178 | 2883 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS041 | 9/30/2019 7:59 | 2439 | 2178 | 2883 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS042 | 9/30/2019 8:01 | 2405 | 2178 | 2883 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS042 | 9/30/2019 8:03 | 2416 | 2178 | 2883 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS042 | 9/30/2019 8:06 | 2447 | 2178 | 2883 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS043 | 9/30/2019 8:09 | 2490 | 2178 | 2883 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS043 | 9/30/2019 8:12 | 2523 | 2178 | 2883 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS043 | 9/30/2019 8:14 | 2442 | 2178 | 2883 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS044 | 9/30/2019 8:17 | 2433 | 2178 | 2883 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS044 | 9/30/2019 8:19 | 2491 | 2178 | 2883 | No |
| 44-10 | PR363452 | 304726 | 12104 | GS044 | 9/30/2019 8:22 | 2523 | 2178 | 2883 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS045 | 9/27/2019 8:00 | 2433 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS045 | 9/27/2019 8:03 | 2477 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS045 | 9/27/2019 8:05 | 2428 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS046 | 9/27/2019 8:09 | 2389 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS046 | 9/27/2019 8:12 | 2391 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS046 | 9/27/2019 8:14 | 2413 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS047 | 9/27/2019 8:18 | 2445 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS047 | 9/27/2019 8:20 | 2417 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS047 | 9/27/2019 8:22 | 2552 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS048 | 9/27/2019 8:26 | 2407 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS048 | 9/27/2019 8:28 | 2388 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS048 | 9/27/2019 8:30 | 2367 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS049 | 9/27/2019 8:33 | 2381 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS049 | 9/27/2019 8:35 | 2337 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS049 | 9/27/2019 8:38 | 2390 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS050 | 9/27/2019 8:42 | 2546 | 2169 | 2873 | No |

| Detector Type | Detector ID | M2350-1 ID | Survey Unit | Location | Date/Time | Scan Logged Result (cpm) | Avg Background (cpm) | Action Level (cpm) | Scan Alarms |
|---|---|---|---|---|---|---|---|---|---|
| 44-10 | PR372143 | 304712 | 12104 | GS050 | 9/27/2019 8:44 | 2301 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS050 | 9/27/2019 8:47 | 2471 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS051 | 9/27/2019 8:51 | 2479 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS051 | 9/27/2019 8:53 | 2338 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS051 | 9/27/2019 8:56 | 2412 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS052 | 9/27/2019 8:59 | 2408 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS052 | 9/27/2019 9:01 | 2374 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS052 | 9/27/2019 9:04 | 2396 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS053 | 9/27/2019 9:09 | 2390 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS053 | 9/27/2019 9:11 | 2380 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS053 | 9/27/2019 9:14 | 2486 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS054 | 9/27/2019 9:17 | 2399 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS054 | 9/27/2019 9:20 | 2508 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS054 | 9/27/2019 9:22 | 2350 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS055 | 9/27/2019 9:27 | 2456 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS055 | 9/27/2019 9:29 | 2317 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS055 | 9/27/2019 9:32 | 2416 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS056 | 9/27/2019 9:35 | 2379 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS056 | 9/27/2019 9:37 | 2302 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS056 | 9/27/2019 9:40 | 2343 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS057 | 9/27/2019 9:43 | 2304 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS057 | 9/27/2019 9:45 | 2378 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS057 | 9/27/2019 9:48 | 2435 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS058 | 9/27/2019 9:51 | 2421 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS058 | 9/27/2019 9:53 | 2461 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS058 | 9/27/2019 9:55 | 2355 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS059 | 9/27/2019 9:58 | 2350 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS059 | 9/27/2019 10:00 | 2594 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS059 | 9/27/2019 10:02 | 2477 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS060 | 9/27/2019 10:05 | 2367 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS060 | 9/27/2019 10:07 | 2311 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS060 | 9/27/2019 10:10 | 2212 | 2169 | 2873 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS061 | 9/30/2019 7:47 | 2471 | 2200 | 2909 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS061 | 9/30/2019 7:49 | 2453 | 2200 | 2909 | No |
| 44-10 | PR372143 | 304712 | 12104 | GS061 | 9/30/2019 7:52 | 2466 | 2200 | 2909 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS067 | 9/27/2019 7:51 | 2446 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS067 | 9/27/2019 7:54 | 2373 | 2066 | 2753 | No |

| Detector Type | Detector ID | M2350-1 ID | Survey Unit | Location | Date/Time | Scan Logged Result (cpm) | Avg Background (cpm) | Action Level (cpm) | Scan Alarms |
|---|---|---|---|---|---|---|---|---|---|
| 44-10 | PR321892 | 304708 | 12104 | GS067 | 9/27/2019 7:55 | 2360 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS068 | 9/27/2019 7:57 | 2339 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS068 | 9/27/2019 7:59 | 2240 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS068 | 9/27/2019 8:00 | 2229 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS069 | 9/27/2019 8:02 | 2370 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS069 | 9/27/2019 8:04 | 2266 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS069 | 9/27/2019 8:05 | 2219 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS070 | 9/27/2019 8:07 | 2347 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS070 | 9/27/2019 8:09 | 2199 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS070 | 9/27/2019 8:10 | 2334 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS071 | 9/27/2019 8:12 | 2352 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS071 | 9/27/2019 8:14 | 2298 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS071 | 9/27/2019 8:15 | 2171 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS072 | 9/27/2019 8:17 | 2299 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS072 | 9/27/2019 8:19 | 2147 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS072 | 9/27/2019 8:20 | 2155 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS073 | 9/27/2019 8:23 | 2202 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS073 | 9/27/2019 8:25 | 2320 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS073 | 9/27/2019 8:26 | 2131 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS074 | 9/27/2019 8:28 | 2108 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS074 | 9/27/2019 8:30 | 2263 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS074 | 9/27/2019 8:31 | 2213 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS075 | 9/27/2019 8:33 | 2172 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS075 | 9/27/2019 8:35 | 2130 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS075 | 9/27/2019 8:36 | 2107 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS076 | 9/27/2019 8:38 | 2267 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS076 | 9/27/2019 8:40 | 2225 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS076 | 9/27/2019 8:41 | 2211 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS077 | 9/27/2019 8:43 | 2300 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS077 | 9/27/2019 8:45 | 2216 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS077 | 9/27/2019 8:46 | 2171 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS078 | 9/27/2019 8:48 | 2305 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS078 | 9/27/2019 8:50 | 2195 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS078 | 9/27/2019 8:51 | 2192 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS079 | 9/27/2019 8:57 | 2206 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS079 | 9/27/2019 8:59 | 2363 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS079 | 9/27/2019 9:00 | 2249 | 2066 | 2753 | No |

| Detector Type | Detector ID | M2350-1 ID | Survey Unit | Location | Date/Time | Scan Logged Result (cpm) | Avg Background (cpm) | Action Level (cpm) | Scan Alarms |
|---|---|---|---|---|---|---|---|---|---|
| 44-10 | PR321892 | 304708 | 12104 | GS080 | 9/27/2019 9:02 | 2215 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS080 | 9/27/2019 9:04 | 2183 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS080 | 9/27/2019 9:05 | 2138 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS081 | 9/27/2019 9:07 | 2154 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS081 | 9/27/2019 9:09 | 2164 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS081 | 9/27/2019 9:12 | 2216 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS082 | 9/27/2019 9:14 | 2257 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS082 | 9/27/2019 9:16 | 2381 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS082 | 9/27/2019 9:17 | 2071 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS083 | 9/27/2019 9:19 | 2197 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS083 | 9/27/2019 9:21 | 2125 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS083 | 9/27/2019 9:22 | 2355 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS084 | 9/27/2019 9:24 | 2273 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS084 | 9/27/2019 9:26 | 2130 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS084 | 9/27/2019 9:27 | 2096 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS085 | 9/27/2019 9:36 | 2213 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS085 | 9/27/2019 9:39 | 2161 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS085 | 9/27/2019 9:40 | 2253 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS086 | 9/27/2019 9:43 | 2150 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS086 | 9/27/2019 9:46 | 2185 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS086 | 9/27/2019 9:48 | 2165 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS066 | 9/27/2019 9:50 | 2216 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS066 | 9/27/2019 9:52 | 2227 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS066 | 9/27/2019 9:53 | 2200 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS065 | 9/27/2019 9:55 | 2175 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS065 | 9/27/2019 9:57 | 2170 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS065 | 9/27/2019 9:58 | 2295 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS064 | 9/27/2019 10:00 | 2161 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS064 | 9/27/2019 10:02 | 2218 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS064 | 9/27/2019 10:03 | 2304 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS063 | 9/27/2019 10:05 | 2261 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS063 | 9/27/2019 10:07 | 2151 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS063 | 9/27/2019 10:08 | 2181 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS062 | 9/27/2019 10:11 | 2137 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS062 | 9/27/2019 10:13 | 2282 | 2066 | 2753 | No |
| 44-10 | PR321892 | 304708 | 12104 | GS062 | 9/27/2019 10:15 | 2202 | 2066 | 2753 | No |

# ATTACHMENT 3

CONSULTATION TRIGGERS FOR RESIDENTIAL AND COMMERCIAL/INDUSTRIAL SOIL CONTAMINATION

**Table H.1 Consultation Triggers for Residential and Commercial/Industrial Soil Contamination (MOU Table 1)**

Except for radium-226, thorium-232, or total uranium, concentrations should be aggregated using a sum of the fraction approach to determine site-specific consultation trigger concentrations. This table is based on single contaminant concentrations for residential and commercial/industrial land use when using generally accepted exposure parameters. Table users should select the appropriate column based on the site's reasonably anticipated land use.

| Radionuclide | Residential Soil Concentration | Industrial/Commercial Soil Concentration |
|---|---|---|
| H-3 | 228 pCi/g | 423 pCi/g |
| C-14 | 46 pCi/g | 123,000 pCi/g |
| Na-22 | 9 pCi/g | 14 pCi/g |
| S-35 | 19,600 pCi/g | 32,200,000 pCi/g |
| Cl-36 | 6 pCi/g | 10,700 pCi/g |
| Ca-45 | 13,500 pCi/g | 3,740,000 pCi/g |
| Sc-46 | 105 pCi/g | 169 pCi/g |
| Mn-54 | 69 pCi/g | 112 pCi/g |
| Fe-55 | 269,000 pCi/g | 2,210,000 pCi/g |
| Co-57 | 873 pCi/g | 1,420 pCi/g |
| Co-60 | 4 pCi/g | 6 pCi/g |
| Ni-59 | 20,800 pCi/g | 1,230,000 pCi/g |
| Ni-63 | 9,480 pCi/g | 555,000 pCi/g |
| Sr-90+D | 23 pCi/g | 1,070 pCi/g |
| Nb-94 | 2 pCi/g | 3 pCi/g |
| Tc-99 | 25 pCi/g | 89,400 pCi/g |
| I-129 | 60 pCi/g | 1,080 pCi/g |
| Cs-134 | 16 pCi/g | 26 pCi/g |
| Cs-137+D | 6 pCi/g | 11 pCi/g |
| Eu-152 | 4 pCi/g | 7 pCi/g |
| Eu-154 | 5 pCi/g | 8 pCi/g |
| Ir-192 | 336 pCi/g | 544 pCi/g |
| Pb-210+D | 15 pCi/g | 123 pCi/g |
| Ra-226 | 5 pCi/g | 5 pCi/g |
| Ac-227+D | 10 pCi/g | 21 pCi/g |
| Th-228+D | 15 pCi/g | 25 pCi/g |
| Th-232 | 5 pCi/g | 5 pCi/g |
| U-234 | 401 pCi/g | 3,310 pCi/g |
| U-235+D | 20 pCi/g | 39 pCi/g |
| U-238+D | 74 pCi/g | 179 pCi/g |
| total uranium | 47 mg/kg | 1230 mg/kg |
| Pu-238 | 297 pCi/g | 1,640 pCi/g |
| Pu-239 | 259 pCi/g | 1,430 pCi/g |
| Pu-241 | 40,600 pCi/g | 172,000 pCi/g |
| Am-241 | 187 pCi/g | 568 pCi/g |
| Cm-242 | 32,200 pCi/g | 344,000 pCi/g |
| Cm-243 | 35 pCi/g | 67 pCi/g |

# ATTACHMENT 4
SIGN TEST

**Attachment 12**
**Sign Statistical Test**

**ZS-LT-300-001-004**
**Revision 7**
**Information Use**

**Survey Area:** No. 12000 **Description:** Security Restricted Area Grounds
**Survey Unit:** No. 12104 **Description:** North Half of Unit 2 Containment
**Classification:** 1 **Type I (α) Error:** 0.05 **Number of Samples:** 17

| # | Fraction of the Release Criterion | | | | | | Weighted Sum ($W_s$) | $1-W_s$ | Sign |
|---|---|---|---|---|---|---|---|---|---|
| | Radionuclides of Concern | | | | | Activity or SOF (as applicable) | | | |
| | Co-60 | Cs-134 | Cs-137 | Ni-63 | Sr-90 | | | | |
| 1 | 0.00E+00 | 2.30E-02 | 2.11E-03 | 0.00E+00 | 4.95E-06 | SOF | 0.025 | 0.975 | + |
| 2 | 9.62E-03 | 1.16E-02 | 0.00E+00 | 2.07E-03 | 0.00E+00 | SOF | 0.023 | 0.977 | + |
| 3 | 3.99E-02 | 0.00E+00 | 1.20E-02 | 8.58E-03 | 2.82E-05 | SOF | 0.060 | 0.940 | + |
| 4 | 0.00E+00 | 2.39E-02 | 5.67E-03 | 0.00E+00 | 1.33E-05 | SOF | 0.030 | 0.970 | + |
| 5 | 0.00E+00 | 1.25E-02 | 1.11E-02 | 0.00E+00 | 2.60E-05 | SOF | 0.024 | 0.976 | + |
| 6 | 2.47E-02 | 7.10E-03 | 0.00E+00 | 5.33E-03 | 0.00E+00 | SOF | 0.037 | 0.963 | + |
| 7 | 3.89E-02 | 1.03E-03 | 0.00E+00 | 8.37E-03 | 0.00E+00 | SOF | 0.048 | 0.952 | + |
| 8 | 3.21E-02 | 8.71E-03 | 8.32E-03 | 6.91E-03 | 1.95E-05 | SOF | 0.056 | 0.944 | + |
| 9 | 3.41E-03 | 1.14E-02 | 1.71E-03 | 7.34E-04 | 4.00E-06 | SOF | 0.017 | 0.983 | + |
| 10 | 2.28E-02 | 0.00E+00 | 0.00E+00 | 4.91E-03 | 0.00E+00 | SOF | 0.028 | 0.972 | + |
| 11 | 4.71E-02 | 2.88E-03 | 4.41E-03 | 1.01E-02 | 1.03E-05 | SOF | 0.065 | 0.935 | + |
| 12 | 1.78E-02 | 1.44E-03 | 0.00E+00 | 3.83E-03 | 0.00E+00 | SOF | 0.023 | 0.977 | + |
| 13 | 3.93E-02 | 1.60E-02 | 4.71E-03 | 8.47E-03 | 1.11E-05 | SOF | 0.068 | 0.932 | + |
| 14 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | SOF | 0.000 | 1.000 | + |
| 15 | 4.86E-03 | 1.41E-02 | 1.02E-02 | 1.05E-03 | 2.38E-05 | SOF | 0.030 | 0.970 | + |
| 16 | 0.00E+00 | 5.76E-03 | 9.12E-03 | 0.00E+00 | 2.14E-05 | SOF | 0.015 | 0.985 | + |
| 17 | 1.45E-02 | 7.85E-04 | 3.44E-03 | 3.12E-03 | 8.08E-06 | SOF | 0.022 | 0.978 | + |

Critical Value (Table I.3 of MARSSIM) = **12** Number of Positive Differences (S+) = **17**

The survey unit ☑ (meets) ☐(does not meet) the acceptance criteria.

**Prepared By (RE):** J Graham / [signature] 12/16/19
(Print Name) (Signature) (Date)

**Peer Reviewed By (RE):** R.J. Mardis / [signature] 12-16-19
(Print Name) (Signature) (Date)

# ATTACHMENT 5
QC SAMPLE ASSESSMENT

## Duplicate Sample Assessment Form

| | | |
|---|---|---|
| Survey Area #: 12000 | Survey Unit # 12104 | Survey Unit Name: North Half of Unit 2 Containment |
| Sample Plan#: L1-12104A-F | | |

Sample Description: Comparison of split samples collected from systematic surface soil sample #13. The samples were analyzed using gamma spectroscopy by on-site HPGe system. The standard/comparison samples were L1-12104A-FSGS-013SS/L1-12104A-FQGS-013SS.

| STANDARD | | | | | COMPARISON | | | |
|---|---|---|---|---|---|---|---|---|
| Radionuclide | Activity Value | Standard Error | Resolution | Agreement Range | Activity Value | Standard Error | Comparison Ratio | Acceptable (Y/N) |
| K-40 | 9.13E+00 | 6.12E-01 | 14.90 | 0.6 - 1.66 | 9.38E+00 | 6.21E-01 | 0.97 | Y |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

Comments/Corrective Actions:
The standard sample and QC sample did not both have positive results for a gamma emitting ROC, therefore K-40 was used in the QC comparison.There was acceptable agreement when using K-40. No further action is necessary.

Table 4-1 from the QAPP is reproduced below to show acceptance criteria used to assess split samples.

| Resolution | Acceptable Ratio |
|---|---|
| <4 | not comparable |
| 4-7 | 0.5-2.0 |
| 8-15 | 0.6-1.66 |
| 16-50 | 0.75-1.33 |
| 51-200 | 0.80-1.25 |
| >200 | 0.85-1.18 |

| | | | |
|---|---|---|---|
| Performed by: J Graham | Date: 12/16/19 | Reveiwed by: R. J. Mandia | Date: 12-16-19 |

# ATTACHMENT 6
GRAPHICAL PRESENTATIONS

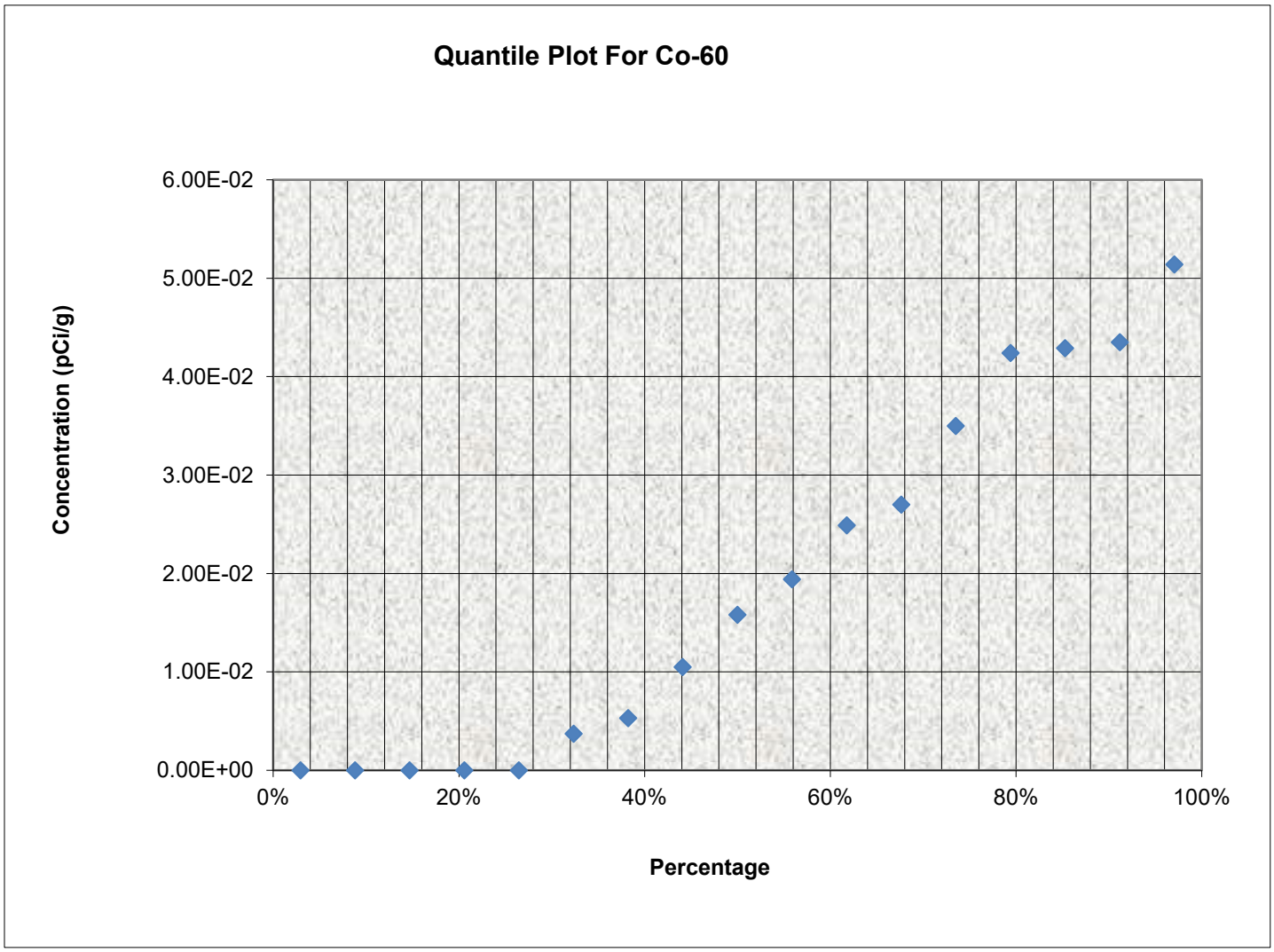
# Posting Plot

**QUANTILE PLOT FOR Co-60**

**Survey Unit:** 12104

**Survey Unit Name:** North Half of Unit 2 Containment

**Mean:** 1.89E-02 pCi/g

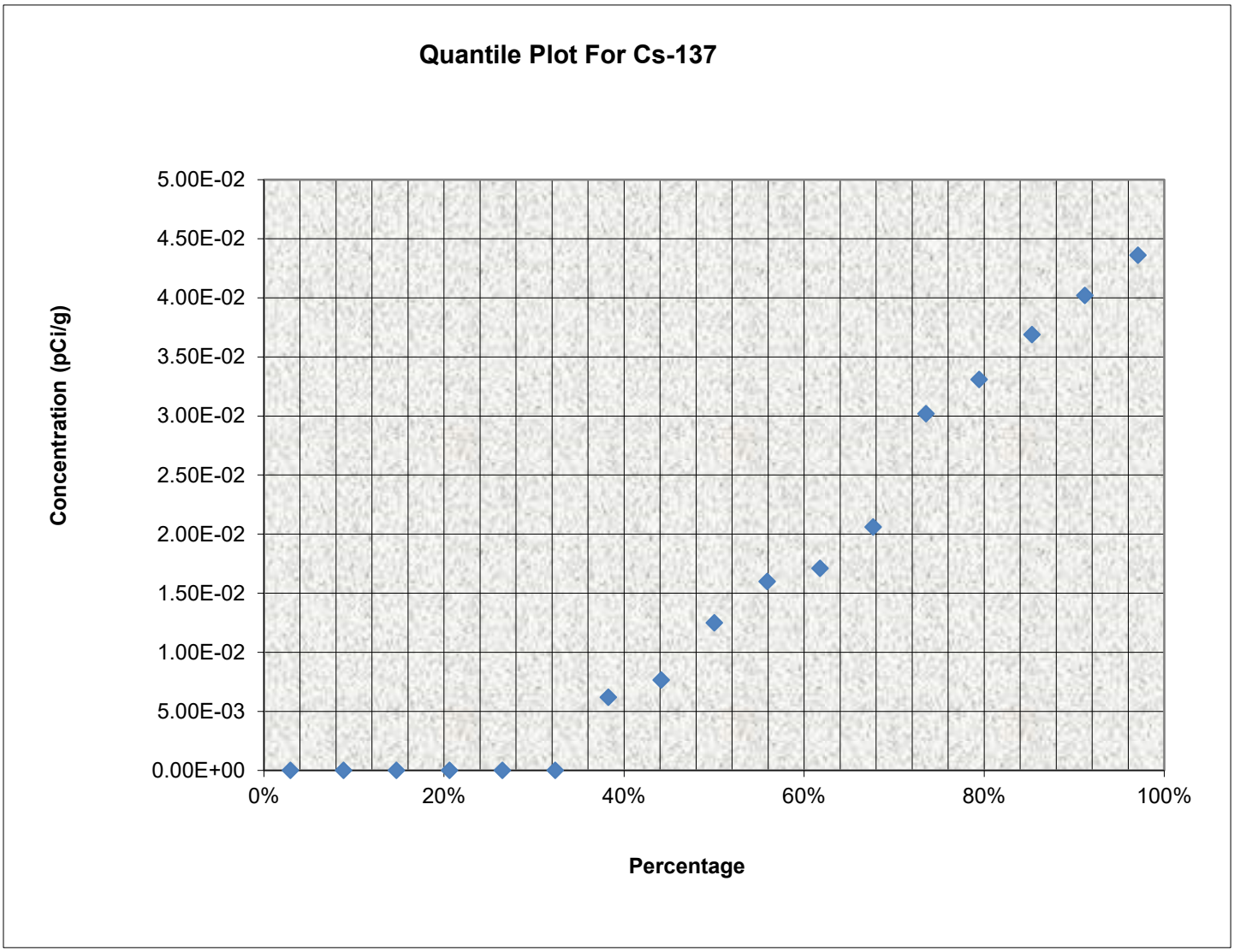


**QUANTILE PLOT FOR Cs-137**

**Survey Unit:** 12104

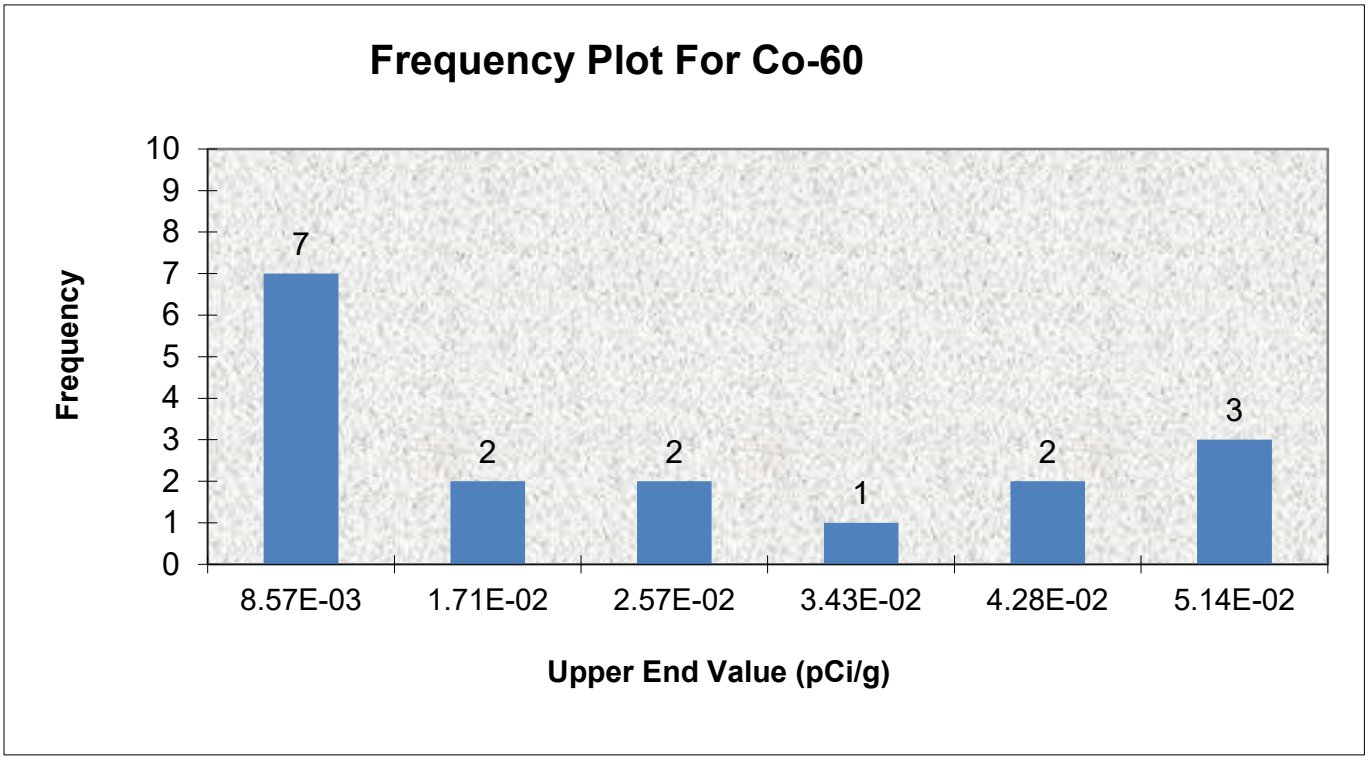
**Survey Unit Name:** North Half of Unit 2 Containment

**Mean:** 1.55E-02 pCi/g



**HISTOGRAM FOR Co-60**

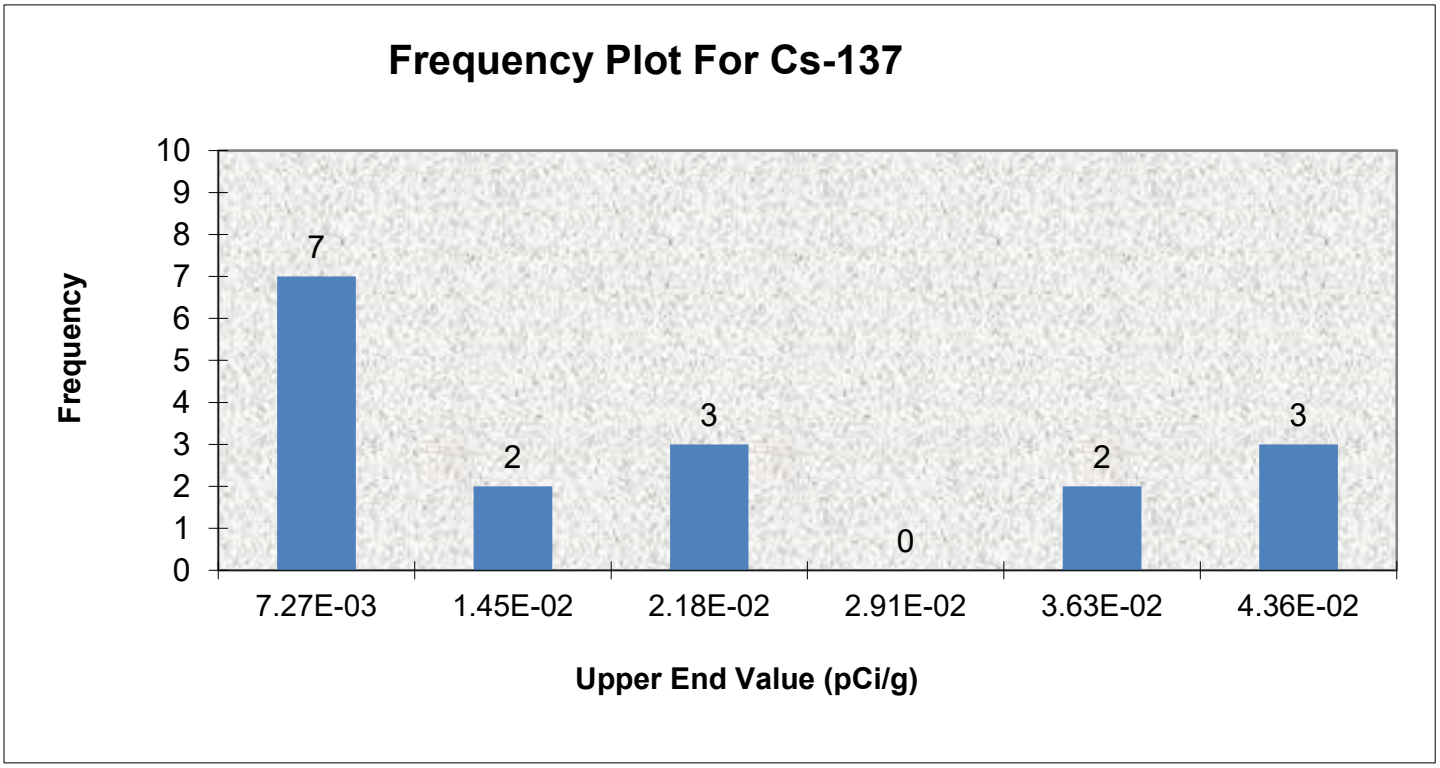
| | | |
|---|---|---|
| **Survey Unit:** | 12104 | |
| **Survey Unit Name:** | North Half of Unit 2 Containment | |
| **Mean:** | 1.89E-02 | pCi/g |
| **Median:** | 1.58E-02 | pCi/g |
| **ST DEV:** | 0.018 | |
| **Skew:** | 0.453 | |




| Upper Value | Observation Frequency | Observation % |
|---|---|---|
| 8.57E-03 | 7 | 41% |
| 1.71E-02 | 2 | 12% |
| 2.57E-02 | 2 | 12% |
| 3.43E-02 | 1 | 6% |
| 4.28E-02 | 2 | 12% |
| 5.14E-02 | 3 | 18% |
| TOTAL | 17 | 100% |

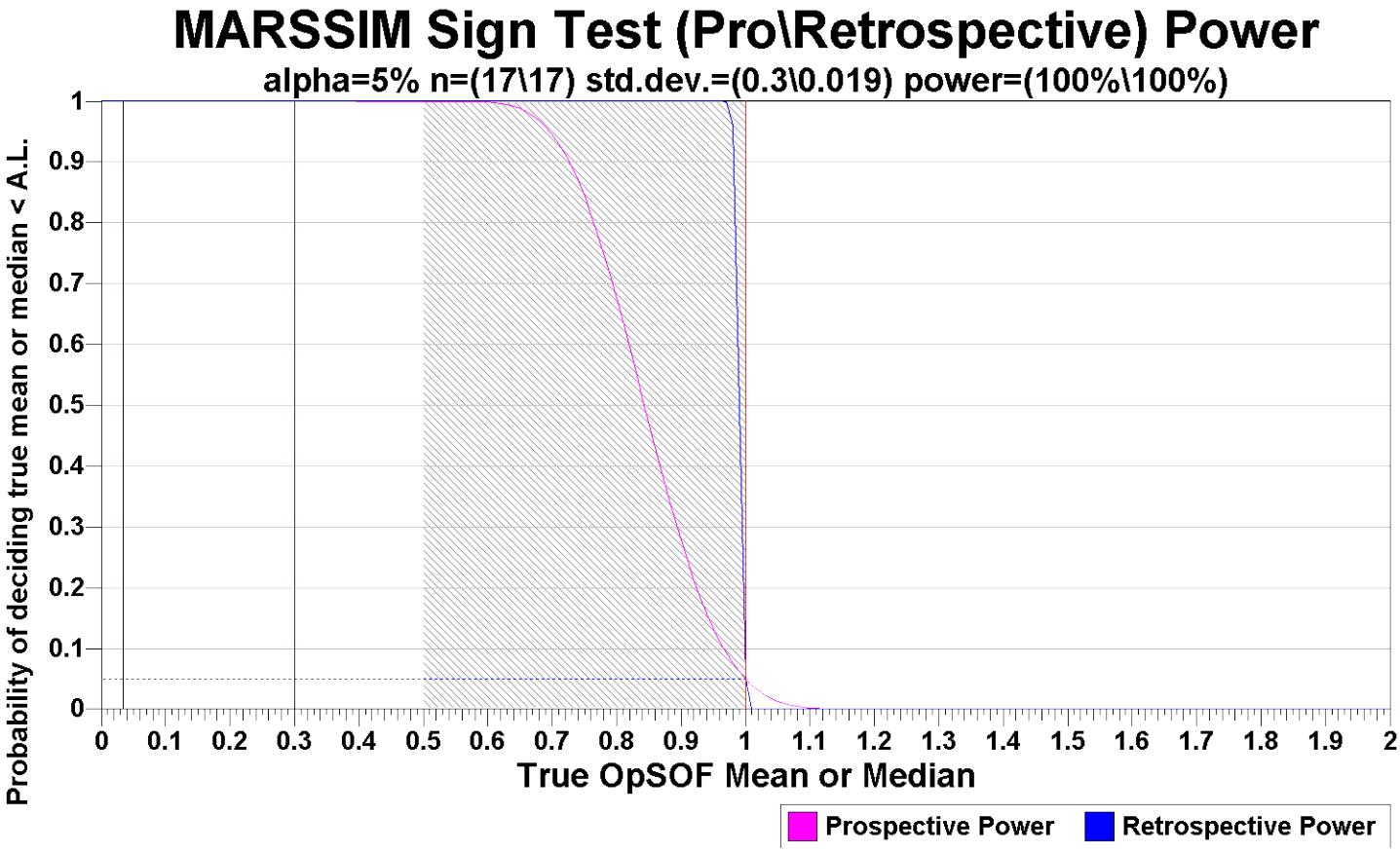
**HISTOGRAM FOR Cs-137**

| | | |
|---|---|---|
| **Survey Unit:** | 12104 | |
| **Survey Unit Name:** | North Half of Unit 2 Containment | |
| **Mean:** | 1.55E-02 | pCi/g |
| **Median:** | 1.25E-02 | pCi/g |
| **ST DEV:** | 0.016 | |
| **Skew:** | 0.567 | |




| Upper Value | Observation Frequency | Observation % |
|---|---|---|
| 7.27E-03 | 7 | 41% |
| 1.45E-02 | 2 | 12% |
| 2.18E-02 | 3 | 18% |
| 2.91E-02 | 0 | 0% |
| 3.63E-02 | 2 | 12% |
| 4.36E-02 | 3 | 18% |
| TOTAL | 17 | 100% |

## Prospective and Retrospective Power Curves for Survey Unit 12104



# ATTACHMENT 7
SAMPLE ANALYTICAL REPORTS

Apex-Gamma

Analysis Report for 02-Oct-19-10016

L1-12104A-FSGS-001SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10016 |
| Sample Description | : L1-12104A-FSGS-001SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.607E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:00:00AM |
| Acquisition Started | : 10/2/2019 10:20:33AM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : 352 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.3 seconds |
| Dead Time | : 0.03 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 9/29/2018 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80181 |
| Fill Height | : 1607.01 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 1/7/2013 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 10:35:39AM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10016

L1-12104A-FSGS-001SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.71 | 951 - | 963 | 955.30 | 1.05E+02 | 17.17 | 6.91E+01 | 1.17 |
| 2 | 295.19 | 1175 - | 1188 | 1180.98 | 4.91E+01 | 11.11 | 2.69E+01 | 0.77 |
| 3 | 351.91 | 1400 - | 1416 | 1407.63 | 8.91E+01 | 13.10 | 2.59E+01 | 1.48 |
| 4 | 499.54 | 1992 - | 2002 | 1997.66 | 1.84E+01 | 6.46 | 9.57E+00 | 1.11 |
| 5 | 583.20 | 2326 - | 2337 | 2332.12 | 4.31E+01 | 8.97 | 1.49E+01 | 0.94 |
| 6 | 609.34 | 2428 - | 2444 | 2436.63 | 4.40E+01 | 9.86 | 1.70E+01 | 1.28 |
| 7 | 911.50 | 3640 - | 3651 | 3645.02 | 2.46E+01 | 7.30 | 1.14E+01 | 0.75 |
| 8 | 1460.85 | 5832 - | 5855 | 5843.77 | 4.18E+02 | 21.26 | 8.64E+00 | 2.45 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 1.00 | 1460.82 | * | 10.66 | 8.64E+00 | 5.78E-01 |
| Tl-208 | 1.00 | 583.19 | * | 85.00 | 6.10E-02 | 1.32E-02 |
| Pb-212 | 0.99 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.63E-01 | 2.97E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 1.00 | 609.32 | * | 45.49 | 1.20E-01 | 2.78E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |

Analysis Report for 02-Oct-19-10016

L1-12104A-FSGS-001SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 1.00 | 1120.29 | | 14.92 | | |
| | | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 1.00 | 241.99 | | 7.25 | | |
| | | 295.22 | * | 18.42 | 2.02E-01 | 4.86E-02 |
| | | 351.93 | * | 35.60 | 2.15E-01 | 3.60E-02 |
| | | 785.96 | | 1.06 | | |
| Ac-228 | 0.99 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | | 11.27 | | |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | * | 25.80 | 1.54E-01 | 4.61E-02 |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | | 15.80 | | |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# *INTERFERENCE CORRECTED REPORT*

Analysis Report for 02-Oct-19-10016

L1-12104A-FSGS-001SS

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | K-40 | 1.000 | 8.64E+00 | 5.78E-01 | |
| | Tl-208 | 1.000 | 6.10E-02 | 1.32E-02 | |
| X | Bi-211 | 0.893 | | | |
| | Pb-212 | 0.999 | 1.63E-01 | 2.97E-02 | |
| | Bi-214 | 1.000 | 1.20E-01 | 2.78E-02 | |
| | Pb-214 | 1.000 | 2.10E-01 | 2.89E-02 | |
| | Ac-228 | 0.996 | 1.54E-01 | 4.61E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10016

L1-12104A-FSGS-001SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 10:35:39AM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|
| 4 | 499.54 | 2.04762E-02 | 35.08 | | |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 4.16E-02 | 4.95E-02 | 4.95E-02 |
| | BE-7 | 477.60 | | 10.44 | 2.52E-01 | 4.01E-01 | 4.01E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 8.64E+00 | 4.66E-01 | 4.66E-01 |
| | Mn-54 | 834.85 | | 99.98 | 8.73E-03 | 4.09E-02 | 4.09E-02 |
| | Co-60 | 1173.23 | | 99.85 | -1.67E-02 | 4.42E-02 | 6.58E-02 |
| | | 1332.49 | | 99.98 | -4.68E-02 | | 4.42E-02 |
| | Nb-94 | 702.65 | | 99.81 | -1.51E-02 | 4.20E-02 | 4.20E-02 |
| | | 871.09 | | 99.89 | 8.48E-03 | | 4.95E-02 |
| | Ag-108m | 79.13 | | 6.60 | 5.83E-01 | 3.84E-02 | 1.54E+00 |
| | | 433.94 | | 90.50 | -1.48E-02 | | 3.84E-02 |
| | | 614.28 | | 89.80 | 4.08E-03 | | 6.27E-02 |
| | | 722.94 | | 90.80 | 2.20E-02 | | 5.40E-02 |
| | Sb-125 | 176.31 | | 6.84 | -4.36E-01 | 1.14E-01 | 4.56E-01 |
| | | 380.45 | | 1.52 | -2.73E-01 | | 1.94E+00 |
| | | 427.87 | | 29.60 | 1.94E-02 | | 1.14E-01 |
| | | 463.36 | | 10.49 | 1.43E-01 | | 3.05E-01 |
| | | 600.60 | | 17.65 | -2.94E-02 | | 2.17E-01 |
| | | 606.71 | | 4.98 | 7.67E-01 | | 1.16E+00 |

Analysis Report for 02-Oct-19-10016

L1-12104A-FSGS-001SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 635.95 | 11.22 | -6.43E-02 | 1.14E-01 | 3.50E-01 |
| | 671.44 | 1.79 | 3.13E-01 | | 2.39E+00 |
| Ba-133 | 79.61 | 2.65 | 1.21E+00 | 7.26E-02 | 3.66E+00 |
| | 81.00 | 32.90 | -2.44E-01 | | 2.58E-01 |
| | 276.40 | 7.16 | 4.86E-01 | | 5.21E-01 |
| | 302.85 | 18.34 | -7.38E-03 | | 1.90E-01 |
| | 356.01 | 62.05 | -3.88E-02 | | 7.26E-02 |
| | 383.85 | 8.94 | 3.85E-02 | | 3.54E-01 |
| Cs-134 | 475.36 | 1.48 | 1.84E+00 | 5.47E-02 | 2.75E+00 |
| | 563.25 | 8.34 | -6.38E-03 | | 3.86E-01 |
| | 569.33 | 15.37 | 2.15E-02 | | 2.53E-01 |
| | 604.72 | 97.62 | -3.39E-03 | | 5.47E-02 |
| | 795.86 | 85.46 | 3.98E-02 | | 5.80E-02 |
| | 801.95 | 8.69 | -1.05E-01 | | 5.60E-01 |
| | 1038.61 | 0.99 | 4.11E+00 | | 5.25E+00 |
| | 1167.97 | 1.79 | 2.48E+00 | | 3.92E+00 |
| | 1365.19 | 3.02 | 5.20E-01 | | 1.45E+00 |
| Cs-137 | 661.66 | 85.10 | 7.66E-03 | 4.98E-02 | 4.98E-02 |
| Eu-152 | 121.78 | 28.67 | -3.41E-02 | 1.33E-01 | 1.33E-01 |
| | 244.70 | 7.61 | 3.73E-01 | | 5.23E-01 |
| | 295.94 | 0.45 | 7.03E+00 | | 9.63E+00 |
| | 344.28 | 26.60 | -6.71E-02 | | 1.33E-01 |
| | 367.79 | 0.86 | -2.25E+00 | | 3.78E+00 |
| | 411.12 | 2.24 | -1.23E+00 | | 1.42E+00 |
| | 443.96 | 2.83 | 1.12E+00 | | 1.32E+00 |
| | 488.68 | 0.42 | 3.86E+00 | | 7.45E+00 |
| | 563.99 | 0.49 | -1.42E+00 | | 6.78E+00 |
| | 586.26 | 0.46 | 1.16E+01 | | 1.17E+01 |
| | 678.62 | 0.47 | 2.82E+00 | | 9.24E+00 |
| | 688.67 | 0.86 | -8.98E-01 | | 4.41E+00 |
| | 719.35 | 0.28 | -3.19E-01 | | 1.60E+01 |
| | 778.90 | 12.96 | 4.58E-02 | | 2.90E-01 |
| | 810.45 | 0.32 | -1.15E+01 | | 1.43E+01 |
| | 867.37 | 4.26 | -1.86E+00 | | 1.19E+00 |
| | 919.33 | 0.43 | -4.75E+00 | | 1.14E+01 |
| | 964.08 | 14.65 | -5.76E-02 | | 4.04E-01 |
| | 1085.87 | 10.24 | -3.20E-01 | | 4.98E-01 |
| | 1089.74 | 1.73 | -7.30E-01 | | 3.18E+00 |
| | 1112.07 | 13.69 | 7.81E-02 | | 4.13E-01 |
| | 1212.95 | 1.43 | -4.59E+00 | | 4.24E+00 |
| | 1249.94 | 0.19 | 4.39E+00 | | 3.74E+01 |
| | 1299.14 | 1.63 | 1.71E+00 | | 3.52E+00 |
| | 1408.01 | 21.07 | 2.24E-02 | | 1.91E-01 |
| | 1457.64 | 0.50 | 1.86E+02 | | 4.50E+01 |
| | 1528.10 | 0.28 | -1.82E+00 | | 7.80E+00 |
| Eu-154 | 123.07 | 40.40 | -9.48E-02 | 9.33E-02 | 9.33E-02 |
| | 247.93 | 6.89 | 1.29E-01 | | 5.08E-01 |
| | 591.76 | 4.95 | 3.56E-01 | | 7.67E-01 |
| | 692.42 | 1.78 | -1.41E+00 | | 2.11E+00 |
| | 723.30 | 20.06 | 1.88E-01 | | 2.47E-01 |
| | 756.80 | 4.52 | 5.42E-01 | | 9.73E-01 |

Analysis Report for 02-Oct-19-10016

L1-12104A-FSGS-001SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 873.18 | 12.08 | 4.21E-02 | 9.33E-02 | 4.30E-01 |
| | 996.29 | 10.48 | 3.17E-01 | | 5.29E-01 |
| | 1004.76 | 18.01 | 3.72E-02 | | 3.31E-01 |
| | 1274.43 | 34.80 | -2.44E-01 | | 1.62E-01 |
| | 1596.48 | 1.80 | -2.84E-01 | | 1.92E+00 |
| Eu-155 | 45.30 | 1.31 | 5.60E+00 | 2.06E-01 | 2.10E+01 |
| | 60.01 | 1.22 | -7.93E+00 | | 2.06E+01 |
| | 86.55 | 30.70 | -7.35E-03 | | 2.16E-01 |
| | 105.31 | 21.10 | -6.40E-02 | | 2.06E-01 |
| Ra-226 | 186.21 | 3.64 | 2.42E-01 | 1.04E+00 | 1.04E+00 |
| Pa-231 | 27.36 | 10.30 | 1.95E+00 | 1.37E+00 | 2.42E+00 |
| | 283.69 | 1.70 | -8.54E-01 | | 1.89E+00 |
| | 300.07 | 2.47 | -4.76E-01 | | 1.37E+00 |
| | 302.65 | 2.20 | 8.09E-01 | | 1.61E+00 |
| | 330.06 | 1.40 | 3.52E-01 | | 2.62E+00 |
| U-235 | 143.76 | 10.96 | -3.06E-02 | 6.57E-02 | 3.26E-01 |
| | 163.33 | 5.08 | -3.27E-01 | | 7.09E-01 |
| | 185.71 | 57.20 | -7.68E-03 | | 6.57E-02 |
| | 202.11 | 1.08 | 1.87E+00 | | 3.29E+00 |
| | 205.31 | 5.01 | -3.48E-01 | | 6.75E-01 |
| Am-241 | 59.54 | 35.90 | -3.28E-01 | 7.33E-01 | 7.33E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10017

L1-12104A-FSGS-002SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10017 |
| Sample Description | : L1-12104A-FSGS-002SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.640E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:02:00AM |
| Acquisition Started | : 10/2/2019 10:38:53AM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : 324 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.3 seconds |
| Dead Time | : 0.04 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 4096 |
| Peak Area Range (in channels) | : 120 - 4096 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 9/29/2018 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80182 |
| Fill Height | : 1640.33 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 1/30/2013 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 10:53:56AM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 4096

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10017

L1-12104A-FSGS-002SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.67 | 473 - | 481 | 477.53 | 9.51E+01 | 19.58 | 1.34E+02 | 1.07 |
| 2 | 295.17 | 585 - | 595 | 590.40 | 4.05E+01 | 13.61 | 6.05E+01 | 1.19 |
| 3 | 352.00 | 699 - | 708 | 703.95 | 8.91E+01 | 13.46 | 4.09E+01 | 1.57 |
| 4 | 510.56 | 1015 - | 1026 | 1020.80 | 6.63E+01 | 12.51 | 3.47E+01 | 1.43 |
| 5 | 609.23 | 1213 - | 1223 | 1218.04 | 4.69E+01 | 11.01 | 3.01E+01 | 1.06 |
| 6 | 1460.80 | 2914 - | 2928 | 2921.65 | 5.02E+02 | 22.77 | 5.60E+00 | 2.06 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| An Pk | 0.96 | 511.00 | * | 100.00 | 6.67E-02 | 1.34E-02 |
| K-40 | 1.00 | 1460.82 | * | 10.66 | 9.27E+00 | 5.82E-01 |
| Pb-212 | 1.00 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.32E-01 | 2.92E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 0.99 | 609.32 | * | 45.49 | 1.14E-01 | 2.77E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |
| | | 1120.29 | | 14.92 | | |
| | | 1155.21 | | 1.63 | | |

Analysis Report for 02-Oct-19-10017

L1-12104A-FSGS-002SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 0.99 | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 0.99 | 241.99 | | 7.25 | | |
| | | 295.22 | * | 18.42 | 1.50E-01 | 5.17E-02 |
| | | 351.93 | * | 35.60 | 1.93E-01 | 3.30E-02 |
| | | 785.96 | | 1.06 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# INTERFERENCE CORRECTED REPORT

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | An Pk | 0.969 | 6.67E-02 | 1.34E-02 | |
| | K-40 | 1.000 | 9.27E+00 | 5.82E-01 | |
| X | Bi-211 | 0.870 | | | |
| | Pb-212 | 1.000 | 1.32E-01 | 2.92E-02 | |
| | Bi-214 | 0.999 | 1.14E-01 | 2.77E-02 | |
| | Pb-214 | 0.999 | 1.80E-01 | 2.78E-02 | |

Analysis Report for 02-Oct-19-10017

L1-12104A-FSGS-002SS

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10017

L1-12104A-FSGS-002SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 10:53:56AM
Peak Locate From Channel : 120
Peak Locate To Channel : 4096

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| + | An Pk | 511.00 | * | 100.00 | 6.67E-02 | 3.53E-02 | 3.53E-02 |
| | BE-7 | 477.60 | | 10.44 | 3.76E-01 | 4.26E-01 | 4.26E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 9.27E+00 | 3.04E-01 | 3.04E-01 |
| | Mn-54 | 834.85 | | 99.98 | -1.18E-03 | 4.32E-02 | 4.32E-02 |
| | Co-60 | 1173.23 | | 99.85 | -9.33E-03 | 5.44E-02 | 5.64E-02 |
| | | 1332.49 | | 99.98 | 1.05E-02 | | 5.44E-02 |
| | Nb-94 | 702.65 | | 99.81 | -6.09E-03 | 3.83E-02 | 3.96E-02 |
| | | 871.09 | | 99.89 | -3.56E-03 | | 3.83E-02 |
| | Ag-108m | 79.13 | | 6.60 | 2.09E-01 | 3.30E-02 | 1.09E+00 |
| | | 433.94 | | 90.50 | -7.75E-03 | | 3.30E-02 |
| | | 614.28 | | 89.80 | -1.09E-02 | | 4.90E-02 |
| | | 722.94 | | 90.80 | 1.10E-02 | | 4.74E-02 |
| | Sb-125 | 176.31 | | 6.84 | 3.34E-02 | 8.93E-02 | 4.98E-01 |
| | | 380.45 | | 1.52 | 6.72E-01 | | 2.11E+00 |
| | | 427.87 | | 29.60 | -3.40E-02 | | 8.93E-02 |
| | | 463.36 | | 10.49 | 2.60E-01 | | 3.43E-01 |
| | | 600.60 | | 17.65 | 7.35E-02 | | 2.27E-01 |
| | | 606.71 | | 4.98 | 2.74E-01 | | 1.16E+00 |
| | | 635.95 | | 11.22 | -1.63E-02 | | 3.35E-01 |

Analysis Report for 02-Oct-19-10017

L1-12104A-FSGS-002SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | -1.56E-01 | 8.93E-02 | 2.09E+00 |
| Ba-133 | 79.61 | 2.65 | 3.69E-01 | 6.42E-02 | 2.59E+00 |
| | 81.00 | 32.90 | -2.18E-01 | | 1.79E-01 |
| | 276.40 | 7.16 | -3.50E-02 | | 4.34E-01 |
| | 302.85 | 18.34 | 8.97E-03 | | 1.71E-01 |
| | 356.01 | 62.05 | -4.46E-02 | | 6.42E-02 |
| | 383.85 | 8.94 | 4.53E-03 | | 3.52E-01 |
| Cs-134 | 475.36 | 1.48 | 2.54E+00 | 4.64E-02 | 2.86E+00 |
| | 563.25 | 8.34 | -8.05E-02 | | 4.21E-01 |
| | 569.33 | 15.37 | 3.03E-02 | | 2.59E-01 |
| | 604.72 | 97.62 | 2.01E-02 | | 5.43E-02 |
| | 795.86 | 85.46 | 1.28E-02 | | 4.64E-02 |
| | 801.95 | 8.69 | -1.22E-01 | | 4.90E-01 |
| | 1038.61 | 0.99 | 2.96E+00 | | 5.62E+00 |
| | 1167.97 | 1.79 | -3.88E-02 | | 3.31E+00 |
| | 1365.19 | 3.02 | 4.66E-01 | | 1.51E+00 |
| Cs-137 | 661.66 | 85.10 | -1.69E-02 | 4.31E-02 | 4.31E-02 |
| Eu-152 | 121.78 | 28.67 | 1.72E-02 | 1.12E-01 | 1.15E-01 |
| | 244.70 | 7.61 | -1.74E-02 | | 4.37E-01 |
| | 295.94 | 0.45 | -6.35E-01 | | 8.10E+00 |
| | 344.28 | 26.60 | -1.05E-01 | | 1.12E-01 |
| | 367.79 | 0.86 | 8.63E-01 | | 3.66E+00 |
| | 411.12 | 2.24 | -5.99E-01 | | 1.41E+00 |
| | 443.96 | 2.83 | 2.58E-01 | | 1.17E+00 |
| | 488.68 | 0.42 | -9.65E+00 | | 7.61E+00 |
| | 563.99 | 0.49 | 8.40E-01 | | 7.47E+00 |
| | 586.26 | 0.46 | 1.27E+01 | | 1.17E+01 |
| | 678.62 | 0.47 | -3.84E+00 | | 8.00E+00 |
| | 688.67 | 0.86 | -1.42E+00 | | 4.71E+00 |
| | 719.35 | 0.28 | 3.50E+00 | | 1.37E+01 |
| | 778.90 | 12.96 | 2.48E-01 | | 3.90E-01 |
| | 810.45 | 0.32 | -3.08E+00 | | 1.37E+01 |
| | 867.37 | 4.26 | -1.49E-01 | | 9.12E-01 |
| | 919.33 | 0.43 | -6.70E+00 | | 8.62E+00 |
| | 964.08 | 14.65 | 1.44E-01 | | 3.76E-01 |
| | 1085.87 | 10.24 | -2.27E-02 | | 5.05E-01 |
| | 1089.74 | 1.73 | 1.18E+00 | | 3.24E+00 |
| | 1112.07 | 13.69 | 1.35E-01 | | 3.93E-01 |
| | 1212.95 | 1.43 | -5.27E+00 | | 3.74E+00 |
| | 1249.94 | 0.19 | -1.47E+01 | | 2.96E+01 |
| | 1299.14 | 1.63 | 1.94E+00 | | 3.20E+00 |
| | 1408.01 | 21.07 | 1.16E-01 | | 2.16E-01 |
| | 1457.64 | 0.50 | -5.11E+00 | | 4.35E+01 |
| | 1528.10 | 0.28 | -5.41E+00 | | 9.81E+00 |
| Eu-154 | 123.07 | 40.40 | 1.30E-03 | 8.01E-02 | 8.01E-02 |
| | 247.93 | 6.89 | -4.67E-02 | | 4.34E-01 |
| | 591.76 | 4.95 | -1.19E-01 | | 7.23E-01 |
| | 692.42 | 1.78 | -8.33E-01 | | 2.12E+00 |
| | 723.30 | 20.06 | 7.90E-02 | | 2.19E-01 |
| | 756.80 | 4.52 | -5.17E-01 | | 8.49E-01 |
| | 873.18 | 12.08 | 5.26E-02 | | 3.44E-01 |

Analysis Report for 02-Oct-19-10017

L1-12104A-FSGS-002SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | 1.52E-01 | 8.01E-02 | 4.79E-01 |
| | 1004.76 | 18.01 | -7.62E-02 | | 2.63E-01 |
| | 1274.43 | 34.80 | -8.89E-02 | | 1.45E-01 |
| | 1596.48 | 1.80 | -6.59E-01 | | 2.20E+00 |
| Eu-155 | 45.30 | 1.31 | 4.70E-01 | 1.75E-01 | 1.09E+01 |
| | 60.01 | 1.22 | 7.23E-01 | | 1.26E+01 |
| | 86.55 | 30.70 | 1.06E-02 | | 1.75E-01 |
| | 105.31 | 21.10 | 1.76E-02 | | 1.80E-01 |
| Ra-226 | 186.21 | 3.64 | 5.29E-01 | 9.96E-01 | 9.96E-01 |
| Pa-231 | 27.36 | 10.30 | 7.57E-01 | 1.17E+00 | 1.17E+00 |
| | 283.69 | 1.70 | -8.23E-01 | | 1.72E+00 |
| | 300.07 | 2.47 | 1.98E-01 | | 1.26E+00 |
| | 302.65 | 2.20 | 7.47E-02 | | 1.43E+00 |
| | 330.06 | 1.40 | 1.03E+00 | | 2.56E+00 |
| U-235 | 143.76 | 10.96 | -2.31E-02 | 6.38E-02 | 2.74E-01 |
| | 163.33 | 5.08 | 6.94E-02 | | 6.74E-01 |
| | 185.71 | 57.20 | 4.02E-02 | | 6.38E-02 |
| | 202.11 | 1.08 | -2.59E+00 | | 3.02E+00 |
| | 205.31 | 5.01 | -3.73E-01 | | 6.62E-01 |
| Am-241 | 59.54 | 35.90 | 4.51E-02 | 4.42E-01 | 4.42E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10018

L1-12104A-FSGS-003SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10018 |
| Sample Description | : L1-12104A-FSGS-003SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.664E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:04:00AM |
| Acquisition Started | : 10/2/2019 10:39:02AM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : P40818B |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 901.4 seconds |
| Dead Time | : 0.15 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 1/29/2019 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80183 |
| Fill Height | : 1664.11 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 1/30/2012 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 10:54:06AM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10018

L1-12104A-FSGS-003SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.44 | 948 - | 960 | 953.86 | 8.27E+01 | 17.07 | 7.63E+01 | 0.33 |
| 2 | 351.77 | 1401 - | 1412 | 1406.83 | 5.96E+01 | 11.86 | 3.24E+01 | 0.55 |
| 3 | 608.92 | 2429 - | 2442 | 2434.85 | 4.70E+01 | 8.15 | 7.00E+00 | 0.73 |
| 4 | 968.52 | 3867 - | 3879 | 3873.07 | 2.16E+01 | 6.43 | 7.41E+00 | 0.72 |
| 5 | 1460.17 | 5829 - | 5852 | 5840.50 | 4.01E+02 | 20.58 | 5.76E+00 | 1.78 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 0.93 | 1460.82 | * | 10.66 | 9.77E+00 | 6.57E-01 |
| Bi-211 | 0.92 | 351.07 | * | 13.02 | 4.49E-01 | 9.64E-02 |
| Pb-212 | 0.99 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.46E-01 | 3.23E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 0.99 | 609.32 | * | 45.49 | 1.48E-01 | 2.72E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |
| | | 1120.29 | | 14.92 | | |
| | | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |

Analysis Report for 02-Oct-19-10018

L1-12104A-FSGS-003SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 0.99 | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 0.99 | 241.99 | | 7.25 | | |
| | | 295.22 | | 18.42 | | |
| | | 351.93 | * | 35.60 | 1.64E-01 | 3.52E-02 |
| | | 785.96 | | 1.06 | | |
| Ac-228 | 0.99 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | | 11.27 | | |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | | 25.80 | | |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | * | 15.80 | 2.68E-01 | 8.08E-02 |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# INTERFERENCE CORRECTED REPORT

| Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|

Analysis Report for 02-Oct-19-10018

L1-12104A-FSGS-003SS

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | K-40 | 0.934 | 9.77E+00 | 6.57E-01 | |
| ? | Bi-211 | 0.924 | 4.49E-01 | 9.64E-02 | |
| | Pb-212 | 0.995 | 1.46E-01 | 3.23E-02 | |
| | Bi-214 | 0.990 | 1.48E-01 | 2.72E-02 | |
| ? | Pb-214 | 0.998 | 1.64E-01 | 3.52E-02 | |
| | Ac-228 | 0.994 | 2.68E-01 | 8.08E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10018

L1-12104A-FSGS-003SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 10:54:06AM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 2.10E-02 | 5.97E-02 | 5.97E-02 |
| | BE-7 | 477.60 | | 10.44 | 1.41E-01 | 4.46E-01 | 4.46E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 9.77E+00 | 4.61E-01 | 4.61E-01 |
| | Mn-54 | 834.85 | | 99.98 | 1.18E-02 | 4.51E-02 | 4.51E-02 |
| | Co-60 | 1173.23 | | 99.85 | 4.35E-02 | 5.63E-02 | 7.74E-02 |
| | | 1332.49 | | 99.98 | -1.82E-02 | | 5.63E-02 |
| | Nb-94 | 702.65 | | 99.81 | -2.15E-02 | 5.01E-02 | 5.01E-02 |
| | | 871.09 | | 99.89 | -2.21E-02 | | 5.07E-02 |
| | Ag-108m | 79.13 | | 6.60 | 1.04E+00 | 4.02E-02 | 1.98E+00 |
| | | 433.94 | | 90.50 | -2.91E-02 | | 4.02E-02 |
| | | 614.28 | | 89.80 | -3.59E-03 | | 5.08E-02 |
| | | 722.94 | | 90.80 | 1.17E-02 | | 6.21E-02 |
| | Sb-125 | 176.31 | | 6.84 | -2.28E-01 | 1.31E-01 | 5.59E-01 |
| | | 380.45 | | 1.52 | -4.80E-02 | | 2.30E+00 |
| | | 427.87 | | 29.60 | -1.85E-02 | | 1.31E-01 |
| | | 463.36 | | 10.49 | -2.08E-01 | | 4.06E-01 |
| | | 600.60 | | 17.65 | 1.03E-02 | | 2.42E-01 |
| | | 606.71 | | 4.98 | 7.48E-01 | | 1.19E+00 |
| | | 635.95 | | 11.22 | 1.86E-01 | | 4.27E-01 |

Analysis Report for 02-Oct-19-10018

L1-12104A-FSGS-003SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | -1.64E+00 | 1.31E-01 | 1.84E+00 |
| Ba-133 | 79.61 | 2.65 | 1.90E+00 | 7.42E-02 | 4.68E+00 |
| | 81.00 | 32.90 | -3.26E-01 | | 3.25E-01 |
| | 276.40 | 7.16 | 2.68E-02 | | 5.48E-01 |
| | 302.85 | 18.34 | 2.07E-01 | | 2.29E-01 |
| | 356.01 | 62.05 | -1.12E-02 | | 7.42E-02 |
| | 383.85 | 8.94 | -2.61E-01 | | 3.74E-01 |
| Cs-134 | 475.36 | 1.48 | 9.84E-01 | 5.86E-02 | 3.07E+00 |
| | 563.25 | 8.34 | -7.21E-02 | | 5.17E-01 |
| | 569.33 | 15.37 | 5.50E-02 | | 2.64E-01 |
| | 604.72 | 97.62 | -3.25E-02 | | 5.90E-02 |
| | 795.86 | 85.46 | -1.51E-03 | | 5.86E-02 |
| | 801.95 | 8.69 | 4.92E-02 | | 5.62E-01 |
| | 1038.61 | 0.99 | -1.61E+00 | | 5.58E+00 |
| | 1167.97 | 1.79 | 3.17E-02 | | 4.31E+00 |
| | 1365.19 | 3.02 | 4.38E-01 | | 1.60E+00 |
| Cs-137 | 661.66 | 85.10 | 4.36E-02 | 5.12E-02 | 5.12E-02 |
| Eu-152 | 121.78 | 28.67 | -3.23E-02 | 1.43E-01 | 1.64E-01 |
| | 244.70 | 7.61 | 1.11E-01 | | 6.20E-01 |
| | 295.94 | 0.45 | -2.95E+00 | | 9.84E+00 |
| | 344.28 | 26.60 | -1.27E-02 | | 1.43E-01 |
| | 367.79 | 0.86 | -9.98E-01 | | 3.81E+00 |
| | 411.12 | 2.24 | 3.70E-01 | | 1.64E+00 |
| | 443.96 | 2.83 | -5.13E-01 | | 1.43E+00 |
| | 488.68 | 0.42 | -7.33E+00 | | 9.30E+00 |
| | 563.99 | 0.49 | 5.96E+00 | | 9.21E+00 |
| | 586.26 | 0.46 | 1.31E+01 | | 1.29E+01 |
| | 678.62 | 0.47 | 4.11E+00 | | 9.67E+00 |
| | 688.67 | 0.86 | -9.53E-01 | | 4.79E+00 |
| | 719.35 | 0.28 | 1.70E+00 | | 1.75E+01 |
| | 778.90 | 12.96 | 3.34E-01 | | 4.39E-01 |
| | 810.45 | 0.32 | 5.12E-01 | | 1.53E+01 |
| | 867.37 | 4.26 | -6.40E-01 | | 1.15E+00 |
| | 919.33 | 0.43 | 1.99E+00 | | 1.23E+01 |
| | 964.08 | 14.65 | -2.43E-01 | | 4.78E-01 |
| | 1085.87 | 10.24 | -1.70E-01 | | 5.75E-01 |
| | 1089.74 | 1.73 | -3.31E+00 | | 2.98E+00 |
| | 1112.07 | 13.69 | -1.98E-01 | | 5.39E-01 |
| | 1212.95 | 1.43 | 2.62E+00 | | 5.24E+00 |
| | 1249.94 | 0.19 | -8.92E+00 | | 3.74E+01 |
| | 1299.14 | 1.63 | -2.49E+00 | | 4.14E+00 |
| | 1408.01 | 21.07 | 1.44E-01 | | 2.34E-01 |
| | 1457.64 | 0.50 | 2.05E+02 | | 5.19E+01 |
| | 1528.10 | 0.28 | -1.29E+01 | | 1.19E+01 |
| Eu-154 | 123.07 | 40.40 | 7.62E-02 | 1.19E-01 | 1.19E-01 |
| | 247.93 | 6.89 | -9.06E-02 | | 6.13E-01 |
| | 591.76 | 4.95 | -8.58E-02 | | 9.55E-01 |
| | 692.42 | 1.78 | -3.59E-02 | | 2.86E+00 |
| | 723.30 | 20.06 | 2.82E-01 | | 2.93E-01 |
| | 756.80 | 4.52 | 3.49E-01 | | 1.31E+00 |
| | 873.18 | 12.08 | -3.36E-02 | | 4.13E-01 |

Analysis Report for 02-Oct-19-10018

L1-12104A-FSGS-003SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | 3.01E-01 | 1.19E-01 | 5.48E-01 |
| | 1004.76 | 18.01 | -1.28E-01 | | 3.00E-01 |
| | 1274.43 | 34.80 | 9.63E-02 | | 1.88E-01 |
| | 1596.48 | 1.80 | -2.58E+00 | | 2.26E+00 |
| Eu-155 | 45.30 | 1.31 | -8.69E+00 | 2.80E-01 | 2.87E+01 |
| | 60.01 | 1.22 | 9.85E+00 | | 3.18E+01 |
| | 86.55 | 30.70 | 3.94E-02 | | 2.80E-01 |
| | 105.31 | 21.10 | 1.95E-01 | | 2.91E-01 |
| Ra-226 | 186.21 | 3.64 | 3.94E-01 | 1.14E+00 | 1.14E+00 |
| Pa-231 | 27.36 | 10.30 | 1.69E+00 | 1.64E+00 | 3.53E+00 |
| | 283.69 | 1.70 | 9.30E-01 | | 2.25E+00 |
| | 300.07 | 2.47 | -1.27E+00 | | 1.64E+00 |
| | 302.65 | 2.20 | 1.80E+00 | | 1.93E+00 |
| | 330.06 | 1.40 | -3.48E-01 | | 3.01E+00 |
| U-235 | 143.76 | 10.96 | 1.40E-01 | 7.39E-02 | 3.94E-01 |
| | 163.33 | 5.08 | -5.49E-02 | | 8.12E-01 |
| | 185.71 | 57.20 | 3.74E-02 | | 7.39E-02 |
| | 202.11 | 1.08 | -4.97E-01 | | 3.43E+00 |
| | 205.31 | 5.01 | -3.41E-01 | | 7.29E-01 |
| Am-241 | 59.54 | 35.90 | 5.15E-01 | 1.14E+00 | 1.14E+00 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10019

L1-12104A-FSGS-004SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10019 |
| Sample Description | : L1-12104A-FSGS-004SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.634E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:06:00AM |
| Acquisition Started | : 10/2/2019 10:39:09AM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : P11314 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.3 seconds |
| Dead Time | : 0.03 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 1/24/2019 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80184 |
| Fill Height | : 1633.63 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 12/22/2008 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 10:54:22AM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Grohan

Analysis Report for 02-Oct-19-10019

L1-12104A-FSGS-004SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.89 | 947 - | 961 | 955.15 | 1.32E+02 | 15.82 | 4.11E+01 | 1.20 |
| 2 | 352.15 | 1399 - | 1415 | 1407.59 | 7.25E+01 | 12.59 | 2.75E+01 | 0.92 |
| 3 | 583.08 | 2325 - | 2338 | 2330.45 | 3.31E+01 | 9.26 | 1.89E+01 | 0.60 |
| 4 | 1460.37 | 5827 - | 5851 | 5839.41 | 4.58E+02 | 21.40 | 0.00E+00 | 2.17 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 0.96 | 1460.82 | * | 10.66 | 1.01E+01 | 6.44E-01 |
| Tl-208 | 0.99 | 583.19 | * | 85.00 | 4.90E-02 | 1.40E-02 |
| Pb-212 | 0.99 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 2.07E-01 | 3.00E-02 |
| | | 300.09 | | 3.30 | | |
| Pb-214 | 0.99 | 241.99 | | 7.25 | | |
| | | 295.22 | | 18.42 | | |
| | | 351.93 | * | 35.60 | 1.80E-01 | 3.45E-02 |
| | | 785.96 | | 1.06 | | |

Analysis Report for 02-Oct-19-10019

L1-12104A-FSGS-004SS

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# INTERFERENCE CORRECTED REPORT

| Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|
| K-40 | 0.968 | 1.01E+01 | 6.44E-01 | |
| Tl-208 | 0.998 | 4.90E-02 | 1.40E-02 | |
| Pb-212 | 0.990 | 2.07E-01 | 3.00E-02 | |
| Pb-214 | 0.996 | 1.80E-01 | 3.45E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10019

L1-12104A-FSGS-004SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 10:54:22AM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 4.46E-02 | 5.40E-02 | 5.40E-02 |
| | BE-7 | 477.60 | | 10.44 | 8.02E-02 | 4.13E-01 | 4.13E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 1.01E+01 | 6.34E-02 | 6.34E-02 |
| | Mn-54 | 834.85 | | 99.98 | -2.25E-02 | 4.96E-02 | 4.96E-02 |
| | Co-60 | 1173.23 | | 99.85 | -4.93E-02 | 5.09E-02 | 6.63E-02 |
| | | 1332.49 | | 99.98 | -2.71E-03 | | 5.09E-02 |
| | Nb-94 | 702.65 | | 99.81 | 3.76E-02 | 4.52E-02 | 4.54E-02 |
| | | 871.09 | | 99.89 | -9.70E-03 | | 4.52E-02 |
| | Ag-108m | 79.13 | | 6.60 | 1.81E-01 | 3.64E-02 | 1.10E+00 |
| | | 433.94 | | 90.50 | -5.66E-02 | | 3.64E-02 |
| | | 614.28 | | 89.80 | -7.41E-02 | | 5.45E-02 |
| | | 722.94 | | 90.80 | 4.45E-03 | | 5.21E-02 |
| | Sb-125 | 176.31 | | 6.84 | -2.90E-01 | 1.14E-01 | 4.26E-01 |
| | | 380.45 | | 1.52 | -5.40E-01 | | 2.17E+00 |
| | | 427.87 | | 29.60 | 1.73E-02 | | 1.14E-01 |
| | | 463.36 | | 10.49 | 6.19E-02 | | 3.48E-01 |
| | | 600.60 | | 17.65 | -1.16E-01 | | 2.39E-01 |
| | | 606.71 | | 4.98 | 1.19E+00 | | 1.20E+00 |
| | | 635.95 | | 11.22 | 1.25E-01 | | 3.48E-01 |

Analysis Report for 02-Oct-19-10019

L1-12104A-FSGS-004SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | -1.19E+00 | 1.14E-01 | 2.16E+00 |
| Ba-133 | 79.61 | 2.65 | 3.74E-01 | 6.70E-02 | 2.69E+00 |
| | 81.00 | 32.90 | -4.24E-01 | | 1.70E-01 |
| | 276.40 | 7.16 | 1.16E-01 | | 4.74E-01 |
| | 302.85 | 18.34 | -6.16E-02 | | 1.75E-01 |
| | 356.01 | 62.05 | -1.16E-02 | | 6.70E-02 |
| | 383.85 | 8.94 | 5.53E-02 | | 4.05E-01 |
| Cs-134 | 475.36 | 1.48 | 2.72E+00 | 5.47E-02 | 2.95E+00 |
| | 563.25 | 8.34 | -4.39E-01 | | 4.62E-01 |
| | 569.33 | 15.37 | 7.88E-02 | | 2.46E-01 |
| | 604.72 | 97.62 | -6.40E-02 | | 5.47E-02 |
| | 795.86 | 85.46 | 4.14E-02 | | 5.54E-02 |
| | 801.95 | 8.69 | -1.59E-01 | | 4.48E-01 |
| | 1038.61 | 0.99 | -2.78E+00 | | 5.88E+00 |
| | 1167.97 | 1.79 | -8.80E-01 | | 3.73E+00 |
| | 1365.19 | 3.02 | 1.18E+00 | | 1.63E+00 |
| Cs-137 | 661.66 | 85.10 | 2.06E-02 | 4.78E-02 | 4.78E-02 |
| Eu-152 | 121.78 | 28.67 | -3.62E-02 | 1.18E-01 | 1.18E-01 |
| | 244.70 | 7.61 | 5.73E-02 | | 4.63E-01 |
| | 295.94 | 0.45 | 2.11E-01 | | 8.48E+00 |
| | 344.28 | 26.60 | -7.58E-02 | | 1.21E-01 |
| | 367.79 | 0.86 | -1.10E+00 | | 3.83E+00 |
| | 411.12 | 2.24 | -7.25E-02 | | 1.49E+00 |
| | 443.96 | 2.83 | -5.86E-01 | | 1.33E+00 |
| | 488.68 | 0.42 | -1.26E+00 | | 8.72E+00 |
| | 563.99 | 0.49 | -4.08E+00 | | 7.42E+00 |
| | 586.26 | 0.46 | 1.81E+00 | | 1.22E+01 |
| | 678.62 | 0.47 | 2.13E+00 | | 8.76E+00 |
| | 688.67 | 0.86 | -1.53E+00 | | 4.41E+00 |
| | 719.35 | 0.28 | 2.02E-01 | | 1.54E+01 |
| | 778.90 | 12.96 | 2.47E-01 | | 3.55E-01 |
| | 810.45 | 0.32 | 1.33E+00 | | 1.22E+01 |
| | 867.37 | 4.26 | -6.77E-02 | | 1.11E+00 |
| | 919.33 | 0.43 | 5.12E-01 | | 1.11E+01 |
| | 964.08 | 14.65 | 5.02E-02 | | 4.02E-01 |
| | 1085.87 | 10.24 | 1.49E-01 | | 5.77E-01 |
| | 1089.74 | 1.73 | 3.08E+00 | | 3.69E+00 |
| | 1112.07 | 13.69 | -4.04E-02 | | 4.02E-01 |
| | 1212.95 | 1.43 | -4.55E+00 | | 4.90E+00 |
| | 1249.94 | 0.19 | 1.28E+01 | | 3.47E+01 |
| | 1299.14 | 1.63 | 6.47E-01 | | 4.30E+00 |
| | 1408.01 | 21.07 | 5.69E-02 | | 2.52E-01 |
| | 1457.64 | 0.50 | 2.07E+02 | | 4.94E+01 |
| | 1528.10 | 0.28 | -2.44E+00 | | 9.65E+00 |
| Eu-154 | 123.07 | 40.40 | -1.46E-02 | 8.15E-02 | 8.15E-02 |
| | 247.93 | 6.89 | -2.44E-01 | | 4.44E-01 |
| | 591.76 | 4.95 | -2.46E-01 | | 8.25E-01 |
| | 692.42 | 1.78 | 3.21E-01 | | 2.14E+00 |
| | 723.30 | 20.06 | 2.25E-01 | | 2.42E-01 |
| | 756.80 | 4.52 | 1.50E-01 | | 8.94E-01 |
| | 873.18 | 12.08 | 1.16E-01 | | 4.05E-01 |

Analysis Report for 02-Oct-19-10019

L1-12104A-FSGS-004SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | 1.06E-01 | 8.15E-02 | 4.47E-01 |
| | 1004.76 | 18.01 | 1.32E-01 | | 3.24E-01 |
| | 1274.43 | 34.80 | -7.50E-02 | | 1.81E-01 |
| | 1596.48 | 1.80 | 9.50E-02 | | 2.18E+00 |
| Eu-155 | 45.30 | 1.31 | 6.79E+00 | 1.82E-01 | 1.12E+01 |
| | 60.01 | 1.22 | 3.19E+00 | | 1.14E+01 |
| | 86.55 | 30.70 | 1.55E-01 | | 1.97E-01 |
| | 105.31 | 21.10 | -5.86E-02 | | 1.82E-01 |
| Ra-226 | 186.21 | 3.64 | 3.80E-01 | 9.55E-01 | 9.55E-01 |
| Pa-231 | 27.36 | 10.30 | 1.84E+00 | 1.28E+00 | 1.54E+00 |
| | 283.69 | 1.70 | 5.19E-02 | | 1.83E+00 |
| | 300.07 | 2.47 | -2.05E+00 | | 1.28E+00 |
| | 302.65 | 2.20 | -5.67E-01 | | 1.46E+00 |
| | 330.06 | 1.40 | 1.36E+00 | | 2.33E+00 |
| U-235 | 143.76 | 10.96 | -8.37E-02 | 6.09E-02 | 2.92E-01 |
| | 163.33 | 5.08 | 4.76E-01 | | 6.39E-01 |
| | 185.71 | 57.20 | 3.99E-02 | | 6.09E-02 |
| | 202.11 | 1.08 | 1.97E-02 | | 2.88E+00 |
| | 205.31 | 5.01 | 1.34E-01 | | 6.17E-01 |
| Am-241 | 59.54 | 35.90 | 5.23E-02 | 3.93E-01 | 3.93E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10020

L1-12104A-FSGS-005SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10020 |
| Sample Description | : L1-12104A-FSGS-005SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.702E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:08:00AM |
| Acquisition Started | : 10/2/2019 10:39:18AM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : 352 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.3 seconds |
| Dead Time | : 0.03 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 9/29/2018 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80185 |
| Fill Height | : 1701.69 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 1/7/2013 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 10:54:21AM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10020

L1-12104A-FSGS-005SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.76 | 948 - | 962 | 955.52 | 8.99E+01 | 16.41 | 6.21E+01 | 0.69 |
| 2 | 295.29 | 1177 - | 1189 | 1181.38 | 4.32E+01 | 10.08 | 2.18E+01 | 0.54 |
| 3 | 338.28 | 1345 - | 1359 | 1353.17 | 4.71E+01 | 10.40 | 2.09E+01 | 0.68 |
| 4 | 351.92 | 1401 - | 1415 | 1407.68 | 7.18E+01 | 11.64 | 2.22E+01 | 1.31 |
| 5 | 477.86 | 1907 - | 1916 | 1911.00 | 2.12E+01 | 7.55 | 1.58E+01 | 0.49 |
| 6 | 583.37 | 2327 - | 2338 | 2332.82 | 3.55E+01 | 7.36 | 7.45E+00 | 1.32 |
| 7 | 609.33 | 2430 - | 2443 | 2436.59 | 5.34E+01 | 8.77 | 8.60E+00 | 0.67 |
| 8 | 911.28 | 3638 - | 3651 | 3644.16 | 4.00E+01 | 7.86 | 7.97E+00 | 1.35 |
| 9 | 1460.86 | 5831 - | 5855 | 5843.79 | 4.61E+02 | 22.34 | 9.34E+00 | 1.75 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| BE-7 | 0.99 | 477.60 | * | 10.44 | 2.16E-01 | 7.83E-02 |
| K-40 | 1.00 | 1460.82 | * | 10.66 | 9.38E+00 | 6.11E-01 |
| Tl-208 | 0.99 | 583.19 | * | 85.00 | 4.98E-02 | 1.07E-02 |
| Pb-212 | 0.99 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.39E-01 | 2.77E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 1.00 | 609.32 | * | 45.49 | 1.44E-01 | 2.51E-02 |
| | | 768.36 | | 4.89 | | |

Analysis Report for 02-Oct-19-10020

L1-12104A-FSGS-005SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 1.00 | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |
| | | 1120.29 | | 14.92 | | |
| | | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 1.00 | 241.99 | | 7.25 | | |
| | | 295.22 | * | 18.42 | 1.77E-01 | 4.36E-02 |
| | | 351.93 | * | 35.60 | 1.72E-01 | 3.10E-02 |
| | | 785.96 | | 1.06 | | |
| Ac-228 | 1.00 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | * | 11.27 | 3.46E-01 | 8.14E-02 |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | * | 25.80 | 2.47E-01 | 4.97E-02 |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | | 15.80 | | |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# *INTERFERENCE CORRECTED REPORT*

Analysis Report for 02-Oct-19-10020

L1-12104A-FSGS-005SS

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | BE-7 | 0.990 | 2.16E-01 | 7.83E-02 | |
| | K-40 | 1.000 | 9.38E+00 | 6.11E-01 | |
| | Tl-208 | 0.994 | 4.98E-02 | 1.07E-02 | |
| X | Bi-211 | 0.890 | | | |
| | Pb-212 | 0.998 | 1.39E-01 | 2.77E-02 | |
| | Bi-214 | 1.000 | 1.44E-01 | 2.51E-02 | |
| | Pb-214 | 1.000 | 1.73E-01 | 2.53E-02 | |
| | Ac-228 | 1.000 | 2.74E-01 | 4.24E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10020

L1-12104A-FSGS-005SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 10:54:21AM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 3.21E-02 | 5.22E-02 | 5.22E-02 |
| + | BE-7 | 477.60 | * | 10.44 | 2.16E-01 | 2.36E-01 | 2.36E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 9.38E+00 | 4.87E-01 | 4.87E-01 |
| | Mn-54 | 834.85 | | 99.98 | 1.42E-02 | 4.64E-02 | 4.64E-02 |
| | Co-60 | 1173.23 | | 99.85 | -2.16E-02 | 4.72E-02 | 7.26E-02 |
| | | 1332.49 | | 99.98 | -7.16E-03 | | 4.72E-02 |
| | Nb-94 | 702.65 | | 99.81 | -2.97E-02 | 4.04E-02 | 4.04E-02 |
| | | 871.09 | | 99.89 | 1.89E-02 | | 4.95E-02 |
| | Ag-108m | 79.13 | | 6.60 | 4.19E-01 | 3.95E-02 | 1.50E+00 |
| | | 433.94 | | 90.50 | -9.07E-04 | | 3.95E-02 |
| | | 614.28 | | 89.80 | -4.23E-02 | | 6.42E-02 |
| | | 722.94 | | 90.80 | 4.71E-02 | | 4.89E-02 |
| | Sb-125 | 176.31 | | 6.84 | -1.18E-01 | 1.23E-01 | 4.83E-01 |
| | | 380.45 | | 1.52 | 1.25E+00 | | 2.35E+00 |
| | | 427.87 | | 29.60 | -6.22E-03 | | 1.23E-01 |
| | | 463.36 | | 10.49 | 2.23E-01 | | 3.53E-01 |
| | | 600.60 | | 17.65 | -1.68E-02 | | 2.48E-01 |
| | | 606.71 | | 4.98 | 2.87E-01 | | 1.19E+00 |
| | | 635.95 | | 11.22 | -1.27E-01 | | 3.69E-01 |

Analysis Report for 02-Oct-19-10020

L1-12104A-FSGS-005SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | -7.29E-01 | 1.23E-01 | 2.28E+00 |
| Ba-133 | 79.61 | 2.65 | 1.46E+00 | 7.32E-02 | 3.67E+00 |
| | 81.00 | 32.90 | -3.53E-01 | | 2.47E-01 |
| | 276.40 | 7.16 | 2.93E-01 | | 5.01E-01 |
| | 302.85 | 18.34 | 3.29E-02 | | 1.95E-01 |
| | 356.01 | 62.05 | 1.09E-02 | | 7.32E-02 |
| | 383.85 | 8.94 | -3.13E-02 | | 3.82E-01 |
| Cs-134 | 475.36 | 1.48 | 2.95E+00 | 5.47E-02 | 3.12E+00 |
| | 563.25 | 8.34 | 1.70E-02 | | 5.00E-01 |
| | 569.33 | 15.37 | 2.25E-02 | | 2.51E-01 |
| | 604.72 | 97.62 | -4.60E-03 | | 5.79E-02 |
| | 795.86 | 85.46 | 2.17E-02 | | 5.47E-02 |
| | 801.95 | 8.69 | -6.74E-02 | | 5.40E-01 |
| | 1038.61 | 0.99 | -7.48E-02 | | 5.18E+00 |
| | 1167.97 | 1.79 | 2.66E-01 | | 3.73E+00 |
| | 1365.19 | 3.02 | -7.64E-01 | | 1.18E+00 |
| Cs-137 | 661.66 | 85.10 | 4.02E-02 | 4.93E-02 | 4.93E-02 |
| Eu-152 | 121.78 | 28.67 | -3.91E-02 | 1.18E-01 | 1.37E-01 |
| | 244.70 | 7.61 | 1.70E-02 | | 4.92E-01 |
| | 295.94 | 0.45 | 6.20E+00 | | 9.19E+00 |
| | 344.28 | 26.60 | -2.77E-02 | | 1.18E-01 |
| | 367.79 | 0.86 | 2.05E+00 | | 4.10E+00 |
| | 411.12 | 2.24 | 5.28E-01 | | 1.60E+00 |
| | 443.96 | 2.83 | -8.42E-01 | | 1.17E+00 |
| | 488.68 | 0.42 | -1.26E+00 | | 8.01E+00 |
| | 563.99 | 0.49 | -8.04E-01 | | 8.15E+00 |
| | 586.26 | 0.46 | 2.66E+00 | | 1.09E+01 |
| | 678.62 | 0.47 | 2.67E+00 | | 9.56E+00 |
| | 688.67 | 0.86 | -2.97E+00 | | 4.70E+00 |
| | 719.35 | 0.28 | -3.80E+00 | | 1.45E+01 |
| | 778.90 | 12.96 | -3.08E-02 | | 3.03E-01 |
| | 810.45 | 0.32 | 1.97E+00 | | 1.52E+01 |
| | 867.37 | 4.26 | -6.66E-01 | | 1.16E+00 |
| | 919.33 | 0.43 | 8.44E+00 | | 1.07E+01 |
| | 964.08 | 14.65 | 8.09E-02 | | 4.26E-01 |
| | 1085.87 | 10.24 | -5.25E-02 | | 4.99E-01 |
| | 1089.74 | 1.73 | -1.75E+00 | | 3.10E+00 |
| | 1112.07 | 13.69 | -2.08E-01 | | 4.23E-01 |
| | 1212.95 | 1.43 | -3.49E+00 | | 4.84E+00 |
| | 1249.94 | 0.19 | 1.45E+01 | | 3.22E+01 |
| | 1299.14 | 1.63 | 1.20E+00 | | 3.24E+00 |
| | 1408.01 | 21.07 | 1.40E-01 | | 2.09E-01 |
| | 1457.64 | 0.50 | 2.05E+02 | | 4.65E+01 |
| | 1528.10 | 0.28 | -8.16E+00 | | 1.08E+01 |
| Eu-154 | 123.07 | 40.40 | -3.50E-02 | 9.55E-02 | 9.55E-02 |
| | 247.93 | 6.89 | -1.87E-01 | | 4.69E-01 |
| | 591.76 | 4.95 | -2.52E-01 | | 8.68E-01 |
| | 692.42 | 1.78 | 4.52E-01 | | 2.31E+00 |
| | 723.30 | 20.06 | 2.25E-01 | | 2.21E-01 |
| | 756.80 | 4.52 | 3.04E-01 | | 1.02E+00 |
| | 873.18 | 12.08 | 3.69E-01 | | 4.05E-01 |

Analysis Report for 02-Oct-19-10020

L1-12104A-FSGS-005SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | 2.33E-01 | 9.55E-02 | 5.35E-01 |
| | 1004.76 | 18.01 | -1.22E-01 | | 2.57E-01 |
| | 1274.43 | 34.80 | -3.87E-02 | | 1.38E-01 |
| | 1596.48 | 1.80 | -1.89E+00 | | 2.23E+00 |
| Eu-155 | 45.30 | 1.31 | 4.73E+00 | 2.20E-01 | 1.99E+01 |
| | 60.01 | 1.22 | 1.48E+01 | | 2.14E+01 |
| | 86.55 | 30.70 | -1.32E-02 | | 2.20E-01 |
| | 105.31 | 21.10 | 2.81E-02 | | 2.23E-01 |
| Ra-226 | 186.21 | 3.64 | 6.71E-01 | 1.04E+00 | 1.04E+00 |
| Pa-231 | 27.36 | 10.30 | 3.07E+00 | 1.47E+00 | 2.49E+00 |
| | 283.69 | 1.70 | -3.40E-01 | | 2.03E+00 |
| | 300.07 | 2.47 | -1.30E-02 | | 1.47E+00 |
| | 302.65 | 2.20 | 7.75E-01 | | 1.63E+00 |
| | 330.06 | 1.40 | 9.01E-01 | | 2.52E+00 |
| U-235 | 143.76 | 10.96 | -2.01E-01 | 6.54E-02 | 3.13E-01 |
| | 163.33 | 5.08 | 4.11E-01 | | 6.77E-01 |
| | 185.71 | 57.20 | 1.88E-02 | | 6.54E-02 |
| | 202.11 | 1.08 | 9.51E-01 | | 3.22E+00 |
| | 205.31 | 5.01 | -2.22E-01 | | 6.53E-01 |
| Am-241 | 59.54 | 35.90 | 6.16E-02 | 7.24E-01 | 7.24E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10021

L1-12104A-FSGS-006SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10021 |
| Sample Description | : L1-12104A-FSGS-006SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.679E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:10:00AM |
| Acquisition Started | : 10/2/2019 11:00:01AM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : 324 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.4 seconds |
| Dead Time | : 0.04 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 4096 |
| Peak Area Range (in channels) | : 120 - 4096 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 9/29/2018 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80186 |
| Fill Height | : 1678.83 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 1/30/2013 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 11:15:04AM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 4096

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10021

L1-12104A-FSGS-006SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 77.20 | 151 - | 158 | 155.00 | 3.39E+01 | 17.37 | 1.32E+02 | 0.58 |
| 2 | 238.66 | 473 - | 481 | 477.51 | 1.11E+02 | 17.93 | 9.58E+01 | 1.15 |
| 3 | 351.88 | 700 - | 708 | 703.71 | 5.93E+01 | 12.47 | 4.47E+01 | 0.94 |
| 4 | 583.08 | 1161 - | 1171 | 1165.77 | 5.31E+01 | 9.75 | 1.69E+01 | 1.26 |
| 5 | 609.16 | 1215 - | 1223 | 1217.90 | 6.18E+01 | 10.06 | 1.82E+01 | 1.30 |
| 6 | 911.05 | 1816 - | 1827 | 1821.56 | 4.02E+01 | 9.20 | 1.78E+01 | 1.21 |
| 7 | 1460.75 | 2914 - | 2928 | 2921.56 | 5.15E+02 | 23.15 | 7.50E+00 | 2.06 |
| 8 | 1764.70 | 3526 - | 3534 | 3530.25 | 1.70E+01 | 4.12 | 0.00E+00 | 1.67 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 0.99 | 1460.82 | * | 10.66 | 9.44E+00 | 5.90E-01 |
| Tl-208 | 0.99 | 583.19 | * | 85.00 | 6.72E-02 | 1.30E-02 |
| Bi-211 | 0.89 | 351.07 | * | 13.02 | 3.49E-01 | 7.87E-02 |
| Pb-212 | 1.00 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.54E-01 | 2.77E-02 |
| | | 300.09 | | 3.30 | | |
| Pb212-XR | 0.99 | 74.82 | | 10.28 | | |
| | | 77.11 | * | 17.10 | 2.19E-01 | 1.15E-01 |
| | | 87.35 | | 3.97 | | |

Analysis Report for 02-Oct-19-10021

L1-12104A-FSGS-006SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Pb212-XR | 0.99 | 89.78 | | 1.46 | | |
| Bi-214 | 0.99 | 609.32 | * | 45.49 | 1.50E-01 | 2.61E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |
| | | 1120.29 | | 14.92 | | |
| | | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | * | 15.30 | 2.50E-01 | 6.15E-02 |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 1.00 | 241.99 | | 7.25 | | |
| | | 295.22 | | 18.42 | | |
| | | 351.93 | * | 35.60 | 1.28E-01 | 2.88E-02 |
| | | 785.96 | | 1.06 | | |
| Pb214-XR | 0.99 | 74.82 | | 5.80 | | |
| | | 77.11 | * | 9.70 | 3.87E-01 | 2.03E-01 |
| | | 87.35 | | 2.24 | | |
| | | 89.78 | | 0.82 | | |
| Ac-228 | 0.99 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | | 11.27 | | |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | * | 25.80 | 2.24E-01 | 5.22E-02 |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | | 15.80 | | |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10021

L1-12104A-FSGS-006SS

# INTERFERENCE CORRECTED REPORT

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | K-40 | 0.999 | 9.44E+00 | 5.90E-01 | |
| | Tl-208 | 0.998 | 6.72E-02 | 1.30E-02 | |
| ? | Bi-211 | 0.899 | 3.49E-01 | 7.87E-02 | |
| | Pb-212 | 1.000 | 1.54E-01 | 2.77E-02 | |
| ? | Pb212-XR | 0.999 | 2.19E-01 | 1.15E-01 | |
| | Bi-214 | 0.997 | 1.65E-01 | 2.40E-02 | |
| ? | Pb-214 | 1.000 | 1.28E-01 | 2.88E-02 | |
| ? | Pb214-XR | 0.999 | 3.87E-01 | 2.03E-01 | |
| | Ac-228 | 0.999 | 2.24E-01 | 5.22E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10021

L1-12104A-FSGS-006SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 11:15:04AM
Peak Locate From Channel : 120
Peak Locate To Channel : 4096

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 5.95E-02 | 5.13E-02 | 5.13E-02 |
| | BE-7 | 477.60 | | 10.44 | -7.09E-02 | 3.07E-01 | 3.07E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 9.44E+00 | 3.42E-01 | 3.42E-01 |
| | Mn-54 | 834.85 | | 99.98 | 2.92E-03 | 3.96E-02 | 3.96E-02 |
| | Co-60 | 1173.23 | | 99.85 | 2.70E-02 | 4.04E-02 | 6.38E-02 |
| | | 1332.49 | | 99.98 | 6.40E-03 | | 4.04E-02 |
| | Nb-94 | 702.65 | | 99.81 | 2.18E-02 | 3.85E-02 | 3.85E-02 |
| | | 871.09 | | 99.89 | 2.07E-02 | | 4.69E-02 |
| | Ag-108m | 79.13 | | 6.60 | -5.07E-02 | 3.49E-02 | 1.03E+00 |
| | | 433.94 | | 90.50 | -1.13E-02 | | 3.49E-02 |
| | | 614.28 | | 89.80 | -2.48E-02 | | 4.64E-02 |
| | | 722.94 | | 90.80 | -1.53E-02 | | 4.08E-02 |
| | Sb-125 | 176.31 | | 6.84 | -5.35E-02 | 1.14E-01 | 5.00E-01 |
| | | 380.45 | | 1.52 | 1.54E+00 | | 2.17E+00 |
| | | 427.87 | | 29.60 | 2.52E-02 | | 1.14E-01 |
| | | 463.36 | | 10.49 | 1.68E-01 | | 3.30E-01 |
| | | 600.60 | | 17.65 | 1.22E-01 | | 2.35E-01 |
| | | 606.71 | | 4.98 | -1.44E+00 | | 1.15E+00 |
| | | 635.95 | | 11.22 | -1.76E-01 | | 2.87E-01 |

Analysis Report for 02-Oct-19-10021

L1-12104A-FSGS-006SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | 9.28E-01 | 1.14E-01 | 2.19E+00 |
| Ba-133 | 79.61 | 2.65 | -9.73E-02 | 6.54E-02 | 2.50E+00 |
| | 81.00 | 32.90 | -1.13E-01 | | 1.66E-01 |
| | 276.40 | 7.16 | 1.18E-02 | | 4.88E-01 |
| | 302.85 | 18.34 | 3.48E-02 | | 1.87E-01 |
| | 356.01 | 62.05 | -1.82E-02 | | 6.54E-02 |
| | 383.85 | 8.94 | 1.82E-02 | | 3.70E-01 |
| Cs-134 | 475.36 | 1.48 | -4.24E-01 | 4.28E-02 | 2.16E+00 |
| | 563.25 | 8.34 | -4.39E-02 | | 3.78E-01 |
| | 569.33 | 15.37 | -1.29E-01 | | 1.88E-01 |
| | 604.72 | 97.62 | -9.74E-02 | | 5.46E-02 |
| | 795.86 | 85.46 | 1.23E-02 | | 4.28E-02 |
| | 801.95 | 8.69 | -1.69E-01 | | 3.78E-01 |
| | 1038.61 | 0.99 | 1.87E+00 | | 5.12E+00 |
| | 1167.97 | 1.79 | 2.28E+00 | | 3.55E+00 |
| | 1365.19 | 3.02 | -5.13E-01 | | 1.40E+00 |
| Cs-137 | 661.66 | 85.10 | -2.25E-02 | 3.81E-02 | 3.81E-02 |
| Eu-152 | 121.78 | 28.67 | -7.77E-03 | 1.11E-01 | 1.11E-01 |
| | 244.70 | 7.61 | -1.30E-01 | | 4.42E-01 |
| | 295.94 | 0.45 | 7.81E+00 | | 8.95E+00 |
| | 344.28 | 26.60 | -1.06E-01 | | 1.17E-01 |
| | 367.79 | 0.86 | -3.84E-01 | | 3.44E+00 |
| | 411.12 | 2.24 | 9.42E-01 | | 1.57E+00 |
| | 443.96 | 2.83 | 5.29E-01 | | 1.29E+00 |
| | 488.68 | 0.42 | -5.01E+00 | | 6.54E+00 |
| | 563.99 | 0.49 | -2.98E-01 | | 6.43E+00 |
| | 586.26 | 0.46 | -1.46E+00 | | 1.10E+01 |
| | 678.62 | 0.47 | 2.00E+00 | | 8.06E+00 |
| | 688.67 | 0.86 | 7.62E-01 | | 4.58E+00 |
| | 719.35 | 0.28 | -3.46E-01 | | 1.27E+01 |
| | 778.90 | 12.96 | 1.01E-01 | | 3.05E-01 |
| | 810.45 | 0.32 | -3.82E+00 | | 1.09E+01 |
| | 867.37 | 4.26 | -2.84E-01 | | 9.79E-01 |
| | 919.33 | 0.43 | -1.74E+00 | | 1.00E+01 |
| | 964.08 | 14.65 | 5.55E-02 | | 3.67E-01 |
| | 1085.87 | 10.24 | 1.53E-01 | | 5.33E-01 |
| | 1089.74 | 1.73 | -1.75E+00 | | 2.79E+00 |
| | 1112.07 | 13.69 | -2.76E-02 | | 4.00E-01 |
| | 1212.95 | 1.43 | -1.70E-01 | | 4.48E+00 |
| | 1249.94 | 0.19 | 2.51E+01 | | 3.35E+01 |
| | 1299.14 | 1.63 | 7.17E-01 | | 3.46E+00 |
| | 1408.01 | 21.07 | -1.40E-02 | | 1.63E-01 |
| | 1457.64 | 0.50 | -3.11E+00 | | 4.38E+01 |
| | 1528.10 | 0.28 | 3.59E-01 | | 8.95E+00 |
| Eu-154 | 123.07 | 40.40 | -7.06E-03 | 7.85E-02 | 7.85E-02 |
| | 247.93 | 6.89 | 3.23E-01 | | 4.72E-01 |
| | 591.76 | 4.95 | -6.75E-01 | | 6.10E-01 |
| | 692.42 | 1.78 | 6.96E-01 | | 2.20E+00 |
| | 723.30 | 20.06 | -6.63E-02 | | 1.88E-01 |
| | 756.80 | 4.52 | 2.53E-01 | | 7.96E-01 |
| | 873.18 | 12.08 | 8.92E-02 | | 3.75E-01 |

Analysis Report for 02-Oct-19-10021

L1-12104A-FSGS-006SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | -1.44E-01 | 7.85E-02 | 3.69E-01 |
| | 1004.76 | 18.01 | -1.32E-02 | | 2.32E-01 |
| | 1274.43 | 34.80 | 5.23E-02 | | 1.47E-01 |
| | 1596.48 | 1.80 | -4.26E-01 | | 1.70E+00 |
| Eu-155 | 45.30 | 1.31 | 1.85E+00 | 1.69E-01 | 1.11E+01 |
| | 60.01 | 1.22 | 4.60E+00 | | 1.32E+01 |
| | 86.55 | 30.70 | 5.80E-02 | | 1.69E-01 |
| | 105.31 | 21.10 | 1.96E-02 | | 1.91E-01 |
| Ra-226 | 186.21 | 3.64 | 4.39E-01 | 9.86E-01 | 9.86E-01 |
| Pa-231 | 27.36 | 10.30 | 1.10E+00 | 1.20E+00 | 1.20E+00 |
| | 283.69 | 1.70 | -1.20E-01 | | 1.81E+00 |
| | 300.07 | 2.47 | -1.38E+00 | | 1.42E+00 |
| | 302.65 | 2.20 | 2.90E-01 | | 1.56E+00 |
| | 330.06 | 1.40 | -2.46E-01 | | 2.35E+00 |
| U-235 | 143.76 | 10.96 | 1.14E-01 | 6.25E-02 | 2.94E-01 |
| | 163.33 | 5.08 | 2.18E-01 | | 7.17E-01 |
| | 185.71 | 57.20 | 8.61E-03 | | 6.25E-02 |
| | 202.11 | 1.08 | 9.82E-01 | | 3.27E+00 |
| | 205.31 | 5.01 | -2.01E-01 | | 6.81E-01 |
| Am-241 | 59.54 | 35.90 | 3.55E-02 | 4.46E-01 | 4.46E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10022

L1-12104A-FSGS-007SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10022 |
| Sample Description | : L1-12104A-FSGS-007SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.698E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:12:00AM |
| Acquisition Started | : 10/2/2019 11:00:07AM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : P40818B |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 901.4 seconds |
| Dead Time | : 0.16 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 1/29/2019 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80187 |
| Fill Height | : 1697.87 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 1/30/2012 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 11:15:11AM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Grohan

Analysis Report for 02-Oct-19-10022

L1-12104A-FSGS-007SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.58 | 947 - | 962 | 954.41 | 1.30E+02 | 19.15 | 7.84E+01 | 0.70 |
| 2 | 295.01 | 1173 - | 1184 | 1179.93 | 2.63E+01 | 10.20 | 3.07E+01 | 0.55 |
| 3 | 351.79 | 1399 - | 1414 | 1406.89 | 7.10E+01 | 13.38 | 3.60E+01 | 0.79 |
| 4 | 582.89 | 2325 - | 2336 | 2330.76 | 4.89E+01 | 8.92 | 1.21E+01 | 0.41 |
| 5 | 609.04 | 2427 - | 2441 | 2435.34 | 5.98E+01 | 9.30 | 9.24E+00 | 1.28 |
| 6 | 910.97 | 3636 - | 3648 | 3642.82 | 2.63E+01 | 6.69 | 6.73E+00 | 1.02 |
| 7 | 968.68 | 3868 - | 3879 | 3873.71 | 2.20E+01 | 6.69 | 9.00E+00 | 0.45 |
| 8 | 1460.23 | 5829 - | 5852 | 5840.77 | 3.76E+02 | 19.39 | 0.00E+00 | 1.82 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 0.94 | 1460.82 | * | 10.66 | 9.11E+00 | 6.14E-01 |
| Tl-208 | 0.98 | 583.19 | * | 85.00 | 7.97E-02 | 1.53E-02 |
| Pb-212 | 1.00 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 2.28E-01 | 3.83E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 0.99 | 609.32 | * | 45.49 | 1.88E-01 | 3.13E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |

Analysis Report for 02-Oct-19-10022

L1-12104A-FSGS-007SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 0.99 | 1120.29 | | 14.92 | | |
| | | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 0.99 | 241.99 | | 7.25 | | |
| | | 295.22 | * | 18.42 | 1.23E-01 | 4.87E-02 |
| | | 351.93 | * | 35.60 | 1.95E-01 | 3.99E-02 |
| | | 785.96 | | 1.06 | | |
| Ac-228 | 0.99 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | | 11.27 | | |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | * | 25.80 | 1.91E-01 | 4.93E-02 |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | * | 15.80 | 2.72E-01 | 8.36E-02 |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# *INTERFERENCE CORRECTED REPORT*

Analysis Report for 02-Oct-19-10022

L1-12104A-FSGS-007SS

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | K-40 | 0.946 | 9.11E+00 | 6.14E-01 | |
| | Tl-208 | 0.986 | 7.97E-02 | 1.53E-02 | |
| X | Bi-211 | 0.920 | | | |
| | Pb-212 | 1.000 | 2.28E-01 | 3.83E-02 | |
| | Bi-214 | 0.995 | 1.88E-01 | 3.13E-02 | |
| | Pb-214 | 0.996 | 1.66E-01 | 3.09E-02 | |
| | Ac-228 | 0.995 | 2.12E-01 | 4.25E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10022

L1-12104A-FSGS-007SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 11:15:11AM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 5.82E-02 | 6.02E-02 | 6.02E-02 |
| | BE-7 | 477.60 | | 10.44 | -1.74E-01 | 3.57E-01 | 3.57E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 9.11E+00 | 6.97E-02 | 6.97E-02 |
| | Mn-54 | 834.85 | | 99.98 | 5.07E-03 | 5.81E-02 | 5.81E-02 |
| | Co-60 | 1173.23 | | 99.85 | 4.24E-02 | 6.12E-02 | 7.29E-02 |
| | | 1332.49 | | 99.98 | 2.33E-02 | | 6.12E-02 |
| | Nb-94 | 702.65 | | 99.81 | -1.63E-03 | 4.52E-02 | 4.52E-02 |
| | | 871.09 | | 99.89 | -1.57E-02 | | 5.45E-02 |
| | Ag-108m | 79.13 | | 6.60 | 6.78E-01 | 4.25E-02 | 1.86E+00 |
| | | 433.94 | | 90.50 | -4.60E-02 | | 4.25E-02 |
| | | 614.28 | | 89.80 | -2.68E-02 | | 5.78E-02 |
| | | 722.94 | | 90.80 | -2.40E-02 | | 5.86E-02 |
| | Sb-125 | 176.31 | | 6.84 | -3.41E-01 | 1.45E-01 | 5.51E-01 |
| | | 380.45 | | 1.52 | -1.70E+00 | | 2.60E+00 |
| | | 427.87 | | 29.60 | -4.03E-02 | | 1.45E-01 |
| | | 463.36 | | 10.49 | -2.85E-01 | | 4.04E-01 |
| | | 600.60 | | 17.65 | 1.64E-01 | | 2.66E-01 |
| | | 606.71 | | 4.98 | 2.44E+00 | | 1.42E+00 |
| | | 635.95 | | 11.22 | 1.30E-01 | | 4.05E-01 |

Analysis Report for 02-Oct-19-10022

L1-12104A-FSGS-007SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | -1.26E+00 | 1.45E-01 | 2.49E+00 |
| Ba-133 | 79.61 | 2.65 | -1.56E+00 | 7.80E-02 | 4.25E+00 |
| | 81.00 | 32.90 | -1.59E-01 | | 2.99E-01 |
| | 276.40 | 7.16 | -2.85E-02 | | 5.31E-01 |
| | 302.85 | 18.34 | -2.37E-02 | | 2.11E-01 |
| | 356.01 | 62.05 | 2.67E-02 | | 7.80E-02 |
| | 383.85 | 8.94 | 3.54E-01 | | 4.80E-01 |
| Cs-134 | 475.36 | 1.48 | -9.22E-01 | 6.34E-02 | 2.62E+00 |
| | 563.25 | 8.34 | -2.67E-01 | | 5.02E-01 |
| | 569.33 | 15.37 | 3.55E-02 | | 2.81E-01 |
| | 604.72 | 97.62 | 1.79E-03 | | 6.94E-02 |
| | 795.86 | 85.46 | 7.92E-04 | | 6.34E-02 |
| | 801.95 | 8.69 | 3.25E-01 | | 5.94E-01 |
| | 1038.61 | 0.99 | -1.50E+00 | | 5.85E+00 |
| | 1167.97 | 1.79 | -2.75E+00 | | 3.71E+00 |
| | 1365.19 | 3.02 | -5.23E-01 | | 1.98E+00 |
| Cs-137 | 661.66 | 85.10 | -1.88E-02 | 5.40E-02 | 5.40E-02 |
| Eu-152 | 121.78 | 28.67 | -5.45E-02 | 1.52E-01 | 1.52E-01 |
| | 244.70 | 7.61 | 3.04E-02 | | 5.94E-01 |
| | 295.94 | 0.45 | 4.37E+00 | | 9.61E+00 |
| | 344.28 | 26.60 | 2.72E-02 | | 1.58E-01 |
| | 367.79 | 0.86 | -8.46E-01 | | 4.06E+00 |
| | 411.12 | 2.24 | 9.09E-01 | | 1.74E+00 |
| | 443.96 | 2.83 | -9.02E-01 | | 1.35E+00 |
| | 488.68 | 0.42 | -5.66E+00 | | 8.13E+00 |
| | 563.99 | 0.49 | 5.96E+00 | | 9.07E+00 |
| | 586.26 | 0.46 | -6.95E+00 | | 1.43E+01 |
| | 678.62 | 0.47 | 6.04E-01 | | 8.90E+00 |
| | 688.67 | 0.86 | 1.98E-01 | | 4.94E+00 |
| | 719.35 | 0.28 | 8.28E+00 | | 1.95E+01 |
| | 778.90 | 12.96 | -3.28E-01 | | 3.55E-01 |
| | 810.45 | 0.32 | 4.77E+00 | | 1.52E+01 |
| | 867.37 | 4.26 | 1.07E+00 | | 1.35E+00 |
| | 919.33 | 0.43 | 1.54E+00 | | 1.20E+01 |
| | 964.08 | 14.65 | -1.49E-01 | | 5.15E-01 |
| | 1085.87 | 10.24 | -1.88E-01 | | 5.62E-01 |
| | 1089.74 | 1.73 | 2.04E+00 | | 3.81E+00 |
| | 1112.07 | 13.69 | -5.58E-01 | | 4.34E-01 |
| | 1212.95 | 1.43 | 3.65E+00 | | 6.05E+00 |
| | 1249.94 | 0.19 | -4.12E+00 | | 3.51E+01 |
| | 1299.14 | 1.63 | -1.87E-01 | | 3.30E+00 |
| | 1408.01 | 21.07 | -3.43E-02 | | 1.96E-01 |
| | 1457.64 | 0.50 | 1.86E+02 | | 4.94E+01 |
| | 1528.10 | 0.28 | 2.85E+00 | | 1.06E+01 |
| Eu-154 | 123.07 | 40.40 | 7.88E-04 | 1.10E-01 | 1.10E-01 |
| | 247.93 | 6.89 | -2.61E-01 | | 5.78E-01 |
| | 591.76 | 4.95 | -1.42E-01 | | 8.73E-01 |
| | 692.42 | 1.78 | 2.50E-01 | | 2.52E+00 |
| | 723.30 | 20.06 | 2.56E-02 | | 2.66E-01 |
| | 756.80 | 4.52 | 9.48E-02 | | 1.11E+00 |
| | 873.18 | 12.08 | -2.30E-01 | | 4.32E-01 |

Analysis Report for 02-Oct-19-10022

L1-12104A-FSGS-007SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | -5.01E-01 | 1.10E-01 | 4.52E-01 |
| | 1004.76 | 18.01 | 8.78E-02 | | 2.99E-01 |
| | 1274.43 | 34.80 | 1.16E-01 | | 1.96E-01 |
| | 1596.48 | 1.80 | -8.56E-03 | | 2.66E+00 |
| Eu-155 | 45.30 | 1.31 | -9.72E+00 | 2.85E-01 | 2.80E+01 |
| | 60.01 | 1.22 | 2.21E+01 | | 3.47E+01 |
| | 86.55 | 30.70 | 1.02E-01 | | 2.85E-01 |
| | 105.31 | 21.10 | -1.63E-02 | | 2.99E-01 |
| Ra-226 | 186.21 | 3.64 | -1.78E-02 | 1.11E+00 | 1.11E+00 |
| Pa-231 | 27.36 | 10.30 | 4.50E+00 | 1.56E+00 | 3.72E+00 |
| | 283.69 | 1.70 | -1.64E-01 | | 2.12E+00 |
| | 300.07 | 2.47 | -7.30E-01 | | 1.56E+00 |
| | 302.65 | 2.20 | 1.85E-01 | | 1.78E+00 |
| | 330.06 | 1.40 | -7.40E-01 | | 2.50E+00 |
| U-235 | 143.76 | 10.96 | -1.86E-01 | 7.26E-02 | 3.92E-01 |
| | 163.33 | 5.08 | 2.02E-01 | | 7.99E-01 |
| | 185.71 | 57.20 | 1.13E-02 | | 7.26E-02 |
| | 202.11 | 1.08 | 1.08E+00 | | 3.65E+00 |
| | 205.31 | 5.01 | 5.05E-01 | | 7.92E-01 |
| Am-241 | 59.54 | 35.90 | 3.83E-01 | 1.20E+00 | 1.20E+00 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10023

L1-12104A-FSGS-008SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10023 |
| Sample Description | : L1-12104A-FSGS-008SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.636E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:14:00AM |
| Acquisition Started | : 10/2/2019 11:00:13AM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : P11314 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.3 seconds |
| Dead Time | : 0.03 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 1/24/2019 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80188 |
| Fill Height | : 1635.90 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 12/22/2008 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 11:15:34AM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10023

L1-12104A-FSGS-008SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 77.43 | 308 - | 315 | 310.27 | 2.37E+01 | 11.61 | 5.43E+01 | 0.64 |
| 2 | 238.82 | 947 - | 960 | 954.85 | 9.83E+01 | 15.67 | 5.27E+01 | 0.74 |
| 3 | 351.77 | 1401 - | 1415 | 1406.11 | 9.62E+01 | 12.34 | 1.98E+01 | 1.62 |
| 4 | 582.92 | 2323 - | 2339 | 2329.80 | 5.91E+01 | 8.05 | 1.93E+00 | 0.72 |
| 5 | 609.30 | 2428 - | 2441 | 2435.24 | 4.81E+01 | 10.01 | 1.79E+01 | 0.48 |
| 6 | 910.95 | 3634 - | 3648 | 3641.26 | 3.34E+01 | 7.09 | 5.58E+00 | 1.42 |
| 7 | 1460.31 | 5826 - | 5851 | 5839.18 | 4.56E+02 | 21.67 | 3.27E+00 | 2.02 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 0.95 | 1460.82 | * | 10.66 | 1.00E+01 | 6.46E-01 |
| Tl-208 | 0.98 | 583.19 | * | 85.00 | 8.76E-02 | 1.30E-02 |
| Bi-211 | 0.92 | 351.07 | * | 13.02 | 6.53E-01 | 9.90E-02 |
| Pb-212 | 0.99 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.54E-01 | 2.76E-02 |
| | | 300.09 | | 3.30 | | |
| Pb212-XR | 0.99 | 74.82 | | 10.28 | | |
| | | 77.11 | * | 17.10 | 1.65E-01 | 8.24E-02 |
| | | 87.35 | | 3.97 | | |
| | | 89.78 | | 1.46 | | |

Analysis Report for 02-Oct-19-10023

L1-12104A-FSGS-008SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 1.00 | 609.32 | * | 45.49 | 1.37E-01 | 2.97E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |
| | | 1120.29 | | 14.92 | | |
| | | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 0.51 | 241.99 | | 7.25 | | |
| | | 295.22 | | 18.42 | | |
| | | 351.93 | * | 35.60 | 2.39E-01 | 3.61E-02 |
| | | 785.96 | | 1.06 | | |
| Pb214-XR | 0.99 | 74.82 | | 5.80 | | |
| | | 77.11 | * | 9.70 | 2.90E-01 | 1.46E-01 |
| | | 87.35 | | 2.24 | | |
| | | 89.78 | | 0.82 | | |
| Ac-228 | 0.99 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | | 11.27 | | |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | * | 25.80 | 2.21E-01 | 4.78E-02 |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | | 15.80 | | |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10023

L1-12104A-FSGS-008SS

# INTERFERENCE CORRECTED REPORT

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | K-40 | 0.959 | 1.00E+01 | 6.46E-01 | |
| | Tl-208 | 0.989 | 8.76E-02 | 1.30E-02 | |
| ? | Bi-211 | 0.924 | 6.53E-01 | 9.90E-02 | |
| | Pb-212 | 0.995 | 1.54E-01 | 2.76E-02 | |
| ? | Pb212-XR | 0.991 | 1.65E-01 | 8.24E-02 | |
| | Bi-214 | 1.000 | 1.37E-01 | 2.97E-02 | |
| ? | Pb-214 | 0.511 | 2.39E-01 | 3.61E-02 | |
| ? | Pb214-XR | 0.991 | 2.90E-01 | 1.46E-01 | |
| | Ac-228 | 0.997 | 2.21E-01 | 4.78E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10023

L1-12104A-FSGS-008SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 11:15:34AM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 6.38E-02 | 5.49E-02 | 5.49E-02 |
| | BE-7 | 477.60 | | 10.44 | -6.55E-03 | 3.85E-01 | 3.85E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 1.00E+01 | 3.43E-01 | 3.43E-01 |
| | Mn-54 | 834.85 | | 99.98 | -2.38E-02 | 4.40E-02 | 4.40E-02 |
| | Co-60 | 1173.23 | | 99.85 | -1.66E-02 | 4.83E-02 | 6.05E-02 |
| | | 1332.49 | | 99.98 | 3.50E-02 | | 4.83E-02 |
| | Nb-94 | 702.65 | | 99.81 | -2.66E-02 | 4.42E-02 | 4.42E-02 |
| | | 871.09 | | 99.89 | 8.71E-03 | | 4.52E-02 |
| | Ag-108m | 79.13 | | 6.60 | 9.35E-02 | 4.25E-02 | 1.08E+00 |
| | | 433.94 | | 90.50 | 8.15E-03 | | 4.25E-02 |
| | | 614.28 | | 89.80 | -6.17E-02 | | 5.86E-02 |
| | | 722.94 | | 90.80 | -1.12E-02 | | 4.95E-02 |
| | Sb-125 | 176.31 | | 6.84 | 1.07E-01 | 1.24E-01 | 4.01E-01 |
| | | 380.45 | | 1.52 | 9.80E-02 | | 2.19E+00 |
| | | 427.87 | | 29.60 | 1.30E-02 | | 1.24E-01 |
| | | 463.36 | | 10.49 | 6.38E-02 | | 3.63E-01 |
| | | 600.60 | | 17.65 | -2.51E-01 | | 1.96E-01 |
| | | 606.71 | | 4.98 | 1.72E+00 | | 1.27E+00 |
| | | 635.95 | | 11.22 | -3.52E-02 | | 3.73E-01 |

Analysis Report for 02-Oct-19-10023

L1-12104A-FSGS-008SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | 2.54E-01 | 1.24E-01 | 2.26E+00 |
| Ba-133 | 79.61 | 2.65 | 3.91E-01 | 6.27E-02 | 2.66E+00 |
| | 81.00 | 32.90 | 1.07E-03 | | 1.83E-01 |
| | 276.40 | 7.16 | 1.34E-01 | | 4.85E-01 |
| | 302.85 | 18.34 | -8.48E-02 | | 1.61E-01 |
| | 356.01 | 62.05 | -1.28E-02 | | 6.27E-02 |
| | 383.85 | 8.94 | -7.70E-02 | | 3.42E-01 |
| Cs-134 | 475.36 | 1.48 | 1.86E+00 | 5.38E-02 | 2.73E+00 |
| | 563.25 | 8.34 | -3.08E-01 | | 4.79E-01 |
| | 569.33 | 15.37 | -9.40E-02 | | 2.39E-01 |
| | 604.72 | 97.62 | -2.64E-02 | | 5.38E-02 |
| | 795.86 | 85.46 | 1.51E-02 | | 5.46E-02 |
| | 801.95 | 8.69 | -1.77E-02 | | 4.92E-01 |
| | 1038.61 | 0.99 | -2.21E-01 | | 5.23E+00 |
| | 1167.97 | 1.79 | -4.97E-02 | | 3.51E+00 |
| | 1365.19 | 3.02 | 6.08E-01 | | 1.76E+00 |
| Cs-137 | 661.66 | 85.10 | 3.02E-02 | 4.91E-02 | 4.91E-02 |
| Eu-152 | 121.78 | 28.67 | -1.34E-02 | 1.15E-01 | 1.15E-01 |
| | 244.70 | 7.61 | 9.99E-02 | | 5.17E-01 |
| | 295.94 | 0.45 | 4.70E+00 | | 8.95E+00 |
| | 344.28 | 26.60 | -2.69E-02 | | 1.29E-01 |
| | 367.79 | 0.86 | -5.63E-01 | | 3.44E+00 |
| | 411.12 | 2.24 | -1.25E-01 | | 1.52E+00 |
| | 443.96 | 2.83 | -4.19E-01 | | 1.11E+00 |
| | 488.68 | 0.42 | -6.34E+00 | | 7.97E+00 |
| | 563.99 | 0.49 | -2.79E+00 | | 7.53E+00 |
| | 586.26 | 0.46 | -3.30E+00 | | 1.18E+01 |
| | 678.62 | 0.47 | 1.41E+00 | | 9.13E+00 |
| | 688.67 | 0.86 | -3.41E+00 | | 4.64E+00 |
| | 719.35 | 0.28 | -6.43E+00 | | 1.42E+01 |
| | 778.90 | 12.96 | -2.99E-02 | | 2.88E-01 |
| | 810.45 | 0.32 | 1.14E+01 | | 1.63E+01 |
| | 867.37 | 4.26 | -7.79E-02 | | 1.13E+00 |
| | 919.33 | 0.43 | 2.01E+00 | | 1.30E+01 |
| | 964.08 | 14.65 | 2.39E-01 | | 4.45E-01 |
| | 1085.87 | 10.24 | -4.27E-01 | | 5.61E-01 |
| | 1089.74 | 1.73 | 1.18E+00 | | 3.42E+00 |
| | 1112.07 | 13.69 | -6.81E-02 | | 3.82E-01 |
| | 1212.95 | 1.43 | -3.38E+00 | | 4.74E+00 |
| | 1249.94 | 0.19 | 1.17E+01 | | 3.52E+01 |
| | 1299.14 | 1.63 | -1.20E+00 | | 3.36E+00 |
| | 1408.01 | 21.07 | 5.08E-02 | | 2.11E-01 |
| | 1457.64 | 0.50 | 2.17E+02 | | 4.96E+01 |
| | 1528.10 | 0.28 | -1.66E+01 | | 1.49E+01 |
| Eu-154 | 123.07 | 40.40 | -2.80E-02 | 8.15E-02 | 8.15E-02 |
| | 247.93 | 6.89 | 5.78E-02 | | 4.88E-01 |
| | 591.76 | 4.95 | 9.00E-02 | | 6.53E-01 |
| | 692.42 | 1.78 | -3.99E-01 | | 2.46E+00 |
| | 723.30 | 20.06 | -5.82E-02 | | 2.21E-01 |
| | 756.80 | 4.52 | 4.59E-01 | | 9.55E-01 |
| | 873.18 | 12.08 | -5.61E-02 | | 3.99E-01 |

Analysis Report for 02-Oct-19-10023

L1-12104A-FSGS-008SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | 4.97E-01 | 8.15E-02 | 5.74E-01 |
| | 1004.76 | 18.01 | -4.74E-02 | | 3.16E-01 |
| | 1274.43 | 34.80 | 2.98E-02 | | 1.61E-01 |
| | 1596.48 | 1.80 | -2.83E+00 | | 1.75E+00 |
| Eu-155 | 45.30 | 1.31 | -9.30E+00 | 1.66E-01 | 1.12E+01 |
| | 60.01 | 1.22 | -5.17E+00 | | 1.14E+01 |
| | 86.55 | 30.70 | 5.29E-02 | | 1.66E-01 |
| | 105.31 | 21.10 | 1.27E-02 | | 1.68E-01 |
| Ra-226 | 186.21 | 3.64 | 3.93E-01 | 9.19E-01 | 9.19E-01 |
| Pa-231 | 27.36 | 10.30 | 8.67E-01 | 1.21E+00 | 1.29E+00 |
| | 283.69 | 1.70 | -1.18E+00 | | 1.86E+00 |
| | 300.07 | 2.47 | -2.67E+00 | | 1.21E+00 |
| | 302.65 | 2.20 | -6.08E-01 | | 1.34E+00 |
| | 330.06 | 1.40 | 1.04E-01 | | 2.46E+00 |
| U-235 | 143.76 | 10.96 | 1.25E-01 | 5.77E-02 | 3.08E-01 |
| | 163.33 | 5.08 | -1.60E-01 | | 5.91E-01 |
| | 185.71 | 57.20 | 9.26E-03 | | 5.77E-02 |
| | 202.11 | 1.08 | -1.66E+00 | | 2.71E+00 |
| | 205.31 | 5.01 | -3.07E-01 | | 5.82E-01 |
| Am-241 | 59.54 | 35.90 | -2.15E-01 | 4.01E-01 | 4.01E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10024

L1-12104A-FSGS-009SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10024 |
| Sample Description | : L1-12104A-FSGS-009SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.634E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:16:00AM |
| Acquisition Started | : 10/2/2019 11:00:21AM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : 352 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.3 seconds |
| Dead Time | : 0.03 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 9/29/2018 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80189 |
| Fill Height | : 1634.15 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 1/7/2013 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 11:15:26AM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10024

L1-12104A-FSGS-009SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.63 | 948 - | 961 | 955.00 | 1.05E+02 | 16.75 | 6.26E+01 | 0.95 |
| 2 | 295.36 | 1174 - | 1186 | 1181.64 | 4.24E+01 | 9.96 | 2.16E+01 | 0.82 |
| 3 | 338.25 | 1349 - | 1359 | 1353.05 | 2.05E+01 | 8.50 | 2.15E+01 | 0.68 |
| 4 | 351.82 | 1402 - | 1416 | 1407.26 | 8.94E+01 | 12.07 | 1.96E+01 | 0.91 |
| 5 | 582.96 | 2323 - | 2337 | 2331.15 | 4.13E+01 | 9.45 | 1.67E+01 | 0.69 |
| 6 | 609.45 | 2427 - | 2443 | 2437.06 | 5.78E+01 | 9.11 | 8.15E+00 | 1.47 |
| 7 | 1460.84 | 5831 - | 5855 | 5843.74 | 4.26E+02 | 21.87 | 1.25E+01 | 1.97 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 1.00 | 1460.82 | * | 10.66 | 8.77E+00 | 5.89E-01 |
| Tl-208 | 0.99 | 583.19 | * | 85.00 | 5.82E-02 | 1.38E-02 |
| Pb-212 | 1.00 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.63E-01 | 2.91E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 0.99 | 609.32 | * | 45.49 | 1.57E-01 | 2.64E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |
| | | 1120.29 | | 14.92 | | |

Analysis Report for 02-Oct-19-10024

L1-12104A-FSGS-009SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 0.99 | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 0.99 | 241.99 | | 7.25 | | |
| | | 295.22 | * | 18.42 | 1.74E-01 | 4.33E-02 |
| | | 351.93 | * | 35.60 | 2.15E-01 | 3.37E-02 |
| | | 785.96 | | 1.06 | | |
| Ac-228 | 1.00 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | * | 11.27 | 1.52E-01 | 6.40E-02 |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | | 25.80 | | |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | | 15.80 | | |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# *INTERFERENCE CORRECTED REPORT*

Analysis Report for 02-Oct-19-10024

L1-12104A-FSGS-009SS

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | K-40 | 1.000 | 8.77E+00 | 5.89E-01 | |
| | Tl-208 | 0.992 | 5.82E-02 | 1.38E-02 | |
| X | Bi-211 | 0.915 | | | |
| | Pb-212 | 1.000 | 1.63E-01 | 2.91E-02 | |
| | Bi-214 | 0.999 | 1.57E-01 | 2.64E-02 | |
| | Pb-214 | 0.998 | 2.00E-01 | 2.66E-02 | |
| | Ac-228 | 1.000 | 1.52E-01 | 6.40E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10024

L1-12104A-FSGS-009SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 11:15:26AM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 5.04E-02 | 4.98E-02 | 4.98E-02 |
| | BE-7 | 477.60 | | 10.44 | 1.79E-01 | 4.21E-01 | 4.21E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 8.77E+00 | 5.61E-01 | 5.61E-01 |
| | Mn-54 | 834.85 | | 99.98 | 3.16E-02 | 4.98E-02 | 4.98E-02 |
| | Co-60 | 1173.23 | | 99.85 | 1.82E-03 | 5.70E-02 | 6.42E-02 |
| | | 1332.49 | | 99.98 | 3.72E-03 | | 5.70E-02 |
| | Nb-94 | 702.65 | | 99.81 | 1.16E-02 | 4.35E-02 | 4.35E-02 |
| | | 871.09 | | 99.89 | 2.73E-04 | | 4.54E-02 |
| | Ag-108m | 79.13 | | 6.60 | 9.11E-02 | 3.86E-02 | 1.52E+00 |
| | | 433.94 | | 90.50 | -2.48E-02 | | 3.86E-02 |
| | | 614.28 | | 89.80 | -3.83E-02 | | 6.36E-02 |
| | | 722.94 | | 90.80 | -5.16E-02 | | 5.22E-02 |
| | Sb-125 | 176.31 | | 6.84 | -2.10E-01 | 1.13E-01 | 4.82E-01 |
| | | 380.45 | | 1.52 | -3.57E-01 | | 2.39E+00 |
| | | 427.87 | | 29.60 | 1.55E-02 | | 1.13E-01 |
| | | 463.36 | | 10.49 | 1.00E-01 | | 3.75E-01 |
| | | 600.60 | | 17.65 | 2.51E-01 | | 2.35E-01 |
| | | 606.71 | | 4.98 | 9.82E-01 | | 1.18E+00 |
| | | 635.95 | | 11.22 | 7.25E-02 | | 3.80E-01 |

Analysis Report for 02-Oct-19-10024

L1-12104A-FSGS-009SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | 8.90E-01 | 1.13E-01 | 2.30E+00 |
| Ba-133 | 79.61 | 2.65 | 5.94E-01 | 7.59E-02 | 3.65E+00 |
| | 81.00 | 32.90 | -9.33E-02 | | 2.69E-01 |
| | 276.40 | 7.16 | -1.02E-02 | | 4.73E-01 |
| | 302.85 | 18.34 | 1.68E-02 | | 1.90E-01 |
| | 356.01 | 62.05 | -8.40E-03 | | 7.59E-02 |
| | 383.85 | 8.94 | -1.73E-01 | | 3.98E-01 |
| Cs-134 | 475.36 | 1.48 | 2.64E+00 | 5.37E-02 | 2.99E+00 |
| | 563.25 | 8.34 | 1.89E-01 | | 4.34E-01 |
| | 569.33 | 15.37 | -1.48E-01 | | 2.31E-01 |
| | 604.72 | 97.62 | 7.69E-03 | | 5.63E-02 |
| | 795.86 | 85.46 | 1.98E-02 | | 5.37E-02 |
| | 801.95 | 8.69 | 3.42E-01 | | 4.65E-01 |
| | 1038.61 | 0.99 | 3.67E-01 | | 5.52E+00 |
| | 1167.97 | 1.79 | 2.43E+00 | | 3.65E+00 |
| | 1365.19 | 3.02 | 6.92E-03 | | 1.25E+00 |
| Cs-137 | 661.66 | 85.10 | 6.19E-03 | 4.66E-02 | 4.66E-02 |
| Eu-152 | 121.78 | 28.67 | 1.32E-01 | 1.24E-01 | 1.43E-01 |
| | 244.70 | 7.61 | 2.11E-01 | | 5.29E-01 |
| | 295.94 | 0.45 | 4.15E+00 | | 9.09E+00 |
| | 344.28 | 26.60 | 1.21E-03 | | 1.24E-01 |
| | 367.79 | 0.86 | -2.07E+00 | | 3.40E+00 |
| | 411.12 | 2.24 | -2.05E-01 | | 1.69E+00 |
| | 443.96 | 2.83 | -7.11E-01 | | 1.24E+00 |
| | 488.68 | 0.42 | 2.03E+00 | | 9.77E+00 |
| | 563.99 | 0.49 | -7.64E-01 | | 7.27E+00 |
| | 586.26 | 0.46 | -8.97E+00 | | 1.24E+01 |
| | 678.62 | 0.47 | -2.25E+00 | | 8.42E+00 |
| | 688.67 | 0.86 | 2.43E-01 | | 5.17E+00 |
| | 719.35 | 0.28 | 9.61E+00 | | 1.67E+01 |
| | 778.90 | 12.96 | 8.38E-03 | | 3.54E-01 |
| | 810.45 | 0.32 | -5.00E+00 | | 1.20E+01 |
| | 867.37 | 4.26 | -1.08E+00 | | 1.08E+00 |
| | 919.33 | 0.43 | -1.15E+01 | | 1.03E+01 |
| | 964.08 | 14.65 | 2.88E-01 | | 4.41E-01 |
| | 1085.87 | 10.24 | 8.56E-02 | | 5.63E-01 |
| | 1089.74 | 1.73 | -1.66E+00 | | 3.30E+00 |
| | 1112.07 | 13.69 | 3.33E-02 | | 3.83E-01 |
| | 1212.95 | 1.43 | 1.32E+00 | | 4.93E+00 |
| | 1249.94 | 0.19 | 1.83E+01 | | 3.46E+01 |
| | 1299.14 | 1.63 | -2.50E-02 | | 3.67E+00 |
| | 1408.01 | 21.07 | 9.92E-02 | | 2.29E-01 |
| | 1457.64 | 0.50 | 1.97E+02 | | 4.56E+01 |
| | 1528.10 | 0.28 | -2.67E+01 | | 9.00E+00 |
| Eu-154 | 123.07 | 40.40 | -1.76E-03 | 9.79E-02 | 9.79E-02 |
| | 247.93 | 6.89 | 2.44E-01 | | 5.16E-01 |
| | 591.76 | 4.95 | 2.11E-02 | | 7.94E-01 |
| | 692.42 | 1.78 | 5.25E-01 | | 2.51E+00 |
| | 723.30 | 20.06 | -1.30E-01 | | 2.39E-01 |
| | 756.80 | 4.52 | 5.27E-01 | | 9.70E-01 |
| | 873.18 | 12.08 | -4.80E-02 | | 3.59E-01 |

Analysis Report for 02-Oct-19-10024

L1-12104A-FSGS-009SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | 1.18E-01 | 9.79E-02 | 3.95E-01 |
| | 1004.76 | 18.01 | 3.33E-02 | | 2.73E-01 |
| | 1274.43 | 34.80 | -1.69E-01 | | 1.59E-01 |
| | 1596.48 | 1.80 | -1.08E+00 | | 2.03E+00 |
| Eu-155 | 45.30 | 1.31 | 1.06E+00 | 2.24E-01 | 2.03E+01 |
| | 60.01 | 1.22 | -8.05E+00 | | 1.92E+01 |
| | 86.55 | 30.70 | 8.69E-02 | | 2.31E-01 |
| | 105.31 | 21.10 | 7.88E-03 | | 2.24E-01 |
| Ra-226 | 186.21 | 3.64 | 6.04E-01 | 1.07E+00 | 1.07E+00 |
| Pa-231 | 27.36 | 10.30 | 1.23E+00 | 1.49E+00 | 2.19E+00 |
| | 283.69 | 1.70 | -3.22E-01 | | 2.04E+00 |
| | 300.07 | 2.47 | -9.92E-01 | | 1.49E+00 |
| | 302.65 | 2.20 | -5.83E-01 | | 1.56E+00 |
| | 330.06 | 1.40 | 1.92E+00 | | 2.51E+00 |
| U-235 | 143.76 | 10.96 | -3.62E-02 | 6.85E-02 | 3.34E-01 |
| | 163.33 | 5.08 | -1.93E-01 | | 6.25E-01 |
| | 185.71 | 57.20 | 8.27E-02 | | 6.85E-02 |
| | 202.11 | 1.08 | -1.68E+00 | | 3.05E+00 |
| | 205.31 | 5.01 | -4.35E-01 | | 6.23E-01 |
| Am-241 | 59.54 | 35.90 | 9.09E-02 | 7.05E-01 | 7.05E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10025

L1-12104A-FSGS-010SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10025 |
| Sample Description | : L1-12104A-FSGS-010SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.723E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:18:00AM |
| Acquisition Started | : 10/2/2019 12:20:58PM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : P11314 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.3 seconds |
| Dead Time | : 0.03 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 1/24/2019 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80190 |
| Fill Height | : 1722.77 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 12/22/2008 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 12:36:01PM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Grohan

Analysis Report for 02-Oct-19-10025

L1-12104A-FSGS-010SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.86 | 947 - | 961 | 955.03 | 1.05E+02 | 17.67 | 7.08E+01 | 0.97 |
| 2 | 352.14 | 1401 - | 1414 | 1407.56 | 6.63E+01 | 11.70 | 2.57E+01 | 0.98 |
| 3 | 609.14 | 2428 - | 2443 | 2434.59 | 5.77E+01 | 8.55 | 5.26E+00 | 0.50 |
| 4 | 911.10 | 3637 - | 3646 | 3641.84 | 1.92E+01 | 6.26 | 8.79E+00 | 0.84 |
| 5 | 1460.23 | 5827 - | 5852 | 5838.84 | 4.08E+02 | 20.20 | 0.00E+00 | 2.08 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 0.94 | 1460.82 | * | 10.66 | 8.87E+00 | 5.84E-01 |
| Pb-212 | 0.99 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.64E-01 | 3.05E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 0.99 | 609.32 | * | 45.49 | 1.63E-01 | 2.60E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |
| | | 1120.29 | | 14.92 | | |
| | | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |

Analysis Report for 02-Oct-19-10025

L1-12104A-FSGS-010SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 0.99 | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 0.99 | 241.99 | | 7.25 | | |
| | | 295.22 | | 18.42 | | |
| | | 351.93 | * | 35.60 | 1.63E-01 | 3.17E-02 |
| | | 785.96 | | 1.06 | | |
| Ac-228 | 0.99 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | | 11.27 | | |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | * | 25.80 | 1.25E-01 | 4.12E-02 |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | | 15.80 | | |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# INTERFERENCE CORRECTED REPORT

| Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|
| K-40 | 0.945 | 8.87E+00 | 5.84E-01 | [123] |

Analysis Report for 02-Oct-19-10025

L1-12104A-FSGS-010SS

| Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|
| Pb-212 | 0.992 | 1.64E-01 | 3.05E-02 | |
| Bi-214 | 0.998 | 1.63E-01 | 2.60E-02 | |
| Pb-214 | 0.996 | 1.63E-01 | 3.17E-02 | |
| Ac-228 | 0.999 | 1.25E-01 | 4.12E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10025

L1-12104A-FSGS-010SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 12:36:01PM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 5.22E-02 | 5.41E-02 | 5.41E-02 |
| | BE-7 | 477.60 | | 10.44 | 2.38E-01 | 4.29E-01 | 4.29E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 8.87E+00 | 6.25E-02 | 6.25E-02 |
| | Mn-54 | 834.85 | | 99.98 | -1.55E-02 | 4.35E-02 | 4.35E-02 |
| | Co-60 | 1173.23 | | 99.85 | 2.49E-02 | 5.02E-02 | 7.06E-02 |
| | | 1332.49 | | 99.98 | 1.16E-02 | | 5.02E-02 |
| | Nb-94 | 702.65 | | 99.81 | 1.63E-02 | 4.06E-02 | 4.49E-02 |
| | | 871.09 | | 99.89 | -1.63E-02 | | 4.06E-02 |
| | Ag-108m | 79.13 | | 6.60 | 8.67E-01 | 3.47E-02 | 1.22E+00 |
| | | 433.94 | | 90.50 | -2.46E-02 | | 3.47E-02 |
| | | 614.28 | | 89.80 | -1.58E-02 | | 5.04E-02 |
| | | 722.94 | | 90.80 | 1.98E-03 | | 4.77E-02 |
| | Sb-125 | 176.31 | | 6.84 | 1.71E-01 | 1.17E-01 | 4.63E-01 |
| | | 380.45 | | 1.52 | -2.30E-01 | | 2.33E+00 |
| | | 427.87 | | 29.60 | 4.40E-02 | | 1.17E-01 |
| | | 463.36 | | 10.49 | 1.09E-01 | | 3.56E-01 |
| | | 600.60 | | 17.65 | 1.33E-01 | | 2.31E-01 |
| | | 606.71 | | 4.98 | -1.79E-01 | | 1.22E+00 |
| | | 635.95 | | 11.22 | -3.95E-02 | | 3.87E-01 |

Analysis Report for 02-Oct-19-10025

L1-12104A-FSGS-010SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | -8.47E-01 | 1.17E-01 | 1.87E+00 |
| Ba-133 | 79.61 | 2.65 | 1.87E+00 | 6.45E-02 | 2.99E+00 |
| | 81.00 | 32.90 | -3.10E-01 | | 1.97E-01 |
| | 276.40 | 7.16 | -5.33E-02 | | 4.40E-01 |
| | 302.85 | 18.34 | 2.85E-02 | | 1.65E-01 |
| | 356.01 | 62.05 | -1.47E-02 | | 6.45E-02 |
| | 383.85 | 8.94 | 1.64E-01 | | 4.21E-01 |
| Cs-134 | 475.36 | 1.48 | 1.46E+00 | 3.97E-02 | 3.12E+00 |
| | 563.25 | 8.34 | -3.04E-01 | | 5.23E-01 |
| | 569.33 | 15.37 | 5.51E-02 | | 2.62E-01 |
| | 604.72 | 97.62 | -7.37E-03 | | 5.60E-02 |
| | 795.86 | 85.46 | -6.53E-03 | | 3.97E-02 |
| | 801.95 | 8.69 | 3.51E-02 | | 4.78E-01 |
| | 1038.61 | 0.99 | -1.45E-02 | | 5.58E+00 |
| | 1167.97 | 1.79 | 2.00E+00 | | 4.00E+00 |
| | 1365.19 | 3.02 | -3.45E-01 | | 1.57E+00 |
| Cs-137 | 661.66 | 85.10 | -4.48E-03 | 4.73E-02 | 4.73E-02 |
| Eu-152 | 121.78 | 28.67 | -1.61E-01 | 1.06E-01 | 1.06E-01 |
| | 244.70 | 7.61 | -1.18E-03 | | 4.74E-01 |
| | 295.94 | 0.45 | 8.27E-01 | | 7.61E+00 |
| | 344.28 | 26.60 | -3.35E-04 | | 1.21E-01 |
| | 367.79 | 0.86 | -1.84E+00 | | 3.41E+00 |
| | 411.12 | 2.24 | 1.65E-01 | | 1.46E+00 |
| | 443.96 | 2.83 | -5.60E-01 | | 1.34E+00 |
| | 488.68 | 0.42 | 8.03E+00 | | 9.12E+00 |
| | 563.99 | 0.49 | -4.77E+00 | | 8.70E+00 |
| | 586.26 | 0.46 | 9.05E+00 | | 1.12E+01 |
| | 678.62 | 0.47 | 9.11E-01 | | 8.14E+00 |
| | 688.67 | 0.86 | 8.68E-01 | | 5.08E+00 |
| | 719.35 | 0.28 | -4.37E+00 | | 1.46E+01 |
| | 778.90 | 12.96 | -3.37E-02 | | 3.20E-01 |
| | 810.45 | 0.32 | 1.06E+00 | | 1.39E+01 |
| | 867.37 | 4.26 | 3.46E-01 | | 1.06E+00 |
| | 919.33 | 0.43 | 1.39E+00 | | 1.05E+01 |
| | 964.08 | 14.65 | -3.02E-01 | | 4.19E-01 |
| | 1085.87 | 10.24 | 2.45E-03 | | 5.70E-01 |
| | 1089.74 | 1.73 | -1.14E-01 | | 3.20E+00 |
| | 1112.07 | 13.69 | -1.97E-01 | | 4.27E-01 |
| | 1212.95 | 1.43 | -2.91E+00 | | 5.10E+00 |
| | 1249.94 | 0.19 | -2.38E+01 | | 3.38E+01 |
| | 1299.14 | 1.63 | 1.83E+00 | | 3.64E+00 |
| | 1408.01 | 21.07 | 1.28E-01 | | 2.09E-01 |
| | 1457.64 | 0.50 | 1.86E+02 | | 4.62E+01 |
| | 1528.10 | 0.28 | -3.67E+00 | | 1.06E+01 |
| Eu-154 | 123.07 | 40.40 | 6.62E-03 | 8.00E-02 | 8.00E-02 |
| | 247.93 | 6.89 | 1.71E-01 | | 4.89E-01 |
| | 591.76 | 4.95 | -4.08E-01 | | 7.53E-01 |
| | 692.42 | 1.78 | 4.86E-01 | | 2.46E+00 |
| | 723.30 | 20.06 | -8.29E-02 | | 2.10E-01 |
| | 756.80 | 4.52 | -1.00E-01 | | 8.51E-01 |
| | 873.18 | 12.08 | -2.85E-01 | | 3.22E-01 |

Analysis Report for 02-Oct-19-10025

L1-12104A-FSGS-010SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | 2.13E-02 | 8.00E-02 | 5.34E-01 |
| | 1004.76 | 18.01 | 6.91E-02 | | 2.82E-01 |
| | 1274.43 | 34.80 | 2.11E-01 | | 1.89E-01 |
| | 1596.48 | 1.80 | 9.67E-01 | | 2.15E+00 |
| Eu-155 | 45.30 | 1.31 | 3.35E+00 | 1.77E-01 | 1.18E+01 |
| | 60.01 | 1.22 | 3.46E+00 | | 1.29E+01 |
| | 86.55 | 30.70 | -6.22E-02 | | 1.77E-01 |
| | 105.31 | 21.10 | 4.94E-02 | | 1.89E-01 |
| Ra-226 | 186.21 | 3.64 | 5.03E-01 | 9.58E-01 | 9.58E-01 |
| Pa-231 | 27.36 | 10.30 | 1.43E+00 | 1.17E+00 | 1.28E+00 |
| | 283.69 | 1.70 | 8.05E-01 | | 2.08E+00 |
| | 300.07 | 2.47 | -1.53E+00 | | 1.17E+00 |
| | 302.65 | 2.20 | 3.14E-01 | | 1.40E+00 |
| | 330.06 | 1.40 | 1.12E+00 | | 2.68E+00 |
| U-235 | 143.76 | 10.96 | 1.76E-02 | 5.96E-02 | 3.14E-01 |
| | 163.33 | 5.08 | -3.45E-01 | | 5.84E-01 |
| | 185.71 | 57.20 | 1.62E-02 | | 5.96E-02 |
| | 202.11 | 1.08 | -2.14E-01 | | 2.84E+00 |
| | 205.31 | 5.01 | 5.78E-02 | | 6.25E-01 |
| Am-241 | 59.54 | 35.90 | 1.38E-01 | 4.51E-01 | 4.51E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10026

L1-12104A-FSGS-011SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10026 |
| Sample Description | : L1-12104A-FSGS-011SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.629E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:20:00AM |
| Acquisition Started | : 10/2/2019 12:21:05PM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : 352 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.3 seconds |
| Dead Time | : 0.03 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 9/29/2018 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80191 |
| Fill Height | : 1629.29 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 1/7/2013 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 12:36:09PM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10026

L1-12104A-FSGS-011SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.69 | 948 - | 961 | 955.23 | 1.11E+02 | 15.95 | 5.13E+01 | 0.76 |
| 2 | 338.21 | 1346 - | 1357 | 1352.87 | 2.14E+01 | 9.26 | 2.56E+01 | 0.40 |
| 3 | 351.94 | 1401 - | 1414 | 1407.77 | 6.43E+01 | 11.85 | 2.77E+01 | 1.09 |
| 4 | 583.38 | 2327 - | 2339 | 2332.85 | 3.76E+01 | 7.54 | 7.38E+00 | 0.74 |
| 5 | 609.24 | 2430 - | 2444 | 2436.25 | 5.27E+01 | 10.56 | 2.03E+01 | 0.40 |
| 6 | 1460.79 | 5831 - | 5855 | 5843.52 | 4.34E+02 | 21.71 | 9.16E+00 | 1.87 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 1.00 | 1460.82 | * | 10.66 | 8.93E+00 | 5.92E-01 |
| Tl-208 | 0.99 | 583.19 | * | 85.00 | 5.31E-02 | 1.11E-02 |
| Bi-211 | 0.88 | 351.07 | * | 13.02 | 4.23E-01 | 8.51E-02 |
| Pb-212 | 0.99 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.72E-01 | 2.84E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 1.00 | 609.32 | * | 45.49 | 1.43E-01 | 2.99E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |
| | | 1120.29 | | 14.92 | | |

Analysis Report for 02-Oct-19-10026

L1-12104A-FSGS-011SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 1.00 | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 1.00 | 241.99 | | 7.25 | | |
| | | 295.22 | | 18.42 | | |
| | | 351.93 | * | 35.60 | 1.55E-01 | 3.11E-02 |
| | | 785.96 | | 1.06 | | |
| Ac-228 | 1.00 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | * | 11.27 | 1.58E-01 | 6.96E-02 |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | | 25.80 | | |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | | 15.80 | | |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# *INTERFERENCE CORRECTED REPORT*

Analysis Report for 02-Oct-19-10026

L1-12104A-FSGS-011SS

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | K-40 | 1.000 | 8.93E+00 | 5.92E-01 | |
| | Tl-208 | 0.994 | 5.31E-02 | 1.11E-02 | |
| ? | Bi-211 | 0.885 | 4.23E-01 | 8.51E-02 | |
| | Pb-212 | 0.999 | 1.72E-01 | 2.84E-02 | |
| | Bi-214 | 1.000 | 1.43E-01 | 2.99E-02 | |
| ? | Pb-214 | 1.000 | 1.55E-01 | 3.11E-02 | |
| | Ac-228 | 1.000 | 1.58E-01 | 6.96E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10026

L1-12104A-FSGS-011SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 12:36:09PM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## NUCLIDE MDA REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 5.58E-02 | 5.43E-02 | 5.43E-02 |
| | BE-7 | 477.60 | | 10.44 | -2.19E-01 | 3.55E-01 | 3.55E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 8.93E+00 | 4.86E-01 | 4.86E-01 |
| | Mn-54 | 834.85 | | 99.98 | -2.38E-03 | 4.36E-02 | 4.36E-02 |
| | Co-60 | 1173.23 | | 99.85 | 5.14E-02 | 5.51E-02 | 6.90E-02 |
| | | 1332.49 | | 99.98 | 5.13E-02 | | 5.51E-02 |
| | Nb-94 | 702.65 | | 99.81 | -2.36E-03 | 4.61E-02 | 4.61E-02 |
| | | 871.09 | | 99.89 | 3.39E-02 | | 4.81E-02 |
| | Ag-108m | 79.13 | | 6.60 | -5.25E-01 | 3.54E-02 | 1.45E+00 |
| | | 433.94 | | 90.50 | -1.49E-03 | | 3.54E-02 |
| | | 614.28 | | 89.80 | -1.30E-02 | | 6.65E-02 |
| | | 722.94 | | 90.80 | -1.28E-02 | | 5.05E-02 |
| | Sb-125 | 176.31 | | 6.84 | 1.92E-01 | 1.24E-01 | 4.82E-01 |
| | | 380.45 | | 1.52 | -8.07E-01 | | 2.31E+00 |
| | | 427.87 | | 29.60 | 2.11E-03 | | 1.24E-01 |
| | | 463.36 | | 10.49 | -2.48E-02 | | 3.23E-01 |
| | | 600.60 | | 17.65 | 5.02E-02 | | 2.14E-01 |
| | | 606.71 | | 4.98 | 1.89E+00 | | 1.25E+00 |
| | | 635.95 | | 11.22 | 2.80E-01 | | 3.59E-01 |

Analysis Report for 02-Oct-19-10026

L1-12104A-FSGS-011SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | -6.55E-02 | 1.24E-01 | 2.21E+00 |
| Ba-133 | 79.61 | 2.65 | 3.60E-01 | 7.17E-02 | 3.44E+00 |
| | 81.00 | 32.90 | -2.72E-01 | | 2.40E-01 |
| | 276.40 | 7.16 | -2.65E-01 | | 4.96E-01 |
| | 302.85 | 18.34 | 1.29E-02 | | 2.04E-01 |
| | 356.01 | 62.05 | 4.74E-03 | | 7.17E-02 |
| | 383.85 | 8.94 | 3.99E-01 | | 4.29E-01 |
| Cs-134 | 475.36 | 1.48 | 4.83E-01 | 5.01E-02 | 2.61E+00 |
| | 563.25 | 8.34 | -4.56E-02 | | 4.17E-01 |
| | 569.33 | 15.37 | 1.19E-01 | | 2.43E-01 |
| | 604.72 | 97.62 | -2.70E-02 | | 5.80E-02 |
| | 795.86 | 85.46 | 4.99E-03 | | 5.01E-02 |
| | 801.95 | 8.69 | -2.50E-01 | | 4.65E-01 |
| | 1038.61 | 0.99 | 2.49E+00 | | 5.38E+00 |
| | 1167.97 | 1.79 | 2.18E+00 | | 3.62E+00 |
| | 1365.19 | 3.02 | 9.70E-01 | | 1.44E+00 |
| Cs-137 | 661.66 | 85.10 | 1.60E-02 | 4.60E-02 | 4.60E-02 |
| Eu-152 | 121.78 | 28.67 | 4.38E-02 | 1.23E-01 | 1.49E-01 |
| | 244.70 | 7.61 | 1.32E-01 | | 4.94E-01 |
| | 295.94 | 0.45 | 2.23E+00 | | 9.44E+00 |
| | 344.28 | 26.60 | 1.60E-03 | | 1.23E-01 |
| | 367.79 | 0.86 | 1.13E+00 | | 3.77E+00 |
| | 411.12 | 2.24 | -8.98E-01 | | 1.45E+00 |
| | 443.96 | 2.83 | -5.36E-01 | | 1.23E+00 |
| | 488.68 | 0.42 | -1.57E+00 | | 7.84E+00 |
| | 563.99 | 0.49 | -4.40E+00 | | 6.65E+00 |
| | 586.26 | 0.46 | 4.75E+00 | | 1.10E+01 |
| | 678.62 | 0.47 | 3.83E+00 | | 9.53E+00 |
| | 688.67 | 0.86 | -4.22E+00 | | 4.87E+00 |
| | 719.35 | 0.28 | -1.69E+00 | | 1.46E+01 |
| | 778.90 | 12.96 | -3.87E-01 | | 3.45E-01 |
| | 810.45 | 0.32 | -7.25E+00 | | 1.39E+01 |
| | 867.37 | 4.26 | -1.43E-01 | | 1.03E+00 |
| | 919.33 | 0.43 | -1.57E+01 | | 1.12E+01 |
| | 964.08 | 14.65 | 3.43E-02 | | 4.19E-01 |
| | 1085.87 | 10.24 | 1.68E-01 | | 5.90E-01 |
| | 1089.74 | 1.73 | -1.83E+00 | | 3.54E+00 |
| | 1112.07 | 13.69 | -3.50E-01 | | 4.43E-01 |
| | 1212.95 | 1.43 | 5.86E-01 | | 5.11E+00 |
| | 1249.94 | 0.19 | -1.39E+01 | | 3.21E+01 |
| | 1299.14 | 1.63 | -2.07E+00 | | 3.39E+00 |
| | 1408.01 | 21.07 | 6.05E-02 | | 2.11E-01 |
| | 1457.64 | 0.50 | 1.88E+02 | | 4.57E+01 |
| | 1528.10 | 0.28 | -7.14E+00 | | 7.78E+00 |
| Eu-154 | 123.07 | 40.40 | 1.04E-01 | 1.06E-01 | 1.06E-01 |
| | 247.93 | 6.89 | 1.53E-01 | | 4.96E-01 |
| | 591.76 | 4.95 | -3.59E-01 | | 8.22E-01 |
| | 692.42 | 1.78 | -1.09E+00 | | 2.36E+00 |
| | 723.30 | 20.06 | -1.79E-02 | | 2.29E-01 |
| | 756.80 | 4.52 | 3.22E-01 | | 9.57E-01 |
| | 873.18 | 12.08 | 2.94E-01 | | 4.04E-01 |

Analysis Report for 02-Oct-19-10026

L1-12104A-FSGS-011SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | -1.09E-01 | 1.06E-01 | 4.29E-01 |
| | 1004.76 | 18.01 | 2.32E-01 | | 3.30E-01 |
| | 1274.43 | 34.80 | 2.43E-02 | | 1.33E-01 |
| | 1596.48 | 1.80 | 1.39E-01 | | 2.15E+00 |
| Eu-155 | 45.30 | 1.31 | 3.93E+00 | 2.05E-01 | 1.97E+01 |
| | 60.01 | 1.22 | -5.56E+00 | | 2.03E+01 |
| | 86.55 | 30.70 | -2.20E-01 | | 2.11E-01 |
| | 105.31 | 21.10 | 1.70E-02 | | 2.05E-01 |
| Ra-226 | 186.21 | 3.64 | -3.65E-01 | 9.03E-01 | 9.03E-01 |
| Pa-231 | 27.36 | 10.30 | 1.84E+00 | 1.54E+00 | 2.08E+00 |
| | 283.69 | 1.70 | -7.31E-01 | | 1.98E+00 |
| | 300.07 | 2.47 | -2.18E+00 | | 1.54E+00 |
| | 302.65 | 2.20 | -8.05E-01 | | 1.67E+00 |
| | 330.06 | 1.40 | -1.07E+00 | | 2.35E+00 |
| U-235 | 143.76 | 10.96 | -2.38E-01 | 5.77E-02 | 3.46E-01 |
| | 163.33 | 5.08 | -3.99E-01 | | 6.25E-01 |
| | 185.71 | 57.20 | -7.93E-04 | | 5.77E-02 |
| | 202.11 | 1.08 | 3.24E-01 | | 3.04E+00 |
| | 205.31 | 5.01 | -6.56E-01 | | 6.51E-01 |
| Am-241 | 59.54 | 35.90 | 4.32E-02 | 7.17E-01 | 7.17E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10027

L1-12104A-FSGS-012SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10027 |
| Sample Description | : L1-12104A-FSGS-012SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.681E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:22:00AM |
| Acquisition Started | : 10/2/2019 12:40:07PM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : P11314 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.3 seconds |
| Dead Time | : 0.03 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 1/24/2019 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80194 |
| Fill Height | : 1680.56 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 12/22/2008 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 12:55:10PM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10027

L1-12104A-FSGS-012SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.82 | 947 - | 961 | 954.86 | 1.19E+02 | 17.69 | 6.74E+01 | 0.84 |
| 2 | 338.24 | 1347 - | 1359 | 1352.05 | 3.17E+01 | 9.39 | 2.13E+01 | 1.16 |
| 3 | 352.05 | 1401 - | 1414 | 1407.19 | 8.79E+01 | 11.96 | 2.01E+01 | 1.11 |
| 4 | 582.84 | 2324 - | 2335 | 2329.48 | 3.30E+01 | 8.60 | 1.50E+01 | 1.35 |
| 5 | 609.22 | 2430 - | 2441 | 2434.94 | 5.36E+01 | 8.18 | 5.44E+00 | 0.94 |
| 6 | 1460.26 | 5827 - | 5851 | 5838.96 | 4.27E+02 | 21.27 | 6.25E+00 | 2.00 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 0.95 | 1460.82 | * | 10.66 | 9.33E+00 | 6.17E-01 |
| Tl-208 | 0.98 | 583.19 | * | 85.00 | 4.86E-02 | 1.30E-02 |
| Bi-211 | 0.85 | 351.07 | * | 13.02 | 5.94E-01 | 9.40E-02 |
| Pb-212 | 0.99 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.85E-01 | 3.15E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 0.99 | 609.32 | * | 45.49 | 1.52E-01 | 2.49E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |
| | | 1120.29 | | 14.92 | | |

Analysis Report for 02-Oct-19-10027

L1-12104A-FSGS-012SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 0.99 | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 0.99 | 241.99 | | 7.25 | | |
| | | 295.22 | | 18.42 | | |
| | | 351.93 | * | 35.60 | 2.17E-01 | 3.43E-02 |
| | | 785.96 | | 1.06 | | |
| Ac-228 | 1.00 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | * | 11.27 | 2.41E-01 | 7.39E-02 |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | | 25.80 | | |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | | 15.80 | | |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# *INTERFERENCE CORRECTED REPORT*

Analysis Report for 02-Oct-19-10027

L1-12104A-FSGS-012SS

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | K-40 | 0.950 | 9.33E+00 | 6.17E-01 | |
| | Tl-208 | 0.981 | 4.86E-02 | 1.30E-02 | |
| ? | Bi-211 | 0.859 | 5.94E-01 | 9.40E-02 | |
| | Pb-212 | 0.995 | 1.85E-01 | 3.15E-02 | |
| | Bi-214 | 0.999 | 1.52E-01 | 2.49E-02 | |
| ? | Pb-214 | 0.999 | 2.17E-01 | 3.43E-02 | |
| | Ac-228 | 1.000 | 2.41E-01 | 7.39E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10027

L1-12104A-FSGS-012SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 12:55:10PM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 3.89E-02 | 5.50E-02 | 5.50E-02 |
| | BE-7 | 477.60 | | 10.44 | -4.95E-02 | 3.60E-01 | 3.60E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 9.33E+00 | 4.40E-01 | 4.40E-01 |
| | Mn-54 | 834.85 | | 99.98 | 2.41E-02 | 4.37E-02 | 4.37E-02 |
| | Co-60 | 1173.23 | | 99.85 | -1.32E-03 | 4.80E-02 | 6.73E-02 |
| | | 1332.49 | | 99.98 | 1.94E-02 | | 4.80E-02 |
| | Nb-94 | 702.65 | | 99.81 | -3.24E-02 | 3.89E-02 | 3.89E-02 |
| | | 871.09 | | 99.89 | 1.05E-02 | | 4.86E-02 |
| | Ag-108m | 79.13 | | 6.60 | 7.92E-01 | 3.57E-02 | 1.19E+00 |
| | | 433.94 | | 90.50 | -1.60E-02 | | 3.57E-02 |
| | | 614.28 | | 89.80 | -1.74E-02 | | 5.32E-02 |
| | | 722.94 | | 90.80 | 2.99E-02 | | 5.12E-02 |
| | Sb-125 | 176.31 | | 6.84 | 1.43E-01 | 1.23E-01 | 4.29E-01 |
| | | 380.45 | | 1.52 | -6.18E-01 | | 2.22E+00 |
| | | 427.87 | | 29.60 | 4.50E-02 | | 1.23E-01 |
| | | 463.36 | | 10.49 | 2.27E-01 | | 4.11E-01 |
| | | 600.60 | | 17.65 | 8.91E-02 | | 2.27E-01 |
| | | 606.71 | | 4.98 | 9.21E-01 | | 1.17E+00 |
| | | 635.95 | | 11.22 | -6.20E-02 | | 3.85E-01 |

Analysis Report for 02-Oct-19-10027

L1-12104A-FSGS-012SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | -1.68E+00 | 1.23E-01 | 2.14E+00 |
| Ba-133 | 79.61 | 2.65 | 3.05E+00 | 6.51E-02 | 2.96E+00 |
| | 81.00 | 32.90 | -1.09E-01 | | 2.03E-01 |
| | 276.40 | 7.16 | -1.55E-01 | | 4.22E-01 |
| | 302.85 | 18.34 | -3.52E-02 | | 1.85E-01 |
| | 356.01 | 62.05 | -1.45E-02 | | 6.51E-02 |
| | 383.85 | 8.94 | 3.22E-01 | | 3.93E-01 |
| Cs-134 | 475.36 | 1.48 | 1.43E+00 | 5.11E-02 | 2.56E+00 |
| | 563.25 | 8.34 | -4.06E-01 | | 4.77E-01 |
| | 569.33 | 15.37 | 6.70E-02 | | 2.34E-01 |
| | 604.72 | 97.62 | -6.46E-02 | | 5.43E-02 |
| | 795.86 | 85.46 | 2.50E-03 | | 5.11E-02 |
| | 801.95 | 8.69 | -1.06E-01 | | 3.95E-01 |
| | 1038.61 | 0.99 | 2.95E+00 | | 5.77E+00 |
| | 1167.97 | 1.79 | 2.17E+00 | | 3.83E+00 |
| | 1365.19 | 3.02 | 4.88E-01 | | 1.48E+00 |
| Cs-137 | 661.66 | 85.10 | -1.55E-02 | 4.61E-02 | 4.61E-02 |
| Eu-152 | 121.78 | 28.67 | 1.82E-02 | 1.17E-01 | 1.17E-01 |
| | 244.70 | 7.61 | 3.54E-02 | | 4.56E-01 |
| | 295.94 | 0.45 | 6.04E-01 | | 9.10E+00 |
| | 344.28 | 26.60 | -4.01E-02 | | 1.21E-01 |
| | 367.79 | 0.86 | 7.60E-01 | | 3.42E+00 |
| | 411.12 | 2.24 | 1.51E+00 | | 1.75E+00 |
| | 443.96 | 2.83 | -8.44E-01 | | 1.13E+00 |
| | 488.68 | 0.42 | -8.37E+00 | | 6.97E+00 |
| | 563.99 | 0.49 | -8.95E+00 | | 7.49E+00 |
| | 586.26 | 0.46 | -3.05E+00 | | 1.24E+01 |
| | 678.62 | 0.47 | -1.12E+00 | | 8.71E+00 |
| | 688.67 | 0.86 | -1.54E+00 | | 4.39E+00 |
| | 719.35 | 0.28 | -4.84E+00 | | 1.42E+01 |
| | 778.90 | 12.96 | -1.62E-01 | | 3.32E-01 |
| | 810.45 | 0.32 | 3.98E+00 | | 1.38E+01 |
| | 867.37 | 4.26 | 5.94E-02 | | 1.15E+00 |
| | 919.33 | 0.43 | 7.27E+00 | | 1.18E+01 |
| | 964.08 | 14.65 | -2.49E-02 | | 3.76E-01 |
| | 1085.87 | 10.24 | 2.01E-01 | | 5.88E-01 |
| | 1089.74 | 1.73 | -1.60E+00 | | 3.58E+00 |
| | 1112.07 | 13.69 | -5.40E-02 | | 3.86E-01 |
| | 1212.95 | 1.43 | 7.56E-02 | | 5.51E+00 |
| | 1249.94 | 0.19 | -1.42E+01 | | 3.54E+01 |
| | 1299.14 | 1.63 | 2.29E+00 | | 3.89E+00 |
| | 1408.01 | 21.07 | -8.07E-02 | | 2.50E-01 |
| | 1457.64 | 0.50 | 2.00E+02 | | 4.77E+01 |
| | 1528.10 | 0.28 | 7.71E+00 | | 1.48E+01 |
| Eu-154 | 123.07 | 40.40 | 2.67E-02 | 8.50E-02 | 8.50E-02 |
| | 247.93 | 6.89 | -1.38E-01 | | 4.12E-01 |
| | 591.76 | 4.95 | -5.84E-02 | | 7.57E-01 |
| | 692.42 | 1.78 | 3.96E-02 | | 2.31E+00 |
| | 723.30 | 20.06 | 1.19E-01 | | 2.32E-01 |
| | 756.80 | 4.52 | 2.81E-01 | | 9.49E-01 |
| | 873.18 | 12.08 | 1.25E-01 | | 3.97E-01 |

Analysis Report for 02-Oct-19-10027

L1-12104A-FSGS-012SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | -1.50E-01 | 8.50E-02 | 4.61E-01 |
| | 1004.76 | 18.01 | 1.06E-01 | | 3.06E-01 |
| | 1274.43 | 34.80 | -8.05E-02 | | 1.66E-01 |
| | 1596.48 | 1.80 | 4.17E-01 | | 1.55E+00 |
| Eu-155 | 45.30 | 1.31 | -3.58E-01 | 1.89E-01 | 1.09E+01 |
| | 60.01 | 1.22 | 3.52E+00 | | 1.26E+01 |
| | 86.55 | 30.70 | 1.19E-01 | | 1.89E-01 |
| | 105.31 | 21.10 | 2.70E-02 | | 1.94E-01 |
| Ra-226 | 186.21 | 3.64 | 3.62E-01 | 8.98E-01 | 8.98E-01 |
| Pa-231 | 27.36 | 10.30 | 1.35E+00 | 1.34E+00 | 1.34E+00 |
| | 283.69 | 1.70 | 1.82E+00 | | 2.02E+00 |
| | 300.07 | 2.47 | -2.12E+00 | | 1.35E+00 |
| | 302.65 | 2.20 | -4.60E-01 | | 1.53E+00 |
| | 330.06 | 1.40 | 9.56E-01 | | 2.39E+00 |
| U-235 | 143.76 | 10.96 | 1.57E-01 | 5.63E-02 | 2.88E-01 |
| | 163.33 | 5.08 | 3.89E-02 | | 6.19E-01 |
| | 185.71 | 57.20 | 2.01E-02 | | 5.63E-02 |
| | 202.11 | 1.08 | 1.56E+00 | | 2.97E+00 |
| | 205.31 | 5.01 | 7.50E-02 | | 6.57E-01 |
| Am-241 | 59.54 | 35.90 | -7.57E-02 | 4.29E-01 | 4.29E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10028

L1-12104A-FSGS-013SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10028 |
| Sample Description | : L1-12104A-FSGS-013SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.628E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:24:00AM |
| Acquisition Started | : 10/2/2019 12:40:14PM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : 352 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.3 seconds |
| Dead Time | : 0.03 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 9/29/2018 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80195 |
| Fill Height | : 1628.20 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 1/7/2013 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 12:55:17PM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10028

L1-12104A-FSGS-013SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.65 | 945 - | 960 | 955.07 | 1.11E+02 | 17.27 | 6.32E+01 | 1.11 |
| 2 | 338.25 | 1348 - | 1358 | 1353.03 | 2.74E+01 | 8.24 | 1.66E+01 | 0.77 |
| 3 | 352.04 | 1400 - | 1414 | 1408.15 | 5.41E+01 | 11.60 | 2.79E+01 | 0.99 |
| 4 | 583.17 | 2327 - | 2337 | 2331.99 | 3.08E+01 | 8.19 | 1.52E+01 | 0.83 |
| 5 | 609.34 | 2429 - | 2445 | 2436.63 | 5.18E+01 | 9.14 | 1.02E+01 | 0.36 |
| 6 | 969.14 | 3870 - | 3882 | 3875.64 | 2.57E+01 | 6.51 | 6.28E+00 | 0.53 |
| 7 | 1460.78 | 5830 - | 5855 | 5843.49 | 4.44E+02 | 22.67 | 1.63E+01 | 1.92 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 1.00 | 1460.82 | * | 10.66 | 9.13E+00 | 6.12E-01 |
| Tl-208 | 1.00 | 583.19 | * | 85.00 | 4.35E-02 | 1.19E-02 |
| Bi-211 | 0.86 | 351.07 | * | 13.02 | 3.56E-01 | 8.15E-02 |
| Pb-212 | 1.00 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.72E-01 | 3.02E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 1.00 | 609.32 | * | 45.49 | 1.41E-01 | 2.62E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |

Analysis Report for 02-Oct-19-10028

L1-12104A-FSGS-013SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 1.00 | 1120.29 | | 14.92 | | |
| | | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 0.99 | 241.99 | | 7.25 | | |
| | | 295.22 | | 18.42 | | |
| | | 351.93 | * | 35.60 | 1.30E-01 | 2.98E-02 |
| | | 785.96 | | 1.06 | | |
| Ac-228 | 0.99 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | * | 11.27 | 2.02E-01 | 6.31E-02 |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | | 25.80 | | |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | * | 15.80 | 2.72E-01 | 6.99E-02 |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

## *INTERFERENCE CORRECTED REPORT*

Analysis Report for 02-Oct-19-10028

L1-12104A-FSGS-013SS

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | K-40 | 1.000 | 9.13E+00 | 6.12E-01 | |
| | Tl-208 | 1.000 | 4.35E-02 | 1.19E-02 | |
| ? | Bi-211 | 0.860 | 3.56E-01 | 8.15E-02 | |
| | Pb-212 | 1.000 | 1.72E-01 | 3.02E-02 | |
| | Bi-214 | 1.000 | 1.41E-01 | 2.62E-02 | |
| ? | Pb-214 | 0.999 | 1.30E-01 | 2.98E-02 | |
| | Ac-228 | 0.999 | 2.34E-01 | 4.69E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10028

L1-12104A-FSGS-013SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 12:55:17PM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 3.26E-02 | 4.96E-02 | 4.96E-02 |
| | BE-7 | 477.60 | | 10.44 | -7.15E-02 | 3.76E-01 | 3.76E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 9.13E+00 | 6.44E-01 | 6.44E-01 |
| | Mn-54 | 834.85 | | 99.98 | -3.34E-02 | 3.70E-02 | 3.70E-02 |
| | Co-60 | 1173.23 | | 99.85 | -1.18E-01 | 5.80E-02 | 6.21E-02 |
| | | 1332.49 | | 99.98 | 4.29E-02 | | 5.80E-02 |
| | Nb-94 | 702.65 | | 99.81 | -1.06E-02 | 4.30E-02 | 4.30E-02 |
| | | 871.09 | | 99.89 | 5.46E-02 | | 4.87E-02 |
| | Ag-108m | 79.13 | | 6.60 | -6.03E-01 | 3.98E-02 | 1.53E+00 |
| | | 433.94 | | 90.50 | -6.87E-03 | | 3.98E-02 |
| | | 614.28 | | 89.80 | -4.40E-03 | | 6.44E-02 |
| | | 722.94 | | 90.80 | -3.88E-03 | | 5.11E-02 |
| | Sb-125 | 176.31 | | 6.84 | -1.30E-01 | 1.21E-01 | 4.97E-01 |
| | | 380.45 | | 1.52 | -2.70E+00 | | 2.23E+00 |
| | | 427.87 | | 29.60 | -1.99E-02 | | 1.21E-01 |
| | | 463.36 | | 10.49 | 5.90E-02 | | 3.45E-01 |
| | | 600.60 | | 17.65 | 8.04E-02 | | 2.46E-01 |
| | | 606.71 | | 4.98 | 1.53E+00 | | 1.19E+00 |
| | | 635.95 | | 11.22 | -8.34E-02 | | 3.40E-01 |

Analysis Report for 02-Oct-19-10028

L1-12104A-FSGS-013SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | -2.62E-01 | 1.21E-01 | 2.33E+00 |
| Ba-133 | 79.61 | 2.65 | 5.69E-01 | 6.87E-02 | 3.76E+00 |
| | 81.00 | 32.90 | -1.80E-01 | | 2.69E-01 |
| | 276.40 | 7.16 | -5.04E-02 | | 5.46E-01 |
| | 302.85 | 18.34 | 1.77E-02 | | 2.11E-01 |
| | 356.01 | 62.05 | -6.26E-03 | | 6.87E-02 |
| | 383.85 | 8.94 | -9.79E-02 | | 3.60E-01 |
| Cs-134 | 475.36 | 1.48 | 1.76E+00 | 5.31E-02 | 2.61E+00 |
| | 563.25 | 8.34 | -1.72E-01 | | 4.34E-01 |
| | 569.33 | 15.37 | -3.38E-02 | | 2.47E-01 |
| | 604.72 | 97.62 | 1.37E-02 | | 5.56E-02 |
| | 795.86 | 85.46 | 2.77E-02 | | 5.31E-02 |
| | 801.95 | 8.69 | -1.61E-01 | | 5.10E-01 |
| | 1038.61 | 0.99 | 1.24E+00 | | 5.60E+00 |
| | 1167.97 | 1.79 | 3.21E+00 | | 3.98E+00 |
| | 1365.19 | 3.02 | 1.21E-01 | | 1.53E+00 |
| Cs-137 | 661.66 | 85.10 | 1.71E-02 | 4.66E-02 | 4.66E-02 |
| Eu-152 | 121.78 | 28.67 | 7.97E-02 | 1.22E-01 | 1.44E-01 |
| | 244.70 | 7.61 | -1.82E-01 | | 4.88E-01 |
| | 295.94 | 0.45 | 5.85E+00 | | 9.95E+00 |
| | 344.28 | 26.60 | -6.13E-02 | | 1.22E-01 |
| | 367.79 | 0.86 | 2.77E+00 | | 4.23E+00 |
| | 411.12 | 2.24 | -1.13E-01 | | 1.72E+00 |
| | 443.96 | 2.83 | 4.43E-02 | | 1.30E+00 |
| | 488.68 | 0.42 | -6.07E+00 | | 7.52E+00 |
| | 563.99 | 0.49 | 2.32E+00 | | 7.57E+00 |
| | 586.26 | 0.46 | 9.38E+00 | | 1.21E+01 |
| | 678.62 | 0.47 | 2.52E+00 | | 9.11E+00 |
| | 688.67 | 0.86 | 5.28E-01 | | 5.11E+00 |
| | 719.35 | 0.28 | -8.99E+00 | | 1.50E+01 |
| | 778.90 | 12.96 | -1.94E-01 | | 3.26E-01 |
| | 810.45 | 0.32 | -5.67E+00 | | 1.31E+01 |
| | 867.37 | 4.26 | -1.23E+00 | | 1.03E+00 |
| | 919.33 | 0.43 | -2.06E+01 | | 1.12E+01 |
| | 964.08 | 14.65 | 9.25E-02 | | 4.59E-01 |
| | 1085.87 | 10.24 | -2.94E-01 | | 4.55E-01 |
| | 1089.74 | 1.73 | -1.22E+00 | | 3.13E+00 |
| | 1112.07 | 13.69 | 5.88E-02 | | 4.63E-01 |
| | 1212.95 | 1.43 | 3.14E+00 | | 5.29E+00 |
| | 1249.94 | 0.19 | 2.05E+00 | | 3.34E+01 |
| | 1299.14 | 1.63 | -2.07E+00 | | 2.81E+00 |
| | 1408.01 | 21.07 | -2.28E-02 | | 1.98E-01 |
| | 1457.64 | 0.50 | 2.05E+02 | | 4.66E+01 |
| | 1528.10 | 0.28 | 6.44E+00 | | 1.32E+01 |
| Eu-154 | 123.07 | 40.40 | 2.33E-02 | 9.93E-02 | 9.93E-02 |
| | 247.93 | 6.89 | 6.12E-02 | | 4.81E-01 |
| | 591.76 | 4.95 | -7.09E-02 | | 8.92E-01 |
| | 692.42 | 1.78 | -1.17E+00 | | 2.36E+00 |
| | 723.30 | 20.06 | -7.18E-02 | | 2.29E-01 |
| | 756.80 | 4.52 | 7.32E-01 | | 9.83E-01 |
| | 873.18 | 12.08 | -2.18E-01 | | 3.76E-01 |

Analysis Report for 02-Oct-19-10028

L1-12104A-FSGS-013SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | -5.20E-02 | 9.93E-02 | 5.08E-01 |
| | 1004.76 | 18.01 | 1.83E-01 | | 2.85E-01 |
| | 1274.43 | 34.80 | -1.28E-01 | | 2.01E-01 |
| | 1596.48 | 1.80 | 9.14E-01 | | 2.03E+00 |
| Eu-155 | 45.30 | 1.31 | -8.50E+00 | 2.25E-01 | 1.84E+01 |
| | 60.01 | 1.22 | -1.83E+01 | | 1.98E+01 |
| | 86.55 | 30.70 | -3.59E-02 | | 2.31E-01 |
| | 105.31 | 21.10 | 7.38E-02 | | 2.25E-01 |
| Ra-226 | 186.21 | 3.64 | 9.68E-01 | 1.02E+00 | 1.02E+00 |
| Pa-231 | 27.36 | 10.30 | 2.25E+00 | 1.72E+00 | 2.45E+00 |
| | 283.69 | 1.70 | -4.03E-01 | | 2.09E+00 |
| | 300.07 | 2.47 | -1.50E+00 | | 1.72E+00 |
| | 302.65 | 2.20 | 1.22E+00 | | 1.79E+00 |
| | 330.06 | 1.40 | 4.48E-02 | | 2.47E+00 |
| U-235 | 143.76 | 10.96 | 1.51E-01 | 6.35E-02 | 3.51E-01 |
| | 163.33 | 5.08 | -6.00E-02 | | 6.78E-01 |
| | 185.71 | 57.20 | 3.04E-02 | | 6.35E-02 |
| | 202.11 | 1.08 | 8.24E-01 | | 3.30E+00 |
| | 205.31 | 5.01 | -2.57E-01 | | 6.68E-01 |
| Am-241 | 59.54 | 35.90 | 4.22E-02 | 7.25E-01 | 7.25E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10029

L1-12104A-FQGS-013SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10029 |
| Sample Description | : L1-12104A-FQGS-013SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.679E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:24:00AM |
| Acquisition Started | : 10/2/2019 1:01:34PM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : 352 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.3 seconds |
| Dead Time | : 0.03 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 9/29/2018 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80196 |
| Fill Height | : 1679.11 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 1/7/2013 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 1:16:37PM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10029

L1-12104A-FQGS-013SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.62 | 949 - | 959 | 954.94 | 8.99E+01 | 13.11 | 3.41E+01 | 1.00 |
| 2 | 295.25 | 1176 - | 1187 | 1181.24 | 5.10E+01 | 9.82 | 1.80E+01 | 0.63 |
| 3 | 351.92 | 1399 - | 1415 | 1407.67 | 6.22E+01 | 11.00 | 1.88E+01 | 1.00 |
| 4 | 582.97 | 2324 - | 2338 | 2331.20 | 4.13E+01 | 9.53 | 1.58E+01 | 1.41 |
| 5 | 609.29 | 2429 - | 2443 | 2436.42 | 4.76E+01 | 10.87 | 2.44E+01 | 0.86 |
| 6 | 911.53 | 3640 - | 3651 | 3645.15 | 3.10E+01 | 6.82 | 6.00E+00 | 0.77 |
| 7 | 1460.73 | 5829 - | 5854 | 5843.31 | 4.59E+02 | 22.95 | 1.60E+01 | 1.78 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 0.99 | 1460.82 | * | 10.66 | 9.38E+00 | 6.21E-01 |
| Tl-208 | 0.99 | 583.19 | * | 85.00 | 5.79E-02 | 1.38E-02 |
| Pb-212 | 1.00 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.39E-01 | 2.31E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 1.00 | 609.32 | * | 45.49 | 1.28E-01 | 3.03E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |
| | | 1120.29 | | 14.92 | | |

Analysis Report for 02-Oct-19-10029

L1-12104A-FQGS-013SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 1.00 | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 1.00 | 241.99 | | 7.25 | | |
| | | 295.22 | * | 18.42 | 2.09E-01 | 4.36E-02 |
| | | 351.93 | * | 35.60 | 1.49E-01 | 2.89E-02 |
| | | 785.96 | | 1.06 | | |
| Ac-228 | 0.99 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | | 11.27 | | |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | * | 25.80 | 1.92E-01 | 4.30E-02 |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | | 15.80 | | |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# *INTERFERENCE CORRECTED REPORT*

Analysis Report for 02-Oct-19-10029

L1-12104A-FQGS-013SS

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | K-40 | 0.999 | 9.38E+00 | 6.21E-01 | |
| | Tl-208 | 0.993 | 5.79E-02 | 1.38E-02 | |
| X | Bi-211 | 0.891 | | | |
| | Pb-212 | 1.000 | 1.39E-01 | 2.31E-02 | |
| | Bi-214 | 1.000 | 1.28E-01 | 3.03E-02 | |
| | Pb-214 | 1.000 | 1.67E-01 | 2.41E-02 | |
| | Ac-228 | 0.995 | 1.92E-01 | 4.30E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10029

L1-12104A-FQGS-013SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 1:16:37PM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## NUCLIDE MDA REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 3.93E-02 | 4.65E-02 | 4.65E-02 |
| | BE-7 | 477.60 | | 10.44 | -5.94E-02 | 3.60E-01 | 3.60E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 9.38E+00 | 6.29E-01 | 6.29E-01 |
| | Mn-54 | 834.85 | | 99.98 | -5.78E-02 | 4.90E-02 | 4.90E-02 |
| | Co-60 | 1173.23 | | 99.85 | 5.03E-03 | 3.97E-02 | 6.02E-02 |
| | | 1332.49 | | 99.98 | -4.33E-03 | | 3.97E-02 |
| | Nb-94 | 702.65 | | 99.81 | -3.77E-02 | 3.99E-02 | 3.99E-02 |
| | | 871.09 | | 99.89 | 4.02E-03 | | 4.78E-02 |
| | Ag-108m | 79.13 | | 6.60 | -5.64E-01 | 3.95E-02 | 1.45E+00 |
| | | 433.94 | | 90.50 | -5.77E-03 | | 3.95E-02 |
| | | 614.28 | | 89.80 | -3.40E-02 | | 6.75E-02 |
| | | 722.94 | | 90.80 | 4.07E-03 | | 4.90E-02 |
| | Sb-125 | 176.31 | | 6.84 | -2.28E-01 | 1.14E-01 | 4.76E-01 |
| | | 380.45 | | 1.52 | 4.20E-02 | | 2.14E+00 |
| | | 427.87 | | 29.60 | -3.59E-02 | | 1.14E-01 |
| | | 463.36 | | 10.49 | 1.31E-01 | | 3.46E-01 |
| | | 600.60 | | 17.65 | 1.10E-01 | | 2.56E-01 |
| | | 606.71 | | 4.98 | 1.19E+00 | | 1.29E+00 |
| | | 635.95 | | 11.22 | -1.87E-01 | | 3.23E-01 |

Analysis Report for 02-Oct-19-10029

L1-12104A-FQGS-013SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | -1.20E+00 | 1.14E-01 | 1.93E+00 |
| Ba-133 | 79.61 | 2.65 | -4.34E-01 | 6.52E-02 | 3.50E+00 |
| | 81.00 | 32.90 | -2.48E-01 | | 2.46E-01 |
| | 276.40 | 7.16 | 2.12E-01 | | 4.97E-01 |
| | 302.85 | 18.34 | 1.19E-01 | | 1.95E-01 |
| | 356.01 | 62.05 | -1.42E-02 | | 6.52E-02 |
| | 383.85 | 8.94 | -6.83E-02 | | 3.40E-01 |
| Cs-134 | 475.36 | 1.48 | 9.23E-01 | 5.48E-02 | 2.40E+00 |
| | 563.25 | 8.34 | -1.34E-01 | | 4.43E-01 |
| | 569.33 | 15.37 | -8.76E-03 | | 2.42E-01 |
| | 604.72 | 97.62 | 1.30E-03 | | 6.22E-02 |
| | 795.86 | 85.46 | -1.57E-02 | | 5.48E-02 |
| | 801.95 | 8.69 | -4.76E-01 | | 5.28E-01 |
| | 1038.61 | 0.99 | 1.86E+00 | | 5.63E+00 |
| | 1167.97 | 1.79 | 2.21E-01 | | 3.43E+00 |
| | 1365.19 | 3.02 | -6.14E-01 | | 1.56E+00 |
| Cs-137 | 661.66 | 85.10 | 3.77E-02 | 5.11E-02 | 5.11E-02 |
| Eu-152 | 121.78 | 28.67 | 1.28E-02 | 1.22E-01 | 1.42E-01 |
| | 244.70 | 7.61 | 2.15E-03 | | 4.62E-01 |
| | 295.94 | 0.45 | 8.01E+00 | | 9.20E+00 |
| | 344.28 | 26.60 | -2.55E-02 | | 1.22E-01 |
| | 367.79 | 0.86 | 2.11E+00 | | 3.54E+00 |
| | 411.12 | 2.24 | 4.22E-01 | | 1.68E+00 |
| | 443.96 | 2.83 | -1.95E-01 | | 1.26E+00 |
| | 488.68 | 0.42 | 3.98E+00 | | 9.72E+00 |
| | 563.99 | 0.49 | -5.24E+00 | | 7.71E+00 |
| | 586.26 | 0.46 | -1.91E-01 | | 1.25E+01 |
| | 678.62 | 0.47 | 1.81E+00 | | 8.01E+00 |
| | 688.67 | 0.86 | -3.51E-01 | | 4.30E+00 |
| | 719.35 | 0.28 | -5.46E+00 | | 1.24E+01 |
| | 778.90 | 12.96 | 3.97E-03 | | 3.47E-01 |
| | 810.45 | 0.32 | -7.74E+00 | | 1.36E+01 |
| | 867.37 | 4.26 | 4.00E-01 | | 1.22E+00 |
| | 919.33 | 0.43 | -5.37E+00 | | 1.11E+01 |
| | 964.08 | 14.65 | 6.10E-01 | | 4.31E-01 |
| | 1085.87 | 10.24 | 3.10E-01 | | 5.16E-01 |
| | 1089.74 | 1.73 | -4.74E-01 | | 2.97E+00 |
| | 1112.07 | 13.69 | -5.06E-02 | | 4.19E-01 |
| | 1212.95 | 1.43 | -4.57E+00 | | 4.94E+00 |
| | 1249.94 | 0.19 | 3.88E+00 | | 3.62E+01 |
| | 1299.14 | 1.63 | -2.43E+00 | | 4.05E+00 |
| | 1408.01 | 21.07 | 8.63E-02 | | 2.45E-01 |
| | 1457.64 | 0.50 | 2.00E+02 | | 4.70E+01 |
| | 1528.10 | 0.28 | -8.39E-01 | | 1.09E+01 |
| Eu-154 | 123.07 | 40.40 | 2.31E-02 | 1.02E-01 | 1.02E-01 |
| | 247.93 | 6.89 | 6.98E-02 | | 4.37E-01 |
| | 591.76 | 4.95 | -2.95E-01 | | 8.44E-01 |
| | 692.42 | 1.78 | 2.24E-02 | | 2.22E+00 |
| | 723.30 | 20.06 | -4.79E-02 | | 2.22E-01 |
| | 756.80 | 4.52 | 1.43E-02 | | 9.11E-01 |
| | 873.18 | 12.08 | 2.24E-01 | | 4.11E-01 |

Analysis Report for 02-Oct-19-10029

L1-12104A-FQGS-013SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | -1.03E-01 | 1.02E-01 | 5.11E-01 |
| | 1004.76 | 18.01 | 8.17E-02 | | 2.79E-01 |
| | 1274.43 | 34.80 | -1.45E-01 | | 1.47E-01 |
| | 1596.48 | 1.80 | 1.17E+00 | | 2.24E+00 |
| Eu-155 | 45.30 | 1.31 | 3.62E+00 | 1.94E-01 | 2.03E+01 |
| | 60.01 | 1.22 | -1.09E+01 | | 2.01E+01 |
| | 86.55 | 30.70 | -7.45E-02 | | 2.05E-01 |
| | 105.31 | 21.10 | -3.30E-02 | | 1.94E-01 |
| Ra-226 | 186.21 | 3.64 | 7.17E-01 | 9.95E-01 | 9.95E-01 |
| Pa-231 | 27.36 | 10.30 | 3.05E+00 | 1.53E+00 | 2.43E+00 |
| | 283.69 | 1.70 | 1.76E-01 | | 1.92E+00 |
| | 300.07 | 2.47 | 4.21E-01 | | 1.53E+00 |
| | 302.65 | 2.20 | 7.94E-01 | | 1.63E+00 |
| | 330.06 | 1.40 | 1.88E+00 | | 2.59E+00 |
| U-235 | 143.76 | 10.96 | -2.70E-01 | 6.41E-02 | 3.26E-01 |
| | 163.33 | 5.08 | -1.84E-01 | | 6.95E-01 |
| | 185.71 | 57.20 | 6.83E-02 | | 6.41E-02 |
| | 202.11 | 1.08 | -1.59E+00 | | 3.16E+00 |
| | 205.31 | 5.01 | 2.97E-01 | | 7.13E-01 |
| Am-241 | 59.54 | 35.90 | -4.59E-02 | 7.36E-01 | 7.36E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10030

L1-12104A-FSGS-014SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10030 |
| Sample Description | : L1-12104A-FSGS-014SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.622E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:26:00AM |
| Acquisition Started | : 10/2/2019 1:01:42PM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : P11314 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.3 seconds |
| Dead Time | : 0.03 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 1/24/2019 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80197 |
| Fill Height | : 1621.56 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 12/22/2008 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 1:16:44PM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10030

L1-12104A-FSGS-014SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.79 | 949 - | 961 | 954.72 | 9.96E+01 | 17.30 | 7.44E+01 | 0.66 |
| 2 | 338.55 | 1347 - | 1360 | 1353.28 | 3.49E+01 | 10.07 | 2.41E+01 | 0.77 |
| 3 | 351.88 | 1399 - | 1415 | 1406.54 | 9.06E+01 | 13.30 | 2.64E+01 | 0.66 |
| 4 | 583.16 | 2325 - | 2335 | 2330.75 | 4.46E+01 | 8.61 | 1.24E+01 | 1.03 |
| 5 | 609.30 | 2428 - | 2441 | 2435.25 | 7.11E+01 | 9.50 | 6.94E+00 | 1.22 |
| 6 | 910.79 | 3635 - | 3646 | 3640.63 | 3.41E+01 | 7.51 | 8.88E+00 | 0.74 |
| 7 | 1460.19 | 5827 - | 5851 | 5838.68 | 4.66E+02 | 21.59 | 0.00E+00 | 1.66 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 0.93 | 1460.82 | * | 10.66 | 1.03E+01 | 6.53E-01 |
| Tl-208 | 1.00 | 583.19 | * | 85.00 | 6.63E-02 | 1.34E-02 |
| Bi-211 | 0.90 | 351.07 | * | 13.02 | 6.17E-01 | 1.03E-01 |
| Pb-212 | 0.99 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.57E-01 | 3.00E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 1.00 | 609.32 | * | 45.49 | 2.03E-01 | 2.98E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |

Analysis Report for 02-Oct-19-10030

L1-12104A-FSGS-014SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 1.00 | 1120.29 | | 14.92 | | |
| | | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 0.51 | 241.99 | | 7.25 | | |
| | | 295.22 | | 18.42 | | |
| | | 351.93 | * | 35.60 | 2.26E-01 | 3.77E-02 |
| | | 785.96 | | 1.06 | | |
| Ac-228 | 0.99 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | * | 11.27 | 2.66E-01 | 7.99E-02 |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | * | 25.80 | 2.26E-01 | 5.07E-02 |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | | 15.80 | | |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# *INTERFERENCE CORRECTED REPORT*

Analysis Report for 02-Oct-19-10030

L1-12104A-FSGS-014SS

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | K-40 | 0.937 | 1.03E+01 | 6.53E-01 | |
| | Tl-208 | 1.000 | 6.63E-02 | 1.34E-02 | |
| ? | Bi-211 | 0.900 | 6.17E-01 | 1.03E-01 | |
| | Pb-212 | 0.997 | 1.57E-01 | 3.00E-02 | |
| | Bi-214 | 1.000 | 2.03E-01 | 2.98E-02 | |
| ? | Pb-214 | 0.512 | 2.26E-01 | 3.77E-02 | |
| | Ac-228 | 0.991 | 2.38E-01 | 4.28E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10030

L1-12104A-FSGS-014SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 1:16:44PM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 6.31E-02 | 5.35E-02 | 5.35E-02 |
| | BE-7 | 477.60 | | 10.44 | 1.42E-01 | 4.18E-01 | 4.18E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 1.03E+01 | 6.35E-02 | 6.35E-02 |
| | Mn-54 | 834.85 | | 99.98 | 4.16E-03 | 4.63E-02 | 4.63E-02 |
| | Co-60 | 1173.23 | | 99.85 | -7.81E-02 | 3.61E-02 | 5.98E-02 |
| | | 1332.49 | | 99.98 | -4.28E-02 | | 3.61E-02 |
| | Nb-94 | 702.65 | | 99.81 | -1.08E-02 | 3.86E-02 | 3.86E-02 |
| | | 871.09 | | 99.89 | -4.47E-02 | | 4.83E-02 |
| | Ag-108m | 79.13 | | 6.60 | 1.06E+00 | 4.02E-02 | 1.21E+00 |
| | | 433.94 | | 90.50 | 4.40E-03 | | 4.02E-02 |
| | | 614.28 | | 89.80 | -4.33E-02 | | 5.00E-02 |
| | | 722.94 | | 90.80 | 2.25E-02 | | 5.22E-02 |
| | Sb-125 | 176.31 | | 6.84 | 4.53E-03 | 1.27E-01 | 4.50E-01 |
| | | 380.45 | | 1.52 | -4.20E-01 | | 2.10E+00 |
| | | 427.87 | | 29.60 | -3.87E-02 | | 1.27E-01 |
| | | 463.36 | | 10.49 | 3.09E-01 | | 3.98E-01 |
| | | 600.60 | | 17.65 | 1.73E-03 | | 2.37E-01 |
| | | 606.71 | | 4.98 | 1.38E+00 | | 1.33E+00 |
| | | 635.95 | | 11.22 | -9.09E-03 | | 3.09E-01 |

Analysis Report for 02-Oct-19-10030

L1-12104A-FSGS-014SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | 1.63E+00 | 1.27E-01 | 2.46E+00 |
| Ba-133 | 79.61 | 2.65 | 2.17E+00 | 6.67E-02 | 2.93E+00 |
| | 81.00 | 32.90 | -2.59E-01 | | 1.91E-01 |
| | 276.40 | 7.16 | 1.62E-01 | | 4.85E-01 |
| | 302.85 | 18.34 | 7.89E-02 | | 1.90E-01 |
| | 356.01 | 62.05 | -2.25E-02 | | 6.67E-02 |
| | 383.85 | 8.94 | -1.02E-01 | | 3.66E-01 |
| Cs-134 | 475.36 | 1.48 | 6.22E-01 | 5.40E-02 | 2.76E+00 |
| | 563.25 | 8.34 | -1.98E-01 | | 4.74E-01 |
| | 569.33 | 15.37 | 8.95E-02 | | 2.49E-01 |
| | 604.72 | 97.62 | -5.58E-03 | | 6.04E-02 |
| | 795.86 | 85.46 | -2.27E-02 | | 5.40E-02 |
| | 801.95 | 8.69 | -2.10E-02 | | 5.71E-01 |
| | 1038.61 | 0.99 | -3.77E+00 | | 5.06E+00 |
| | 1167.97 | 1.79 | -4.80E-01 | | 3.65E+00 |
| | 1365.19 | 3.02 | 3.69E-01 | | 1.28E+00 |
| Cs-137 | 661.66 | 85.10 | -1.70E-02 | 4.10E-02 | 4.10E-02 |
| Eu-152 | 121.78 | 28.67 | -4.42E-03 | 1.13E-01 | 1.13E-01 |
| | 244.70 | 7.61 | 1.70E-01 | | 4.91E-01 |
| | 295.94 | 0.45 | -3.87E+00 | | 8.43E+00 |
| | 344.28 | 26.60 | 3.78E-03 | | 1.22E-01 |
| | 367.79 | 0.86 | 8.99E-01 | | 4.01E+00 |
| | 411.12 | 2.24 | -7.68E-01 | | 1.55E+00 |
| | 443.96 | 2.83 | -3.54E-01 | | 1.21E+00 |
| | 488.68 | 0.42 | -5.16E+00 | | 8.53E+00 |
| | 563.99 | 0.49 | -6.67E+00 | | 7.65E+00 |
| | 586.26 | 0.46 | -1.34E+01 | | 1.26E+01 |
| | 678.62 | 0.47 | -9.57E-01 | | 9.03E+00 |
| | 688.67 | 0.86 | -6.04E-01 | | 5.53E+00 |
| | 719.35 | 0.28 | -4.89E+00 | | 1.45E+01 |
| | 778.90 | 12.96 | -2.05E-01 | | 3.12E-01 |
| | 810.45 | 0.32 | 8.22E-01 | | 1.55E+01 |
| | 867.37 | 4.26 | -1.46E+00 | | 1.15E+00 |
| | 919.33 | 0.43 | -5.93E-01 | | 9.77E+00 |
| | 964.08 | 14.65 | -2.33E-01 | | 3.88E-01 |
| | 1085.87 | 10.24 | -1.64E-01 | | 5.63E-01 |
| | 1089.74 | 1.73 | -1.53E-01 | | 3.86E+00 |
| | 1112.07 | 13.69 | -4.64E-02 | | 3.89E-01 |
| | 1212.95 | 1.43 | -2.21E+00 | | 5.12E+00 |
| | 1249.94 | 0.19 | 1.43E+01 | | 3.29E+01 |
| | 1299.14 | 1.63 | 6.97E-01 | | 3.09E+00 |
| | 1408.01 | 21.07 | -1.18E-01 | | 1.88E-01 |
| | 1457.64 | 0.50 | 2.19E+02 | | 5.00E+01 |
| | 1528.10 | 0.28 | 1.25E+00 | | 1.18E+01 |
| Eu-154 | 123.07 | 40.40 | 1.17E-02 | 7.80E-02 | 7.80E-02 |
| | 247.93 | 6.89 | -2.46E-02 | | 4.70E-01 |
| | 591.76 | 4.95 | 3.98E-01 | | 8.36E-01 |
| | 692.42 | 1.78 | 7.99E-01 | | 2.65E+00 |
| | 723.30 | 20.06 | 1.83E-01 | | 2.42E-01 |
| | 756.80 | 4.52 | -1.38E+00 | | 8.11E-01 |
| | 873.18 | 12.08 | 8.06E-02 | | 4.76E-01 |

Analysis Report for 02-Oct-19-10030

L1-12104A-FSGS-014SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | -4.76E-02 | 7.80E-02 | 5.12E-01 |
| | 1004.76 | 18.01 | 1.41E-02 | | 3.08E-01 |
| | 1274.43 | 34.80 | -3.22E-02 | | 1.86E-01 |
| | 1596.48 | 1.80 | 2.66E-01 | | 2.18E+00 |
| Eu-155 | 45.30 | 1.31 | -1.48E+00 | 1.72E-01 | 1.16E+01 |
| | 60.01 | 1.22 | 7.30E-01 | | 1.33E+01 |
| | 86.55 | 30.70 | 4.27E-02 | | 1.72E-01 |
| | 105.31 | 21.10 | -9.99E-02 | | 1.75E-01 |
| Ra-226 | 186.21 | 3.64 | 3.97E-01 | 9.10E-01 | 9.10E-01 |
| Pa-231 | 27.36 | 10.30 | 7.56E-01 | 1.27E+00 | 1.27E+00 |
| | 283.69 | 1.70 | 4.96E-01 | | 1.93E+00 |
| | 300.07 | 2.47 | -1.67E+00 | | 1.37E+00 |
| | 302.65 | 2.20 | 1.08E+00 | | 1.61E+00 |
| | 330.06 | 1.40 | 2.10E+00 | | 2.53E+00 |
| U-235 | 143.76 | 10.96 | 5.55E-02 | 5.85E-02 | 3.01E-01 |
| | 163.33 | 5.08 | -3.50E-01 | | 5.86E-01 |
| | 185.71 | 57.20 | 5.09E-02 | | 5.85E-02 |
| | 202.11 | 1.08 | -7.13E-01 | | 3.04E+00 |
| | 205.31 | 5.01 | -1.19E-01 | | 6.43E-01 |
| Am-241 | 59.54 | 35.90 | -2.03E-02 | 4.74E-01 | 4.74E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10031

L1-12104A-FSGS-015SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10031 |
| Sample Description | : L1-12104A-FSGS-015SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.693E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:28:00AM |
| Acquisition Started | : 10/2/2019 1:19:07PM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : P11314 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.3 seconds |
| Dead Time | : 0.04 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 1/24/2019 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80198 |
| Fill Height | : 1692.78 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 12/22/2008 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 1:34:10PM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Grohan

Analysis Report for 02-Oct-19-10031

L1-12104A-FSGS-015SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.82 | 950 - | 961 | 954.87 | 1.31E+02 | 14.83 | 3.47E+01 | 0.77 |
| 2 | 338.54 | 1348 - | 1359 | 1353.24 | 3.27E+01 | 9.43 | 2.23E+01 | 0.59 |
| 3 | 352.02 | 1400 - | 1414 | 1407.11 | 7.84E+01 | 12.24 | 2.46E+01 | 1.11 |
| 4 | 477.41 | 1902 - | 1913 | 1908.12 | 3.22E+01 | 7.90 | 1.18E+01 | 0.34 |
| 5 | 583.13 | 2326 - | 2338 | 2330.64 | 4.10E+01 | 8.39 | 1.10E+01 | 0.89 |
| 6 | 609.30 | 2428 - | 2441 | 2435.23 | 5.94E+01 | 8.34 | 3.56E+00 | 1.30 |
| 7 | 727.14 | 2902 - | 2912 | 2906.30 | 2.14E+01 | 5.08 | 1.64E+00 | 0.45 |
| 8 | 910.89 | 3637 - | 3647 | 3641.00 | 2.53E+01 | 8.03 | 1.47E+01 | 0.94 |
| 9 | 1460.26 | 5828 - | 5851 | 5838.99 | 4.06E+02 | 21.21 | 1.14E+01 | 1.88 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| BE-7 | 0.99 | 477.60 | * | 10.44 | 3.42E-01 | 8.75E-02 |
| K-40 | 0.95 | 1460.82 | * | 10.66 | 8.85E+00 | 6.02E-01 |
| Tl-208 | 0.99 | 583.19 | * | 85.00 | 6.04E-02 | 1.29E-02 |
| Bi-211 | 0.86 | 351.07 | * | 13.02 | 5.30E-01 | 9.30E-02 |
| Bi-212 | 0.99 | 39.86 | | 1.06 | | |
| | | 727.33 | * | 6.67 | 4.65E-01 | 1.14E-01 |
| | | 785.37 | | 1.10 | | |
| | | 1620.50 | | 1.47 | | |

Analysis Report for 02-Oct-19-10031

L1-12104A-FSGS-015SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Pb-212 | 0.99 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 2.05E-01 | 2.85E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 1.00 | 609.32 | * | 45.49 | 1.68E-01 | 2.57E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |
| | | 1120.29 | | 14.92 | | |
| | | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 0.99 | 241.99 | | 7.25 | | |
| | | 295.22 | | 18.42 | | |
| | | 351.93 | * | 35.60 | 1.94E-01 | 3.40E-02 |
| | | 785.96 | | 1.06 | | |
| Ac-228 | 0.99 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | * | 11.27 | 2.48E-01 | 7.43E-02 |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | * | 25.80 | 1.66E-01 | 5.31E-02 |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | | 15.80 | | |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10031

L1-12104A-FSGS-015SS

# INTERFERENCE CORRECTED REPORT

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | BE-7 | 0.994 | 3.42E-01 | 8.75E-02 | |
| | K-40 | 0.951 | 8.85E+00 | 6.02E-01 | |
| | Tl-208 | 0.999 | 6.04E-02 | 1.29E-02 | |
| ? | Bi-211 | 0.864 | 5.30E-01 | 9.30E-02 | |
| | Bi-212 | 0.996 | 4.65E-01 | 1.14E-01 | |
| | Pb-212 | 0.995 | 2.05E-01 | 2.85E-02 | |
| | Bi-214 | 1.000 | 1.68E-01 | 2.57E-02 | |
| ? | Pb-214 | 0.999 | 1.94E-01 | 3.40E-02 | |
| | Ac-228 | 0.994 | 1.94E-01 | 4.32E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10031

L1-12104A-FSGS-015SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 1:34:10PM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 6.73E-02 | 5.68E-02 | 5.68E-02 |
| + | BE-7 | 477.60 | * | 10.44 | 3.42E-01 | 2.29E-01 | 2.29E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 8.85E+00 | 5.55E-01 | 5.55E-01 |
| | Mn-54 | 834.85 | | 99.98 | -7.13E-03 | 4.37E-02 | 4.37E-02 |
| | Co-60 | 1173.23 | | 99.85 | -1.52E-02 | 5.40E-02 | 6.17E-02 |
| | | 1332.49 | | 99.98 | 5.30E-03 | | 5.40E-02 |
| | Nb-94 | 702.65 | | 99.81 | 2.63E-02 | 4.02E-02 | 4.02E-02 |
| | | 871.09 | | 99.89 | -8.81E-03 | | 4.25E-02 |
| | Ag-108m | 79.13 | | 6.60 | -6.24E-01 | 3.83E-02 | 1.12E+00 |
| | | 433.94 | | 90.50 | -2.47E-02 | | 3.83E-02 |
| | | 614.28 | | 89.80 | -2.45E-02 | | 5.50E-02 |
| | | 722.94 | | 90.80 | -3.55E-02 | | 5.47E-02 |
| | Sb-125 | 176.31 | | 6.84 | 1.32E-01 | 1.26E-01 | 4.55E-01 |
| | | 380.45 | | 1.52 | 1.63E+00 | | 2.11E+00 |
| | | 427.87 | | 29.60 | -2.41E-02 | | 1.26E-01 |
| | | 463.36 | | 10.49 | -2.25E-01 | | 3.69E-01 |
| | | 600.60 | | 17.65 | 1.62E-01 | | 2.29E-01 |
| | | 606.71 | | 4.98 | 9.96E-01 | | 1.19E+00 |
| | | 635.95 | | 11.22 | -3.05E-01 | | 2.75E-01 |

Analysis Report for 02-Oct-19-10031

L1-12104A-FSGS-015SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | -5.23E-01 | 1.26E-01 | 2.44E+00 |
| Ba-133 | 79.61 | 2.65 | -1.03E+00 | 6.91E-02 | 2.72E+00 |
| | 81.00 | 32.90 | -2.15E-01 | | 1.97E-01 |
| | 276.40 | 7.16 | -2.48E-01 | | 4.53E-01 |
| | 302.85 | 18.34 | 6.17E-02 | | 2.03E-01 |
| | 356.01 | 62.05 | -4.92E-03 | | 6.91E-02 |
| | 383.85 | 8.94 | 2.88E-01 | | 3.63E-01 |
| Cs-134 | 475.36 | 1.48 | 2.80E+00 | 5.39E-02 | 3.20E+00 |
| | 563.25 | 8.34 | -4.25E-01 | | 5.15E-01 |
| | 569.33 | 15.37 | 2.84E-03 | | 2.54E-01 |
| | 604.72 | 97.62 | -1.86E-02 | | 5.39E-02 |
| | 795.86 | 85.46 | 2.44E-02 | | 5.58E-02 |
| | 801.95 | 8.69 | -2.00E-01 | | 5.05E-01 |
| | 1038.61 | 0.99 | 3.06E-02 | | 5.36E+00 |
| | 1167.97 | 1.79 | -3.07E+00 | | 3.66E+00 |
| | 1365.19 | 3.02 | -1.28E-01 | | 1.38E+00 |
| Cs-137 | 661.66 | 85.10 | 3.69E-02 | 4.46E-02 | 4.46E-02 |
| Eu-152 | 121.78 | 28.67 | -7.19E-03 | 1.07E-01 | 1.11E-01 |
| | 244.70 | 7.61 | 2.98E-01 | | 4.53E-01 |
| | 295.94 | 0.45 | 2.10E+00 | | 1.02E+01 |
| | 344.28 | 26.60 | -9.82E-02 | | 1.07E-01 |
| | 367.79 | 0.86 | 4.27E+00 | | 4.08E+00 |
| | 411.12 | 2.24 | -4.04E-01 | | 1.53E+00 |
| | 443.96 | 2.83 | -7.42E-01 | | 1.15E+00 |
| | 488.68 | 0.42 | 3.25E+00 | | 8.78E+00 |
| | 563.99 | 0.49 | -1.14E+01 | | 7.99E+00 |
| | 586.26 | 0.46 | 1.30E+01 | | 1.21E+01 |
| | 678.62 | 0.47 | -1.08E+00 | | 8.95E+00 |
| | 688.67 | 0.86 | 2.79E+00 | | 4.90E+00 |
| | 719.35 | 0.28 | 1.38E+01 | | 1.66E+01 |
| | 778.90 | 12.96 | -1.55E-01 | | 3.26E-01 |
| | 810.45 | 0.32 | 6.24E+00 | | 1.46E+01 |
| | 867.37 | 4.26 | 1.15E-01 | | 1.01E+00 |
| | 919.33 | 0.43 | 6.69E+00 | | 1.11E+01 |
| | 964.08 | 14.65 | 2.93E-01 | | 4.57E-01 |
| | 1085.87 | 10.24 | 3.25E-02 | | 5.95E-01 |
| | 1089.74 | 1.73 | 1.02E+00 | | 3.61E+00 |
| | 1112.07 | 13.69 | 1.15E-01 | | 4.17E-01 |
| | 1212.95 | 1.43 | 6.08E-01 | | 4.81E+00 |
| | 1249.94 | 0.19 | -9.54E+00 | | 3.35E+01 |
| | 1299.14 | 1.63 | -1.45E+00 | | 3.13E+00 |
| | 1408.01 | 21.07 | -5.10E-02 | | 1.77E-01 |
| | 1457.64 | 0.50 | 1.93E+02 | | 4.69E+01 |
| | 1528.10 | 0.28 | 4.27E+00 | | 1.16E+01 |
| Eu-154 | 123.07 | 40.40 | -2.11E-03 | 7.91E-02 | 7.91E-02 |
| | 247.93 | 6.89 | 3.55E-02 | | 4.64E-01 |
| | 591.76 | 4.95 | -2.25E-01 | | 7.98E-01 |
| | 692.42 | 1.78 | -4.32E-01 | | 2.24E+00 |
| | 723.30 | 20.06 | -1.55E-01 | | 2.51E-01 |
| | 756.80 | 4.52 | 8.15E-02 | | 8.55E-01 |
| | 873.18 | 12.08 | -5.76E-02 | | 3.65E-01 |

Analysis Report for 02-Oct-19-10031

L1-12104A-FSGS-015SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | -2.72E-01 | 7.91E-02 | 4.92E-01 |
| | 1004.76 | 18.01 | 2.28E-01 | | 3.05E-01 |
| | 1274.43 | 34.80 | -9.97E-02 | | 1.54E-01 |
| | 1596.48 | 1.80 | -1.03E+00 | | 2.03E+00 |
| Eu-155 | 45.30 | 1.31 | 2.93E+00 | 1.85E-01 | 1.16E+01 |
| | 60.01 | 1.22 | -1.01E+00 | | 1.20E+01 |
| | 86.55 | 30.70 | 6.89E-03 | | 1.85E-01 |
| | 105.31 | 21.10 | 1.62E-01 | | 1.91E-01 |
| Ra-226 | 186.21 | 3.64 | 2.60E-01 | 9.08E-01 | 9.08E-01 |
| Pa-231 | 27.36 | 10.30 | 1.23E+00 | 1.31E+00 | 1.31E+00 |
| | 283.69 | 1.70 | -1.09E+00 | | 1.78E+00 |
| | 300.07 | 2.47 | -2.79E+00 | | 1.50E+00 |
| | 302.65 | 2.20 | 1.04E+00 | | 1.69E+00 |
| | 330.06 | 1.40 | 7.33E-01 | | 2.44E+00 |
| U-235 | 143.76 | 10.96 | 1.61E-01 | 5.68E-02 | 3.13E-01 |
| | 163.33 | 5.08 | 2.64E-01 | | 6.15E-01 |
| | 185.71 | 57.20 | -1.36E-02 | | 5.68E-02 |
| | 202.11 | 1.08 | 6.32E-01 | | 2.78E+00 |
| | 205.31 | 5.01 | -1.98E-01 | | 6.11E-01 |
| Am-241 | 59.54 | 35.90 | -2.65E-01 | 4.01E-01 | 4.01E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10032

L1-12104A-FSGS-016SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10032 |
| Sample Description | : L1-12104A-FSGS-016SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.642E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:30:00AM |
| Acquisition Started | : 10/2/2019 1:19:15PM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : 352 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.3 seconds |
| Dead Time | : 0.03 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 9/29/2018 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80199 |
| Fill Height | : 1642.38 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 1/7/2013 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 1:34:19PM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10032

L1-12104A-FSGS-016SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.62 | 950 - | 962 | 954.96 | 1.05E+02 | 16.61 | 6.22E+01 | 0.75 |
| 2 | 295.27 | 1172 - | 1188 | 1181.31 | 6.63E+01 | 12.62 | 2.98E+01 | 1.03 |
| 3 | 311.10 | 1240 - | 1249 | 1244.57 | 1.01E+01 | 5.51 | 8.86E+00 | 0.38 |
| 4 | 338.30 | 1347 - | 1360 | 1353.26 | 3.76E+01 | 10.54 | 2.64E+01 | 0.42 |
| 5 | 351.92 | 1399 - | 1415 | 1407.67 | 7.36E+01 | 12.39 | 2.54E+01 | 0.38 |
| 6 | 609.26 | 2430 - | 2443 | 2436.29 | 3.21E+01 | 9.56 | 2.09E+01 | 0.63 |
| 7 | 1460.83 | 5830 - | 5855 | 5843.68 | 4.15E+02 | 22.00 | 1.63E+01 | 1.81 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 1.00 | 1460.82 | * | 10.66 | 8.52E+00 | 5.84E-01 |
| Pb-212 | 1.00 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.62E-01 | 2.89E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 1.00 | 609.32 | * | 45.49 | 8.70E-02 | 2.64E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |
| | | 1120.29 | | 14.92 | | |
| | | 1155.21 | | 1.63 | | |

Analysis Report for 02-Oct-19-10032

L1-12104A-FSGS-016SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 1.00 | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 1.00 | 241.99 | | 7.25 | | |
| | | 295.22 | * | 18.42 | 2.72E-01 | 5.63E-02 |
| | | 351.93 | * | 35.60 | 1.77E-01 | 3.30E-02 |
| | | 785.96 | | 1.06 | | |
| Ac-228 | 0.57 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | * | 11.27 | 2.77E-01 | 8.10E-02 |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | | 25.80 | | |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | | 15.80 | | |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# *INTERFERENCE CORRECTED REPORT*

Analysis Report for 02-Oct-19-10032

L1-12104A-FSGS-016SS

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | K-40 | 1.000 | 8.52E+00 | 5.84E-01 | |
| X | Bi-211 | 0.891 | | | |
| | Pb-212 | 1.000 | 1.62E-01 | 2.89E-02 | |
| | Bi-214 | 1.000 | 8.70E-02 | 2.64E-02 | |
| | Pb-214 | 1.000 | 2.01E-01 | 2.84E-02 | |
| | Ac-228 | 0.571 | 2.77E-01 | 8.10E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10032

L1-12104A-FSGS-016SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 1:34:19PM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|
| 3 | 311.10 | 1.12719E-02 | 54.34 | | |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 6.92E-02 | 5.34E-02 | 5.34E-02 |
| | BE-7 | 477.60 | | 10.44 | -2.97E-02 | 3.72E-01 | 3.72E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 8.52E+00 | 6.40E-01 | 6.40E-01 |
| | Mn-54 | 834.85 | | 99.98 | 6.95E-03 | 4.68E-02 | 4.68E-02 |
| | Co-60 | 1173.23 | | 99.85 | -5.03E-02 | 4.13E-02 | 5.90E-02 |
| | | 1332.49 | | 99.98 | -2.20E-02 | | 4.13E-02 |
| | Nb-94 | 702.65 | | 99.81 | 4.07E-04 | 3.95E-02 | 3.95E-02 |
| | | 871.09 | | 99.89 | 2.40E-02 | | 5.56E-02 |
| | Ag-108m | 79.13 | | 6.60 | 1.33E+00 | 4.01E-02 | 1.52E+00 |
| | | 433.94 | | 90.50 | 1.17E-03 | | 4.01E-02 |
| | | 614.28 | | 89.80 | 1.01E-03 | | 6.17E-02 |
| | | 722.94 | | 90.80 | 1.20E-02 | | 4.62E-02 |
| | Sb-125 | 176.31 | | 6.84 | 1.92E-01 | 1.12E-01 | 4.59E-01 |
| | | 380.45 | | 1.52 | -9.07E-01 | | 1.86E+00 |
| | | 427.87 | | 29.60 | -7.13E-02 | | 1.12E-01 |
| | | 463.36 | | 10.49 | 3.26E-01 | | 3.48E-01 |
| | | 600.60 | | 17.65 | 9.56E-02 | | 2.30E-01 |
| | | 606.71 | | 4.98 | 1.22E+00 | | 1.18E+00 |

Analysis Report for 02-Oct-19-10032

L1-12104A-FSGS-016SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 635.95 | 11.22 | 7.35E-03 | 1.12E-01 | 3.76E-01 |
| | 671.44 | 1.79 | -2.34E+00 | | 2.55E+00 |
| Ba-133 | 79.61 | 2.65 | 3.04E-01 | 7.36E-02 | 3.55E+00 |
| | 81.00 | 32.90 | -2.96E-01 | | 2.40E-01 |
| | 276.40 | 7.16 | -4.01E-03 | | 4.96E-01 |
| | 302.85 | 18.34 | 1.54E-02 | | 1.59E-01 |
| | 356.01 | 62.05 | -2.76E-03 | | 7.36E-02 |
| | 383.85 | 8.94 | -2.27E-01 | | 3.26E-01 |
| Cs-134 | 475.36 | 1.48 | 1.81E+00 | 5.44E-02 | 2.49E+00 |
| | 563.25 | 8.34 | 1.16E-01 | | 4.62E-01 |
| | 569.33 | 15.37 | -4.62E-02 | | 2.55E-01 |
| | 604.72 | 97.62 | -3.22E-03 | | 5.79E-02 |
| | 795.86 | 85.46 | 9.98E-03 | | 5.44E-02 |
| | 801.95 | 8.69 | -1.89E-01 | | 5.10E-01 |
| | 1038.61 | 0.99 | 4.41E-01 | | 4.99E+00 |
| | 1167.97 | 1.79 | -1.00E+00 | | 3.45E+00 |
| | 1365.19 | 3.02 | -9.68E-01 | | 1.75E+00 |
| Cs-137 | 661.66 | 85.10 | 3.31E-02 | 5.25E-02 | 5.25E-02 |
| Eu-152 | 121.78 | 28.67 | -1.11E-01 | 1.23E-01 | 1.34E-01 |
| | 244.70 | 7.61 | 1.75E-01 | | 4.94E-01 |
| | 295.94 | 0.45 | 1.09E+01 | | 9.92E+00 |
| | 344.28 | 26.60 | -5.18E-02 | | 1.23E-01 |
| | 367.79 | 0.86 | -9.57E-01 | | 4.13E+00 |
| | 411.12 | 2.24 | -7.02E-01 | | 1.52E+00 |
| | 443.96 | 2.83 | -1.00E+00 | | 1.09E+00 |
| | 488.68 | 0.42 | -5.71E+00 | | 8.33E+00 |
| | 563.99 | 0.49 | 3.23E-01 | | 7.65E+00 |
| | 586.26 | 0.46 | 9.36E+00 | | 1.12E+01 |
| | 678.62 | 0.47 | -2.54E+00 | | 1.05E+01 |
| | 688.67 | 0.86 | 4.15E+00 | | 5.39E+00 |
| | 719.35 | 0.28 | 1.84E+00 | | 1.22E+01 |
| | 778.90 | 12.96 | -2.96E-01 | | 3.62E-01 |
| | 810.45 | 0.32 | -4.67E-01 | | 1.26E+01 |
| | 867.37 | 4.26 | 2.81E-01 | | 1.30E+00 |
| | 919.33 | 0.43 | -2.21E+01 | | 1.13E+01 |
| | 964.08 | 14.65 | 1.02E-01 | | 4.55E-01 |
| | 1085.87 | 10.24 | 1.31E-01 | | 5.33E-01 |
| | 1089.74 | 1.73 | -7.80E-02 | | 3.41E+00 |
| | 1112.07 | 13.69 | -4.93E-01 | | 3.94E-01 |
| | 1212.95 | 1.43 | -2.53E+00 | | 4.97E+00 |
| | 1249.94 | 0.19 | -1.69E+01 | | 3.64E+01 |
| | 1299.14 | 1.63 | -1.01E+00 | | 3.50E+00 |
| | 1408.01 | 21.07 | 9.99E-02 | | 2.23E-01 |
| | 1457.64 | 0.50 | 1.83E+02 | | 4.52E+01 |
| | 1528.10 | 0.28 | -1.82E+01 | | 1.25E+01 |
| Eu-154 | 123.07 | 40.40 | -3.15E-03 | 9.65E-02 | 9.65E-02 |
| | 247.93 | 6.89 | -3.89E-01 | | 4.58E-01 |
| | 591.76 | 4.95 | 2.49E-01 | | 8.12E-01 |
| | 692.42 | 1.78 | 5.02E-01 | | 2.30E+00 |
| | 723.30 | 20.06 | -8.73E-02 | | 2.12E-01 |
| | 756.80 | 4.52 | 2.11E-01 | | 9.43E-01 |

Analysis Report for 02-Oct-19-10032

L1-12104A-FSGS-016SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 873.18 | 12.08 | 3.93E-01 | 9.65E-02 | 4.61E-01 |
| | 996.29 | 10.48 | 4.85E-01 | | 5.14E-01 |
| | 1004.76 | 18.01 | -2.12E-01 | | 2.81E-01 |
| | 1274.43 | 34.80 | -5.20E-02 | | 1.54E-01 |
| | 1596.48 | 1.80 | 4.40E-01 | | 2.14E+00 |
| Eu-155 | 45.30 | 1.31 | 2.10E+00 | 2.02E-01 | 1.99E+01 |
| | 60.01 | 1.22 | -6.13E-01 | | 2.02E+01 |
| | 86.55 | 30.70 | 4.13E-02 | | 2.17E-01 |
| | 105.31 | 21.10 | -9.23E-02 | | 2.02E-01 |
| Ra-226 | 186.21 | 3.64 | 2.13E-01 | 1.05E+00 | 1.05E+00 |
| Pa-231 | 27.36 | 10.30 | 1.74E+00 | 1.31E+00 | 2.26E+00 |
| | 283.69 | 1.70 | -6.96E-01 | | 2.06E+00 |
| | 300.07 | 2.47 | 8.09E-02 | | 1.37E+00 |
| | 302.65 | 2.20 | 2.48E-01 | | 1.31E+00 |
| | 330.06 | 1.40 | 1.36E+00 | | 2.46E+00 |
| U-235 | 143.76 | 10.96 | -2.31E-01 | 6.73E-02 | 3.19E-01 |
| | 163.33 | 5.08 | -8.31E-01 | | 6.22E-01 |
| | 185.71 | 57.20 | 3.20E-02 | | 6.73E-02 |
| | 202.11 | 1.08 | -2.75E+00 | | 2.90E+00 |
| | 205.31 | 5.01 | -4.43E-01 | | 6.22E-01 |
| Am-241 | 59.54 | 35.90 | -2.91E-01 | 7.00E-01 | 7.00E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10033

L1-12104A-FSGS-017SS

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10033 |
| Sample Description | : L1-12104A-FSGS-017SS |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.612E+03 grams |
| Facility | : Default |
| Sample Taken On | : 10/1/2019 9:32:00AM |
| Acquisition Started | : 10/2/2019 1:45:37PM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : P11314 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.3 seconds |
| Dead Time | : 0.03 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 1/24/2019 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80202 |
| Fill Height | : 1611.73 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 12/22/2008 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 2:00:40PM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10033

L1-12104A-FSGS-017SS

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.78 | 950 - | 960 | 954.69 | 1.10E+02 | 14.89 | 4.55E+01 | 1.11 |
| 2 | 295.24 | 1176 - | 1187 | 1180.24 | 3.87E+01 | 9.99 | 2.33E+01 | 0.96 |
| 3 | 352.03 | 1401 - | 1413 | 1407.14 | 6.83E+01 | 10.46 | 1.57E+01 | 1.10 |
| 4 | 582.95 | 2324 - | 2336 | 2329.90 | 3.97E+01 | 8.00 | 9.26E+00 | 0.86 |
| 5 | 609.06 | 2428 - | 2440 | 2434.28 | 4.86E+01 | 8.87 | 1.14E+01 | 1.15 |
| 6 | 1460.21 | 5826 - | 5851 | 5838.79 | 4.65E+02 | 21.87 | 3.18E+00 | 2.29 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 0.94 | 1460.82 | * | 10.66 | 1.03E+01 | 6.58E-01 |
| Tl-208 | 0.99 | 583.19 | * | 85.00 | 5.91E-02 | 1.24E-02 |
| Pb-212 | 0.99 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.72E-01 | 2.73E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 0.99 | 609.32 | * | 45.49 | 1.39E-01 | 2.67E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |
| | | 1120.29 | | 14.92 | | |
| | | 1155.21 | | 1.63 | | |

Analysis Report for 02-Oct-19-10033

L1-12104A-FSGS-017SS

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 0.99 | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 0.99 | 241.99 | | 7.25 | | |
| | | 295.22 | * | 18.42 | 1.64E-01 | 4.43E-02 |
| | | 351.93 | * | 35.60 | 1.70E-01 | 2.94E-02 |
| | | 785.96 | | 1.06 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# INTERFERENCE CORRECTED REPORT

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | K-40 | 0.942 | 1.03E+01 | 6.58E-01 | |
| | Tl-208 | 0.991 | 5.91E-02 | 1.24E-02 | |
| X | Bi-211 | 0.862 | | | |
| | Pb-212 | 0.997 | 1.72E-01 | 2.73E-02 | |
| | Bi-214 | 0.996 | 1.39E-01 | 2.67E-02 | |
| | Pb-214 | 0.999 | 1.68E-01 | 2.45E-02 | |

Analysis Report for 02-Oct-19-10033

L1-12104A-FSGS-017SS

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10033

L1-12104A-FSGS-017SS

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 2:00:40PM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 6.07E-02 | 5.46E-02 | 5.46E-02 |
| | BE-7 | 477.60 | | 10.44 | 2.24E-01 | 4.05E-01 | 4.05E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 1.03E+01 | 3.38E-01 | 3.38E-01 |
| | Mn-54 | 834.85 | | 99.98 | -1.51E-02 | 4.26E-02 | 4.26E-02 |
| | Co-60 | 1173.23 | | 99.85 | 1.58E-02 | 5.47E-02 | 6.49E-02 |
| | | 1332.49 | | 99.98 | 1.26E-02 | | 5.47E-02 |
| | Nb-94 | 702.65 | | 99.81 | -1.69E-02 | 4.37E-02 | 4.61E-02 |
| | | 871.09 | | 99.89 | -3.03E-02 | | 4.37E-02 |
| | Ag-108m | 79.13 | | 6.60 | 5.22E-01 | 4.03E-02 | 1.12E+00 |
| | | 433.94 | | 90.50 | -4.05E-02 | | 4.03E-02 |
| | | 614.28 | | 89.80 | -3.59E-02 | | 5.32E-02 |
| | | 722.94 | | 90.80 | 4.78E-02 | | 5.35E-02 |
| | Sb-125 | 176.31 | | 6.84 | -9.64E-02 | 1.33E-01 | 4.40E-01 |
| | | 380.45 | | 1.52 | -2.11E-01 | | 2.06E+00 |
| | | 427.87 | | 29.60 | 6.44E-03 | | 1.33E-01 |
| | | 463.36 | | 10.49 | -8.49E-02 | | 3.45E-01 |
| | | 600.60 | | 17.65 | 2.00E-01 | | 2.59E-01 |
| | | 606.71 | | 4.98 | 1.62E+00 | | 1.26E+00 |
| | | 635.95 | | 11.22 | -3.00E-02 | | 3.74E-01 |

Analysis Report for 02-Oct-19-10033

L1-12104A-FSGS-017SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | 3.69E-01 | 1.33E-01 | 2.40E+00 |
| Ba-133 | 79.61 | 2.65 | 1.86E+00 | 6.36E-02 | 2.72E+00 |
| | 81.00 | 32.90 | -4.33E-01 | | 1.69E-01 |
| | 276.40 | 7.16 | 2.48E-01 | | 4.50E-01 |
| | 302.85 | 18.34 | -1.32E-02 | | 1.89E-01 |
| | 356.01 | 62.05 | 5.12E-03 | | 6.36E-02 |
| | 383.85 | 8.94 | 1.27E-01 | | 3.71E-01 |
| Cs-134 | 475.36 | 1.48 | -1.86E-01 | 5.08E-02 | 2.74E+00 |
| | 563.25 | 8.34 | -5.74E-01 | | 4.05E-01 |
| | 569.33 | 15.37 | -2.23E-02 | | 2.17E-01 |
| | 604.72 | 97.62 | 1.36E-03 | | 5.86E-02 |
| | 795.86 | 85.46 | -1.40E-02 | | 5.08E-02 |
| | 801.95 | 8.69 | -1.27E-01 | | 5.57E-01 |
| | 1038.61 | 0.99 | -2.24E+00 | | 4.79E+00 |
| | 1167.97 | 1.79 | 1.30E+00 | | 3.57E+00 |
| | 1365.19 | 3.02 | 7.43E-01 | | 1.34E+00 |
| Cs-137 | 661.66 | 85.10 | 1.25E-02 | 4.86E-02 | 4.86E-02 |
| Eu-152 | 121.78 | 28.67 | 2.38E-02 | 1.09E-01 | 1.20E-01 |
| | 244.70 | 7.61 | -2.79E-01 | | 4.56E-01 |
| | 295.94 | 0.45 | 5.86E+00 | | 8.90E+00 |
| | 344.28 | 26.60 | 7.14E-03 | | 1.09E-01 |
| | 367.79 | 0.86 | 5.93E-01 | | 3.65E+00 |
| | 411.12 | 2.24 | 6.00E-01 | | 1.44E+00 |
| | 443.96 | 2.83 | -7.43E-01 | | 1.20E+00 |
| | 488.68 | 0.42 | -4.87E+00 | | 7.52E+00 |
| | 563.99 | 0.49 | -7.31E+00 | | 6.64E+00 |
| | 586.26 | 0.46 | 4.75E-01 | | 1.15E+01 |
| | 678.62 | 0.47 | -5.25E-01 | | 8.12E+00 |
| | 688.67 | 0.86 | -8.02E-01 | | 4.95E+00 |
| | 719.35 | 0.28 | 6.53E+00 | | 1.59E+01 |
| | 778.90 | 12.96 | 2.67E-02 | | 3.61E-01 |
| | 810.45 | 0.32 | -3.44E+00 | | 1.52E+01 |
| | 867.37 | 4.26 | -2.50E-01 | | 1.02E+00 |
| | 919.33 | 0.43 | -4.86E+00 | | 1.12E+01 |
| | 964.08 | 14.65 | 1.58E-01 | | 4.67E-01 |
| | 1085.87 | 10.24 | -3.22E-01 | | 4.95E-01 |
| | 1089.74 | 1.73 | 8.35E-01 | | 3.29E+00 |
| | 1112.07 | 13.69 | -1.31E-02 | | 4.90E-01 |
| | 1212.95 | 1.43 | -3.65E+00 | | 4.53E+00 |
| | 1249.94 | 0.19 | -4.60E+00 | | 3.35E+01 |
| | 1299.14 | 1.63 | -2.80E-01 | | 3.94E+00 |
| | 1408.01 | 21.07 | 6.35E-03 | | 1.59E-01 |
| | 1457.64 | 0.50 | 2.22E+02 | | 5.02E+01 |
| | 1528.10 | 0.28 | -3.25E+00 | | 1.18E+01 |
| Eu-154 | 123.07 | 40.40 | 6.08E-02 | 9.02E-02 | 9.02E-02 |
| | 247.93 | 6.89 | 3.28E-01 | | 4.93E-01 |
| | 591.76 | 4.95 | -7.82E-02 | | 7.74E-01 |
| | 692.42 | 1.78 | 6.00E-02 | | 2.33E+00 |
| | 723.30 | 20.06 | 1.73E-01 | | 2.42E-01 |
| | 756.80 | 4.52 | -4.83E-01 | | 1.02E+00 |
| | 873.18 | 12.08 | -2.36E-02 | | 3.76E-01 |

Analysis Report for 02-Oct-19-10033

L1-12104A-FSGS-017SS

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | -3.61E-03 | 9.02E-02 | 4.57E-01 |
| | 1004.76 | 18.01 | 9.64E-02 | | 3.05E-01 |
| | 1274.43 | 34.80 | 3.96E-03 | | 1.62E-01 |
| | 1596.48 | 1.80 | 4.85E-01 | | 2.54E+00 |
| Eu-155 | 45.30 | 1.31 | 6.11E+00 | 1.72E-01 | 1.16E+01 |
| | 60.01 | 1.22 | -5.33E-02 | | 1.19E+01 |
| | 86.55 | 30.70 | 1.83E-02 | | 1.74E-01 |
| | 105.31 | 21.10 | -7.50E-02 | | 1.72E-01 |
| Ra-226 | 186.21 | 3.64 | -1.94E-01 | 8.81E-01 | 8.81E-01 |
| Pa-231 | 27.36 | 10.30 | 7.68E-01 | 1.21E+00 | 1.21E+00 |
| | 283.69 | 1.70 | -1.86E+00 | | 1.71E+00 |
| | 300.07 | 2.47 | 2.71E-01 | | 1.41E+00 |
| | 302.65 | 2.20 | -2.16E-01 | | 1.54E+00 |
| | 330.06 | 1.40 | 6.09E-01 | | 2.28E+00 |
| U-235 | 143.76 | 10.96 | -1.38E-01 | 5.47E-02 | 3.01E-01 |
| | 163.33 | 5.08 | 5.27E-01 | | 6.22E-01 |
| | 185.71 | 57.20 | -3.05E-02 | | 5.47E-02 |
| | 202.11 | 1.08 | 8.96E-02 | | 2.80E+00 |
| | 205.31 | 5.01 | -2.35E-01 | | 5.62E-01 |
| Am-241 | 59.54 | 35.90 | -1.14E-03 | 4.16E-01 | 4.16E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10001

L1-12104A-FSGS-003SB

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10001 |
| Sample Description | : L1-12104A-FSGS-003SB |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.831E+03 grams |
| Facility | : Default |
| Sample Taken On | : 9/30/2019 2:15:00PM |
| Acquisition Started | : 10/2/2019 9:23:05AM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : 324 |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 900.4 seconds |
| Dead Time | : 0.04 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 4096 |
| Peak Area Range (in channels) | : 120 - 4096 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 9/29/2018 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80166 |
| Fill Height | : 1830.79 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 1/30/2013 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 9:38:08AM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 4096

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10001

L1-12104A-FSGS-003SB

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.67 | 473 - | 481 | 477.52 | 1.21E+02 | 17.77 | 9.13E+01 | 1.27 |
| 2 | 351.88 | 698 - | 707 | 703.71 | 8.52E+01 | 13.59 | 4.38E+01 | 1.35 |
| 3 | 583.19 | 1160 - | 1171 | 1165.98 | 5.80E+01 | 10.86 | 2.40E+01 | 1.84 |
| 4 | 609.44 | 1214 - | 1222 | 1218.45 | 4.89E+01 | 10.38 | 2.71E+01 | 1.43 |
| 5 | 911.04 | 1815 - | 1826 | 1821.52 | 3.42E+01 | 8.44 | 1.48E+01 | 1.39 |
| 6 | 1460.73 | 2915 - | 2929 | 2921.52 | 4.89E+02 | 22.51 | 6.54E+00 | 1.94 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 0.99 | 1460.82 | * | 10.66 | 8.81E+00 | 5.57E-01 |
| Tl-208 | 1.00 | 583.19 | * | 85.00 | 7.23E-02 | 1.42E-02 |
| Bi-211 | 0.90 | 351.07 | * | 13.02 | 4.95E-01 | 8.85E-02 |
| Pb-212 | 1.00 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.65E-01 | 2.77E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 0.99 | 609.32 | * | 45.49 | 1.17E-01 | 2.58E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |
| | | 1120.29 | | 14.92 | | |

Analysis Report for 02-Oct-19-10001

L1-12104A-FSGS-003SB

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 0.99 | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |
| | | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 1.00 | 241.99 | | 7.25 | | |
| | | 295.22 | | 18.42 | | |
| | | 351.93 | * | 35.60 | 1.81E-01 | 3.23E-02 |
| | | 785.96 | | 1.06 | | |
| Ac-228 | 0.99 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | | 11.27 | | |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | * | 25.80 | 1.87E-01 | 4.69E-02 |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | | 15.80 | | |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# *INTERFERENCE CORRECTED REPORT*

Analysis Report for 02-Oct-19-10001

L1-12104A-FSGS-003SB

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | K-40 | 0.999 | 8.81E+00 | 5.57E-01 | |
| | Tl-208 | 1.000 | 7.23E-02 | 1.42E-02 | |
| ? | Bi-211 | 0.900 | 4.95E-01 | 8.85E-02 | |
| | Pb-212 | 1.000 | 1.65E-01 | 2.77E-02 | |
| | Bi-214 | 0.999 | 1.17E-01 | 2.58E-02 | |
| ? | Pb-214 | 1.000 | 1.81E-01 | 3.23E-02 | |
| | Ac-228 | 0.999 | 1.87E-01 | 4.69E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10001

L1-12104A-FSGS-003SB

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 9:38:08AM
Peak Locate From Channel : 120
Peak Locate To Channel : 4096

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 5.87E-02 | 5.01E-02 | 5.01E-02 |
| | BE-7 | 477.60 | | 10.44 | 8.17E-02 | 3.29E-01 | 3.29E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 8.81E+00 | 3.06E-01 | 3.06E-01 |
| | Mn-54 | 834.85 | | 99.98 | -1.81E-02 | 4.02E-02 | 4.02E-02 |
| | Co-60 | 1173.23 | | 99.85 | -9.30E-03 | 4.17E-02 | 5.31E-02 |
| | | 1332.49 | | 99.98 | 1.15E-03 | | 4.17E-02 |
| | Nb-94 | 702.65 | | 99.81 | 3.31E-03 | 3.59E-02 | 3.59E-02 |
| | | 871.09 | | 99.89 | -8.27E-03 | | 4.12E-02 |
| | Ag-108m | 79.13 | | 6.60 | 2.98E-02 | 3.74E-02 | 1.16E+00 |
| | | 433.94 | | 90.50 | 6.73E-03 | | 3.74E-02 |
| | | 614.28 | | 89.80 | -3.88E-02 | | 5.55E-02 |
| | | 722.94 | | 90.80 | -5.16E-03 | | 4.24E-02 |
| | Sb-125 | 176.31 | | 6.84 | 6.24E-03 | 1.10E-01 | 4.97E-01 |
| | | 380.45 | | 1.52 | -5.98E-01 | | 1.96E+00 |
| | | 427.87 | | 29.60 | -6.46E-04 | | 1.10E-01 |
| | | 463.36 | | 10.49 | 8.35E-02 | | 3.37E-01 |
| | | 600.60 | | 17.65 | 3.59E-02 | | 1.84E-01 |
| | | 606.71 | | 4.98 | -3.71E-01 | | 1.06E+00 |
| | | 635.95 | | 11.22 | -8.02E-02 | | 3.00E-01 |

Analysis Report for 02-Oct-19-10001

L1-12104A-FSGS-003SB

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | 6.88E-01 | 1.10E-01 | 2.03E+00 |
| Ba-133 | 79.61 | 2.65 | 6.86E-01 | 6.69E-02 | 2.80E+00 |
| | 81.00 | 32.90 | -1.25E-01 | | 1.95E-01 |
| | 276.40 | 7.16 | 2.59E-01 | | 4.91E-01 |
| | 302.85 | 18.34 | 1.00E-01 | | 1.74E-01 |
| | 356.01 | 62.05 | -4.89E-02 | | 6.69E-02 |
| | 383.85 | 8.94 | -1.10E-01 | | 3.28E-01 |
| Cs-134 | 475.36 | 1.48 | -6.18E-01 | 4.45E-02 | 2.16E+00 |
| | 563.25 | 8.34 | 7.20E-02 | | 4.13E-01 |
| | 569.33 | 15.37 | 2.70E-02 | | 2.12E-01 |
| | 604.72 | 97.62 | -3.07E-02 | | 4.45E-02 |
| | 795.86 | 85.46 | 3.81E-02 | | 5.04E-02 |
| | 801.95 | 8.69 | -3.70E-01 | | 4.23E-01 |
| | 1038.61 | 0.99 | 1.19E+00 | | 5.44E+00 |
| | 1167.97 | 1.79 | 1.61E+00 | | 3.20E+00 |
| | 1365.19 | 3.02 | 3.52E-01 | | 1.44E+00 |
| Cs-137 | 661.66 | 85.10 | 1.55E-02 | 4.69E-02 | 4.69E-02 |
| Eu-152 | 121.78 | 28.67 | -1.41E-01 | 1.07E-01 | 1.07E-01 |
| | 244.70 | 7.61 | -1.85E-01 | | 4.23E-01 |
| | 295.94 | 0.45 | 3.74E+00 | | 8.55E+00 |
| | 344.28 | 26.60 | -5.57E-02 | | 1.14E-01 |
| | 367.79 | 0.86 | -4.06E-01 | | 3.76E+00 |
| | 411.12 | 2.24 | 3.74E-01 | | 1.56E+00 |
| | 443.96 | 2.83 | 4.25E-01 | | 1.10E+00 |
| | 488.68 | 0.42 | 2.66E-02 | | 7.29E+00 |
| | 563.99 | 0.49 | -1.32E+00 | | 6.76E+00 |
| | 586.26 | 0.46 | -3.64E+00 | | 1.12E+01 |
| | 678.62 | 0.47 | -1.58E+00 | | 7.00E+00 |
| | 688.67 | 0.86 | -7.96E-01 | | 4.00E+00 |
| | 719.35 | 0.28 | -8.34E+00 | | 1.21E+01 |
| | 778.90 | 12.96 | 4.88E-02 | | 3.23E-01 |
| | 810.45 | 0.32 | 4.18E+00 | | 1.26E+01 |
| | 867.37 | 4.26 | -3.46E-01 | | 9.35E-01 |
| | 919.33 | 0.43 | -8.30E-01 | | 9.54E+00 |
| | 964.08 | 14.65 | -7.32E-02 | | 3.58E-01 |
| | 1085.87 | 10.24 | 6.55E-02 | | 4.69E-01 |
| | 1089.74 | 1.73 | 2.28E-01 | | 2.78E+00 |
| | 1112.07 | 13.69 | 2.05E-02 | | 3.65E-01 |
| | 1212.95 | 1.43 | 5.52E-01 | | 4.40E+00 |
| | 1249.94 | 0.19 | 6.74E+00 | | 3.10E+01 |
| | 1299.14 | 1.63 | -9.28E-01 | | 2.97E+00 |
| | 1408.01 | 21.07 | -3.66E-02 | | 1.73E-01 |
| | 1457.64 | 0.50 | -9.01E+00 | | 4.21E+01 |
| | 1528.10 | 0.28 | -7.39E+00 | | 6.79E+00 |
| Eu-154 | 123.07 | 40.40 | -2.00E-02 | 8.24E-02 | 8.24E-02 |
| | 247.93 | 6.89 | -6.09E-02 | | 4.46E-01 |
| | 591.76 | 4.95 | -1.21E-01 | | 6.39E-01 |
| | 692.42 | 1.78 | 5.97E-01 | | 2.03E+00 |
| | 723.30 | 20.06 | -6.52E-02 | | 1.90E-01 |
| | 756.80 | 4.52 | -2.41E-01 | | 7.96E-01 |
| | 873.18 | 12.08 | 2.29E-01 | | 3.41E-01 |

Analysis Report for 02-Oct-19-10001

L1-12104A-FSGS-003SB

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | 2.74E-01 | 8.24E-02 | 4.16E-01 |
| | 1004.76 | 18.01 | -7.72E-02 | | 2.24E-01 |
| | 1274.43 | 34.80 | -5.07E-02 | | 1.39E-01 |
| | 1596.48 | 1.80 | 5.49E-01 | | 2.22E+00 |
| Eu-155 | 45.30 | 1.31 | 4.14E+00 | 1.71E-01 | 1.18E+01 |
| | 60.01 | 1.22 | -5.68E+00 | | 1.19E+01 |
| | 86.55 | 30.70 | 4.45E-02 | | 1.71E-01 |
| | 105.31 | 21.10 | -7.83E-02 | | 1.82E-01 |
| Ra-226 | 186.21 | 3.64 | 7.36E-01 | 1.04E+00 | 1.04E+00 |
| Pa-231 | 27.36 | 10.30 | 2.30E-01 | 1.01E+00 | 1.01E+00 |
| | 283.69 | 1.70 | -3.95E-01 | | 1.74E+00 |
| | 300.07 | 2.47 | -1.31E+00 | | 1.28E+00 |
| | 302.65 | 2.20 | 8.33E-01 | | 1.45E+00 |
| | 330.06 | 1.40 | 9.70E-01 | | 2.53E+00 |
| U-235 | 143.76 | 10.96 | -1.33E-02 | 6.56E-02 | 2.73E-01 |
| | 163.33 | 5.08 | 1.31E-01 | | 6.94E-01 |
| | 185.71 | 57.20 | 3.25E-02 | | 6.56E-02 |
| | 202.11 | 1.08 | 5.92E-01 | | 3.19E+00 |
| | 205.31 | 5.01 | -1.72E-01 | | 6.76E-01 |
| Am-241 | 59.54 | 35.90 | -9.09E-02 | 4.25E-01 | 4.25E-01 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

Apex-Gamma

Analysis Report for 02-Oct-19-10002

L1-12104A-FSGS-007SB

# GAMMA SPECTRUM ANALYSIS

| | |
|---|---|
| Sample Identification | : 02-Oct-19-10002 |
| Sample Description | : L1-12104A-FSGS-007SB |
| Sample Type | : Soil |
| Unit | : |
| Sample Point | : |
| Sample Size | : 1.620E+03 grams |
| Facility | : Default |
| Sample Taken On | : 9/30/2019 2:05:00PM |
| Acquisition Started | : 10/2/2019 9:23:12AM |
| Procedure | : 130G_SOIL_1 |
| Operator | : Administrator |
| Detector Name | : P40818B |
| Geometry | : 130G_SOIL_1 |
| Live Time | : 900.0 seconds |
| Real Time | : 901.4 seconds |
| Dead Time | : 0.15 % |
| Peak Locate Threshold | : 3.00 |
| Peak Locate Range (in channels) | : 120 - 8192 |
| Peak Area Range (in channels) | : 120 - 8192 |
| Identification Energy Tolerance | : 1.000 keV |
| Energy Calibration Used Done On | : 1/29/2019 |
| Efficiency Calibration Used Done On | : 10/2/2019 |
| Efficiency Calibration Description | : |
| Sample Number | : 80167 |
| Fill Height | : 1619.79 gram |
| Certificate Name | : Eu155-Na22 |
| Certificate Date | : 1/30/2012 12:00:00PM |

# PEAK ANALYSIS REPORT

Peak Analysis Performed on : 10/2/2019 9:38:16AM

Peak Analysis From Channel : 120

Peak Analysis To Channel : 8192

DATA VALIDATED 10/2/19 - 1500

J Graham

Analysis Report for 02-Oct-19-10002

L1-12104A-FSGS-007SB

| Peak No. | Energy (keV) | ROI start | ROI end | Peak Centroid | Net Peak Area | Net Area Uncertainty | Continuum Counts | FWHM (keV) |
|---|---|---|---|---|---|---|---|---|
| 1 | 238.63 | 949 - | 959 | 954.61 | 9.30E+01 | 14.65 | 5.10E+01 | 1.26 |
| 2 | 338.24 | 1346 - | 1357 | 1352.73 | 3.22E+01 | 8.76 | 1.78E+01 | 0.58 |
| 3 | 351.78 | 1400 - | 1412 | 1406.85 | 6.88E+01 | 11.17 | 2.12E+01 | 1.11 |
| 4 | 609.18 | 2429 - | 2443 | 2435.88 | 5.20E+01 | 10.08 | 1.70E+01 | 1.16 |
| 5 | 1460.20 | 5830 - | 5854 | 5840.64 | 4.24E+02 | 20.59 | 0.00E+00 | 1.67 |

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

No background subtract performed on this spectrum.

# NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

## IDENTIFIED NUCLIDES

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| K-40 | 0.94 | 1460.82 | * | 10.66 | 1.04E+01 | 6.77E-01 |
| Bi-211 | 0.92 | 351.07 | * | 13.02 | 5.20E-01 | 9.44E-02 |
| Pb-212 | 1.00 | 115.18 | | 0.60 | | |
| | | 238.63 | * | 43.60 | 1.65E-01 | 2.91E-02 |
| | | 300.09 | | 3.30 | | |
| Bi-214 | 0.99 | 609.32 | * | 45.49 | 1.65E-01 | 3.35E-02 |
| | | 768.36 | | 4.89 | | |
| | | 806.18 | | 1.26 | | |
| | | 934.06 | | 3.11 | | |
| | | 1120.29 | | 14.92 | | |
| | | 1155.21 | | 1.63 | | |
| | | 1238.12 | | 5.83 | | |

Analysis Report for 02-Oct-19-10002

L1-12104A-FSGS-007SB

| Nuclide Name | Id Confidence | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Activity Uncertainty |
|---|---|---|---|---|---|---|
| Bi-214 | 0.99 | 1280.98 | | 1.43 | | |
| | | 1377.67 | | 3.99 | | |
| | | 1385.31 | | 0.79 | | |
| | | 1401.52 | | 1.33 | | |
| | | 1407.99 | | 2.39 | | |
| | | 1509.21 | | 2.13 | | |
| | | 1661.27 | | 1.05 | | |
| | | 1729.59 | | 2.88 | | |
| | | 1764.49 | | 15.30 | | |
| | | 1847.43 | | 2.03 | | |
| | | 2118.51 | | 1.16 | | |
| Pb-214 | 0.99 | 241.99 | | 7.25 | | |
| | | 295.22 | | 18.42 | | |
| | | 351.93 | * | 35.60 | 1.90E-01 | 3.45E-02 |
| | | 785.96 | | 1.06 | | |
| Ac-228 | 1.00 | 129.07 | | 2.42 | | |
| | | 209.25 | | 3.89 | | |
| | | 270.24 | | 3.46 | | |
| | | 328.00 | | 2.95 | | |
| | | 338.32 | * | 11.27 | 2.74E-01 | 7.77E-02 |
| | | 409.46 | | 1.92 | | |
| | | 463.00 | | 4.40 | | |
| | | 794.95 | | 4.25 | | |
| | | 911.20 | | 25.80 | | |
| | | 964.77 | | 4.99 | | |
| | | 968.97 | | 15.80 | | |
| | | 1588.20 | | 3.22 | | |

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000sigma

# INTERFERENCE CORRECTED REPORT

| Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|

Analysis Report for 02-Oct-19-10002

L1-12104A-FSGS-007SB

| | Nuclide Name | Nuclide Id Confidence | Wt mean Activity (pCi/grams) | Wt mean Activity Uncertainty | Comments |
|---|---|---|---|---|---|
| | K-40 | 0.940 | 1.04E+01 | 6.77E-01 | |
| ? | Bi-211 | 0.923 | 5.20E-01 | 9.44E-02 | |
| | Pb-212 | 1.000 | 1.65E-01 | 2.91E-02 | |
| | Bi-214 | 0.999 | 1.65E-01 | 3.35E-02 | |
| ? | Pb-214 | 0.998 | 1.90E-01 | 3.45E-02 | |
| | Ac-228 | 1.000 | 2.74E-01 | 7.77E-02 | |

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000sigma

Analysis Report for 02-Oct-19-10002

L1-12104A-FSGS-007SB

## UNIDENTIFIED PEAKS

Peak Locate Performed on : 10/2/2019 9:38:16AM
Peak Locate From Channel : 120
Peak Locate To Channel : 8192

| Peak No. | Energy (keV) | Peak Size (CPS) | Peak CPS (%) Uncertainty | Peak Type | Tolerance Nuclide |
|---|---|---|---|---|---|

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 1.000sigma

## *NUCLIDE MDA REPORT*

Nuclide Library Used : C:\Canberra\Apex\Root\Default\Library\ZION LIB-BNL.NLB

| | Nuclide Name | Energy (keV) | | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|---|---|
| | An Pk | 511.00 | | 100.00 | 6.72E-02 | 6.37E-02 | 6.37E-02 |
| | BE-7 | 477.60 | | 10.44 | -3.07E-03 | 3.97E-01 | 3.97E-01 |
| + | K-40 | 1460.82 | * | 10.66 | 1.04E+01 | 7.05E-02 | 7.05E-02 |
| | Mn-54 | 834.85 | | 99.98 | 1.24E-02 | 4.63E-02 | 4.63E-02 |
| | Co-60 | 1173.23 | | 99.85 | 6.09E-03 | 5.80E-02 | 7.29E-02 |
| | | 1332.49 | | 99.98 | 2.91E-02 | | 5.80E-02 |
| | Nb-94 | 702.65 | | 99.81 | -2.28E-02 | 4.71E-02 | 4.71E-02 |
| | | 871.09 | | 99.89 | -1.24E-02 | | 5.43E-02 |
| | Ag-108m | 79.13 | | 6.60 | 7.77E-01 | 4.33E-02 | 1.76E+00 |
| | | 433.94 | | 90.50 | -2.96E-02 | | 4.33E-02 |
| | | 614.28 | | 89.80 | -5.27E-02 | | 6.42E-02 |
| | | 722.94 | | 90.80 | 3.74E-02 | | 5.72E-02 |
| | Sb-125 | 176.31 | | 6.84 | -4.41E-01 | 1.47E-01 | 5.50E-01 |
| | | 380.45 | | 1.52 | -1.60E+00 | | 2.46E+00 |
| | | 427.87 | | 29.60 | 1.15E-01 | | 1.47E-01 |
| | | 463.36 | | 10.49 | -1.98E-01 | | 4.12E-01 |
| | | 600.60 | | 17.65 | 2.21E-02 | | 2.33E-01 |
| | | 606.71 | | 4.98 | 1.70E+00 | | 1.36E+00 |
| | | 635.95 | | 11.22 | 8.89E-02 | | 3.81E-01 |

Analysis Report for 02-Oct-19-10002

L1-12104A-FSGS-007SB

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Sb-125 | 671.44 | 1.79 | -2.64E-01 | 1.47E-01 | 2.66E+00 |
| Ba-133 | 79.61 | 2.65 | 3.39E-01 | 7.46E-02 | 4.11E+00 |
| | 81.00 | 32.90 | -1.36E-01 | | 2.97E-01 |
| | 276.40 | 7.16 | 8.60E-02 | | 5.21E-01 |
| | 302.85 | 18.34 | 1.93E-02 | | 2.07E-01 |
| | 356.01 | 62.05 | -5.64E-03 | | 7.46E-02 |
| | 383.85 | 8.94 | 8.88E-02 | | 4.44E-01 |
| Cs-134 | 475.36 | 1.48 | 1.48E-01 | 5.99E-02 | 2.77E+00 |
| | 563.25 | 8.34 | 6.58E-02 | | 4.64E-01 |
| | 569.33 | 15.37 | 6.45E-02 | | 2.45E-01 |
| | 604.72 | 97.62 | -1.94E-02 | | 6.12E-02 |
| | 795.86 | 85.46 | 5.06E-04 | | 5.99E-02 |
| | 801.95 | 8.69 | 2.50E-02 | | 6.01E-01 |
| | 1038.61 | 0.99 | 2.20E+00 | | 6.46E+00 |
| | 1167.97 | 1.79 | -1.00E+00 | | 4.20E+00 |
| | 1365.19 | 3.02 | -2.27E-01 | | 1.49E+00 |
| Cs-137 | 661.66 | 85.10 | -3.07E-03 | 5.82E-02 | 5.82E-02 |
| Eu-152 | 121.78 | 28.67 | -2.16E-02 | 1.54E-01 | 1.71E-01 |
| | 244.70 | 7.61 | 5.46E-02 | | 5.66E-01 |
| | 295.94 | 0.45 | 2.89E+00 | | 1.01E+01 |
| | 344.28 | 26.60 | -8.89E-02 | | 1.54E-01 |
| | 367.79 | 0.86 | 1.67E+00 | | 4.76E+00 |
| | 411.12 | 2.24 | -4.61E-01 | | 1.67E+00 |
| | 443.96 | 2.83 | -4.37E-01 | | 1.31E+00 |
| | 488.68 | 0.42 | -2.32E+00 | | 9.23E+00 |
| | 563.99 | 0.49 | -5.08E+00 | | 7.22E+00 |
| | 586.26 | 0.46 | 6.23E-01 | | 1.26E+01 |
| | 678.62 | 0.47 | -1.17E+00 | | 1.01E+01 |
| | 688.67 | 0.86 | -8.72E-01 | | 4.99E+00 |
| | 719.35 | 0.28 | -8.64E+00 | | 1.71E+01 |
| | 778.90 | 12.96 | -3.61E-02 | | 3.71E-01 |
| | 810.45 | 0.32 | -1.46E+00 | | 1.56E+01 |
| | 867.37 | 4.26 | -9.56E-01 | | 1.04E+00 |
| | 919.33 | 0.43 | -1.67E+00 | | 1.30E+01 |
| | 964.08 | 14.65 | -2.37E-02 | | 4.81E-01 |
| | 1085.87 | 10.24 | 2.97E-01 | | 7.29E-01 |
| | 1089.74 | 1.73 | 2.21E+00 | | 4.19E+00 |
| | 1112.07 | 13.69 | -4.81E-02 | | 4.25E-01 |
| | 1212.95 | 1.43 | -2.59E+00 | | 5.28E+00 |
| | 1249.94 | 0.19 | 3.26E+01 | | 4.06E+01 |
| | 1299.14 | 1.63 | 1.23E-02 | | 3.89E+00 |
| | 1408.01 | 21.07 | 4.32E-02 | | 2.18E-01 |
| | 1457.64 | 0.50 | 2.24E+02 | | 5.32E+01 |
| | 1528.10 | 0.28 | -3.76E+00 | | 1.40E+01 |
| Eu-154 | 123.07 | 40.40 | 5.51E-02 | 1.23E-01 | 1.23E-01 |
| | 247.93 | 6.89 | 4.27E-01 | | 5.49E-01 |
| | 591.76 | 4.95 | 6.63E-01 | | 9.27E-01 |
| | 692.42 | 1.78 | 5.75E-01 | | 2.38E+00 |
| | 723.30 | 20.06 | 3.53E-03 | | 2.56E-01 |
| | 756.80 | 4.52 | -1.25E-01 | | 1.03E+00 |
| | 873.18 | 12.08 | 2.11E-01 | | 4.50E-01 |

Analysis Report for 02-Oct-19-10002

L1-12104A-FSGS-007SB

| Nuclide Name | Energy (keV) | Yield(%) | Activity (pCi/grams) | Nuclide MDA (pCi/grams) | Line MDA (pCi/grams) |
|---|---|---|---|---|---|
| Eu-154 | 996.29 | 10.48 | 2.85E-01 | 1.23E-01 | 5.60E-01 |
| | 1004.76 | 18.01 | 1.29E-01 | | 3.47E-01 |
| | 1274.43 | 34.80 | 1.02E-02 | | 1.89E-01 |
| | 1596.48 | 1.80 | 7.80E-01 | | 2.12E+00 |
| Eu-155 | 45.30 | 1.31 | 5.23E-01 | 2.58E-01 | 3.00E+01 |
| | 60.01 | 1.22 | 2.24E+00 | | 2.84E+01 |
| | 86.55 | 30.70 | 9.40E-02 | | 2.58E-01 |
| | 105.31 | 21.10 | -7.91E-02 | | 2.70E-01 |
| Ra-226 | 186.21 | 3.64 | -7.42E-03 | 1.11E+00 | 1.11E+00 |
| Pa-231 | 27.36 | 10.30 | 1.43E+00 | 1.53E+00 | 3.39E+00 |
| | 283.69 | 1.70 | 9.57E-01 | | 2.10E+00 |
| | 300.07 | 2.47 | -1.06E+00 | | 1.53E+00 |
| | 302.65 | 2.20 | 4.88E-01 | | 1.75E+00 |
| | 330.06 | 1.40 | 9.42E-01 | | 2.80E+00 |
| U-235 | 143.76 | 10.96 | -2.81E-01 | 6.96E-02 | 3.94E-01 |
| | 163.33 | 5.08 | 4.31E-02 | | 7.96E-01 |
| | 185.71 | 57.20 | -1.64E-02 | | 6.96E-02 |
| | 202.11 | 1.08 | -1.87E+00 | | 3.45E+00 |
| | 205.31 | 5.01 | -2.45E-02 | | 7.28E-01 |
| Am-241 | 59.54 | 35.90 | -7.56E-02 | 1.01E+00 | 1.01E+00 |

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
? = CAUTION: MDA value is inconsistent with Currie MDA at 95% confidence level

# ATTACHMENT 8
EBERLINE ANALYTICAL REPORTS

EBERLINE ANALYTICAL

EBERLINE ANALYTICAL CORPORATION
601 SCARBORO ROAD
OAK RIDGE, TENNESSEE 37830
PHONE (865) 481-0683
FAX (865) 483-4621

EBS-OR-46634

January 22, 2020

Jeffrey Graham
Zion Solutions, LLC
2701 Deborah Avenue
Zion, IL 60099

CASE NARRATIVE
Work Order # 19-10093-OR

SAMPLE RECEIPT

This work order contains twelve soil samples received 10/21/2019. Samples were analyzed for Total Strontium, Tritium, Nickel-63 and by Gamma Spectroscopy.

| CLIENT ID | LAB ID | CLIENT ID | LAB ID |
|---|---|---|---|
| L1-12107-A-FSGS-012-SS-A | 19-10093-04 | L1-12104-A-FSGS-013-SS-A | 19-10093-10 |
| L1-12105-A-FSGS-016-SS-A | 19-10093-05 | L1-12205-A-FSGS-101-SB-A | 19-10093-11 |
| L1-12105-A-FSGS-002-SS-A | 19-10093-06 | L1-12109-A-FSGS-012-SS-A | 19-10093-12 |
| L1-12107-A-FSGS-010-SB-A | 19-10093-07 | L1-12205-C-FSGS-105-SS-A | 19-10093-13 |
| L1-12205-A-FSGS-111-SS-A | 19-10093-08 | L1-12111-A-FSGS-003-SS-A | 19-10093-14 |
| L1-12104-A-FSGS-011-SS-A | 19-10093-09 | L1-12205-D-FSGS-111-SB-A | 19-10093-15 |

ANALYTICAL METHODS

Total Strontium was analyzed using EIChroM Method SRW01 Modified. Tritium was performed using Method LANL ER-210 Modified. Nickel-63 was performed using Method ASTM 3500-Ni Modified. Gamma Spectroscopy was performed using EPA Method 901.1 Modified.

Laboratory qualifiers are as follows:

U - Result is less than the MDA.

ANALYTICAL RESULTS

Combined Standard Uncertainty is reported at 1-sigma value.

Minimum Detectable Activity (MDA) values for data represented in this report are sample-specific. MDA measurements are determined based on factors and conditions including instrument settings, aliquot size and matrix type.

ANALYTICAL RESULTS CONTINUED

TOTAL STRONTIUM

Samples were prepared by acid digestion as appropriate for the matrix. Digested samples were acidified and were selectively extracted and precipitated. Precipitates were then mounted on 47mm filters. Filters were reweighed to determine aliquot size. Sample activities were determined by gas flow proportional counting.

Samples demonstrated acceptable results for all Total Strontium analyses. Strontium-90 results are reported from Total Strontium. Chemical recovery was acceptable for all samples. The Total Strontium method blank demonstrated an acceptable result. Results for the Total Strontium duplicate demonstrated a high relative percent difference; however, normalized difference is within acceptable limits for the analytical technique. Results for the Total Strontium laboratory control sample demonstrated an acceptable percent recovery.

TRITIUM

A representative aliquot of each sample was equilibrated with Tritium free water. Equilibrates were transferred into round-bottomed distillation flasks and attached to single stage stills. A portion of each middle distillation fraction was transferred to a liquid scintillation vial and cocktail was added. Samples were counted by beta liquid scintillation.

Samples demonstrated acceptable results for all Tritium analyses. The Tritium method blank demonstrated an acceptable result. Results for the Tritium duplicate demonstrated a high relative percent difference; however, normalized difference is within acceptable limits for the analytical technique. Results for the Tritium laboratory control sample demonstrated an acceptable percent recovery.

NICKEL-63

A representative aliquot of each sample was prepared by leaching in acids. Aliquots were placed into appropriately sized beakers. Stable elemental Nickel carrier was added to each sample prior to digestion. Samples were digested in concentrated Nitric acid. After digestion, each sample pH was adjusted and Nickel-63 was precipitated selectively with Dimethylglyoxime. Precipitates were selectively separated, redissolved, and residual acid was effectively neutralized. Sample residuals were placed into scintillation vials, scintillation cocktail was added and Nickel-63 activity was determined by beta liquid scintillation.

Samples demonstrated acceptable results for all Nickel-63 analyses. The Nickel-63 method blank demonstrated an acceptable result. Results for the Nickel-63 duplicate demonstrated a high relative percent difference; however, normalized difference is within acceptable limits for the analytical technique. Results for the Nickel-63 laboratory control sample demonstrated an acceptable percent recovery.

GAMMA SPECTROSCOPY

Samples for Gamma Spectroscopy analysis were prepared by transferring a known mass of each homogenized sample to a standard geometry container. Samples were counted on High Purity Germanium (HPGe) gamma ray detectors.

ANALYTICAL RESULTS CONTINUED

GAMMA SPECTROSCOPY CONTINUED

Samples demonstrated acceptable results for all gamma-emitting radionuclides as reported. The method blank demonstrated acceptable results for all radionuclides as reported. Results for the Actinium-228, Bismuth-214 and Potassium-40 replicate demonstrated an acceptable relative percent difference and normalized difference. Results for the Cobalt-60 and Cesium-137 laboratory control sample demonstrated an acceptable percent recovery.

CERTIFICATION OF ACCURACY

I certify that this data report is in compliance with the terms and conditions of the Purchase Order, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hard copy data package has been authorized by the cognizant project manager or his/her designee to be accurate as verified by the following signature.

M.R. McDougall
Laboratory Manager

Date: 1/22/2020

Eberline Analytical wants and encourages your feedback regarding our performance providing radioanalytical services. Please visit http://eberlineanalytical.com/ to provide us with feedback on our services.

# Eberline Analytical
## Final Report of Analysis

*Report To:*
Jeffrey Graham
Zion Solutions
2701 Deborah Ave
Zion, IL 60099

*Work Order Details:*
*SDG:* 19-10093
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-01 | LCS | KNOWN | 10/21/19 00:00 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | 2.04E+02 | 7.36E+00 | | | | pCi/g |
| 19-10093-01 | LCS | SPIKE | 10/21/19 00:00 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | 1.85E+02 | 7.36E+00 | 1.27E+01 | 5.48E+00 | | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | 3.02E+00 | 3.29E+00 | 3.30E+00 | 5.53E+00 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | 1.47E+00 | 3.16E+00 | 3.16E+00 | 5.39E+00 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | 1.99E+00 | 3.12E+00 | 3.13E+00 | 5.30E+00 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | -1.72E-01 | 2.89E+00 | 2.89E+00 | 5.04E+00 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | 2.46E+00 | 3.06E+00 | 3.06E+00 | 5.15E+00 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | 1.40E+00 | 3.00E+00 | 3.01E+00 | 5.13E+00 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | 3.68E-01 | 3.11E+00 | 3.11E+00 | 5.38E+00 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | 1.26E+00 | 3.09E+00 | 3.09E+00 | 5.28E+00 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | 2.76E+00 | 3.21E+00 | 3.21E+00 | 5.39E+00 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | -5.42E-01 | 3.03E+00 | 3.03E+00 | 5.30E+00 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | 9.18E-01 | 3.13E+00 | 3.13E+00 | 5.37E+00 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | 1.50E+00 | 3.22E+00 | 3.22E+00 | 5.49E+00 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | 1.64E+00 | 3.13E+00 | 3.13E+00 | 5.33E+00 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 11/26/2019 | 19-10093 | Tritium | LANL ER-210 Modified | -3.56E-01 | 2.99E+00 | 2.99E+00 | 5.21E+00 | U | pCi/g |
| | | | | | | | | | | | | | | |
| 19-10093-01 | LCS | KNOWN | 10/21/19 00:00 | 10/21/2019 | 12/27/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | 1.51E+03 | 4.54E+01 | | | | pCi/g |
| 19-10093-01 | LCS | SPIKE | 10/21/19 00:00 | 10/21/2019 | 12/27/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | 1.56E+03 | 1.34E+01 | 9.26E+01 | 3.17E+00 | | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 12/27/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | 4.38E-01 | 1.83E+00 | 1.83E+00 | 3.13E+00 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 12/27/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | 1.14E+00 | 1.72E+00 | 1.73E+00 | 2.92E+00 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 12/27/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | 4.93E-01 | 1.72E+00 | 1.72E+00 | 2.94E+00 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 12/27/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | 1.16E+00 | 1.75E+00 | 1.75E+00 | 2.95E+00 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 12/27/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | -9.21E-02 | 1.90E+00 | 1.90E+00 | 3.29E+00 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 12/27/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | 1.96E+00 | 1.99E+00 | 1.99E+00 | 3.33E+00 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 12/27/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | -4.57E-01 | 1.88E+00 | 1.88E+00 | 3.26E+00 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 12/27/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | 9.68E-01 | 1.85E+00 | 1.85E+00 | 3.14E+00 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 12/27/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | -6.24E-01 | 2.13E+00 | 2.13E+00 | 3.71E+00 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 12/27/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | -4.37E-01 | 1.79E+00 | 1.79E+00 | 3.12E+00 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 12/27/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | 9.06E-01 | 1.90E+00 | 1.90E+00 | 3.23E+00 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 12/27/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | -1.02E+00 | 1.89E+00 | 1.89E+00 | 3.31E+00 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 12/28/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | 1.85E-01 | 1.92E+00 | 1.92E+00 | 3.30E+00 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 12/28/2019 | 19-10093 | Nickel-63 | ASTM 3500-Ni Modified | -1.61E+00 | 2.33E+00 | 2.33E+00 | 4.11E+00 | U | pCi/g |

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect

0019

EBERLINE ANALYTICAL

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601 SCARBORO ROAD OAK RIDGE, TN 37830 865/481-0683 FAX 865/483-4621

# Eberline Analytical
## Final Report of Analysis

*Report To:*

Jeffrey Graham
Zion Solutions
2701 Deborah Ave
Zion, IL 60099

*Work Order Details:*

*SDG:* 19-10093
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-01 | LCS | KNOWN | 10/21/19 00:00 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | 5.06E+01 | 2.83E-01 | | | | pCi/g |
| 19-10093-01 | LCS | SPIKE | 10/21/19 00:00 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | 5.71E+01 | 3.42E+00 | 2.02E+01 | 1.22E+00 | | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | 3.78E-01 | 3.95E-01 | 4.16E-01 | 8.02E-01 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | 6.37E-02 | 3.07E-01 | 3.08E-01 | 6.49E-01 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | -1.58E-01 | 2.93E-01 | 2.98E-01 | 6.42E-01 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | 3.56E-01 | 2.94E-01 | 3.19E-01 | 5.89E-01 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | 2.83E-02 | 3.31E-01 | 3.31E-01 | 7.05E-01 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | 1.61E-01 | 3.00E-01 | 3.05E-01 | 6.23E-01 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | 9.02E-02 | 2.72E-01 | 2.74E-01 | 5.74E-01 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | 3.74E-01 | 2.89E-01 | 3.17E-01 | 5.72E-01 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | 2.44E-01 | 3.04E-01 | 3.15E-01 | 6.22E-01 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | 3.63E-02 | 3.22E-01 | 3.22E-01 | 6.85E-01 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | 3.50E-01 | 2.96E-01 | 3.20E-01 | 5.94E-01 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | -1.34E-01 | 3.46E-01 | 3.50E-01 | 7.53E-01 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | 8.98E-02 | 2.56E-01 | 2.58E-01 | 5.39E-01 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 11/21/2019 | 19-10093 | Strontium-90 | ElChroM SRW01 Modified | 9.69E-02 | 3.10E-01 | 3.12E-01 | 6.53E-01 | U | pCi/g |
| | | | | | | | | | | | | | | |
| 19-10093-01 | LCS | KNOWN | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | 1.31E+02 | 5.10E+00 | | | | pCi/g |
| 19-10093-01 | LCS | KNOWN | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | 8.26E+01 | 3.39E+00 | | | | pCi/g |
| 19-10093-01 | LCS | SPIKE | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | 1.31E+02 | 7.49E+00 | 1.01E+01 | 1.08E+00 | | pCi/g |
| 19-10093-01 | LCS | SPIKE | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | 8.62E+01 | 7.30E+00 | 8.53E+00 | 1.47E+00 | | pCi/g |

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect

0020

# Eberline Analytical
## Final Report of Analysis

*Report To:*

**Jeffrey Graham**
**Zion Solutions**
**2701 Deborah Ave**
**Zion, IL 60099**

*Work Order Details:*

*SDG:* **19-10093**
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Actinium-228 | EPA 901.1 Modified | -3.61E-02 | 1.09E-01 | 1.09E-01 | 1.75E-01 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Silver-108m | EPA 901.1 Modified | 7.53E-03 | 2.99E-02 | 2.99E-02 | 4.13E-02 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Americium-241 | EPA 901.1 Modified | -2.61E-02 | 3.86E-02 | 3.86E-02 | 5.37E-02 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Barium-133 | EPA 901.1 Modified | 7.61E-03 | 5.08E-02 | 5.08E-02 | 5.80E-02 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Bismuth-214 | EPA 901.1 Modified | 4.74E-02 | 7.87E-02 | 7.87E-02 | 1.26E-01 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | -1.07E-02 | 3.21E-02 | 3.21E-02 | 5.04E-02 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-134 | EPA 901.1 Modified | -1.32E-02 | 4.28E-02 | 4.28E-02 | 5.70E-02 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | 4.74E-03 | 3.80E-02 | 3.80E-02 | 5.63E-02 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-152 | EPA 901.1 Modified | 3.83E-02 | 1.10E-01 | 1.10E-01 | 9.02E-02 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-154 | EPA 901.1 Modified | 2.99E-02 | 8.81E-02 | 8.81E-02 | 4.62E-02 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-155 | EPA 901.1 Modified | -5.49E-02 | 4.85E-02 | 4.86E-02 | 6.08E-02 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Holmium-166m | EPA 901.1 Modified | 5.20E-02 | 4.75E-02 | 4.76E-02 | 3.64E-02 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Iodine-129 | EPA 901.1 Modified | 6.62E-02 | 8.55E-02 | 8.56E-02 | 1.36E-01 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Potassium-40 | EPA 901.1 Modified | 2.20E-01 | 3.55E-01 | 3.55E-01 | 7.41E-01 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Manganese-54 | EPA 901.1 Modified | -2.14E-02 | 3.82E-02 | 3.82E-02 | 5.10E-02 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Molybdenum-93 | EPA 901.1 Modified | 2.47E-02 | 3.16E-02 | 3.16E-02 | 4.77E-02 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Niobium-94 | EPA 901.1 Modified | 4.42E-03 | 2.53E-02 | 2.53E-02 | 4.81E-02 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-210 | EPA 901.1 Modified | 6.37E-01 | 3.93E-01 | 3.95E-01 | 6.78E-01 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-212 | EPA 901.1 Modified | 1.97E-02 | 3.91E-02 | 3.91E-02 | 6.38E-02 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-214 | EPA 901.1 Modified | 1.04E-01 | 9.35E-02 | 9.36E-02 | 1.44E-01 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Promethium-145 | EPA 901.1 Modified | -5.31E-02 | 6.47E-02 | 6.48E-02 | 8.82E-02 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Radium-226 | EPA 901.1 Modified | 4.74E-02 | 7.87E-02 | 7.87E-02 | 1.26E-01 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Antimony-125 | EPA 901.1 Modified | 5.57E-02 | 8.37E-02 | 8.37E-02 | 1.35E-01 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Thorium-234 | EPA 901.1 Modified | 1.54E-01 | 3.53E-01 | 3.53E-01 | 5.49E-01 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Thallium-208 | EPA 901.1 Modified | -5.79E-03 | 9.81E-02 | 9.81E-02 | 1.23E-01 | U | pCi/g |
| 19-10093-02 | MBL | BLANK | 10/21/19 00:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Uranium-235 | EPA 901.1 Modified | -5.60E-02 | 1.42E-01 | 1.42E-01 | 2.06E-01 | U | pCi/g |

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect

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# Eberline Analytical
## Final Report of Analysis

*Report To:*

**Jeffrey Graham**
**Zion Solutions**
**2701 Deborah Ave**
**Zion, IL 60099**

*Work Order Details:*

*SDG:* **19-10093**
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Actinium-228 | EPA 901.1 Modified | 2.86E-01 | 1.43E-01 | 1.44E-01 | 3.26E-01 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Silver-108m | EPA 901.1 Modified | 1.76E-03 | 2.91E-02 | 2.91E-02 | 5.05E-02 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Americium-241 | EPA 901.1 Modified | -6.95E-02 | 6.88E-02 | 6.89E-02 | 1.04E-01 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Barium-133 | EPA 901.1 Modified | -3.10E-02 | 4.07E-02 | 4.07E-02 | 7.76E-02 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Bismuth-214 | EPA 901.1 Modified | 2.92E-01 | 9.57E-02 | 9.68E-02 | 1.62E-01 | | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | -3.29E-03 | 5.18E-02 | 5.18E-02 | 7.53E-02 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-134 | EPA 901.1 Modified | 4.62E-03 | 1.32E-02 | 1.32E-02 | 5.48E-02 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | -7.32E-03 | 3.65E-02 | 3.65E-02 | 5.47E-02 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-152 | EPA 901.1 Modified | 5.44E-03 | 8.68E-02 | 8.68E-02 | 1.71E-01 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-154 | EPA 901.1 Modified | 1.12E-02 | 1.16E-01 | 1.16E-01 | 8.59E-02 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-155 | EPA 901.1 Modified | 1.05E-01 | 8.54E-02 | 8.55E-02 | 1.31E-01 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Holmium-166m | EPA 901.1 Modified | -5.03E-02 | 6.62E-02 | 6.63E-02 | 5.20E-02 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Iodine-129 | EPA 901.1 Modified | 3.43E-02 | 1.72E-01 | 1.72E-01 | 2.80E-01 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Potassium-40 | EPA 901.1 Modified | 1.27E+01 | 1.69E+00 | 1.81E+00 | 6.54E-01 | | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Manganese-54 | EPA 901.1 Modified | -1.35E-02 | 3.32E-02 | 3.32E-02 | 4.79E-02 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Molybdenum-93 | EPA 901.1 Modified | 1.10E-02 | 3.11E-02 | 3.11E-02 | 5.14E-02 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Niobium-94 | EPA 901.1 Modified | 2.70E-02 | 3.52E-02 | 3.52E-02 | 5.28E-02 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-210 | EPA 901.1 Modified | 1.10E+00 | 7.19E-01 | 7.21E-01 | 1.24E+00 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-212 | EPA 901.1 Modified | 1.81E-01 | 6.93E-02 | 6.99E-02 | 1.23E-01 | | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-214 | EPA 901.1 Modified | 2.11E-01 | 8.42E-02 | 8.49E-02 | 1.10E-01 | | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Promethium-145 | EPA 901.1 Modified | 3.94E-02 | 1.19E-01 | 1.19E-01 | 1.96E-01 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Radium-226 | EPA 901.1 Modified | 2.92E-01 | 9.57E-02 | 9.68E-02 | 1.62E-01 | | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Antimony-125 | EPA 901.1 Modified | 2.91E-02 | 9.73E-02 | 9.73E-02 | 1.54E-01 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Thorium-234 | EPA 901.1 Modified | 7.00E-01 | 6.03E-01 | 6.04E-01 | 1.02E+00 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Thallium-208 | EPA 901.1 Modified | 1.29E-01 | 9.00E-02 | 9.03E-02 | 1.70E-01 | U | pCi/g |
| 19-10093-03 | DUP | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Uranium-235 | EPA 901.1 Modified | 1.18E-01 | 2.15E-01 | 2.15E-01 | 3.28E-01 | U | pCi/g |

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect

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601 SCARBORO ROAD OAK RIDGE, TN 37830 865/481-0683 FAX 865/483-4621

# Eberline Analytical
## Final Report of Analysis

*Report To:*
Jeffrey Graham
Zion Solutions
2701 Deborah Ave
Zion, IL 60099

*Work Order Details:*
*SDG:* 19-10093
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Actinium-228 | EPA 901.1 Modified | 2.70E-01 | 1.23E-01 | 1.23E-01 | 3.72E-01 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Silver-108m | EPA 901.1 Modified | -1.80E-02 | 4.13E-02 | 4.13E-02 | 4.65E-02 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Americium-241 | EPA 901.1 Modified | 2.19E-02 | 4.45E-02 | 4.45E-02 | 1.05E-01 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Barium-133 | EPA 901.1 Modified | -6.22E-03 | 1.57E-02 | 1.57E-02 | 7.63E-02 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Bismuth-214 | EPA 901.1 Modified | 2.88E-01 | 1.12E-01 | 1.13E-01 | 1.59E-01 | | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | 9.06E-03 | 2.90E-02 | 2.90E-02 | 6.22E-02 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-134 | EPA 901.1 Modified | -1.52E-01 | 7.02E-02 | 7.07E-02 | 5.43E-02 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | -1.73E-02 | 3.68E-02 | 3.68E-02 | 5.32E-02 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-152 | EPA 901.1 Modified | -4.14E-03 | 1.09E-01 | 1.09E-01 | 1.60E-01 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-154 | EPA 901.1 Modified | -9.99E-03 | 1.19E-01 | 1.19E-01 | 8.03E-02 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-155 | EPA 901.1 Modified | -2.85E-02 | 9.02E-02 | 9.02E-02 | 1.28E-01 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Holmium-166m | EPA 901.1 Modified | -2.39E-02 | 6.33E-02 | 6.33E-02 | 5.03E-02 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Iodine-129 | EPA 901.1 Modified | -1.48E-02 | 1.66E-01 | 1.66E-01 | 2.66E-01 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Potassium-40 | EPA 901.1 Modified | 1.25E+01 | 1.69E+00 | 1.80E+00 | 8.30E-01 | | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Manganese-54 | EPA 901.1 Modified | -2.76E-02 | 4.18E-02 | 4.18E-02 | 5.57E-02 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Molybdenum-93 | EPA 901.1 Modified | -4.09E-02 | 3.53E-02 | 3.54E-02 | 4.40E-02 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Niobium-94 | EPA 901.1 Modified | -2.13E-02 | 3.98E-02 | 3.98E-02 | 5.02E-02 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-210 | EPA 901.1 Modified | 6.82E-01 | 7.44E-01 | 7.45E-01 | 1.24E+00 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-212 | EPA 901.1 Modified | 2.71E-01 | 8.89E-02 | 9.00E-02 | 1.21E-01 | | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-214 | EPA 901.1 Modified | 2.45E-01 | 1.03E-01 | 1.04E-01 | 1.83E-01 | | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Promethium-145 | EPA 901.1 Modified | 1.99E-02 | 1.14E-01 | 1.14E-01 | 1.87E-01 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Radium-226 | EPA 901.1 Modified | 2.88E-01 | 1.12E-01 | 1.13E-01 | 1.59E-01 | | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Antimony-125 | EPA 901.1 Modified | -4.69E-02 | 9.63E-02 | 9.63E-02 | 1.36E-01 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Thorium-234 | EPA 901.1 Modified | 8.11E-01 | 8.08E-01 | 8.09E-01 | 1.35E+00 | U | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Thallium-208 | EPA 901.1 Modified | 2.27E-01 | 9.64E-02 | 9.71E-02 | 4.48E-02 | | pCi/g |
| 19-10093-04 | DO | L1-12107-A-FSGS-012-SS-A | 09/26/19 07:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Uranium-235 | EPA 901.1 Modified | 6.89E-02 | 2.06E-01 | 2.06E-01 | 3.11E-01 | U | pCi/g |

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CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect

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# Eberline Analytical
## Final Report of Analysis

*Report To:*

**Jeffrey Graham**
**Zion Solutions**
**2701 Deborah Ave**
**Zion, IL 60099**

*Work Order Details:*

*SDG:* **19-10093**
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Actinium-228 | EPA 901.1 Modified | 5.49E-02 | 2.06E-01 | 2.06E-01 | 3.47E-01 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Silver-108m | EPA 901.1 Modified | 4.72E-04 | 4.47E-02 | 4.47E-02 | 6.35E-02 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Americium-241 | EPA 901.1 Modified | -6.98E-02 | 7.31E-02 | 7.32E-02 | 1.01E-01 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Barium-133 | EPA 901.1 Modified | 1.26E-02 | 1.87E-02 | 1.87E-02 | 1.05E-01 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Bismuth-214 | EPA 901.1 Modified | 2.12E-01 | 1.18E-01 | 1.18E-01 | 8.99E-02 | | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | -3.27E-02 | 7.97E-02 | 7.97E-02 | 9.94E-02 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-134 | EPA 901.1 Modified | -6.94E-03 | 2.59E-02 | 2.59E-02 | 7.68E-02 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | 1.85E-02 | 5.79E-02 | 5.79E-02 | 8.38E-02 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-152 | EPA 901.1 Modified | -3.77E-02 | 1.85E-01 | 1.85E-01 | 1.47E-01 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-154 | EPA 901.1 Modified | -1.34E-01 | 1.99E-01 | 1.99E-01 | 7.57E-02 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-155 | EPA 901.1 Modified | 1.06E-01 | 7.90E-02 | 7.92E-02 | 1.22E-01 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Holmium-166m | EPA 901.1 Modified | 6.63E-02 | 7.51E-02 | 7.51E-02 | 5.93E-02 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Iodine-129 | EPA 901.1 Modified | 2.32E-03 | 1.33E-01 | 1.33E-01 | 1.98E-01 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Potassium-40 | EPA 901.1 Modified | 1.14E+01 | 1.83E+00 | 1.92E+00 | 1.04E+00 | | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Manganese-54 | EPA 901.1 Modified | 6.50E-03 | 2.45E-02 | 2.45E-02 | 8.31E-02 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Molybdenum-93 | EPA 901.1 Modified | 2.23E-02 | 4.19E-02 | 4.19E-02 | 7.20E-02 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Niobium-94 | EPA 901.1 Modified | 2.21E-02 | 4.44E-02 | 4.45E-02 | 6.60E-02 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-210 | EPA 901.1 Modified | 1.11E+00 | 6.99E-01 | 7.01E-01 | 1.12E+00 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-212 | EPA 901.1 Modified | 3.79E-01 | 1.61E-01 | 1.62E-01 | 2.00E-01 | | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-214 | EPA 901.1 Modified | 2.15E-01 | 1.05E-01 | 1.05E-01 | 1.81E-01 | | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Promethium-145 | EPA 901.1 Modified | -1.33E-01 | 1.05E-01 | 1.06E-01 | 1.39E-01 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Radium-226 | EPA 901.1 Modified | 2.12E-01 | 1.18E-01 | 1.18E-01 | 8.99E-02 | | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Antimony-125 | EPA 901.1 Modified | -1.97E-02 | 1.31E-01 | 1.31E-01 | 1.80E-01 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Thorium-234 | EPA 901.1 Modified | 7.35E-01 | 6.33E-01 | 6.34E-01 | 9.92E-01 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Thallium-208 | EPA 901.1 Modified | 1.67E-01 | 1.69E-01 | 1.69E-01 | 2.66E-01 | U | pCi/g |
| 19-10093-05 | TRG | L1-12105-A-FSGS-016-SS-A | 09/30/19 13:30 | 10/21/2019 | 10/23/2019 | 19-10093 | Uranium-235 | EPA 901.1 Modified | 2.92E-02 | 2.30E-01 | 2.30E-01 | 3.45E-01 | U | pCi/g |

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect



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# Eberline Analytical
## Final Report of Analysis

*Report To:*

**Jeffrey Graham**
**Zion Solutions**
**2701 Deborah Ave**
**Zion, IL 60099**

*Work Order Details:*

*SDG:* **19-10093**
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Actinium-228 | EPA 901.1 Modified | 9.19E-02 | 5.03E-02 | 5.05E-02 | 1.59E-01 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Silver-108m | EPA 901.1 Modified | -9.55E-04 | 3.62E-02 | 3.62E-02 | 4.07E-02 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Americium-241 | EPA 901.1 Modified | -9.37E-02 | 7.79E-02 | 7.80E-02 | 1.04E-01 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Barium-133 | EPA 901.1 Modified | -1.86E-02 | 5.89E-02 | 5.89E-02 | 6.50E-02 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Bismuth-214 | EPA 901.1 Modified | 2.38E-01 | 8.80E-02 | 8.88E-02 | 1.46E-01 | | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | -1.35E-02 | 3.63E-02 | 3.63E-02 | 3.97E-02 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-134 | EPA 901.1 Modified | -4.98E-03 | 1.19E-02 | 1.19E-02 | 6.06E-02 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | -2.80E-02 | 3.58E-02 | 3.58E-02 | 4.42E-02 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-152 | EPA 901.1 Modified | -8.76E-02 | 1.24E-01 | 1.24E-01 | 1.34E-01 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-154 | EPA 901.1 Modified | -2.42E-02 | 9.29E-02 | 9.29E-02 | 6.62E-02 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-155 | EPA 901.1 Modified | 2.52E-02 | 6.11E-02 | 6.11E-02 | 1.18E-01 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Holmium-166m | EPA 901.1 Modified | 2.27E-02 | 6.01E-02 | 6.01E-02 | 4.95E-02 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Iodine-129 | EPA 901.1 Modified | 4.24E-02 | 1.13E-01 | 1.13E-01 | 1.70E-01 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Potassium-40 | EPA 901.1 Modified | 1.14E+01 | 1.44E+00 | 1.56E+00 | 7.80E-01 | | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Manganese-54 | EPA 901.1 Modified | -3.48E-03 | 9.29E-03 | 9.29E-03 | 4.87E-02 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Molybdenum-93 | EPA 901.1 Modified | -1.21E-02 | 3.26E-02 | 3.26E-02 | 4.29E-02 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Niobium-94 | EPA 901.1 Modified | -4.27E-02 | 3.85E-02 | 3.86E-02 | 4.34E-02 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-210 | EPA 901.1 Modified | 9.29E-02 | 6.93E-01 | 6.93E-01 | 1.02E+00 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-212 | EPA 901.1 Modified | 3.21E-01 | 9.06E-02 | 9.20E-02 | 1.21E-01 | | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-214 | EPA 901.1 Modified | 2.03E-01 | 8.88E-02 | 8.94E-02 | 1.64E-01 | | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Promethium-145 | EPA 901.1 Modified | -4.37E-02 | 9.84E-02 | 9.85E-02 | 1.40E-01 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Radium-226 | EPA 901.1 Modified | 2.38E-01 | 8.80E-02 | 8.88E-02 | 1.46E-01 | | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Antimony-125 | EPA 901.1 Modified | -1.86E-02 | 7.77E-02 | 7.77E-02 | 1.15E-01 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Thorium-234 | EPA 901.1 Modified | 7.86E-01 | 8.40E-01 | 8.41E-01 | 1.40E+00 | U | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Thallium-208 | EPA 901.1 Modified | 2.58E-01 | 8.80E-02 | 8.90E-02 | 8.32E-02 | | pCi/g |
| 19-10093-06 | TRG | L1-12105-A-FSGS-002-SS-A | 09/30/19 13:02 | 10/21/2019 | 10/23/2019 | 19-10093 | Uranium-235 | EPA 901.1 Modified | -1.88E-02 | 2.02E-01 | 2.02E-01 | 2.97E-01 | U | pCi/g |

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect

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# Eberline Analytical
## Final Report of Analysis

*Report To:*

Jeffrey Graham
Zion Solutions
2701 Deborah Ave
Zion, IL 60099

*Work Order Details:*

*SDG:* 19-10093
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Actinium-228 | EPA 901.1 Modified | 5.64E-01 | 1.64E-01 | 1.67E-01 | 2.37E-01 | | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Silver-108m | EPA 901.1 Modified | 9.35E-03 | 2.39E-02 | 2.39E-02 | 4.32E-02 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Americium-241 | EPA 901.1 Modified | -6.06E-02 | 1.03E-01 | 1.03E-01 | 1.23E-01 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Barium-133 | EPA 901.1 Modified | -1.03E-02 | 2.39E-02 | 2.39E-02 | 6.60E-02 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Bismuth-214 | EPA 901.1 Modified | 4.21E-01 | 1.02E-01 | 1.04E-01 | 1.32E-01 | | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | 1.79E-02 | 5.34E-02 | 5.34E-02 | 7.01E-02 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-134 | EPA 901.1 Modified | -6.64E-03 | 1.80E-02 | 1.80E-02 | 4.79E-02 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | 3.82E-03 | 4.16E-02 | 4.16E-02 | 6.50E-02 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-152 | EPA 901.1 Modified | -1.76E-02 | 9.03E-02 | 9.03E-02 | 1.75E-01 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-154 | EPA 901.1 Modified | 3.57E-02 | 1.25E-01 | 1.25E-01 | 8.97E-02 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-155 | EPA 901.1 Modified | 1.95E-02 | 1.16E-01 | 1.16E-01 | 1.51E-01 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Holmium-166m | EPA 901.1 Modified | -1.80E-02 | 6.30E-02 | 6.30E-02 | 6.66E-02 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Iodine-129 | EPA 901.1 Modified | 4.54E-01 | 1.99E-01 | 2.00E-01 | 2.80E-01 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Potassium-40 | EPA 901.1 Modified | 1.39E+01 | 1.79E+00 | 1.92E+00 | 6.74E-01 | | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Manganese-54 | EPA 901.1 Modified | -6.06E-03 | 4.61E-02 | 4.61E-02 | 6.89E-02 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Molybdenum-93 | EPA 901.1 Modified | 9.10E-03 | 3.43E-02 | 3.43E-02 | 4.62E-02 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Niobium-94 | EPA 901.1 Modified | 2.31E-02 | 3.55E-02 | 3.55E-02 | 6.07E-02 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-210 | EPA 901.1 Modified | 9.41E-01 | 1.04E+00 | 1.05E+00 | 1.42E+00 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-212 | EPA 901.1 Modified | 4.85E-01 | 1.35E-01 | 1.37E-01 | 1.77E-01 | | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-214 | EPA 901.1 Modified | 4.24E-01 | 1.20E-01 | 1.22E-01 | 1.97E-01 | | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Promethium-145 | EPA 901.1 Modified | -6.33E-02 | 1.57E-01 | 1.58E-01 | 1.95E-01 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Radium-226 | EPA 901.1 Modified | 4.21E-01 | 1.02E-01 | 1.04E-01 | 1.32E-01 | | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Antimony-125 | EPA 901.1 Modified | -4.28E-02 | 8.50E-02 | 8.50E-02 | 1.30E-01 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Thorium-234 | EPA 901.1 Modified | 8.76E-01 | 9.70E-01 | 9.71E-01 | 1.30E+00 | U | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Thallium-208 | EPA 901.1 Modified | 3.73E-01 | 1.13E-01 | 1.14E-01 | 1.33E-01 | | pCi/g |
| 19-10093-07 | TRG | L1-12107-A-FSGS-010-SB-A | 09/30/19 12:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Uranium-235 | EPA 901.1 Modified | 2.70E-01 | 2.84E-01 | 2.84E-01 | 4.04E-01 | U | pCi/g |

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CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect

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601 SCARBORO ROAD OAK RIDGE, TN 37830 865/481-0683 FAX 865/483-4621

# Eberline Analytical
## Final Report of Analysis

*Report To:*
Jeffrey Graham
Zion Solutions
2701 Deborah Ave
Zion, IL 60099

*Work Order Details:*
*SDG:* 19-10093
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Actinium-228 | EPA 901.1 Modified | 7.56E-02 | 2.28E-01 | 2.28E-01 | 3.85E-01 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Silver-108m | EPA 901.1 Modified | -1.24E-02 | 5.36E-02 | 5.36E-02 | 6.67E-02 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Americium-241 | EPA 901.1 Modified | -4.85E-02 | 7.58E-02 | 7.58E-02 | 1.07E-01 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Barium-133 | EPA 901.1 Modified | 6.25E-03 | 2.58E-02 | 2.58E-02 | 1.12E-01 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Bismuth-214 | EPA 901.1 Modified | 2.91E-01 | 1.27E-01 | 1.28E-01 | 2.05E-01 | | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | -6.67E-02 | 8.00E-02 | 8.01E-02 | 9.19E-02 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-134 | EPA 901.1 Modified | 2.40E-02 | 3.19E-02 | 3.20E-02 | 8.38E-02 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | -4.35E-02 | 6.47E-02 | 6.48E-02 | 7.81E-02 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-152 | EPA 901.1 Modified | -3.49E-02 | 1.95E-01 | 1.95E-01 | 1.56E-01 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-154 | EPA 901.1 Modified | 2.81E-02 | 8.22E-02 | 8.22E-02 | 7.92E-02 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-155 | EPA 901.1 Modified | -1.13E-02 | 8.29E-02 | 8.29E-02 | 1.21E-01 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Holmium-166m | EPA 901.1 Modified | 4.02E-03 | 8.60E-02 | 8.60E-02 | 6.17E-02 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Iodine-129 | EPA 901.1 Modified | -8.91E-03 | 1.36E-01 | 1.36E-01 | 2.01E-01 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Potassium-40 | EPA 901.1 Modified | 1.15E+01 | 1.85E+00 | 1.94E+00 | 1.04E+00 | | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Manganese-54 | EPA 901.1 Modified | -3.24E-02 | 5.96E-02 | 5.96E-02 | 8.32E-02 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Molybdenum-93 | EPA 901.1 Modified | 1.08E-03 | 4.81E-02 | 4.81E-02 | 7.64E-02 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Niobium-94 | EPA 901.1 Modified | 1.11E-02 | 4.83E-02 | 4.83E-02 | 7.63E-02 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-210 | EPA 901.1 Modified | 6.50E-01 | 7.07E-01 | 7.08E-01 | 1.10E+00 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-212 | EPA 901.1 Modified | 2.38E-01 | 1.03E-01 | 1.04E-01 | 2.00E-01 | | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-214 | EPA 901.1 Modified | 2.37E-01 | 1.12E-01 | 1.13E-01 | 1.68E-01 | | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Promethium-145 | EPA 901.1 Modified | -2.42E-02 | 1.03E-01 | 1.03E-01 | 1.50E-01 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Radium-226 | EPA 901.1 Modified | 2.91E-01 | 1.27E-01 | 1.28E-01 | 2.05E-01 | | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Antimony-125 | EPA 901.1 Modified | -1.17E-01 | 1.49E-01 | 1.49E-01 | 1.80E-01 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Thorium-234 | EPA 901.1 Modified | 8.60E-01 | 6.64E-01 | 6.65E-01 | 1.04E+00 | U | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Thallium-208 | EPA 901.1 Modified | 2.58E-01 | 1.25E-01 | 1.26E-01 | 2.32E-01 | | pCi/g |
| 19-10093-08 | TRG | L1-12205-A-FSGS-111-SS-A | 09/25/19 13:05 | 10/21/2019 | 10/23/2019 | 19-10093 | Uranium-235 | EPA 901.1 Modified | -1.58E-02 | 9.48E-02 | 9.49E-02 | 3.58E-01 | U | pCi/g |

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect



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# Eberline Analytical
## Final Report of Analysis

*Report To:*

**Jeffrey Graham**
**Zion Solutions**
**2701 Deborah Ave**
**Zion, IL 60099**

*Work Order Details:*

*SDG:* **19-10093**
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Actinium-228 | EPA 901.1 Modified | 2.90E-02 | 1.80E-02 | 1.80E-02 | 3.30E-02 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Silver-108m | EPA 901.1 Modified | -2.96E-03 | 4.19E-03 | 4.19E-03 | 4.89E-03 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Americium-241 | EPA 901.1 Modified | -3.72E-03 | 6.98E-03 | 6.98E-03 | 1.05E-02 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Barium-133 | EPA 901.1 Modified | 6.19E-04 | 1.79E-03 | 1.79E-03 | 8.09E-03 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Bismuth-214 | EPA 901.1 Modified | 2.99E-02 | 1.01E-02 | 1.02E-02 | 6.28E-03 | | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | -1.09E-03 | 5.32E-03 | 5.32E-03 | 5.49E-03 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-134 | EPA 901.1 Modified | 1.49E-04 | 1.29E-03 | 1.29E-03 | 5.78E-03 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | 2.17E-03 | 3.38E-03 | 3.39E-03 | 5.82E-03 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-152 | EPA 901.1 Modified | -1.10E-02 | 1.42E-02 | 1.42E-02 | 1.63E-02 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-154 | EPA 901.1 Modified | 6.57E-03 | 5.08E-03 | 5.09E-03 | 9.70E-03 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-155 | EPA 901.1 Modified | 4.81E-03 | 8.81E-03 | 8.81E-03 | 1.31E-02 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Holmium-166m | EPA 901.1 Modified | 4.73E-03 | 4.75E-03 | 4.75E-03 | 5.57E-03 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Iodine-129 | EPA 901.1 Modified | 8.69E-03 | 1.74E-02 | 1.74E-02 | 2.84E-02 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Potassium-40 | EPA 901.1 Modified | 1.23E+00 | 1.64E-01 | 1.76E-01 | 7.28E-02 | | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Manganese-54 | EPA 901.1 Modified | -2.75E-04 | 2.95E-03 | 2.95E-03 | 5.77E-03 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Molybdenum-93 | EPA 901.1 Modified | 2.37E-03 | 2.69E-03 | 2.69E-03 | 3.36E-03 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Niobium-94 | EPA 901.1 Modified | 1.35E-03 | 3.50E-03 | 3.50E-03 | 5.20E-03 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-210 | EPA 901.1 Modified | 1.36E-01 | 7.25E-02 | 7.29E-02 | 1.25E-01 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-212 | EPA 901.1 Modified | 2.08E-02 | 7.45E-03 | 7.52E-03 | 1.55E-02 | | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-214 | EPA 901.1 Modified | 2.90E-02 | 1.03E-02 | 1.04E-02 | 1.78E-02 | | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Promethium-145 | EPA 901.1 Modified | -3.45E-04 | 1.12E-02 | 1.12E-02 | 1.82E-02 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Radium-226 | EPA 901.1 Modified | 2.99E-02 | 1.01E-02 | 1.02E-02 | 6.28E-03 | | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Antimony-125 | EPA 901.1 Modified | -1.07E-02 | 1.04E-02 | 1.04E-02 | 1.33E-02 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Thorium-234 | EPA 901.1 Modified | -1.33E-02 | 6.10E-02 | 6.10E-02 | 9.78E-02 | U | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Thallium-208 | EPA 901.1 Modified | 2.09E-02 | 9.44E-03 | 9.50E-03 | 4.37E-03 | | pCi/g |
| 19-10093-09 | TRG | L1-12104-A-FSGS-011-SS-A | 10/01/19 09:20 | 10/21/2019 | 10/23/2019 | 19-10093 | Uranium-235 | EPA 901.1 Modified | 1.51E-02 | 2.06E-02 | 2.07E-02 | 3.17E-02 | U | pCi/g |

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect

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# Eberline Analytical
## Final Report of Analysis

*Report To:*

Jeffrey Graham
Zion Solutions
2701 Deborah Ave
Zion, IL 60099

*Work Order Details:*

*SDG:* **19-10093**
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Actinium-228 | EPA 901.1 Modified | 2.15E-01 | 1.34E-01 | 1.35E-01 | 2.54E-01 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Silver-108m | EPA 901.1 Modified | -9.26E-03 | 1.66E-02 | 1.66E-02 | 3.55E-02 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Americium-241 | EPA 901.1 Modified | -6.62E-02 | 7.86E-02 | 7.87E-02 | 1.08E-01 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Barium-133 | EPA 901.1 Modified | -6.21E-03 | 2.53E-02 | 2.53E-02 | 6.48E-02 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Bismuth-214 | EPA 901.1 Modified | 1.58E-01 | 7.50E-02 | 7.54E-02 | 1.48E-01 | | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | -7.45E-03 | 4.03E-02 | 4.03E-02 | 5.08E-02 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-134 | EPA 901.1 Modified | 1.05E-02 | 1.76E-02 | 1.76E-02 | 5.26E-02 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | 1.25E-02 | 3.38E-02 | 3.39E-02 | 5.08E-02 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-152 | EPA 901.1 Modified | -3.62E-02 | 1.19E-01 | 1.19E-01 | 1.38E-01 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-154 | EPA 901.1 Modified | 2.61E-02 | 9.81E-02 | 9.81E-02 | 7.01E-02 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-155 | EPA 901.1 Modified | 8.59E-02 | 7.76E-02 | 7.77E-02 | 1.19E-01 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Holmium-166m | EPA 901.1 Modified | -7.00E-03 | 5.85E-02 | 5.85E-02 | 5.28E-02 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Iodine-129 | EPA 901.1 Modified | 2.40E-02 | 1.19E-01 | 1.19E-01 | 1.78E-01 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Potassium-40 | EPA 901.1 Modified | 1.23E+01 | 1.54E+00 | 1.67E+00 | 5.49E-01 | | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Manganese-54 | EPA 901.1 Modified | 8.16E-03 | 3.61E-02 | 3.61E-02 | 5.28E-02 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Molybdenum-93 | EPA 901.1 Modified | -4.95E-03 | 3.07E-02 | 3.07E-02 | 3.35E-02 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Niobium-94 | EPA 901.1 Modified | -1.69E-02 | 3.07E-02 | 3.07E-02 | 3.87E-02 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-210 | EPA 901.1 Modified | 7.78E-01 | 6.93E-01 | 6.94E-01 | 1.14E+00 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-212 | EPA 901.1 Modified | 2.35E-01 | 8.25E-02 | 8.34E-02 | 1.19E-01 | | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-214 | EPA 901.1 Modified | 2.89E-01 | 7.75E-02 | 7.89E-02 | 2.50E-01 | | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Promethium-145 | EPA 901.1 Modified | 1.56E-02 | 9.58E-02 | 9.58E-02 | 1.43E-01 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Radium-226 | EPA 901.1 Modified | 1.58E-01 | 7.50E-02 | 7.54E-02 | 1.48E-01 | | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Antimony-125 | EPA 901.1 Modified | 4.30E-02 | 7.65E-02 | 7.65E-02 | 1.24E-01 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Thorium-234 | EPA 901.1 Modified | 9.69E-01 | 6.87E-01 | 6.88E-01 | 1.07E+00 | U | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Thallium-208 | EPA 901.1 Modified | 2.33E-01 | 9.24E-02 | 9.31E-02 | 1.71E-01 | | pCi/g |
| 19-10093-10 | TRG | L1-12104-A-FSGS-013-SS-A | 10/01/19 09:24 | 10/21/2019 | 10/23/2019 | 19-10093 | Uranium-235 | EPA 901.1 Modified | 1.18E-02 | 2.01E-01 | 2.01E-01 | 2.99E-01 | U | pCi/g |

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect

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# Eberline Analytical
## Final Report of Analysis

*Report To:*

Jeffrey Graham
Zion Solutions
2701 Deborah Ave
Zion, IL 60099

*Work Order Details:*

*SDG:* **19-10093**
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Actinium-228 | EPA 901.1 Modified | 3.35E-01 | 1.57E-01 | 1.58E-01 | 2.80E-01 | | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Silver-108m | EPA 901.1 Modified | 3.35E-04 | 4.49E-02 | 4.49E-02 | 4.66E-02 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Americium-241 | EPA 901.1 Modified | -2.36E-02 | 1.05E-01 | 1.05E-01 | 1.28E-01 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Barium-133 | EPA 901.1 Modified | 8.04E-03 | 2.70E-02 | 2.70E-02 | 5.70E-02 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Bismuth-214 | EPA 901.1 Modified | 4.21E-01 | 1.03E-01 | 1.05E-01 | 1.30E-01 | | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | 8.00E-03 | 3.44E-02 | 3.44E-02 | 5.39E-02 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-134 | EPA 901.1 Modified | -1.03E-03 | 2.10E-02 | 2.10E-02 | 5.26E-02 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | -1.99E-02 | 4.12E-02 | 4.12E-02 | 5.84E-02 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-152 | EPA 901.1 Modified | 2.96E-02 | 1.39E-01 | 1.39E-01 | 1.74E-01 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-154 | EPA 901.1 Modified | -1.15E-02 | 1.11E-01 | 1.11E-01 | 8.89E-02 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-155 | EPA 901.1 Modified | -2.20E-02 | 1.08E-01 | 1.08E-01 | 1.39E-01 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Holmium-166m | EPA 901.1 Modified | -3.17E-02 | 6.41E-02 | 6.42E-02 | 6.61E-02 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Iodine-129 | EPA 901.1 Modified | 5.31E-01 | 2.00E-01 | 2.02E-01 | 2.73E-01 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Potassium-40 | EPA 901.1 Modified | 1.21E+01 | 1.61E+00 | 1.73E+00 | 7.35E-01 | | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Manganese-54 | EPA 901.1 Modified | 2.62E-02 | 2.83E-02 | 2.83E-02 | 5.28E-02 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Molybdenum-93 | EPA 901.1 Modified | 5.38E-03 | 2.44E-02 | 2.44E-02 | 4.40E-02 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Niobium-94 | EPA 901.1 Modified | -9.87E-03 | 4.12E-02 | 4.12E-02 | 5.36E-02 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-210 | EPA 901.1 Modified | 8.82E-01 | 8.07E-01 | 8.08E-01 | 1.33E+00 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-212 | EPA 901.1 Modified | 4.39E-01 | 1.19E-01 | 1.21E-01 | 1.53E-01 | | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-214 | EPA 901.1 Modified | 5.03E-01 | 1.14E-01 | 1.17E-01 | 1.42E-01 | | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Promethium-145 | EPA 901.1 Modified | 1.42E-02 | 1.49E-01 | 1.49E-01 | 1.92E-01 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Radium-226 | EPA 901.1 Modified | 4.21E-01 | 1.03E-01 | 1.05E-01 | 1.30E-01 | | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Antimony-125 | EPA 901.1 Modified | -3.59E-02 | 7.54E-02 | 7.54E-02 | 1.15E-01 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Thorium-234 | EPA 901.1 Modified | 1.33E+00 | 8.76E-01 | 8.79E-01 | 1.26E+00 | U | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Thallium-208 | EPA 901.1 Modified | 2.49E-01 | 9.46E-02 | 9.55E-02 | 1.77E-01 | | pCi/g |
| 19-10093-11 | TRG | L1-12205-A-FSGS-101-SB-A | 10/01/19 08:25 | 10/21/2019 | 10/23/2019 | 19-10093 | Uranium-235 | EPA 901.1 Modified | -1.99E-01 | 2.76E-01 | 2.77E-01 | 3.30E-01 | U | pCi/g |

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CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect

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601 SCARBORO ROAD OAK RIDGE, TN 37830 865/481-0683 FAX 865/483-4621

# Eberline Analytical
## Final Report of Analysis

*Report To:*

**Jeffrey Graham**
**Zion Solutions**
**2701 Deborah Ave**
**Zion, IL 60099**

*Work Order Details:*

*SDG:* **19-10093**
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Actinium-228 | EPA 901.1 Modified | 3.10E-01 | 1.38E-01 | 1.39E-01 | 2.14E-01 | | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Silver-108m | EPA 901.1 Modified | -2.82E-02 | 4.46E-02 | 4.46E-02 | 4.16E-02 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Americium-241 | EPA 901.1 Modified | -1.23E-01 | 7.07E-02 | 7.09E-02 | 1.01E-01 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Barium-133 | EPA 901.1 Modified | 7.09E-03 | 2.12E-02 | 2.12E-02 | 7.51E-02 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Bismuth-214 | EPA 901.1 Modified | 2.08E-01 | 9.31E-02 | 9.37E-02 | 1.59E-01 | | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | -1.71E-03 | 4.56E-02 | 4.56E-02 | 5.54E-02 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-134 | EPA 901.1 Modified | 7.18E-03 | 1.83E-02 | 1.83E-02 | 5.60E-02 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | 1.92E-02 | 3.52E-02 | 3.52E-02 | 5.91E-02 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-152 | EPA 901.1 Modified | -2.05E-02 | 4.88E-02 | 4.88E-02 | 1.54E-01 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-154 | EPA 901.1 Modified | 1.04E-01 | 1.20E-01 | 1.20E-01 | 7.85E-02 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-155 | EPA 901.1 Modified | 1.05E-01 | 7.86E-02 | 7.88E-02 | 1.63E-01 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Holmium-166m | EPA 901.1 Modified | -1.84E-02 | 6.48E-02 | 6.48E-02 | 5.54E-02 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Iodine-129 | EPA 901.1 Modified | -1.99E-03 | 1.63E-01 | 1.63E-01 | 2.64E-01 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Potassium-40 | EPA 901.1 Modified | 1.09E+01 | 1.51E+00 | 1.61E+00 | 6.83E-01 | | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Manganese-54 | EPA 901.1 Modified | -1.94E-02 | 4.10E-02 | 4.10E-02 | 5.90E-02 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Molybdenum-93 | EPA 901.1 Modified | 1.61E-02 | 3.26E-02 | 3.26E-02 | 5.23E-02 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Niobium-94 | EPA 901.1 Modified | 1.54E-02 | 3.12E-02 | 3.12E-02 | 4.78E-02 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-210 | EPA 901.1 Modified | 9.52E-01 | 7.32E-01 | 7.34E-01 | 1.24E+00 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-212 | EPA 901.1 Modified | 3.34E-01 | 9.93E-02 | 1.01E-01 | 1.31E-01 | | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-214 | EPA 901.1 Modified | 2.33E-01 | 9.26E-02 | 9.34E-02 | 1.61E-01 | | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Promethium-145 | EPA 901.1 Modified | 2.86E-02 | 1.13E-01 | 1.13E-01 | 1.85E-01 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Radium-226 | EPA 901.1 Modified | 2.08E-01 | 9.31E-02 | 9.37E-02 | 1.59E-01 | | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Antimony-125 | EPA 901.1 Modified | -1.71E-03 | 9.66E-02 | 9.66E-02 | 1.46E-01 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Thorium-234 | EPA 901.1 Modified | 1.07E+00 | 6.19E-01 | 6.22E-01 | 1.06E+00 | U | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Thallium-208 | EPA 901.1 Modified | 2.44E-01 | 1.07E-01 | 1.07E-01 | 4.38E-02 | | pCi/g |
| 19-10093-12 | TRG | L1-12109-A-FSGS-012-SS-A | 09/17/19 09:22 | 10/21/2019 | 10/23/2019 | 19-10093 | Uranium-235 | EPA 901.1 Modified | 1.66E-01 | 2.12E-01 | 2.12E-01 | 3.26E-01 | U | pCi/g |

0031

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect

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601 SCARBORO ROAD OAK RIDGE, TN 37830 865/481-0683 FAX 865/483-4621

# Eberline Analytical
## Final Report of Analysis

*Report To:*

**Jeffrey Graham**
**Zion Solutions**
**2701 Deborah Ave**
**Zion, IL 60099**

*Work Order Details:*

*SDG:* **19-10093**
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Actinium-228 | EPA 901.1 Modified | 1.91E-01 | 2.26E-01 | 2.26E-01 | 3.96E-01 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Silver-108m | EPA 901.1 Modified | 6.72E-03 | 2.15E-02 | 2.15E-02 | 6.12E-02 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Americium-241 | EPA 901.1 Modified | -2.40E-02 | 7.42E-02 | 7.42E-02 | 1.05E-01 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Barium-133 | EPA 901.1 Modified | 5.13E-03 | 3.96E-02 | 3.96E-02 | 1.04E-01 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Bismuth-214 | EPA 901.1 Modified | 2.89E-01 | 1.07E-01 | 1.08E-01 | 1.53E-01 | | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | 5.97E-02 | 6.90E-02 | 6.90E-02 | 1.03E-01 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-134 | EPA 901.1 Modified | 1.02E-02 | 3.14E-02 | 3.14E-02 | 8.66E-02 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | 1.48E-02 | 3.26E-02 | 3.26E-02 | 7.38E-02 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-152 | EPA 901.1 Modified | -2.67E-02 | 5.42E-02 | 5.42E-02 | 1.59E-01 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-154 | EPA 901.1 Modified | -1.19E-01 | 1.88E-01 | 1.88E-01 | 7.97E-02 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-155 | EPA 901.1 Modified | 6.20E-03 | 8.52E-02 | 8.52E-02 | 1.25E-01 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Holmium-166m | EPA 901.1 Modified | -3.68E-02 | 7.89E-02 | 7.89E-02 | 6.02E-02 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Iodine-129 | EPA 901.1 Modified | -1.63E-01 | 1.41E-01 | 1.41E-01 | 1.81E-01 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Potassium-40 | EPA 901.1 Modified | 1.26E+01 | 1.92E+00 | 2.02E+00 | 8.10E-01 | | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Manganese-54 | EPA 901.1 Modified | 2.35E-02 | 5.43E-02 | 5.43E-02 | 9.27E-02 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Molybdenum-93 | EPA 901.1 Modified | 1.64E-02 | 4.34E-02 | 4.34E-02 | 6.63E-02 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Niobium-94 | EPA 901.1 Modified | -2.79E-03 | 4.32E-02 | 4.32E-02 | 7.02E-02 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-210 | EPA 901.1 Modified | 4.80E-01 | 7.09E-01 | 7.09E-01 | 1.08E+00 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-212 | EPA 901.1 Modified | 2.87E-01 | 1.41E-01 | 1.42E-01 | 1.91E-01 | | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-214 | EPA 901.1 Modified | 1.89E-01 | 1.07E-01 | 1.07E-01 | 1.70E-01 | | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Promethium-145 | EPA 901.1 Modified | 1.69E-02 | 1.05E-01 | 1.05E-01 | 1.53E-01 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Radium-226 | EPA 901.1 Modified | 2.89E-01 | 1.07E-01 | 1.08E-01 | 1.53E-01 | | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Antimony-125 | EPA 901.1 Modified | -5.41E-02 | 1.45E-01 | 1.45E-01 | 1.90E-01 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Thorium-234 | EPA 901.1 Modified | 8.78E-01 | 6.46E-01 | 6.47E-01 | 1.02E+00 | U | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Thallium-208 | EPA 901.1 Modified | 2.58E-01 | 1.00E-01 | 1.01E-01 | 1.25E-01 | | pCi/g |
| 19-10093-13 | TRG | L1-12205-C-FSGS-105-SS-A | 09/24/19 13:08 | 10/21/2019 | 10/23/2019 | 19-10093 | Uranium-235 | EPA 901.1 Modified | 3.26E-02 | 2.28E-01 | 2.28E-01 | 3.42E-01 | U | pCi/g |

0032

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect

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# Eberline Analytical
## Final Report of Analysis

*Report To:*

**Jeffrey Graham**
**Zion Solutions**
**2701 Deborah Ave**
**Zion, IL 60099**

*Work Order Details:*

*SDG:* **19-10093**
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Actinium-228 | EPA 901.1 Modified | 3.11E-01 | 2.08E-01 | 2.09E-01 | 3.84E-01 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Silver-108m | EPA 901.1 Modified | -1.66E-02 | 5.63E-02 | 5.63E-02 | 5.71E-02 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Americium-241 | EPA 901.1 Modified | -5.51E-02 | 6.77E-02 | 6.78E-02 | 9.32E-02 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Barium-133 | EPA 901.1 Modified | -4.12E-02 | 3.93E-02 | 3.93E-02 | 1.01E-01 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Bismuth-214 | EPA 901.1 Modified | 8.43E-02 | 1.20E-01 | 1.20E-01 | 1.82E-01 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | -1.97E-02 | 6.98E-02 | 6.98E-02 | 8.37E-02 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-134 | EPA 901.1 Modified | -8.46E-02 | 7.52E-02 | 7.53E-02 | 7.68E-02 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | 2.43E-02 | 5.57E-02 | 5.58E-02 | 8.53E-02 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-152 | EPA 901.1 Modified | 1.48E-02 | 8.00E-02 | 8.00E-02 | 1.58E-01 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-154 | EPA 901.1 Modified | -5.22E-02 | 1.71E-01 | 1.71E-01 | 8.05E-02 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-155 | EPA 901.1 Modified | 5.63E-02 | 6.74E-02 | 6.74E-02 | 1.13E-01 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Holmium-166m | EPA 901.1 Modified | 2.66E-02 | 7.92E-02 | 7.93E-02 | 5.89E-02 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Iodine-129 | EPA 901.1 Modified | -2.32E-03 | 1.24E-01 | 1.24E-01 | 1.83E-01 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Potassium-40 | EPA 901.1 Modified | 9.59E+00 | 1.68E+00 | 1.75E+00 | 1.25E+00 | | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Manganese-54 | EPA 901.1 Modified | -1.65E-02 | 5.49E-02 | 5.49E-02 | 8.28E-02 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Molybdenum-93 | EPA 901.1 Modified | -1.18E-03 | 3.99E-02 | 3.99E-02 | 6.27E-02 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Niobium-94 | EPA 901.1 Modified | 2.88E-02 | 4.38E-02 | 4.38E-02 | 7.50E-02 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-210 | EPA 901.1 Modified | 5.03E-01 | 6.54E-01 | 6.54E-01 | 1.01E+00 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-212 | EPA 901.1 Modified | 2.23E-01 | 1.00E-01 | 1.01E-01 | 1.75E-01 | | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-214 | EPA 901.1 Modified | 2.80E-01 | 1.09E-01 | 1.10E-01 | 1.52E-01 | | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Promethium-145 | EPA 901.1 Modified | -8.62E-02 | 9.92E-02 | 9.93E-02 | 1.36E-01 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Radium-226 | EPA 901.1 Modified | 8.43E-02 | 1.20E-01 | 1.20E-01 | 1.82E-01 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Antimony-125 | EPA 901.1 Modified | 1.96E-02 | 1.27E-01 | 1.27E-01 | 1.82E-01 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Thorium-234 | EPA 901.1 Modified | -3.16E-01 | 6.31E-01 | 6.32E-01 | 8.98E-01 | U | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Thallium-208 | EPA 901.1 Modified | 3.10E-01 | 1.63E-01 | 1.64E-01 | 2.29E-01 | | pCi/g |
| 19-10093-14 | TRG | L1-12111-A-FSGS-003-SS-A | 09/16/19 08:06 | 10/21/2019 | 10/23/2019 | 19-10093 | Uranium-235 | EPA 901.1 Modified | 3.45E-02 | 2.19E-01 | 2.19E-01 | 3.28E-01 | U | pCi/g |

0033

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect

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# Eberline Analytical
## Final Report of Analysis

*Report To:*

**Jeffrey Graham**
**Zion Solutions**
**2701 Deborah Ave**
**Zion, IL 60099**

*Work Order Details:*

*SDG:* **19-10093**
*Purchase Order:* 677118
*Analysis Category:* ENVIRONMENTAL
*Sample Matrix:* SO

| Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Qualifier | Report Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Actinium-228 | EPA 901.1 Modified | 3.26E-01 | 1.76E-01 | 1.77E-01 | 3.23E-01 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Silver-108m | EPA 901.1 Modified | -1.15E-02 | 4.44E-02 | 4.44E-02 | 5.05E-02 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Americium-241 | EPA 901.1 Modified | -1.31E-01 | 7.88E-02 | 7.91E-02 | 1.12E-01 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Barium-133 | EPA 901.1 Modified | 2.62E-02 | 2.66E-02 | 2.66E-02 | 8.71E-02 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Bismuth-214 | EPA 901.1 Modified | 2.96E-01 | 1.11E-01 | 1.12E-01 | 2.22E-01 | | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Cobalt-60 | EPA 901.1 Modified | 5.36E-02 | 2.58E-02 | 2.60E-02 | 3.98E-02 | | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-134 | EPA 901.1 Modified | -2.72E-04 | 1.46E-02 | 1.46E-02 | 6.22E-02 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Cesium-137 | EPA 901.1 Modified | 7.34E-03 | 4.69E-02 | 4.69E-02 | 7.15E-02 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-152 | EPA 901.1 Modified | -1.47E-01 | 1.77E-01 | 1.77E-01 | 1.80E-01 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-154 | EPA 901.1 Modified | 7.81E-03 | 1.15E-01 | 1.15E-01 | 9.19E-02 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Europium-155 | EPA 901.1 Modified | 7.78E-02 | 9.68E-02 | 9.69E-02 | 1.45E-01 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Holmium-166m | EPA 901.1 Modified | -4.54E-02 | 5.67E-02 | 5.68E-02 | 5.75E-02 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Iodine-129 | EPA 901.1 Modified | 3.14E-02 | 1.76E-01 | 1.76E-01 | 2.88E-01 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Potassium-40 | EPA 901.1 Modified | 9.36E+00 | 1.43E+00 | 1.51E+00 | 8.93E-01 | | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Manganese-54 | EPA 901.1 Modified | -5.37E-03 | 4.30E-02 | 4.30E-02 | 6.35E-02 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Molybdenum-93 | EPA 901.1 Modified | 1.57E-02 | 3.15E-02 | 3.15E-02 | 5.28E-02 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Niobium-94 | EPA 901.1 Modified | -2.47E-02 | 3.46E-02 | 3.46E-02 | 5.42E-02 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-210 | EPA 901.1 Modified | 5.59E-01 | 8.01E-01 | 8.01E-01 | 1.33E+00 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-212 | EPA 901.1 Modified | 4.05E-01 | 1.23E-01 | 1.25E-01 | 1.66E-01 | | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Lead-214 | EPA 901.1 Modified | 2.85E-01 | 9.14E-02 | 9.26E-02 | 2.94E-01 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Promethium-145 | EPA 901.1 Modified | -1.04E-01 | 1.28E-01 | 1.28E-01 | 1.95E-01 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Radium-226 | EPA 901.1 Modified | 2.96E-01 | 1.11E-01 | 1.12E-01 | 2.22E-01 | | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Antimony-125 | EPA 901.1 Modified | 8.40E-02 | 8.89E-02 | 8.90E-02 | 1.53E-01 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Thorium-234 | EPA 901.1 Modified | 8.88E-01 | 6.66E-01 | 6.67E-01 | 1.13E+00 | U | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Thallium-208 | EPA 901.1 Modified | 3.00E-01 | 1.22E-01 | 1.23E-01 | 2.40E-01 | | pCi/g |
| 19-10093-15 | TRG | L1-12205-D-FSGS-111-SB-A | 09/16/19 14:00 | 10/21/2019 | 10/23/2019 | 19-10093 | Uranium-235 | EPA 901.1 Modified | 9.72E-02 | 2.22E-01 | 2.22E-01 | 3.36E-01 | U | pCi/g |

0034

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample;MBL=Blank;DUP=Duplicate;TRG=Normal Sample;DO=Duplicate Original;U=Non-detect

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601 SCARBORO ROAD OAK RIDGE, TN 37830 865/481-0683 FAX 865/483-4621

ZIONSOLUTIONS LLC
An EnergySolutions Company

REC'D OCT 21 2019

19-10093

ZS-WM-131
Revision 0
Information Use

Attachment 1 – Chain-of-Custody Form

| | Sample ID | Sample Log | Matrix | Sample Type | Sample Container Vol | Unit | Type | Qty | Sample Date | Sample Time | Analysis Type | Preservative | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | L1-12107-A-FSGS-012-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/26/2019 | 0722 | 5 ROC HTD | NA | 939.51 |
| 5 | L1-12105-A-FSGS-016-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/30/2019 | 1330 | 5 ROC HTD | NA | 1026.88 |
| 6 | L1-12105-A-FSGS-002-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/30/2019 | 1302 | 5 ROC HTD | NA | 969.33 |
| 7 | L1-12107-A-FSGS-010-SB-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/30/2019 | 1225 | 5 ROC HTD | NA | 923.24 |
| 8 | L1-12205-A-FSGS-111-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/25/2019 | 1305 | 5 ROC HTD | NA | 952.09 |
| 9 | L1-12104-A-FSGS-011-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 10/1/2019 | 0920 | 5 ROC HTD | NA | 1013.10 |
| 10 | L1-12104-A-FSGS-013-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 10/1/2019 | 0924 | 5 ROC HTD | NA | 975.70 |
| 11 | L1-12205-A-FSGS-101-SB-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 10/1/2019 | 0825 | 5 ROC HTD | NA | 859.10 |
| 12 | L1-12109-A-FSGS-012-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/17/2019 | 0922 | 5 ROC HTD | NA | 1013.58 |
| 13 | L1-12205-C-FSGS-105-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/24/2019 | 1308 | 5 ROC HTD | NA | 979.04 |
| 14 | L1-12111-A-FSGS-003-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/16/2019 | 0806 | 5 ROC HTD | NA | 1122.70 |
| 15 | L1-12205-D-FSGS-111-SB-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/16/2019 | 1400 | 5 ROC HTD | NA | 974.36 |
| | L1-12205-E-FSGS-104-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/9/2019 | 1306 | 5 ROC HTD | NA | 1087.82 |
| | L1-12205-E-QIGS-101-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/11/2019 | 0900 | 5 ROC HTD | NA | 829.86 |
| | L1-12205-D-FSGS-117-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/9/2019 | 1022 | 5 ROC HTD | NA | 1028.72 |
| | L1-12205-E-FSGS-117-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/9/2019 | 1332 | 5 ROC HTD | NA | 1106.09 |
| | L1-12205-A-FSGS-116-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/25/2019 | 1315 | 5 ROC HTD | NA | 1078.92 |

Rec. [illegible] 10-21-19 @ 1100

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ZS-WM-131
Revision 0
Information Use

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L1-12111-A-QJGS-001-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/23/2019 | 1330 | 5 ROC HTD | NA | 1137.81 |
| L1-12111-A-FJGS-003-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/23/2019 | 1334 | 5 ROC HTD | NA | 1029.33 |
| L1-12205-B-FSGS-105-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/25/2019 | 0908 | 5 ROC HTD | NA | 1044.71 |
| L1-12106-A-FSGS-009-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/26/2019 | 1246 | 5 ROC HTD | NA | 1127.18 |
| L1-12205-A-FSGS-104-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/25/2019 | 1251 | 5 ROC HTD | NA | 1135.95 |
| L1-12205-A-FSGS-109-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/25/2019 | 1301 | 5 ROC HTD | NA | 1130.91 |
| L1-12106-A-FSGS-013-SS-A | NA | NA | SOIL | 500 | ml | MARINELLI | 1 | 9/26/2019 | 1254 | 5 ROC HTD | NA | 1159.18 |

| Laboratory: | Date Submitted To Lab: | Ship Container No.: | Cooler Temperature: | Airbill Number: |
|---|---|---|---|---|
| EBERLINE LABS | | NA | N/A | FedEx Ground |

| Relinquished by: | Date (mm/dd/yyyy): | Time: | Received by: | Date: (mm/dd/yyyy): | |
|---|---|---|---|---|---|
| Jack Mucia | 10/16/19 | 0710 | Richard F. Rickert | 10/16/2019 | 0710 |
| Richard F. Rickert | 10/17/2019 | 1600 | FedEx Ground | 10/17/2019 | 1600 |
| Fedex G | | | Randolph Spencer | 10/21/2019 | 1100 |
| Relinquished by: | Date (mm/dd/yyyy): | Time: | Received by: | Date: (mm/dd/yyyy): | |

Comments
PO # 67718 HTD's 30 Day turnaround

9000