Zion*Solutions*

ZS-2021-0001
Attachment 2

Zion Nuclear Power Station, Units 1 and 2

Response to Request for Additional Information Related to the Final Status Survey Final Reports

Zion Nuclear Power Station, Units 1 and 2 – Request for Additional Information Related to Final Status Survey Reports, dated November 4, 2020

NRC RAI Question #1a Provide revised Final Status Survey Reports that reflect the final radiological conditions of the site and that incorporate any revisions to the release records referenced in the report. Provide a statement confirming that the Final Status Survey Reports reflect the final conditions of the site and remediation or potential recontamination of the survey units (including with concrete debris from the demolition of structures on site) after the time of FSS is documented in the report or its associated release records. Also confirm that all investigations and remediation that occurred after FSS are documented information in the report or its associated release records.

RESPONSE: All release records and final reports provided to the NRC to demonstrate compliance with the unrestricted release criteria reflect the final radiological conditions of the site. Any remediation or potential recontamination of the survey units (including recontamination from Clean Concrete Demolition Debris [CCDD] and water intrusion) occurred prior to the execution of FSS documented in the applicable release records, with the exception of survey units 12112, 12113, 12203A, 12203B, 12203C, and 12203D. These six survey units had CCDD temporarily placed in them, or transported through them, after FSS was completed.

The NRC conclusion is that the FSSs for survey units 12112, 12113, 12203A, 12203B, 12203C, and 12203D were invalidated when contaminated material was stored on them, which compromised the isolation and control of the survey units. This concern was also addressed as a non-cited violation (NCV) of License Condition 2.C.(17), received in March 2020, for failing to implement and maintain in effect all provisions of the approved LTP. Specifically, the NCV contends that the Licensee placed contaminated concrete debris in an area under FSS isolation and control measures, which is inconsistent with LTP Section 5.6.3 to implement controls throughout FSS activities until there is no risk of recontamination from decommissioning or the survey area has been released from the license.

Zion*Solutions* offers the following points of clarification to address the NCV and the NRC contention that the concrete debris was contaminated before being placed in controlled FSS areas:

- All CCDD was surveyed in accordance with approved MARSAME-based Unconditional Release Survey (URS) procedures to meet requirements for unconditional release. TSD 17-007, "Evaluation of Static Measurements Performed for Unconditional Release Surveys of Building Materials Used for Backfill at the Zion Decommissioning Project," Revision 1, and TSD 17-010, "Final Report -Unconditional Release Surveys at the Zion

Station Restoration Project," Revision 1, were provided to NRC documenting the CCDD's compliance with both FSS and URS requirements, respectively.

- The CCDD that was temporarily placed in survey units 12112, 12113, 12203A, 12203B, 12203C, and 12203D was comprised of concrete originating from the exterior of the Containment Buildings (i.e., concrete on the outside of the ½-inch stainless steel liner), and therefore was considered low risk with respect to plant-originated contamination.

URS was performed on the Unit 1 and Unit 2 Containment Building exterior surfaces in July 2016. Results indicated no plant-related activity above background (see TSD 17-010). A second URS was performed between March and May of 2018 for the purpose of verifying the findings of the original URS. For each Containment Building, sample plans were developed using guidance from ZS-LT-400-001-001, "Unconditional Release of Material, Equipment and Secondary Structures," which has been provided to the NRC. For each unit, the survey design called for a 100% scan of the surfaces between grade and three meters above grade and at the surfaces that previously resided within the tent enclosure (equipment hatch area), with a minimum of 60 smears and static measurements also required. Additionally, the survey design called for a 10% scan of the surfaces from three meters above grade to nine meters above grade, with a minimum of 14 smears and static measurements also required. Surfaces were surveyed utilizing a Ludlum Model 2350-1 data logger coupled to a Ludlum Model 43-68 gas-proportional beta detector. For all scan measurements, static measurements, and smears, no detectable plant-related radioactivity above background was identified. The sample plans and results for the URSs performed in 2018 are included on the enclosure to this response.

Prior to initiating the URS on the Unit 1 and Unit 2 Containment Building exteriors in 2016, both structures were isolated and controlled in accordance with ZS-LT-300-001-003, "Isolation and Control for Final Status Survey." These isolation and control measures consisted primarily of a physical boundary, established a minimum of 1 meter from the structure surface, with the intent of preventing personnel and equipment from potentially cross contaminating the structure surfaces. These isolation and control measures remained in place through the 2018 URSs and after building demolition. Prior to the demolition of the Containment Buildings, the physical boundaries for isolation and control were expanded to the boundary of the Power Block area.

As an additional measure to prevent cross contamination, a three-foot thick sacrificial layer, using clean soil from an off-site location, was placed around each of the Containment Buildings. During the demolition process, the clean exterior concrete debris ultimately landed on top of the clean sacrificial soil layer. All personnel and equipment were surveyed into this isolated and controlled area prior to and during demolition. Likewise, personnel and equipment were surveyed into the isolated and controlled area during the loading and transport of the CCDD. The CCDD was temporarily stored or transported through survey units 12112, 12113, 12203A, 12203B, 12203C, and 12203D. The process of moving the concrete from the perimeter of the

Containment Buildings to the final resting place in survey units 12205A, 12205B, 12205C, 12205D, and 12205E took less than two months.

Throughout handling and stockpiling of the CCDD, procedurally required isolation and control measures were maintained. As required by procedure ZS-LT-300-001-003, "Isolation and Control for Final Status Survey," the CCDD was always posted with access controls instated. Therefore, LTP Section 5.6.3 and procedural requirements for isolation controls were met. When Zion*Solutions* placed the CCDD into the six survey units where FSS had been initially completed, the CCDD entered as clean, unconditionally-released material based on procedurally specified surveys with no measurements above background (similar to as it was entered into basements that had previously undergone FSS).

For open land survey units, residual radioactivity can remain on-site, given that it meets the site release criteria. Once the CCDD was placed within the survey units that had undergone FSS, the CCDD could no longer be considered "clean". When the decision was made to remove the CCDD from the survey units that had undergone FSS, the CCDD would have had to have undergone another release survey to verify that there was no plant-related radioactivity above background so that it could be disposed of in a clean landfill. Given that the CCDD was in a rubblized state, performance of a release survey would have been extremely unsafe. Given this, Zion*Solutions* made the decision to dispose of the concrete as radioactive waste.

Following the removal of all CCDD from these six survey units, a walkdown and inspection was performed. It was determined that the hard-frozen soil surface prevented mixing of CCDD with the soil that was previously subjected to FSS, and the physical configurations of the survey units were unchanged from the FSS. This initial special surveillance, as well as the subsequent routine surveillances performed per procedure, are included in this response as supplemental information. Additionally, a spreadsheet ("Post-CCDD Surveillance Summary") that summarizes the results from surveillances in these six survey units is provided on the enclosure to this response. The results from the special surveillance and subsequent routine surveillances demonstrate that the as-left radiological conditions in these six survey units have not changed from the results seen in the initial FSS. Therefore, per Section 5.12 of the LTP, the FSS for these survey units was not required to be re-performed. As a note, although less scanning was performed during the surveillance surveys than was performed during FSS, scanning was biased to the locations of the survey unit that were impacted by CCDD. For instance, in survey unit 12203B, although 30% of the total surface area of the survey unit was scanned, the scanned area covered 100% of the area impacted by CCDD. This response serves as addendums to the release records for survey units 12112, 12113, 12203A, 12203B, 12203C, and 12203D. Additional details on the surveillances performed and the FSS timeline regarding CCDD are provided in the response to NRC RAI Question #9a.

Revised or Supplemental Documentation: “2018 Unit 1 and Unit 2 Containment Exterior URS,” “Special Surveillances,” “2020 Surveillance Surveys,” “Post-CCDD Surveillance Summary” spreadsheet

NRC RAI Question #1b Provide revised release records for any survey unit in which an investigation and/or resurvey was performed after FSS was completed (see e.g., RAI 10).

RESPONSE: Revisions to the release records are not necessary, because, for the survey units in question, the radiological conditions presented in the release records were validated by several post-FSS surveillances performed in accordance with procedure ZS-LT-300-001-003. All release records provided to the NRC to demonstrate compliance with the unrestricted release criteria reflect the final radiological conditions of the site.

In addition to the re-performance of FSS in survey units 12205A, 12205B, 12205C, 12205D, and 12205E, FSS was initially performed in several other survey units and then re-performed again later due to the performance of decommissioning activities inside of the survey unit that invalidated the initial FSS. These survey units are as follows:

- Class 3 Survey Unit 10212A - FSS was initially performed in Class 3 survey unit 10212 in May of 2016 as part of the Phase 1 scope. However, following the submittal of the release record documenting the initial FSS, it was discovered that additional subgrade piping systems in the survey unit required removal, and the original FSS was nullified. Following the removal of the pipe, FSS was attempted a second time in December of 2018. During the execution of that survey, residual radioactivity was identified in the survey unit at concentrations in excess of the OpDCGL. As this was a Class 3 open land survey unit, survey unit 10212A was divided into two Class 1 survey units (10212C and 10212D) which encompassed the elevated area and all of the drainage ditch, and one Class 2 survey unit (10212A), which provided a buffer between the newly created Class 1 survey units and the adjacent Class 3 survey units. The end-state FSS of survey unit 10212A was performed between July 2019 and November 2019. The duration of the survey execution was extended due to constant flooding of the survey unit and the time necessary to make the survey unit accessible again. The scan data, on-site gamma spectroscopy reports, and Eberline reports provided in the release record for survey unit 10212A are all correctly dated as being acquired between July 2019 and November 2019. The release record for survey unit 10212A, with approval dated February 2020, reflects the final end-state conditions of the survey unit.
- Class 1 Survey Unit 10212C - FSS was initially performed of Class 3 survey unit 10212 in May of 2016 as part of the Phase 1 scope. Due to the discovery of residual radioactivity at concentrations in excess of the OpDCGL, Class 3 open land 10212A was divided into two Class 1 survey units (10212C and 10212D) and one Class 2 survey unit (10212A). The end-state FSS of survey unit 10212C was performed in September 2019.

The scan data, on-site gamma spectroscopy reports, and Eberline reports provided in the release record for survey unit 10212C are all correctly dated as September 2019. The release record for survey unit 10212A, with approval dated March 2020, reflects the final end-state conditions of the survey unit.

- Class 1 Survey Unit 10212D - FSS was initially performed of Class 3 survey unit 10212 in May of 2016 as part of the Phase 1 scope. Due to the discovery of residual radioactivity at concentrations in excess of the OpDCGL, Class 3 open land 10212A was divided into two Class 1 survey units (10212C and 10212D) and one Class 2 survey unit (10212A). The end-state FSS of survey unit 10212D was performed in August and September 2019. The scan data, on-site gamma spectroscopy reports, and Eberline reports provided in the release record for survey unit 10212D are all correctly dated. The release record for survey unit 10212D, with approval dated March 2020, reflects the final end-state conditions of the survey unit.
- Class 3 Survey Unit 10213A - FSS was initially performed of Class 3 survey unit 10213A in April of 2016 as part of the Phase 1 scope. However, following the submittal of the release record documenting the initial FSS, it was discovered that additional subgrade piping systems in the survey unit required removal, and the original FSS was nullified. Following the removal of the pipe, FSS was attempted a second time in December of 2018. During the execution of that survey, residual radioactivity was identified in the survey unit at concentrations in excess of the OpDCGL. As this was a Class 3 open land survey unit, survey unit 10213A was divided into two Class 1 survey units (10213B and 10213C), which encompassed the elevated area, and one Class 2 survey unit (10213A), which provided a buffer between the newly created Class 1 survey units and the adjacent Class 3 survey unit. The end-state FSS of survey unit 10213A was performed in July 2019. The scan data, on-site gamma spectroscopy reports, and Eberline reports provided in the release record for survey unit 10213A are all correctly dated as July 2019. The release record for survey unit 10213A, with approval dated February 2020, reflects the final end-state conditions of the survey unit.
- Class 1 Survey Unit 10213B - FSS was initially performed of Class 3 survey unit 10213A in April of 2016 as part of the Phase 1 scope. Due to the discovery residual radioactivity at concentrations in excess of the OpDCGL, Class 3 open land survey unit 10213A was divided into two Class 1 survey units (10213B and 10213C) and one Class 2 survey unit (10213A). The end-state FSS of survey unit 10213B was performed in October and November 2019. The scan data, on-site gamma spectroscopy reports, and Eberline reports provided in the release record for survey unit 10213B are all correctly dated. The release record for survey unit 10213B, with approval dated March 2020, reflects the final end-state conditions of the survey unit.

- Class 1 Survey Unit 10213C - FSS was initially performed of Class 3 survey unit 10213A in April of 2016 as part of the Phase 1 scope. Due to the discovery of residual radioactivity at concentrations in excess of the OpDCGL, Class 3 open land survey unit 10213A was divided into two Class 1 survey units (10213B and 10213C) and one Class 2 survey unit (10213A). The end-state FSS of survey unit 10213C was performed in November 2019 through January 2020. The scan data, on-site gamma spectroscopy reports, and Eberline reports provided in the release record for survey unit 10213C are all correctly dated. The release record for survey unit 10213C, with approval dated March 2020, reflects the final end-state conditions of the survey unit.
- Class 1 Survey Unit 12201D - In February of 2019, FSS was initially performed in survey unit 12201D. Following that survey, it was decided to perform additional remediation in the survey unit, thus invalidating the FSS. A second FSS was performed in March of 2019. This second FSS was again rendered invalid as it was discovered that additional backfill was placed in the area, which changed the end state conditions of the survey unit. The end-state FSS of survey unit 12201D was performed in September 2019. The scan data, on-site gamma spectroscopy reports, and Eberline reports provided in the release record for survey unit 12201D are all correctly dated. The release record for survey unit 12201D, with approval dated February 2020, reflects the final end-state conditions of the survey unit.

NRC RAI Question #1c Provide revised release records for any survey unit which concrete demolition debris was placed on or transported through after FSS was completed (see e.g., RAI 9).

<u>RESPONSE:</u> Survey units 12205A, 12205B, 12205C, 12205D, and 12205E had CCDD placed in them. Because the physical conditions changed during removal of the CCDD (deep depressions in the original grade of soil), the FSS was re-performed. The release records for these five survey units reflect the final radiological conditions of the site. Survey units 12112, 12113, 12203A, 12203B, 12203C, and 12203D had CCDD temporarily placed in them, or transported through them, after FSS was completed. However, upon removal of the material, the subsequent surveillance surveys did not identify a change to the physical configuration of the survey units, and the results of radiological scan measurements and soil samples did not require further investigation. Therefore, per Section 5.12 of the LTP, the FSS for these survey units was not required to be re-performed. Revisions to the release records for these six survey units were not required, because the survey units reflect the final radiological conditions of the site. Please refer to the response to NRC RAI Question #9a for further discussion.

NRC RAI Question #1d Provide a list of the revision numbers for the release records that are to be relied on for demonstrating compliance with 10 CFR 20.1402. If any of the revisions used for demonstrating compliance have not already been provided to the NRC, provide those release records.

RESPONSE: The release records currently submitted to the NRC to demonstrate compliance for each survey unit are the most current versions and represent the end-state condition at Zion. In response to these RAIs, Zion*Solutions* has revised several release records or has supplemented the release records with additional information and documents. A list of release records and final reports submitted to the NRC with the most current revision numbers is included on the enclosure to this response. The list also denotes the supplemental documents that are provided for each release record, the reason the supplemental document was provided, and a summary of conclusions, if any.

Revised or Supplemental Documentation: “Release Records Revision and Supplement List”

NRC RAI Question #2a Provide more discussion on the inability to survey the complete pipe in the Unit 1 Containment In-Core Sump Drain, including details such as the location of each sample on a diagram, the location of the 90 degree bend on a diagram and some text about why the licensee believes their analysis is reasonable and the remaining pipe is not contaminated beyond the levels surveyed. The licensee may consider process information, operating history, and preliminary monitoring at available access points in their response.

RESPONSE: The Unit 1 Containment In-Core Sump Discharge Pipe was a 2-inch diameter drain pipe embedded in the concrete of the In-Core Access Tunnel. The pipe entered the wall at the floor of the In-Core Sump and ran for 1 foot, made a 90-degree turn up into the concrete wall, and proceeded vertically 22 feet. The pipe was exposed where it protruded from the concrete at the top of the ladder going under-vessel on the 565-foot elevation. At this time, the pipe was cut flush with the concrete, leaving only the embedded portion, which consisted of a straight pipe traversing 22 feet downward and then entering the 90-degree elbow previously described. Please note that prior to releasing this pipe for FSS, the entire pipe, including the 90-degree elbow, was subjected to cleaning by hydrolazing.

There is no diagram except for the engineering drawing provided as Attachment 1 in the release record, and there were no other official graphics to be found. Survey locations were not depicted on Attachment 1 as measurements were taken in one-foot increments.

The detector was successfully inserted into the pipe from the 565-foot elevation, and 22 measurements were obtained at one-foot intervals. Because the detector could not progress through the elbow, the one-foot pipe measurement representing the elbow could not be acquired due to obstruction.

The first measurement for the survey is the zero-measurement representing the 1st foot of horizontal pipe as it enters the wall in the In-Core Sump with the detector centerline at the 6-inch position. It could not advance any further into the pipe, again encountering the elbow. It was postulated that the initial measurement was elevated due to ambient background from the Containment under-vessel, as compared to when the detector was fully shielded in the 22-foot vertical section. The gamma measurement on each side of the elbow obstruction is 3.13E+08 pCi/m^2 in the horizontal section and 4.80E+06 pCi/m^2 in the vertical section.

The mean OpSOF for the pipe while not including the elevated 1st measurement was 0.104. Adding the elevated measurement into the population increases the OpSOF to 0.363. In assessing the obstructed foot of pipe, the measurement taken adjacent to the obstruction had an OpSOF of 0.198. If significant residual radioactivity existed in the obstructed foot of pipe, one would expect that a gamma measurement taken one foot away would have provided some type of indication, which it does not. Zion*Solutions* believes that this analysis is credible, and the remaining pipe is not contaminated beyond the levels surveyed.

NRC RAI Question #2b For the revised combined release records on Class 1 Penetrations (Survey Units 01112, 02112, and 05120), clarify whether certain areas of the smaller penetrations were inaccessible for measurements. If so, provide the reasons why they were inaccessible, and the percentage of the penetration that was accessible. If less than 100% coverage was achieved, the licensee should provide justification in the FSS Reports as to why their analysis is reasonable and the remaining penetration is not contaminated beyond the levels surveyed. The licensee may consider process information, operating history, and preliminary monitoring at available access points in their response.

RESPONSE: There were no obstructions encountered during the FSS of penetrations documented in the release record for survey units 01112, 02112, and 05120. In all penetrations less than 12 inches in diameter, one measurement was acquired for every foot of penetration, resulting in 100% areal coverage. With the exception of the penetrations associated with the Recirculating Water Sump and Cavity Flood Sump, the interior surfaces of all penetrations with diameters greater than 12 inches were 100% scanned using a hand-held detector, and static measurements were acquired at systematic locations denoted by VSP (refer to Response to NRC RAI Question #2c for additional detail). Again, the result is 100% areal coverage. For the penetrations associated with the Recirculating Water Sump and Cavity Flood Sump, the penetrations are greater than 12 inches in diameter; however, the pipes were ~52 feet long. The five 24-inch diameter penetrations for the Cavity Flood Sump and the Recirculating Sump suctions (P035-P037, P123, and P124 for Unit 1 Containment and P235-P237, P323, and P324 for Unit 2 Containment) were surveyed using the NaI pipe detector approach as the length of the pipes prevented access solely by hand-held detectors. Instrument efficiencies were recalculated for a 23-inch diameter pipe, permitting one-foot interval static measurements along the approximate 50-foot length of each pipe. One measurement was acquired for every foot of penetration, again resulting in 100% areal coverage. Since the Class 1 penetrations had 100% areal coverage, there is no need to revise the FSS release records.

NRC RAI Question #2c For the penetrations that had measurements taken at systematic locations, clarify how the required number of samples was calculated (i.e., relatives shift, std dev, etc.). Also, if debris samples from within the pipe system were available for analysis, please provide the results of those samples.

RESPONSE: This process is described in the Survey Design section of the release record. The total length of the penetrations greater than 12 inches in diameter that were subjected to FSS using the hand-held approach was 351.90 feet with a total interior surface area of 190.64 m^2 where the interior area of the pipes was combined as a single surface. The number of measurements (14) was determined in accordance with section 5.5 of the LTP using a relative shift of 3 with the Type I and Type II errors set at 0.05. However, when using Visual Sample Plan (VSP) to set the static measurement locations, the number was increased to 16 to account for void spaces or gaps. The interior surfaces of the combined penetrations were graphically flattened, and VSP was used to set the triangular systematic pattern and random start point. A minimum of one 1-minute static measurement was acquired in each penetration at systematic locations based on a triangular grid, and at least one 1-minute static measurement was acquired in each penetration at the location of the highest scan result. In addition, the penetrations subjected to this FSS approach were completely scanned over 100% of the interior surfaces.

Finally, there were no sediment samples obtained from the penetrations as they were cleaned during remediation.

NRC RAI Question #3a Provide additional information, e.g., as a picture or map, on the area that could not safely be scanned for the survey units described above (see, for example the thorough description of the areas not scanned in Section 13 of the release record for 10212D, Revision 1).

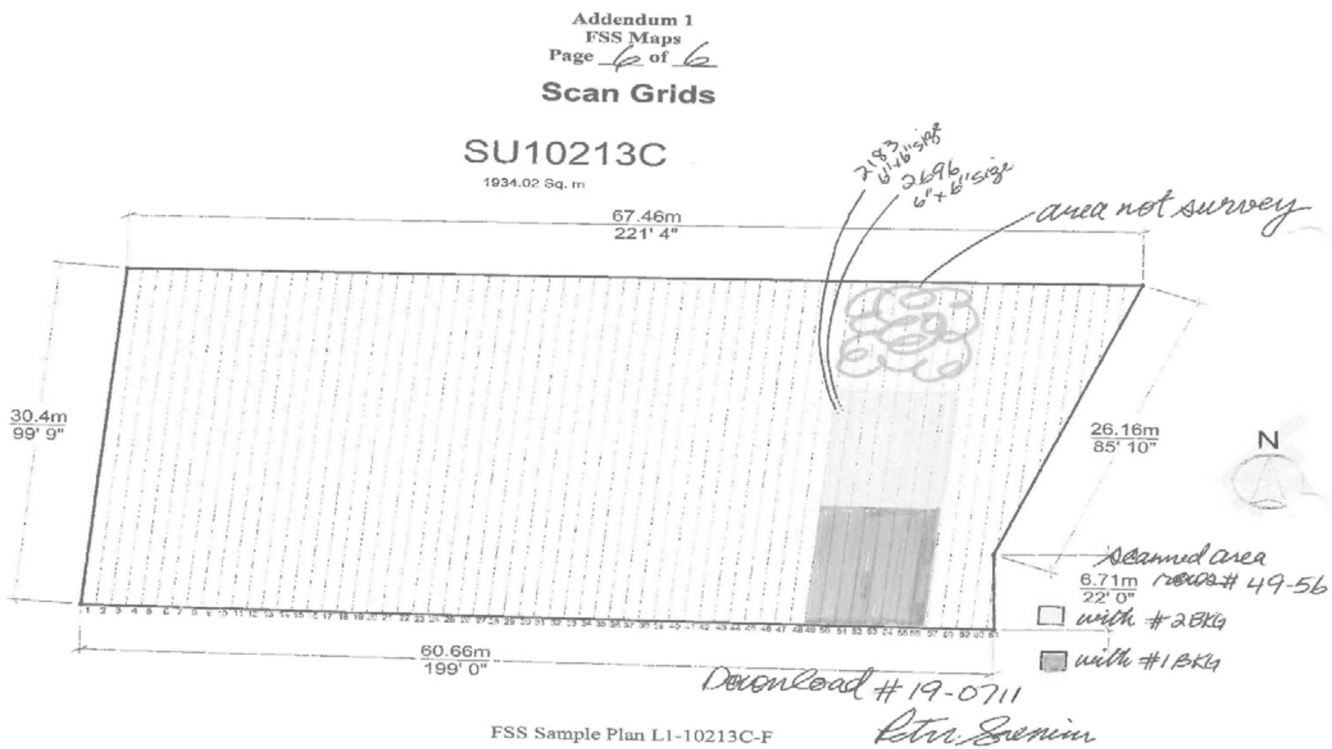
RESPONSE: LTP Chapter 5, section 5.6.4.4 provides the scan requirements for FSS. For Class 1 survey units, 100 percent of the *accessible* soil surface is required to be scanned.

Sections 6 and 13 of the release records provide information on the inaccessible areas identified during FSS, as necessary.

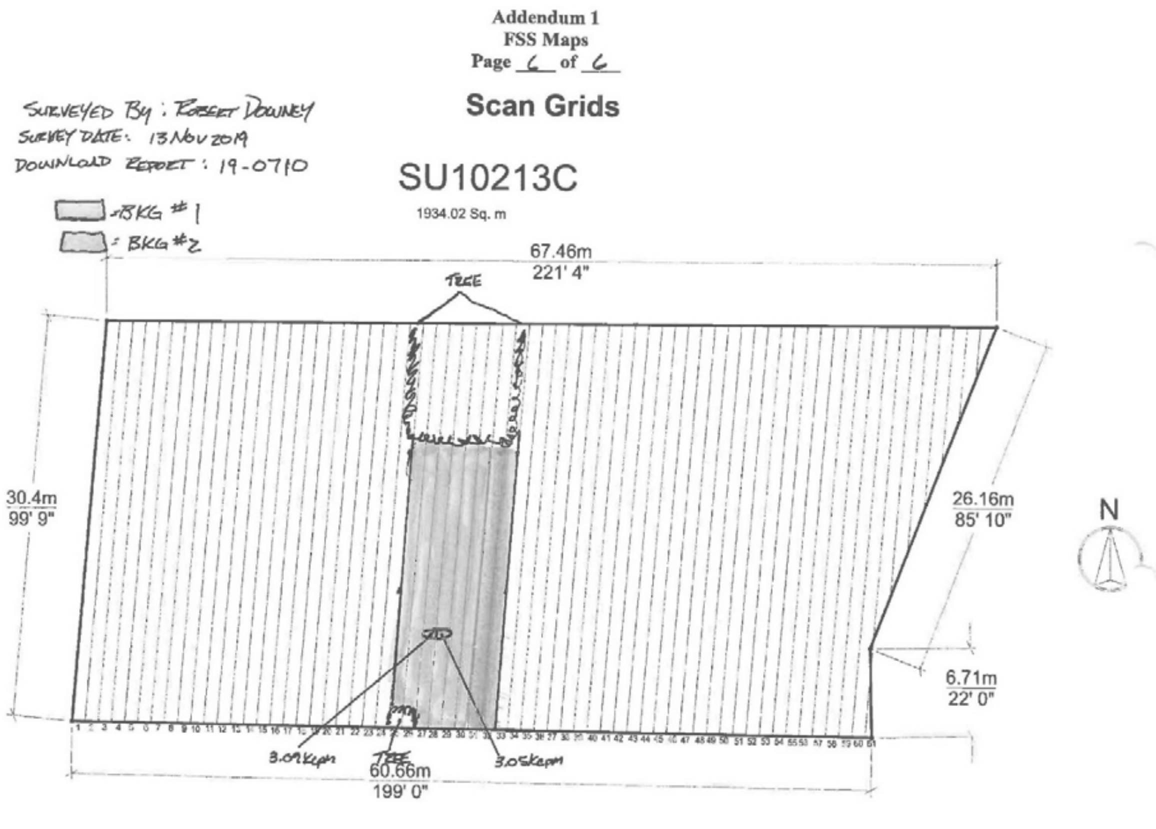
Graphics, and in some cases photographs, are provided in the release records to describe the areas in question. When the area was not specifically designated on the drawing, the location was described pertaining to the location of “scan rows”, and the scan rows are presented on the drawing in Attachment 1. For further clarification, the depictions of the obstructed areas from the individual FSS package Field Logs are provided.

Survey Unit 10213B

Survey Unit 10213C



Survey Unit 10213C

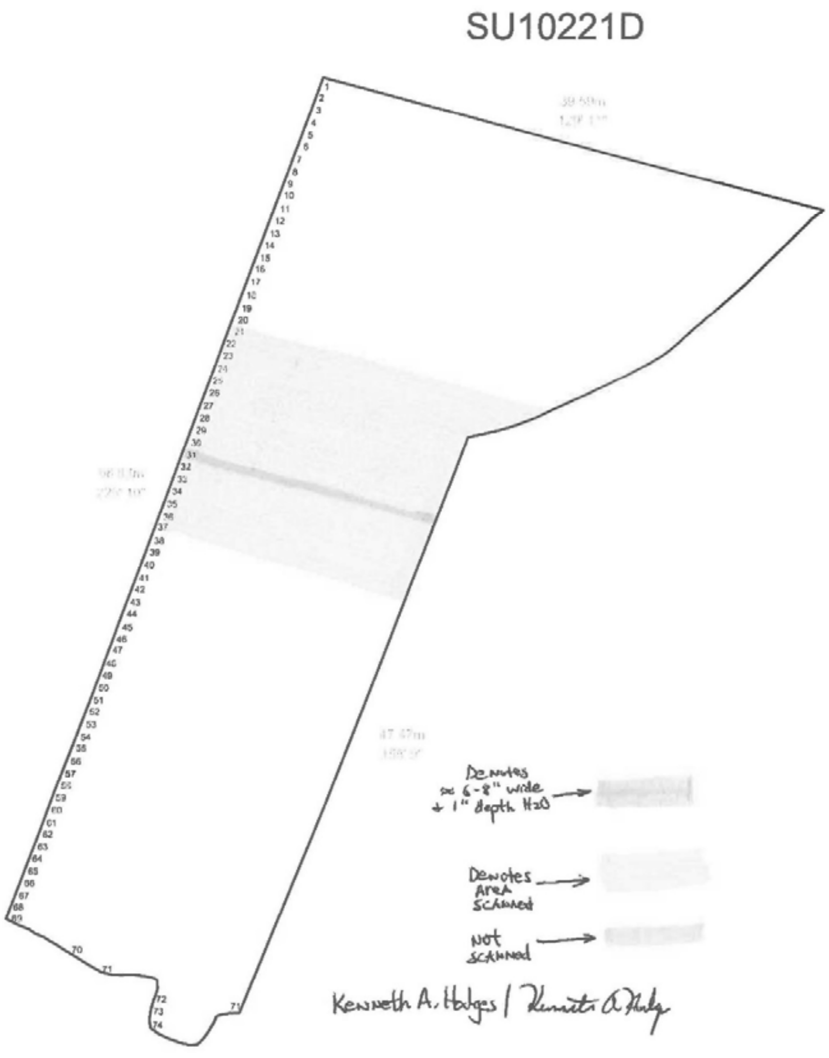


FSS Sample Plan L1-10213C-F

Survey Unit 10221D

Addendum 1
FSS Maps
Page ____ of ____

Scan Grids



FSS Sample Plan L1-10221D-F

Survey Unit 10211A

Attachment 14
FSS Field Log
Page ___ of ___

ZS-LT-300-001-001
Revision 6
Information Use

Survey Area **No.:** 10200 **Description:** Radiological Restricted Area Grounds
Survey Unit **No.:** 10211A **Description:** Southeast Corner of Restricted Area, Lakeshore

Field Log: **Date: 11/17/2018 and 11/19/2018**

Time:	Observation or Comment:	Technician
11/17/18 06:15	Attended morning meeting.	AB/JRM/JAT
06:35	Briefed to the SU10211A package.	AB/JRM/JAT
07:30	Successful pre-checks completed on Model 2350-1 #304712 with 44-10 probe #PR372143. Calibration for both due 07/12/19.	JAT
07:39	Successful pre-checks completed on Model 2350-1 #304708 with 44-10 probe #PR321892. Calibration for both due 05/05/19.	JRM
07:50	Successful pre-checks completed on Model 2350-1 #304713 with 44-10 probe #PR311786. Calibration for both due 04/10/19.	AB
08:50	Performed 2-minute drill at job site, posted area for FSS.	AB/JRM/JAT
08:58	Field backgrounds collected with 3" collimator attached for 2350-1 #304708: 2297, 2410, 2341, 2196, and 2413 cpm, averaging 2331 cpm. Calculated MDCR: 730cpm. **Alarm Setpoint: 3061 cpm.**	JRM
09:03	Field backgrounds collected with 3" collimator attached for 2350-1 #304712: 2374, 2249, 2411, 2396, and 2328 cpm, averaging 2352 cpm. Calculated MDCR: 733 cpm. **Alarm Setpoint: 3085 cpm.**	JAT
09:16	Field backgrounds collected with 3" collimator attached for 2350-1 #304713: 2494, 2122, 2402, 2529, and 2327 cpm, averaging 2375 cpm. Calculated MDCR: 737 cpm. **Alarm Setpoint: 3111 cpm.**	AB
09:04 to 14:13	Gamma scanning performed in rows 1-5 with 2350-1 #304713, rows 17-22 with 2350-1 #304712, and rows 31-40 with 2350-1 #304708. No alarms detected.	AB/JRM/JAT
NOTE:	Easternmost 2-4 meters of Rows 43-45 not surveyed due to caution rope/sign denoting "razor wire and open hole."	JRM

Survey Unit 10211F

Attachment 14
FSS Field Log
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ZS-LT-300-001-001
Revision 6
Information Use

07:52	Field backgrounds collected with 3" collimator attached for 2350-1 #304711: 2844, 2752, 2972, 2275, and 2872 cpm, averaging 2743 cpm. Calculated MDCR: 792 cpm. **Alarm Setpoint: 3535 cpm.**	WC
07:52	Field backgrounds collected with 3" collimator attached for 2350-1 #304726: 2007, 2139, 1926, 1969, and 2313 cpm, averaging 2071 cpm. Calculated MDCR: 688 cpm. **Alarm Setpoint: 2759 cpm.**	AB
08:05 to 09:54	Gamma scanning performed in rows 11-17 with 2350-1 #304726, rows 18-28 with 2350-1 #304708, and rows 57-72 with 2350-1 #304711. No alarms detected.	AB/WC/JRM
NOTE:	Rows 29-34 not surveyed due to standing water:	AB/WC/JRM

NOTE:	Northernmost 3-4 meters of rows 36-44 not surveyed due to standing water:	AB/WC/JRM

10:20	Successful post-checks completed on all instruments.	AB/WC/JRM

Survey Unit 12111

Addendum 1
FSS Maps
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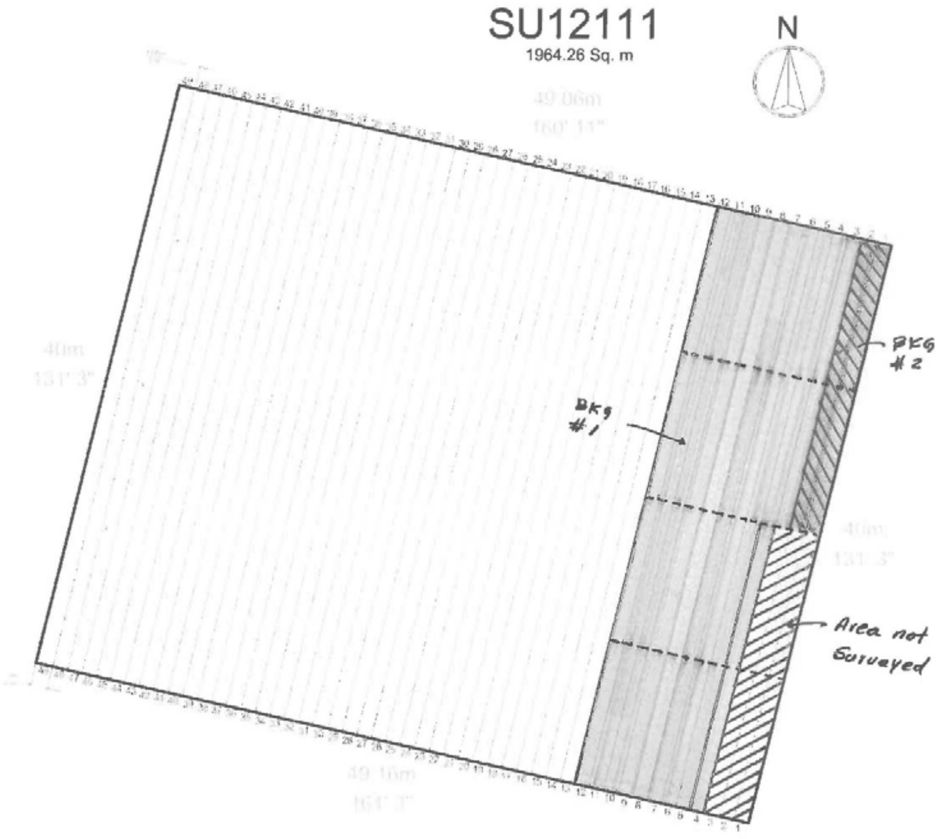
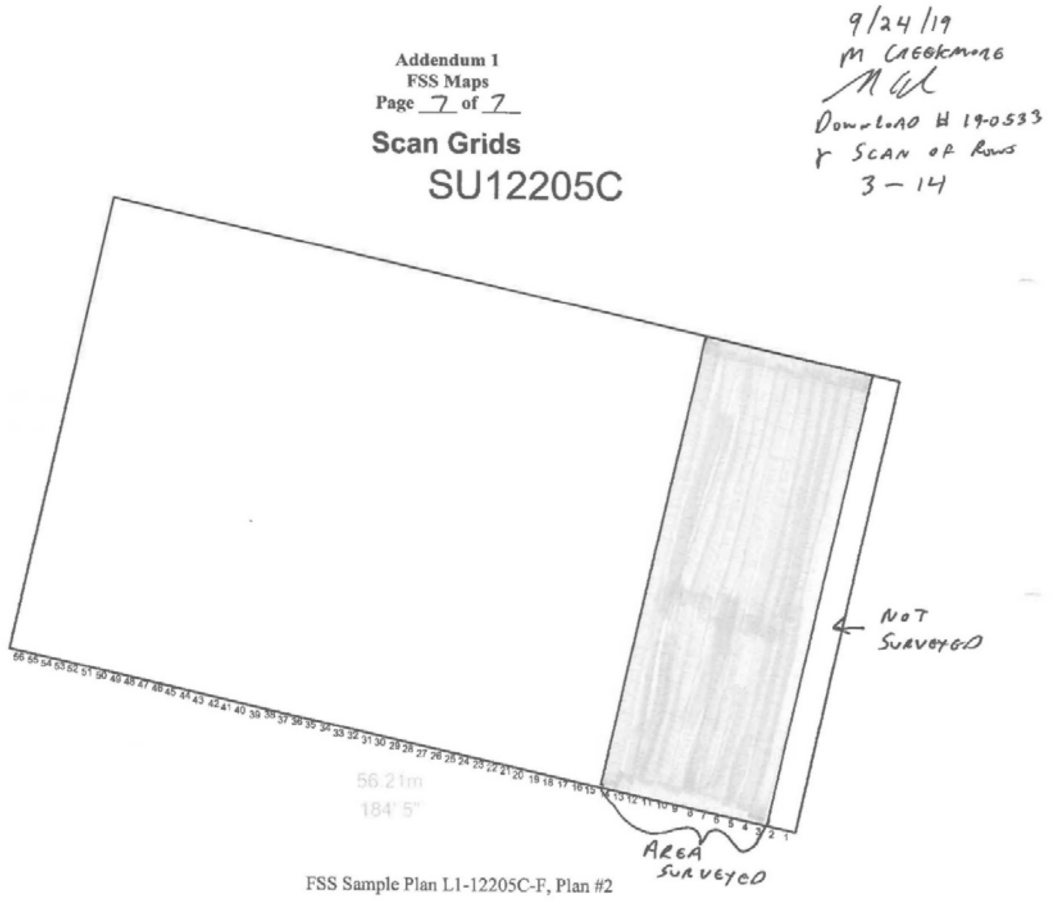
Scan Grids



Surveyor: Jose F. Enriquez
DATE: 9-16-2019
Down load report: 19-0504
Surveyed Area

FSS Sample Plan L1-12111A-F

Survey Unit 12205C



NRC RAI Question #3b For the areas in the survey units described above that were not scanned due to the presence of ice, standing water, or unsafe conditions, provide additional information on why measures could not be taken to allow scans of these areas or why the areas could not be scanned at a later date when the areas were free of ice and standing water.

RESPONSE: During the performance of FSS, continuous attempts were made to mitigate the standing water, snow, or ice that was obstructing the performance of scan surveys. Inclement weather was frequent, and portions of the site routinely flooded during periods of snow melting or heavy rains. As examples, the FSS of survey unit 10212B took one month to complete as FSS was constantly delayed due to flooding. The same can be said for the FSS of survey unit 10212C, which took two months to complete. Efforts were constantly made to respond to winter conditions (e.g., using sump pumps to attempt to dewater survey units and using snow removal equipment). In most cases, the efforts were successful. At other times, decisions had to be made to attempt to finish the FSS with the existing obstructions prior to the next bout of inclement weather, which could potentially increase the obstructed surface area. To compensate for the decreased level of scanning due to obstructions, in each case, additional judgmental samples were collected. The response to NRC RAI Question #3c provides a detailed description of each case.

NRC RAI Question #3c Provide a justification that there is reasonable assurance that the survey units described above meet the 25 mrem/yr unrestricted release criteria despite the fact that some areas within the survey unit were not scanned. This justification should include an evaluation of the results of other samples or scans in and around the areas that were not scanned. Include whether contamination is known to exist or a high potential for contamination exists in these areas.

RESPONSE: As requested, Zion*Solutions* has reviewed the release records of the examples cited. An evaluation of the results of other samples or scans in and around the areas that were not scanned was performed. The results of that evaluation provide reasonable assurance that the survey units in question meet the 25 mrem/yr unrestricted release criteria, and that there is not a high potential that contamination exists in the inaccessible areas. Zion*Solutions* offers the following observations and conclusions:

- Survey Unit 10209B – The surface in question was a 1 m^2 area obstructed by standing water located within scan row 42. The area of the survey unit that was subjected to scans equates to 99.95% areal coverage of the open land surface in this survey unit, which was completely scanned with no alarms. The highest scan reading in Row 41, directly south of the obstructed area, was 4,249 cpm with an alarm setpoint of 4,592 cpm. The highest scan reading in Row 43, directly north of the obstructed, area was 4,330 cpm with an alarm setpoint of 4,592 cpm, and the highest scan reading observed in the remaining surface area in Row 42 was 4,425 with an alarm setpoint of 4,592 cpm. It can be concluded that surface scans of the surface area directly surrounding the obstructed surface did not indicate the potential presence of residual radioactivity at concentrations exceeding background. As such, no investigation was required (e.g., additional biased soil samples). It can also be reasonably concluded that the summation of the mean dose fraction for each ROC from the systematic sample population is representative of the dose exhibited by this survey unit to a 95% confidence level. Please note that the mean BcSOF for survey unit 10209B was 0.012, which equates to a dose of 0.304 mrem/yr TEDE.

- Survey Unit 10211A – The surface in question was a 12 m^2 area located in the northeast corner of the survey unit was not accessible to safely scan. The area of the survey unit that was subjected to scans equates to 99.92% areal coverage of the open land surface in this survey unit, which was completely scanned with no alarms. The described position of the surface in question is an approximate 3-meter by 4-meter area consisting of open hole and razor wire located along the northeast ends of scan rows 41 through 44. With an average observed background of 1,907 cpm, the highest scan reading observed in scan rows 41 through 44 was 2,282 cpm with an alarm setpoint of 2,567 cpm. It can be concluded that scans of the surface area directly surrounding the obstructed surface did not indicate the potential presence of residual radioactivity at concentrations exceeding background. As such, no investigation was required (e.g., additional biased soil samples). It can also be reasonably concluded that the summation of the mean dose fraction for each ROC from the systematic sample population is representative of the dose exhibited by this survey unit to a 95% confidence level. Please note that the mean BcSOF for survey unit 10211A was 0.008, which equates to a dose of 0.189 mrem/yr TEDE.

- Survey Unit 10213B – The surface in question was a 42 m^2 area obstructed by the branches of several large trees along the south boundary in the approximate center of the survey unit. The area of the survey unit that was subjected to scans equates to 99.92% areal coverage of the open land surface in this survey unit. The surface in question is located along the south boundary of scan rows 25 through 37. With an average observed background of 1,601 cpm, the highest scan reading observed in scan rows 25 through 37 was 2,456 cpm with an alarm setpoint of 2,253 cpm. In addition, systematic sample L1-10213B-FSGS-003-SS was acquired at the north point of the obstructed surface. The analysis of sample L1-10213B-FSGS-003-SS did not indicate the positive presence of plant-derived residual radioactivity at concentrations greater than MDC. Based on the scans and soil sample results, it can be concluded that the potential presence of residual radioactivity at concentrations exceeding background in the obstructed area was negligible. As such, no investigation was required (e.g., additional biased soil samples). It can also be reasonably concluded that the summation of the mean dose fraction for each ROC from the systematic sample population is representative of the dose exhibited by this survey unit to a 95% confidence level. Please note that the mean BcSOF for survey unit 10213B was 0.039, which equates to a dose of 0.968 mrem/yr TEDE.

- Survey Unit 10213C – There were two separate areas described as obstructed in survey unit 10213C. The first area is a 123 m^2 surface described as obstructed by “low lying trees.” This area is contiguous with the area described above in survey unit 10213B. The second area is described as an 86 m^2 surface obstructed by standing water/ice located in the northeast corner of the survey unit. This second area is depicted on a graphic in Attachment 1 of the release record and is further described as a low point within the area that was being used as a sump to support the removal of water from the survey unit, which at the time, was regularly flooded due to inclement weather. The depression was later backfilled with clean fill. It should be noted that during the survey unit turnover performed one month earlier, the area was unobstructed, dry, and completely scanned with no alarms. Combining the two obstructed survey areas equals a total of 209 m^2 of obstructed surface that was not scanned in this survey unit. The area of the survey unit that was subjected to scans equates to 89.19% areal coverage of the open land surface in this survey unit. The larger area obstructed by vegetation is located along the north boundary of scan rows 24 through 34. With an average observed background of 2,456 cpm, the highest scan reading observed in scan rows 25 through 37 was 3,091 cpm with an alarm setpoint of 3,206 cpm. In addition, two systematic samples, L1-10213C-FSGS-014-SS and L1-10213C-FSGS-015-SS, were acquired at the east and west boundary of the obstructed area. The analysis of samples L1-10213C-FSGS-014-SS and L1-10213C-FSGS-015-SS indicated positively detected concentrations of Cs-137 at 2.97 E-01 and 2.12 E-01 pCi/g, respectively. No other plant-derived radionuclides were detected at concentrations greater than MDC. Nine (9) judgmental surface soil samples and one judgmental subsurface sample were taken inside the second area that was described as obstructed by standing water. The analysis of these samples indicated positive concentrations of Cs-137 ranging from 2.10 E-01 pCi/g to 6.54 E-01 pCi/g, and Co-60 was detected in one sample at a concentration of 3.92 E-01 pCi/g. However, the maximum OpSOF for these samples was 0.540. Based on a review of the field notes, the Co-60 identified in one of the judgmental samples was not a discrete particle. The origin of the Co-60 is likely the drainage ditch in survey unit 10212D, which was prone to flooding. Based on the scans and soil sample results, it can be concluded that the potential presence of residual radioactivity at concentrations exceeding background in the obstructed areas was negligible. As such, no additional investigations were required. It can be reasonably concluded that the summation of the mean dose fraction for each ROC from the systematic sample population is representative of the dose exhibited by this survey unit to a 95% confidence level. Please note that the mean BcSOF for survey unit 10213C was 0.025, which equates to a dose of 0.616 mrem/yr TEDE.
- Survey Unit 10220H – The areal coverage for scan surveys performed for FSS in this survey unit was 100%. Section 7 of the release record states, “One hundred percent (100%) of the

surface of the survey unit was scanned for elevated radiation levels. Seventy-nine (79) 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 scans." Section 6 states, "Four (4) judgmental surface soil samples were taken in the wetland area, which was inaccessible for gamma walkover scans." Further review of the field logs indicated that this area dried up prior to the completion of FSS in this survey unit, and the previously inaccessible area was eventually scanned. The scan data is provided in the release record. The statement regarding the inaccessible discrete area in Section 6 of the release record should be deleted, because the area was eventually scanned, resulting in a 100% scan coverage for the survey unit. This RAI response serves as an addendum to the release record to reflect this change.

- Survey Unit 10220I – The areal coverage for scan surveys performed for FSS in this survey unit was 100%. Section 7 of the release record states, "One hundred percent (100%) of the surface of the survey unit was scanned for elevated radiation levels. Sixty-two (62) 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. One (1) elevated measurement location was identified by surface scan." Section 13 of the release record states, "A discrete area in the wetland was not accessible for surface soil scanning due to the presence of standing water. This area is documented on the field logs." Further review of the field logs indicated that this area dried up prior to the completion of FSS in this survey unit, and the previously inaccessible area was eventually scanned. The scan data is provided in the release record. The statement regarding the inaccessible discrete area in Section 13 of the release record should be deleted, because the area was eventually scanned, resulting in a 100% scan coverage for the survey unit. This RAI response serves as an addendum to the release record to reflect this change.
- Survey Unit 10221D – The surface in question was a 1.6 m^2 area obstructed by standing water. The area is described as the approximate center of the survey unit between scan rows 22 and 30. The area of the survey unit that was subjected to scans equates to 99.81% areal coverage of the open land surface in this survey unit, which was completely scanned with no alarms. Additionally, systematic soil samples L1-10221D-FSGS-009-SS and L1-10221D-FSGS-010-SS were taken on both sides of the obstructed surface. A concentration of 9.25 E-02 pCi/g for Cs-137 was positively detected in sample L1-10221D-FSGS-010-SS. The concentrations for all other ROC were less than MDC. Based on the scans and soil sample results, it can be concluded that the potential presence of residual radioactivity at concentrations exceeding background in the obstructed areas was negligible. As such, no additional investigations were required. It can be reasonably concluded that the summation of the mean dose fraction for each ROC from the systematic sample population is

representative of the dose exhibited by this survey unit to a 95% confidence level. Please note that the mean BcSOF for survey unit 10221D was 0.011, which equates to a dose of 0.286 mrem/yr TEDE.

- Survey Unit 10221F – The surface in question was a 120 m^2 area obstructed by standing water. The area is described as fully encompassing scan rows 29 through 34. The area of the survey unit that was subjected to scans equates to 93.90% areal coverage of the open land surface in this survey unit, which was completely scanned with no alarms. Additionally, systematic soil samples L1-10221F-FSGS-004-SS and L1-10221F-FSGS-012-SS were taken on both sides of the obstructed surface. Analysis of the samples did not identify concentrations of plant-derived residual radioactivity at concentration greater than MDC. Based on the scans and soil sample results, it can be concluded that the potential presence of residual radioactivity at concentrations exceeding background in the obstructed areas was negligible. As such, no additional investigations were required. It can be reasonably concluded that the summation of the mean dose fraction for each ROC from the systematic sample population is representative of the dose exhibited by this survey unit to a 95% confidence level. Please note that the mean BcSOF for survey unit 10221F was 0.013, which equates to a dose of 0.331 mrem/yr TEDE.
- Survey Unit 12111 – The surface in question was a 60 m^2 area obstructed by standing water. The area is described as encompassing scan rows 1 through 3. The area of the survey unit that was subjected to scans equates to 96.95% areal coverage of the open land surface in this survey unit, which was completely scanned with no alarms. Additionally, systematic soil sample L1-12111A-FSGS-009-SS was taken in scan row 3. Analysis of the sample did not identify concentrations of plant-derived residual radioactivity at concentration greater than MDC. Based on the scans and soil sample results, it can be concluded that the potential presence of residual radioactivity at concentrations exceeding background in the obstructed areas was negligible. As such, no additional investigations were required. It can be reasonably concluded that the summation of the mean dose fraction for each ROC from the systematic sample population is representative of the dose exhibited by this survey unit to a 95% confidence level. Please note that the mean BcSOF for survey unit 12111 was 0.008, which equates to a dose of 0.197 mrem/yr TEDE.
- Survey Unit 12205C – The surface in question was a 65 m^2 area obstructed by standing water. The area is described as fully encompassing scan rows 1 and 2. The area of the survey unit that was subjected to scans equates to 96.44% areal coverage of the open land surface in this survey unit, which was completely scanned with no alarms. Additionally, systematic soil sample L1-12205C-FSGS-109-SS was taken in scan row 2. Analysis of the sample did not identify concentrations of plant-derived residual radioactivity at concentration greater than MDC. Based on the scans and soil sample results, it can be concluded that the

potential presence of residual radioactivity at concentrations exceeding background in the obstructed areas was negligible. As such, no additional investigations were required. It can be reasonably concluded that the summation of the mean dose fraction for each ROC from the systematic sample population is representative of the dose exhibited by this survey unit to a 95% confidence level. Please note that the mean BcSOF for survey unit 12111 was 0.009, which equates to a dose of 0.220 mrem/yr TEDE.

NRC RAI Question #3d For the portion of 10213C that was scanned with ice greater than 2 inches of snow/ice being present, adjust the scan data to account for attenuation through the snow.

RESPONSE: The release record for survey unit 10213C states the following, "On November 13, 2019, the accessible areas of rows 25-40 and the middle section of rows 9-16 were scanned with greater than 2 inches of snow/ice being present. These conditions did not ensure that the detector end-cap was within 2 inches from the ground surface as specified in the FSS Plan. These areas were scanned again on November 16, 2019, when there was only up to 1 inch of snow present. The alarms that occurred in rows 27 and 28 on the earlier scans (see Section 9 for further discussion) could not be reproduced on the subsequent scans, and no elevated areas were identified during these scans." Therefore, as the initial scans were not performed in accordance with procedure, they were not considered as valid FSS data and were omitted from the data set and replaced with the scan data from November 2019. The inclusion of this paragraph into the Anomalies section of the release record was provided as an explanation of why the scans were performed again.

NRC Supplemental RAI Question #3d (January 21, 2020) Licensee should provide supporting technical analysis showing the results are still appropriate given that there was 1 inch of snow. Licensee did not appear to adjust the scan data to account for a 1-inch snow cover between the detector and land, the scan speed for snow, different surface efficiency, etc. The scan MDC will also change with a 1-inch snow cover so the technical basis for the MDC should address that. Provide relevant procedures for conducting scans with 1-inch snow cover.

RESPONSE: The scan MDC was established in TSD 11-004, which follows the guidance in MARSSIM and NUREG-1507. The hotspot model for Zion was a 0.196 m^2 (50 cm diameter) area by 15.24 cm deep soil area. To account for the potential impact of snow on the ground, some additional MicroShield runs were performed using the same hotspot model including snow. Snow is frozen water and Snow Water Equivalent (SWE) is a common snowpack measurement. It is the amount of water contained within the snowpack. It can be thought of as the depth of water that would theoretically result if you melted the entire snowpack instantaneously.

According to the USDA Natural Resource Conservation Service, the density of new snow ranges from about 5% of water when the air temperature is 14° F, to about 20% of water when the temperature is 32° F. After the snow falls its density increases due to gravitational settling, wind packing, melting, and recrystallization. Thus 1 inch of settled snow would be equal to 0.3 inches of water.

A model was created in MicroShield (Version 8.03) using the same parameters as in TSD 11-004 to evaluate the impact of 1 inch of snow at 10% SWE (a density of 0.1 g/cc) to simulate fresh snow and at 30% SWE (a density of 0.3 g/cc) to simulate the effects of settling and wind packing. The dose point was maintained at 2 inches from the ground to the detector end-cap (3 inches to the detector center of the crystal), as the snow replaced a portion of the air gap. Snow was modeled as water with densities as indicated for the SWE above. The source was Co-60 and Cs-137, the primary gamma emitters from TSD 11-004. The attenuated exposure rates were then compared to the unattenuated exposure rates. The table below presents the results of this evaluation.

Reduction in Exposure Rates due to Snow

Gamma Energy (MeV)	1 inch Snow at 0.1 g/cc	1 inch Snow at 0.3 g/cc
0.6616 (Cs-137)	99%	97%
1.1732 (Co-60)	99%	97%
1.3325 (Co-60)	99%	97%

As shown in the above table, the impact of 1-inch fresh snow on the Cs-137 and Co-60 gamma energies is a reduction in gamma flux of 3% for settled and wind packed snow as compared to the unattenuated exposure rates. The rest of the scan MDC calculation is conversion units or parameters that did not change due to the snow being present in the survey area. Therefore, the change in exposure rate due to the snow as an attenuation layer in the MicroShield model is the only effect on the scan MDC. As demonstrated, the attenuation effect of snow is a maximum 3% reduction in the exposure rate, consequently there is a minimal effect on the scan MDC (no more than a 3% increase).

An additional review of the survey unit 10213C release record scan surveys for the snow affected areas was performed. Scan surveys were conducted in a portion of the survey unit with up to 1 inch of snow cover on the ground surface. Since the scan surveys could be performed while maintaining the detector end-cap within 2 inches of the ground surface, there were no changes or modifications to the procedures. No elevated areas or additional areas for investigation were identified.

In summary, the effect of a 1-inch cover of snow on the scan MDC is minimal, would not have changed the number of samples to be collected for analysis, and would not have changed the conclusion that the survey unit is acceptable for unconditional release.

NRC RAI Question #4a For the Power Block survey units, the licensee should revise the release records to include the post-remediation survey data (or point to the data in the RAI response). The licensee should provide additional information demonstrating how the post-remediation scans meet the DQOs of an FSS.

RESPONSE: A formal readiness review was performed by site management to ensure that the Power Block area had been remediated sufficiently and was ready for survey (see enclosed "Power Block RA Readiness Review" and "Power Block RA Report Attachments"). ORISE completed the confirmatory survey in July 2019. During ORISE's survey, particles were discovered in survey units 12202D and 12202F. These particles were captured, and the suspect areas were bounded by samples that Zion*Solutions* collected (four in each survey unit) on July 18, 2019. All four samples collected in survey unit 12202D were below an OpSOF of 0.5, and no remediation was necessary after retrieval of the particle. One (1) sample, collected from survey unit 12202F, had an OpSOF greater than one (1.58). In response to this result, the area was remediated. On July 24, 2019, one sample, at the center of the remediated area where the particle was discovered, and four bounding samples, were collected to confirm that remediation was complete. All the bounding samples had ROC concentrations less than MDC. The one sample at the center of remediated area where the particle was discovered had an OpSOF of 0.19. The results for the pre-remediation samples and the centrally-located post-remediation sample collected in survey unit 12202F ("July 2019 Power Block Remediation Results" spreadsheet) are provided on the enclosure to this response.

The remediation and survey of the subsurface soils in the Power Block were performed in accordance with LTP Section 5.7.1.6 and ZS-LT-200-001-001, "Radiological Assessments and Remedial Action Support Surveys," which ensured that the scan surveys and the collection and subsequent laboratory analysis of soil samples were performed in a manner that met the DQOs of FSS as required by LTP Section 5.7.1.6. The data obtained during the post-remediation surveys is expected to provide a high degree of confidence that the excavation, or portion of the excavation, meets the criterion for the unrestricted release of open land survey units.

ZS-LT-200-001-001, "Radiological Assessments and Remedial Action Support Surveys," was used to ensure that the DQO process was followed in designing surveys sufficient to verify that remediation was complete and that the areas were ready for FSS. This is supported by the fact that ORISE confirmatory surveys verified that the areas in the Power Block were ready for fill. Backfilling was performed after the NRC did not object to backfilling subject to FSS results.

Isolation and control (in accordance with ZS-LT-300-001-003, “Isolation and Control for Final Status Survey”) of the Power Block was initiated on or about February 26, 2019, to assure maintenance of the radiological integrity of turnover surveys in the area. The isolation and control measures consisted of establishing a physical rope barrier around all survey units where isolation and control measures were implemented. Additionally, all personnel, equipment, and vehicles were surveyed prior to entering areas where isolation and control measures were implemented, and a log book was maintained that tracked all ingress and egress. Isolation and control was maintained on the power block until the present day and will remain until license termination. No breakdowns in isolation and control were noted or documented for the power block survey units after initiation of isolation and control measures.

Revised or Supplemental Documentation: “July 2019 Power Block Remediation Results” spreadsheet

NRC RAI Question #5a For Survey Unit 10212D, revise the release record to provide any additional information (including prior samples and/or survey data) on why the area that was inaccessible does not contain concentrations that may have needed additional remediation.

RESPONSE: The drainage ditch located in the center of survey unit 10212D is an “as-found” feature of this survey unit. It serviced the outfall of the storm drain system from the Switchyard. This storm drain system was excavated and replaced in June of 2019 and subsequently surveyed as an impacted buried system (see the release record for survey unit 00150ABC).

The drainage ditch was subjected to FSS during the initial FSS performed on Class 3 open land survey unit 10212A in May of 2016. The drainage ditch was classified by permit as “wetlands” but was reasonably dry during the initial FSS (see picture in the response to NRC RAI Question #5b). It extended from the outfall of the Switchyard located in adjacent Class 3 survey unit 10213A and discharged into a gated outfall pipe which discharged to the beach. At times, the gated outfall pipe became clogged, causing the drainage ditch to overflow its banks.

As part of the survey design for the initial FSS of Class 3 survey unit 10212A, 5 judgmental soil samples were acquired on the banks of the ditch. The analysis of those samples showed that no plant-derived radionuclides were positively identified at concentrations greater than MDC.

The FSS of this survey unit was invalidated in November of 2018 as it was discovered that additional subgrade piping was located within the boundaries that required removal by excavation. Gamma scans performed during the pipe removal showed no activity above the MDC_{scan} of the instrument. When the pipe removal was completed, FSS of Class 3 survey unit 10212A was attempted for a second time at the end of November in 2018. The FSS indicated positively detected plant-derived radionuclides at concentrations exceeding 50% of the applicable OpDCGL and in some cases, exceeding the OpDCGL. As required, the area of the Class 3 survey unit was reclassified into one Class 2 survey unit (10212A) and two Class 1 survey units (10212C and 10212D). It was speculated that the potential source of the soil contamination was an earlier flooding event where the area was subjected to heavy rains combined with a clogging of the discharge outfall. The area encompassing survey units 10212A, 10213A, the south half of the parking lot, and the potentially contaminated soils north of Unit 2 Containment were completely under water. The water was removed by sump pump. It should be noted that, in all events, the pump output water was analyzed for radioactivity by Radiation Protection, and if residual radioactivity was positively detected in any of the water samples taken at the outfall, the water pumping would have stopped and an investigation would have occurred.

From December 2018 through April of 2019, the two Class 1 survey units were remediated, using the survey data from the failed FSS as direction. Remediation consisted of scraping the surface soil at the locations identified as contaminated. Following remediation, a survey was performed to determine if the survey unit was ready for FSS. An RA was performed that consisted of the scanning of all accessible soil surfaces, including the ditch, and the acquisition of biased soil samples at the location of scan alarms. Section 3 of the release record states, "Twenty-three (23) surface soil samples were obtained. Eighteen (18) of the samples indicated positive activity for Cs-137 at concentrations greater than the MDC with the highest observed concentration of 9.410 pCi/g. Six (6) of the samples indicated positive activity for Co-60 at concentrations greater than the MDC with the highest observed concentration of 0.303 pCi/g. Five (5) of the samples resulted in an OpSOF greater than 1.0 (all but one was in the drainage ditch) with a maximum value of 2.680." A list of the 23 sample analysis results from the RA are presented in the following table.

Soil Sample Results from 10212D during April 2019 RA

DATE	SAMPLE DESCRIPTION	Co-60 (pCi/g)	Cs-137 (pCi/g)
4/17/19	L1-10212D-AJGS-001SS	<MDC	3.33E-01
4/17/19	L1-10212D-AJGS-002SS	<MDC	6.42E-01
4/17/19	L1-10212D-AJGS-003SS	<MDC	2.84E+00
4/17/19	L1-10212D-AJGS-004SS	<MDC	3.92E-01
4/17/19	L1-10212D-AJGS-005SS	<MDC	<MDC
4/17/19	L1-10212D-AJGS-006SS	<MDC	9.11E-02
4/17/19	L1-10212D-AJGS-007SS	<MDC	<MDC
4/17/19	L1-10212D-AJGS-008SS	<MDC	<MDC
4/17/19	L1-10212D-AJGS-009SS	<MDC	<MDC
4/17/19	L1-10212D-AJGS-010SS	<MDC	<MDC
4/17/19	L1-10212D-AJGS-011SS	3.03E-01	4.50E+00
4/17/19	L1-10212D-AJGS-012SS	<MDC	1.25E+00
4/17/19	L1-10212D-AJGS-013SS	1.33E-01	4.80E+00
4/17/19	L1-10212D-AJGS-014SS	8.89E-02	3.35E+00
4/17/19	L1-10212D-AJGS-015SS	<MDC	5.85E-01
4/17/19	L1-10212D-AJGS-016SS	1.28E-01	3.74E+00
4/17/19	L1-10212D-AJGS-017SS	8.18E-02	5.23E-01
4/17/19	L1-10212D-AJGS-018SS	<MDC	7.23E-01
4/17/19	L1-10212D-AJGS-019SS	<MDC	1.03E+00
4/17/19	L1-10212D-AJGS-020SS	<MDC	2.42E+00
4/17/19	L1-10212D-AIGS-001SS	<MDC	2.82E+00
4/17/19	L1-10212D-AIGS-002SS	<MDC	2.84E+00
4/17/19	L1-10212D-AIGS-003SS	6.35E-02	9.41E+00

Based on the results illustrated above, further remediation was necessary in survey unit 10212D. Unlike the spot remediation previously attempted, it was decided to remediate using heavy excavators. As the ditch was a permitted "wetland", permission was given by the state to remediate but only as much as was necessary to remove the identified contaminated soil. Permission was also obtained through the state to unclog the outfall pipe. In addition, from April until June of 2019, large excavators were also used in survey unit 10212D and adjacent survey unit 10213C to excavate portions of the Switchyard storm drain.

The second remediation of the soil in survey unit 10212D occurred between April 2019 and August of 2019, again under the coverage of an RA. Approximately one to two feet of soil was removed from the drainage ditch, and approximately six inches of soil was removed from the area north of the drainage ditch. Samples were taken every 10 feet in the center of the drainage ditch (under water) and every 30 feet at the water line on the north and south banks. One (1) of the samples resulted in an OpSOF greater than 1.0 with a value of 1.003 (L1-10212D-EJGS-438-SS). This sample was located at the water line on the south bank of the west half of the survey unit. With the exception of the one sample result presented above, the balance of the soil samples taken in the ditch did not contain residual radioactivity at concentrations in excess of the OpDCGLs with a maximum observed concentration for Cs-137 of 2.30 E+00 pCi/g and 5.30 E-02 pCi/g for Co-60.

Seven (7) additional samples were taken within a 1-meter radius of the sample taken at the water line on the south bank with a OpSOF greater than one. Four (4) of these samples also resulted in an OpSOF greater than one with maximum observed concentrations of 6.180 pCi/g for Cs-137 (L1-10212D-AIGS-010-SS) and 0.093 pCi/g for Co-60 (L1-10212D-EJGS-453-SS).

NaI walkover scans were also performed on all the accessible areas. The scans identified the area discussed above and an additional area in the southeast corner of the survey unit, outside of the drainage ditch, where two (2) of the subsequent soil samples resulted in an OpSOF greater than 1.0 with maximum observed concentrations of 10.500 pCi/g for Cs-137 and 0.116 pCi/g for Co-60 (L1-10212D-AIGS-012-SS). The results from the soil samples taken under the RA that were used to determine remediation effectiveness and areas for additional remediation are presented in the following table.

Soil Sample Results from RA Taken in 10212D Following Second Remediation

DATE	SAMPLE DESCRIPTION	Co-60 (pCi/g)	Cs-137 (pCi/g)
8/15/19	L1-10212D-EJGS-401SS	<MDC	4.83E-02
8/15/19	L1-10212D-EJGS-402SS	<MDC	1.62E-01
8/15/19	L1-10212D-EJGS-403SS	<MDC	5.95E-01
8/15/19	L1-10212D-EJGS-404SS	<MDC	6.36E-01
8/15/19	L1-10212D-EJGS-405SS	<MDC	7.24E-01
8/15/19	L1-10212D-EJGS-406SS	<MDC	6.13E-01
8/15/19	L1-10212D-EJGS-407SS	<MDC	5.85E-01
8/15/19	L1-10212D-EJGS-408SS	<MDC	4.60E-01
8/15/19	L1-10212D-EJGS-409SS	<MDC	7.27E-01
8/15/19	L1-10212D-EJGS-410SS	<MDC	1.33E+00
8/15/19	L1-10212D-EJGS-411SS	<MDC	1.30E-01
8/15/19	L1-10212D-EJGS-412SS	<MDC	5.08E-01
8/15/19	L1-10212D-EJGS-413SS	<MDC	1.87E-01
8/15/19	L1-10212D-EJGS-414SS	4.39E-02	1.48E+00
8/15/19	L1-10212D-EJGS-419SS	<MDC	1.09E+00
8/15/19	L1-10212D-EJGS-420SS	<MDC	1.42E-01
8/15/19	L1-10212D-EJGS-421SS	<MDC	<MDC
8/15/19	L1-10212D-EJGS-422SS	<MDC	<MDC
8/15/19	L1-10212D-EJGS-423SS	<MDC	<MDC
8/15/19	L1-10212D-EJGS-426SS	<MDC	2.22E-01
8/15/19	L1-10212D-EJGS-430SS	<MDC	<MDC
8/15/19	L1-10212D-EJGS-431SS	<MDC	7.91E-02
8/15/19	L1-10212D-EJGS-432SS	<MDC	1.39E-01
8/15/19	L1-10212D-EJGS-433SS	<MDC	<MDC
8/15/19	L1-10212D-EJGS-434SS	<MDC	1.73E-01
8/15/19	L1-10212D-EJGS-435SS	<MDC	4.91E-02
8/15/19	L1-10212D-EJGS-436SS	<MDC	<MDC
8/15/19	L1-10212D-EJGS-438SS	<MDC	3.64E+00
8/15/19	L1-10212D-EJGS-439SS	<MDC	3.76E-01
8/15/19	L1-10212D-EJGS-440SS	<MDC	1.79E-01
8/15/19	L1-10212D-EJGS-441SS	<MDC	1.44E-01
8/15/19	L1-10212D-EJGS-442SS	<MDC	7.49E-02
8/15/19	L1-10212D-EJGS-443SS	<MDC	7.70E-02
8/15/19	L1-10212D-EJGS-444SS	<MDC	<MDC
8/15/19	L1-10212D-EJGS-445SS	<MDC	5.47E-02

Soil Sample Results from RA Taken in 10212D Following Second Remediation (cont.)

DATE	SAMPLE DESCRIPTION	Co-60 (pCi/g)	Cs-137 (pCi/g)
8/15/19	L1-10212D-EJGS-446SS	<MDC	<MDC
8/15/19	L1-10212D-EJGS-447SS	<MDC	<MDC
8/15/19	L1-10212D-EJGS-448SS	<MDC	<MDC
8/15/19	L1-10212D-EJGS-449SS	<MDC	<MDC
8/15/19	L1-10212D-EJGS-450SS	<MDC	8.49E-02
8/16/19	L1-10212D-EJGS-415SS	<MDC	7.99E-01
8/16/19	L1-10212D-EJGS-416SS	<MDC	6.38E-01
8/16/19	L1-10212D-EJGS-417SS	<MDC	3.37E-01
8/16/19	L1-10212D-EJGS-418SS	5.30E-02	1.02E+00
8/16/19	L1-10212D-EJGS-424SS	<MDC	1.04E-01
8/16/19	L1-10212D-EJGS-425SS	<MDC	1.38E-01
8/16/19	L1-10212D-EJGS-427SS	<MDC	2.08E-01
8/16/19	L1-10212D-EJGS-428SS	<MDC	6.47E-02
8/16/19	L1-10212D-EJGS-429SS	<MDC	3.02E-01
8/16/19	L1-10212D-EJGS-437SS	<MDC	5.83E-01
8/19/19	L1-10212D-AIGS-004SS	<MDC	1.67E-01
8/19/19	L1-10212D-AIGS-005SS	<MDC	1.56E+00
8/19/19	L1-10212D-AIGS-006SS	<MDC	1.31E-01
8/19/19	L1-10212D-AIGS-007SS	<MDC	4.48E-02
8/19/19	L1-10212D-AIGS-008SS	<MDC	9.80E-02
8/19/19	L1-10212D-AIGS-009SS	<MDC	2.30E+00
8/19/19	L1-10212D-FSGS-001SS	<MDC	1.58E-01
8/19/19	L1-10212D-FSGS-002SS	<MDC	<MDC
8/19/19	L1-10212D-FSGS-003SS	<MDC	1.51E-01
8/19/19	L1-10212D-FSGS-004SS	<MDC	7.70E-02
8/19/19	L1-10212D-FSGS-005SS	<MDC	<MDC
8/19/19	L1-10212D-FSGS-006SS	<MDC	9.83E-02
8/19/19	L1-10212D-FSGS-007SS	<MDC	3.88E-01
8/19/19	L1-10212D-FSGS-008SS	<MDC	8.81E-01
8/19/19	L1-10212D-FSGS-009SS	<MDC	<MDC
8/19/19	L1-10212D-FSGS-010SS	<MDC	4.21E-01
8/19/19	L1-10212D-FQGS-010SS	<MDC	4.79E-01
8/19/19	L1-10212D-FSGS-011SS	<MDC	7.18E-02
8/19/19	L1-10212D-FSGS-012SS	<MDC	3.11E-01

Soil Sample Results from RA Taken in 10212D Following Second Remediation (cont.)

DATE	SAMPLE DESCRIPTION	Co-60 (pCi/g)	Cs-137 (pCi/g)
8/19/19	L1-10212D-FSGS-013SS	<MDC	9.68E-02
8/19/19	L1-10212D-FSGS-014SS	<MDC	2.79E-01
8/19/19	L1-10212D-FSGS-015SS	<MDC	5.95E-02
8/19/19	L1-10212D-FQGS-015SS	<MDC	1.41E-01
8/19/19	L1-10212D-FSGS-016SS	<MDC	<MDC
8/19/19	L1-10212D-FSGS-017SS	<MDC	1.93E-01
8/19/19	L1-10212D-FSGS-018SS	<MDC	<MDC
8/19/19	L1-10212D-FSGS-019SS	<MDC	<MDC
8/19/19	L1-10212D-FSGS-020SS	<MDC	1.17E+00
8/19/19	L1-10212D-FSGS-021SS	<MDC	5.48E-02
8/19/19	L1-10212D-FSGS-022SS	<MDC	<MDC
8/20/19	L1-10212D-EJGS-451SS	8.31E-02	4.90E+00
8/20/19	L1-10212D-EJGS-452SS	<MDC	1.73E+00
8/20/19	L1-10212D-EJGS-453SS	9.34E-02	5.38E+00
8/20/19	L1-10212D-EJGS-454SS	<MDC	8.32E-01
8/20/19	L1-10212D-EJGS-455SS	<MDC	2.83E-01
8/20/19	L1-10212D-AIGS-010SS	8.76E-02	6.18E+00
8/20/19	L1-10212D-AIGS-011SS	<MDC	4.22E+00
8/20/19	L1-10212D-AIGS-012SS	1.16E-01	1.05E+01
8/21/19	L1-10212D-AIGS-013SS	<MDC	7.46E-02
8/21/19	L1-10212D-AIGS-014SS	<MDC	<MDC
8/21/19	L1-10212D-AIGS-015SS	5.24E-02	6.70E+00

As a result of the post-remediation surveys described above, additional soil was removed. Approximately six inches to one foot of soil was removed from a 40’ x 50’ area in the west half of the drainage ditch, and approximately one foot of soil was removed from a 6’ x 6’ area located in the southeast corner of the survey unit. A post-remediation survey was then performed on the remediated areas.

Twenty-one (21) soil samples were acquired in the two areas remediated above. Nineteen (19) surface soil samples were collected in the larger area in the west half of the survey unit. Samples were taken every 10 feet in the center of the drainage ditch and every 10 feet at the water line on the north and south banks. Two (2) samples were taken in the smaller area in the southeast corner of the survey unit. All the samples resulted in an OpSOF of less than 1.0 with a maximum value of 0.707. The Cs-137 concentration in this sample was 2.39E+00 pCi/g and the concentration for Co-60 was less than MDC. In addition, NaI walkover scans were performed on all accessible areas of the remediated locations with no activity being observed above the MDC_{scan} of the instrument. The analysis results of the 21 soil samples taken to determine if the ditch was adequately remediated are presented in the following table.

Soil Sample Results from RA Taken in 10212D Following Final Remediation

DATE	SAMPLE DESCRIPTION	Co-60 (pCi/g)	Cs-137 (pCi/g)
8/22/19	L1-10212D-AIGS-016SS	<MDC	1.70E-01
8/22/19	L1-10212D-AIGS-017SS	<MDC	2.39E+00
8/22/19	L1-10212D-EJGS-456SS	<MDC	4.68E-01
8/22/19	L1-10212D-EJGS-457SS	<MDC	8.26E-02
8/22/19	L1-10212D-EJGS-458SS	<MDC	1.34E-01
8/22/19	L1-10212D-EJGS-459SS	<MDC	5.32E-01
8/22/19	L1-10212D-EJGS-460SS	<MDC	1.82E-01
8/22/19	L1-10212D-EJGS-461SS	<MDC	<MDC
8/22/19	L1-10212D-EJGS-462SS	<MDC	<MDC
8/22/19	L1-10212D-EJGS-463SS	<MDC	4.66E-02
8/22/19	L1-10212D-EJGS-464SS	<MDC	8.24E-02
8/22/19	L1-10212D-EJGS-465SS	<MDC	4.70E-02
8/22/19	L1-10212D-EJGS-466SS	<MDC	1.11E-01
8/22/19	L1-10212D-EJGS-467SS	<MDC	4.03E-02
8/22/19	L1-10212D-EJGS-468SS	<MDC	<MDC
8/22/19	L1-10212D-EJGS-469SS	<MDC	<MDC
8/22/19	L1-10212D-EJGS-470SS	<MDC	<MDC
8/22/19	L1-10212D-EJGS-471SS	<MDC	<MDC
8/22/19	L1-10212D-EJGS-472SS	<MDC	<MDC
8/22/19	L1-10212D-EJGS-473SS	<MDC	4.76E-02
8/26/19	L1-10212D-EJGS-474SS	<MDC	1.15E-01

NRC RAI Question #5b Describe approximately when the water intrusion occurred and if the water was present during the August 2019 post-remediations survey when samples were collected from the center of the drainage ditch. Clarify if those samples were collected from beneath the water or not.

RESPONSE: As stated in the Response to NRC RAI Question #5a, the drainage ditch located in the center of survey unit 10212D is the normal discharge pathway for storm water drains servicing the Switchyard. The drainage ditch was classified by permit as “wetlands”. It extended from the outfall of the Switchyard outfall located in adjacent Class 3 survey unit 10213A and discharged into a gated outfall pipe which discharged to the beach. At times, the gated outfall pipe became clogged, causing the drainage ditch to overflow its banks.

Prior to the performance of the initial FSS, the drainage ditch was fairly dry (see picture below from May of 2016). Between the time of the initial FSS in 2016 and the second attempt to FSS in November of 2018, the drainage ditch flooded its banks twice, the second time resulting in the flooding of a large portion of the north half of the site. This event was precluded by several days of heavy rains coupled with the fact that the discharge outfall was clogged. In response to the flooding event, the water was removed by sump pump. It should be noted that the pump output water was analyzed for radioactivity by Radiation Protection personnel.

Drainage Ditch in 10212D in May of 2016

Before the second FSS attempt, the water pumping out of the survey unit 10212D discharge ditch had become a routine occurrence. The decision to redo the FSS was made because, at the time, the survey unit was dry enough to make another attempt. Following the second FSS attempt, another flooding event occurred; however, water pumping had rendered most of the survey unit dry when remediation commenced.

Following the soil remediation in August of 2019, the drainage ditch appeared as shown in the picture below. Please note that there is a clear comparison between the two images of the drainage ditch taken in 2016 and 2019. In the second photo, it is clear that the ditch is significantly wider than the image from 2016 and devoid of vegetation. In addition, the discharge outfall has been unclogged. What is seen in the 2019 photo was the end-state grade for this survey unit as the soils removed from the ditch that was disposed of as potentially contaminated soil was not replaced with clean fill.

Drainage Ditch in 10212D in August of 2019

The last set of post-remediation soil samples were acquired from the ditch in the condition illustrated by the photo above. Soil samples were taken underwater every 10 feet in the center of the drainage ditch and every 10 feet at the water line on the north and south banks. As illustrated in the response to NRC RAI Question #5a, the OpSOF observed for each of these sample results was less than one.

NRC RAI Question #5c Provide the date of when the first set of FSS samples were collected and whether any additional remediation occurred after the August 2019 post-remediation surveys. The licensee should provide the first set of sample results (locations and results) and any remediation that occurred due to those sample results.

RESPONSE: On August 19, 2019, a set of FSS samples was collected erroneously before remediation was completed. The table “Soil Sample Results from RA Taken in 10212D Following Second Remediation” in the response to NRC RAI Question #5a contains the data for these samples (denoted with “FSGS” and “FQGS” in the sample description). The compliance samples for FSS were collected on September 5, 2019. These are the samples presented in the release record for survey unit 10212D. No other remediation was required or performed after the September 5, 2019, samples were collected. Please see the response to NRC RAI Question #5a for additional details.

NRC RAI Question #6a Provide additional information on the derivation of the MDC for the Ludlum 44-159 CsI detector that was used to perform the survey in this pipe system, taking into account the radionuclide mixture in the pipe and the detector calibration.

RESPONSE: The FSS of embedded pipe interior surfaces was performed using Zion*Solutions* procedure ZS-LT-300-001-006, "Radiation Surveys of Pipe Interiors using Sodium/Cesium Iodine Detectors." The efficiency factor for each detector and data logger pairing used for FSS pipe surveys was determined in accordance with section 5.1 upon receipt after calibration. Response checks were performed in accordance with section 5.2 for each detector and data logger pairing daily, prior to use (Pre-Test) and upon completion of surveys (Post-Test).

The detector used to perform FSS in the Unit 1 Containment In-core Sump drain (Survey Unit 01111) was the Ludlum 44-159 CsI detector #PR327895. The efficiency factor for detector #PR327895, on the date of the survey, was 0.0044; it was derived in accordance with section 5.1 of procedure ZS-LT-300-001-006. The values cited in Table 4 of the release record were taken from Table 5-28 from LTP Chapter 5. The efficiency of 0.024 cited for the Ludlum 44-159 CsI detector in Table 4 is a "typical", or example, efficiency and not the efficiency applied for the FSS of this pipe.

In accordance with section 5.1 of procedure ZS-LT-300-001-006, the efficiency factor of 0.0044 for the Ludlum 44-159 CsI detector #PR327895, on the survey date of December 8, 2017, was derived by exposing the detector to a 3.02E-08 Ci Cs-137 point source, in a set geometry, for 30 one-minute static counts. The mean net count rate in cpm is then divided by the source emission rate in dpm to derive the efficiency factor. The geometry is usually established in a pipe test jig commensurate with the diameter of the pipe to be surveyed, and the source used is typically a flexible plane source that is inserted into the pipe test jig. However, in this case, the diameter of the pipe to be surveyed was too small to use a flexible source within a pipe jig. In these cases, the procedure states that if a pipe test jig is not available for a pipe diameter, then the efficiency determination can be performed by substituting a certified point source of acceptable activity for the flexible radiological source and using a table-top jig that models the detector to source distance represented by the interior diameter of the pipe to be surveyed instead of a pipe test jig.

Response checks were performed in accordance with section 5.2 for Ludlum 44-159 CsI detector #PR327895 daily, prior to use (Pre-Test) and upon completion of surveys (Post-Test). The performance of the checks is documented on Attachment 2 from procedure ZS-LT-300-001-006, and the actual survey is documented on Attachment 3. Images of the completed Attachment 2 and Attachment 3 forms from the FSS package for survey unit 01111 are provided as part of this Response.

The MDC for the detector is derived in accordance with section 5.3.5 of procedure ZS-LT-300-001-006 by dividing the MDCR by the efficiency factor, resulting in an MDC in units of dpm per foot of pipe. To compare the MDC to the embedded pipe DCGLs, the MDC must be converted to units of pCi/m^2.

A one-minute static measurement was acquired for every linear foot of pipe during the FSS of the Unit 1 Containment In-core Sump drain. Static measurement results of the detector were documented in units of net cpm, converted to units of dpm by dividing by the efficiency factor. The measurement results in dpm were then converted to units of pCi/m^2 through the calculation of effective detection area in m^2, which is then used to divide the activity converted to units of pCi.

ZS-LT-300-001-006, ATTACHMENT 1: DOCUMENTATION FROM FSS PACKAGE 01111

Detector Type:	44-159	Serial No.:	PR327895	Cal Date:	5/2/2017	Cal Due Date:	4/12/2018
Data Logger Type:	2350-1	Data Logger Serial	304713	Cal Date:	4/12/2017	Cal Due Date:	4/12/2018

Pipe Size: 1.5 in Cable Length: 150 ft Background RPTF Instrument Lab

BACKGROUND DETERMINATION

Count Time (t_b) (minutes)	**Position #1**		**Position #2**		**Position #3**	
	counts	**cpm**	**counts**	**cpm**	**counts**	**cpm**
10	2130	213	2090	209	2127	213

Mean Background 212 cpm (B_R) Mean Background +20% 254 cpm Mean Background -20% 169 cpm

EFFICIENCY FACTOR DETERMINATION

Source information Isotope: Cs-137 Serial No: 1599-36-1 Activity 3.02E-08 Ci

#	Count Time (min)	Gross Counts	Gross cpm	Net cpm	#	Count Time (min)	Gross Counts	Gross cpm	Net cpm
1	1	496	496	284	16	1	482	482	270
2	1	550	550	338	17	1	520	520	308
3	1	510	510	298	18	1	540	540	328
4	1	511	511	299	19	1	501	501	289
5	1	502	502	290	20	1	503	503	291
6	1	501	501	289	21	1	503	503	291
7	1	517	517	305	22	1	510	510	298
8	1	517	517	305	23	1	524	524	312
9	1	520	520	308	24	1	554	554	342
10	1	487	487	275	25	1	561	561	349
11	1	532	532	320	26	1	482	482	270
12	1	480	480	268	27	1	487	487	275
13	1	506	506	294	28	1	563	563	351
14	1	465	465	253	29	1	495	495	283
15	1	497	497	285	30	1	475	475	263

Efficiency Factor Determination

Mean Net cpm	Standard Deviation	+2σ value	-2σ value	Source SER (dpm)	Efficiency Factor (Mean Net cpm/dpm)
298	25	349	248	67044	0.0044

Performed by: Anton Simon Date 12/6/2017

Approved by: G. Wood Date 12/6/2017

ZS-LT-300-001-006, ATTACHMENT 2: DOCUMENTATION FROM FSS PACKAGE 01111

PRE-WORK Date: 12/7/2017 Time: 15:30

Detector Type: 44-159 Serial No.: PR327895 Cal Date: 5/2/2017 Cal Due Date: 4/12/2018

Data Logger Type: 2350-1 Data Logger Serial 304713 Cal Date: 4/12/2017 Cal Due Date: 4/12/2018

Pipe Size: 1.5 in Cable Length: 150 ft Background RPTF Instrument Lab

PRE-WORK BACKGROUND CHECK Acceptable Background Range (from Attachment 1) +20% 253.88 cpm -20% 169.25 cpm

Initial Background Count

Count #	Count Time (tb) (min)	counts	cpm (BR)
Initial	10	1827	182.7

1. Is pre-work background within the acceptable range? Yes ☑ No ☐ (If no, initiate three additional background counts)

2. Is mean pre-work background within the acceptable range? Yes ☑ No ☐ (If no, stop and investigate reasons for change in background)

Additional Background Counts (if necessary)

Count #	Count Time (tb) (min)	counts	cpm (BR)
1			
2			
3			
		Mean Background (BR)	

MINIMUM DETECTABLE COUNT RATE (MDCR):

$$MDCR_{static} = \frac{3 + 3.29\sqrt{B_R \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s}$$

B_R = 183 cpm t_s = 1 min t_b = 10 min $MDCR_{static}$ = 49.64 cpm

t_s will initially be set to 1 minute

PRE-WORK SOURCE RESPONSE CHECK

Source information Isotope: Cs-137 Serial No: 1599-36-1 Activity 3.02E-08 Ci

Acceptable Response Range (from Attachment 1) Mean Net cpm: 298 cpm +2σ value: 349 cpm -2σ value: 248 cpm

#	Count Time (min)	Gross counts	Gross cpm	Net cpm	
Initial	1	495	495	312	Sat ☑ Unsat ☐
Additional Source Response Check (if necessary)					
1	1		N/A	N/A	Sat ☐ Unsat ☐
2	1		N/A	N/A	Sat ☐ Unsat ☐
3	1		N/A	N/A	Sat ☐ Unsat ☐
4	1		N/A	N/A	Sat ☐ Unsat ☐

- If the initial source response count falls outside of the established acceptable response range (±2σ), then initiate three additional source counts. If all of the 3 additional source checks fall within the acceptable response range, then the operational response check is satisfactory. If 1 of the 3 additional source counts falls outside of the acceptable response range, then initiate 1 additional source count. If the additional source check falls within the acceptable response range, then the operational response check is satisfactory and the detector may be used. If more than 1 of the 3 additional source checks fall outside of the acceptable response range, or if the single additional source check falls outside of the acceptable response range, then place the detector out of service.

COMMENTS

POST-WORK Date: 12/8/2017 Time: 9:30

POST-WORK BACKGROUND CHECK Acceptable Background Range (from Attacment 1) +20% 253.88 cpm -20% 169.25 cpm

Initial Background Count

Count #	Count Time (tb) (min)	counts	cpm (BR)
Initial	10	1762	176.2

1. Is pre-work background within the acceptable range? Yes ☑ No ☐ (If no, initiate three additional background counts)

2. Is mean pre-work background within the acceptable range? Yes ☑ No ☐ (If no, stop and investigate reasons for change in background)

Additional Background Counts (if necessary)

Count #	Count Time (tb) (min)	counts	cpm (BR)
1			
2			
3			
		Mean Background (BR)	

POST-WORK SOURCE RESPONSE CHECK

Source information Isotope: Cs-137 Serial No: 1599-36-1 Activity 3.02E-08 Ci

Acceptable Response Range (from Attachment 1) Mean Net cpm: 298.1333 cpm +2σ value: 349 cpm -2σ value: 248 cpm

#	Count Time (min)	Gross counts	Gross cpm	Net cpm		
Initial	1	507	507	507	Sat ☑	Unsat ☐

Additional Source Response Check (if necessary)

#	Count Time (min)	Gross counts	Gross cpm	Net cpm		
1	1		N/A	N/A	Sat ☐	Unsat ☐
2	1		N/A	N/A	Sat ☐	Unsat ☐
3	1		N/A	N/A	Sat ☐	Unsat ☐
4	1		N/A	N/A	Sat ☐	Unsat ☐

- If the initial source response count falls outside of the established acceptable response range (±2σ), then initiate three additional source counts. If all of the 3 additional source checks fall within the acceptable response range, then the operational response check is satisfactory. If 1 of the 3 additional source counts falls outside of the acceptable response range, then initiate 1 additional source count. If the additional source check falls within the acceptable response range, then the operational response check is satisfactory and the detector may be used. If more than 1 of the 3 additional source checks fall outside of the acceptable response range, or if the single additional source check falls outside of the acceptable response range, then place the detector out of service.

COMMENTS

Detector/Data Logger Assembly Physical Inspecti	Satisfactory	☑	nsatisfactory	☐	Technicia A. Simon	Date 12/6/2017	Time 1530
Pre-Work Detector Background Determination:	Satisfactory	☑	nsatisfactory	☐	Technicia A. Simon	Date 12/6/2017	Time 1530
Pre-Work Instrument Response Check:	Satisfactory	☑	nsatisfactory	☐	Technicia A. Simon	Date 12/6/2017	Time 1530
Post-Work Detector Background Determination:	Satisfactory	☑	nsatisfactory	☐	Technicia A. Simon	Date 12/8/2017	Time 9:30
Post-Work Instrument Response Check:	Satisfactory	☑	nsatisfactory	☐	Technicia A. Simon	Date 12/8/2017	Time 9:30

Approved by: G Wood Date 12/6/2017

ZS-LT-300-001-006, ATTACHMENT 3: DOCUMENTATION FROM FSS PACKAGE 01111

Date: 12/8/2017 Time: 1:52

Building: U1 CTMT Elevation: 565' Access Point Area: CTMT Bridge

System: In Core Sump Pipe Diameter: 1.5 in. Pipe #: P125

Type of Survey Investigation ☐ Characterization ☐ Buried ☐ FSS ☑

Detector: 44-159 Detector ID #: PR327895

Cal Date: 5/2/2017 Cal Due Date: 4/12/2018

Data Logger: 2350-1 Data Logger ID #: 304713

Cal Date: 4/12/2017 Cal Due Date: 4/12/2018

Cable Length: 150 ft.

$MDCR_{static}$ 49.64 cpm (taken from Attachment 2)

Efficiency Factor for Pipe Diameter 0.0044 (taken from Attachment 1)

MDC_{static} 11281.82 dpm/foot of pipe Sample Count Time (ts) 1 min

Is the MDCstatic acceptable? Yes ☑ No ☐ (if no, adjust sample count time and recalculate MDCF

Comments: The first reading location was on the sump entry location (9.5" Horizontal Long) & the other 2 were taken in the vertical pipe line

Pipe Interior Radiological Survey

Radiological Survey Commenced: Date: 12/7/2017 Time: 19:15

Radiological Survey Increment Frequency: One measurement for every 1 feet of pipe surveyed

Position #	Feet into Pipe from Opening	Sample Count Time (t_s) (min)	Gross Counts	Gross cpm	dpm	Effective Area (m2)	Activity/ Area (pCi/m2)
Zero	0	1	111666	111666	25378636	0.036	3.13E+08
1	1	1	16907	16907	3842500	0.036	4.74E+07
2	2	1	3561	3561	809318	0.036	9.98E+06
3	3	1	1589	1589	361136	0.036	4.45E+06
4	4	1	1557	1557	353864	0.036	4.36E+06
5	5	1	1232	1232	280000	0.036	3.45E+06
6	6	1	1229	1229	279318	0.036	3.45E+06
6QC	6	1	1185	1185	269318	0.036	3.32E+06
7	7	1	1170	1170	265909	0.036	3.28E+06
8	8	1	1056	1056	240000	0.036	2.96E+06
9	9	1	910	910	206818	0.036	2.55E+06
10	10	1	1013	1013	230227	0.036	2.84E+06
11	11	1	849	849	192955	0.036	2.38E+06
12	12	1	750	750	170455	0.036	2.10E+06
12QC	12	1	760	760	172727	0.036	2.13E+06
13	13	1	740	740	168182	0.036	2.07E+06
14	14	1	642	642	145909	0.036	1.80E+06
15	15	1	652	652	148182	0.036	1.83E+06
16	16	1	795	795	180682	0.036	2.23E+06
17	17	1	875	875	198864	0.036	2.45E+06
18	18	1	1021	1021	232045	0.036	2.86E+06
19	19	1	842	842	191364	0.036	2.36E+06
20	20	1	1040	1040	236364	0.036	2.92E+06
20QC	20	1	1486	1486	337727	0.036	4.17E+06
21	21	1	3817	3817	867500	0.036	1.07E+07
22	22	1	1712	1712	389091	0.036	4.80E+06

Pipe Interior Survey Completion

Radiological Survey Completed: Date: 12/7/2017 Time: 20:07

Length of Pipe Surveyed and the Number of Bends: 22 feet in, 90° elbow

Unexpected Conditions Encountered (Specify any obstructions encountered or other results that may impac future work): None

Did the equipment work properly? Yes ☑ No ☐ (if "no", explain below)

Summary of Radiological Conditions (include average radiological results and any hot spot location(s) encountered) Gamma Scan Range: 642 to 16,907 cpm

Survey Completed By:	Jose A Torres		12/8/2017
	(Print Name)	(Signature)	(Date & Time)
	K. Long-Holt		12/8/2017
	(Print Name)	(Signature)	(Date & Time)
	(Print Name)	(Signature)	(Date & Time)
Survey Reviewed By:	Vicki Baldwin		12/19/2017
	(Print Name)	(Signature)	(Date & Time)

The "Activity/Area" value represents a gross gamma measurement in units of pCi/m^2. The radionuclide mixture within the pipe assumes the distribution for Containment from LTP Chapter 5, Table 5-2. To express the concentrations of the other gamma-emitting ROC, the Containment mixture from Table 5-2 was normalized to include only the gamma-emitting ROC. The ratios for inferring HTD ROCs are taken from the maximum ratios from LTP Chapter 5, Table 5-15. This is illustrated in the following table.

Containment Mixtures and Ratios (LTP Chapter 5, Table 5-2 and Table 5-15)

Nuclide	CTMT Bldg Mixture	Normalized Gamma Mixture	HTD Ratios
H-3	0.08%		1.76
Co-60	4.72%	6.43%	
Ni-63	26.50%		442
Sr-90	0.03%		0.021
Cs-134	0.01%	0.01%	
Cs-137	68.17%	92.87%	
Eu-152	0.44%	0.60%	
Eu-154	0.06%	0.08%	

The gross gamma value for each measurement was then multiplied by each applicable mixture percentage to derive specific concentrations for each gamma-emitting ROC. The resultant concentration for Co-60 was then multiplied by the maximum ratio to derive a concentration for Ni-63, and the resultant concentration for Cs-137 was then multiplied by the maximum ratio to derive a concentration for H-3 and Sr-90.

NRC RAI Question #6b Provide additional information on the location of the elevated measurement near the opening of the pipe, and any ALARA measures that may have been taken to evaluate or reduce activity of the elevated area within the pipe system.

RESPONSE: The elevated measurement was located 6 inches from the opening of the pipe and six inches from the 90-degree elbow. No additional ALARA measures were specifically applied to the pipe itself; however, it should be noted that a significant volume of concrete was remediated and removed from the Unit 1 Containment Under-Vessel area following the performance of this survey. In addition, the pipe was completely grouted. The discussion regarding the as-left condition of the pipe is provided in the response to NRC RAI Question #2a.

NRC RAI Question #6c Check the values presented in Attachment 2 and provide the raw measurement data if available. Provide a revised release record for this survey unit with corrected information if errors are confirmed in Attachment 2.

<u>RESPONSE:</u> The value listed in Attachment 2 for the BcSOF for measurement S1-01111AF-SSM-002-GD is incorrect. The BcSOF value of 0.464, presented in the submitted release record, should be 0.070. A review of the data concluded the value in the spreadsheet used to generate Attachment 2 was correct, and that correct values were used in the calculation of statistical values. Please note that it was the only error identified in Attachment 2 as the other data presented was verified correct. Zion*Solutions* has provided a revised release record for survey unit 01111 with a corrected Attachment 2.

Supplemental or Revised Documentation: Revised Release Record for survey unit 01111.

NRC RAI Question #7a Clarify under what circumstances the licensee decided to perform FSS of excavated and remediated soil prior to placing clean backfill versus only performing post-remediation or RASS surveys.

<u>RESPONSE:</u> LTP Chapter 5, section 5.7.1.6 states, "Any soil excavation created to expose or remove a potentially contaminated subgrade basement structure will be subjected to FSS prior to backfill. The FSS will be designed as an open land survey using the classification of the removed structure in accordance with section 5.6.4 of the LTP using the Operational DCGLs for subsurface soils as the release criteria." The only potentially contaminated sub-grade basement that was exposed by excavation at Zion was the bottom of the Spent Fuel Pool which was uncovered for the demolition of the Fuel Handling Building (FHB) and Car Shed. Consequently, in accordance with section 5.7.1.6, an FSS was performed of the excavation prior to backfill.

The sub-grade soil beneath the FHB was divided into three (3) Class 1 survey units (12105K, 12106K, and 12107K). The results of the FSS performed in these three survey units are provided as addendums to the release records for survey units 12105, 12106, and 12107.

NRC RAI Question #7b The licensee should clarify if the subsurface access-interfering structures (e.g., Waste Annex Building) that were removed to expose soil in Survey Units 12109 and 12110 classify as 'potentially contaminated sub-grade basement structures' according to the LTP Section 5.7.1.6. If they do, the licensee should provide a reason for why the FSS was not performed on the excavation prior to backfilling with clean soil.

<u>RESPONSE:</u> The other subsurface access-interfering structures cited in survey units 12109 and 12110, such as the Waste Handling Annex, were on-grade concrete slabs with no sub-grade basements; therefore, they were not subject to the FSS requirement of LTP Section 5.7.1.6. When the slab was removed, the resultant shallow depression was scanned and surveyed under an RA in accordance with LTP Section 5.4.1. Backfilling was performed after the NRC did not object to backfilling subject to FSS results.

NRC RAI Question #7c For the land survey units that had an FSS performed on a sub-grade soil excavation, the dose from the sub-grade excavation should be accounted for when determining the total compliance dose.

RESPONSE: As stated in the response to NRC RAI Question #7a, the only sub-grade soil excavation that underwent FSS (as per LTP Section 5.7.1.6 requirements) was the soil beneath the FHB (survey units 12105K, 12106K, 12107K). Although the results of the FSS were provided as addendums to the release records for survey units 12105, 12106, and 12107, dose was not attributed to these three soil sub-grade survey units. Consequently, a dose assessment was performed in accordance with LTP Section 5.2.14, and the results are summarized in the table below. Note that the investigational samples with OpSOF greater than one (L1-12106K-FIGS-005-SB, L1-12106K-FIGS-008-SB, L1-12106K-FIGS-010-SB) were not included in the dose calculation. The small, elevated areas where these samples originated were remediated and verified by follow-up samples to have activities below the OpDCGL. Although these three samples were remediated, they were inadvertently included in the judgmental/investigational data set within the release record but should not have been.

Survey Unit	Mean BcSOF	Dose (mrem/yr)
12105K	0.020	0.509
12106K	0.041	1.016
12107K	0.040	0.992

This response serves as addendums to the release records for survey units 12105, 12106, and 12107 and the Phase 4 Final Report. Additionally, Table 9 on Attachment, “Supporting Information for the Phased Release of Land from the 10 CFR Part 50 License,” to ZS-2020-0011 has been revised as follows:

- Survey Units 12105K, 12106K, and 12107K were added to Table 5 – Phase 4 Survey Units, as separate land area (soil) survey units.
- Survey Units 12105K, 12106K, and 12107K were added to Table 9 – Mean BcSOF Values for Soil, to include the mean BcSOF and dose contributions from the survey units.
- Because the mean BcSOF for Survey Unit 12106K (0.041) is larger than the previous maximum BcSOF for Survey Unit 12203A, this value was used for the variable “Max $BcSOF_{SOIL}$) in the compliance equation (Equation 3).
- Equation 4 was revised to include the change to the “Max $BcSOF_{SOIL}$” (0.041). This increased the final dose summation for the site from 17.781 mrem/year to 17.8 mrem/year.

Supplemental or Revised Documentation: “Subsurface Soil FSS Dose” spreadsheet

NRC RAI Question #7d The licensee should revise the release records for Survey Units 12109 and 12110 to include the post-remediation survey data for that was performed in accordance with section 5.4.2 of the LTP. The revised release record should show how the RASS scans meet the DQOs of the FSS and how the data collected as part of the RASS is sufficient for NRC to have reasonable assurance that the performance objectives are met. The data should include any analysis for HTDs or insignificant radionuclides in samples that were acquired during the post-remediation surveys.

RESPONSE: As stated in the response to NRC RAI Question #7a, the only sub-grade soil excavation that underwent FSS (as per LTP Section 5.7.1.6 requirements) was the soil beneath the FHB. Because a major sub-grade structure was not removed in survey units 12109 and 12110, the requirements of LTP Section 5.7.1.6 are not applicable.

A RASS as described in LTP Section 5.4.2 was not performed in survey units 12109 and 12110. Rather, an RA was performed in accordance with LTP Section 5.4.1 prior to backfill. During the RA, a gamma scan survey was performed over 100% of the surfaces in the excavations. The scans were performed using the same instrumentation, survey methodologies, and alarm setpoints that would have been used during an FSS, thus meeting the DQOs of FSS.

Ten (10) soil samples were obtained in each survey unit prior to backfill. The following table presents the radionuclide concentrations, MDC, and SOF as compared to the subsurface soil OpDCGLs for the 20 samples collected prior to backfill in survey units 12109 and 12110. This information is recreated from the “12000 A 09 1st REMED 2 NRC” and “12000 A 09 2nd REMED 2 NRC” tables in the “Power Block RA Readiness Review.”

Sample ID	Co-60 (pCi/g)		Cs-134 (pCi/g)	Cs-137(pCi/g)		OpSOF
	Result	MDC	MDC	Result	MDC	
L1-12109A-RIGS-017-SB	<MDC	6.23E-02	5.37E-02	5.69E-02	4.07E-02	0.20
L1-12109A-RIGS-018-SB	<MDC	3.18E-02	4.00E-02	<MDC	4.23E-02	0.12
L1-12109A-RIGS-019-SB	<MDC	5.09E-02	5.43E-02	<MDC	5.62E-02	0.18
L1-12109A-RIGS-020-SB	<MDC	4.53E-02	5.93E-02	<MDC	4.32E-02	0.17
L1-12109A-RIGS-021-SB	<MDC	4.64E-02	3.75E-02	<MDC	4.73E-02	0.15
L1-12109A-RIGS-022-SB	<MDC	4.94E-02	5.98E-02	9.81E-02	6.61E-02	0.20
L1-12109A-RIGS-023-SB	<MDC	5.67E-02	5.77E-02	<MDC	5.77E-02	0.20
L1-12109A-RIGS-024-SB	<MDC	5.00E-02	4.64E-02	<MDC	4.57E-02	0.17
L1-12109A-RIGS-025-SB	<MDC	4.63E-02	4.88E-02	<MDC	5.14E-02	0.16
L1-12109A-RIGS-026-SB	<MDC	3.44E-02	3.91E-02	<MDC	3.88E-02	0.12
L1-12110A-RIGS-034-SB	<MDC	5.85E-02	8.30E-02	<MDC	8.05E-02	0.23
L1-12110A-RIGS-035-SB	<MDC	7.27E-02	7.70E-02	<MDC	7.57E-02	0.26
L1-12110A-RIGS-036-SB	<MDC	6.75E-02	7.83E-02	1.50E-01	9.96E-02	0.28
L1-12110A-RIGS-037-SB	<MDC	7.87E-02	7.87E-02	<MDC	7.13E-02	0.23
L1-12110A-RIGS-038-SB	<MDC	6.54E-02	6.39E-02	<MDC	7.35E-02	0.23
L1-12110A-RIGS-039-SB	<MDC	5.69E-02	6.18E-02	<MDC	5.70E-02	0.20
L1-12110A-RIGS-040-SB	<MDC	5.74E-02	5.12E-02	<MDC	5.16E-02	0.19
L1-12110A-RIGS-041-SB	<MDC	5.88E-02	5.59E-02	<MDC	7.02E-02	0.21
L1-12110A-RIGS-042-SB	<MDC	5.32E-02	5.09E-02	<MDC	6.70E-02	0.19
L1-12110A-RIGS-043-SB	<MDC	7.08E-02	7.16E-02	<MDC	7.31E-02	0.25

The required number of samples for the RA was selected in accordance with ZS-LT-200-001-001, "Radiological Assessments and Remedial Action Support Surveys." Cs-137 was positively identified in 3 of the 20 samples, with a maximum concentration of 1.50E-01 pCi/g. No other ROC were positively identified at concentrations above MDC. The maximum SOF, when compared to the OpDCGLs for subsurface soil, was 0.28. Backfilling was performed after the NRC did not object to backfilling subject to FSS results.

This response serves as addendums to the release records for survey units 12109 and 12210.

NRC RAI Question #7e For any other survey units in Phase 3 or Phase 4 where soil remediation occurred, but the FSS took place after clean back-fill had been placed, the licensee should clarify if there were removed sub-grade basement structures removed to access those areas. The licensee should provide the post-remediation or RASS surveys performed just prior to backfill, describe how those surveys meet the DQOs of the FSS, and provide a dose based on the post-remediation surveys.

<u>RESPONSE:</u> For any survey units in Phase 3 or Phase 4 where soil remediation occurred, radiological surveys were performed in accordance with ZS-LT-200-001-001, "Radiological Assessments and Remedial Action Support Surveys," prior to the placement of clean backfill. Scan surveys were performed using the same instrumentation, survey methodologies, and alarm setpoints that would have been used during an FSS, thus meeting the DQOs of FSS. The required number of samples for the RAs/RASSs were selected in accordance with ZS-LT-200-001-001. As stated in the response to NRC RAI Question #7a, the only sub-grade soil excavation that underwent FSS (as per LTP Section 5.7.1.6 requirements) was the soil beneath the FHB. Because a major sub-grade structure was not removed in any other survey units, the requirements of LTP Section 5.7.1.6 are not applicable, and the assignment of dose to the survey units is not compulsory. Data and survey documentation for RAs performed prior to backfill are provided on the enclosure to this response ("Buried Pipe RA Results" spreadsheet, "July 2019 Power Block Remediation Results" spreadsheet, "Power Block RA Readiness Review," and "Power Block RA Report Attachments).

NRC RAI Question #8a Provide additional information on any land survey unit where buried piping or subgrade piping systems were removed that required subsurface remediation before FSS (e.g., WWTP subsurface piping), including the results of the post-remediation surveys.

<u>RESPONSE:</u> From March 2017 through June 2019, a significant amount of buried pipe was excavated and removed from various soil areas around the Zion site. While low levels of contamination were found in several pipes after they were removed, most of the pipe removed was uncontaminated drain pipe servicing storm drains and rainwater run-off from building exteriors. The contamination event cited for survey unit 12112 was the only instance of cross-contamination of soils caused by the removal of buried pipe. It should be noted that the remediation of the cross-contaminated soil in survey unit 12112 was performed manually and not by excavation.

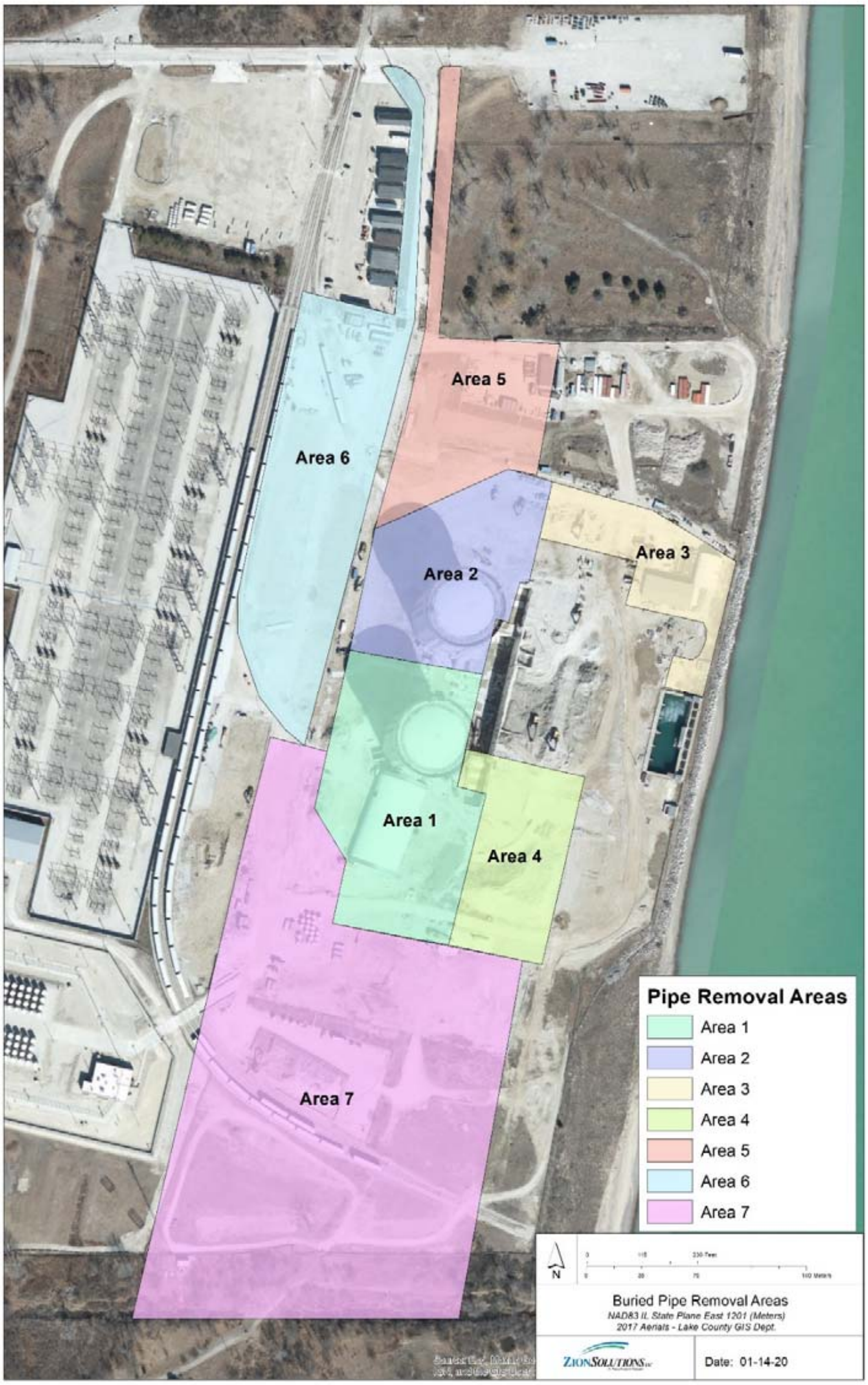
Section 5.7.1.7 of LTP Chapter 5 states, "ZSRP will not stockpile and store excavated soil for reuse as backfill in basements. However, overburden soils will be created to expose buried components (e.g. concrete pads, buried pipe, buried conduit, etc.) that will be removed and disposed of as waste or to install a new buried system. In these cases, the overburden soil will be removed, the component will be removed or installed, and the overburden soil will be replaced back into the excavation. In these cases, a RA will be performed. The footprint of the excavation, and areas adjacent to the excavation where the soil will be staged, will be scanned prior to the excavation. In addition, periodic scans will be performed on the soil as it is excavated, and the exposed surfaces of the excavated soil will be scanned after it is piled next to the excavation for reuse. Scanning will be performed in accordance with section 5.7.1.5.1. A soil sample will be acquired at any scan location that indicates activity in excess of 50% of the soil Operational DCGL. Any soil confirmed as containing residual radioactivity at concentrations exceeding 50% of the soil Operational DCGL will not be used to backfill the excavation and will be disposed of as waste."

All radiological surveys performed to evaluate soils from the excavations of buried pipe, including the grade footprint of the excavation, the grade footprint of the overburden laydown area, the bottom and sidewalls of the excavation, and acceptability of the overburden to be used to eventually backfill the excavation were performed in accordance with LTP Chapter 5, section 5.7.1.7. RAs were designed, evaluated and documented in accordance with Zion*Solutions* procedure ZS-LT-200-001-001, "Radiological Assessments and Remedial Action Support Surveys." For all media sampling performed to evaluate excavation soils, the OpDCGLs for subsurface soils from LTP Chapter 5, Table 5-8 were used as the action level. The action level for scanning was set at the MDCR of the instrument plus background. The instrument and data quality requirements specified in procedure ZS-LT-200-001-001 for the performance of an RA are the same instrument and data quality requirements required for the performance of FSS.

The RA survey design required the scanning of the footprint of the excavation, the footprint of the area where the excavated overburden would be placed, and the periodic scanning of the material in the excavator bucket as it was removed from the excavation. When complete, if the excavation could be accessed safely, then the exposed surfaces within the excavation were also scanned. If not, then the excavator was used to acquire soil samples from the bottom and sides of the excavation at a typical frequency of approximately one sample every 10 feet. The results were documented in the applicable RA.

A graphic depicting the approximate locations of the buried pipe that was removed, broken into seven areas, is provided below. On the enclosure to this response, Zion*Solutions* has provided the spreadsheet documenting the soil sample analysis results for all soil samples acquired to assess the acceptability of excavation overburden prior to backfill into the excavation from which it was obtained.

Supplemental or Revised Documentation: "Buried Pipe RA Results" spreadsheet


Area 5
Area 6
Area 2
Area 3
Area 1
Area 4
Area 7
Pipe Removal Areas
Area 1
Area 2
Area 3
Area 4
Area 5
Area 6
Area 7
N
Buried Pipe Removal Areas
NAD83 IL State Plane East 1201 (Meters)
2017 Aerials - Lake County GIS Dept.
ZionSolutions
Date: 01-14-20

NRC RAI Question #8b For Survey Unit 10220G, provide the source of the radioactive particle and describe why it was located subsurface.

RESPONSE: The particle found was not located in subsurface soil. It was detected in the footprint of an impending excavation on the surface. Please see response to NRC Question #4 for additional details (NRC Questions on Zion FSS Reports – October 1, 2020 Conference Call). The source of particles in soil at Zion is discussed in our response to NRC RAI Question #11b.

NRC Supplemental RAI Question #8 (December 17, 2020) The response states that, "ZSRP was required to solicit permission from the NRC prior to backfilling any excavation. Permission was typically solicited through e-mail correspondence from ZSRP to the NRC with an attached letter detailing the location of the excavation, the purpose, the results of scanning, and soil sample analysis from the RA. Until regulatory permission was received, excavations were not backfilled and remained open." Staff note that the example of the correspondence provided in the response is an internal memo from the Zion Rad Engineer to the Zion Licensing Manager as opposed to an example of NRC correspondence permitting backfill. Regardless, any permission to backfill from NRC during decommissioning is "at-risk" and is not commensurate with release of the survey unit. The licensee still needs to provide a technical basis in the release record that the survey unit meets the release criteria, including excavated or remediated areas that have been backfilled. Staff are requesting the post-remediation surveys where buried piping was removed to be submitted formally to demonstrate that the site meets the release criteria.

RESPONSE: From late 2017 until July 2019, ZSRP was required to solicit permission from the NRC prior to backfilling any excavation. Permission was typically solicited through e-mail correspondence from ZSRP to the NRC with an attached letter detailing the location of the excavation, the purpose, the results of scanning, and the results of soil sample analysis from the RA. Until regulatory permission was received, excavations were not backfilled and remained open. Zion*Solutions* understands that, regardless of any permission from NRC during decommissioning, backfilling is "at risk" and is not commensurate with release of the survey unit. Excavations created to remove buried pipe do not fall under the criteria of LTP Section 5.7.1.6; therefore, FSS was not required prior to backfill. However, as shown in the enclosed spreadsheet, the as-left survey data demonstrate that all ROC concentrations in soil are below a 0.5 OpSOF and would have passed FSS.

NRC Supplemental RAI Question #8 (December 17, 2020) LTP Section 5.7.1.7, "Reuse of Excavated Soils," states that a soil sample will be collected at any scan location with residual radioactivity in excess of 50% of the *soil* OpDCGL, and that any soil confirmed with concentrations exceeding 50% of the *soil* OpDCGL will be disposed as waste. Page 45 of Attachment 2 states that the *subsurface* soil OpDCGLs were used as action levels for scans and sampling. Page 47 of Attachment 2 states the alarm set point was 90% of the *sub*surface OpDCGL for scans. Page 48 of Attachment 2 states that no sample locations exceeded "0.50 of the MDC" were identified. Please clarify these statements in terms of the LTP commitment to not reuse soil that is above 50% of the *soil* OpDCGL from excavations and describe how the scans were used to identify soils above 50% of the *soil* OpDCGL for sampling and possible disposition as low-level waste.

RESPONSE: LTP Section 5.7.1.7, "Reuse of Excavated Soils" specifically states "Scanning will be performed in accordance with section 5.7.1.5.1. A soil sample will be acquired at any scan location that indicates activity in excess of 50% of the soil Operational DCGL. Any soil confirmed as containing residual radioactivity at concentrations exceeding 50% of the soil Operational DCGL will not be used to backfill the excavation and will be disposed of as waste." Zion*Solutions* determined the acceptability of overburden soils in accordance with Section 5.7.1.7 of LTP Chapter 5 using the results of gamma spectroscopy analysis of soil samples. Scanning was performed to determine biased locations for the acquisition of soil samples and not to determine acceptability. Due to the very low Operational DCGLs for subsurface soils, the alarm set point used for scanning was set at the instrument MDCR plus background. Scan measurements observed at activity greater than the instrument MDCR plus background would prompt the acquisition of a soil sample at the location identified. Overburden soil identified as containing residual radioactivity in excess of 50% of the soil Operational DCGL by gamma spectroscopy (as highlighted in the enclosed spreadsheet) was not placed back into the excavation, but rather removed and disposed of as radioactive waste.

NRC RAI Question #9a Provide a list of all survey units in which concrete debris was stored or transported through after the FSS had been completed for the survey unit.

RESPONSE: From January 2019 through June 2019, CCDD was temporarily stored in survey units 12205A, 12205B, 12205C, 12205D, and 12205E with the intention of eventually using this material as fill. Survey units 12112, 12113, 12203A, 12203B, 12203C, and 12203D were also impacted as they were used as staging areas and transfer paths for the movement of the CCDD. All of the survey units cited had recently been subjected to FSS and compliance with the unrestricted release criteria was demonstrated as required by the LTP. Following the removal of the CCDD, a decision was made to re-perform the FSS in survey units 12205A, 12205B, 12205C, 12205D, and 12205E. This decision was not prompted due to any potential radiological cross-contamination but rather, from the creation of a depression that required backfill to restore the grade. In the other survey units impacted by the storage or transfer of the CCDD (survey units 12112, 12113, 12203A, 12203B, 12203C, and 12203D), post-FSS special surveillances were performed in accordance with Zion*Solutions* procedure ZS-LT-300-001-003, "Isolation and Control for Final Status Survey" to assess any potential radiological cross-contamination.

The following documents the timeline and milestone events pertaining to the movement, storage and eventual disposition of Clean Concrete Demolition Debris (CCDD) from the demolition of Unit 1 and Unit 2 Containment structures.

May 2016 – Aug 2016	Unconditional Release Surveys (URS) of the Unit 1 and Unit 2 Containment exterior concrete surfaces were performed in accordance with Zion*Solutions* procedure ZS-LT-400-001-001, "URS of Materials Equipment and Secondary Structures."
April 2018 – May 2018	Performed scan survey of all exterior concrete surfaces that could safely be accessed from grade using a man-lift
July 2018 – Aug 2018	A foot and ½ of "clean fill" from off-site sources was used to cover the ground around both Containments as well as filling the Auxiliary Building and FHB basements. (Due to this act, all concrete demolition debris from the demolition of the Unit 1 and Unit 2 Containments would fall on "clean un-contaminated" soil) Isolation and control measures specified in procedure ZS-LT-300-001-003 were established around each Containment, the Auxiliary Building and FHB to mitigate the risk of any cross-contamination. All machinery used to demolish the Unit 1 and Unit 2 Containments were surveyed and verified as clear of plant-derived contamination.
Sept 2018 – Jan 2019	Both Unit 1 and Unit 2 Containments were demolished as "clean" structures. Metal and rebar were removed and the concrete debris was reduced in size.
Nov 2018	A management decision was made to move excess CCDD from around containments into open land survey units where FSS had been successfully completed.
Jan 2019	FSS was successfully performed in open lands survey units 12112, 12113, 12203C, 12203D, 12205A, 12205B, 12205C, 12205D, and 12205E. Isolation and control measures as specified in procedure ZS-LT-300-001-003 were established around each. Commenced transfer of CCDD from areas around Containment to the base layer for storage stockpile located in survey units 12205A, 12205B, 12205C, 12205D, and 12205E.

Feb 2019

FSS was successfully performed of open lands survey units 12203A and 12203B. Isolation and control measures as specified in procedure ZS-LT-300-001-003 were established around each.

Commenced dumping of CCDD from areas around Containment to the hard surface placed in survey units 12203B, 12203C, 12203D, 12112, and 12113. CCDD was then pushed from the hard surface in survey units 12205A, 12203B, 12203C, 12203D, 12112, and 12113 onto the large storage pile in survey units 12205B, 12205C, 12205D, and 12205E (note; this activity occurred with I&C measures in place – frisking, boundary control, technician monitoring).

March 2019

Completed transfer of CCDD onto the large storage pile in survey units 12205A, 12205B, 12205C, 12205D, and 12205E.

Project management revised the approach from potentially using the concrete debris as clean fill to disposing of the concrete as potentially contaminated waste.

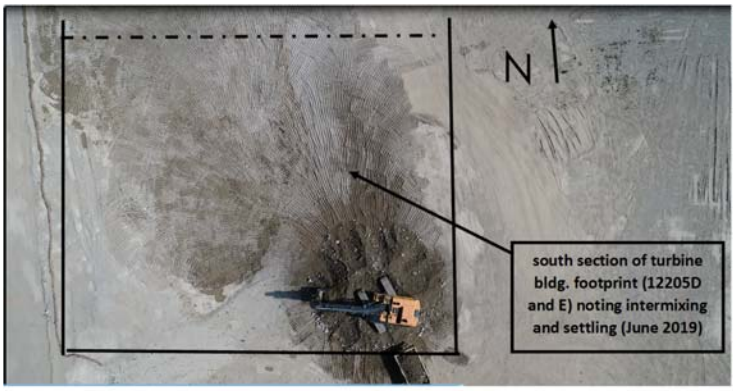
April 2019 CCDD hard surface removed from survey units 12203A, 12203B, 12203C, 12203D, 12112 and 12113 and placed into storage stockpile in survey units 12205A, 12205B, 12205C, 12205D, and 12205E.

Following the removal of all CCDD from survey units 12203A, 12203B, 12203C, 12203D, 12112, and 12113, a walkdown and inspection was performed. It was determined that the hard-frozen soil surface prevented mixing of CCDD with the soil during the transfer process, exposing the soil grade that was previously successfully subjected to FSS. The assessment of any potential radiological cross-contamination was to be made by surveillance as per procedure.

June 2019 To support shipment, the CCDD was transferred from survey units 12205A, 12205B, 12205C, 12205D, and 12205E to survey units 10214B and 10206B. All concrete debris was loaded into rail cars at these two locations and disposed of as potentially radioactive materials.

During the movement of CCDD to survey units 10214B and 10206B, walkdowns and inspections performed in survey units 12205A, 12205B, 12205C, 12205D, and 12205E noted significant intermixing and deep settling of the CCDD in the survey unit footprints.

On June 18, 2019, a surveillance was performed in survey unit 12203A, located directly south and adjacent to the CCDD storage pile. The portion of the surface soil within the survey unit that was impacted by CCDD was scanned and 8 biased soil samples were acquired. Surveillance scans and soil sample analyses yielded radiological conditions consistent with FSS results for survey unit 12203A (all scans were less than investigation levels, and all soil samples were less than surface soil OpDCGLs). Also reference ES-ZION-CR-2019-0066.



July 2019	On July 30, 2019, a surveillance was performed in survey unit 12112. The surface impacted by the CCDD within the survey unit was scanned and 2 biased soil samples were acquired. Surveillance scans and soil sample analyses yielded radiological conditions consistent with FSS results for survey unit 12112 (all scans were less than investigation levels, and all soil samples were less than surface soil OpDCGLs) A walkdown and inspection was performed following the removal of all CCDD from survey units 12205A, 12205B, 12205C, 12205D, and 12205E. Based on observations of the physical condition of these survey units, a decision was made to re-perform the FSS in survey units 12205A, 12205B, 12205C, 12205D, and 12205E. Due to intermixing and deep settling of the CCDD into the surface soil layer, removal of the CCDD had created a shallow excavated depression in the survey unit. Clean fill was imported from off-site and used to restore the grade. Condition report ES-ZION-CR-2019-0101 was initiated to capture the schedule change and any other potential impacts.

Aug 2019	On August 1, 2019, surveillances were performed in survey units 12203B, 12203C and 12203D. Between the 3 surveillances performed, the surface impacted by the CCDD within the survey units were scanned and 5 biased soil samples were acquired. Surveillance scans and soil sample analyses yielded radiological conditions consistent with FSS results for survey units 12203B, 12203C and 12203D (all scans were less than investigation levels, and all soil samples were less than surface soil OpDCGLs)
Sept 2019	On September 6, 2019, a surveillance was performed in survey unit 12113. The surface impacted by the CCDD within the survey unit was scanned and 2 biased soil samples were acquired. Surveillance scans and soil sample analyses yielded radiological conditions consistent with FSS results for survey unit 12113 (all scans were less than investigation levels, and all soil samples were less than surface soil OpDCGLs)
Oct 2019	The repeat FSS of survey units 12205A, 12205B, 12205C, 12205D, and 12205E is successfully completed. The isolation and control measures that were previously implemented in January 2019 remain in effect. All CCDD in survey unit 10206B loaded into railcars and shipped off-site as potentially contaminated waste.
Nov 2019	The FSS of survey unit 10206B is successfully completed. Isolation and control measures as specified in procedure ZS-LT-300-001-003 were established.
Dec 2019	All CCDD in survey unit 10214B loaded into railcars and shipped off-site as waste. At this point, all excess CCDD has been removed from site. The FSS of survey unit 10214B is successfully completed. Isolation and control measures as specified in procedure ZS-LT-300-001-003 were established.
Jan 2020	On January 7, 2020, a surveillance was performed in survey unit 12203D. Biased scan surveys were performed and 4 biased soil samples were acquired. Surveillance scans and soil sample analyses yielded radiological conditions consistent with FSS results for survey unit 12203D (all scans were less than investigation levels, and all soil samples were less than surface soil OpDCGLs). Also reference ES-ZION-CR-2020-0001.

May 2020	On May 26, 2020, surveillances were performed in survey units 12113, 12203A, 12203B, 12203C and 12203D. Biased scan surveys were performed. Surveillance scans indicated radiological conditions consistent with FSS results for survey units 12113, 12203A, 12203B, 12203C, and 12203D. (all scans were less than investigation levels)
August 2020	Between August and September 2020, surveillances were performed in survey units 12113, 12203A, 12203B, 12203C, and 12203D. Biased scan surveys were performed. Surveillance scans indicated radiological conditions consistent with FSS results for survey units 12113, 12203A, 12203B, 12203C and 12203D. (all scans were less than investigation levels)

Following removal of the concrete debris from the survey units, FSS was re-performed on survey units 12205A, 12205B, 12205C, 12205D, and 12205E. The radiological conditions described in the release record for each pertain to the end-state of the survey units after CCDD removal and restoring the soil to grade. The release records for survey units 12112, 12113, 12203A, 12203B, 12203C, and 12203D describes the FSS performed prior to the introduction of CCDD into these survey units; however, the radiological conditions presented in the release records were validated by several post-FSS surveillances that were performed in accordance with procedure ZS-LT-300-001-003. The FSS of survey units 10206B and 10214B were performed after the excess CCDD was removed from site.

Revised or Supplemental Documentation: CR-2019-0066, CR-2019-0101, CR-2020-0001

NRC RAI Question #9b For any survey unit in which concrete was stored on or transported through after completion of the FSS, provide details on: the amount and type of debris stored on the survey unit, remediation performed to remove the debris after completion of the FSS, surveys performed post removal of the debris, and data collected during surveys performed post-removal of the debris.

RESPONSE: The type of debris that was stored on, or transported through, the survey units discussed in the response to NRC RAI Question #9a was CCDD generated from the demolition of Unit 1 and Unit 2 Containment exteriors. The demolition of each Containment building generated approximately 15,000 cubic yards of CCDD, for a total of 30,000 cubic yards. This equates to 57,510,000 pounds of CCDD. After demolition, this material was transported through, or temporarily staged in, survey units 12112, 12113, 12203A, 12203B, 12203C, and 12203D. The majority of the CCDD was temporarily placed in survey unit 12203A, located directly south and adjacent to the CCDD storage pile. The total volume of material was ultimately stored in 12205A, 12205B, 12205C, 12205D, and 12205E.

Details on the remediation performed to remove the debris after completion of the FSS, surveys performed post removal of the debris, and data collected during surveys performed post-removal of the debris are provided in the responses to NRC RAI Questions #1a and #9a.

NRC RAI Question #9c Provide revised release records which reflect the final status of the survey units for any survey unit in which concrete debris was stored on or transported through after completion of the FSS.

RESPONSE: The release records submitted by Zion*Solutions* to demonstrate compliance for the survey units in question represent the end-state conditions of the survey units. For the survey units in question, the radiological conditions presented in the release records were validated by several post-FSS surveillances that were performed in accordance with procedure ZS-LT-300-001-003.

NRC RAI Question #9d Provide information on measures used to prevent the concrete debris from contaminating neighboring survey units that were already final status surveyed. Provide information on surveys performed to confirm that neighboring survey units were not contaminated from the concrete debris after FSS had been completed.

RESPONSE: Prior to demolition, the concrete domes of both Containments were surveyed twice for unconditional release in accordance with Zion*Solutions* procedure ZS-LT-400-001-001, “Unconditional Release Survey (URS) of Materials Equipment and Secondary Structures.” The first survey was performed in September of 2016, and the survey was performed again in April of 2018. The URS results were documented in Technical Support Document 17-010 “Final Report – Unconditional Release Surveys (URS) at the Zion Station Restoration Project.” The surveys were performed *in situ* with hand-held survey instruments using a graded MARSAME approach, and Lower Limits of Detection (LLD) in the 2,500-3,000 dpm/100 cm^2 range were achieved. TSD 17-010 was previously submitted to the NRC, and it was incorporated as a license condition for the approval of Revision 2 of the Zion LTP. Following completion and documentation of these surveys, in accordance with Zion*Solutions* approved processes and procedures for the unrestricted release of materials, the concrete was considered to be “non-radioactive” material.

To ensure the pedigree of the “non-radioactive” designation, three feet of clean sacrificial fill, imported from off-site sources, was placed over the indigenous soils surrounding the Containments. The area around both Containments were then subjected to isolation and control (I&C) measures in accordance with procedure ZS-LT-300-001-003, “Isolation and Control for Final Status Survey.” These measures are designed to prevent the reintroduction of a source term into an area that has been surveyed and determined to be “non-radioactive.” The measures include establishing rope boundaries, controlling personnel and equipment access into the areas through Access Control logs, and the scanning of personnel and equipment prior to entry into the I&C area to ensure radioactive material was not introduced.

During the demolition of the Containment exteriors and the period afterwards, I&C controls ensured that no additional radioactive material was introduced into the area. As the demolition progressed, the I&C controls were merged with the I&C measures already established in survey units 12205A, 12205B, 12205C, 12205D, and 12205E, located adjacent and to the west of the Containment domes. I&C measures were also already in place around survey units 12112, 12113, 12203A, 12203B, 12203C, and 12203D as FSS was recently completed in those survey units.

I&C measures remained in place around survey units 12112, 12113, 12203A, 12203B, 12203C, 12203D, 12205A, 12205B, 12205C, 12205D, and 12205E throughout the entire time that the concrete was excavated and placed in dump trucks for transportation to survey unit 10214B for loading into railcars for disposal. The controls were suspended following the decision to ship the concrete from survey unit 10206B instead of 10214B. At that time, it made no sense to continue attempting to maintain the pedigree of the concrete as non-radioactive. As described in the response to NRC RAI Question #1a, the FSSs performed in survey units 12205A, 12205B, 12205C, 12205D, and 12205E were deemed invalid and the FSSs were performed again once the concrete debris was removed from the survey units. This decision was not prompted due to any potential radiological cross-contamination but rather, from the creation of a depression that required backfill to restore the grade. In the other survey units impacted by the storage or transfer of the CCDD (survey units 12112, 12113, 12203A, 12203B, 12203C and 12203D), post-FSS special surveillances were performed in accordance with Zion*Solutions* procedure ZS-LT-300-001-003, "Isolation and Control for Final Status Survey" to assess any potential radiological cross-contamination. The FSSs of survey units 10206B, 10214B, and all of the survey units that were in the travel path from the storage pile in survey units 12205A, 12205B, 12205C, 12205D, and 12205E to the shipping locations in survey units 10206B and 10214B were performed after the shipment of the concrete debris.

NRC RAI Question #10a For Survey Units 10209C, 10220I, 12112 and 12204A, provide information on investigations and remediation performed after the FSS was completed (including any investigations and remediation based on issues identified by ORISE) and provide the results of scans and sample analyses performed after the FSS.

RESPONSE: Confirmatory surveys were performed by ORISE in these 4 survey units in December 2019 with follow-up surveys occurring in January 2020. Section 6.1 of ORISE Report 5271-SR-08-0 states the following, "Five other areas had elevated gamma radiation levels distinguishable from background: survey areas 10209C, 10220I, 12112, 12113, and 12204A. Two of the locations were localized (less than 1 square meter [m^2]) and had slightly-elevated gamma radiation levels compared to surrounding gamma radiation levels, while the other three locations were discrete (0.1 to 0.5 m^2) and had significantly-elevated gamma radiation levels compared to surrounding gamma radiation levels."

In addition to scans, ORISE Report 5271-SR-08-0 states that 37 soil samples were taken by ORISE for the survey. Of the 37 soil samples taken, soil analysis showed only sample with residual radioactivity at concentrations more than a SOF of one when compared to the OpDCGLs. This sample was taken from survey unit 10209C. The report then states, "This judgmental sample (5271S0075) represented the soil surrounding a piece of concrete debris that was identified as having elevated direct gamma radiation. As requested by NRC staff, the debris (collected as sample 5271S0074) was not submitted for laboratory analysis and was left with site personnel." ORISE also acquired investigation soil samples from elevated scan locations in survey units 10208A (5271S0082) and 12113 (5271S0101). The result of the soil analysis performed by ORISE on the other 2 judgmental samples are presented in B.7 of ORISE Report 5271-SR-08-0. The report indicates that only Cs-137 was positively detected at concentrations greater than MDC in sample 5271S0082 at a concentration of 8.80 E-02 pCi/g. No other ROC was positively detected at concentrations exceeding the instrument MDC. The Zion*Solutions* staff investigated the other 3 areas exhibiting elevated scans. The actions taken in each are described below.

<u>10209C</u>

In survey unit 10209C, Zion*Solutions* collected the piece of concrete debris discovered during the confirmatory survey and initiated Condition Report ES-ZION-CR-2019-0176. The piece of concrete debris weighed 283 grams and was discovered approximately two inches below the ground surface. The collected piece of concrete was transferred to the on-site laboratory where gamma spectroscopy analysis indicated Co-60 at a concentration of 2.69 E+02 pCi/sample and Cs-137 at a concentration of 1.21 E+05 pCi/sample. The soil where the debris was found was scanned by both ORISE and Zion*Solutions* using a Ludlum Model 44-10 NaI detector. The soil comprising ORISE judgmental sample 5217S0075 had already been removed from the location, leaving a shallow hole. Scanning of the soils at and around that location did not indicate residual radioactivity at levels exceeding the MDCR of the detector plus background. Section 7 of ORISE Report 5271-SR-08-0 states that a gamma walkover scan was also performed by ORISE and showed gamma radiation levels to be similar to the surrounding area. As scanning did not indicate the presence of any additional residual radioactivity at levels exceeding background, no additional actions were deemed necessary at the time. Zion*Solutions* realizes that, in addition to scanning, a soil sample should have been collected as further confirmation that the location contained no more elevated material after removal of the concrete debris. In lieu of this sample, an elevated area dose calculation was performed using the ORISE judgmental sample 5217S0075, in accordance with ZS-LT-300-001-004, "Final Status Survey Data Assessment." The calculation of the Elevated Radioactivity Fraction is provided below.

$$f_{ELEV} = \sum \frac{\tau_j - \delta_j}{DCGL_{EMC}}$$

Where f_{ELEV} = Elevated Radioactivity Fraction

τ_j = average concentration for each ROC in elevated area

δ_j = average concentration for each ROC in survey unit

ROC	$DCGL_{BC}$	AF (0.1 m^2)	$DCGL_{EMC}$	τ_j	δ_j	$\tau_j - \delta_j$	f_{ROC}	f_{ELEV}
Co-60	4.26E+00	1.23E+02	5.24E+02	7.00E-03	3.19E-02	-2.49E-02	0.0000	
Cs-134	6.77E+00	1.33E+02	9.00E+02	5.00E-02	1.30E-02	3.70E-02	0.0000	
Cs-137	1.42E+01	1.50E+02	2.13E+03	7.25E+00	6.04E-02	7.19E+00	0.0034	0.0034
Ni-63	3.57E+03	6.92E+04	2.47E+08	6.30E-01	5.75E+00	-5.12E+00	0.0000	
Sr-90	1.21E+01	8.52E+03	1.03E+05	0.00E+00	1.21E-04	-1.21E-04	0.0000	

The Elevated Radioactivity Fraction for the ORISE judgmental sample 5217S0075 is 0.0034. The original BcSOF for survey unit 10209C is 0.0153, which equates to a dose of 0.382 mrem/year. Adding the Elevated Radioactivity Fraction to the BcSOF results in a total SOF of 0.0187, which equates to a dose of 0.466 mrem/year. This response serves as an addendum to the release record for survey unit 10209C and the Phase 4 Final Report. Additionally, the dose attributed to survey unit 10209C has been revised in Table 9 on Attachment, "Supporting Information for the Phased Release of Land from the 10 CFR Part 50 License," to ZS-2020-0011.

The concrete debris was not identified during FSS most likely due to the discrete nature of the contamination and detector geometry differences between ZS and ORISE. This is explained in more detail in the RAI #11 response. Once the concrete debris was removed, as well as surrounding contaminated soils in the ORISE judgmental sample 5217S0075, a biased scan of the area where the concrete debris was identified was performed over an area of approximately 25 m^2. No measurements above the MDCR plus background were identified. The follow-up survey, "2019-1953 Follow Up to Concrete in 10209C," is included on the enclosure to this response.

10220I

The area identified as exhibiting elevated scan measurements in survey unit 10220I was investigated by Zion*Solutions*. The soil identified as "elevated" by ORISE was scanned using a Ludlum Model 44-10 NaI detector. The scan identified gross counts at approximately twice the ambient background while scanning an approximate 1 m^2 area of soil surface. The investigation narrowed the focus to a small piece of asphalt debris, which was removed and recovered along with the surrounding soil. The recovered debris was labeled as 10220I-120519 Asphalt Sample (sample ID 81865) and was analyzed by the on-site gamma spectroscopy system. No plant-derived gamma-emitting radionuclides were positively identified at concentrations greater than MDC. Based on the gamma spectroscopy results, it was concluded that the elevated scans observed in survey unit 10220I were due to the presence of NORM. Following the removal of the debris, the location was scanned again, and no measurement exceeded the MDCR of the detector plus background. No additional actions were deemed necessary. The results of all surveillances performed since the ORISE visit are consistent with the radiological conditions as established during the FSS, and no additional findings were identified. All the surveillance surveys from 2020, "2020 Surveillance Surveys," are included on the enclosure to this response.

<u>12112</u>

Following the discovery by ORISE of elevated scan results in survey unit 12112, Zion*Solutions* performed an investigation of the identified location. The area was scanned, and the presence of the elevated scan measurement was verified. However, the same location was also identified as a location of elevated scan measurements during the FSS of survey unit 12112 in January 2019. During the FSS, elevated scans were identified at the end of scan rows 41 and 42, which corresponds to the same location identified by ORISE. This is illustrated in the following graphic from the FSS package for survey unit 12112. An investigation surface soil sample was taken in each row: L1-12112A-FIGS-001-SS in row 41 and L1-12112A-FIGS-002-SS in row 42. In addition, a subsurface soil sample was also taken at the same locations to a depth of one meter.

Sample Map for FSS of Survey Unit 12112 from January 2019

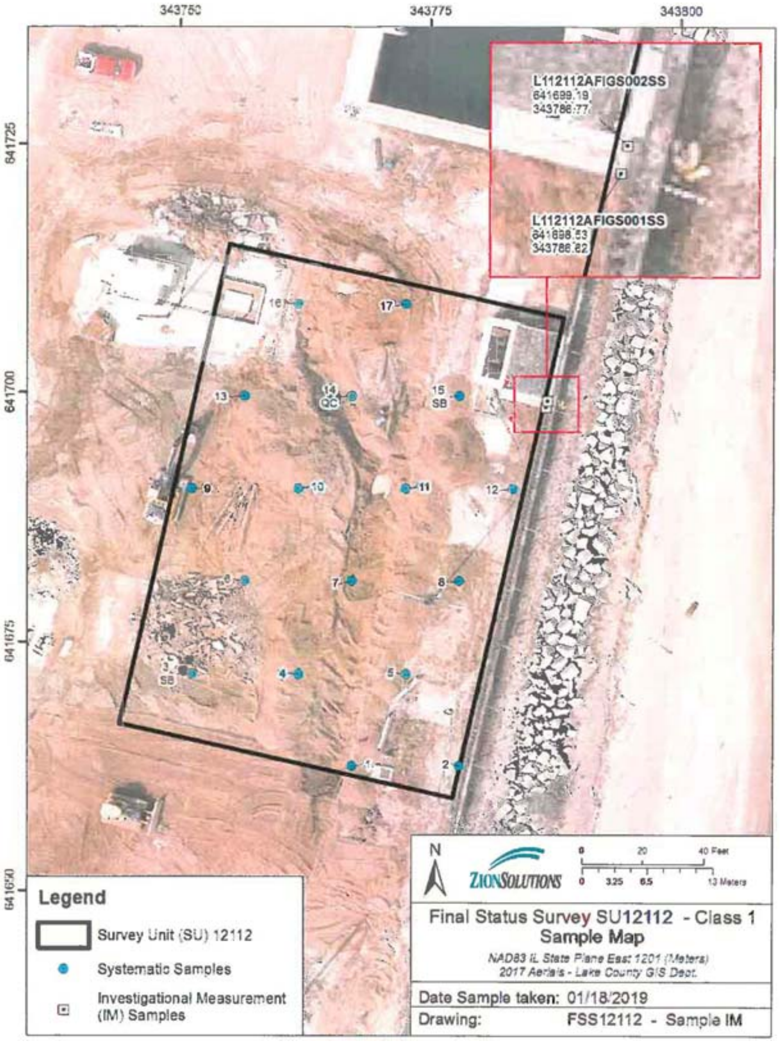


Photo of Elevated Scan Location During FSS of Survey Unit 12112 from January 2019

The gamma spectroscopy results of the investigation samples taken during FSS are presented in the following table.

Summary of Gamma Spectroscopy Results for Investigation Surface Soil Samples

MEASUREMENT ID	Co-60 (pCi/g)	Cs-134 (pCi/g)	Cs-137 (pCi/g)	Ni-63 (pCi/g)	Sr-90 (pCi/g)	OpSOF
L1-12112A-FIGS-001-SS	1.71E-02	3.75E-02	1.99E-02	3.09E+00	3.98E-05	0.046
L1-12112A-FIGS-002-SS	1.06E-04	1.75E-02	**5.48E-02**	1.91E-02	1.10E-04	0.025
L1-12112A-FIGS-001-SB	2.03E-03	0.00E+00	0.00E+00	3.66E-01	0.00E+00	0.004
L1-12112A-FIGS-002-SB	2.03E-02	3.48E-02	2.97E-02	3.66E+00	5.94E-05	0.088

During the performance of the scan, it was identified that the soil at this location contained quantities of clay as part of the soil matrix. The clay had been identified as a causal factor for increased background during scanning due to the increased concentrations of NORM. Due to the lack of significant concentrations of plant derived radioactivity in the investigations samples taken and the continued presence of elevated scan measurements at the identified location, it was concluded that the elevated scan measurements were the result of the presence of clay material. Upon the successful performance of FSS, survey unit 12112 was subjected to I&C measures in accordance with procedure ZS-LT-300-001-003, "Isolation and Control for Final Status Survey" and was isolated from the time FSS was concluded until the performance of the ORISE confirmatory survey. The investigation concluded that this was the same location identified during the FSS, and no further actions were necessary.

It also should be noted that since the completion of FSS field activities in survey unit 12112, four (4) surveillances have been accomplished in accordance with procedure ZS-LT-300-001-003, Section 5.4. Three (3) of these surveillances were performed after December of 2019. The results of all four surveillances are consistent with the radiological conditions as established during the FSS, and no additional findings were identified. All the surveillance surveys from 2020 are included on the enclosure to this response.

<u>12204A</u>

Following the discovery by ORISE of elevated scan results in survey unit 12204A, Zion*Solutions* performed an investigation of the identified location. Scanning identified the presence of a radioactive particle. The particle was retrieved and captured and Condition Report ES-ZION-CR-2019-0177 was initiated. The bag containing the radioactive particle and surrounding soil was assessed using portable instrumentation and then sent to on-site laboratory for qualitative isotopic analysis. Gamma spectroscopy analysis of the sample positively identified Co-60 at a concentration of 9.87 E+05 pCi/g. No other plant-derived gamma-emitting ROC were positively identified. The soil where the particle was found was scanned again using a Ludlum Model 44-10 NaI detector and scans did not indicate residual radioactivity at levels exceeding the MDCR of the detector plus background. In addition, a verification soil sample was taken at the same location where the particle was located, and gamma spectroscopy analysis of the verification sample indicated Cs-137 at a concentration of 1.05 E-01 pCi/g. No other gamma-emitting ROC were positively detected at concentrations greater than MDC. The follow-up survey, “2019-1971 Follow Up to Particle in 12204A,” is included on the enclosure to this response.

The DRP was not identified during FSS most likely due to the discrete nature of the contamination and detector geometry differences between ZS and ORISE. This is explained in more detail in the RAI #11 response. There was no breakdown in isolation and control measures identified. The results of all surveillances performed since the ORISE visit are consistent with the radiological conditions as established during the FSS, and no additional findings were identified. All the surveillance surveys from 2020 are included on the enclosure to this response.

Revised or Supplemental Documentation: “2019-1953 Follow Up to Concrete in 10209C;” ZS-2020-0011, Attachment, Revision 2; “2020 Surveillance Surveys;” and “2019-1971 Follow Up to Particle in 12204A;” CR-2019-0176, CR-2019-0177

NRC RAI Question #10b In the survey units where the source of the elevated areas identified by ORISE was found to be a discrete particle (e.g., 12204A), provide information on composition of the particle. Provide information on the expected origin of these particles given their composition and location.

<u>**RESPONSE:**</u> The composition of the particle is indicative of activated metal, and the particle was visible to the naked eye. The origin of this DRP, and other similar DRPs identified on-site, are most likely to have originated in the Unit 1 and Unit 2 Containment Buildings and were generated during reactor internals segmentation activities. A comprehensive list of survey units where DRPs were identified is provided in the “Recommended Table for Licensee Completion” spreadsheet, which is included on the enclosure to this response.

Revised or Supplemental Documentation: “Recommended Table for Licensee Completion” spreadsheet

NRC RAI Question #10c Provide information on corrective actions taken to ensure that elevated areas like those identified by ORISE are not missed in other survey units.

RESPONSE: As a response to changing radiological and operational conditions brought about by site decommissioning activities, a decision was made in July of 2016 to reclassify all Class 2 survey units within the Security Restricted Area and Class 3 survey units located within the Radiologically Restricted Area, as Class 1 FSS units. This action was also taken to ensure that the open land survey units susceptible to the potential presence of particles were scanned during FSS with the appropriate rigor. This action impacted the reclassification of the following open land survey units: Class 3 survey units 10201, 10202, 10203, 10204, 10206, 10207, 10208, 10209, 10210, 10211, 10219A, 10220A, 10220B, 10221A, and 10221B and Class 2 survey units 12201, 12202, 12203, 12204, and 12205. The survey units within the Security Restricted Area were reclassified from Class 2 to Class 1 primarily due to these areas being directly impacted by demolition of the Containment Buildings, Auxiliary Building, and Fuel Handling Building, including the deposition of low levels of radioactive material within the surface soils, movement and storage of low levels of radioactive material during demolition. These survey units became part of the expanded Radiologically Controlled Area during demolition activities. Some of these survey units were also locations of previously identified DRPs and considered higher risk. Some of the survey units were reclassified from Class 3 to Class 1 within the Radiologically Restricted Area for similar reasons as those within the Security Restricted Area, such as survey units 10209, 10221B, 10208, and 10210. The eastern portions of survey units 10206 and 10207, and the southern portion of 10203, were going to become part of the demolition area and Radiologically Controlled Area. The remaining survey units were reclassified for conservatism as they had the potential to be impacted by demolition activities and the movement of radioactive material around the site during said activities. The Radiologically Restricted Area was selected as the boundary for reclassification, as equipment and personnel movement impacted by radioactive material were typically only within this boundary.

Scan survey parameters for using a Ludlum Model 44-10 NaI detector is included in the survey instructions for every Class 1 open land survey. Typical scan instructions were to walk and move the detector in a serpentine motion at a scan speed of 0.25 to 0.5 m/s while maintaining the detector end-cap within two inches of the ground surface. The technician would advance the detector approximately 20 cm per lateral pass (5 passes per linear meter) in one meter scan rows. This was to ensure 100% scan coverage of the ground area in the chosen survey areas. Technicians were trained in the proper scanning technique during qualification, and if a technician was observed in the field not adhering to the correct technique, the technician was coached in the proper operation by supervision.

A large percentage of the accessible soil surfaces in most of the Class 1 open land survey units were scanned multiple times prior to performing FSS. Aside from the scanning and sampling performed under RAs and RASSs, all open land survey units were completely scanned as part of the "turnover" process described in procedure ZS-LT-300-001-003, "Isolation and Control for Final Status Survey." Any discrete particles, when discovered, were immediately removed/remediated, and the surrounding area was scanned to ensure no additional particles were present. Radiological Operations personnel performed surveys in accordance with Job Aid ZS-RP-JA-011, "Use of the M3/M12-44-10 Gamma Detector for Discrete Radioactive Particles" of travel paths from the Radiologically Controlled Area/Demolition Boundary to the Radiation Protection Control Point multiple times per week during open-air demolition of radiological structures. Radiological Operations personnel performed the same DRP surveys of the travel path from the Radiologically Controlled Area/Demolition Boundary to the Lower South Lot where demolition debris was staged and loaded for transport throughout 2018 and 2019. All DRPs identified by Radiological Operations personnel were immediately remediated and disposed of. Isolation and control measures were implemented for survey units at the start of FSS in accordance with procedure ZS-LT-300-001-003, "Isolation and Control for Final Status Survey." The isolation and control measures remained in place from the time FSS was initiated, throughout the performance of the ORISE confirmatory survey, and will remain in place until License Termination. These I&C measures were sufficient to prevent any spread of contamination including DRPs.

Based upon the identification of multiple DRPs in areas outside of structures in October of 2014, following the event identified in CR-2014-001074, the 8-120 liner storage area present within portions of survey units 10208, 10209, and 10221, was deemed an elevated risk for DRPs. Soil was utilized for shielding purposes inside of roll-off containers surrounding the liner storage array, as well as within the array in-between the liner shield vaults and the roll-off containers. All of this soil was remediated and disposed of as radioactive waste in June 2016. The rad vaults and roll-offs were surveyed and removed from the site. Once cleared of all material, all of the asphalt surfaces were surveyed to ensure no DRPs were present. As follow-up to the CR-2014-001074 event in 2014, radiological surveys in adjacent potentially impacted areas outside of the Security Restricted Area and outside of the Radiologically Restricted Area were performed. These surveys did not identify the presence of DRPs.

Based upon the identification of multiple DRPs in areas outside of the Unit 2 Containment Building in June of 2015 (CR-2015-000324), the ground areas within the Security Restricted Area surrounding the Containment Construction Doors in each Containment Building were deemed an elevated risk for DRPs. Within the CR-2015-000324 investigation, the DRPs were determined to be legacy in nature and not related to the outside storage of radioactive material. The origin of the DRPs, based upon their radiological and dimensional characteristics, was assumed to be from within the Containment Buildings. The most likely source of the DRPs is activated metal tailings generated during reactor internals segmentation activities. An exact date or dates of contamination spread could not be determined. The DRPs were not highly transportable, were deposited outside and adjacent to the Containment Buildings, and remained primarily localized within these areas over time. Prior to commencement of open-air demolition of the Auxiliary Building and Fuel Handling Building, the top 6”-8” of surface soils surrounding both Containment Buildings were remediated and disposed of as radioactive waste in July of 2016. This was performed as a precautionary measure to reduce the risk of DRPs being present prior to commencing major demolition of radiological structures.

Revised or Supplemental Documentation: CR-2014-001074, CR-2015-000324

NRC RAI Question #10d For any survey unit in which there were investigations and/or remediation performed after the FSS was completed, provide revised release records that incorporate the post-FSS investigations and remediation and that accurately describe the final status of the survey unit.

RESPONSE: There have been no investigations required based upon continuing surveillances. Investigations and remediations performed as a result of ORISE confirmatory surveys are documented in the Corrective Action program and in these RAI responses. All release records currently provided to the NRC to demonstrate compliance with the unrestricted release criteria reflect the final conditions of the site.

NRC RAI Question #10e For the NRC staff to have reasonable assurance that the elevated areas identified by ORISE in confirmatory report 5271-SR-07-0 were investigated and remediated properly prior to the licensee emplacing clean fill, and for completeness of the release records, more information should be included in the release records where investigations and remediation occurred as a result of the confirmatory surveys.

RESPONSE: The elevated areas identified by ORISE in confirmatory report 5271-SR-07-0 were investigated and remediated properly prior to the placement of clean fill. The response to NRC RAI Question #4a provides specific details on the investigations performed and the results in the affected survey units.

NRC RAI Question #11a Demonstrate that the scan sensitivity was adequate to meet the data needs for the survey and was adequate to detect small discrete particles like the one observed in the QC sample in Survey Unit 12112. This demonstration should include an evaluation of the assumed relative ratio of radionuclides observed in the particles (i.e., the particles primarily consisting of Co-60 versus primarily consisting of Cs-137). The demonstration should also evaluate the impact of the collimators used on the field of view. The licensee should also revise the scan MDC calculations for the Ludlum 44-10 detector to address the small discrete particles of Co-60 with the collimator.

RESPONSE: In reference to QC sample L1-12112A-FQGS-014SS-A, the release record describes the difference between the on-site and off-site laboratories as due to a potential DRP present in the sample. The presence of a DRP would explain the difference in the two results, as the sample geometry for the instrumentation both on-site and off-site assume the activity in the sample is homogenously mixed. However, a DRP present in the sample, in a different physical geometry within the sample matrix on-site versus off-site, would result in different analysis results due to the inherent shielding characteristics of the sample material. The result of the off-site sample analysis was 1.01 pCi/g of Co-60. The $MDCR_{scan}$ referenced in the release record for survey unit 12112 was 3.75 pCi/g. This was based upon an average background count rate of 5,000 cpm and 95% Cs-137 and 5% Co-60 radionuclide composition, with a scan speed of 0.5 m/s. A collimator was used on the 44-10 which reduced the background count rate down to an average of approximately 2,367 cpm. Utilizing TSD 11-004, this equates to an $MDCR_{surveyor}$ of 735 cpm. Assuming 100% Co-60 homogenously mixed within the survey unit surface soils, this equates to an $MDCR_{scan}$ of 1.60 pCi/g. Empirical testing was performed to evaluate the field of view (FOV) reduction on the 44-10 when utilizing the collimator. This resulted in an average reduced response rate for Co-60 of 412 cpm/μR/hr versus the value of 430 cpm/μR/hr referenced in TSD 11-004. Utilizing this value for the response rate equates to a slightly higher $MDCR_{scan}$ of 1.67 pCi/g. If the collimator was not utilized, assuming a background count rate of 5,000 cpm at 100% Co-60 contamination, the $MDCR_{scan}$ would have been approximately 2.32 pCi/g. The reduction of FOV and induced reduction in detector response is more than offset by the reduction in background when utilizing a collimator. The 44-10 will achieve a smaller MDCR utilizing the collimator primarily due to the reduction in background. The presence of 1.01 pCi/g Co-60, if homogenously mixed within the surface soils, would not have resulted in a scan alarm as it was below actual field $MDCR_{scan}$ of 1.67 pCi/g.

The mass of the sample was approximately 749.17 grams. Utilizing the off-site analysis result of 1.01 pCi/g of Co-60, would result in a DRP with activity of approximately 757 pCi based upon 1.01 pCi/g. Empirical testing was performed to determine the impact of collimator use on DRPs versus a homogenously mixed source. Utilizing the same assumptions in TSD 11-004, the 44-10 would view a 50 cm diameter region that is 15 cm deep during a one-second interval at a scan rate of 0.5 m/s. During this one-second interval, the DRP could be present anywhere within this volume. Specific responses were determined based upon the location of the DRP within this volume. The best-case geometry of the detector centerline directly above the DRP on the surface, would result in a Minimum Detectable Activity (MDA) of approximately 7,987 pCi of Co-60, assuming the same average background of 2,367 cpm. This assumes the utilization of a collimator with a detector response of 412 cpm/μR/hr. This also demonstrates that the 44-10 would not have been able to detect the calculated Co-60 DRP during the scan of the survey unit.

Given a typical 50 cm diameter region that is 15 cm deep being analyzed during a one-second window, and advancing the detector in 25 cm steps, the detector could, at best-case geometry, be directly above the DRP at some point during the scan. At worst-case geometry during the same pass, the detector would be at the edge of the region approximately 25 cm away from the DRP. If the DRP were offset at 12.5 cm from the center of the region between both passes, this would be the best-case geometry from the detector, and 28 cm away from the detector at the worst-case geometry during both passes. MicroShield was utilized to determine approximate Co-60 DRP activity strength at positions directly under the centerline of the detector, at 12.5 cm, 25 cm, and 28 cm offsets on the surface of the soil. The Co-60 DRP activity was evaluated utilizing detector sensitivity based upon empirical testing with and without a collimator. With the detector directly above the DRP, the average detector response is approximately 6.3% less for Co-60 and 6.9% less for Cs-137 when utilizing a collimator. With the detector at a 12" offset from the DRP, the average detector response is approximately 22.1% less for Co-60 and 44.3% less for Cs-137 when utilizing a collimator. Based upon the empirical data and MicroShield evaluations, utilizing the collimator with reduced background and reduced detector response can achieve a lower MDCR than without the collimator at higher background levels. This is assuming the detector is in the same relative position with respect to the DRP. The position of the DRP within the survey region has the greatest impact to the MDCR of the detector during surveys. At worst-case geometries, the MDA for detection of a DRP is approximately 17 times higher than that during best-case geometries. This is primarily due to the positional dependence and limited FOV of the DRP due to the collimator on the 44-10 response. This positional and FOV impact can result in elevated readings during one survey and no elevated readings above background in another survey of the same region with the same detector if the detector is not moved in the exact same scan path. This positional impact would explain the DRPs identified during the ORISE surveys in survey units 12204A, 12202D, and 12202F. The positional impact is larger for Cs-137 than it is for Co-60 based upon the empirical testing. Because the piece of concrete debris that was identified by ORISE in survey unit 10209C was discrete rather than uniform contamination in the survey region, its detection would have been impacted by this positional dependence and FOV of the collimated 44-10.

Typical scan instructions for performing surveys with the 44-10 were to walk and move the detector in a serpentine motion at a scan speed of 0.25 to 0.5 m/s while maintaining the detector end-cap within two inches of the ground surface. The technician would advance the detector approximately 20 cm per lateral pass (5 passes per linear meter) in one-meter scan rows. These typical scan instructions are representative of scan surveys performed by the Site Characterization/License Termination Group as well as the Radiological Operations Group. The alarm level was typically established based upon the average background in the scan area plus the $MDCR_{surveyor}$ for the detector. A collimator was utilized to reduce background when applicable, and as explained above, would allow the technicians to scan to a lower MDCR even when accounting for the reduced FOV of the detector. The technicians would utilize headphones to enable better hearing of deviations in counts and typically did not walk next to other technicians. Upon hearing an increase in the audible counts, the technician would slow the scan speed to better identify a potential discrete elevated area. These typical scan instructions were to ensure technicians could identify radiological material, whether distributed or discrete in nature, to levels as low as practical depending upon background radiation levels. This typical survey protocol was successfully used to identify the hundreds of DRPs on-site over the course of the project. The Site Characterization/License Termination Group would also typically utilize GPS and data loggers when performing surveys to further enhance the ability to identify regions of elevated measurements for biased sample locations.

The action level was established at MDCR plus background for all scans. The scan sensitivity was as low as achievable based upon background radiation within each survey unit and was adequate to meet the needs of the survey designs. A DRP of similar source strength as referenced in Survey Unit 12112 would not have been identified during scans. The source strength of such a DRP would have been below the MDA of the detector, and, below the action level. The use of the collimator on the 44-10 did restrict the FOV of the detector, and as a result, reduced the sensitivity of the 44-10. The 44-10 with a collimator was still able to achieve a lower MDCR than without a collimator. This was due to the reduction of FOV and induced reduction in sensitivity being offset by the reduced background radiation levels.

NRC RAI Question #11b Provide information on the composition of particles found onsite. Provide information on the source of the particles observed onsite given their composition and location. Provide details on what areas of the site in which these particles would be expected to be found.

RESPONSE: The majority of all DRPs identified on-site outside of structures from 2014 onward have been composed of primarily Co-60, based upon on-site gamma spectroscopy analyses. The DRPs are metallic in nature, mildly magnetic, typically visible to the naked eye, irregular in shape, and with typical dimensions of around 1 mm in diameter and less than 1 mm thick. Below is a photo of typical tailings generated from reactor internals segmentation activities, which utilized a diamond wire saw, taken during equipment mockups. The DRPs identified on-site are similar in appearance and size to these tailings.

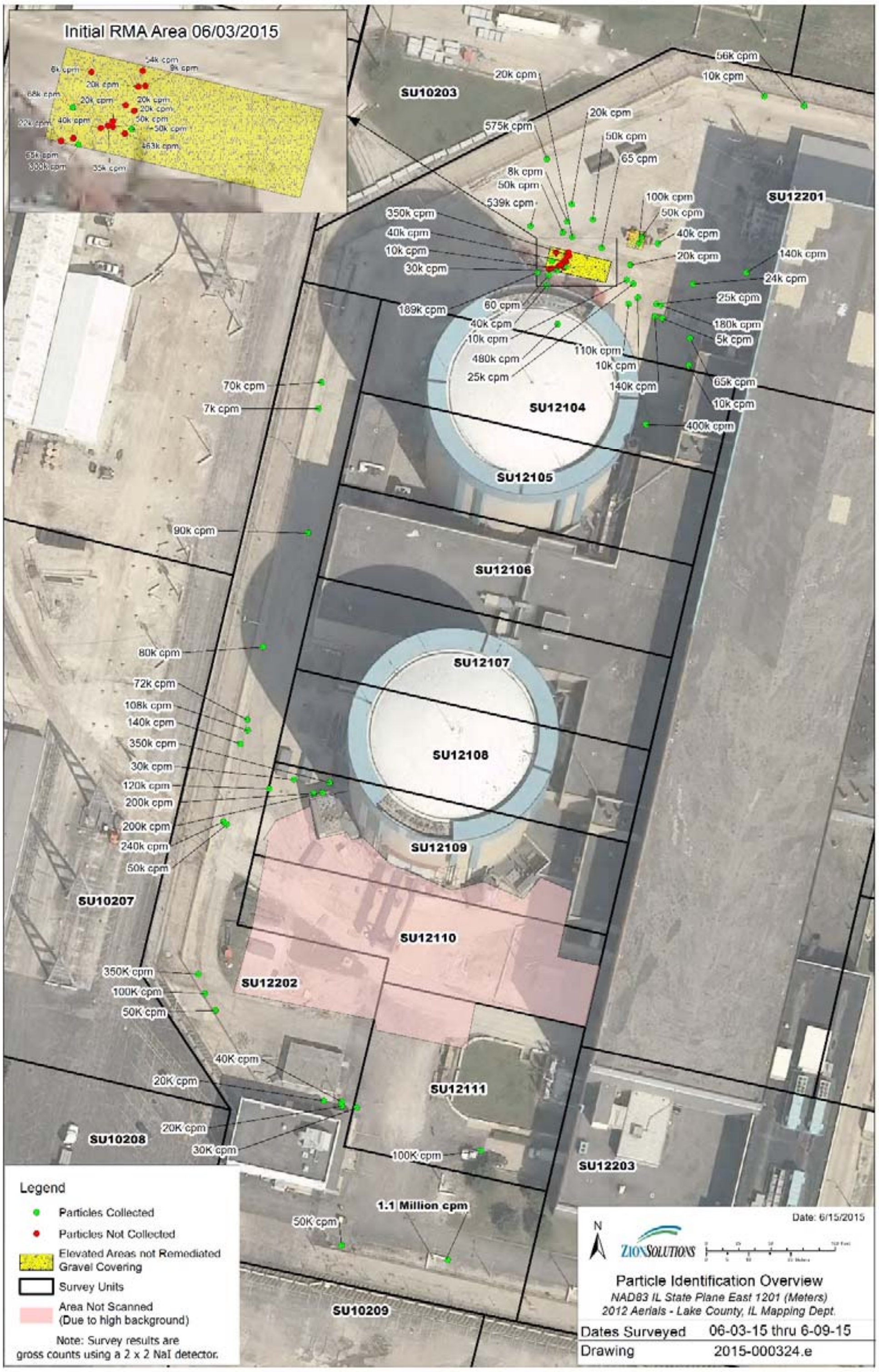
The identification of Co-60 as the sole gamma emitter in the majority of the DRPs identified is consistent with the neutron activated reactor internals components.

Prior to the implementation of physical decommissioning and demolition activities, discrete radioactive particles as defined in procedure ZS-RP-106-002-005 were not encountered in soils at the Zion site. As part of the site characterization, the entire exposed soil surface was scanned using a Ludlum Model 44-10 detector, and no particles were identified.

DRPs were first identified outside of structures after a spread of contamination event in September of 2014. 8-120 liners loaded with reactor internals segments were temporarily stored in a shielded array in the lower south lot present in survey units 10221A, 10221B, and 10221C. The spread of contamination event is documented in CR-2014-001074, with subsequent investigation performed under an Apparent Cause Evaluation. The cause of the contamination spread was inserting an 8-120 liner into its overpack outside. The liner was transported north across the site to the NGET parking lot located in survey unit 10202. DRPs were identified in survey unit 10221, where the loading took place, across survey units 10208, 10207, 10206, 10204, 10203, and then in 10202, where the liner and trailer were staged temporarily for shipping survey. Over 100 DRPs ranging from 0.001 µCi to 3 µCi were identified and remediated after this event. Surveys were performed of walking areas adjacent to the travel path of the liner, parking areas inside and outside of the Radiologically Restricted Area, and the main access road entering the Radiologically Restricted Area. No DRPs were identified in these areas. No surveys were performed of areas inside the Security Restricted Area, as they were not considered impacted by this event. The cause of the spread of contamination was corrected, and all contamination was remediated following this event. The corrective action documentation and surveys are supplied on the enclosure to this response.

A Radiological Assessment performed in survey unit 10203A during 2014 identified seven DRPs with a maximum level of 6.76E-3 µCi within the Security Restricted Area near the west fence. The DRPs were remediated along with surrounding soils at time of discovery.

DRPs were again identified in June of 2015 as documented in CR-2015-000324. The DRPs were identified during down-posting of a Radiological Material Area (RMA) outside of the Unit 2 Containment Building that previously contained pieces of the Steam Generators. The DRPs were again consistent with activated metal tailings identified during the September 2014 event. Expanded surveys were performed within the Security Restricted Area concentrating around the Unit 1 and Unit 2 Containment Buildings and the western path between the two buildings. Approximately 100 DRPs were identified ranging from 0.002 µCi to 0.5 µCi. The presence of the DRPs was determined to be not related to the temporary RMA and Steam Generator segments. Below is an image identifying locations of DRPs identified during this investigation.



Initial RMA Area 06/03/2015
SU10203
SU12201
SU12104
SU12105
SU12106
SU12107
SU12108
SU12109
SU12110
SU12202
SU12111
SU10207
SU10208
SU12203
SU10209
56k cpm
10k cpm
20k cpm
575k cpm
20k cpm
50k cpm
65 cpm
8k cpm
50k cpm
539k cpm
100k cpm
50k cpm
40k cpm
350k cpm
40k cpm
10k cpm
30k cpm
20k cpm
140k cpm
24k cpm
25k cpm
189k cpm
60 cpm
40k cpm
10k cpm
480k cpm
25k cpm
110k cpm
10k cpm
140k cpm
180k cpm
5k cpm
65k cpm
10k cpm
400k cpm
70k cpm
7k cpm
90k cpm
80K cpm
72K cpm
108k cpm
140k cpm
350k cpm
30k cpm
120k cpm
200k cpm
200k cpm
240k cpm
50k cpm
350K cpm
100K cpm
50K cpm
40K cpm
20K cpm
20K cpm
30K cpm
100K cpm
1.1 Million cpm
50K cpm
Legend
Particles Collected
Particles Not Collected
Elevated Areas not Remediated Gravel Covering
Survey Units
Area Not Scanned (Due to high background)
Note: Survey results are gross counts using a 2 x 2 NaI detector.
Date: 6/15/2015
N
ZIONSOLUTIONS
Particle Identification Overview
NAD83 IL State Plane East 1201 (Meters)
2012 Aerials - Lake County, IL Mapping Dept.
Dates Surveyed 06-03-15 thru 6-09-15
Drawing 2015-000324.e

The cause of the spread of contamination within the Security Restricted Area could not be determined. The DRPs were believed to have originated from reactor internals segmentation activities. In June of 2015, reactor internals segmentation activities were complete, and both reactor cavities were drained, cleaned, and locked down with a fixative. One program failure identified during the investigation was the inadequacy of instrumentation Radiological Operations personnel were utilizing to survey areas outside of structures, primarily Geiger Mueller type friskers versus scintillation detectors. Corrective actions were implemented to ensure down-posting of RMAs including the use of scintillation type detectors. Additionally, the Site Characterization/License Termination Group performed secondary surveys prior to down-posting. The corrective action documentation and surveys are supplied on the enclosure to this response.

During generation of lessons learned for the Zion D&D in early 2019, the cause of the DRPs located within the Security Restricted Area was re-evaluated. In the second half of 2014, partially full 8-120 liners, the Unit 2 Lower Core Support Assembly, tooling, and components were relocated from the Unit 2 reactor cavity to the Unit 1 reactor cavity by transportation along the west side of the Security Restricted Area. This was determined to not be a cause, as there was no breakdown in radiological controls identified during these movements. The Containment Building ventilation was re-evaluated as another potential cause. Engineering analyses were performed when creating the construction openings into each Containment Building in late 2011. These evaluations ensured that the Containment Buildings maintained a negative pressure with respect to outside atmosphere and that air was being pulled into the Containment Building. What was not considered in the evaluation was the face velocity of the opening compared against average wind speeds impacting the opening. Based upon the ventilation capacity and the size of the opening in each Containment Building, the face velocity entering each opening was less than one mile per hour. This was not adequate to overcome the average wind speed. The most likely cause for the DRPs identified within the Security Restricted Area was wind entrainment of DRPs inside of each Containment Building in the immediate vicinity of the openings. This potential cause was created as a lesson learned for future D&D projects. With this being the most probable cause of DRPs within the Security Restricted Area, it is likely the DRPs could have migrated outside of each Containment Building between approximately 2012 through late 2016 when the tented enclosures were installed around each Containment Building opening. Following this logic, it is reasonable to assume that, since no DRPs were identified outside of the Security Restricted Area or Radiologically Restricted Area in areas adjacent to the travel path of the liner contamination event in 2014, the DRPs were not highly mobile and were not easily dispersed throughout the site. It is also reasonable to assume that more DRPs may have migrated outside of each Containment Building after the identification and remediation of DRPs within the Security Restricted Area in 2015, albeit to a lesser extent, as reactor internals segmentation activities were completed and there was no longer a generation source for this type of contamination. Based upon this information, the highest-risk areas for the presence of DRPs would have been within the Security Restricted Area, concentrating in the areas around each Containment Building and the western side of the Fuel Handling Building travel path between each Containment Building. A second high-risk area for the presence of DRPs would have also been in survey units 10221A, 10221B, and 10221C, where reactor internals segmentation liners were temporarily stored and due to the event documented in CR-2014-001074.

In 2016, these two high-risk areas were remediated. The south liner storage array in survey units 10221A, 10221B, and 10221C was dismantled, and all potentially DRP contaminated soils utilized for shielding was shipped off-site as radioactive waste. Due to the identification of DRPs within the Security Restricted Area in 2015, a management decision was made to remediate approximately 6”-8” of surface soils around each Containment Building to further reduce the risk of DRPs still being present. This was performed prior to building the tented enclosures around each Containment Building opening and prior to commencement of open-air demolition of the Auxiliary Building and Fuel Handling Building. There was approximately seven million pounds of soils shipped off-site in 2016, accounting for this potentially contaminated DRP material.

Open-air demolition of the Auxiliary Building and Fuel Handling Building, as well as internal demolition of each Containment Building, was performed from late 2016 through early 2018. During this time, demolition debris from each Containment Building, along with system components from the Auxiliary Building and Fuel Handling Building, was loaded into milgon containers within each Containment Building tented enclosure. Structural steel and concrete debris generated during Auxiliary Building and Fuel Handling Building demolition was staged and loaded in outside areas on the west side of the Containment Buildings and Fuel Handling Building, within the old Security Restricted Area footprint. During this time, the old Security Restricted Area boundary became part of the Demolition Boundary and was treated as an RCA. All personnel were required to perform frisking prior to exiting the RCA. Radiological Operations personnel would survey all equipment and material prior to allowing exit and removal of materials from the RCA. The travel paths from the exits of this demolition area/RCA to the Radiological Control Point located in the old NGET Building, present in survey unit 10203, were surveyed weekly by Radiological Operations personnel utilizing Job Aid ZS-RP-JA-011, “Use of the M3-44-10 Gamma Detector for Discrete Radioactive Particles.” Radiological Operations identified and remediated approximately 15 DRPs from early 2017 through the middle of 2018, ranging in activity from 0.004 μCi to 0.23 μCi of Co-60 and were consistent with activated metal tailings identified earlier in the project. In the middle of 2018, the lower south lot became the primary waste staging and loading area for demolition debris in survey units 10221A, 10221B, and 10221C. The waste travel path from the Demolition Area exit near the southern end of survey unit 10202D to the lower south lot waste loading area were surveyed weekly by Radiological Operations personnel utilizing Job Aid ZS-RP-JA-011, “Use of the M3-44-10 Gamma Detector for Discrete Radioactive Particles." Radiological Operations identified and remediated approximately 24 DRPs from the middle of 2018 through most of 2019, ranging in activity from 0.00054 µCi to 1.08 µCi of Co-60 and were consistent with activated metal tailings identified earlier in the project.

Concrete debris generated during all radiological structural demolition was never a source of DRPs on-site. The majority of all DRPs identified outside of structures throughout the project are conducive with the radiological, metallurgical, and dimensional characteristics representative of reactor internals segmentation tailings.

The remaining demolition debris from the Auxiliary Building and Fuel Handling Building was shipped off-site by the middle of 2018. Approximately 100 million pounds of contaminated soils from within the Radiologically Restricted Area were shipped off-site in 2019. This is the equivalent of remediating the top two feet of soil within the entire old Security Restricted Area footprint. The majority of the soils originated within the Security Restricted Area, the lower south lot waste loading area, and the transit areas in between these two locations.

As a response to changing radiological and operational conditions brought about by site decommissioning activities, a decision was made in July of 2016 to reclassify all Class 2 survey units within the Security Restricted Area and the majority of Class 3 survey units located within the Radiologically Restricted Area, as Class 1 FSS units. This action was also taken to ensure that the open land survey units susceptible to the potential presence of particles were scanned during FSS with the appropriate rigor. This action impacted the reclassification of the following open land survey units: Class 3 survey units 10201, 10202, 10203, 10204, 10206, 10207, 10208, 10209, 10210, 10211, 10219A, 10220A, 10220B, 10221A, and 10221B and Class 2 survey units 12201, 12202, 12203, 12204, and 12205.

As a result of performing 100% scan surveys, an additional 14 DRPs were identified during FSS and pre-FSS activities occurring in 2019, primarily in the areas that were re-classified.

The risk of DRPs remaining on-site at License Termination has been mitigated through the initial identification and remediation of DRPs in 2014 and 2015, the remediation of soils prior to large scale radiological demolition in 2016, the extensive soil remediation occurring in 2019, frequent Radiological Operations survey and subsequent identification and remediation of DRPs, and expanded scope of FSS to include the majority of the Radiologically Restricted Area as Class 1 and subsequent identification and remediation of DRPs.

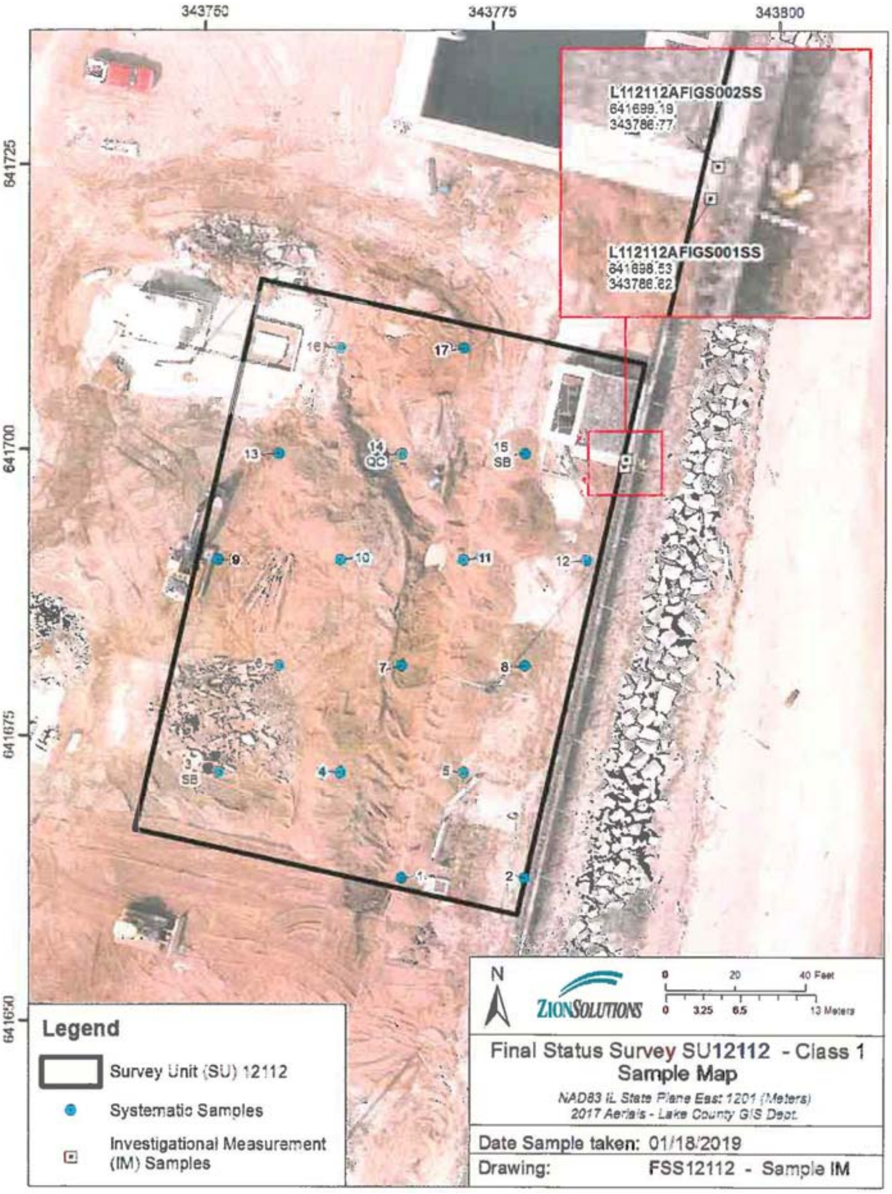
A map depicting the survey units within which particles were discovered is included on the enclosure to this response.

Revised or Supplemental Documentation: CR-2014-001074, CR-2015-000324, 2014 DRP Surveys, 2015 DRP Surveys, 2016 DRP Surveys, 2017 DRP Surveys, 2018 DRP Surveys, 2019 DRP Surveys, Zion Survey Unit Particle Identification Map

NRC RAI Question #11c For Survey Unit 12112, provide information on the location of sample L1-12112A-FQGS-014-SS in relation to the location of the scan alarms in rows 41 and 42. Also provide information on the location of both sample L1-12112A-FQGS-014-SS and the scan alarms in rows 41 and 42 in relation to the scan alarms. If the scan alarms did not identify the particle observed in sample L1-12112A-FQGS-014-SS and/or the elevated area observed by ORISE, provide information on the reason that the scan might have missed the particles.

RESPONSE: Below is a picture identifying the location of L1-12112A-FQGS-014-SS in relation to the scan alarms in rows 41 and 42 of Survey Unit 12112. The scan alarms occurred at location of soil samples L1-12112A-FIGS-001-SS in row 41 and L1-12112A-FIGS-002-SS in row 42. The location of L1-12112A-FQGS-014-SS is annotated in map by marker 14-QC.

Sample Map for FSS of Survey Unit 12112 from January 2019



The scan alarms in rows 41 and 42 identified by ZS were in similar location in which ORISE identified elevated measurements. The cause of the elevated measurements in these locations were due to NORM and not DRPs as discussed in further detail in the RAI #10a response. A DRP of source strength similar in nature as to that identified in soil sample L1-12112A-FQGS-014-SS would not have been identified during scans as it would be below the MDA of the detector as discussed in further detail in the RAI #11a response.

NRC RAI Question #11d Describe any corrective actions taken to ensure that all risk-significant particles were identified in all survey units.

RESPONSE: This is answered in the response to NRC RAI Question #11b.

Supplemental NRC RAI Question #11 Provide an estimate of the dose from a hypothetical intake (both inhalation and ingestion) of a typical discrete particle for the site, taking into account the range of sizes, chemical compositions, and radioactivity of the discrete particles discovered in soils at the site.

RESPONSE: Zion*Solutions* performed a dose assessment for the hypothetical intake (both inhalation and ingestion) of a typical discrete particle for the site. The results are provided in the "Ingestion Pathway Dose" and "Inhalation Pathway Dose" tables below.

Based upon a review of all DRPs identified on-site over the course of the project, the average activity of those identified was approximately 0.21 µCi of Co-60. These DRPs were identified under various background radiation levels typically with the collimator being used on the 44-10. The general background levels during the liner event in 2014 were 5,000 to 13,000 cpm. The general background levels during the spread of contamination identified in 2015 were 2,000 to 12,000 cpm. The general background levels during FSS of survey units within the Radiological Restricted Area were 2,000 to 3,000 cpm. For those survey units near the southwest end of the Radiological Restricted Area, the average background during FSS was 4,000 cpm. The background dose rates varied during Radiological Operations surveys performed between 2016 and 2019, based upon proximity to stored radioactive material, with an average background level of approximately 3,000 cpm.

As the majority of DRPs identified on-site are believed to have originated from reactor internals segmentation activities, Waste Management Group activation analysis report 07-46D-RE-088 (provided on the enclosure to this response) was utilized for the radionuclide composition of the DRPs. A weighted average was determined for all radionuclides based upon both units and all components. All activities were then decay corrected to a date of January 1, 2021. Below is a table of the radionuclide constituents and their calculated radionuclide activity concentrations.

Radionuclide Constituents and Activity Concentrations

Radionuclide	Activity Concentration (Ci/g) as of 1/1/2021
H-3	1.32E-06
C-14	2.02E-06
Mn-54	4.36E-12
Fe-55	4.00E-05
Co-60	5.49E-04
Ni-59	9.00E-06
Ni-63	1.28E-03
Nb-94	3.11E-08
Tc-99	6.53E-09

As described in the response to NRC RAI Question #11b, the DRPs were typically irregularly shaped and of various dimensions. For calculation of activity median aerodynamic diameter (AMAD) the DRP was assumed to be spherical in nature. For a Co-60 DRP with a source strength of 0.21 µCi, this would equate to an AMAD of approximately 450 µm.

NCRP 130, "Biological Effects and Exposure Limits for Hot Particles" was reviewed with respect to internal dose evaluation. NCRP 130, Section 9.3, "Respiratory System" states, "It is recommended that: 'Limitation be based on currently applicable effective dose limits, with the effective dose determined using general respiratory system models and residence times for insoluble material.'" NCRP 130, Section 9.4, "Gastrointestinal (GI) System" states, "It is recommended that: 'Limitation be based on currently applicable effective dose limits, with the effective dose determined using general GI system models and residence times for insoluble material.'"

Ingestion Pathway Dose

ICRP 100, "Human Alimentary Tract Model for Radiological Protection (HATM)" was evaluated with respect to more recent dose modeling for the ingestion pathway. ICRP 100 states, "The HATM can be used to calculate doses from discrete particles of high activity such as fragments of irradiated fuel (often called 'hot particles'), as well as for the normal situation of distribution of activity throughout the contents of the alimentary tract. The consideration of realistic target cell locations in the HATM enables doses to be calculated using radiation transport calculations considering, for example, different particle sizes, densities, and elemental compositions. The particles can be taken to be at different radial positions within the lumen as this can lead to a different dose to the target cells. Calculations of this sort have been performed using a model similar to the HATM (Darley et al., 2003). This approach takes absorption of energy within the particle into account. It generally yields lower doses than the Publication 30 model, although the extent of the difference will depend on the radionuclides that provide the major fraction of the dose and the size of the particles."

Additionally, ICRP 100 states, "Previous in vitro studies have shown that the particles are not readily soluble and are likely to pass through the alimentary tract with the loss of only a small proportion (≤1%) of their radionuclide content."

Based upon this review, ICRP 30 models and assumptions were utilized to assess the internal dose based upon the ingestion pathway. Due to the insoluble nature of DRPs, the lowest solubility class was utilized for each radionuclide when selecting dose conversion factors.

Dose conversion factors were taken from Federal Guidance Report No. 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors For Inhalation, Submersion and Ingestion." Below is a table summarizing the Committed Effective Dose Equivalent (CEDE) to an individual from a 0.21 µCi Co-60 DRP following the ingestion pathway.

Ingestion Pathway Dose

Radionuclide	Scaling Factor	Intake Activity (µCi)	Uptake Fraction (f1)	CEDE (Sv/Bq)	CEDE (mrem)
H-3	0.002409186	0.000505929	1	1.73E-11	3.24E-05
C-14	0.003673375	0.000771409	1	5.64E-10	1.61E-03
Mn-54	7.93822E-09	1.66703E-09	0.1	7.48E-10	4.61E-09
Fe-55	0.072707804	0.015268639	0.1	1.64E-10	9.27E-03
Co-60	1	2.10E-01	0.05	2.77E-09	2.15E+00
Ni-59	0.016384405	0.003440725	0.05	5.67E-11	7.22E-04
Ni-63	2.324053072	0.488051145	0.05	1.56E-10	2.82E-01
Nb-94	5.65344E-05	1.18722E-05	0.01	1.93E-09	8.48E-05
Tc-99	1.18866E-05	2.49619E-06	0.8	3.95E-10	3.65E-06
				Total	**2.45E+00**

The calculated hypothetical CEDE due to ingestion of a 0.21 µCi Co-60 equivalent DRP is approximately 2.45 mrem.

Inhalation Pathway Dose

ICRP 66, "Human Respiratory Tract Model for Radiological Protection (HRTM)" was evaluated with respect to more recent dose modeling for the inhalation pathway. No additional information was identified with respect to the internal dose modeling following the inhalation of a single DRP.

As recommended in NCRP 130, ICRP 30 models and assumptions were utilized to assess the internal dose based upon the inhalation pathway. ICRP 30 states, "For an unusual distribution with an AMAD of greater than 20 µm, complete deposition in the N-P pathway can be assumed." Based upon this information, a DRP of 0.21 µCi equating to an AMAD of 421 µm would have remained in the extrathoracic region and transferred to the GI tract thus following the ingestion pathway with associated dose as described earlier. To assess a hypothetical dose to the body from inhalation, the DRP size was corrected to 20 µm AMAD. At this AMAD the approximate activity of the DRP would have been 1.86E-05 µCi of Co-60.

Due to the insoluble nature of DRPs, the longest clearance time was utilized for each radionuclide when selecting dose conversion factors. Dose conversion factors were taken from Federal Guidance Report No. 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors For Inhalation, Submersion and Ingestion." Below is a table summarizing the CEDE to an individual from a 20 µm AMAD Co-60 DRP following the inhalation pathway.

Inhalation Pathway Dose

Radionuclide	Scaling Factor	Intake Activity (uCi)	Class / f1	CEDE (Sv/Bq)	CEDE (mrem)
H-3	0.002409186	4.46924E-08	Vapor - 1	1.73E-11	2.86E-09
C-14	0.003673375	6.81441E-08	1	5.64E-10	1.42E-07
Mn-54	7.93822E-09	1.4726E-13	W - 0.1	1.81E-08	9.86E-12
Fe-55	0.072707804	1.34879E-06	D - 0.1	7.26E-10	3.62E-06
Co-60	1	1.86E-05	Y - 0.05	5.91E-08	4.06E-03
Ni-59	0.016384405	3.03944E-07	D - 0.05	3.58E-10	4.03E-07
Ni-63	2.324053072	4.31131E-05	D - 0.05	8.39E-10	1.34E-04
Nb-94	5.65344E-05	1.04876E-09	Y - 0.01	1.12E-07	4.35E-07
Tc-99	1.18866E-05	2.20507E-10	W - 0.8	2.25E-09	1.84E-09
				Total	**4.19E-03**

The calculated hypothetical CEDE due to inhalation of a 20 μm AMAD DRP is approximately 0.004 mrem.

This calculation is extremely conservative. The dose conversion factors from FGR-11 were derived based on an assumed inhalation of an aerosol distribution with an AMAD of 1 micron. That is, the particle sizes of the inhaled radioactivity covered a range of sizes with half of the activity being associated with particles with an AMAD less than 1 micron and half with an AMAD greater than 1 micron. Such a distribution of particles would be inhaled and deposited throughout the entire respiratory system, including the nasal-pharyngeal region, the tracheal-bronchial region, and the pulmonary region. For dosimetry purposes, the deposition pattern of such a dispersed distribution is assumed to be uniform within a given dosimetric segment of the respiratory tract. Material deposited in the respective segments of the tract may be absorbed into body fluids, transported to the throat and swallowed, expelled through the nose or mouth, or trapped in lymph tissue.

This is very dissimilar to the fate and behavior of a single 20-micron particle, which would deposit at a single site in the upper respiratory tract and be cleared by swallowing or be expelled from the nose or mouth. As a related aside, it is also an accepted dosimetric truth that the potential (cancer) risk from respiratory tract dose delivered by a single particle of a given activity is less than the risk from the same amount of activity spread uniformly over a larger area of the respiratory tract.

Zion*Solutions* acknowledges the fact that ORISE confirmatory surveys identified 3 DRPs. Based upon this fact, and the limitations of the 44-10 detection capability, it is plausible that some DRPs may still exist on-site at end state. With respect to the hypothetical internal dose from DRPs, it was the intention of Zion*Solutions* to identify and immediately remediate all DRPs on-site. Through both extensive surveys by the Site Characterization/License Termination Group and Radiological Operations groups, as well as extensive remediation and disposal of soils potentially contaminated with DRPs, it is highly unlikely that DRPs currently remain on-site.

The average soil ingestion transfer rate from NUREG/CR-5512 is 0.05 grams/day which equates to 18.25 grams/year. Conservatively assuming one DRP is present in each one-second interval survey region, this equates to approximately one DRP in 15,000 grams of soil. This is based upon a survey region 50 cm in diameter, 15 cm thick, and a soil density of 1.6 g/cc. The probability of an average member of the critical group ingesting a DRP is therefore 1.22E-03, or 0.122%. Inhalation of a DRP is not deemed plausible, as the AMAD for the tailings generated during reactor internals segmentation activities was significantly larger than 20 μm, and an inhaled DRP would ultimately be transferred to the GI tract.

Revised or Supplemental Documentation: 07-46D-RE-088

NRC RAI Question #12a Additional information is needed regarding the remediation and post-remediation scans of the keyway soils. (See RAI7 above).

RESPONSE: Based upon the history cited in the Zion HSA, section 5.3.4.4 of LTP Chapter 5 states that the subsurface soils in the "keyways" between the Containment Buildings and the Turbine Building will be assessed for radiological contamination of subsurface soils once subsurface utilities and subsurface access-interfering structures (e.g., Waste Annex Building) had been removed.

In May 2016, as part of the demolition of the Turbine Building, the approximate nine feet of soil over the Unit 1 Steam Tunnel located along the south side of Unit 1 Containment and three feet of soil over the Unit 2 Steam Tunnel located along the north side of Unit 1 Containment was excavated, removed, and disposed of as potentially contaminated waste. This included the volume of soil located in each "keyway" and positioned on-top of these subsurface structures (grade of 588 foot, top of Steam Tunnels and Diesel Fuel Oil Tank rooms are at approximate grade of 579 foot or nine feet below grade). The roofs of the exposed Steam Tunnels were subsequently demolished, exposing the inner walls and floor surfaces. The interior of the Steam Tunnels and the 9-foot deep excavations created to expose the structures were then backfilled with clean fill from off-site sources. This process was necessary to support machinery weight from the eventual demolition of the Containment domes. It should be noted that this area was not considered to be contaminated as surface and subsurface soil samples were acquired from the keyways during characterization. The maximum observed concentration of Co-60 in soil was 1.04 pCi/g, and the maximum observed concentration of Cs-137 in soil was 3.39 pCi/g. Radiological coverage and surveys performed for this activity were provided under a Radiation Work Permit. No RA or RASS surveys were performed, because the excavation completely removed all the overburden soils and no subsurface soils remained inside of the excavation.

In 2017, the concrete ceiling and the of the Unit 1 and Unit 2 Diesel Fuel Oil Tank rooms was removed to support the removal of radioactive commodities from the Auxiliary Building. The clean fill introduced into the "keyways" prior to building demolition was completely removed and disposed of as waste, exposing the east entrances into the Steam Tunnel and the Unit 1 and 2 East and West Valve Rooms. The Unit 1 and Unit 2 East Valve rooms are located directly in the "keyways". The interiors of the Unit 1 and 2 East and West Valve Rooms were successfully subjected to FSS in April of 2018. Prior to demolition of the Containment domes, this entire area was backfilled with clean fill from off-site. The figure below shows the keyways and the underlying structures following the removal of the indigenous soil.

Unit 1 and Unit 2 Keyways

NRC RAI Question #12b The licensee should describe the continuing characterization soil samples from under the SFP foundation slab, that were part of the commitments in LTP Section 5.3.4.4 or point to the release record in which they are discussed. If no samples were taken prior to backfill, provide additional information to support that these soils do not contain residual radioactivity that would be in excess of the release criteria.

RESPONSE: In March of 2018, the walls and floor of the FHB were demolished and removed. A large excavation was created to accomplish this, and when complete, the only part of the FHB that remained was the bottom of the SFP.

The soil directly beneath the SFP slab was inaccessible. Attempts to sample the soil beneath the slab with angled boring techniques (GeoProbe) were met with refusal due to a previously unidentified mud-mat. Additionally, during FSS of the SFP/Transfer Canal, hotspots were not observed that would indicate a crack or travel path for subsurface contamination.

The Excavation Created for Demolition of the Fuel Handling Building

Inside the FHB Excavation Looking West

As illustrated in the photos, the excavation created to remove the FHB completely exposed the subsurface soils around the north, west, and south side of the SFP floor concrete slab. The subsurface soils surrounding the SFP slab were scanned and sampled as part of the FSS of this excavation prior to backfill. The results of scanning and soil samples taken directly adjacent to the SFP floor slab are found in the release records for survey units 12106 and 12107, Addendum 1 which documents the FSS of the open excavation. The following table reproduces the scan results reported in the release records.

Results of Scan Surveys of Soils Directly Adjacent to SFP Floor Pad

Survey Unit	Scan Row	Highest Logged Reading (cpm)	Action Level (cpm)	# of Scan Alarms
12106K	24	14000	3269	1
12106K	25	3120	3269	0
12106K	26	3350	3388	0
12106K	27	6770	3269	1
12107K	31	2794	3261	0
12107K	32	2794	3261	0
12107K	33	2796	3261	0
12107K	34	2890	3261	0
12107K	35	2902	3261	0
12107K	36	2909	3261	0
12107K	37	3064	3261	0
12107K	38	3135	3261	0
12107K	39	3067	3261	0

Investigations were performed in two (2) areas identified by gamma scans. Following investigation, spot remediation occurred at each location directed by scanning until all identified elevated activity was removed. The final post remediation sample result showed a maximum OpSOF of 0.922.

Results of Analysis of Subsurface Soils Directly Adjacent to SFP Floor Pad

Sample ID	Co-60 (pCi/g)	Cs-134 (pCi/g)	Cs-137 (pCi/g)	Ni-63 (pCi/g)	Sr-90 (pCi/g)	OpSOF
L1-12106K-FSGS-021-SB	**5.09E-02**	0.00E+00	**1.03E+00**	9.18E+00	2.06E-03	0.629
L1-12106K-FSGS-022-SB	**2.35E-01**	2.62E-02	**1.40E-01**	4.24E+01	2.80E-04	0.578
L1-12107K-FSGS-001-SB	3.92E-02	2.22E-02	**5.36E-02**	7.07E+00	1.07E-04	0.127
L1-12107K-FSGS-005-SB	6.68E-02	0.00E+00	**1.01E-01**	1.21E+01	2.02E-04	0.189
L1-12107K-FSGS-015-SB	3.78E-02	0.00E+00	**1.60E-01**	6.82E+00	3.20E-04	0.159

NRC RAI Question #13a At a minimum, the discussion of these QA/QC topics should address how quality assurance protocols were followed during collection and analysis of these samples (e.g., measurement instrument performance checks, MDCs for the original and QC sample measurements, chain of custody, etc.).

RESPONSE: The QA/QC requirements for the performance of FSS at Zion is addressed in LTP Section 5.9 and the approved QAPP. As stated in LTP Section 5.9.2, compliance with the QAPP ensured the following:

- FSS was implemented in accordance with the approved procedures,
- FSS was conducted by trained personnel using calibrated instrumentation,

- The quality of the data collected was adequate,
- All phases of package design and survey were properly reviewed, and
- Corrective actions, when identified, were implemented in a timely manner and were determined to be effective.

The QA/QC requirements from the QAPP were incorporated into approved procedures used to implement FSS, including replicate measurement and sample frequency and agreement criteria, data validation, instrumentation quality checks, and corrective action.

Instrument quality requirements such as calibration frequency, instrument performance checks (pre- and post-use), and acceptance criteria are addressed in the instrument implementation procedure for the instrument. Required QA/QC requirements such as the acquisition frequency for duplicate measurements and samples and acceptable instrument MDC are specified in the survey design for the FSS of each survey unit. Data validation requirements are addressed in the FSS Data Analysis procedure, and the quality aspects of sample acquisition, preparation, and Chain-of-Custody requirements are addressed in the sample preparation procedure.

Each gamma spectroscopy report and instrument download report is validated by a Radiological Engineer in accordance with Section 5.1 of procedure ZS-LT-300-001-004, "Final Status Survey Data Assessment." The procedure addresses the required content from QAPP Section 6.2.2.1, including the verification of the absence of anomalies in the sample or measurement results, or in the supporting data, including but not limited to MDC, uncertainty, deviation from established procedure, or analysis flags.

The QC requirements for data acquisition are addressed in LTP Section 5.9.3, which requires the that a replicate measurement be performed at 5% of the static and scan locations or a duplicate sample be taken at 5% of the volumetric sample locations (systematic and biased). In accordance with Section 4.1.2 of the QAPP, as well as LTP Section 5.9.3, the acceptance criteria specified for replicate measurements states, "The acceptance criteria for static measurements and scan surveys, based on the professional judgment of the Radiological Engineer, is that the same conclusion is reached for each measurement location and no other locations, greater than the scan investigation level for the area classification, are found." The acceptance criteria for duplicate or split volumetric samples is addressed in QAPP Section 4.2 and LTP Section 5.9.3.2, which both state, "NRC Inspection Procedure, No. 84750, *"Radioactive Waste Treatment, and Effluent and Environmental Monitoring"* will be used to determine the acceptability of split and duplicate sample analyses." In addition, LTP Section 5.9.3.2 also states, "Agreement is ultimately determined when the same conclusion is reached for each compared result."

NRC RAI Question #13b For original and split samples with results greater than the MDC, explain why the QC checks failed the acceptance criterion for compared sample results. If the subsequent investigation and/or discussion reveals the survey data is suspect and may not represent actual conditions in the survey unit, provide information on the collection of additional measurements, the usability of the survey data, and the potential for the discrepancy to adversely affect the decision on the radiological status of the overall survey unit.

RESPONSE: Please refer to the response to Additional NRC Question #2 (Additional NRC Questions on Zion FSS Reports –October 8, 2020 Conference Call) for discussion of replicate ISOCS measurements that were acquired for QC agreement.

During the FSS of the 116 open land survey units at Zion, 183 duplicate or split samples were acquired to meet the required frequency of 5%. Of the 183 samples analyzed, Cs-137 was positively detected in both the standard and QC sample in 42 samples. In the remaining 141 surface and subsurface soil samples acquired to meet the replicate frequency, no plant-derived radionuclides were positively detected in either the standard sample or the QC sample. In the absence of positive concentrations of plant-derived radionuclides, K-40 was used to demonstrate agreement. As K-40 is a naturally occurring gamma emitter with a discernable 1,460 KeV gamma, it can be used to demonstrate accuracy and precision agreement on a counting system used to analyze two aliquots. As it is assumed to be homogeneously distributed in the soil media, it can be used in lieu of a water-soluble radionuclide such as Cs-137. The other major gamma-emitting ROC at Zion is Co-60. Co-60 is a particulate radionuclide and is not soluble. Therefore, the homogeneous distribution of Co-60 in a soil matrix between two aliquots is not realistic, and Co-60 is not recommended for use to demonstrate agreement. As a note, positively detected concentrations of Co-60 were documented for both the standard and QC sample on the "Replicate Measurement Assessment" forms for 4 of the 183 samples. However, in all four cases, Cs-137 was also positively detected, and the documented Co-60 results were not used to demonstrate agreement.

In 27 of the 42 samples where Cs-137 was positively detected in both the standard and QC sample, agreement was achieved using the resolution table from Inspection Procedure No. 84750. Ten (10) of the 42 sample comparisons showed a resolution for Cs-137 of less than four, which is not comparable. In these 10 cases, agreement was achieved using K-40 with ratios acceptable to the resolution table from the current revision of Inspection Procedure No. 84750.

In 5 of the 42 samples where Cs-137 was positively detected in both the standard and QC sample, sample comparisons showed an unacceptable ratio for Cs-137 between the standard and QC sample. In 4 of the 5 sample comparisons with unacceptable ratios for Cs-137, agreement was achieved using the K-40 concentrations. As this is an indicator that the Cs-137 concentrations were not homogeneously distributed between the two aliquots, the acceptable ratios for K-40 demonstrated acceptable agreement. In the one sample comparison where both Cs-137 and K-40 demonstrated unacceptable ratios, three additional QC samples were acquired, and agreement was demonstrated in all three.

Based on this review, Zion*Solutions* concluded that the survey data is not suspect and represents the actual radiological conditions in the overall survey units. The results of the review of the analysis of QC soil samples taken during the FSS of open land survey units is provided in the following table. Due to rounding errors, the values provided in the table below may deviate slightly from the values provided in the applicable release records.

Review of QC Soil Samples Acquired during FSS of Open Land Survey Units

Survey Unit	Description	Phase	Correct 84750 Table	Sample ID		Standard					QC			
				Standard	QC	Isotope	Activity	Error	Resolution	Range	Activity	Error	Ratio	Agreement
10201A	NE Corner of Restricted Area - Lakeshore	3	No	L1-10201A-FSGS-006-SS	L1-10201A-FQGS-006-SS	Cs-137	6.12E-02	1.56E-02	3.92	N/A	6.32E-02	1.56E-02	N/A	No
						K-40	1.03E+00	7.28E-01	1.41	0.5-2.0	9.57E+00	6.91E-01	0.11	Yes
10201B	NE Corner of Restricted Area - Lakeshore	3	No	L1-10201B-FSGS-006-SS	L1-10201B-FQGS-006-SS	K-40	3.97E+00	3.50E-01	11.34	0.5-2.0	3.65E+00	3.32E-01	1.09	Yes
10201C	NE Corner of Restricted Area - Lakeshore	3	Yes	L1-10201C-FSGS-012-SS	L1-10201C-FQGS-012-SS	Cs-137	1.20E-01	1.56E-02	7.69	0.6-1.66	1.70E-01	1.40E-02	0.71	Yes
10201D	NE Corner of Restricted Area - Lakeshore	3	Yes	L1-10201D-FSGS-012-SS	L1-10201D-FQGS-012-SS	Cs-137	4.98E-02	1.24E-02	4.02	0.5-2.0	4.06E-02	7.03E-03	1.23	Yes
				L1-10201D-FSGS-012-SB	L1-10201D-FQGS-012-SB	K-40	4.55E+00	3.92E-01	11.61	0.6-1.66	5.07E+00	4.23E-01	0.90	Yes
10202A	IRSF/Fire Training Area	3	No	L1-10202A-FSGS-007-SS	L1-10202A-FQGS-007-SS	K-40	5.11E+00	4.11E-01	12.43	0.6-1.66	5.18E+00	4.22E-01	0.99	Yes
10202B	IRSF/Fire Training Area	3	No	L1-10202B-FSGS-004-SS	L1-10202B-FQGS-004-SS	K-40	4.55E+00	3.78E-01	12.04	0.6-1.66	4.52E+00	3.87E-01	1.01	Yes
				L1-10202B-FIGS-001-SS	L1-10202B-QIGS-001-SS	K-40	5.23E+00	4.17E-01	12.54	0.6-1.66	5.09E+00	4.07E-01	1.03	Yes
				L1-10202B-FIGS-008-SS	L1-10202B-QIGS-008-SS	Cs-137	7.33E-02	1.51E-02	4.85	0.5-2.0	6.39E-02	1.41E-02	1.15	Yes
10202C	IRSF/Fire Training Area	3	No	L1-10202C-FSGS-007-SS	L1-10202C-FQGS-007-SS	K-40	5.97E+00	4.64E-01	12.87	0.6-1.66	6.23E+00	4.82E-01	0.96	Yes
10202D	IRSF/Fire Training Area	3	No	L1-10202D-FSGS-010-SS	L1-10202D-FQGS-010-SS	K-40	6.07E+00	4.49E-01	13.52	0.6-1.66	6.76E+00	4.74E-01	0.90	Yes
				L1-10202B-FIGS-001-SS	L1-10202B-QIGS-001-SS	K-40	7.85E+00	5.79E-01	13.56	0.6-1.66	9.16E+00	6.17E-01	0.86	Yes
10203A	East Training Area	4	No	L1-10203A-FSGS-013-SS	L1-10203A-FQGS-013-SS	K-40	6.85E+00	5.19E-01	13.20	0.6-1.66	6.94E+00	5.27E-01	0.99	Yes
10203B	East Training Area	4	Yes	L1-10203B-FSGS-005-SS	L1-10203B-FQGS-005-SS	Cs-137	1.45E-01	2.16E-02	6.71	0.5-2.0	6.68E-02	1.44E-01	2.17	No
						K-40	6.36E+00	4.77E-01	13.33	0.6-1.66	6.21E+00	4.80E-01	1.02	Yes
				L1-10203B-FJGS-001-SS	L1-10203B-QJGS-001-SS	K-40	7.24E+00	5.16E-01	14.03	0.6-1.66	7.38E+00	5.24E-01	0.98	Yes
10203C	East Training Area	4	Yes	L1-10203C-FSGS-004-SS	L1-10203C-FQGS-004-SS	K-40	6.04E+00	4.53E-01	13.33	0.6-1.66	7.24E+00	5.41E-01	0.83	Yes
				L1-10203C-FJGS-001-SS	L1-10203C-QJGS-001-SS	Cs-137	9.81E-02	2.00E-02	4.91	0.5-2.0	6.53E-02	1.90E-02	1.50	Yes
10203D	East Training Area	3	No	L1-10203D-FSGS-002-SS	L1-10203D-FQGS-002-SS	K-40	6.46E+00	4.74E-01	13.63	0.6-1.66	6.96E+00	5.04E-01	0.93	Yes
				L1-10203D-FJGS-001-SS	L1-10203D-QJGS-001-SS	K-40	1.50E+01	9.13E-01	16.43	0.6-1.66	1.56E+01	9.33E-01	0.96	Yes
10203E	East Training Area	3	No	L1-10203E-FSGS-001-SS	L1-10203E-FQGS-001-SS	K-40	5.49E+00	4.49E-01	12.23	0.6-1.66	4.65E+00	3.93E-01	1.18	Yes
				L1-10203E-FIGS-002-SS	L1-10203E-QIGS-002-SS	K-40	7.59E+00	5.64E-01	13.46	0.6-1.66	7.41E+00	5.40E-01	1.02	Yes
10203F	East Training Area	4	Yes	L1-10203F-FSGS-008-SS	L1-10203F-FQGS-008-SS	K-40	6.85E+00	5.19E-01	13.20	0.6-1.66	6.94E+00	5.27E-01	0.99	Yes
10204A	North Gate Area	4	Yes	L1-10204A-FSGS-009-SS	L1-10204A-FQGS-009-SS	K-40	2.97E+00	3.17E-01	9.37	0.6-1.66	3.50E+00	3.46E-01	0.85	Yes
				L1-10204A-FSGS-019-SS	L1-10204A-FQGS-019-SS	K-40	5.72E+00	4.66E-01	12.27	0.6-1.66	5.20E+00	4.56E-01	1.10	Yes
10204B	North Gate Area	4	Yes	L1-10204B-FSGS-009-SS	L1-10204B-FQGS-009-SS	K-40	8.84E+00	5.65E-01	15.65	0.75-1.33	8.62E+00	5.54E-01	1.03	Yes
				L1-10204B-FIGS-001-SS	L1-10204B-QIGS-001-SS	K-40	1.05E+01	6.45E-01	16.28	0.75-1.33	1.08E+01	6.68E-01	0.97	Yes
10204C	North Gate Area	4	Yes	L1-10204C-FSGS-001-SS	L1-10204C-FQGS-001-SS	K-40	4.30E+00	3.56E-01	12.08	0.6-1.66	5.39E+00	4.06E-01	0.80	Yes
10204D	North Gate Area	4	Yes	L1-10204D-FSGS-012-SS	L1-10204D-FQGS-012-SS	K-40	5.21E+00	4.33E-01	12.03	0.6-1.66	5.78E+00	4.46E-01	0.90	Yes
				L1-10204D-FIGS-001-SS	L1-10204D-QIGS-001-SS	K-40	2.85E+00	2.72E-01	10.48	0.6-1.66	3.49E+00	2.94E-01	0.82	Yes
10205	Switchyard	1	Yes	L3-10205A-FRGC-013-CV	L3-10205A-FRQC-013-CV	K-40	1.52E+00	4.80E-01	3.17	N/A	2.21E+01	7.15E-01	0.07	Yes
10206A	Station Construction Area	4	Yes	L1-10206A-FSGS-005-SS	L1-10206A-FQGS-005-SS	Cs-137	6.08E-02	1.62E-02	3.75	N/A	1.14E-01	1.74E-02	0.53	No
						K-40	6.21E+00	4.43E-01	14.02	0.6-1.66	6.72E+00	4.71E-01	0.92	Yes
				L1-10206A-FSGS-013-SS	L1-10206A-FQGS-013-SS	K-40	8.62E+00	5.94E-01	14.51	0.6-1.66	9.13E+00	6.20E-01	0.94	Yes
10206B	Station Construction Area	4	Yes	L1-10206B-FSGS-005-SS	L1-10206B-FQGS-005-SS	K-40	1.03E+01	6.74E-01	15.28	0.6-1.66	9.33E+00	6.21E-01	1.10	Yes
				L1-10206B-FIGS-001-SS	L1-10206B-QIGS-001-SS	K-40	1.05E+01	6.46E-01	16.25	0.75-1.33	8.90E+00	5.69E-01	1.18	Yes

Review of QC Soil Samples Acquired during FSS of Open Land Survey Units (continued)

Survey Unit	Description	Phase	Correct 84750 Table	Sample ID		Standard					QC			
				Standard	QC	Isotope	Activity	Error	Resolution	Range	Activity	Error	Ratio	Agreement
10206C	Station Construction Area	4	Yes	L1-10206C-FSGS-014-SS	L1-10206C-FQGS-014-SS	Cs-137	5.91E-02	1.53E-02	3.86	N/A	5.97E-02	1.52E-02	0.99	No
						K-40	7.70E+00	5.66E-01	13.60	0.6-1.66	8.56E+00	6.19E-01	0.90	Yes
10206D	Station Construction Area	4	Yes	L1-10206D-FSGS-013-SS	L1-10206D-FQGS-013-SS	Cs-137	7.10E-02	1.39E-02	5.11	0.5-2.0	4.23E-02	1.11E-02	1.68	Yes
				L1-10206D-FIGS-001-SB	L1-10206D-QIGS-001-SB	K-40	6.40E+00	4.37E-01	14.65	0.6-1.66	9.50E+00	6.22E-01	0.67	Yes
10206E	Station Construction Area	4	Yes	L1-10206E-FSGS-008-SS	L1-10206E-FQGS-008-SS	K-40	6.08E+00	4.74E-01	12.83	0.6-1.66	7.40E+00	5.40E-01	0.82	Yes
10207A	North Warehouse Area	4	Yes	L1-10207A-FSGS-012-SS	L1-10207A-FQGS-012-SS	K-40	1.14E+01	7.29E-01	15.64	0.6-1.66	1.12E+01	7.37E-01	1.02	Yes
				L1-10207A-FSGS-017-SS	L1-10207A-FQGS-017-SS	K-40	6.14E+00	4.30E-01	14.28	0.6-1.66	5.39E+00	3.97E-01	1.14	Yes
				L1-10207A-FIGS-001-SS	L1-10207A-QIGS-001-SS	K-40	1.19E+01	7.19E-01	16.55	0.75-1.33	1.20E+01	6.50E-01	0.99	Yes
				L1-10207A-FIGS-025-SS	L1-10207A-QIGS-025-SS	K-40	3.92E+00	3.70E-01	10.59	0.6-1.66	3.28E+00	3.19E-01	1.20	Yes
10207B	North Warehouse Area	4	Yes	L1-10207B-FSGS-014-SS	L1-10207B-FQGS-014-SS	K-40	1.15E+01	7.06E-01	16.29	0.75-1.33	9.11E+00	6.18E-01	1.26	Yes
				L1-10207B-FIGS-001-SS	L1-10207B-QIGS-001-SS	K-40	4.38E+00	3.78E-01	11.59	0.6-1.66	4.35E+00	3.92E-01	1.01	Yes
10207C	North Warehouse Area	4	Yes	L1-10207C-FSGS-009-SS	L1-10207C-FQGS-009-SS	K-40	1.02E+01	6.81E-01	14.98	0.6-1.66	9.61E+00	6.46E-01	1.06	Yes
				L1-10207C-FIGS-001-SS	L1-10207C-QIGS-001-SS	Cs-137	5.07E-02	1.50E-02	3.38	N/A	7.38E-02	1.20E-02	0.69	No
						K-40	8.75E+00	5.68E-01	15.40	0.6-1.66	9.35E+00	5.15E-01	0.94	Yes
10207D	North Warehouse Area	4	Yes	L1-10207D-FSGS-012-SS	L1-10207D-FQGS-012-SS	Cs-137	5.44E-02	1.46E-02	3.73	N/A	4.53E-02	1.40E-01	1.20	No
				L1-10207D-FIGS-001-SS	L1-10207D-QIGS-001-SS	K-40	8.14E+00	5.31E-01	15.33	0.6-1.66	9.57E+00	6.09E-01	0.85	Yes
						K-40	8.09E+00	5.40E-01	14.98	0.6-1.66	8.20E+00	5.37E-01	0.99	Yes
10207E	North Warehouse Area	4	Yes	L1-10207E-FSGS-010-SS	L1-10207E-FQGS-010-SS	K-40	6.44E+00	4.90E-01	13.14	0.6-1.66	7.80E+00	5.62E-01	0.83	Yes
10208A	South Warehouse Area	4	Yes	L1-10208A-FSGS-019-SS	L1-10208A-FQGS-019-SS	K-40	8.94E+00	6.11E-01	14.63	0.6-1.66	9.44E+00	6.20E-01	0.95	Yes
				L1-10208A-FSGS-021-SS	L1-10208A-FQGS-021-SS	Cs-137	8.74E-02	1.62E-02	5.40	0.5-2.0	5.53E-02	1.61E-02	1.58	Yes
10208B	South Warehouse Area	4	Yes	L1-10208B-FSGS-010-SS	L1-10208B-FQGS-010-SS	K-40	6.61E+00	4.84E-01	13.66	0.6-1.66	6.67E+00	4.74E-01	0.99	Yes
10208C	South Warehouse Area	4	Yes	L1-10208C-FSGS-005-SS	L1-10208C-FQGS-005-SS	K-40	7.44E+00	4.99E-01	14.91	0.6-1.66	6.85E+00	4.76E-01	1.09	Yes
				L1-10208C-FIGS-004-SS	L1-10208C-QIGS-004-SS	K-40	8.00E+00	5.65E-01	14.16	0.6-1.66	7.42E+00	5.25E-01	1.08	Yes
10208D	South Warehouse Area	4	Yes	L1-10208D-FSGS-005-SS	L1-10208D-FQGS-005-SS	K-40	1.38E+00	1.54E-01	8.96	0.6-1.66	1.15E+00	1.57E-01	1.20	Yes
				L1-10208D-FIGS-007-SS	L1-10208D-QIGS-007-SS	K-40	9.69E+00	6.39E-01	15.16	0.6-1.66	1.11E+01	7.04E-01	0.87	Yes
10209A	Restricted Area South of Gate House	3	No	L1-10209A-FSGS-010-SS	L1-10209A-FQGS-010-SS	K-40	7.78E+00	5.25E-01	14.82	0.6-1.66	7.66E+00	5.18E-01	1.02	Yes
				L1-10209A-FIGS-001-SS	L1-10209A-QIGS-001-SS	K-40	7.66E+00	5.43E-01	14.11	0.6-1.66	7.41E+00	5.43E-01	1.03	Yes
10209B	Restricted Area South of Gate House	3	No	L1-10209B-FSGS-003-SS	L1-10209B-FQGS-003-SS	K-40	2.86E+00	2.89E-01	9.90	0.6-1.66	3.14E+00	3.11E-01	0.91	Yes
10209C	Restricted Area South of Gate House	4	Yes	L1-10209C-FSGS-001-SS	L1-10209C-FQGS-001-SS	Cs-137	1.48E-01	2.11E-02	7.01	0.5-2.0	1.32E-01	1.96E-02	1.12	Yes
				L1-10209C-FSGS-010-SS	L1-10209C-FQGS-010-SS	Cs-137	8.37E-02	1.59E-02	5.26	0.5-2.0	8.23E-02	1.60E-02	1.02	Yes
10209D	Restricted Area South of Gate House	3	No	L1-10209D-FSGS-014-SS	L1-10209D-FQGS-014-SS	Cs-137	7.12E-02	1.62E-02	4.40	0.5-2.0	6.59E-02	1.57E-02	1.08	Yes
10209E	Restricted Area South of Gate House	3	No	L1-10209E-FSGS-014-SS	L1-10209E-FQGS-014-SS	Cs-137	6.20E-02	1.67E-02	3.71	N/A	6.32E-02	1.56E-02	N/A	No
						K-40	7.50E+00	5.33E-01	14.07	0.6-1.66	7.23E+00	5.27E-01	1.04	Yes
				L1-10209D-FIGS-002-SS	L1-10209D-QIGS-002-SS	Cs-137	1.72E-01	2.33E-02	7.38	0.6-1.66	1.20E-01	1.92E-01	1.43	Yes
10210A	Restricted Area South of Turbine Building	3	Yes	L1-10210A-FSGS-009-SS	L1-10210A-FQGS-009-SS	K-40	7.01E+00	3.76E-01	18.64	0.75-1.33	7.28E+00	5.44E-01	0.96	Yes
10210B	Restricted Area South of Turbine Building	3	Yes	L1-10210B-FSGS-010-SS	L1-10210B-FQGS-010-SS	K-40	4.67E+00	4.16E-01	11.23	0.6-1.66	4.91E+00	3.99E-01	0.95	Yes
10210C	Restricted Area South of Turbine Building	3	Yes	L1-10210C-FSGS-001-SS	L1-10210C-FQGS-001-SS	K-40	5.45E+00	4.54E-01	12.00	0.6-1.66	5.40E+00	4.30E-01	1.01	Yes
10211A	SE Corner of Restricted Area (Lakeshore)	3	Yes	L1-10211A-FSGS-013-SS	L1-10211A-FQGS-013-SS	K-40	7.27E+00	4.86E-01	14.96	0.6-1.66	7.63E+00	5.43E-01	0.95	Yes

Review of QC Soil Samples Acquired during FSS of Open Land Survey Units (continued)

Survey Unit	Description	Phase	Correct 84750 Table	Sample ID		Standard					QC			
				Standard	QC	Isotope	Activity	Error	Resolution	Range	Activity	Error	Ratio	Agreement
10211B	SE Corner of Restricted Area (Lakeshore)	3	Yes	L1-10211B-FSGS-014-SS	L1-10211B-FQGS-014-SS	K-40	6.80E+00	5.12E-01	13.28	0.6-1.66	7.24E+00	5.28E-01	0.94	Yes
				L1-10211B-FSGS-014-SB	L1-10211B-FQGS-014-SB	K-40	6.21E+00	4.69E-01	13.24	0.6-1.66	5.93E+00	4.43E-01	1.05	Yes
10212A	NE Corner of Exclusion Area - Lakeshore	4	Yes	L2-10212A-FSGS-005-SS	L2-10212A-FQGS-005-SS	Cs-137	1.32E-01	2.13E-02	6.20	0.5-2.0	1.62E-01	2.38E-02	0.81	Yes
				L2-10212A-FIGS-002-SS	L2-10212A-QIGS-002-SS	Cs-137	1.48E-01	1.97E-02	7.51	0.5-2.0	1.67E-01	1.97E-02	0.89	Yes
10212B	VCC Construction Area	4	Yes	L3-10212B-FRGS-002-SS	L3-10212B-FQGS-002-SS	K-40	6.49E+00	5.53E-01	11.74	0.6-1.66	6.97E+00	5.41E-01	0.93	Yes
				L3-10212B-FIGS-001-SS	L3-10212B-QIGS-001-SS	K-40	4.10E+00	3.63E-01	11.29	0.6-1.66	3.78E+00	3.51E-01	1.08	Yes
10212C	NE Corner of Exclusion Area - Lakeshore	4	Yes	L1-10212C-FSGS-002-SS	L1-10212C-FQGS-002-SS	K-40	6.82E+00	5.26E-01	12.97	0.6-1.66	7.05E+00	5.40E-01	0.97	Yes
				L1-10212C-FSGS-011-SS	L1-10212C-FQGS-011-SS	Cs-137	1.29E-01	1.82E-02	7.09	0.5-2.0	1.59E-01	2.31E-02	0.81	Yes
10212D	NE Corner of Exclusion Area - Lakeshore	4	Yes	L1-10212D-FSGS-106-SS	L1-10212D-FQGS-106-SS	Cs-137	1.21E-01	1.96E-02	6.17	0.5-2.0	1.24E-01	2.01E-02	0.98	Yes
				L1-10212D-FSGS-111-SS	L1-10212D-FQGS-111-SS	K-40	5.24E+00	4.12E-01	12.72	0.6-1.66	4.72E+00	4.02E-01	1.11	Yes
10213A	NE Corner of Exclusion Area	4	Yes	L2-10213A-FSGS-005-SS	L2-10213A-FQGS-005-SS	Cs-137	8.51E-02	1.52E-02	5.60	0.5-2.0	6.60E-02	1.64E-02	1.29	Yes
10213B	NE Corner of Exclusion Area	4	Yes	L1-10213B-FSGS-015-SS	L1-10213B-FQGS-015-SS	Cs-137	3.47E+00	2.17E-01	15.99	0.6-1.66	2.64E+00	1.74E-01	1.31	Yes
				L1-10213B-FIGS-001-SS	L1-10213B-QIGS-001-SS	Cs-137	2.17E-01	2.84E-02	7.64	0.5-2.0	3.75E-01	3.86E-02	0.58	Yes
						K-40	7.38E+00	5.66E-01	13.04	0.6-1.66	6.56E+00	5.60E-01	1.13	Yes
10213C	NE Corner of Exclusion Area	4	Yes	L1-10213C-FSGS-004-SS	L1-10213C-FQGS-004-SS	Cs-137	1.17E-01	2.00E-02	5.85	0.5-2.0	7.84E-02	1.75E-02	1.49	Yes
				L1-10213C-FIGS-001-SS	L1-10213C-QIGS-001-SS	Cs-137	3.55E-01	3.42E-02	10.38	0.6-1.66	4.82E-01	4.03E-02	0.74	Yes
10214A	Construction Parking Area	4	Yes	L2-10214A-FSGS-002-SS	L2-10214A-FQGS-002-SS	K-40	5.52E+00	4.16E-01	13.27	0.6-1.66	5.34E+00	4.12E-01	1.03	Yes
				L2-10214A-FIGS-001-SS	L2-10214A-QIGS-001-SS	Cs-137	9.50E-02	2.27E-02	4.19	0.5-2.0	1.14E-01	2.11E-02	0.83	Yes
10214B	Construction Parking Area	4	Yes	L2-10214B-FSGS-006-SS	L2-10214B-FQGS-006-SS	K-40	2.13E+00	2.68E-01	7.95	0.5-2.0	2.22E+00	2.64E-01	0.96	Yes
				L2-10214B-FIGS-001-SS	L2-10214B-QIGS-001-SS	K-40	7.90E+00	4.55E-01	17.36	0.6-1.66	7.35E+00	5.70E-01	1.07	Yes
10214C	Construction Parking Area	4	Yes	L2-10214C-FSGS-012-SS	L2-10214C-FQGS-012-SS	K-40	3.47E+00	3.24E-01	10.71	0.6-1.66	3.94E+00	3.52E-01	0.88	Yes
				L2-10214C-FIGS-001-SS	L2-10214C-QIGS-001-SS	K-40	7.64E+00	5.16E-01	14.81	0.6-1.66	7.46E+00	5.10E-01	1.02	Yes
10214D	Construction Parking Area	4	Yes	L2-10214D-FSGS-014-SS	L2-10214D-FQGS-014-SS	K-40	3.49E+00	3.50E-01	9.97	0.6-1.66	3.51E+00	3.47E-01	0.99	Yes
				L2-10214D-FIGS-001-SS	L2-10214D-QIGS-001-SS	Cs-137	6.57E-02	1.73E-02	3.80	N/A	7.67E-02	1.70E-02	0.86	No
						K-40	7.52E+00	5.36E-01	14.03	0.6-1.66	7.95E+00	5.51E-01	0.95	Yes
10214E	Construction Parking Area	4	Yes	L1-10214E-FSGS-008-SS	L1-10214E-FQGS-008-SS	K-40	8.27E+00	5.96E-01	13.88	0.6-1.66	6.83E+00	5.22E-01	1.21	Yes
				L1-10214E-FIGS-001-SB	L1-10214E-QIGS-001-SB	K-40	6.03E+00	4.27E-01	14.12	0.6-1.66	6.28E+00	4.51E-01	0.96	Yes
10214F	Construction Parking Area	4	Yes	L1-10214F-FSGS-011-SS	L1-10214F-FQGS-011-SS	K-40	2.57E+00	2.77E-01	9.28	0.6-1.66	2.43E+00	2.68E-01	1.06	Yes
				L1-10214F-FIGS-001-SS	L1-10214F-QIGS-001-SS	K-40	6.67E+00	4.96E-01	13.45	0.6-1.66	6.38E+00	4.75E-01	1.05	Yes
10219A	Area Far South of Switchyard	1	Yes	L3-10219A-FRGS-006-SS	L3-10219A-FRGS-006-SS	K-40	7.19E+00	1.78E+00	4.04	0.5-2.0	7.49E+00	1.78E+00	0.96	Yes
				L3-10219A-FRGS-014-SS	L3-10219A-FRGS-014-SS	K-40	7.46E+00	1.75E+00	4.26	0.5-2.0	6.81E+00	1.74E+00	1.10	Yes
10219B	Area Far South of Switchyard	1	Yes	L3-10219B-FRGS-012-SS	L3-10219B-FQGS-012-SS	Cs-137	1.56E-01	8.54E-02	1.83	N/A	2.67E-01	1.16E-01	0.58	Yes
10220A	SE Corner of Exclusion Area – Lakeshore	4	Yes	L1-10220A-FSGS-105-SS	L1-10220A-FQGS-105-SS	K-40	5.36E+00	4.58E-01	11.70	0.6-1.66	6.08E+00	4.73E-01	0.88	Yes
				L1-10220A-FSGS-121-SS	L1-10220A-FQGS-121-SS	K-40	5.01E+00	4.01E-01	12.49	0.6-1.66	5.09E+00	4.08E-01	0.98	Yes
				L1-10220A-FIGS-001-SS	L1-10220A-QIGS-001-SS	K-40	5.65E+00	4.22E-01	13.39	0.6-1.66	6.43E+00	4.54E-01	0.88	Yes
10220B	SE Corner of Exclusion Area - Inland	3	Yes	L1-10220B-FSGS-008-SS	L1-10220B-FQGS-008-SS	K-40	5.02E+00	4.08E-01	12.30	0.6-1.66	5.25E+00	4.37E-01	0.96	Yes
10220C	Adjacent of South Restricted Area (Lakeshore)	1	Yes	L3-10220C-FRGS-011-SS	L3-10220C-FQGS-011-SS	Cs-137	1.65E-01	3.68E-02	4.48	0.5-2.0	1.95E-01	4.52E-02	0.85	Yes
10220D	SE Corner of Exclusion Area - Inland	3	Yes	L1-10220D-FSGS-008-SS	L1-10220D-FQGS-008-SS	K-40	4.79E+00	4.26E-01	11.24	0.6-1.66	5.57E+00	5.88E-01	0.86	Yes

Review of QC Soil Samples Acquired during FSS of Open Land Survey Units (continued)

Survey Unit	Description	Phase	Correct 84750 Table	Sample ID		Standard					QC			
				Standard	QC	Isotope	Activity	Error	Resolution	Range	Activity	Error	Ratio	Agreement
10220E	SE Corner of Exclusion Area - Inland	3	Yes	L1-10220E-FSGS-011-SS	L1-10220E-FQGS-011-SS	K-40	5.23E+00	4.30E-01	12.16	0.6-1.66	5.49E+00	4.21E-01	0.95	Yes
10220F	SE Corner of Exclusion Area - Inland	3	No	L1-10220F-FSGS-013-SS	L1-10220F-FQGS-013-SS	K-40	2.85E+00	3.30E-01	8.64	0.6-1.66	3.45E+00	3.47E-01	0.83	Yes
10220G	SE Corner of Exclusion Area - Inland	3	No	L1-10220G-FSGS-010-SS	L1-10220G-FQGS-010-SS	K-40	5.02E+00	3.90E-01	12.87	0.6-1.66	4.65E+00	3.53E-01	1.08	Yes
				L1-10220G-FSGS-010-SB	L1-10220G-FQGS-010-SB	K-40	5.12E+00	3.87E-01	13.23	0.6-1.66	5.71E+00	4.12E-01	0.90	Yes
10220H	SE Corner of Exclusion Area – Lakeshore	4	No	L1-10220H-FSGS-006-SS	L1-10220H-FQGS-006-SS	K-40	4.89E+00	4.17E-01	11.73	0.6-1.66	5.26E+00	4.17E-01	0.93	Yes
				L1-10220H-FJGS-004-SS	L1-10220H-QJGS-004-SS	Cs-137	9.48E-01	6.36E-02	14.91	0.6-1.66	4.74E-01	3.52E-02	2.00	Yes
						K-40	6.49E+00	3.88E-01	16.73	0.75-1.33	6.17E+00	3.71E-01	1.05	Yes
10220I	SE Corner of Exclusion Area – Lakeshore	4	No	L1-10220I-FSGS-006-SS	L1-10220I-FQGS-006-SS	K-40	5.87E+00	4.50E-01	13.04	0.6-1.66	6.80E+00	4.95E-01	0.86	Yes
				L1-10220I-FJGS-005-SS	L1-10220I-QJGS-005-SS	Cs-137	1.54E+00	1.10E-01	14.00	0.6-1.66	1.41E+00	1.03E-01	1.09	Yes
10220J	SE Corner of Exclusion Area - Inland	3	No	L1-10220J-FSGS-003-SS	L1-10220J-FQGS-003-SS	K-40	5.80E+00	4.69E-01	12.37	0.6-1.66	4.59E+00	3.75E-01	1.26	Yes
10221A	South of Protected Area - Inland	4	Yes	L1-10221A-FSGS-005-SS	L1-10221A-FQGS-005-SS	K-40	4.52E+00	3.97E-01	11.39	0.6-1.66	6.10E+00	4.78E-01	0.74	Yes
				L1-10221A-FIGS-001-SS	L1-10221A-QIGS-001-SS	Cs-137	7.50E+00	4.66E-01	16.09	0.75-1.33	7.26E+00	4.51E-01	1.03	Yes
				L1-10221A-FJGS-001-SS	L1-10221A-QJGS-001-SS	K-40	7.94E+00	5.58E-01	14.23	0.6-1.66	4.97E+00	4.02E-01	1.60	Yes
				L1-10221A-FIGS-001-SB	L1-10221A-QIGS-001-SB	Cs-137	3.70E-01	3.57E-02	10.36	0.6-1.66	6.99E-01	5.66E-02	0.53	No
						K-40	7.97E+00	5.50E-01	14.49	0.6-1.66	7.18E+00	5.47E-01	1.11	Yes
				L1-10221A-FSGS-107-SS	L1-10221A-FQGS-107-SS	K-40	6.19E+00	4.81E-01	12.87	0.6-1.66	6.13E+00	4.93E-01	1.01	Yes
				L1-10221A-FSGS-111-SS	L1-10221A-FQGS-111-SS	K-40	6.14E+00	4.31E-01	14.25	0.6-1.66	5.62E+00	4.11E-01	1.09	Yes
10221B	South of Protected Area - Inland	3	No	L1-10221B-FSGS-001-SS	L1-10221B-FQGS-001-SS	K-40	2.60E+00	2.55E-01	10.20	0.6-1.66	3.08E+00	2.81E-01	0.84	Yes
				L1-10221B-FJGS-001-SS	L1-10221B-QJGS-001-SS	K-40	3.00E+00	2.98E-01	10.07	0.6-1.66	3.24E+00	3.02E-01	0.93	Yes
10221C	South of Protected Area - Inland	4	Yes	L1-10221C-FSGS-012-SS	L1-10221C-FQGS-012-SS	Cs-137	3.18E-01	3.23E-02	9.85	0.6-1.66	1.52E-01	1.95E-02	2.09	No
						K-40	9.45E+00	6.26E-01	15.10	0.6-1.66	9.89E+00	6.29E-01	0.96	Yes
				L1-10221C-FJGS-001-SS	L1-10221C-QJGS-001-SS	K-40	3.82E+00	3.25E-01	11.75	0.6-1.66	3.01E+00	2.77E-01	1.27	Yes
				L1-10221C-FIGS-110-SS	L1-10221C-QIGS-110-SS	K-40	3.53E+00	3.37E-01	10.47	0.6-1.66	2.93E+00	3.06E-01	1.20	Yes
10221D	South of Protected Area - Inland	4	Yes	L1-10221D-FSGS-009-SS	L1-10221D-FQGS-009-SS	K-40	5.67E+00	4.53E-01	12.52	0.6-1.66	5.00E+00	4.34E-01	1.13	Yes
				L1-10221D-FJGS-001-SS	L1-10221D-QJGS-001-SS	K-40	2.34E+00	2.69E-01	8.70	0.6-1.66	2.48E+00	2.56E-01	0.94	Yes
				L1-10221D-FIGS-013-SS	L1-10221D-QIGS-013-SS	Cs-137	5.75E-01	4.90E-02	11.73	0.6-1.66	3.23E-01	3.17E-02	1.78	No
						K-40	6.32E+00	4.79E-01	13.19	0.6-1.66	6.07E+00	4.55E-01	1.04	Yes
10221E	South of Protected Area - Lakeshore	3	Yes	L1-10221E-FSGS-015-SS	L1-10221E-FQGS-015-SS	K-40	7.92E+00	5.73E-01	13.82	0.6-1.66	8.82E+00	5.75E-01	0.90	Yes
10221F	South of Protected Area - Lakeshore	3	Yes	L1-10221F-FSGS-004-SS	L1-10221F-FQGS-004-SS	K-40	7.05E+00	5.55E-01	12.70	0.6-1.66	6.56E+00	4.93E-01	1.07	Yes
10221G	South of Protected Area - Lakeshore	3	No	L1-10221G-FSGS-002-SS	L1-10221G-FQGS-002-SS	K-40	6.26E+00	4.70E-01	13.32	0.6-1.66	5.43E+00	4.29E-01	1.15	Yes
10221H	South of Protected Area - Lakeshore	3	No	L1-10221H-FSGS-015-SS	L1-10221H-FQGS-015-SS	K-40	3.20E+00	3.17E-01	10.09	0.6-1.66	3.34E+00	3.12E-01	0.96	Yes
10222	North Beach Area	1	Yes	L3-10222A-FRGS-007-SS	L3-10222A-FQGS-007-SS	K-40	3.55E+00	3.49E-01	10.17	0.6-1.66	4.39E+00	3.88E-01	0.81	Yes
10223	Power Block Beach Area	1	Yes	L3-10223A-FRGS-014-SS	L3-10223A-FQGS-014-SS	K-40	4.24E+00	8.73E-01	4.86	0.5-2.0	4.84E+00	9.37E-01	0.88	Yes
10224	South Beach Area	1	Yes	L3-10224A-FRGS-006-SS	L3-10224A-FQGS-006-SS	K-40	4.01E+00	8.41E-01	4.77	0.5-2.0	3.82E+00	8.18E-01	1.05	Yes
10301	West Training Area	1	Yes	L3-10301A-FRGS-010-SS	L3-10301A-FQGS-010-SS	K-40	7.83E+00	1.08E+00	7.25	0.6-1.66	8.25E+00	1.17E+00	0.95	Yes
12101	WWTF Sludge Drying Bed Area	3	No	L1-12101A-FSGS-009-SS	L1-12101A-FQGS-009-SS	K-40	8.60E+00	4.26E-01	20.19	0.75-1.33	7.77E+00	4.65E-01	1.11	Yes
12102	WWTF Sludge Drying Bed Area	3	No	L1-12102A-FSGS-003-SS	L1-12102A-FQGS-003-SS	K-40	1.75E+01	8.93E-01	19.60	0.75-1.33	1.68E+01	8.65E-01	1.04	Yes
12103	WWTF Sludge Drying Bed Area	3	No	L1-12103A-FSGS-008-SS	L1-12103A-FQGS-008-SS	K-40	9.72E+00	5.49E-01	17.70	0.75-1.33	9.77E+00	5.49E-01	0.99	Yes

Review of QC Soil Samples Acquired during FSS of Open Land Survey Units (continued)

Survey Unit	Description	Phase	Correct 84750 Table	Sample ID		Standard					QC			
				Standard	QC	Isotope	Activity	Error	Resolution	Range	Activity	Error	Ratio	Agreement
12104	North Half of Unit 2 Containment	4	Yes	L1-12104A-FSGS-013-SS	L1-12104A-FQGS-013-SS	K-40	9.13E+00	6.12E-01	14.92	0.6-1.66	9.38E+00	6.21E-01	0.97	Yes
12105	South Half of Unit 2 Containment	4	Yes	L1-12105A-FSGS-002-SS	L1-12105A-FQGS-002-SS	K-40	9.79E+00	6.30E-01	15.54	0.6-1.66	9.00E+00	6.04E-01	1.09	Yes
12106	North Half of Fuel & Auxiliary Buildings	4	Yes	L1-12106A-FSGS-016-SS	L1-12106A-FQGS-016-SS	K-40	9.53E+00	5.90E-01	16.15	0.75-1.33	9.45E+00	5.88E-01	1.01	Yes
12107	South Half of Fuel & Auxiliary Buildings	4	Yes	L1-12107A-FSGS-009-SS	L1-12107A-FQGS-009-SS	K-40	9.06E+00	5.89E-01	15.38	0.6-1.66	9.06E+00	5.91E-01	1.00	Yes
12108	North Half of Unit 1 Containment	4	Yes	L1-12108A-FSGS-001-SS	L1-12108A-FQGS-001-SS	K-40	8.83E+00	5.65E-01	15.63	0.6-1.66	8.42E+00	5.40E-01	1.05	Yes
12109	South Half of Unit 1 Containment	4	Yes	L1-12109A-FSGS-012-SS	L1-12109A-FQGS-012-SS	K-40	8.70E+00	5.88E-01	14.80	0.6-1.66	8.59E+00	5.78E-01	1.01	Yes
12110	Yard Between Unit 1 Containment and Turbine	4	Yes	L1-12110A-FSGS-006-SS	L1-12110A-FQGS-006-SS	K-40	9.03E+00	6.22E-01	14.52	0.6-1.66	8.62E+00	6.06E-01	1.05	Yes
12111	South Yard Area Northeast of Gate House	4	Yes	L1-12110A-FSGS-006-SS	L1-12110A-FQGS-006-SS	K-40	9.34E+00	6.26E-01	14.92	0.6-1.66	8.62E+00	6.10E-01	1.08	Yes
				L1-12111A-FJGS-001-SS	L1-12111A-QJGS-001-SS	K-40	8.52E+00	5.91E-01	14.42	0.6-1.66	8.61E+00	5.80E-01	0.99	Yes
12112	Unit 1 PWST/SST Area West	3	No	L1-12112A-FSGS-014-SS	L1-12112A-FQGS-014-SS	Cs-137	3.82E-02	9.83E-03	3.89	N/A	2.35E-01	2.63E-02	0.16	No
						K-40	7.85E+00	4.68E-01	16.77	0.75-1.33	7.29E+00	5.16E-01	1.08	Yes
				L1-12112A-FIGS-002-SS	L1-12112A-QIGS-002-SS	Cs-137	5.48E-02	2.75E-02	1.99	N/A	3.02E-02	1.87E-02	1.81	No
						K-40	1.61E+01	1.62E+00	9.94	0.6-1.66	1.73E+01	1.66E+00	0.93	Yes
12113	Unit 1 PWST/SST Area West	3	Yes	L1-12113A-FSGS-005-SS	L1-12113A-FQGS-005-SS	K-40	1.06E+01	6.44E-01	16.46	0.75-1.33	1.15E+01	7.33E-01	0.92	Yes
12201A	North Protected Area Yard	4	Yes	L1-12201A-FSGS-017-SS	L1-12201A-FQGS-017-SS	K-40	9.46E+00	5.88E-01	16.09	0.6-1.66	9.56E+00	5.97E-01	0.99	Yes
12201B	North Protected Area Yard	4	Yes	L1-12201B-FSGS-007-SS	L1-12201B-FQGS-007-SS	K-40	8.85E+00	6.10E-01	14.51	0.6-1.66	9.91E+00	6.54E-01	0.89	Yes
12201C	North Protected Area Yard	4	Yes	L1-12201C-FSGS-007-SS	L1-12201C-FQGS-007-SS	K-40	9.33E+00	6.04E-01	15.45	0.6-1.66	8.89E+00	5.91E-01	1.05	Yes
12201D	North Protected Area Yard	4	Yes	L1-12201D-FSGS-207-SS	L1-12201D-FQGS-207-SS	Cs-137	1.01E-01	1.82E-02	5.55	0.5-2.0	7.72E-02	1.86E-02	1.31	Yes
				L1-12201D-FIGS-001-SS	L1-12201D-QIGS-001-SS	K-40	4.26E+00	3.40E-01	12.53	0.6-1.66	4.41E+00	3.44E-01	0.97	Yes
12201E	North Protected Area Yard	4	Yes	L1-12201E-FSGS-014-SS	L1-12201E-FQGS-014-SS	K-40	7.63E+00	5.47E-01	13.95	0.6-1.66	7.17E+00	5.55E-01	1.06	Yes
12202A	Gate House and Southwest Yard	4	Yes	L1-12202A-FSGS-014-SS	L1-12202A-FQGS-014-SS	K-40	9.64E+00	5.99E-01	16.09	0.75-1.33	9.82E+00	6.05E-01	0.98	Yes
12202B	Gate House and Southwest Yard	4	Yes	L1-12202B-FSGS-007-SS	L1-12202B-FQGS-007-SS	K-40	8.19E+00	5.63E-01	14.55	0.6-1.66	8.75E+00	5.96E-01	0.94	Yes
12202C	Gate House and Southwest Yard	4	Yes	L1-12202C-FSGS-010-SS	L1-12202C-FQGS-010-SS	K-40	9.67E+00	6.51E-01	14.85	0.6-1.66	9.79E+00	6.90E-01	0.99	Yes
12202D	Gate House and Southwest Yard	4	Yes	L1-12202D-FSGS-004-SS	L1-12202D-FQGS-004-SS	K-40	7.88E+00	5.65E-01	13.95	0.6-1.66	7.93E+00	5.67E-01	0.99	Yes
12202E	Gate House and Southwest Yard	4	Yes	L1-12202E-FSGS-004-SS	L1-12202E-FQGS-004-SS	K-40	7.44E+00	5.30E-01	14.04	0.6-1.66	7.94E+00	5.71E-01	0.94	Yes
				L1-12202E-FJGS-001-SS	L1-12202E-QJGS-001-SS	K-40	6.59E+00	4.83E-01	13.64	0.6-1.66	6.84E+00	4.99E-01	0.96	Yes
12202F	Gate House and Southwest Yard	4	Yes	L1-10202F-FRGS-008-SS	L1-10202F-FQGS-008-SS	K-40	7.42E+00	5.14E-01	14.44	0.6-1.66	6.38E+00	4.85E-01	1.16	Yes
				L1-10202F-FJGS-001-SS	L1-10202F-QJGS-001-SS	K-40	7.95E+00	5.79E-01	13.73	0.6-1.66	8.93E+00	6.09E-01	0.89	Yes
12203A	Under Service Building and Southeast Yard	4	No	L1-12203A-FSGS-012-SS	L1-12203A-FQGS-012-SS	Cs-137	6.18E-02	1.53E-02	4.04	0.5-2.0	2.32E-01	2.27E-02	0.27	No
						K-40	1.48E+01	7.82E-01	18.93	0.75-1.33	1.01E+01	5.67E-01	1.47	No
				L1-12203A-FIGS-010-SS	L1-12203A-QIGS-010-SS	Cs-137	2.67E-02	8.57E-03	3.12	N/A	3.17E-02	7.94E-03	0.84	No
						K-40	7.83E+00	4.69E-01	16.70	0.75-1.33	9.81E+00	5.12E-01	0.80	Yes
				L1-12203A-FIGS-001-SB	L1-12203A-QIGS-001-SB	K-40	1.63E+01	9.18E-01	17.76	0.75-1.33	1.48E+01	9.11E-01	1.10	Yes
				L1-12203A-FIGS-014-SS	L1-12203A-QIGS-014-SS	Cs-137	8.13E-02	1.19E-02	6.83	0.5-2.0	2.40E-02	7.50E-03	3.39	Yes
						K-40	5.54E+00	3.37E-01	16.44	0.75-1.33	6.36E+00	3.79E-01	0.87	Yes
12203B	Under Service Building and Southeast Yard	3	Yes	L1-12203B-FSGS-004-SS	L1-12203B-FQGS-004-SS	K-40	3.70E+00	3.54E-01	10.45	0.6-1.66	4.52E+00	3.68E-01	0.82	Yes
12203C	Under Service Building and Southeast Yard	3	Yes	L1-12203C-FSGS-007-SS	L1-12203C-FQGS-007-SS	K-40	7.05E+00	5.14E-01	13.72	0.6-1.66	7.66E+00	5.38E-01	0.92	Yes
12203D	Under Service Building and Southeast Yard	3	Yes	L1-12203D-FSGS-004-SS	L1-12203D-FQGS-004-SS	K-40	8.21E+00	5.93E-01	13.84	0.6-1.66	9.24E+00	5.91E-01	0.89	Yes

Review of QC Soil Samples Acquired during FSS of Open Land Survey Units (continued)

Survey Unit	Description	Phase	Correct 84750 Table	Sample ID		Standard					QC			
				Standard	QC	Isotope	Activity	Error	Resolution	Range	Activity	Error	Ratio	Agreement
12204A	Crib House Area	3	Yes	L1-12204A-FSGS-015-SS	L1-12204A-FQGS-015-SS	K-40	1.06E+01	6.07E-01	17.46	0.75-1.33	9.95E+00	5.60E-01	1.07	Yes
12204B	Crib House Area	3	No	L1-12204B-FSGS-004-SS	L1-12204B-FQGS-004-SS	K-40	1.42E+01	7.18E-01	19.78	0.75-1.33	1.54E+01	8.17E-01	0.92	Yes
12204C	Crib House Area	3	No	L1-12204C-FSGS-001-SS	L1-12204C-FQGS-001-SS	K-40	8.95E+00	6.35E-01	14.09	0.6-1.66	1.31E+01	7.29E-01	0.68	Yes
				L1-12204C-FSGS-001-SB	L1-12204C-FQGS-001-SB	K-40	9.24E+00	4.72E-01	19.58	0.75-1.33	9.11E+00	5.05E-01	1.01	Yes
				L1-12204C-FSGS-002-SS	L1-12204C-FQGS-002-SS	Cs-137	8.47E-02	1.47E-02	5.76	0.5-2.0	6.04E-02	1.14E-02	1.40	Yes
12205A	Area Under the Turbine Building	4	Yes	L1-12205A-FSGS-107-SS	L1-12205A-FQGS-107-SS	K-40	9.75E+00	6.36E-01	15.33	0.6-1.66	9.85E+00	6.42E-01	0.99	Yes
				L1-12205A-FIGS-002-SS	L1-12205A-QIGS-002-SS	K-40	8.80E+00	5.86E-01	15.02	0.6-1.66	9.11E+00	5.95E-01	0.97	Yes
12205B	Area Under the Turbine Building	4	Yes	L1-12205B-FSGS-114-SS	L1-12205B-FQGS-114-SS	K-40	1.00E+01	6.12E-01	16.34	0.75-1.33	1.03E+01	6.34E-01	0.97	Yes
12205C	Area Under the Turbine Building	4	Yes	L1-12205C-FSGS-110-SS	L1-12205C-FQGS-110-SS	K-40	1.05E+01	6.73E-01	15.60	0.6-1.66	9.05E+00	6.18E-01	1.16	Yes
12205D	Area Under the Turbine Building	4	Yes	L1-12205D-FSGS-106-SS	L1-12205D-FQGS-106-SS	K-40	8.77E+00	6.00E-01	14.62	0.6-1.66	9.39E+00	6.56E-01	0.93	Yes
12205E	Area Under the Turbine Building	4	Yes	L1-12205E-FQGS-109-SS	L1-12205E-FQGS-109-SS	K-40	7.67E+00	5.31E-01	14.44	0.6-1.66	7.33E+00	5.52E-01	1.05	Yes
				L1-12205E-QIGS-101-SS	L1-12205E-QIGS-101-SS	K-40	8.35E+00	5.64E-01	14.80	0.6-1.66	8.19E+00	5.61E-01	1.02	Yes

NRC RAI Question #13c Provide additional information on what is meant in QC investigations that state "the same conclusion was reached for each measurement" and therefore no further action is necessary.

RESPONSE: Zion*Solutions* offers the following clarification on what is meant in QC investigations that state "the same conclusion was reached for each measurement and therefore no further action is necessary."

For a replicate scan measurement, the same conclusion is reached if the replicate scan confirms the alarm status of the original scan measurement. For example, if an alarm is produced in the original scan, agreement would be reached if an alarm was identified in the replicate scan.

For a replicate static measurement (i.e., buried pipe, embedded pipe, and penetration survey units), the same conclusion is reached if both the standard and replicate static measurements are above or below the OpDCGL (i.e., the same dose conclusion is reached).

For duplicate or split volumetric samples and replicate ISOCS measurements, the same conclusion is reached if both standard and comparison sample or measurement activities are above or below the OpDCGL (i.e., the same dose conclusion is reached).

NRC RAI Question #13d Provide a discussion of the supplementary QC steps that were taken, in addition to the use of a K-40 concentration comparison, in the data assessments for the survey units. The NRC staff notes that K-40 should not, by itself, be considered a substitute for explaining the QC assessment results. The licensee should supplement the QC analyses with other data analysis considerations and/or discussion of the various QA/QC processes that lead to confidence in the data assessment results (e.g., different MDCs for the ROCs in the samples, heterogeneity of soil samples, use of spiked samples, sample reanalysis, etc.).

RESPONSE: All gamma spectroscopy reports for each FSS sample, including QC samples is subjected to data validation in accordance with section 5.1 of ZS-LT-300-001-004, "Final Status Survey Data Assessment", which includes the following:

- Verification that unique sample identification number is consistent between the sample analysis report, the Chain-of-Custody (CoC) form and the FSS sample plan.
- Verification that the recorded date & time is consistent with the CoC form (if applicable) and the FSS Sample Plan.
- Verification that the data is complete and that there are no missing results or supporting data, including but not limited to MDC, uncertainty, background, geometry, or methods of analysis.
- Verification that the MDC of the instrument used for analysis was adequate to detect all ROC or gross activity at the target MDC values specified in the FSS Sample Plan.

- Verification that the absence of anomalies in the sample or measurement results, or in the supporting data, including but not limited to MDC, uncertainty, deviation from established procedure or analysis flags.

Following data validation, additional confidence in the data assessment results is obtained using Attachment 10, "Final Status Survey Data Quality Objectives Review Checklist" from procedure ZS-LT-300-001-004. Using the checklist, the FSS sample plan, the sample instructions, the Field Notes, survey records and/or data analysis reports are reviewed to ensure that the DQOs used for the survey design were applicable and valid.

The QC process/requirements specified for FSS as documented in the LTP, the QAPP and the implementing procedures were performed and achieved during FSS. Based on the implementation of the existing QC processes and the observed results, no additional supplementary QC steps were considered or performed.

NRC RAI Question #13e Please describe the QC steps used for the ISOCS measurements, including the use of replicate or duplicate measurements and comparisons to core sample analysis for the survey units where ISOCS was a primary measurement instrument. The licensee should clarify if the ISOCS QC measurements are replicate measurements or duplicate measurements. This clarification should address the use of NRC Inspection Procedure 84750, "Radioactive Waste Treatment and Effluent and Environmental Monitoring," for ISOCS QC measurements, rather than other evaluation methods described in the QAPP that are used to evaluate results from other measurement systems, such as pipe detectors, that provide radiological data in the same units (pCi per square meter).

<u>RESPONSE:</u> This information has been provided in the response to Additional NRC Question #2 (Additional NRC Questions on Zion FSS Reports –October 8, 2020 Conference Call).

NRC RAI Question #13f For the duplicate or split measurements that had inadequate resolution, ensure that the licensee is applying Table 4-1 of the QAPP for resolution values.

<u>RESPONSE:</u> This information has been provided in the responses to Additional NRC Question #2 (Additional NRC Questions on Zion FSS Reports –October 8, 2020 Conference Call) and NRC RAI Question #13b.

NRC RAI Question #13g For instances where there was high resolution in both the standard and comparison samples, but the comparison failure is attributed to "relatively low concentrations" please provide additional information as per the above bullets in the path forward.

RESPONSE: This information has been provided in the responses to Additional NRC Question #2 (Additional NRC Questions on Zion FSS Reports –October 8, 2020 Conference Call) and NRC RAI Question #13b.

NRC RAI Question #14a Review the aforementioned release records to determine the potential for discrete particles of Co-60 in the sample matrix. It is recommended the licensee provide further explanation of the Co-60 results, besides attributing the results to relatively low concentration of Co-60 in the samples matrix.

RESPONSE: ZionSolutions performed a review of the aforementioned release records to determine the potential for discrete particles of Co-60 in the sample matrix. A discrete radioactive particle as defined in procedure ZS-RP-106-002-005 was encountered in survey unit 10202D during FSS. After the small particle was removed from the soil matrix of sample L1-10202D-FIGS-001-SS, the sample was counted, which resulted in an OpSOF of 0.034. Discrete radioactive particles were not encountered in three of the four survey units cited as examples in the basis for this question. Rather, the Co-60 concentrations cited for survey units 10220H, 10220I, and 10221A are considered as low-level residual radioactivity positively detected at concentrations greater than the instrument MDC. In these three survey units (10220H, 10220I, and 10221A), the cognizant Radiological Engineer listed Co-60 as an isotope to establish agreement between the standard and QC sample. While not a violation of procedure, use of Co-60 as a comparable radionuclide to establish QC agreement is technically not recommended due to the particulate nature of Co-60 and the inherent inability to completely homogenize the soil matrix between two split soil aliquots. In all three cases, agreement was reached, either using Cs-137 or K-40.

A discussion of the scan sensitivity to adequately detect particles comprised solely of Co-60 by the Ludlum Model 44-10 NaI detector is addressed in the response to NRC RAI Question #11a.

NRC RAI Question #15a The licensee should perform a comparison of the onsite laboratory results to the Eberline results and investigate the potential differences between the labs.

RESPONSE: The on-site laboratory results and the Eberline results have been compared and the potential differences investigated. The results and conclusions of the comparison are presented below.

A total of 183 soil samples were collected for QC comparison during the performance of FSS. All of the 183 soil samples were analyzed by the on-site gamma spectroscopy system. Of the 183 QC samples, 27 split samples, representing 22 open land survey units, were sent to Eberline Laboratories for gamma spectroscopy and HTD analysis. This population of 27 samples is used for the investigation in this response and is sufficient to make statistical conclusions about the entire sample population.

Section 4.2.1 of the QAPP states, "During the performance of FSS, approximately 5% of the total number of split samples taken will be sent for analysis by a qualified off-site laboratory." The 27 split soil samples meet the 5% frequency specified in the QAPP.

Sample results for Cs-137 between the on-site and off-site laboratories were evaluated using the methodology described in NRC Inspection Procedure No. 84750. The results were acceptable in 8 of the 27 sample comparisons. Ten (10) results were not acceptable. Nine (9) of the samples had a resolution for Cs-137 of less than 4 and therefore were not required to be assessed. Cs-137 was positively detected at concentrations greater than MDC in all of the standard and comparison samples.

The results of the evaluation using NRC Inspection Procedure No. 84750 are presented in the table below.

Number of sample pairs evaluated	Number meeting NRC IP criteria	Number not meeting NRC IP criteria	Number with resolution less than 4
27	8	10	9

The sample results for Cs-137 were also evaluated using the methodology presented in Appendix C of NUREG-1576, "Multi-Agency Radiological Laboratory Analytical Protocols Manual" (MARLAP). The results of the evaluation indicated that 22 of the 27 comparisons were below the warning limit. Five (5) comparisons were above the warning limit, and of those, 2 comparisons were also above the control limit. One of the two samples that were greater than the control limit was an investigation sample for an elevated area as summarized in the table below.

Number of sample pairs evaluated	Number meeting MARLAP App. C criteria	Number > Warning Limit	Number > Control Limit
27	22	5	2

The potential causes in the difference in the results has been investigated. It is speculated that a potential contributing cause is the preparation methodology of the samples. The basis for this reasoning is detailed below in the response to NRC RAI Question #15c.

NRC RAI Question #15b Describe how radionuclide concentration data from the onsite Zion gamma spectroscopy laboratory and the off-site Eberline Laboratories measurements for the same samples were evaluated and compared under the Zion QAPP.

<u>RESPONSE:</u> The results from the on-site Zion gamma spectroscopy laboratory and the off-site Eberline Laboratories measurements for the 27 split samples were compared following Section 4.2.2 of the QAPP and MARLAP protocol (see the response to #15a above).

NRC RAI Question #15c Provide additional information on the samples analyzed by both laboratories. For example, provide information on whether the samples analyzed by each laboratory were the same sample, split samples, or separate samples taken from the same location. In addition, provide information on differences in sample preparation between the two laboratories, and any other differences (e.g., analytical method) that could explain why the onsite laboratory generally reported lower concentrations than Eberline Laboratories.

<u>RESPONSE:</u> The samples sent off-site to Eberline were split samples, a sample in which the original sample aliquot is separated into two aliquots in the sample preparation area and analyzed as separate samples. One aliquot was typically analyzed on-site and the other sent to Eberline for gamma spectroscopy and HTD analysis. The use of split samples can produce differing results, since sample heterogeneity may differ from one sample to the other.

At Zion, soil samples were prepared for analysis in accordance with Section 5.1 of ZS-LT-100-001-004, "Sample Media Preparation." The procedure describes the process to sufficiently dry and homogenize the soil media prior to analyzing the sample with the on-site gamma spectroscopy system. The procedure also states, "If the soil sample is to be sent to an off-site laboratory for analysis, then only dry the sample if directed by the survey instructions." Zion*Solutions* did not dry or homogenize soil sample media that was intended for off-site analysis, and sample preparation was performed by Eberline.

Differences in sample preparation can result in discrepancies in sample results, including sample homogenization, differences in sample weight and volume, and differences in moisture percentage. These are all factors that could contribute to a consistent reporting of higher radionuclide concentrations.

In addition, the Zion gamma spectroscopy laboratory counted soil samples in 1-liter Marinelli containers, while a split of this sample was sent to Eberline, which also had additional analyses performed. Therefore, there was a difference in sample volume for analysis by gamma spectroscopy which can highlight sample heterogeneity issues. It also should be noted that while the Eberline results seem to be higher than the on-site results, the on-site analysis routinely achieved slightly lower MDCs.

Laboratory Differences in Sample Prep and Analysis

<u>On-site Sample Preparation</u>

1. Remove large rocks, vegetation, and foreign materials, and break the remainder into small clumps.

2. Place a sufficient amount of sample into a clean sample-drying container.
3. Dry the sample using a drying oven until all visible traces of moisture are removed (typically 6 to 12 hours).
4. Break the blend into a fine homogeneous mixture and transfer into an approved container (typically a 1-liter Marinelli), after determining the sample mass, for gamma spectroscopy.

Off-site (Eberline) Sample Preparation

1. From the split sample collected at the site, the sample is packaged and sent to the laboratory with no sample preparation.
2. If the analysis of volatile radionuclides (i.e., H-3, Tc-99, or I-129) is requested, then thoroughly mix the sample and remove approximately 50 grams for separate processing and analysis.
3. For soil samples that require drying, determine the sample mass and transfer to a drying pan.
4. Place samples into a pre-heated drying oven at 104 degrees Celsius for 12 hours or until dry and re-weigh after drying.
5. Using a pulverizer, pulverize each sample to the appropriate mash size, unless other instructions are given from the laboratory manager.
6. After pulverization, blend each sample until homogeneous.
7. Transfer each sample into a container close to the standard counting geometry (volume and mass). Weigh each sample and proceed with gamma spectroscopy.

From the above, it is clear that the Eberline sample preparation is likely to create soil samples that are more homogeneous compared to the on-site soil preparation and that the drying method is more uniform. Also, it is clear that each analysis is of different sample media.

These differences in sample preparation and analysis could account for a bias in the gamma spectroscopy results between the laboratories.

NRC RAI Question #15d Given the differences between the onsite measurements and the measurements made by Eberline Laboratories, additional justification is needed to provide assurance that the onsite gamma spectroscopy results were not underreporting the concentration of residual radioactivity in the samples analyzed onsite.

RESPONSE:

The reported results by both Eberline and the on-site gamma spectroscopy system were both valid and acceptable for use as FSS data. This conclusion was reached based on the following:

- Both gamma spectroscopy systems were calibrated with NIST traceable sources.
- Both systems were subjected to and passed daily operational checks, including pre- and post-use source checks against a standardized source.
- All sample analysis reports were validated in accordance with procedure ZS-LT-300-001-004, "Final Status Survey Data Assessment."

Even though the sample comparison indicated a consistent reporting of higher concentrations of gamma-emitting radionuclides by the off-site gamma spectroscopy system verses the on-site gamma spectroscopy system, and several sample comparisons between the on-site and off-site results did not show acceptable agreement using the resolution table from Inspection Procedure No. 84750, most samples were acceptable following the MARLAP protocol. Based upon the results of the review, it was concluded that the reported results by both Eberline and the on-site gamma spectroscopy system were both valid and acceptable for use as FSS data.

In conclusion, when comparing the replicate analysis of the same sample, the radionuclide concentrations for gamma-emitting ROC that were reported by Eberline were higher than the radionuclide concentrations for gamma-emitting ROC that were reported by the on-site laboratory.

For the FSS of all open land survey units, the derivation of the mean ROC concentrations for the systematic population and the subsequent mean dose assigned to the survey unit exclusively used the results of the on-site gamma spectroscopy system. In addition, while the Eberline data was not used to derive the mean dose fraction for the survey unit, the dose significance of the sample results was assessed in the same manner as a judgmental or investigation sample. In all cases, the individual gamma spectroscopy results were directly compared against the applicable OpDCGL, and if the concentrations exceeded a SOF of one, then the soils represented by the sample results were remediated.

Upon further evaluation, ZS-2020-0011 shows that the total site dose from the soil pathway is 1.016 mrem/year out of a total of 17.8 mrem/year from all pathways. In the event that the Eberline analytical results could be considered more conservative than the on-site analysis, then this difference would be likely bounded by a factor of nearly 2 as shown in the comparison table below. This table includes QC samples analyzed on-site with the corresponding split samples analyzed at Eberline where the relative standard deviation was less than or equal to 25% for both analysis results and for the analysis of K-40 and Cs-137. This data shows that the average ratio of the Eberline results to the on-site results was 1.91 for this data set.

As a conservative measure, Zion*Solutions* will apply this factor to the soil BcSOF of 0.041. The resulting BcSOF is 0.078, which equates to a dose of 1.95 mrem/year. The final dose summation for the Zion site becomes 18.73 mrem/year. The Attachment to ZS-2020-0011 will be revised to include this increased dose. Therefore, Zion*Solutions* believes this bounds the potential difference between the two types of analysis results.

		Standard		Eberline			Avg. Ratio	1.91
Standard Sample No.	Isotope	Activity	Error	Activity	Error	Standard %CV	Eberline %CV	Eberline/ STD
L1-10201C-FSGS-012-SS	K-40	6.87	0.43	17.70	3.39	6%	19%	2.58
L1-10203D-FSGS-002-SS	K-40	6.46	0.47	13.00	2.66	7%	20%	2.01
L1-10204A-FSGS-019-SS	K-40	5.72	0.47	8.26	1.35	8%	16%	1.44
L1-10206A-FSGS-005-SS	K-40	6.21	0.44	11.70	1.82	7%	16%	1.88
L1-10208C-FIGS-004-SS	K-40	8.00	0.57	10.00	1.40	7%	14%	1.25
L1-10213B-FSGS-015-SS	Cs-137	3.47	0.22	6.26	0.61	6%	10%	1.80
L1-10213B-FSGS-015-SS	K-40	4.66	0.33	10.20	1.84	7%	18%	2.19
L1-10213B-FIGS-001-SS	Cs-137	0.22	0.03	0.89	0.16	13%	18%	4.08
L1-10213B-FIGS-001-SS	K-40	7.38	0.57	15.70	2.56	8%	16%	2.13
L1-10213C-FIGS-001-SS	Cs-137	0.36	0.03	0.83	0.11	10%	14%	2.34
L1-10213C-FIGS-001-SS	K-40	9.65	0.62	14.10	1.99	6%	14%	1.46
L2-10214A-FIGS-001-SS	K-40	6.28	0.50	12.30	1.87	8%	15%	1.96
L1-10214F-FIGS-001-SS	K-40	6.67	0.50	17.70	2.41	7%	14%	2.65
L1-10220D-FSGS-008-SS	K-40	4.79	0.43	12.10	1.61	9%	13%	2.53
L1-10220H-FJGS-004-SS	Cs-137	0.95	0.06	0.90	0.14	7%	15%	0.95
L1-10220I-FJGS-005-SS	Cs-137	1.54	0.11	2.65	0.34	7%	13%	1.72
L1-10220I-FJGS-005-SS	K-40	7.94	0.63	17.30	2.52	8%	15%	2.18
L1-10221A-FIGS-001-SS	Cs-137	7.50	0.47	2.14	0.29	6%	13%	0.29
L1-10221A-FIGS-001-SS	K-40	6.39	0.51	9.69	1.60	8%	17%	1.52
L1-10221A-FIGS-001-SB	Cs-137	0.37	0.04	1.37	0.23	10%	17%	3.70
L1-10221A-FIGS-001-SB	K-40	7.97	0.55	14.00	2.36	7%	17%	1.76
L1-10221D-FIGS-013-SS	Cs-137	0.58	0.05	0.66	0.12	9%	18%	1.14
L1-10221D-FIGS-013-SS	K-40	6.32	0.48	12.10	2.58	8%	21%	1.91
L1-12111A-FJGS-001-SS	K-40	8.52	0.59	11.00	1.72	7%	16%	1.29
L1-12112A-FSGS-014-SS	K-40	7.85	0.47	15.90	2.51	6%	16%	2.03
L1-12201E-FSGS-014-SS	K-40	7.63	0.55	12.70	2.55	7%	20%	1.66
L1-12203A-FSGS-012-SS	K-40	14.80	0.78	18.10	3.00	5%	17%	1.22
L1-12204C-FSGS-001-SS	K-40	8.95	0.64	21.00	4.05	7%	19%	2.35
L1-12205E-FIGS-101-SS	K-40	8.35	0.56	10.40	1.59	7%	15%	1.25

Revised or Supplemental Documentation: ZS-2020-0011, Attachment

NRC RAI Question #16a Review future submittals for overall quality and editorial errors.

RESPONSE: For this submittal, Zion*Solutions* had the response reviewed by Larry Camper, as an independent reviewer, to determine if there was a full response to the NRC questions.

Energy*Solutions* will take the following actions to improve the quality of future FSS deliverables:

1. The LT/FSS Manager and Director of Radiological Site Closure will be the primary authors of Chapter 5 of the LTPs for all future Energy*Solutions* projects to ensure the FSS

requirements follow standard industry guidance (NUREG-1757, MARSSIM, etc.) and in accordance with NRC guidance/requirements.

2. Energy*Solutions* will divide final reports into smaller, more concise reports with fewer release records for ease of NRC reviews.
3. The release record and final report review process will be modified to provide more detailed focus on both editorial and technical errors.
4. Independent third-party reviewers will be utilized as part of the release record and final report review process.
5. To promote the goals of readability and consistency when writing LTPs, survey unit release records, and FSS final reports, Energy*Solutions* will follow the guidance provided in NUREG-1379, *NRC Editorial Style Guide*.
6. Any references to meeting the intent of the LTP have been deleted and replaced with language depicting results and language demonstrating compliance with the criteria in 10 CFR Part 20, Subpart E.