**Technical Specification 5.6.2**

**Palo Verde**
**Nuclear Generating Station**
PO Box 52034
Phoenix, Arizona 85072-2034
Mail Station 7636

102-08088-MDD/MSC
April 9, 2020

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Sirs:

Subject: **Palo Verde Nuclear Generating Station (PVNGS)**
**Units 1, 2, and 3**
**Docket Nos. STN 50-528/529/530**
**Annual Radiological Environmental Operating Report 2019**

In accordance with PVNGS Technical Specification 5.6.2, enclosed, please find the Annual Radiological Environmental Operating Report for 2019.

No new commitments are being made to the NRC by this letter. Should you need further information regarding this submittal, please contact Matthew S. Cox, Licensing Section Leader, at (623) 393-5753.

Sincerely,

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Department Leader, Regulatory Affairs

MDD/MSC/mg

Enclosure: Palo Verde Nuclear Generating Station Annual Radiological Environmental Operating Report 2019

| | | |
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# Enclosure

## Palo Verde Nuclear Generating Station
## Annual Radiological Environmental Operating Report 2019

# PALO VERDE NUCLEAR GENERATING STATION ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT 2019

(Reference: RCTSAI 1643, Legacy Item No.036843.01)

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**Director, Radiation Protection**

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# ABSTRACT

The Radiological Environmental Monitoring Program (REMP) is an ongoing program conducted by Arizona Public Service Company (APS) for the Palo Verde Nuclear Generating Station (PVNGS). Various types of environmental samples are collected near PVNGS and analyzed for plant-related radionuclide concentrations.

During 2019, the following categories of samples were collected by APS:

- Broadleaf vegetation
- Groundwater
- Drinking water
- Surface water
- Airborne particulate and radioiodine
- Goat milk
- Sludge and sediment

Thermoluminescent dosimeters (TLDs) were used to measure environmental gamma radiation. The Environmental TLD program is also conducted by APS.

The Arizona Department of Health Services, Bureau of Radiation Control (BRC) performs radiochemistry analyses on various duplicate samples provided to them by APS. Samples analyzed by BRC include onsite samples from the Reservoirs, Evaporation Ponds, and two (2) Deep Wells. Offsite samples analyzed by BRC include two (2) local resident wells. BRC also performs air sampling at seven (7) offsite locations identical to APS and maintains approximately fifty (50) environmental TLD monitoring locations, eighteen (18) of which are duplicates of APS locations.

A comparison of pre-operational and operational data indicates no changes to environmental radiation levels.

(NOTE: Reference to APS throughout this report refers to PVNGS personnel)

# 1. Introduction

This report presents the results of the operational Radiological Environmental Monitoring Program conducted by Arizona Public Service Company (APS). The Radiological Environmental Monitoring Program (REMP) was established for the Palo Verde Nuclear Generating Station (PVNGS) by APS in 1979.

This report contains the measurements and findings for 2019. All references are specifically identified in Section 12.

## 1.1 Overview

The Radiological Environmental Monitoring Program (REMP) provides representative measurements of radiation and radioactive materials in exposure pathways. REMP measures radionuclides that lead to the highest potential radiation exposures to members of the public resulting from station operation. This monitoring program implements Title 10 of the Code of Federal Regulations (CFR) Part 50, Appendix I, Section IV.B.2., and thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the US Nuclear Regulatory Commission (USNRC) in their Radiological Assessment Branch Technical Position on Environmental Monitoring, Revision 1, November 1979 (incorporated into NUREG 1301). Results from the REMP help to evaluate sources of elevated levels of radioactivity in the environment (i.e. atmospheric nuclear detonations or abnormal plant releases).

The Land Use Census ensures that changes in the use of areas at, and beyond the site boundary, are identified and that modifications to the REMP are made if required by the results of this census. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50.

The Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are valid for the purposes of 10 CFR 50, Appendix I, Section IV.B.2.

Results of the PVNGS pre-operational environmental monitoring program are presented in Reference 1.

The initial criticality of Unit 1 occurred May 25, 1985. Initial criticality for Units 2 and 3 were April 18, 1986, and October 25, 1987, respectively. PVNGS operational findings (historical) are presented in Reference 2.

## 1.2 Radiation and Radioactivity

Atoms are the basic building blocks of matter. Unstable atoms emit radiation and material that spontaneously emits radiation is referred to as radioactive. Radioactive material is frequently categorized as either "Natural" or "Man-made"

Natural sources of radiation exist naturally in the environment and include: radon, thoron, cosmic, terrestrial, and internal. The sun and stars are a source of cosmic radiation. Atmospheric conditions, the Earth's magnetic field, and differences in elevation can affect the amount, or dose, of cosmic radiation an individual receives. The Earth is a source of terrestrial radiation. Uranium, thorium, and radium exist naturally in rock and soil. All organic matter contains carbon and potassium, and water contains small amounts of dissolved uranium and thorium. The largest contributor of dose to Americans from natural sources is attributed to radon which is found in air. All people are a source of internal radiation. Potassium-40 and carbon-14 are radioactive nuclides and inside all people from birth, making people a source of exposure.

Man-made sources of radiation include: consumer products, nuclear medicine, and medical procedures. There are a number of occupational areas which result in exposure to individuals of varying amounts of radiation such as: radiography, radiology, radiation oncology, power generation, and research laboratories. The Nuclear Regulatory Commission (NRC) requires licensees to monitor exposure to workers and limit occupational exposure to 5,000 millirem per year. Several consumer products contain radioactive material such as: some ceramics, thorium lantern mantles, luminous watches containing tritium, smoke detectors, and tobacco. Other consumer product sources of radiation can come from building and road construction materials, combustible fuels (i.e. gas, coal), and x-ray security systems. The most significant contributor to radiation exposure from man-made sources is medical procedures. Diagnostic x-rays and nuclear medicine procedures, such as those that use iodine-131 or cesium-137, are examples of man-made medical sources.

The average member of the public receives a total annual dose of approximately 620 millirem from ionizing radiation. Figure 1-1 illustrates the contribution of various sources of radiation to radiation exposure in the United States (NCRP Report No.160 (2009)).

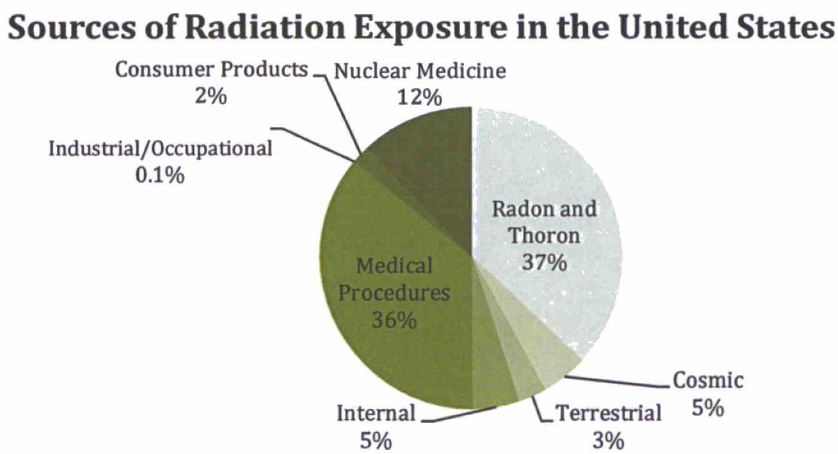



**Figure 1-1 Sources of Radiation Exposure in the United States**

# 2. Description of the Monitoring Program

APS and vendor organizations performed the pre-operational Radiological Environmental Monitoring Program between 1979 and 1985. APS and vendors continued the program into the operational phase.

## 2.1 Radiological Environmental Monitoring Program

The assessment program consists of routine measurements of environmental gamma radiation and of radionuclide concentrations in media such as air, groundwater, drinking water, surface water, vegetation, milk, sludge, and sediment.

Samples were collected by APS at the monitoring sites shown in Figures 2-1 and 2-2. The specific sample types, sampling locations, and sampling frequencies, as set forth in the PVNGS Offsite Dose Calculation Manual (ODCM), Reference 4, are presented in Tables 2-l, 2-2 and 9-1. Additional onsite sampling (outside the scope of the ODCM) is performed to supplement the REMP. All results are included in this report. Routine sample analyses were performed at the onsite Central Chemistry Laboratory and Operating Unit laboratories. Analyses for hard-to-detect radionuclides were performed by GEL Laboratories LLC.

Environmental gamma radiation measurements were performed by APS using TLDs at fifty (50) locations near PVNGS. The PVNGS Dosimetry Department is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) to process personnel ionizing radiation dosimeters.

In addition to monitoring environmental media, a Land Use Census is performed annually to identify the nearest milk animals, residents, and gardens. This information is used to evaluate the potential dose to members of the public for those exposure pathways that are indicated.

## 2.2 Radiological Environmental Monitoring Program Changes for 2019

Two (2) onsite groundwater wells, Site 58A (Well 27dcb) and Site 65 (Well 34aab) were added to the ODCM. These wells were sampled as supplemental sites prior to the July 2019 revision of the ODCM, at which time they were added to the Radiological Environmental Monitoring Program. There were no other changes to the Radiological Environmental Monitoring Program that impacted the Offsite Dose Calculation Manual (ODCM) Revision 28.

## 2.3 REMP Deviations/Abnormal Events Summary

During calendar year 2019, there were eleven (11) deviations/abnormal events with regards to the monitoring program. Refer to Table 2-3 for more detail and corrective actions taken.

There was eight (8) events involving Air Sample data. Six (6) events involved reduced sampling period due to pump failure, either due to pump malfunction or loss of power to the pump. Two (2) events were due to failure of the Elapsed Time Meter (ETM). Three (3) of these eight (8) events resulted in sufficient data to obtain VALID results for the sampling period, while five (5) events resulted in the determination that the sample was INVALID. Palo Verde Nuclear

Generating Station has ten (10) Air Sample sites: one (1) control, four (4) ODCM required, and five (5) supplemental sites. Supplemental sampling locations were available and produced valid data for the sampling period involving an invalid sample from a required sample location.

Two (2) events were due to the inability to obtain a Drinking Water Sample, resulting from an inoperable well pump at the donor location. One (1) event impacted the ability to meet the required Lower Limit of Detection for La-140. One (1) event resulted in the inability to collect the drinking water sample from the location for the month of December.

There was one (1) event involving environmental dosimetry; dosimetry at Site 47 was identified as missing during the 2nd Quarter TLD change-out. Data for this location was unavailable for the 1st quarter.

## 2.4 Groundwater Protection

PVNGS has implemented a groundwater protection initiative developed by the Nuclear Energy Institute (NEI). The implementing guidance of this initiative, NEI 07-07 (Industry Ground Water Protection Initiative – Final Guidance Document, August 2007), and later revised in March of 2019, provides added assurance that groundwater will not be adversely affected by PVNGS operations.

Several monitoring wells have been installed to monitor the subsurface water and shallow aquifer at Units 1, 2, and 3. Many of these wells were previously monitored in accordance with the State of Arizona Aquifer Protection Permit (Area-Wide) No. P-100388 (APP), which provided agreed upon monitoring parameters and reporting thresholds. The APP was revised in 2018, which included the removal of several of the wells from mandated sampling. These wells are now referred to as Legacy Wells and continue to be sampled for data continuity and in support of the Groundwater Protection Initiative. The frequency of sampling of the wells varies and may be done monthly, quarterly, and or annually for chemical and radiological parameters. Sample results for the shallow aquifer wells are reported in the PVNGS Annual Radioactive Effluent Release Report (ARERR).

Three subsurface samples were obtained, one each from Units 2 and 3 tritium monitoring wells, and one from the shallow aquifer outside of the Unit 1 Radiologically Controlled Area (RCA). These samples were analyzed for hard-to-detect radionuclides (e.g. C-14, Fe-55, Ni-63, Sr-90) as verification that there are no underground leaks from plant systems that may affect groundwater. All results were <MDA. Refer to Table 8-12 for sample results.

**Table 2-1 Sample Collection Locations**

| *SAMPLE SITE #* | *SAMPLE TYPE* | *LOCATION* (a) | *LOCATION DESCRIPTION* |
|---|---|---|---|
| **4** | Air | E16 | APS Office |
| **6A*** | Air | SSE13 | Old US 80 |
| **7A** | Air | ESE3 | Arlington School |
| **14A** | Air | NNE2 | 371st Ave. and Buckeye-Salome Rd. |
| **15** | Air | NE2 | NE Site Boundary |
| **17A** | Air | E3 | 351st Ave. |
| **21** | Air | S3 | S Site Boundary |
| **29** | Air | W1 | W Site Boundary |
| **35** | Air | NNW8 | Tonopah |
| **40** | Air | N2 | Transmission Rd |
| **46** | Drinking Water | NNW8 | Local resident |
| **47** | Vegetation | N3 | Local resident |
| **48** | Drinking Water | SW1 | Local resident |
| **49** | Drinking Water | N2 | Local resident |
| **51** | Milk | NNE3 | Local resident-goats |
| | Vegetation | NNE3 | Local resident |
| **53*** | Milk | NE30 | Local resident- goats |
| **54** | Milk | NNE4 | Local resident- goats |
| **55** | Drinking Water (Supplemental) | SW3 | Local resident |
| **57** | Groundwater | ONSITE | Well 27ddc |
| **58** | Groundwater | ONSITE | Well 34abb |
| **58A** | Groundwater | ONSITE | Well 27dcb |
| **59** | Surface Water | ONSITE | Evaporation Pond 1 |
| **60** | Surface Water | ONSITE | 85 Acre Reservoir |
| **61** | Surface Water | ONSITE | 45 Acre Reservoir |
| **62*** | Vegetation | ENE26 | Commercial Farm |
| **63** | Surface Water | ONSITE | Evaporation Pond 2 |
| **64** | Surface Water | ONSITE | Evaporation Pond 3 |
| **65** | Groundwater | ONSITE | Well 34aab |

NOTES:

*Designates a control site

**(a)** Distances and direction are from the center-line of Unit 2 containment and rounded to the nearest mile

Air sample sites designated with the letter 'A' are sites that have the same site number as a TLD location, but are not in the same location (e.g. site **#6** TLD location is different from site **#6A** air sample location; site **#4** TLD location is the same as site **#4** air sample location)

**Table 2-2 Sample Collection Schedule**

| *SAMPLE SITE #* | *AIRBORNE PARTICULATE* | *MILK* | *AIRBORNE RADIOIODINE* | *VEGETATION* | *GROUND WATER* | *DRINKING WATER* | *SURFACE WATER* |
|---|---|---|---|---|---|---|---|
| 4 | W | | W | | | | |
| 6A | W | | W | | | | |
| 7A | W | | W | | | | |
| 14A | W | | W | | | | |
| 15 | W | | W | | | | |
| 17A | W | | W | | | | |
| 21 | W | | W | | | | |
| 29 | W | | W | | | | |
| 35 | W | | W | | | | |
| 40 | W | | W | | | | |
| 46 | | | | | | W | |
| 47 | | | | M/AA | | | |
| 48 | | | | | | W | |
| 49 | | | | | | W | |
| 51 | | | M/AA | M/AA | | | |
| 53 | | | M/AA | | | | |
| 54 | | | M/AA | | | | |
| 55 | | | | | | W | |
| 57 | | | | | Q | | |
| 58 | | | | | Q | | |
| 59 | | | | | | | Q |
| 60 | | | | | | | Q |
| 61 | | | | | | | Q |
| 62 | | | | M/AA | | | |
| 63 | | | | | | | Q |
| 64 | | | | | | | Q |

W = WEEKLY     M/AA = MONTHLY AS AVAILABLE     Q = QUARTERLY

**Table 2-3 Summaries of the REMP Deviations/Abnormal Events**

| *Deviation/Abnormal Event* | *Actions Taken* |
|---|---|
| 1. Air Sample Site 17A INVALID due to pump failure for sample period 4/16/2019-4/23/2019 and 4/23/2019- 4/30/2019. | Pump failure resulted in insufficient data for statistical analysis for sample period 4/16/2019- 4/23/2019 (Week 16). Data for Week 16 is INVALID and data is for INFO only. Pump was replaced during sample period 4/23/2019-4/30/2019 (Week 17), providing sufficient data for a VALID sample. Event documented through CR 19-06328 (Table 8-5, Note 2). |
| 2. Air Sample site 35 INVALID due to power loss and pump failure for sample period 5/21/2019-5/28/2019 and 5/28/2019-6/4/2019. | Site 35 lost power during Week 21; however the Elapsed Time Meter continued recording time. Week 22 experienced a pump failure once the power was restored and had a shortened sampling run time. Samples are INVALID due to unknown volume of sample. Event documented through CR 19-08404 (Table 8-5, Note 3). |
| 3. Air Sample Site 40 INVALID due to failed pump for sample period 6/18/2019- 6/25/2019. | Pump failed with Elapsed Time Meter still running, resulting in inability to determine sample flow volume. Sample is INVALID and data is for INFO only. Event documented through CR 19-09504 (Table 8-5, Note 4). |
| 4. Air Sample Site 40 Elapsed Time Meter (ETM) did not have expected run time for sample period 7/9/2019-7/16/2019. | ETM did not reflect expected run time (actual 141.9 hrs. vs expected 167.2 hrs.). Upon testing, ETM was functioning properly. Possible cause was due to power outage. Sample appeared to have normal dust loading. Sample run time sufficient for data collection and statistical analysis; sample is VALID. Event documented through CR 19-10403 (Table 8-5, Note 5). |
| 5. Air Sample Site 6A INVALID due to pump failure for sample period 8/13/2019- 8/20/2019. | Pump failed with Elapsed Time Meter still running resulted in inability to determine sample flow volume. Sample is INVALID and data is for INFO only. Event documented through CR 19-12139 (Table 8-5, Note 6). |
| 6. Air Sample Site 6A Elapsed Time Meter (ETM) failed to operate as expected run time for sample period 8/20/2019-8/27/2019. | ETM failed to operate as expected. Pump was running satisfactorily and collection on filter had normal distribution. Sample run time was calculated; sample is VALID. Event documented through CR 19-12487 (Table 8-5, Note 7). |
| 7. Air Sample Site 29 INVALID due to failed pump and inability to estimate volume of sample for sample period 10/30/2019- 11/5/2019. | Pump failed with Elapsed Time Meter still running resulted in inability to determine sample flow volume. Sample is INVALID and data is for INFO only. Event documented through CR 19-16553 (Table 8-5, Note 8). |
| 8. Air Sample Site 29 INVALID due to failed pump and inability to estimate volume of sample for sample period 11/5/2019- 11/12/2019. | Pump failed with Elapsed Time Meter still running resulted in inability to determine sample flow volume. Sample is INVALID and data is for INFO only. Event documented through CR 19-16890 (Table 8-5, Note 9). |

| | |
|---|---|
| 9. Drinking Water Site 55 did not meet LLD for La-140 for November. | Composite drinking water sample achieved an MDA of 46 pCi/L, versus the required LLD of 15 pCi/L, due to inability to collect sample for final week of sampling period. Event documented through CR 19-17596 and 19-17770 (Table 8-8, Note 2). |
| 10. No sample available for Drinking Water Site 55 for December. | Donor's pump failed to operate. As a result, no sample could be obtained from Site 55 for the sampling period of December. Event documented through CR 19-17897 and 20-000862 (Table 8-8, Note 3). |
| 11. Direct Radiation TLD Site 47 data unavailable for 1st Quarter. | During the 2nd Quarter TLD change-out, TLD Site 47 was identified as missing. Data for this location was unavailable; however, dosimetry was replaced for 2nd Quarter data collection. Event documented through CR 19-04547 (Table 9-2, Note 1). |

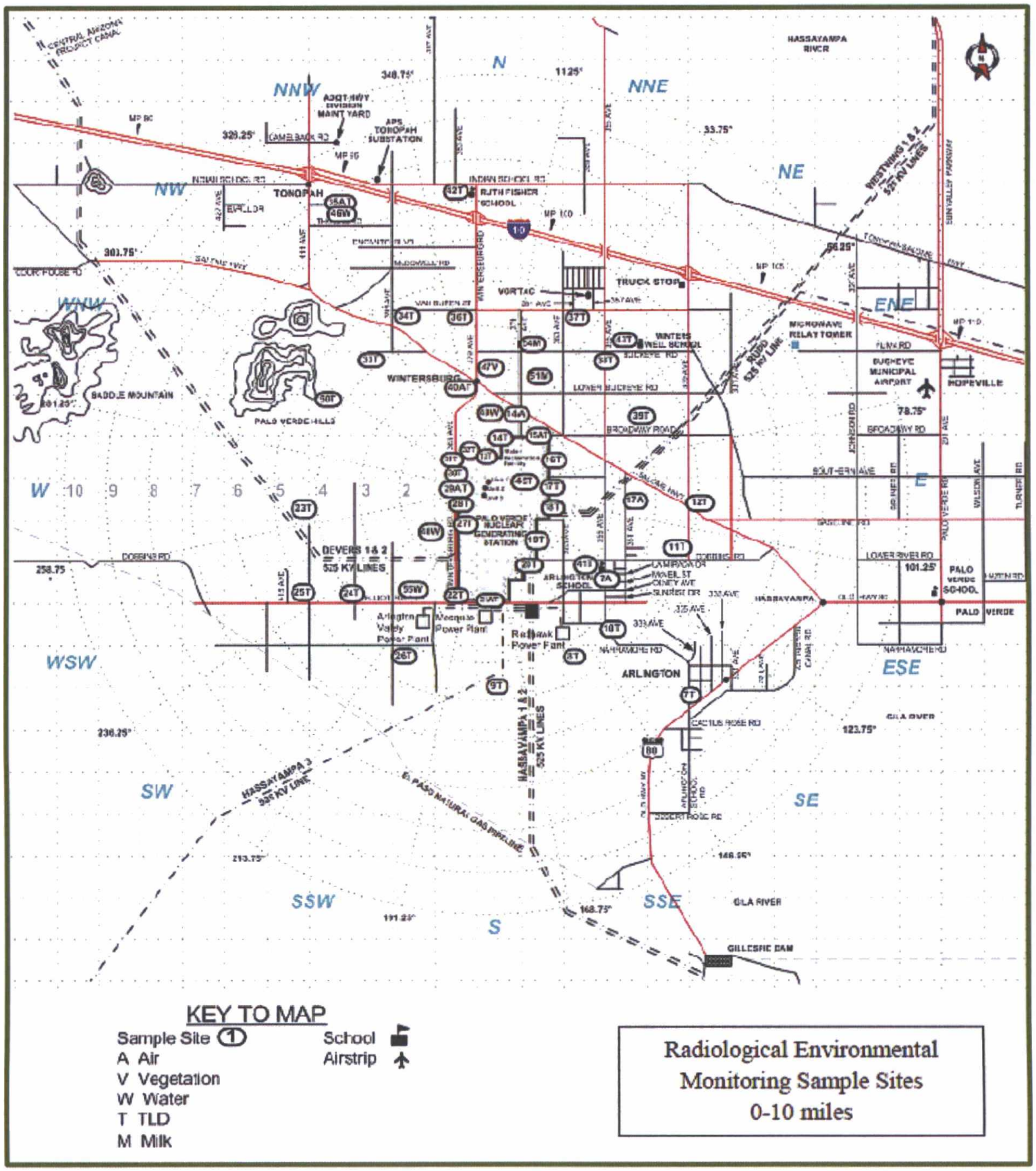



**Figure 2-1 REMP Sample Sites- Map (0-10 miles)**

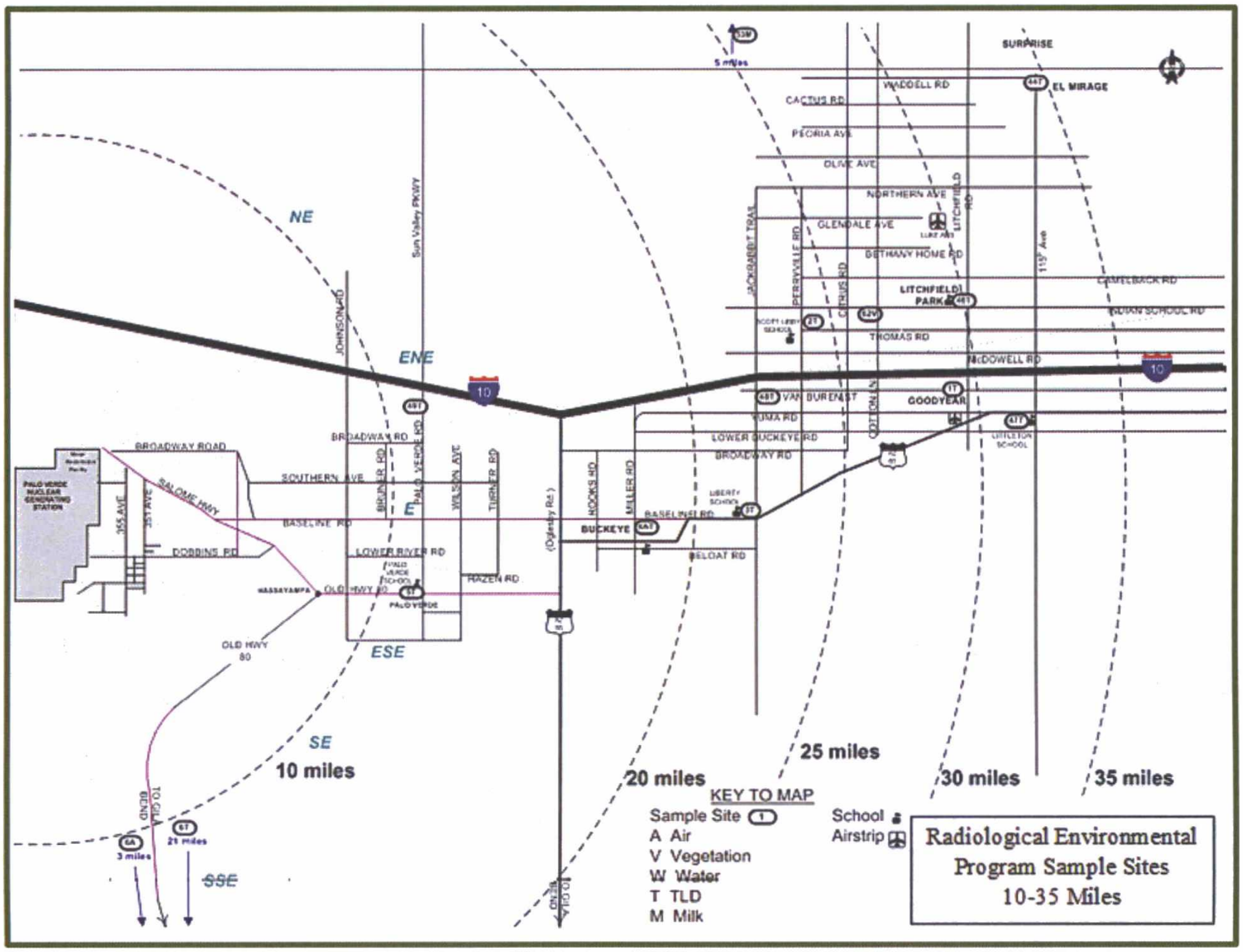



**Figure 2-2 REMP Sample Sites- Map (10-35 Miles)**

# 3. Sample Collection Program

APS Personnel, using PVNGS procedures, collected all samples.

## 3.1 Water

Weekly samples were collected from four (4) residence wells for monthly and quarterly composites. Samples were collected in one-gallon containers (plastic cubitainers) and 500 mL glass bottles. The samples were analyzed for gross beta, gamma-emitting radionuclides, and tritium.

Quarterly grab samples were collected from the 45 and 85 acre Reservoirs, active Evaporation Ponds 1A/B/C, 2A/B, and 3A/B, and onsite wells 34abb, 27ddc, 34aab, and 27dcb. Samples were collected in one-gallon containers (plastic cubitainers) and 500 mL glass bottles. Samples were analyzed for gamma-emitting radionuclides and tritium.

Treated sewage effluent from the City of Phoenix was sampled as a weekly composite at the onsite Water Resources (WR), and analyzed for gamma-emitting radionuclides. A monthly composite was analyzed for tritium.

## 3.2 Vegetation

Vegetation samples were collected monthly, as available, and were analyzed for gamma-emitting radionuclides.

## 3.3 Milk

Goat milk samples were collected monthly, as available, and were analyzed for gamma-emitting radionuclides, including low level I-131.

## 3.4 Air

Air particulate filters and charcoal cartridges were collected at ten (10) sites on a weekly basis. Particulate filters were analyzed for gross beta. Charcoal cartridges were analyzed for Iodine-131. Particulate filters were composited quarterly, by location, and analyzed for gamma-emitting radionuclides.

## 3.5 Soil, Sludge, and Sediment

Sludge samples were obtained weekly from the WR waste centrifuge (during operational periods) and analyzed for gamma-emitting radionuclides. Cooling tower sludge was analyzed for gamma-emitting radionuclides prior to disposal in the WR sludge landfill.

# 4. Analytical Procedures

The procedures described in this report are those used by APS to routinely analyze samples

## 4.1 Air Particulate

### 4.1.1 Gross Beta

A glass fiber filter sample is placed in a stainless steel planchet and counted for gross beta activity utilizing a low background gas flow proportional counter.

### 4.1.2 Gamma Spectroscopy

The glass fiber filters are counted on a multichannel analyzer equipped with a High-purity Germanium (HPGe) detector. The resulting spectrum is analyzed by a computer for specific radionuclides and verified by trained technicians.

## 4.2 Airborne Radioiodine

### 4.2.1 Gamma Spectroscopy

The charcoal cartridge is counted on a multichannel analyzer equipped with an HPGe detector. The resulting spectrum is analyzed by a computer for Iodine-131.

## 4.3 Milk

### 4.3.1 Gamma Spectroscopy

The sample is placed in a plastic marinelli beaker and counted on a multichannel analyzer equipped with an HPGe detector. The resulting spectrum is analyzed by a computer for specific radionuclides and verified by trained technicians.

### 4.3.2 Radiochemical I-131 Separation

Iodine in milk sample is reduced with sodium bisulfite and iodine is absorbed by the anion exchange resin. The iodine is eluted with NaOCl. Iodine is extracted from the sample with carbon tetrachloride. The iodine is back extracted from the organic phase with water containing sodium bisulfate and then precipitated as CuI. The precipitate is mounted in a planchet and counted for gross beta.

## 4.4 Vegetation

### 4.4.1 Gamma Spectroscopy

The sample is pureed in a food processor, placed in a one liter plastic marinelli beaker, weighed, and counted on a multichannel analyzer equipped with an HPGe detector. The resulting spectrum is analyzed by a computer for specific radionuclides and verified by trained technicians.

## 4.5 Sludge/Sediment

### 4.5.1 Gamma Spectroscopy

The wet/dry sample is placed in a one-liter plastic marinelli beaker, weighed, and counted on a multichannel analyzer equipped with an HPGe detector. The resulting spectrum is analyzed by a computer for specific radionuclides and verified by trained technicians.

## 4.6 Water

### 4.6.1 Gamma Spectroscopy

The sample is placed in a one-liter plastic marinelli beaker and counted on a multichannel analyzer equipped with a HPGe detector. The resulting spectrum is analyzed by a computer for specific radionuclides and verified by trained technicians.

### 4.6.2 Tritium

The sample is evaluated to determine the appropriate method of preparation prior to counting. If the sample contains suspended solids or is turbid, it may be filtered, distilled, and/or de-ionized, as appropriate. Eight (8) milliliters of sample are mixed with fifteen (15) milliliters of liquid scintillation cocktail. The mixture is dark adapted and counted for tritium activity using a liquid scintillation counting system.

### 4.6.3 Gross Beta

A 200-250 milliliter sample is placed in a beaker. Five (5) milliliters of concentrated nitric ($HNO_3$) acid is added and the sample is evaporated down to about twenty (20) milliliters. The remaining sample is transferred to a stainless steel planchet. The sample is heated to dryness and counted for gross beta in a gas flow proportional counter.

## 4.7 Soil

### 4.7.1 Gamma Spectroscopy

The samples are sieved, placed in a one-liter plastic marinelli beaker, and weighed. The samples are then counted on a multichannel analyzer equipped with an HPGe detector. The resulting spectrum is analyzed by a computer for specific radionuclides and verified by trained technicians.

# 5. Nuclear Instrumentation

### 5.1 Gamma Spectrometer

The Canberra Gamma Spectrometer consists of a Canberra System equipped with HPGe detectors, having resolutions of 1.73 keV and 1.88 keV (as determined by full width half max with an energy of 0.5 keV per channel) and respective efficiencies of 21.5% and 38.4% (as determined by the manufacturer with Co-60). The Canberra System is used for all gamma counting. The system uses Canberra developed software to search, identify, and quantify the peaks of interest.

### 5.2 Liquid Scintillation Spectrometer

A Beckman LS-6500 Liquid Scintillation Counter is used for tritium determinations. The system background averages approximately 12-16 cpm with a counting efficiency of approximately 40% using a quenched standard.

### 5.3 Gas Flow Proportional Counter

The Tennelec S5E is a low background gas flow proportional counter for gross beta analysis. The system contains an automatic sample changer capable of counting 50 samples in succession. Average beta background count rate is about 1-2 cpm with a beta efficiency of approximately 30% for Cs-137.

# 6. Isotopic Detection Limits and Reporting Criteria

## 6.1 Lower Limits of Detection

The lower limits of detection (LLD) and the method for calculation are specified in the PVNGS ODCM, Reference 4. The ODCM required *a priori* LLDs are presented in Table 6-1.

## 6.2 Data Reporting Criteria

All results that are greater than the Minimum Detectable Activity (MDA) (*a posteriori* LLD) are reported as positive activity with its associated 2σ counting error. All results that are less than the MDA are reported as less than values at the associated MDA. For example, if the MDA is 12 pCi/liter, the value is reported as <12.

Typical MDA values are presented in Table 6-3.

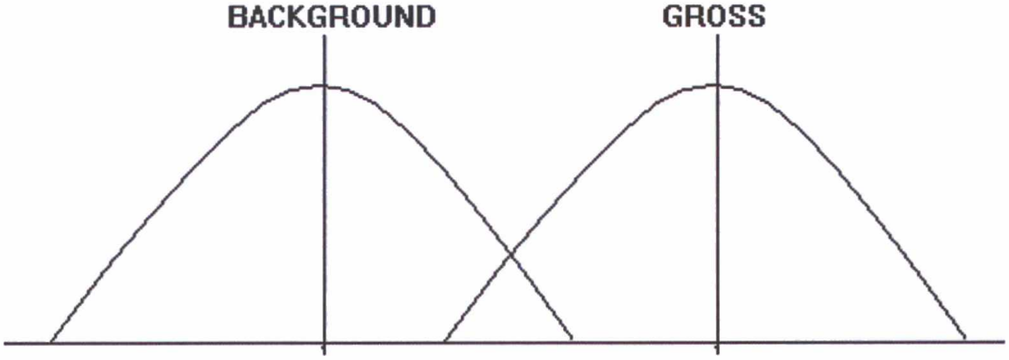
Occasionally, the PVNGS ODCM *a priori* LLDs may not be achieved as a result of:

- Background fluctuations
- Unavoidably small sample sizes
- The presence of interfering radionuclides
- Self-absorption corrections
- Decay corrections for short half-life radionuclides
- Other uncontrollable circumstances

In these instances, the contributing factors will be noted in the table where the data are presented. A summary of deviations/abnormal events is presented in Table 2-3 Summaries of the REMP Deviations/Abnormal Events and includes a description of any sample results that did not meet *a priori* LLD requirements.

## 6.3 LLD and Reporting Criteria Overview

Making a reasonable estimate of the limits of detection for a counting procedure or a radiochemical method is usually complicated by the presence of significant background. It must be considered that the background or blank is not a fixed value but that a series of replicates would be normally distributed. The desired net activity is the difference between the gross and background activity distributions. The interpretation of this difference becomes a problem if the two distributions intersect as indicated in the diagram.




If a sufficient number of replicate analyses are run, it is expected that the results would fall in a normal Gaussian distribution. Standard statistics allow an estimate of the probability of any particular deviation from the mean value. It is common practice to report the mean ± one or two standard deviations as the result. In routine analysis, such replication is not carried out, and it is not possible to report a Gaussian standard deviation. With counting procedures, however, it is possible to estimate a Poisson standard deviation directly from the count. Data are commonly reported as the measured value ± one or two Poisson standard deviations. The reported values are then considered to give some indication of the range in which the true value might be expected to occur.

LLD is the smallest amount of sample activity that will yield a net count for which there is confidence at a predetermined level that activity is present. LLDs are calculated values for individual radionuclides based on a number of different factors including sample size, counting efficiency and background count rate of the instrument, the background and sample counting time, the decay time, and the chemical recovery of the analytical procedures. A minimum detectable activity value (MDA) is the smallest amount of activity that can be detected in an actual sample and uses the values obtained from the instrument and outcome of the analytical process. Therefore, the MDA values may differ from the calculated LLD values if the sample size and chemical recovery, decay values, or the instrument efficiency, background, or count time differed from those used in the LLD calculation.

The factors governing the calculation of the LLD and MDA values are discussed below:

1. **Sample Size:** The number of observations included in a statistical analysis. Sample size dictates the amount of information available about a studied subject to make accurate inferences.

2. **Counting Efficiency**: The fundamental quantity in the measurement of a radioactive substance is the number of disintegrations per unit time. As with most physical measurements in analytical chemistry, an absolute measurement of the disintegration rate is seldom possible, rather it is necessary to compare the sample with one or more standards. The standards determine the counter efficiency that may then be used to convert sample counts per minute (cpm) to disintegrations per minute (dpm).

3. **Background Count Rate**: Any counter will show a certain counting rate without a sample in position. This background counting rate comes from several sources: 1) natural environmental radiation from the surrounding materials, 2) cosmic radiation, and 3) the natural radioactivity in the counter material itself. The background counting rate will depend on the amounts of these types of radiation and the sensitivity of the counter to the radiation.

4. **Background and Sample Counting Time**: The amount of time devoted to the counting of the background depends on the level of activity being measured. In general, with low level samples, this time should be about equal to that devoted to counting a sample.

5. **Time Interval between Sample Collection and Counting**: Decay measurements are useful in identifying certain short-lived nuclides. The disintegration constant is one of the basic characteristics of a specific radionuclide and is readily determined, if the half-life is sufficiently short. To ensure the required LLDs are achieved, appropriate decay correction values are used to account for radioactive decay during transit time and sample processing.

**Table 6-1 ODCM Required Lower Limits of Detection (a priori)**

| Analysis | Water (pCi/l) | Airborne Particulate or Gas (pCi/m$^3$) | Fresh Milk (pCi/l) | Food Products (pCi/kg, wet) |
|---|---|---|---|---|
| Gross Beta | 4 | 0.01 | | |
| H-3 | 2000* | | | |
| Mn-54 | 15 | | | |
| Fe-59 | 30 | | | |
| Co-58, -60 | 15 | | | |
| Zn-65 | 30 | | | |
| Zr-95 | 30 | | | |
| Nb-95 | 15 | | | |
| I-131 | 1** | 0.07 | 1 | 60 |
| Cs-134 | 15 | 0.05 | 15 | 60 |
| Cs-137 | 18 | 0.06 | 18 | 80 |
| Ba-140 | 60 | | 60 | |
| La-140 | 15 | | 15 | |

* If no drinking water pathway exists, a value of 3000 pCi/liter may be used

** If no drinking water pathway exists, a value of 15 pCi/liter may be used

NOTES:

This list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

**Table 6-2 ODCM Required Reporting Levels**

| Analysis | Water (pCi/l) | Airborne Particulate or Gas (pCi/m$^3$) | Fresh Milk (pCi/l) | Food Products (pCi/kg, wet) |
|---|---|---|---|---|
| H-3 | 20,000 * | | | |
| Mn-54 | 1,000 | | | |
| Fe-59 | 400 | | | |
| Co-58 | 1,000 | | | |
| Co-60 | 300 | | | |
| Zn-65 | 300 | | | |
| Zr-Nb-95 | 400 | | | |
| I-131 | 2 ** | 0.9 | 3 | 100 |
| Cs-134 | 30 | 10 | 60 | 1,000 |
| Cs-137 | 50 | 20 | 70 | 2,000 |
| Ba-La-140 | 200 | | 300 | |

* For drinking water samples. This is a 40 CFR 141 value. If no drinking water pathway exists, a value of 30,000 pCi/L may be used.

** If no drinking water pathway exists, a reporting level of 20 pCi/L may be used.

**Table 6-3 Typical MDA Values**

| Analysis/Nuclide | Water (pCi/liter) | Milk (pCi/liter) | Airborne Particulate or Gas (pCi/m³) | Vegetation (pCi/kg, wet) |
|---|---|---|---|---|
| Gross Beta | 2.08 | | 0.004 | |
| H-3 | 326 | | | |
| Mn-54 | 10 | | | |
| Fe-59 | 20 | | | |
| Co-58 | 9 | | | |
| Co-60 | 11 | | | |
| Zn-65 | 22 | | | |
| Zr-95 | 16 | | | |
| Nb-95 | 10 | | | |
| I-131 | 10[a] | 1 | 0.04[b] | 49 |
| Cs-134 | 9 | 1 | 0.003[b] | 47 |
| Cs-137 | 10 | 1 | 0.003[b] | 61 |
| Ba-140 | 33 | 3 | | |
| La-140 | 13 | 1 | | |

NOTES:

a - low level I-131 is not required since there is no drinking water pathway
b - Based on 433 $m^3$, the normal weekly sample volume

# 7. Interlaboratory Comparison Program

## 7.1 Quality Control Program

APS maintains an extensive QA/QC Program to provide assurance that samples are collected, handled, tracked, and analyzed to specified requirements. This program includes appropriate elements of USNRC Regulatory Guide 4.15, Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment, Revision 1. Included in the program are procedures for sample collection, preparation and tracking, sample analysis, equipment calibration and checks, and ongoing participation in an interlaboratory comparison program. Duplicate/replicate samples are analyzed to verify analytical precision and sample methodology. Comprehensive data reviews are performed including trending of data where appropriate.

During 2018, APS analyzed the following sample types under the interlaboratory comparison program:

- Beta/Gamma/ in Air Filter
- I-131 in Air
- Beta in Water
- Gamma in Water
- Tritium in Water
- Gamma in Milk

## 7.2 Intercomparison Results

APS participates in a crosscheck program using vendor supplied blind radionuclide samples. Results for the interlaboratory comparison program are presented in Table 7-1.

## Table 7-1 Interlaboratory Comparison Results

| Sample ID | Analysis Type | Nuclide | Units | Known Value | PVNGS Value | 1 sigma Error | Resolution* | Ratio | NRC Range | Results |
|---|---|---|---|---|---|---|---|---|---|---|
| E12511 | Gamma Water CL Det 1 | Ce-141 | pCi/L | 1.13E+02 | 1.12E+02 | 1.20E+01 | 9 | 0.99 | 0.60 - 1.66 | Acceptable |
| | | Co-58 | pCi/L | 1.39E+02 | 1.45E+02 | 1.49E+01 | 10 | 1.04 | 0.60 - 1.66 | Acceptable |
| | | Co-60 | pCi/L | 2.90E+02 | 2.87E+02 | 1.87E+01 | 15 | 0.99 | 0.60 - 1.66 | Acceptable |
| | | Cr-51 | pCi/L | 2.84E+02 | 2.75E+02 | 5.46E+01 | 5 | 0.97 | 0.50 - 2.00 | Acceptable |
| | | Cs-134 | pCi/L | 1.55E+02 | 1.48E+02 | 1.03E+01 | 14 | 0.95 | 0.60 - 1.66 | Acceptable |
| | | Cs-137 | pCi/L | 1.91E+02 | 2.02E+02 | 2.06E+01 | 10 | 1.06 | 0.60 - 1.66 | Acceptable |
| | | Fe-59 | pCi/L | 1.54E+02 | 1.62E+02 | 1.52E+01 | 11 | 1.05 | 0.60 - 1.66 | Acceptable |
| | | I-131 | pCi/L | 8.65E+01 | 7.89E+01 | 1.21E+01 | 7 | 0.91 | 0.50 - 2.00 | Acceptable |
| | | Mn-54 | pCi/L | 1.39E+02 | 1.46E+02 | 1.47E+01 | 10 | 1.05 | 0.60 - 1.66 | Acceptable |
| | | Zn-65 | pCi/L | 2.14E+02 | 2.18E+02 | 2.43E+01 | 9 | 1.02 | 0.60 - 1.66 | Acceptable |
| E12511 | Gamma Water CL Det 2 | Ce-141 | pCi/L | 1.13E+02 | 1.13E+02 | 1.11E+01 | 10 | 1.00 | 0.60 - 1.66 | Acceptable |
| | | Co-58 | pCi/L | 1.39E+02 | 1.31E+02 | 1.27E+01 | 10 | 0.94 | 0.60 - 1.66 | Acceptable |
| | | Co-60 | pCi/L | 2.90E+02 | 2.84E+02 | 1.70E+01 | 17 | 0.98 | 0.75 - 1.33 | Acceptable |
| | | Cr-51 | pCi/L | 2.84E+02 | 2.69E+02 | 4.70E+01 | 6 | 0.95 | 0.50 - 2.00 | Acceptable |
| | | Cs-134 | pCi/L | 1.55E+02 | 1.38E+02 | 9.02E+00 | 15 | 0.89 | 0.60 - 1.66 | Acceptable |
| | | Cs-137 | pCi/L | 1.91E+02 | 1.91E+02 | 1.78E+01 | 11 | 1.00 | 0.60 - 1.66 | Acceptable |
| | | Fe-59 | pCi/L | 1.54E+02 | 1.67E+02 | 1.34E+01 | 12 | 1.08 | 0.60 - 1.66 | Acceptable |
| | | I-131 | pCi/L | 8.65E+01 | 8.16E+01 | 9.49E+00 | 9 | 0.94 | 0.60 - 1.66 | Acceptable |
| | | Mn-54 | pCi/L | 1.39E+02 | 1.40E+02 | 1.34E+01 | 10 | 1.01 | 0.60 - 1.66 | Acceptable |
| | | Zn-65 | pCi/L | 2.14E+02 | 2.18E+02 | 2.13E+01 | 10 | 1.02 | 0.60 - 1.66 | Acceptable |
| E12511 | Gamma Water CL Det 3 | Ce-141 | pCi/L | 1.13E+02 | 1.08E+02 | 7.19E+00 | 15 | 0.96 | 0.60 - 1.66 | Acceptable |
| | | Co-58 | pCi/L | 1.39E+02 | 1.36E+02 | 8.32E+00 | 16 | 0.98 | 0.75 - 1.33 | Acceptable |
| | | Co-60 | pCi/L | 2.90E+02 | 2.98E+02 | 1.23E+01 | 24 | 1.03 | 0.75 - 1.33 | Acceptable |
| | | Cr-51 | pCi/L | 2.84E+02 | 3.11E+02 | 2.99E+01 | 10 | 1.10 | 0.60 - 1.66 | Acceptable |
| | | Cs-134 | pCi/L | 1.55E+02 | 1.43E+02 | 6.65E+00 | 22 | 0.92 | 0.75 - 1.33 | Acceptable |
| | | Cs-137 | pCi/L | 1.91E+02 | 1.97E+02 | 1.24E+01 | 16 | 1.03 | 0.75 - 1.33 | Acceptable |
| | | Fe-59 | pCi/L | 1.54E+02 | 1.63E+02 | 8.95E+00 | 18 | 1.06 | 0.75 - 1.33 | Acceptable |
| | | I-131 | pCi/L | 8.65E+01 | 8.74E+01 | 7.90E+00 | 11 | 1.01 | 0.60 - 1.66 | Acceptable |
| | | Mn-54 | pCi/L | 1.39E+02 | 1.45E+02 | 9.83E+00 | 15 | 1.04 | 0.60 - 1.66 | Acceptable |
| | | Zn-65 | pCi/L | 2.14E+02 | 2.19E+02 | 1.37E+01 | 16 | 1.02 | 0.75 - 1.33 | Acceptable |
| E12512 | Beta Filter | G. Beta | pCi/ea | 2.39E+02 | 2.49E+02 | 4.00E+00 | 62 | 1.04 | 0.80 - 1.25 | Acceptable |
| E12513 | CL Det 1 I-131 Cartridge | I-131 | pCi/ea | 7.54E+01 | 6.73E+01 | 1.13E+01 | 6 | 0.89 | 0.50 - 2.00 | Acceptable |
| E12513 | CL Det 2 I-131 Cartridge | I-131 | pCi/ea | 7.54E+01 | 7.25E+01 | 7.12E+00 | 10 | 0.96 | 0.60 - 1.66 | Acceptable |
| E12513 | CL Det 3 I-131 Cartridge | I-131 | pCi/ea | 7.54E+01 | 7.39E+01 | 8.44E+00 | 9 | 0.98 | 0.60 - 1.66 | Acceptable |
| E12514 | Gamma Filter CL Det 1 | Ce-141 | pCi/ea | 7.49E+01 | 8.00E+01 | 1.03E+01 | 8 | 1.07 | 0.60 - 1.66 | Acceptable |
| | | Co-58 | pCi/ea | 9.17E+01 | 1.03E+02 | 1.45E+01 | 7 | 1.12 | 0.50 - 2.00 | Acceptable |
| | | Co-60 | pCi/ea | 1.91E+02 | 2.06E+02 | 1.60E+01 | 13 | 1.08 | 0.60 - 1.66 | Acceptable |
| | | Cr-51 | pCi/ea | 1.87E+02 | 1.83E+02 | 5.07E+01 | 4 | 0.98 | 0.50 - 2.00 | Acceptable |
| | | Cs-134 | pCi/ea | 1.02E+02 | 9.74E+01 | 8.34E+00 | 12 | 0.95 | 0.60 - 1.66 | Acceptable |
| | | Cs-137 | pCi/ea | 1.26E+02 | 1.30E+02 | 1.75E+01 | 7 | 1.03 | 0.50 - 2.00 | Acceptable |
| | | Fe-59 | pCi/ea | 1.02E+02 | 1.07E+02 | 1.50E+01 | 7 | 1.05 | 0.50 - 2.00 | Acceptable |
| | | Mn-54 | pCi/ea | 9.15E+01 | 1.07E+02 | 1.46E+01 | 7 | 1.17 | 0.50 - 2.00 | Acceptable |
| | | Zn-65 | pCi/ea | 1.41E+02 | 1.39E+02 | 2.34E+01 | 6 | 0.99 | 0.50 - 2.00 | Acceptable |
| E12514 | Gamma Filter CL Det 2 | Ce-141 | pCi/ea | 7.49E+01 | 7.76E+01 | 6.89E+00 | 11 | 1.04 | 0.60 - 1.66 | Acceptable |
| | | Co-58 | pCi/ea | 9.17E+01 | 9.66E+01 | 1.15E+01 | 8 | 1.05 | 0.60 - 1.66 | Acceptable |
| | | Co-60 | pCi/ea | 1.91E+02 | 1.93E+02 | 1.11E+01 | 17 | 1.01 | 0.75 - 1.33 | Acceptable |
| | | Cr-51 | pCi/ea | 1.87E+02 | 1.79E+02 | 2.91E+01 | 6 | 0.96 | 0.50 - 2.00 | Acceptable |
| | | Cs-134 | pCi/ea | 1.02E+02 | 7.95E+01 | 5.17E+00 | 15 | 0.78 | 0.60 - 1.66 | Acceptable |
| | | Cs-137 | pCi/ea | 1.26E+02 | 1.38E+02 | 2.04E+01 | 7 | 1.10 | 0.50 - 2.00 | Acceptable |
| | | Fe-59 | pCi/ea | 1.02E+02 | 1.19E+02 | 8.94E+00 | 13 | 1.17 | 0.60 - 1.66 | Acceptable |
| | | Mn-54 | pCi/ea | 9.15E+01 | 1.04E+02 | 1.15E+01 | 9 | 1.14 | 0.60 - 1.66 | Acceptable |
| | | Zn-65 | pCi/ea | 1.41E+02 | 1.60E+02 | 1.44E+01 | 11 | 1.13 | 0.60 - 1.66 | Acceptable |

* calculated from PVNGS value/1 sigma error value

** Eckert & Ziegler Analytics, Inc. NIST-traceable known value

NRC Acceptance Criteria [1]

| Resolution | Ratio |
|---|---|
| 4-7 | 0.5-2.0 |
| 8-15 | 0.6-1.66 |
| 16-50 | 0.75-1.33 |
| 51-200 | 0.80-1.25 |
| >200 | 0.85-1.18 |

[1] From NRC Inspection Manual, procedure #84750, "Radioactive Waste Treatment, and Effluent and Environmental Monitoring"

## Table 7-1 Interlaboratory Comparison Results (Continued)

| Sample ID | Analysis Type | Nuclide | Units | Known Value | PVNGS Value | 1 sigma Error | Resolution* | Ratio | NRC Range | Results |
|---|---|---|---|---|---|---|---|---|---|---|
| E12514 | Gamma Filter CL Det 3 | Ce-141 | pCi/ea | 7.49E+01 | 7.94E+01 | 7.47E+00 | 11 | 1.06 | 0.60 - 1.66 | Acceptable |
| | | Co-58 | pCi/ea | 9.17E+01 | 1.02E+02 | 1.12E+01 | 9 | 1.11 | 0.60 - 1.66 | Acceptable |
| | | Co-60 | pCi/ea | 1.91E+02 | 2.02E+02 | 1.19E+01 | 17 | 1.06 | 0.75 - 1.33 | Acceptable |
| | | Cr-51 | pCi/ea | 1.87E+02 | 2.05E+02 | 3.01E+01 | 7 | 1.10 | 0.50 - 2.00 | Acceptable |
| | | Cs-134 | pCi/ea | 1.02E+02 | 8.26E+01 | 4.89E+00 | 17 | 0.81 | 0.75 - 1.33 | Acceptable |
| | | Cs-137 | pCi/ea | 1.26E+02 | 1.39E+02 | 1.74E+01 | 8 | 1.10 | 0.60 - 1.66 | Acceptable |
| | | Fe-59 | pCi/ea | 1.02E+02 | 1.21E+02 | 9.31E+00 | 13 | 1.19 | 0.60 - 1.66 | Acceptable |
| | | Mn-54 | pCi/ea | 9.15E+01 | 1.07E+02 | 1.14E+01 | 9 | 1.17 | 0.60 - 1.66 | Acceptable |
| | | Zn-65 | pCi/ea | 1.41E+02 | 1.63E+02 | 1.53E+01 | 11 | 1.16 | 0.60 - 1.66 | Acceptable |
| E12515B | Gamma Milk CL Det 1 | Ce-141 | pCi/L | 1.40E+01 | 1.54E+01 | 2.64E+00 | 6 | 1.10 | 0.50 - 2.00 | Acceptable |
| | | Co-58 | pCi/L | 1.71E+01 | 1.60E+01 | 2.18E+00 | 7 | 0.94 | 0.50 - 2.00 | Acceptable |
| | | Co-60 | pCi/L | 3.58E+01 | 3.57E+01 | 2.66E+00 | 13 | 1.00 | 0.60 - 1.66 | Acceptable |
| | | Cr-51 | pCi/L | 3.51E+01 | 3.99E+01 | 1.13E+01 | 4 | 1.14 | 0.50 - 2.00 | Acceptable |
| | | Cs-134 | pCi/L | 1.92E+01 | 1.90E+01 | 1.31E+00 | 15 | 0.99 | 0.60 - 1.66 | Acceptable |
| | | Cs-137 | pCi/L | 2.35E+01 | 2.41E+01 | 2.88E+00 | 8 | 1.03 | 0.60 - 1.66 | Acceptable |
| | | Fe-59 | pCi/L | 1.90E+01 | 2.02E+01 | 2.92E+00 | 7 | 1.06 | 0.50 - 2.00 | Acceptable |
| | | I-131 | pCi/L | 3.22E+01 | 3.19E+01 | 5.26E+00 | 6 | 0.99 | 0.50 - 2.00 | Acceptable |
| | | Mn-54 | pCi/L | 1.71E+01 | 1.72E+01 | 2.29E+00 | 8 | 1.01 | 0.60 - 1.66 | Acceptable |
| | | Zn-65 | pCi/L | 2.64E+01 | 2.76E+01 | 3.32E+00 | 8 | 1.05 | 0.60 - 1.66 | Acceptable |
| E12515B | Gamma Milk CL Det 2 | Ce-141 | pCi/L | 1.40E+01 | 1.57E+01 | 4.29E+00 | 4 | 1.12 | 0.50 - 2.00 | Acceptable |
| | | Co-58 | pCi/L | 1.71E+01 | 1.74E+01 | 2.53E+00 | 7 | 1.02 | 0.50 - 2.00 | Acceptable |
| | | Co-60 | pCi/L | 3.58E+01 | 3.85E+01 | 2.78E+00 | 14 | 1.08 | 0.60 - 1.66 | Acceptable |
| | | Cr-51 | pCi/L | 3.51E+01 | 2.28E+01 | 1.90E+01 | 1 | 0.65 | 0.50 - 2.00 | Acceptable |
| | | Cs-134 | pCi/L | 1.92E+01 | 1.82E+01 | 1.29E+00 | 14 | 0.95 | 0.60 - 1.66 | Acceptable |
| | | Cs-137 | pCi/L | 2.35E+01 | 2.62E+01 | 3.05E+00 | 9 | 1.11 | 0.60 - 1.66 | Acceptable |
| | | Fe-59 | pCi/L | 1.90E+01 | 2.26E+01 | 2.83E+00 | 8 | 1.19 | 0.60 - 1.66 | Acceptable |
| | | I-131 | pCi/L | 3.22E+01 | 2.68E+01 | 6.15E+00 | 4 | 0.83 | 0.50 - 2.00 | Acceptable |
| | | Mn-54 | pCi/L | 1.71E+01 | 1.57E+01 | 2.30E+00 | 7 | 0.92 | 0.50 - 2.00 | Acceptable |
| | | Zn-65 | pCi/L | 2.64E+01 | 2.63E+01 | 3.24E+00 | 8 | 1.00 | 0.60 - 1.66 | Acceptable |
| E12515B | Gamma Milk CL Det 3 | Ce-141 | pCi/L | 1.40E+01 | 1.57E+01 | 2.87E+00 | 5 | 1.12 | 0.50 - 2.00 | Acceptable |
| | | Co-58 | pCi/L | 1.71E+01 | 1.73E+01 | 2.21E+00 | 8 | 1.01 | 0.60 - 1.66 | Acceptable |
| | | Co-60 | pCi/L | 3.58E+01 | 3.77E+01 | 2.62E+00 | 14 | 1.05 | 0.60 - 1.66 | Acceptable |
| | | Cr-51 | pCi/L | 3.51E+01 | 3.48E+01 | 2.42E+01 | 1 | 0.99 | 0.50 - 2.00 | Acceptable |
| | | Cs-134 | pCi/L | 1.92E+01 | 1.78E+01 | 1.16E+00 | 15 | 0.93 | 0.60 - 1.66 | Acceptable |
| | | Cs-137 | pCi/L | 2.35E+01 | 2.41E+01 | 2.48E+00 | 10 | 1.03 | 0.60 - 1.66 | Acceptable |
| | | Fe-59 | pCi/L | 1.90E+01 | 2.21E+01 | 2.67E+00 | 8 | 1.16 | 0.60 - 1.66 | Acceptable |
| | | I-131 | pCi/L | 3.22E+01 | 2.99E+01 | 6.32E+00 | 5 | 0.93 | 0.50 - 2.00 | Acceptable |
| | | Mn-54 | pCi/L | 1.71E+01 | 1.78E+01 | 2.25E+00 | 8 | 1.04 | 0.60 - 1.66 | Acceptable |
| | | Zn-65 | pCi/L | 2.64E+01 | 2.69E+01 | 5.82E+00 | 5 | 1.02 | 0.50 - 2.00 | Acceptable |
| E12516 | Beta Water | G. Beta | pCi/L | 2.88E+02 | 3.34E+02 | 4.20E+00 | 80 | 1.16 | 0.80 - 1.25 | Acceptable |

* calculated from PVNGS value/1 sigma error value

NRC Acceptance Criteria [1]

| Resolution | Ratio |
|---|---|
| 4-7 | 0.5-2.0 |
| 8-15 | 0.6-1.66 |
| 16-50 | 0.75-1.33 |
| 51-200 | 0.80-1.25 |
| >200 | 0.85-1.18 |

[1] From NRC Inspection Manual, procedure #84750, "Radioactive Waste Systems; Water Chemistry; Confirmatory Measurements"

## Table 7-1 Interlaboratory Comparison Results (Continued)

| Sample ID | Analysis Type | Nuclide | Units | Known Value | PVNGS Value | 1 sigma Error | Resolution* | Ratio | NRC Range | Results |
|---|---|---|---|---|---|---|---|---|---|---|
| E13032 | Gamma Water CL Det 1 | Ce-141 | pCi/L | 1.27E+02 | 1.23E+02 | 6.15E+00 | 20 | 0.97 | 0.75 - 1.33 | Acceptable |
| | | Co-58 | pCi/L | 1.33E+02 | 1.35E+02 | 6.80E+00 | 20 | 1.02 | 0.75 - 1.33 | Acceptable |
| | | Co-60 | pCi/L | 1.60E+02 | 1.65E+02 | 5.65E+00 | 29 | 1.03 | 0.75 - 1.33 | Acceptable |
| | | Cr-51 | pCi/L | 2.51E+02 | 3.39E+02 | 5.40E+01 | 6 | 1.35 | 0.50 - 2.00 | Acceptable |
| | | Cs-134 | pCi/L | 1.57E+02 | 1.50E+02 | 5.05E+00 | 30 | 0.96 | 0.75 - 1.33 | Acceptable |
| | | Cs-137 | pCi/L | 1.14E+02 | 1.18E+02 | 6.20E+00 | 19 | 1.04 | 0.75 - 1.33 | Acceptable |
| | | Fe-59 | pCi/L | 1.12E+02 | 1.19E+02 | 6.15E+00 | 19 | 1.06 | 0.75 - 1.33 | Acceptable |
| | | I-131 | pCi/L | 8.99E+01 | 1.02E+02 | 1.32E+01 | 8 | 1.13 | 0.60 - 1.66 | Acceptable |
| | | Mn-54 | pCi/L | 1.17E+02 | 1.24E+02 | 6.05E+00 | 20 | 1.06 | 0.75 - 1.33 | Acceptable |
| | | Zn-65 | pCi/L | 2.22E+02 | 2.31E+02 | 1.08E+01 | 21 | 1.04 | 0.75 - 1.33 | Acceptable |
| E13032 | Gamma Water CL Det 2 | Ce-141 | pCi/L | 1.27E+02 | 1.34E+02 | 6.90E+00 | 19 | 1.06 | 0.75 - 1.33 | Acceptable |
| | | Co-58 | pCi/L | 1.33E+02 | 1.27E+02 | 6.30E+00 | 20 | 0.95 | 0.75 - 1.33 | Acceptable |
| | | Co-60 | pCi/L | 1.60E+02 | 1.63E+02 | 5.10E+00 | 32 | 1.02 | 0.75 - 1.33 | Acceptable |
| | | Cr-51 | pCi/L | 2.51E+02 | 2.29E+02 | 4.33E+01 | 5 | 0.91 | 0.50 - 2.00 | Acceptable |
| | | Cs-134 | pCi/L | 1.57E+02 | 1.38E+02 | 4.49E+00 | 31 | 0.88 | 0.75 - 1.33 | Acceptable |
| | | Cs-137 | pCi/L | 1.14E+02 | 1.13E+02 | 5.55E+00 | 20 | 0.99 | 0.75 - 1.33 | Acceptable |
| | | Fe-59 | pCi/L | 1.12E+02 | 1.20E+02 | 5.10E+00 | 24 | 1.07 | 0.75 - 1.33 | Acceptable |
| | | I-131 | pCi/L | 8.99E+01 | 7.08E+01 | 9.80E+00 | 7 | 0.79 | 0.50 - 2.00 | Acceptable |
| | | Mn-54 | pCi/L | 1.17E+02 | 1.20E+02 | 5.80E+00 | 21 | 1.03 | 0.75 - 1.33 | Acceptable |
| | | Zn-65 | pCi/L | 2.22E+02 | 2.33E+02 | 1.05E+01 | 22 | 1.05 | 0.75 - 1.33 | Acceptable |
| E13032 | Gamma Water CL Det 3 | Ce-141 | pCi/L | 1.27E+02 | 1.22E+02 | 4.74E+00 | 26 | 0.96 | 0.75 - 1.33 | Acceptable |
| | | Co-58 | pCi/L | 1.33E+02 | 1.28E+02 | 5.00E+00 | 26 | 0.96 | 0.75 - 1.33 | Acceptable |
| | | Co-60 | pCi/L | 1.60E+02 | 1.61E+02 | 3.89E+00 | 41 | 1.01 | 0.75 - 1.33 | Acceptable |
| | | Cr-51 | pCi/L | 2.51E+02 | 2.60E+02 | 1.95E+01 | 13 | 1.04 | 0.60 - 1.66 | Acceptable |
| | | Cs-134 | pCi/L | 1.57E+02 | 1.38E+02 | 3.50E+00 | 39 | 0.88 | 0.75 - 1.33 | Acceptable |
| | | Cs-137 | pCi/L | 1.14E+02 | 1.15E+02 | 4.46E+00 | 26 | 1.01 | 0.75 - 1.33 | Acceptable |
| | | Fe-59 | pCi/L | 1.12E+02 | 1.15E+02 | 4.57E+00 | 25 | 1.03 | 0.75 - 1.33 | Acceptable |
| | | I-131 | pCi/L | 8.99E+01 | 8.93E+01 | 4.22E+00 | 21 | 0.99 | 0.75 - 1.33 | Acceptable |
| | | Mn-54 | pCi/L | 1.17E+02 | 1.15E+02 | 4.65E+00 | 25 | 0.98 | 0.75 - 1.33 | Acceptable |
| | | Zn-65 | pCi/L | 2.22E+02 | 2.30E+02 | 8.30E+00 | 28 | 1.04 | 0.75 - 1.33 | Acceptable |
| E13033 | Beta Filter | G. Beta | pCi/ea | 1.30E+02 | 1.27E+02 | 2.44E+00 | 52 | 0.98 | 0.80 - 1.25 | Acceptable |
| E13034 | CL Det 1 I-131 Cartridge | I-131 | pCi/ea | 9.43E+01 | 9.81E+01 | 6.75E+00 | 15 | 1.04 | 0.60 - 1.66 | Acceptable |
| E13034 | CL Det 2 I-131 Cartridge | I-131 | pCi/ea | 9.43E+01 | 8.99E+01 | 3.86E+00 | 23 | 0.95 | 0.75 - 1.33 | Acceptable |
| E13034 | CL Det 3 I-131 Cartridge | I-131 | pCi/ea | 9.43E+01 | 9.56E+01 | 4.51E+00 | 21 | 1.01 | 0.75 - 1.33 | Acceptable |
| E13035 | Gamma Filter CL Det 1 | Ce-141 | pCi/ea | 1.52E+02 | 1.54E+02 | 6.70E+00 | 23 | 1.01 | 0.75 - 1.33 | Acceptable |
| | | Co-58 | pCi/ea | 1.59E+02 | 1.72E+02 | 8.50E+00 | 20 | 1.08 | 0.75 - 1.33 | Acceptable |
| | | Co-60 | pCi/ea | 1.91E+02 | 2.07E+02 | 6.25E+00 | 33 | 1.08 | 0.75 - 1.33 | Acceptable |
| | | Cr-51 | pCi/ea | 3.01E+02 | 3.05E+02 | 2.13E+01 | 14 | 1.01 | 0.60 - 1.66 | Acceptable |
| | | Cs-134 | pCi/ea | 1.88E+02 | 1.72E+02 | 4.51E+00 | 38 | 0.91 | 0.75 - 1.33 | Acceptable |
| | | Cs-137 | pCi/ea | 1.37E+02 | 1.50E+02 | 8.25E+00 | 18 | 1.09 | 0.75 - 1.33 | Acceptable |
| | | Fe-59 | pCi/ea | 1.35E+02 | 1.55E+02 | 6.00E+00 | 26 | 1.15 | 0.75 - 1.33 | Acceptable |
| | | Mn-54 | pCi/ea | 1.40E+02 | 1.59E+02 | 7.60E+00 | 21 | 1.14 | 0.75 - 1.33 | Acceptable |
| | | Zn-65 | pCi/ea | 2.66E+02 | 3.11E+02 | 1.40E+01 | 22 | 1.17 | 0.75 - 1.33 | Acceptable |
| E13035 | Gamma Filter CL Det 2 | Ce-141 | pCi/ea | 1.52E+02 | 1.51E+02 | 6.10E+00 | 25 | 0.99 | 0.75 - 1.33 | Acceptable |
| | | Co-58 | pCi/ea | 1.59E+02 | 1.68E+02 | 9.80E+00 | 17 | 1.06 | 0.75 - 1.33 | Acceptable |
| | | Co-60 | pCi/ea | 1.91E+02 | 1.98E+02 | 5.70E+00 | 35 | 1.04 | 0.75 - 1.33 | Acceptable |
| | | Cr-51 | pCi/ea | 3.01E+02 | 3.09E+02 | 1.71E+01 | 18 | 1.03 | 0.75 - 1.33 | Acceptable |
| | | Cs-134 | pCi/ea | 1.88E+02 | 1.50E+02 | 4.54E+00 | 33 | 0.80 | 0.75 - 1.33 | Acceptable |
| | | Cs-137 | pCi/ea | 1.37E+02 | 1.49E+02 | 1.11E+01 | 13 | 1.09 | 0.60 - 1.66 | Acceptable |
| | | Fe-59 | pCi/ea | 1.35E+02 | 1.64E+02 | 5.75E+00 | 29 | 1.21 | 0.75 - 1.33 | Acceptable |
| | | Mn-54 | pCi/ea | 1.40E+02 | 1.60E+02 | 8.70E+00 | 18 | 1.14 | 0.75 - 1.33 | Acceptable |
| | | Zn-65 | pCi/ea | 2.66E+02 | 3.12E+02 | 1.32E+01 | 24 | 1.17 | 0.75 - 1.33 | Acceptable |
| E13035 | Gamma Filter CL Det 3 | Ce-141 | pCi/ea | 1.52E+02 | 1.64E+02 | 7.40E+00 | 22 | 1.08 | 0.75 - 1.33 | Acceptable |
| | | Co-58 | pCi/ea | 1.59E+02 | 1.77E+02 | 1.00E+01 | 18 | 1.11 | 0.75 - 1.33 | Acceptable |
| | | Co-60 | pCi/ea | 1.91E+02 | 2.08E+02 | 6.55E+00 | 32 | 1.09 | 0.75 - 1.33 | Acceptable |
| | | Cr-51 | pCi/ea | 3.01E+02 | 2.84E+02 | 2.15E+01 | 13 | 0.94 | 0.60 - 1.66 | Acceptable |
| | | Cs-134 | pCi/ea | 1.88E+02 | 1.60E+02 | 4.97E+00 | 32 | 0.85 | 0.75 - 1.33 | Acceptable |
| | | Cs-137 | pCi/ea | 1.37E+02 | 1.55E+02 | 1.01E+01 | 15 | 1.13 | 0.60 - 1.66 | Acceptable |
| | | Fe-59 | pCi/ea | 1.35E+02 | 1.71E+02 | 7.25E+00 | 24 | 1.27 | 0.75 - 1.33 | Acceptable |
| | | Mn-54 | pCi/ea | 1.40E+02 | 1.64E+02 | 8.85E+00 | 19 | 1.17 | 0.75 - 1.33 | Acceptable |
| | | Zn-65 | pCi/ea | 2.66E+02 | 3.25E+02 | 1.57E+01 | 21 | 1.22 | 0.75 - 1.33 | Acceptable |

## Table 7-1 Interlaboratory Comparison Results (Continued)

| Sample ID | Analysis Type | Nuclide | Units | Known Value | PVNGS Value | 1 sigma Error | Resolution* | Ratio | NRC Range | Results |
|---|---|---|---|---|---|---|---|---|---|---|
| E13036 | Tech A H-3 Water | H-3 | pCi/L | 1.40E+04 | 1.23E+04 | 3.59E+02 | 34 | 0.88 | 0.75 - 1.33 | Acceptable |
| E13036 | Tech B H-3 Water | H-3 | pCi/L | 1.40E+04 | 1.23E+04 | 3.58E+02 | 34 | 0.88 | 0.75 - 1.33 | Acceptable |
| E13036 | Tech C H-3 Water | H-3 | pCi/L | 1.40E+04 | 1.22E+04 | 3.58E+02 | 34 | 0.87 | 0.75 - 1.33 | Acceptable |
| E13036 | Tech D H-3 Water | H-3 | pCi/L | 1.40E+04 | 1.20E+04 | 3.56E+02 | 34 | 0.86 | 0.75 - 1.33 | Acceptable |
| E13036 | Tech E H-3 Water | H-3 | pCi/L | 1.40E+04 | 1.24E+04 | 3.58E+02 | 35 | 0.88 | 0.75 - 1.33 | Acceptable |
| E13036 | Tech F H-3 Water | H-3 | pCi/L | 1.40E+04 | 1.25E+04 | 3.62E+02 | 34 | 0.89 | 0.75 - 1.33 | Acceptable |
| E13036 | Tech G H-3 Water | H-3 | pCi/L | 1.40E+04 | 1.23E+04 | 3.60E+02 | 34 | 0.88 | 0.75 - 1.33 | Acceptable |

* calculated from PVNGS value/1 sigma error value

NRC Acceptance Criteria [1]

| Resolution | Ratio |
|---|---|
| 4-7 | 0.5-2.0 |
| 8-15 | 0.6-1.66 |
| 16-50 | 0.75-1.33 |
| 51-200 | 0.80-1.25 |
| >200 | 0.85-1.18 |

[1] From NRC Inspection Manual, procedure #84750, "Radioactive Waste Systems; Water Chemistry; Confirmatory Measurements"

## Table 7-1 Interlaboratory Comparison Results (Continued)

| Sample Type | Analysis Type | ERA PT Study | Nuclide | Units | PVNGS Value | Assigned Value [1] | Acceptance Limit [2] | Results |
|---|---|---|---|---|---|---|---|---|
| Water | Tritium | MRAD-030 | H-3 | pCi/L | 22,700 | 23,700 | 17900-28800 | Acceptable |
| Water | Gross Beta | RAD-118 | Gross Beta | pCi/L | 60.1 | 63.9 | 44.2-70.5 | Acceptable |

[1] The ERA assigned values are established per the guidelines contained in the National Environmental Laboratory Accreditation Conference (NELAC) program criteria as applicable.

[2] "Acceptance Limits" have been calculated per ERA's Standard Operating Procedure for the Generation of Performance Acceptance Limits.

# 8. Data Interpretation and Conclusions

Associated with the analytical process are potential random and systematic errors. Systematic errors can be caused by instrument malfunctions, incomplete precipitation, back scattering, and self-absorption.

Efforts are made to minimize both systematic and random errors in the data reported. Systematic errors are minimized by performing reviews throughout the analysis. For example, instruments are checked routinely with radioactive sources, and recovery and self-absorption factors based on individual sample analyses are incorporated into the calculation equations where necessary. Random errors are reduced by comparing all data to historical data for the same site and performing comparisons between analytical results when available. In addition, when data do not appear to match historical results, analyses may be rerun on a separate aliquot of the sample to verify the presence of the activity. The acceptance of data is dependent upon the results of quality control samples and is part of the data review process for all analytical results.

The "plus or minus value" reported with each analytical result represents the counting error associated with the result and gives the 95% confidence ($2\sigma$) interval around the data.

Most samples contain radioactivity associated with natural background/cosmic radioactivity (e.g. K-40, Th-234, Be-7). Gross beta results for drinking water and air are due to natural background. Gamma-emitting radionuclides, which can be attributed to natural background sources, are not indicated in this report.

Results and interpretation of the data for all of the samples analyzed during 2019 are presented in the following sections.

### 8.1 Air Particulates

Weekly gross beta results, in quarterly format, are presented in Table 8-1 and Table 8-2. Gross beta activity at indicator locations ranged from 0.011 to 0.075 pCi/m$^3$. Mean quarterly activity is normally calculated using weekly activity over a thirteen (13) week period. Also presented in the tables are the weekly mean values of all the sites as well as the percent relative standard deviation (RSD %) for the data.

Table 8-3 displays the results of gamma spectroscopy on the quarterly composites of the weekly samples. No plant-related activity was identified

### 8.2 Airborne Radioiodine

Table 8-4 and Table 8-5 present the quarterly radioiodine results. Radioiodine was not observed in any samples.

### 8.3 Vegetation

Table 8-6 presents gamma isotopic data for the vegetation samples. No gamma-emitting radionuclides were observed in any of the samples.

## 8.4 Milk

Table 8-7 presents gamma isotopic data for the goat milk samples. No gamma-emitting radionuclides were observed in any of the samples.

## 8.5 Drinking Water

Samples were analyzed for gross beta, tritium, and gamma-emitting radionuclides. Results of these analyses are presented in Table 8-8. No tritium or gamma-emitting radionuclides were detected in any samples. Gross beta activity ranged from less than detectable to a high of 8.75 pCi/liter. The gross beta activity is attributable to natural (background) radioactive materials.

## 8.6 Groundwater

Groundwater samples were analyzed from two onsite wells (regional aquifer) for tritium and gamma-emitting radionuclides. Results obtained from the analysis of the samples are presented in Table 8-9.

No tritium or gamma-emitting radionuclides were observed in any of the samples.

## 8.7 Surface Water

Surface water samples from the Reservoirs and Evaporation Ponds were analyzed for tritium and gamma-emitting radionuclides. The two Reservoirs contain processed sewage water from the City of Phoenix and are approximately 45 and 85 acres in size. The three Evaporation Ponds receive mostly circulating water from main turbine condenser cooling and are about 200-250 acres each.

Sample results are presented in Table 8-10. I-131 was observed in both reservoirs and Evaporation Pond 1B. The I-131 levels ranged from 13 pCi/L – 17 pCi/L. I-131 in these surface water locations is a result of radiopharmaceutical I-131 in the Phoenix sewage effluent and is not attributable to plant effluents.

Tritium was routinely observed in the Evaporation Ponds. The highest concentration was 1086 pCi/liter. Tritium was not detected in the Reservoirs. The tritium identified in the Evaporation Ponds has been attributed to permitted plant gaseous effluent releases and secondary plant liquid discharges (e.g. condensate overboard discharge, secondary side steam generator drains, secondary plant sumps, demineralizer regeneration waste). The tritium concentrations were compared to historical values and are considered typical for the Evaporation Ponds.

Low levels of Cs-137 has been detected in Evaporation Pond 3A. Evaporation Pond 3A is in the process of being drained for liner repairs. The water inventory is very low, such that the sampling tool comes into contact with the bottom and sides of the pond, resulting in a small amount of salt and sediment intrude into the water sample. Evaporation Pond 3A has not received any influent from the plant since 2016, and the low levels of Cs-137 was not detectable until the water inventory in the pond was low, such that sampling tools also came into contact with the salt and/or sediment during sampling. The low levels of Cs-137 is consistent with diluted background levels seen in preoperational sediment analysis, and is attributed sediment intrusion from the surrounding area. No action levels have been exceeded.

## 8.8 Sludge and Sediment

### 8.8.1 WR Centrifuge Waste Sludge

Sludge samples were obtained from the WR centrifuge and analyzed by gamma spectroscopy. I-131 activity in the sludge is consistent with historical values and, as previously discussed, is due to radiopharmaceuticals in the WR Influent. The concentration of I-131 ranged from "no detectable" to 1020 pCi/kg.

Results for WR centrifuge waste sludge can be found in Table 8-11.

### 8.8.2 Cooling Tower Sludge

Sludge/sediment originating from the Unit 1 and Unit 3 Cooling Towers and Circulating Water canals was disposed of in the WR sludge landfill during 2019. Sample results can be found in Table 8-11.

## 8.9 Data Trends

Figure 8-1 through Figure 8-8 present data in graphical format. Historical data are displayed for comparison where practical.

## 8.10 Hard-To-Detect Radionuclide Results

Table 8-12 shows the results of the three subsurface samples obtained from 3 tritium monitoring points. These samples were analyzed for hard-to-detect radionuclides (e.g. C-14, Fe-55, Ni-63, Sr-90) and all results were <MDA. These results indicate that no leaks from plant systems have affected groundwater.

# Table 8-1 Particulate Gross Beta in Air 1st-2nd Quarter

## PARTICULATE GROSS BETA IN AIR 1st QUARTER

ODCM required samples denoted by *

units are pCi/m$^3$

| Week # | START DATE | STOP DATE | Site 4 | (control) Site 6A* | Site 7A | Site 14A* | Site 15* | Site 17A | Site 21 | Site 29* | Site 35 | Site 40* | Mean | RSD (%) | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 31-Dec-18 | 8-Jan-19 | 0.042 | 0.039 | 0.039 | 0.042 | 0.043 | 0.046 | 0.043 | 0.039 | 0.043 | 0.040 | 0.041 | 5.8 | |
| 2 | 8-Jan-19 | 15-Jan-19 | 0.043 | 0.041 | 0.039 | 0.038 | 0.032 | 0.038 | 0.041 | 0.037 | 0.038 | 0.038 | 0.038 | 7.6 | |
| 3 | 15-Jan-19 | 22-Jan-19 | 0.017 | 0.017 | 0.018 | 0.015 | 0.020 | 0.016 | 0.017 | 0.016 | 0.018 | 0.016 | 0.017 | 7.4 | |
| 4 | 22-Jan-19 | 29-Jan-19 | 0.030 | 0.031 | 0.030 | 0.027 | 0.026 | 0.026 | 0.030 | 0.027 | 0.029 | 0.024 | 0.028 | 8.0 | |
| 5 | 29-Jan-19 | 5-Feb-19 | 0.038 | 0.040 | 0.040 | 0.033 | 0.035 | 0.041 | 0.038 | 0.036 | 0.037 | 0.035 | 0.037 | 6.8 | |
| 6 | 5-Feb-19 | 12-Feb-19 | 0.021 | 0.022 | 0.022 | 0.021 | 0.022 | 0.021 | 0.020 | 0.021 | 0.018 | 0.021 | 0.021 | 5.1 | |
| 7 | 12-Feb-19 | 19-Feb-19 | 0.020 | 0.021 | 0.020 | 0.018 | 0.018 | 0.022 | 0.020 | 0.017 | 0.019 | 0.016 | 0.019 | 9.8 | |
| 8 | 19-Feb-19 | 26-Feb-19 | 0.024 | 0.024 | 0.023 | 0.026 | 0.023 | 0.027 | 0.030 | 0.027 | 0.026 | 0.026 | 0.026 | 8.1 | |
| 9 | 26-Feb-19 | 6-Mar-19 | 0.026 | 0.026 | 0.028 | 0.025 | 0.027 | 0.032 | 0.027 | 0.025 | 0.028 | 0.026 | 0.027 | 7.1 | 1 |
| 10 | 6-Mar-19 | 12-Mar-19 | 0.020 | 0.019 | 0.019 | 0.019 | 0.017 | 0.019 | 0.020 | 0.021 | 0.020 | 0.019 | 0.019 | 5.5 | 1 |
| 11 | 12-Mar-19 | 19-Mar-19 | 0.025 | 0.024 | 0.023 | 0.024 | 0.022 | 0.025 | 0.028 | 0.021 | 0.024 | 0.025 | 0.024 | 7.1 | |
| 12 | 19-Mar-19 | 26-Mar-19 | 0.029 | 0.033 | 0.029 | 0.029 | 0.030 | 0.032 | 0.028 | 0.029 | 0.031 | 0.028 | 0.030 | 5.2 | |
| 13 | 26-Mar-19 | 2-Apr-19 | 0.032 | 0.029 | 0.028 | 0.024 | 0.031 | 0.034 | 0.032 | 0.030 | 0.032 | 0.028 | 0.030 | 9.3 | |
| | Mean | | 0.028 | 0.028 | 0.028 | 0.026 | 0.027 | 0.029 | 0.029 | 0.027 | 0.028 | 0.026 | 0.028 | 4.0 | |

Note 1: Sample period altered by 1 day. Sampling period remains within procedural requirements.

## PARTICULATE GROSS BETA IN AIR 2nd QUARTER

ODCM required samples denoted by *

units are pCi/m$^3$

| Week # | START DATE | STOP DATE | Site 4 | (control) Site 6A* | Site 7A | Site 14A* | Site 15* | Site 17A | Site 21 | Site 29* | Site 35 | Site 40* | Mean | RSD (%) | ⊥Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | 2-Apr-19 | 9-Apr-19 | 0.022 | 0.020 | 0.018 | 0.019 | 0.015 | 0.019 | 0.019 | 0.016 | 0.018 | 0.020 | 0.019 | 12.0 | |
| 15 | 9-Apr-19 | 16-Apr-19 | 0.023 | 0.021 | 0.022 | 0.021 | 0.018 | 0.020 | 0.020 | 0.017 | 0.020 | 0.017 | 0.020 | 10.6 | |
| 16 | 16-Apr-19 | 23-Apr-19 | 0.025 | 0.023 | 0.025 | 0.023 | 0.020 | ⊥0.003 | 0.025 | 0.026 | 0.022 | 0.023 | 0.023 | 7.7 | 2 |
| 17 | 23-Apr-19 | 30-Apr-19 | 0.027 | 0.027 | 0.028 | 0.028 | 0.027 | 0.031 | 0.029 | 0.028 | 0.028 | 0.030 | 0.028 | 5.3 | 2 |
| 18 | 30-Apr-19 | 7-May-19 | 0.027 | 0.025 | 0.020 | 0.024 | 0.022 | 0.025 | 0.025 | 0.025 | 0.016 | 0.025 | 0.023 | 14.3 | |
| 19 | 7-May-19 | 14-May-19 | 0.021 | 0.018 | 0.016 | 0.016 | 0.022 | 0.019 | 0.019 | 0.020 | 0.022 | 0.017 | 0.019 | 12.7 | |
| 20 | 14-May-19 | 21-May-19 | 0.020 | 0.021 | 0.020 | 0.021 | 0.020 | 0.020 | 0.022 | 0.020 | 0.020 | 0.022 | 0.020 | 4.3 | |
| 21 | 21-May-19 | 28-May-19 | 0.011 | 0.010 | 0.013 | 0.011 | 0.015 | 0.016 | 0.012 | 0.014 | ⊥0.013 | 0.013 | 0.013 | 15.5 | 3 |
| 22 | 28-May-19 | 4-Jun-19 | 0.018 | 0.027 | 0.025 | 0.026 | 0.024 | 0.023 | 0.026 | 0.028 | ⊥0.0177 | 0.027 | 0.025 | 12.0 | 3 |
| 23 | 4-Jun-19 | 11-Jun-19 | 0.032 | 0.030 | 0.035 | 0.029 | 0.032 | 0.032 | 0.028 | 0.027 | 0.029 | 0.026 | 0.030 | 9.6 | |
| 24 | 11-Jun-19 | 18-Jun-19 | 0.034 | 0.033 | 0.032 | 0.031 | 0.031 | 0.033 | 0.029 | 0.030 | 0.031 | 0.030 | 0.031 | 4.7 | |
| 25 | 18-Jun-19 | 25-Jun-19 | 0.030 | 0.026 | 0.027 | 0.028 | 0.029 | 0.028 | 0.030 | 0.028 | 0.028 | ⊥0.0489 | 0.028 | 4.8 | 4 |
| 26 | 25-Jun-19 | 1-Jul-19 | 0.027 | 0.024 | 0.023 | 0.023 | 0.024 | 0.028 | 0.024 | 0.026 | 0.015 | 0.023 | 0.024 | 14.9 | |
| | Mean | | 0.024 | 0.023 | 0.023 | 0.023 | 0.023 | 0.024 | 0.024 | 0.024 | 0.022 | 0.023 | 0.023 | 2.7 | |

Note 2: Site 17A had a pump failure that impacted collection time during Weeks 16 and 17. Volume insufficient for statistical analysis for Week 16 and data is INFO ONLY. CR 19-06328

Note 3: Site 35 lost power during Week 21; however the Elapsed Time Meter continued recording time. Week 22 experienced a pump failure once the power was restored and had a shortened sampling run time. Samples are INVALID due to unknown volume of sample.

Note 4: Site 40 pump failed during sampling period with time meter still running, resulting in inability to determine sample flow. Sample is INVALID and data is for INFO ONLY. CR 19-09504

## Table 8-2 Particulate Gross Beta in Air 3rd-4th Quarter

### PARTICULATE GROSS BETA IN AIR 3rd QUARTER

**ODCM required samples denoted by ***

**units are pCi/m$^3$**

**3rd Quarter**

| Week # | START DATE | STOP DATE | Site 4 | (control) Site 6A* | Site 7A | Site 14A* | Site 15* | Site 17A | Site 21 | Site 29* | Site 35 | Site 40* | Mean | RSD (%) | ⊥Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | 1-Jul-19 | 9-Jul-19 | 0.026 | 0.022 | 0.021 | 0.022 | 0.024 | 0.024 | 0.022 | 0.023 | 0.022 | 0.022 | 0.023 | 5.8 | |
| 28 | 9-Jul-19 | 16-Jul-19 | 0.031 | 0.028 | 0.030 | 0.027 | 0.030 | 0.026 | 0.030 | 0.028 | 0.025 | 0.030 | 0.029 | 7.5 | 5 |
| 29 | 16-Jul-19 | 23-Jul-19 | 0.032 | 0.030 | 0.027 | 0.031 | 0.031 | 0.028 | 0.030 | 0.031 | 0.029 | 0.029 | 0.030 | 4.7 | |
| 30 | 23-Jul-19 | 30-Jul-19 | 0.028 | 0.028 | 0.028 | 0.031 | 0.033 | 0.032 | 0.027 | 0.032 | 0.030 | 0.029 | 0.030 | 6.4 | |
| 31 | 30-Jul-19 | 6-Aug-19 | 0.031 | 0.033 | 0.032 | 0.029 | 0.031 | 0.032 | 0.031 | 0.030 | 0.032 | 0.032 | 0.031 | 3.4 | |
| 32 | 6-Aug-19 | 13-Aug-19 | 0.033 | 0.034 | 0.033 | 0.033 | 0.032 | 0.032 | 0.035 | 0.035 | 0.037 | 0.035 | 0.034 | 4.8 | |
| 33 | 13-Aug-19 | 20-Aug-19 | 0.028 | ⊥0.007 | 0.025 | 0.021 | 0.025 | 0.026 | 0.023 | 0.024 | 0.028 | 0.022 | 0.025 | 9.3 | 6 |
| 34 | 20-Aug-19 | 27-Aug-19 | 0.021 | 0.019 | 0.020 | 0.018 | 0.019 | 0.018 | 0.017 | 0.019 | 0.019 | 0.019 | 0.019 | 5.7 | 7 |
| 35 | 27-Aug-19 | 3-Sep-19 | 0.029 | 0.027 | 0.026 | 0.022 | 0.023 | 0.024 | 0.026 | 0.023 | 0.025 | 0.022 | 0.025 | 9.0 | |
| 36 | 3-Sep-19 | 10-Sep-19 | 0.040 | 0.035 | 0.035 | 0.034 | 0.036 | 0.039 | 0.034 | 0.036 | 0.035 | 0.037 | 0.036 | 5.5 | |
| 37 | 10-Sep-19 | 17-Sep-19 | 0.027 | 0.034 | 0.030 | 0.029 | 0.031 | 0.032 | 0.030 | 0.030 | 0.032 | 0.031 | 0.031 | 6.5 | |
| 38 | 17-Sep-19 | 24-Sep-19 | 0.026 | 0.024 | 0.023 | 0.019 | 0.021 | 0.024 | 0.022 | 0.023 | 0.018 | 0.022 | 0.022 | 10.2 | |
| 39 | 24-Sep-19 | 1-Oct-19 | 0.018 | 0.017 | 0.022 | 0.018 | 0.021 | 0.020 | 0.017 | 0.019 | 0.021 | 0.016 | 0.019 | 10.6 | |
| | **Mean** | | 0.028 | 0.028 | 0.027 | 0.026 | 0.027 | 0.027 | 0.026 | 0.027 | 0.027 | 0.027 | 0.027 | 3.2 | |

Note 5: Site 40 Elapsed Time Meter (ETM) did not reflect the expected run time (actual 141.9 hrs. vs expected 167.2 hrs.). Upon testing, it appeared that the ETM was functioning properly. Possible cause- power outage. Sample appeared to have normal dust loading. Sample run time sufficient for data collection; sample considered VALID. CR 19-10403

Note 6: Site 6A experienced pump failure and runtime could not be determined. Sample INVALID. Date for INFO ONLY. CR 19-12139

Note 7: Site 6A experienced a failure of the Elapsed Time Meter. Pump was running satisfactorily and collection on filter had normal distribution. Sample is VALID. CR 19-12487.

### PARTICULATE GROSS BETA IN AIR 4th QUARTER

**ODCM required samples denoted by ***

**units are pCi/m$^3$**

| Week # | START DATE | STOP DATE | Site 4 | (control) Site 6A* | Site 7A | Site 14A* | Site 15* | Site 17A | Site 21 | Site 29* | Site 35 | Site 40* | Mean | RSD (%) | ⊥Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 1-Oct-19 | 8-Oct-19 | 0.034 | 0.037 | 0.033 | 0.034 | 0.033 | 0.037 | 0.036 | 0.034 | 0.034 | 0.034 | 0.034 | 4.8 | |
| 41 | 8-Oct-19 | 15-Oct-19 | 0.039 | 0.035 | 0.036 | 0.037 | 0.036 | 0.037 | 0.039 | 0.037 | 0.039 | 0.033 | 0.037 | 5.1 | |
| 42 | 15-Oct-19 | 22-Oct-19 | 0.032 | 0.032 | 0.031 | 0.029 | 0.030 | 0.028 | 0.030 | 0.030 | 0.029 | 0.029 | 0.030 | 3.9 | |
| 43 | 22-Oct-19 | 30-Oct-19 | 0.032 | 0.031 | 0.028 | 0.023 | 0.030 | 0.029 | 0.030 | 0.029 | 0.029 | 0.028 | 0.029 | 8.5 | |
| 44 | 30-Oct-19 | 5-Nov-19 | 0.046 | 0.047 | 0.045 | 0.039 | 0.040 | 0.042 | 0.044 | ⊥0.014 | 0.042 | 0.043 | 0.043 | 5.9 | 8 |
| 45 | 5-Nov-19 | 12-Nov-19 | 0.042 | 0.042 | 0.038 | 0.039 | 0.041 | 0.040 | 0.043 | ⊥0.003 | 0.040 | 0.039 | 0.040 | 3.5 | 9 |
| 46 | 12-Nov-19 | 19-Nov-19 | 0.071 | 0.066 | 0.056 | 0.062 | 0.063 | 0.058 | 0.067 | 0.075 | 0.066 | 0.068 | 0.065 | 9.0 | |
| 47 | 19-Nov-19 | 25-Nov-19 | 0.022 | 0.023 | 0.023 | 0.022 | 0.025 | 0.025 | 0.022 | 0.023 | 0.022 | 0.022 | 0.023 | 4.6 | |
| 48 | 25-Nov-19 | 3-Dec-19 | 0.020 | 0.022 | 0.021 | 0.021 | 0.018 | 0.021 | 0.023 | 0.024 | 0.020 | 0.021 | 0.021 | 7.8 | |
| 49 | 3-Dec-19 | 10-Dec-19 | 0.029 | 0.031 | 0.028 | 0.027 | 0.024 | 0.027 | 0.027 | 0.025 | 0.024 | 0.022 | 0.026 | 10.4 | |
| 50 | 10-Dec-19 | 17-Dec-19 | 0.026 | 0.026 | 0.025 | 0.025 | 0.026 | 0.023 | 0.028 | 0.025 | 0.024 | 0.025 | 0.025 | 5.5 | |
| 51 | 17-Dec-19 | 23-Dec-19 | 0.027 | 0.031 | 0.033 | 0.029 | 0.033 | 0.035 | 0.029 | 0.029 | 0.030 | 0.026 | 0.030 | 9.7 | |
| 52 | 23-Dec-19 | 30-Dec-19 | 0.025 | 0.023 | 0.021 | 0.021 | 0.022 | 0.023 | 0.025 | 0.023 | 0.023 | 0.021 | 0.023 | 6.4 | |
| | **Mean** | | 0.034 | 0.034 | 0.032 | 0.031 | 0.032 | 0.033 | 0.034 | 0.032 | 0.032 | 0.032 | 0.033 | 3.3 | |
| | ***Annual Average*** | | ***0.02882*** | ***0.02841*** | ***0.02747*** | ***0.02659*** | ***0.02736*** | ***0.02852*** | ***0.02823*** | ***0.02720*** | ***0.02765*** | ***0.02681*** | ***0.0277*** | ***7.6150*** | |

Note 8: Site 29 experience pump failure and volume could not be estimated. Sample is INVALID and data is for INFO ONLY. CR 19-16553

Note 9: Site 29 experience pump failure and volume could not be estimated. Sample is INVALID and data is for INFO ONLY. CR 19-16890

## Table 8-3 Gamma in Air Filter Composites

**GAMMA IN AIR FILTER COMPOSITES**

**ODCM required samples denoted by ***

**units are pCi/m$^3$**

| QUARTER ENDPOINT | NUCLIDE | Site 4 | (control) Site 6A* | Site 7A | Site 14A* | Site 15* | Site 17A | Site 21 | Site 29* | Site 35 | Site 40* | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26-Mar-19 | Cs-134 | <0.001 | <0.003 | <0.002 | <0.001 | <0.003 | <0.001 | <0.002 | <0.002 | <0.002 | <0.003 | |
| | Cs-137 | <0.002 | <0.003 | <0.004 | <0.003 | <0.004 | <0.004 | <0.002 | <0.003 | <0.004 | <0.001 | |
| 25-Jun-19 | Cs-134 | <0.003 | <0.002 | <0.004 | <0.001 | <0.003 | <0.001 | <0.002 | <0.001 | <0.001 | <0.001 | |
| | Cs-137 | <0.003 | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.003 | <0.001 | <0.004 | <0.004 | |
| 24-Sep-19 | Cs-134 | <0.003 | <0.004 | <0.003 | <0.001 | <0.001 | <0.001 | <0.002 | <0.001 | <0.002 | <0.001 | |
| | Cs-137 | <0.002 | <0.002 | <0.002 | <0.003 | <0.002 | <0.003 | <0.003 | <0.001 | <0.004 | <0.002 | |
| 30-Dec-19 | Cs-134 | <0.001 | <0.003 | <0.002 | <0.003 | <0.001 | <0.003 | <0.002 | <0.001 | <0.001 | <0.001 | |
| | Cs-137 | <0.003 | <0.001 | <0.001 | <0.004 | <0.006 | <0.001 | <0.004 | <0.003 | <0.001 | <0.001 | |

## Table 8-4 Radioiodine in Air 1st-2nd Quarter

### RADIOIODINE IN AIR 1st QUARTER

**ODCM required samples denoted by ***

**units are pCi/m³**

required LLD <0.070

| Week # | START DATE | STOP DATE | Site 4 | (control) Site 6A* | Site 7A | Site 14A* | Site 15* | Site 17A | Site 21 | Site 29* | Site 35 | Site 40* | ⊥Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 31-Dec-18 | 8-Jan-19 | <0.030 | <0.024 | <0.031 | <0.020 | <0.024 | <0.026 | <0.021 | <0.037 | <0.024 | <0.031 | |
| 2 | 8-Jan-19 | 15-Jan-19 | <0.028 | <0.028 | <0.049 | <0.027 | <0.017 | <0.017 | <0.049 | <0.036 | <0.042 | <0.022 | |
| 3 | 15-Jan-19 | 22-Jan-19 | <0.034 | <0.018 | <0.052 | <0.030 | <0.045 | <0.031 | <0.053 | <0.043 | <0.053 | <0.031 | |
| 4 | 22-Jan-19 | 29-Jan-19 | <0.042 | <0.023 | <0.023 | <0.030 | <0.018 | <0.035 | <0.019 | <0.038 | <0.023 | <0.007 | |
| 5 | 29-Jan-19 | 5-Feb-19 | <0.025 | <0.055 | <0.022 | <0.049 | <0.064 | <0.033 | <0.035 | <0.024 | <0.007 | <0.036 | |
| 6 | 5-Feb-19 | 12-Feb-19 | <0.017 | <0.017 | <0.021 | <0.031 | <0.028 | <0.017 | <0.035 | <0.033 | <0.029 | <0.016 | |
| 7 | 12-Feb-19 | 19-Feb-19 | <0.030 | <0.032 | <0.042 | <0.024 | <0.048 | <0.029 | <0.033 | <0.017 | <0.064 | <0.036 | |
| 8 | 19-Feb-19 | 26-Feb-19 | <0.030 | <0.048 | <0.033 | <0.048 | <0.021 | <0.022 | <0.033 | <0.022 | <0.017 | <0.033 | |
| 9 | 26-Feb-19 | 6-Mar-19 | <0.025 | <0.015 | <0.037 | <0.015 | <0.052 | <0.029 | <0.043 | <0.025 | <0.026 | <0.025 | 1 |
| 10 | 6-Mar-19 | 12-Mar-19 | <0.051 | <0.031 | <0.014 | <0.026 | <0.049 | <0.030 | <0.020 | <0.060 | <0.035 | <0.031 | 1 |
| 11 | 12-Mar-19 | 19-Mar-19 | <0.031 | <0.032 | <0.053 | <0.023 | <0.059 | <0.027 | <0.044 | <0.034 | <0.026 | <0.037 | |
| 12 | 19-Mar-19 | 26-Mar-19 | <0.025 | <0.006 | <0.047 | <0.027 | <0.054 | <0.031 | <0.033 | <0.031 | <0.025 | <0.052 | |
| 13 | 26-Mar-19 | 2-Apr-19 | <0.026 | <0.036 | <0.027 | <0.033 | <0.025 | <0.033 | <0.017 | <0.033 | <0.017 | <0.022 | |

Note 1: Sample period altered by 1 day. Sampling period remains within procedural requirements.

### RADIOIODINE IN AIR 2nd QUARTER

**ODCM required samples denoted by ***

**units are pCi/m³**

required LLD <0.070

| Week # | DATE | DATE | 4 | (control) 6A* | 7A | 14A* | 15* | 17A | 21 | 29* | 35 | 40* | ⊥Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | 2-Apr-19 | 9-Apr-19 | <0.029 | <0.021 | <0.022 | <0.025 | <0.006 | <0.026 | <0.025 | <0.006 | <0.033 | <0.025 | |
| 15 | 9-Apr-19 | 16-Apr-19 | <0.030 | <0.016 | <0.025 | <0.021 | <0.032 | <0.025 | <0.031 | <0.021 | <0.022 | <0.017 | |
| 16 | 16-Apr-19 | 23-Apr-19 | <0.029 | <0.017 | <0.006 | <0.031 | <0.032 | ⊥<0.061 | <0.022 | <0.032 | <0.021 | <0.022 | 2 |
| 17 | 23-Apr-19 | 30-Apr-19 | <0.030 | <0.034 | <0.035 | <0.023 | <0.051 | <0.067 | <0.052 | <0.024 | <0.026 | <0.068 | 2 |
| 18 | 30-Apr-19 | 7-May-19 | <0.033 | <0.026 | <0.035 | <0.018 | <0.053 | <0.032 | <0.068 | <0.035 | <0.029 | <0.064 | |
| 19 | 7-May-19 | 14-May-19 | <0.040 | <0.021 | <0.056 | <0.016 | <0.049 | <0.029 | <0.012 | <0.017 | <0.042 | <0.006 | |
| 20 | 14-May-19 | 21-May-19 | <0.054 | <0.017 | <0.047 | <0.027 | <0.040 | <0.016 | <0.032 | <0.027 | <0.058 | <0.027 | |
| 21 | 21-May-19 | 28-May-19 | <0.051 | <0.066 | <0.039 | <0.061 | <0.043 | <0.053 | <0.033 | <0.063 | ⊥<0.033 | <0.042 | 3 |
| 22 | 28-May-19 | 4-Jun-19 | <0.028 | <0.006 | <0.048 | <0.021 | <0.048 | <0.037 | <0.041 | <0.030 | ⊥<0.028 | <0.043 | 3 |
| 23 | 4-Jun-19 | 11-Jun-19 | <0.029 | <0.057 | <0.044 | <0.023 | <0.033 | <0.030 | <0.035 | <0.029 | <0.026 | <0.050 | |
| 24 | 11-Jun-19 | 18-Jun-19 | <0.067 | <0.012 | <0.031 | <0.033 | <0.035 | <0.028 | <0.013 | <0.026 | <0.006 | <0.034 | |
| 25 | 18-Jun-19 | 25-Jun-19 | <0.024 | <0.018 | <0.068 | <0.027 | <0.052 | <0.028 | <0.065 | <0.031 | <0.018 | ⊥<0.065 | 4 |
| 26 | 25-Jun-19 | 1-Jul-19 | <0.029 | <0.031 | <0.069 | <0.008 | <0.062 | <0.036 | <0.063 | <0.029 | <0.031 | <0.065 | |

Note 2: Site 17A had a pump failure that impacted collection time during Weeks 16 and 17. Volume insufficient for statistical analysis for Week 16 and data is for INFO ONLY. CR 19-06328

Note 3: Site 35 lost power during Week 21; however the Elapsed Time Meter continued recording time. Week 22 experienced a pump failure once the power was restored and had a shortened sampling run time. Samples are INVALID due to unknown volume of sample.

Note 4: Site 40 pump failed during sampling period with time meter still running, resulting in inability to determine sample flow. Sample is INVALID and data is for INFO ONLY. CR 19-09504

## Table 8-5 Radioiodine in Air 3rd-4th Quarter

### RADIOIODINE IN AIR 3rd QUARTER

ODCM required samples denoted by *

units are pCi/m$^3$

required LLD <0.070

| Week # | START DATE | STOP DATE | Site 4 | Site 6A* (control) | Site 7A | Site 14A* | Site 15* | Site 17A | Site 21 | Site 29* | Site 35 | Site 40* | ⊥Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | 1-Jul-19 | 9-Jul-19 | <0.019 | <0.024 | <0.036 | <0.026 | <0.042 | <0.026 | <0.037 | <0.029 | <0.019 | <0.054 | |
| 28 | 9-Jul-19 | 16-Jul-19 | <0.028 | <0.023 | <0.045 | <0.030 | <0.052 | <0.030 | <0.036 | <0.023 | <0.030 | <0.015 | 5 |
| 29 | 16-Jul-19 | 23-Jul-19 | <0.031 | <0.028 | <0.021 | <0.033 | <0.027 | <0.022 | <0.022 | <0.006 | <0.027 | <0.031 | |
| 30 | 23-Jul-19 | 30-Jul-19 | <0.034 | <0.027 | <0.037 | <0.023 | <0.059 | <0.031 | <0.045 | <0.036 | <0.023 | <0.035 | |
| 31 | 30-Jul-19 | 6-Aug-19 | <0.036 | <0.023 | <0.046 | <0.007 | <0.051 | <0.027 | <0.037 | <0.028 | <0.018 | <0.036 | |
| 32 | 6-Aug-19 | 13-Aug-19 | <0.022 | <0.017 | <0.033 | <0.027 | <0.067 | <0.033 | <0.053 | <0.021 | <0.017 | <0.012 | |
| 33 | 13-Aug-19 | 20-Aug-19 | <0.032 | ⊥<0.058 | <0.023 | <0.038 | <0.007 | <0.026 | <0.034 | <0.029 | <0.030 | <0.030 | 6 |
| 34 | 20-Aug-19 | 27-Aug-19 | <0.022 | ⊥<0.025 | <0.026 | <0.027 | <0.017 | <0.028 | <0.025 | <0.025 | <0.022 | <0.021 | 7 |
| 35 | 27-Aug-19 | 3-Sep-19 | <0.026 | <0.021 | <0.032 | <0.025 | <0.031 | <0.017 | <0.023 | <0.022 | <0.018 | <0.031 | |
| 36 | 3-Sep-19 | 10-Sep-19 | <0.023 | <0.022 | <0.029 | <0.032 | <0.030 | <0.023 | <0.031 | <0.032 | <0.030 | <0.034 | |
| 37 | 10-Sep-19 | 17-Sep-19 | <0.017 | <0.034 | <0.017 | <0.017 | <0.025 | <0.017 | <0.022 | <0.017 | <0.025 | <0.021 | |
| 38 | 17-Sep-19 | 24-Sep-19 | <0.036 | <0.017 | <0.045 | <0.026 | <0.057 | <0.020 | <0.059 | <0.028 | <0.028 | <0.035 | |
| 39 | 24-Sep-19 | 1-Oct-19 | <0.023 | <0.026 | <0.027 | <0.026 | <0.031 | <0.022 | <0.032 | <0.031 | <0.036 | <0.024 | |

Note 5: Site 40 Elapsed Time Meter (ETM) did not reflect the expected run time (actual 141.9 hrs. vs expected 167.2 hrs.). Upon testing, it appeared that the ETM was functioning properly. Possible cause- power outage. Sample appeared to have normal dust loading. Sample run time sufficient for data collection; sample considered VALID. CR 19-10403

Note 6: Site 6A experienced pump failure and runtime could not be determined. Sample INVALID. Data for INFO ONLY. CR 19-12139

Note 7: Site 6A experienced a failure of the Elapsed Time Meter. Pump was running satisfactorily and collection on filter had normal distribution. Sample is VALID. CR 19-12487.

### RADIOIODINE IN AIR 4th QUARTER

ODCM required samples denoted by *

units are pCi/m$^3$

required LLD <0.070

| Week # | START DATE | STOP DATE | Site 4 | Site 6A* (control) | Site 7A | Site 14A* | Site 15* | Site 17A | Site 21 | Site 29* | Site 35 | Site 40* | ⊥Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 1-Oct-19 | 8-Oct-19 | <0.033 | <0.027 | <0.012 | <0.017 | <0.041 | <0.026 | <0.012 | <0.025 | <0.025 | <0.022 | |
| 41 | 8-Oct-19 | 15-Oct-19 | <0.019 | <0.022 | <0.052 | <0.007 | <0.051 | <0.033 | <0.036 | <0.023 | <0.023 | <0.057 | |
| 42 | 15-Oct-19 | 22-Oct-19 | <0.032 | <0.032 | <0.013 | <0.018 | <0.044 | <0.036 | <0.050 | <0.028 | <0.023 | <0.036 | |
| 43 | 22-Oct-19 | 30-Oct-19 | <0.027 | <0.022 | <0.022 | <0.032 | <0.024 | <0.034 | <0.030 | <0.027 | <0.022 | <0.032 | |
| 44 | 30-Oct-19 | 5-Nov-19 | <0.020 | <0.047 | <0.035 | <0.027 | <0.014 | <0.029 | <0.031 | ⊥<0.048 | <0.029 | <0.028 | 8 |
| 45 | 5-Nov-19 | 12-Nov-19 | <0.028 | <0.036 | <0.027 | <0.039 | <0.029 | <0.031 | <0.027 | ⊥ | <0.035 | <0.043 | 9 |
| 46 | 12-Nov-19 | 19-Nov-19 | <0.029 | <0.033 | <0.028 | <0.017 | <0.035 | <0.017 | <0.031 | <0.022 | <0.033 | <0.030 | |
| 47 | 19-Nov-19 | 25-Nov-19 | <0.032 | <0.007 | <0.054 | <0.028 | <0.054 | <0.032 | <0.056 | <0.035 | <0.025 | <0.049 | |
| 48 | 25-Nov-19 | 3-Dec-19 | <0.020 | <0.023 | <0.046 | <0.015 | <0.050 | <0.031 | <0.039 | <0.023 | <0.028 | <0.030 | |
| 49 | 3-Dec-19 | 10-Dec-19 | <0.025 | <0.027 | <0.042 | <0.032 | <0.054 | <0.031 | <0.033 | <0.043 | <0.021 | <0.012 | |
| 50 | 10-Dec-19 | 17-Dec-19 | <0.030 | <0.016 | <0.041 | <0.031 | <0.040 | <0.017 | <0.046 | <0.024 | <0.006 | <0.026 | |
| 51 | 17-Dec-19 | 23-Dec-19 | <0.031 | <0.038 | <0.035 | <0.031 | <0.050 | <0.031 | <0.028 | <0.045 | <0.042 | <0.028 | |
| 52 | 23-Dec-19 | 30-Dec-19 | <0.043 | <0.053 | <0.015 | <0.038 | <0.042 | <0.042 | <0.015 | <0.037 | <0.067 | <0.038 | |

Note 8: Site 29 experience pump failure and volume could not be estimated. Sample is INVALID and data is for INFO ONLY. CR 19-16553

Note 9: Site 29 experience pump failure and volume could not be estimated. Radioiodine data not analyzed. CR 19-16890

## Table 8-6 Vegetation

| VEGETATION<br>ODCM required samples denoted by *<br>units are pCi/kg, wet | | | | | | |
|---|---|---|---|---|---|---|
| LOCATION | TYPE | DATE COLLECTED | I-131 | Cs-134 | Cs-137 | Note |
| LOCAL RESIDENCE (Site #47)* | Lettuce | 17-Jan-19 | <9 | <17 | <49 | |
| | Lettuce | 14-Feb-19 | <57 | <45 | <64 | |
| | Hybrid Lettuce | 21-Mar-19 | <44 | <58 | <76 | |
| | Lettuce | 17-Apr-19 | <32 | <55 | <62 | |
| | Lettuce | 17-May-19 | <57 | <46 | <57 | |
| | Lettuce | 21-Jun-19 | <54 | <51 | <56 | |
| | Lettuce | 19-Jul-19 | <54 | <37 | <66 | |
| | Spinach | 22-Aug-19 | <55 | <59 | <78 | |
| | | No Sample Available - September | | | | |
| | | No Sample Available - October | | | | |
| | | No Sample Available - November | | | | |
| | Lettuce | 19-Dec-19 | <53 | <49 | <52 | |
| COMMERCIAL FARM (Site #62)* | Arugula | 17-Jan-19 | <36 | < 8 | <41 | |
| | Spring Mix | 17-Jan-19 | <35 | <45 | <50 | |
| | Kale | 17-Jan-19 | <41 | <12 | <57 | |
| | Spring Mix | 28-Feb-19 | <32 | <35 | <60 | |
| | Red Oak Lettuce | 21-Mar-19 | <49 | <52 | <49 | |
| | Spinach | 21-Mar-19 | <44 | <43 | <46 | |
| | Red Butter Lettuce | 21-Mar-19 | <36 | <41 | <49 | |
| | Kale | 17-Apr-19 | <41 | <52 | <42 | |
| | Spinach | 17-Apr-19 | <36 | <28 | <45 | |
| | Spring Mix | 17-Apr-19 | <31 | <35 | <29 | |
| | | No Sample Available - May | | | | |
| | | No Sample Available - June | | | | |
| | | No Sample Available - July | | | | |
| | | No Sample Available - August | | | | |
| | | No Sample Available - September | | | | |
| | Green Romaine | 24-Oct-19 | <43 | <40 | <74 | |
| | Red Romaine | 24-Oct-19 | <43 | <47 | <36 | |
| | Arugula | 24-Oct-19 | <45 | <53 | <77 | |
| | Spring Mix | 26-Nov-19 | <46 | <48 | <53 | |
| | Spinach | 26-Nov-19 | <56 | <55 | <48 | |
| | Tatsoi | 26-Nov-19 | <28 | <11 | <36 | |
| | Lettuce | 19-Dec-19 | <45 | <27 | <40 | |
| | Spring Mix | 19-Dec-19 | <35 | <38 | <61 | |
| LOCAL RESIDENCE (Site #51) | | No Sample Available - January | | | | |
| | | No Sample Available - February | | | | |
| | | No Sample Available - March | | | | |
| | | So Sample Available - April | | | | |
| | Lettuce | 17-May-19 | <35 | <27 | <49 | |
| | Chard | 21-Jun-19 | <47 | <51 | <66 | |
| | Lettuce | 19-Jul-19 | <54 | <57 | <56 | |
| | | No Sample Available - August | | | | |
| | | No Sample Available - September | | | | |
| | | No Sample Available - October | | | | |
| | | No Sample Available - November | | | | |
| | | No Sample Available - December | | | | |

## Table 8-7 Milk

ODCM required samples denoted by *
units are pCi/liter

| SAMPLE LOCATION | DATE COLLECTED | I-131 | Cs-134 | Cs-137 | Ba-140 | La-140 | Note |
|---|---|---|---|---|---|---|---|
| Local Resident Goats (Site #51)* | 18-Jan-19 | <1 | <1 | <0.8 | <3 | <9 | 1 |
| | February- No Sample Available | | | | | | |
| | 22-Mar-19 | <1 | <1 | <1 | <3 | <1 | |
| | April- No Sample Available | | | | | | |
| | 17-May-19 | <1 | <1 | <1 | <4 | <1 | |
| | 27-Jun-19 | <1 | <1 | <1 | <3 | <1 | 3 |
| | 19-Jul-19 | <1 | <1 | <1 | <3 | <1 | |
| | 23-Aug-19 | <1 | <1 | <1 | <3 | <1 | |
| | September- No Sample Available | | | | | | |
| | October- No Sample Available | | | | | | |
| | November- No Sample Available | | | | | | |
| | December- No Sample Available | | | | | | |
| Local Resident Goats (Site #53)* | January- No Sample Available | | | | | | |
| | 22-Feb-19 | <1 | <1 | <1 | <3 | <1 | 2 |
| | 28-Mar-19 | <1 | <1 | <1 | <3 | <1 | |
| | 25-Apr-19 | <1 | <1 | <1 | <3 | <1 | |
| | 30-May-19 | <1 | <1 | <1 | <3 | <1 | |
| | 27-Jun-19 | <1 | <1 | <1 | <3 | <1 | |
| | 25-Jul-19 | <1 | <1 | <1 | <3 | <1 | |
| | 22-Aug-19 | <1 | <1 | <1 | <3 | <1 | |
| | 26-Sep-19 | <1 | <1 | <1 | <4 | <1 | |
| | 24-Oct-19 | <1 | <1 | <1 | <3 | <1 | |
| | 22-Nov-19 | <1 | <1 | <1 | <3 | <1 | |
| | 26-Dec-19 | <1 | <1 | <1 | <3 | <1 | |
| Local Resident Goats (Site #54)* | 10-Jan-19 | <1 | <1 | <1 | <3 | <1 | |
| | 07-Feb-19 | <1 | <1 | <1 | <3 | <1 | |
| | 14-Mar-19 | <1 | <1 | <1 | <3 | <1 | |
| | 11-Apr-19 | <1 | <1 | <1 | <3 | <2 | |
| | 09-May-19 | <1 | <1 | <1 | <3 | <1 | |
| | 13-Jun-19 | <1 | <1 | <1 | <3 | <1 | |
| | 12-Jul-19 | <1 | <1 | <1 | <3 | <1 | |
| | 15-Aug-19 | <1 | <1 | <1 | <3 | <1 | |
| | 13-Sep-19 | <1 | <1 | <1 | <3 | <1 | |
| | 11-Oct-19 | <1 | <1 | <1 | <3 | <1 | |
| | 15-Nov-19 | <1 | <1 | <1 | <3 | <1 | |
| | 20-Dec-19 | <1 | <1 | <1 | <3 | <1 | |

Note 1: Sample recounted; results reported are average of the two counts.
Note 2: Initial sample did not meet required LLD; media resampled and LLD met. Initial missed LLD documented via CR 19-02899. Re-sampled results reported.
Note 3: Initial sample did not meet required LLD; media resampled and LLD met. Initial missed LLD documented via CR 19-09506. Re-sampled results reported.

## Table 8-8 Drinking Water

ODCM required samples denoted by *
units are pCi/liter

| SAMPLE LOCATION | MONTH ENDPOINT | Mn-54 | Co-58 | Fe-59 | Co-60 | Zn-65 | Nb-95 | Zr-95 | I-131 | Cs-134 | Cs-137 | Ba-140 | La-140 | Qtrly Tritium | Gross Beta | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOCAL RESIDENCE (Site #48) * | 29-Jan-19 | <12 | <12 | <19 | <13 | <24 | <15 | <24 | <11 | <11 | <13 | <36 | <14 | | <2.95 | |
| | 26-Feb-19 | <8 | <9 | <17 | <8 | <19 | <9 | <19 | <8 | <8 | <10 | <33 | <14 | | <2.75 | |
| | 26-Mar-19 | <11 | <12 | <24 | <12 | <15 | <11 | <23 | <12 | <11 | <12 | <43 | <8 | <319 | 6.82±1.75 | |
| | 30-Apr-19 | <8 | <8 | <18 | <10 | <20 | <11 | <16 | <9 | <6 | <10 | <28 | <10 | | 5.16±1.78 | |
| | 28-May-19 | <9 | <9 | <17 | <4 | <14 | <8 | <15 | <7 | <6 | <8 | <24 | <15 | | 3.11±1.81 | |
| | 25-Jun-19 | <12 | <10 | <17 | <10 | <21 | <10 | <17 | <9 | <8 | <11 | <33 | <13 | <333 | <2.99 | |
| | 30-Jul-19 | <3 | <3 | <6 | <3 | <6 | <3 | <5 | <6 | <2 | <2 | <14 | <15 | | <2.73 | 1 |
| | 27-Aug-19 | <7 | <7 | <13 | <7 | <12 | <7 | <14 | <8 | <6 | <8 | <26 | <15 | | <2.83 | |
| | 24-Sep-19 | <9 | <10 | <21 | <11 | <21 | <11 | <16 | <9 | <9 | <12 | <32 | <11 | <339 | <2.78 | |
| | 29-Oct-19 | <12 | <12 | <25 | <7 | <22 | <13 | <19 | <11 | <9 | <12 | <31 | <12 | | <2.77 | |
| | 25-Nov-19 | <10 | <10 | <18 | <7 | <18 | <10 | <17 | <8 | <8 | <11 | <30 | <13 | | 4.82±1.74 | |
| | 30-Dec-19 | <11 | <8 | <22 | <9 | <19 | <9 | <18 | <9 | <8 | <10 | <30 | <8 | <337 | <2.93 | |
| LOCAL RESIDENCE (Site #55) | 29-Jan-19 | <10 | <9 | <18 | <9 | <18 | <11 | <17 | <9 | <8 | <10 | <33 | <9 | | <2.75 | |
| | 26-Feb-19 | <10 | <10 | <16 | <9 | <18 | <9 | <15 | <9 | <8 | <9 | <31 | <15 | | 5.01±1.71 | |
| | 26-Mar-19 | <9 | <7 | <20 | <8 | <19 | <10 | <16 | <10 | <8 | <9 | <29 | <14 | <319 | 8.75±1.76 | |
| | 30-Apr-19 | <10 | <9 | <20 | <11 | <22 | <9 | <17 | <8 | <9 | <7 | <36 | <12 | | 4.99±1.68 | |
| | 28-May-19 | <8 | <10 | <19 | <7 | <20 | <9 | <15 | <9 | <7 | <9 | <29 | <15 | | 4.85±1.68 | |
| | 25-Jun-19 | <7 | <11 | <18 | <8 | <22 | <9 | <17 | <9 | <8 | <8 | <29 | <8 | <335 | 3.66±1.71 | |
| | 30-Jul-19 | <12 | <11 | <26 | <14 | <29 | <13 | <23 | <10 | <9 | <15 | <43 | <12 | | 4.67±1.69 | |
| | 27-Aug-19 | <6 | <6 | <12 | <6 | <12 | <6 | <13 | <7 | <4 | <6 | <21 | <15 | | 3.30±1.69 | |
| | 24-Sep-19 | <11 | <9 | <20 | <10 | <20 | <11 | <17 | <9 | <10 | <12 | <32 | <9 | <336 | 4.30±1.69 | |
| | 29-Oct-19 | <9 | <8 | <17 | <9 | <17 | <8 | <14 | <8 | <6 | <9 | <29 | <13 | | 4.69±1.71 | |
| | 19-Nov-19 | <1 | <1 | <2 | <1 | <2 | <1 | <2 | <2 | <1 | <1 | <5 | <46 | <338 | 6.31±1.67 | 2 |
| | 30-Dec-19 | **NO SAMPLE AVAILABLE** | | | | | | | | | | | | | | 3 |

Note 1: Site 48 Initial analysis had detectable Fe-50 (8.42 pCi/L ± 5 pCi/L). Per procedure, sample reanalyzed to confirm; reanalysis had no detectable Fe-59. Recount analysis results reported. Some LLDs lower than typical, to achieve all required LLDs. This is NOT considered an "abnormal event."

Note 2: Site 55 Missed final week in sampling period, resulting in inability to achieve La-140 required LLD and lower than typical MDA for other radionuclides. CR 19-17770

Note 3: No Sample available for the Site 55 for the month of December due to pump failure. CR 20-00862

# Table 8-8 Drinking Water (Continued)

ODCM required samples denoted by *
units are pCi/liter

| SAMPLE LOCATION | MONTH ENDPOINT | Mn-54 | Co-58 | Fe-59 | Co-60 | Zn-65 | Nb-95 | Zr-95 | I-131 | Cs-134 | Cs-137 | Ba-140 | La-140 | Qtrly Tritium | Gross Beta | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOCAL RESIDENCE (Site #46) * | 29-Jan-19 | <10 | <9 | <18 | <9 | <23 | <11 | <20 | <9 | <9 | <11 | <31 | <12 | | <2.70 | |
| | 26-Feb-19 | <12 | <11 | <21 | <12 | <22 | <13 | <16 | <10 | <8 | <10 | <30 | <14 | | <2.50 | |
| | 26-Mar-19 | <5 | <5 | <10 | <4 | <11 | <5 | <10 | <6 | <5 | <6 | <18 | <13 | <317 | 5.44±1.62 | |
| | 30-Apr-19 | <9 | <9 | <20 | <8 | <19 | <8 | <17 | <7 | <9 | <10 | <32 | <15 | | 3.93±1.62 | |
| | 28-May-19 | <11 | <10 | <24 | <12 | <29 | <14 | <19 | <11 | <10 | <15 | <37 | <13 | | 2.82±1.64 | |
| | 25-Jun-19 | <10 | <9 | <21 | <12 | <25 | <10 | <18 | <8 | <9 | <13 | <33 | <14 | <330 | <2.62 | |
| | 30-Jul-19 | <10 | <11 | <15 | <7 | <20 | <12 | <16 | <8 | <7 | <11 | <35 | <13 | | <2.58 | |
| | 27-Aug-19 | <6 | <6 | <11 | <6 | <11 | <5 | <11 | <6 | <5 | <6 | <20 | <15 | | <2.67 | |
| | 24-Sep-19 | <10 | <10 | <20 | <9 | <20 | <6 | <15 | <9 | <9 | <10 | <27 | <11 | <337 | 2.72±1.63 | |
| | 29-Oct-19 | <9 | <11 | <15 | <9 | <30 | <13 | <18 | <9 | <10 | <11 | <34 | <10 | | 3.28±1.67 | |
| | 25-Nov-19 | <11 | <8 | <20 | <7 | <20 | <10 | <18 | <9 | <9 | <10 | <30 | <12 | | 4.96±1.60 | |
| | 30-Dec-19 | <15 | <11 | <19 | <7 | <27 | <12 | <20 | <12 | <10 | <11 | <35 | <14 | <334 | <2.71 | |
| LOCAL RESIDENCE (Site #49) * | 29-Jan-19 | <13 | <10 | <29 | <10 | <25 | <15 | <17 | <11 | <12 | <14 | <39 | <4 | | <2.67 | |
| | 26-Feb-19 | <6 | <6 | <13 | <8 | <15 | <7 | <11 | <7 | <6 | <6 | <24 | <14 | | <2.50 | |
| | 26-Mar-19 | <6 | <5 | <12 | <5 | <11 | <5 | <9 | <6 | <4 | <6 | <19 | <11 | <317 | <2.36 | |
| | 30-Apr-19 | <10 | <9 | <18 | <6 | <23 | <11 | <15 | <11 | <8 | <10 | <34 | <13 | | <2.45 | |
| | 28-May-19 | <7 | <8 | <15 | <9 | <12 | <10 | <16 | <8 | <8 | <7 | <25 | <15 | | <2.53 | |
| | 25-Jun-19 | <10 | <9 | <21 | <9 | <17 | <8 | <18 | <10 | <9 | <10 | <31 | <15 | <330 | <2.69 | |
| | 30-Jul-19 | <12 | <10 | <15 | <8 | <20 | <11 | <17 | <9 | <7 | <8 | <30 | <14 | | <2.52 | |
| | 27-Aug-19 | <5 | <5 | <10 | <5 | <11 | <4 | <10 | <6 | <3 | <5 | <17 | <14 | | <2.55 | |
| | 24-Sep-19 | <9 | <11 | <18 | <12 | <19 | <11 | <15 | <9 | <9 | <9 | <24 | <12 | <337 | <2.50 | |
| | 29-Oct-19 | <11 | <12 | <22 | <10 | <24 | <14 | <23 | <12 | <9 | <12 | <38 | <14 | | <2.54 | |
| | 25-Nov-19 | <10 | <11 | <20 | <9 | <22 | <10 | <19 | <9 | <9 | <9 | <26 | <15 | | <2.33 | |
| | 30-Dec-19 | <10 | <10 | <19 | <11 | <22 | <10 | <18 | <9 | <10 | <12 | <32 | <10 | <330 | <2.65 | |

## Table 8-9 Groundwater

ODCM required samples denoted by *
units are pCi/liter

| SAMPLE LOCATION | DATE COLLECTED | Mn-54 | Co-58 | Fe-59 | Co-60 | Zn-65 | Nb-95 | Zr-95 | I-131 | Cs-134 | Cs-137 | Ba-140 | La-140 | Tritium | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WELL 27ddc (Site #57)* | 29-Jan-19 | <9 | <10 | <21 | <10 | <25 | <12 | <19 | <11 | <9 | <10 | <35 | <15 | <339 | |
| | 30-Apr-19 | <12 | <12 | <23 | <8 | <20 | <13 | <22 | <9 | <10 | <12 | <35 | <12 | <326 | |
| | 30-Jul-19 | <10 | <9 | <20 | <7 | <23 | <8 | <16 | <8 | <7 | <8 | <28 | <13 | <345 | |
| | 29-Oct-19 | <8 | <8 | <16 | <9 | <17 | <9 | <13 | <7 | <7 | <8 | <22 | <14 | <342 | |
| WELL 34abb (Site #58)* | 29-Jan-19 | Out of Service | | | | | | | | | | | | | |
| | 30-Apr-19 | Out of Service | | | | | | | | | | | | | |
| | 30-Jul-19 | Out of Service | | | | | | | | | | | | | |
| | 29-Oct-19 | Out of Service | | | | | | | | | | | | | |
| Well 34aab (Site #65)* | 29-Jan-19 | <8 | <8 | <19 | <10 | <18 | <10 | <16 | <9 | <8 | <8 | <28 | <13 | <335 | |
| | 30-Apr-19 | <12 | <11 | <22 | <11 | <23 | <13 | <22 | <11 | <9 | <12 | <37 | <12 | <325 | |
| | 30-Jul-19 | <8 | <8 | <15 | <8 | <20 | <9 | <14 | <8 | <7 | <9 | <25 | <15 | <351 | |
| | 29-Oct-20 | <8 | <7 | <14 | <8 | <15 | <10 | <11 | <7 | <6 | <7 | <22 | <13 | <331 | |
| Well 27dcb (Site #58A) | 29-Jan-19 | <9 | <8 | <18 | <8 | <18 | <10 | <15 | <8 | <9 | <9 | <27 | <15 | <336 | |
| | 30-Apr-19 | <11 | <10 | <21 | <11 | <25 | <12 | <18 | <8 | <11 | <13 | <37 | <15 | <326 | |
| | 30-Jul-19 | <11 | <11 | <18 | <7 | <20 | <9 | <17 | <10 | <7 | <9 | <31 | <11 | <347 | |
| | 29-Oct-19 | <10 | <13 | <24 | <10 | <20 | <15 | <17 | <10 | <9 | <13 | <31 | <14 | <341 | |

## Table 8-10 Surface Water

ODCM required samples denoted by *
units are pCi/liter

| SAMPLE LOCATION | DATE COLLECTED | Mn-54 | Co-58 | Fe-59 | Co-60 | Zn-65 | Nb-95 | Zr-95 | I-131 | Cs-134 | Cs-137 | Ba-140 | La-140 | Tritium | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45 ACRE RESERVOIR (Site #61) * | 29-Jan-19 | <10 | <10 | <14 | <10 | <18 | <11 | <19 | 13±10 | <8 | <10 | <36 | <12 | <339 | |
| | 30-Apr-19 | <9 | <10 | <20 | <8 | <22 | <11 | <16 | <9 | <9 | <10 | <28 | <10 | <328 | |
| | 30-Jul-19 | <9 | <8 | <16 | <8 | <24 | <9 | <15 | <10 | <8 | <8 | <33 | <13 | <350 | |
| | **No Sample. Reservoir Empty for Repairs.** | | | | | | | | | | | | | | |
| 85 ACRE RESERVOIR (Site #60) * | 29-Jan-19 | <9 | <9 | <17 | <9 | <22 | <9 | <14 | 16±9 | <8 | <8 | <23 | <13 | <336 | 1 |
| | 30-Apr-19 | <12 | <11 | <24 | <7 | <18 | <13 | <20 | <9 | <12 | <13 | <34 | <9 | <323 | |
| | 30-Jul-19 | <9 | <8 | <17 | <8 | <17 | <11 | <17 | <10 | <8 | <10 | <29 | <11 | <356 | |
| | 29-Oct-19 | <9 | <11 | <18 | <12 | <25 | <11 | <14 | <9 | <8 | <9 | <31 | <10 | <335 | |
| EVAP POND 1 (Site #59) *CELL 1A | 29-Jan-19 | <9 | <8 | <19 | <10 | <27 | <11 | <16 | <9 | <8 | <10 | <32 | <8 | 807±216 | |
| | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| | 30-Jul-19 | <13 | <8 | <29 | <9 | <26 | <11 | <19 | <12 | <7 | <12 | <33 | <12 | 782±218 | 2 |
| | 29-Oct-19 | <13 | <11 | <18 | <11 | <24 | <11 | <16 | <10 | <10 | <12 | <33 | <14 | 1086±213 | |
| CELL 1B | 29-Jan-19 | <9 | <8 | <18 | <9 | <26 | <10 | <17 | 17±10 | <8 | <7 | <25 | <23 | 549±212 | |
| | 30-Apr-19 | <10 | <10 | <19 | <10 | <20 | <11 | <17 | <8 | <7 | <11 | <29 | <8 | 725±207 | |
| | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| CELL 1C | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| | 29-Oct-20 | <11 | <11 | <23 | <12 | <29 | <12 | <20 | <8 | <9 | <11 | <31 | <12 | 972±209 | |
| EVAP POND 2 (Site #63) *CELL 2A | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| | 29-Oct-19 | <11 | <10 | <26 | <11 | <24 | <13 | <16 | <10 | <9 | <10 | <31 | <11 | 881±210 | |
| CELL 2B | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| | 30-Apr-19 | <9 | <11 | <19 | <9 | <25 | <10 | <16 | <11 | <7 | <8 | <30 | <15 | 1027±209 | |
| | 30-Jul-19 | <8 | <9 | <17 | <10 | <24 | <9 | <18 | <9 | <7 | <10 | <33 | <9 | 542±216 | |
| | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| EVAP POND 3 (Site #64) *CELL 3A | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| | 29-Oct-19 | <10 | <10 | <25 | <12 | <29 | <10 | <17 | <8 | <7 | 41±9 | <29 | <5 | 439±204 | |
| CELL 3B | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| | **No Influent Since Last Sample** | | | | | | | | | | | | | | |
| | 30-Jul-19 | <13 | <11 | <27 | <12 | <30 | <10 | <18 | <9 | <9 | <12 | <34 | <12 | <343 | |
| | **No Influent Since Last Sample** | | | | | | | | | | | | | | |

Note 1: Recounted. Results averaged and reported.
Note 2: Duplicate sample taken. Results reported are averaged.

## Table 8-10 Surface Water (Continued)

ODCM required samples denoted by *
units are pCi/liter

| SAMPLE LOCATION | DATE COLLECTED | Mn-54 | Co-58 | Fe-59 | Co-60 | Zn-65 | Nb-95 | Zr-95 | I-131 | Cs-134 | Cs-137 | Ba-140 | La-140 | Tritium | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8-Jan-19 | <7 | <8 | <16 | <6 | <18 | <6 | <11 | <8 | <6 | <6 | <20 | <14 | | |
| | 15-Jan-19 | <8 | <10 | <16 | <8 | <22 | <8 | <12 | <11 | <7 | <9 | <27 | <15 | | |
| | 22-Jan-19 | <13 | <13 | <20 | <12 | <28 | <12 | <21 | 19±10 | <13 | <16 | <32 | <11 | | |
| | 29-Jan-19 | <10 | <10 | <21 | <11 | <23 | <11 | <12 | 31±11 | <9 | <9 | <31 | <10 | <353 | |
| | 5-Feb-19 | <8 | <7 | <19 | <11 | <19 | <8 | <15 | 18±7 | <9 | <7 | <28 | <15 | | |
| | 12-Feb-19 | <10 | <9 | <22 | <8 | <16 | <10 | <14 | <9 | <9 | <8 | <34 | <15 | | |
| | 19-Feb-19 | <9 | <9 | <13 | <10 | <20 | <10 | <15 | 7±9 | <8 | <9 | <28 | <9 | | |
| | 26-Feb-19 | <10 | <10 | <17 | <12 | <22 | <10 | <18 | 8±9 | <8 | <10 | <30 | <11 | <339 | |
| | 5-Mar-19 | <8 | <8 | <13 | <9 | <16 | <9 | <15 | 13±7 | <6 | <8 | <27 | <13 | | |
| | 12-Mar-19 | <12 | <12 | <21 | <12 | <30 | <11 | <21 | <14 | <13 | <12 | <33 | <4 | | |
| | 19-Mar-19 | <9 | <8 | <18 | <8 | <24 | <11 | <14 | 9±9 | <7 | <7 | <25 | <12 | | |
| | 26-Mar-19 | <10 | <11 | <21 | <11 | <16 | <8 | <16 | <11 | <8 | <8 | <29 | <15 | <330 | |
| | 2-Apr-19 | <10 | <9 | <17 | <11 | <22 | <9 | <15 | <11 | <8 | <10 | <29 | <11 | | |
| WRF INFLUENT | 9-Apr-19 | <9 | <10 | <20 | <10 | <23 | <7 | <13 | <13 | <7 | <8 | <32 | <12 | | |
| | 16-Apr-19 | | | | | **NO SAMPLE WRF OUTAGE** | | | | | | | | | |
| | 23-Apr-19 | <10 | <10 | <21 | <8 | <24 | <12 | <20 | 6±7 | <9 | <10 | <29 | <15 | | |
| | 30-Apr-19 | <12 | <9 | <19 | <8 | <21 | <9 | <10 | <10 | <6 | <10 | <27 | <14 | <338 | |
| | 7-May-19 | <8 | <10 | <16 | <8 | <20 | <10 | <13 | <10 | <9 | <10 | <31 | <13 | | |
| | 14-May-19 | <9 | <7 | <17 | <11 | <20 | <9 | <17 | <12 | <7 | <11 | <29 | <7 | | |
| | 21-May-19 | <8 | <9 | <19 | <8 | <23 | <10 | <15 | <10 | <9 | <10 | <29 | <7 | | |
| | 28-May-19 | <10 | <10 | <20 | <9 | <23 | <10 | <19 | <11 | <8 | <11 | <31 | <12 | <330 | |
| | 4-Jun-19 | <9 | <8 | <22 | <11 | <17 | <11 | <16 | <11 | <8 | <9 | <31 | <13 | | |
| | 11-Jun-19 | <10 | <9 | <15 | <11 | <20 | <9 | <16 | 16±9 | <8 | <11 | <32 | <7 | | |
| | 18-Jun-19 | <8 | <10 | <16 | <10 | <18 | <10 | <12 | 11±9 | <8 | <7 | <28 | <12 | | |
| | 25-Jun-19 | <12 | <9 | <23 | <8 | <25 | <12 | <20 | 29±11 | <10 | <12 | <34 | <11 | <347 | |
| | 1-Jul-19 | <10 | <10 | <19 | <10 | <19 | <8 | <17 | <10 | <7 | <9 | <31 | <13 | | |
| | 9-Jul-19 | <10 | <10 | <18 | <9 | <21 | <10 | <17 | 16±9 | <8 | <9 | <32 | <12 | | |
| | 16-Jul-19 | <9 | <9 | <16 | <10 | <21 | <10 | <17 | 9±7 | <8 | <10 | <34 | <10 | | |
| | 23-Jul-19 | <11 | <11 | <20 | <9 | <25 | <10 | <12 | 15±8 | <9 | <11 | <28 | <14 | | |

## Table 8-10 Surface Water (Continued)

ODCM required samples denoted by *
units are pCi/liter

| SAMPLE LOCATION | DATE COLLECTED | Mn-54 | Co-58 | Fe-59 | Co-60 | Zn-65 | Nb-95 | Zr-95 | I-131 | Cs-134 | Cs-137 | Ba-140 | La-140 | Tritium | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WRF INFLUENT | 30-Jul-19 | <9 | <9 | <14 | <9 | <22 | <9 | <18 | <10 | <9 | <11 | <30 | <13 | <363 | |
| | 6-Aug-19 | <8 | <8 | <17 | <7 | <20 | <9 | <16 | <11 | <8 | <10 | <30 | <10 | | |
| | 13-Aug-19 | <11 | <9 | <17 | <7 | <20 | <10 | <18 | 16±9 | <7 | <11 | <32 | <11 | | |
| | 20-Aug-19 | <8 | <9 | <13 | <9 | <19 | <10 | <14 | 21±8 | <9 | <8 | <26 | <11 | | |
| | 27-Aug-19 | <9 | <7 | <19 | <8 | <17 | <10 | <13 | 14±9 | <7 | <10 | <27 | <8 | <342 | |
| | 3-Sep-19 | <8 | <8 | <19 | <10 | <23 | <9 | <16 | <11 | <8 | <9 | <28 | <11 | | |
| | 10-Sep-19 | <10 | <9 | <20 | <10 | <24 | <8 | <16 | <9 | <9 | <8 | <35 | <10 | | |
| | 17-Sep-19 | <8 | <8 | <18 | <9 | <21 | <9 | <15 | <10 | <9 | <9 | <27 | <8 | | |
| | 24-Sep-19 | <11 | <15 | <21 | <9 | <28 | <13 | <19 | <13 | <9 | <12 | <30 | <14 | <345 | |
| | 1-Oct-19 | <10 | <7 | <14 | <7 | <17 | <11 | <17 | 12±9 | <7 | <9 | <30 | <14 | | |
| | 8-Oct-19 | **NO SAMPLE WRF OUTAGE** | | | | | | | | | | | | | |
| | 15-Oct-19 | **NO SAMPLE WRF OUTAGE** | | | | | | | | | | | | | |
| | 22-Oct-19 | **NO SAMPLE WRF OUTAGE** | | | | | | | | | | | | | |
| | 29-Oct-19 | <8 | <8 | <16 | <9 | <19 | <9 | <12 | <9 | <7 | <7 | <27 | <14 | <342 | |
| | 5-Nov-19 | <13 | <8 | <19 | <9 | <22 | <13 | <21 | <12 | <11 | <13 | <34 | <12 | | |
| | 12-Nov-19 | <10 | <10 | <19 | <9 | <23 | <12 | <19 | <11 | <9 | <13 | <28 | <10 | | |
| | 19-Nov-19 | <7 | <10 | <20 | <8 | <20 | <10 | <17 | 29±9 | <8 | <10 | <30 | <8 | | |
| | 25-Nov-19 | <11 | <8 | <21 | <9 | <21 | <10 | <16 | <10 | <7 | <8 | <29 | <14 | <329 | |
| | 3-Dec-19 | <9 | <10 | <17 | <12 | <20 | <11 | <16 | <11 | <8 | <9 | <29 | <10 | | |
| | 10-Dec-19 | <9 | <11 | <20 | <7 | <24 | <10 | <17 | <9 | <10 | <10 | <30 | <13 | | |
| | 17-Dec-19 | <10 | <8 | <15 | <10 | <25 | <10 | <18 | <11 | <9 | <11 | <30 | <9 | | |
| | 23-Dec-19 | <7 | <11 | <21 | <7 | <21 | <10 | <17 | <12 | <10 | <11 | <28 | <6 | | |
| | 30-Dec-19 | <11 | <10 | <20 | <11 | <24 | <11 | <15 | <11 | <8 | <12 | <35 | <11 | <348 | |

# Table 8-10 Surface Water (Continued)

ODCM required samples denoted by *
units are pCi/liter

| SAMPLE LOCATION | DATE COLLECTED | Mn-54 | Co-58 | Fe-59 | Co-60 | Zn-65 | Nb-95 | Zr-95 | I-131 | Cs-134 | Cs-137 | Ba-140 | La-140 | Tritium | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEDIMENTATION BASIN #2 | 8-Jan-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 15-Jan-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 22-Jan-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 29-Jan-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 5-Feb-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 12-Feb-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 19-Feb-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 26-Feb-19 | <11 | <11 | <21 | <12 | <28 | <12 | <21 | <9 | <12 | <12 | <42 | <14 | 587±217 | |
| | 5-Mar-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 12-Mar-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 19-Mar-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 26-Mar-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 2-Apr-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 9-Apr-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 16-Apr-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 23-Apr-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 30-Apr-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 7-May-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 14-May-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 21-May-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 28-May-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 4-Jun-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 11-Jun-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 18-Jun-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 25-Jun-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 1-Jul-19 | | | | | | EMPTY- No Sample | | | | | | | | |

# Table 8-10 Surface Water (Continued)

ODCM required samples denoted by *
units are pCi/liter

| SAMPLE LOCATION | DATE COLLECTED | Mn-54 | Co-58 | Fe-59 | Co-60 | Zn-65 | Nb-95 | Zr-95 | I-131 | Cs-134 | Cs-137 | Ba-140 | La-140 | Tritium | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9-Jul-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 16-Jul-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 23-Jul-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 30-Jul-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 6-Aug-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 13-Aug-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 20-Aug-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 27-Aug-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 3-Sep-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 10-Sep-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 17-Sep-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 24-Sep-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| SEDIMENTATION | 1-Oct-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| BASIN #2 | 8-Oct-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 15-Oct-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 22-Oct-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 29-Oct-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 5-Nov-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 12-Nov-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 19-Nov-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 26-Nov-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 3-Dec-19 | <12 | <12 | <20 | <10 | <23 | <11 | <19 | <9 | <9 | <13 | <31 | <12 | 645±216 | |
| | 10-Dec-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 17-Dec-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 23-Dec-19 | | | | | | EMPTY- No Sample | | | | | | | | |
| | 30-Dec-19 | <13 | <11 | <25 | <13 | <26 | <11 | <22 | <10 | <12 | <14 | <42 | <10 | <356 | |

**Table 8-11 Sludge/Sediment**

| SAMPLE LOCATION | DATE COLLECTED | I-131 | Cs-134 | Cs-137 | In-111 | Notes |
|---|---|---|---|---|---|---|
| | | ODCM required samples denoted by * units are pCi/kg, wet | | | | |
| WRF CENTRIFUGE WASTE SLUDGE | 8-Jan-19 | | <75 | <177 | | |
| | 15-Jan-19 | 283±176 | <145 | <142 | | |
| | 22-Jan-19 | | <70 | <125 | | |
| | 29-Jan-19 | 492±156 | <89 | <142 | | |
| | 5-Feb-19 | 868±221 | <122 | <169 | | |
| | 12-Feb-19 | 547±151 | <33 | <140 | | |
| | 19-Feb-19 | 408±167 | <136 | <138 | | |
| | 26-Feb-19 | 356±123 | <128 | <126 | | |
| | 5-Mar-19 | 433±142 | <114 | <128 | | |
| | 12-Mar-19 | | <80 | <126 | | |
| | 19-Mar-19 | 180±119 | <35 | <104 | | |
| | 26-Mar-19 | 335±136 | <98 | <178 | | |
| | 2-Apr-19 | 291±148 | <86 | <105 | | |
| | 9-Apr-19 | 595±206 | <130 | <143 | | |
| | 16-Apr-19 | **NO SAMPLE WRF OUTAGE** | | | | |
| | 23-Apr-19 | **NO SAMPLE WRF OUTAGE** | | | | |
| | 30-Apr-19 | | <88 | <125 | | |
| | 7-May-19 | 288±140 | <135 | <114 | | |
| | 14-May-19 | | <92 | <79 | | |
| | 21-May-19 | 291±193 | <144 | <178 | | |
| | 28-May-19 | 351±116 | <104 | <148 | | |
| | 4-Jun-19 | 449±155 | <85 | <159 | | |
| | 11-Jun-19 | 372±220 | <111 | <173 | | |
| | 18-Jun-19 | 557±90 | <45 | <51 | | |
| | 25-Jun-19 | 551±188 | <104 | <164 | | |
| | 1-Jul-19 | 1020±256 | <84 | <168 | | |

No required LLD for I-131 in Sludge/Sediment. Only values for detectable I-131 are reported in this table.

**Table 8-11 Sludge/Sediment (Continued)**

| SAMPLE LOCATION | DATE COLLECTED | I-131 | Cs-134 | Cs-137 | In-111 | Notes |
|---|---|---|---|---|---|---|
| | | ODCM required samples denoted by * units are pCi/kg, wet | | | | |
| WRF CENTRIFUGE WASTE SLUDGE | 9-Jul-19 | 298±136 | <92 | <154 | | |
| | 16-Jul-19 | 388±148 | <92 | <151 | | |
| | 23-Jul-19 | 248±133 | <96 | <102 | | |
| | 30-Jul-19 | 421±141 | <101 | <107 | | |
| | 6-Aug-19 | 164±114 | <100 | <110 | | |
| | 13-Aug-19 | | <39 | <114 | | |
| | 20-Aug-19 | 427±128 | <23 | <96 | | |
| | 27-Aug-19 | 315±144 | <77 | <144 | | |
| | 3-Sep-19 | 492±159 | <124 | <122 | | |
| | 10-Sep-19 | 284±124 | <82 | <117 | | |
| | 17-Sep-19 | 126±98 | <109 | <110 | | |
| | 24-Sep-19 | 376±141 | <61 | <95 | | |
| | 1-Oct-19 | 497±149 | <67 | <104 | | |
| | 8-Oct-19 | **NO SAMPLE WRF OUTAGE** | | | | |
| | 15-Oct-19 | **NO SAMPLE WRF OUTAGE** | | | | |
| | 22-Oct-19 | **NO SAMPLE WRF OUTAGE** | | | | |
| | 29-Oct-19 | **NO SAMPLE WRF OUTAGE** | | | | |
| | 5-Nov-19 | **NO SAMPLE WRF OUTAGE** | | | | |
| | 12-Nov-19 | 167±166 | <128 | <126 | | |
| | 19-Nov-19 | | <62 | <124 | | |
| | 26-Nov-19 | 324±131 | <107 | <132 | | |
| | 3-Dec-19 | 135±109 | <140 | <148 | | |
| | 10-Dec-19 | | <66 | <119 | | |
| | 17-Dec-19 | 100±120 | <119 | <111 | | |
| | 23-Dec-19 | 262±115 | <71 | <89 | | |
| | 30-Dec-19 | 254±138 | <68 | <107 | | |

No required LLD for I-131 in Sludge/Sediment. Only values for detectable I-131 are reported in this table.

**Table 8-11 Sludge/Sediment (Continued)**
**Cooling Tower Sludge**

| Unit Cycle | Approximate Volume ($yd^3$) | Isotope | Activity Range (pCi/g) | Sample Type |
|---|---|---|---|---|
| U1R21 | 392 | All principal gamma-emitters | <MDA | Towers/Canal Sludge |
| U3R21 | 615 | All principal gamma-emitters | <MDA | Towers/Canal Sludge |

**Table 8-12 Hard -To-Detect Radionuclide Results**

| Hard-To-Detect Radionuclide (pCi/Liter) | | | | | | |
|---|---|---|---|---|---|---|
| Sample Location | Well number | Sample Date | C-14 | Fe-55 | Ni-63 | Sr-90 |
| Unit 1 (outside RCA) | APP-12 | 11/12/2019 | <63.4 | <192 | <2.76 | <1.98 |
| Unit 2 (inside RCA) | H0A | 11/12/2019 | <63.5 | <185 | <3.54 | <1.88 |
| Unit 3 (inside RCA) | H11 | 10/13/2019 | <63.4 | <156 | <3.82 | <1.39 |

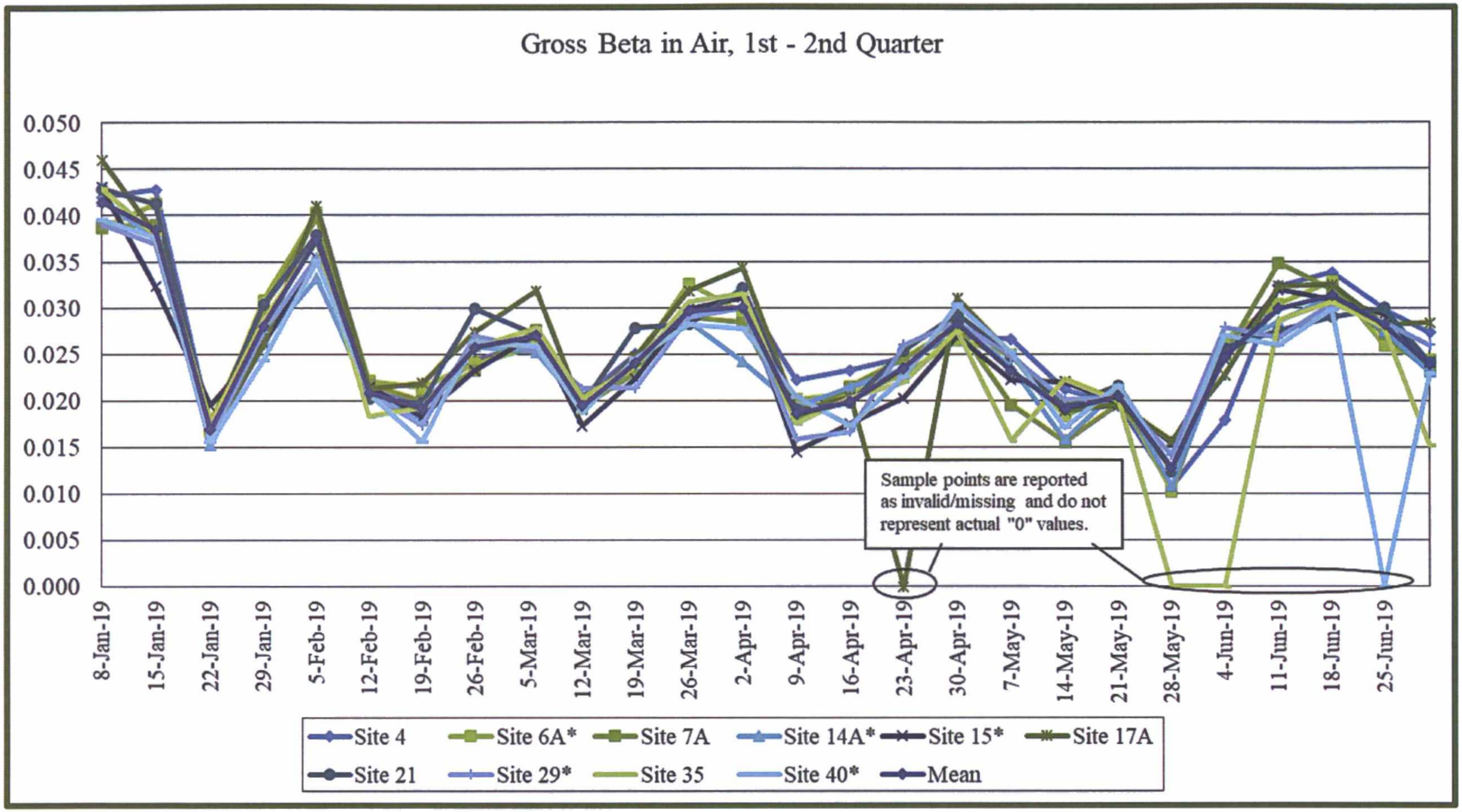



**Figure 8-1 Gross Beta in Air, 1st-2nd Quarter**

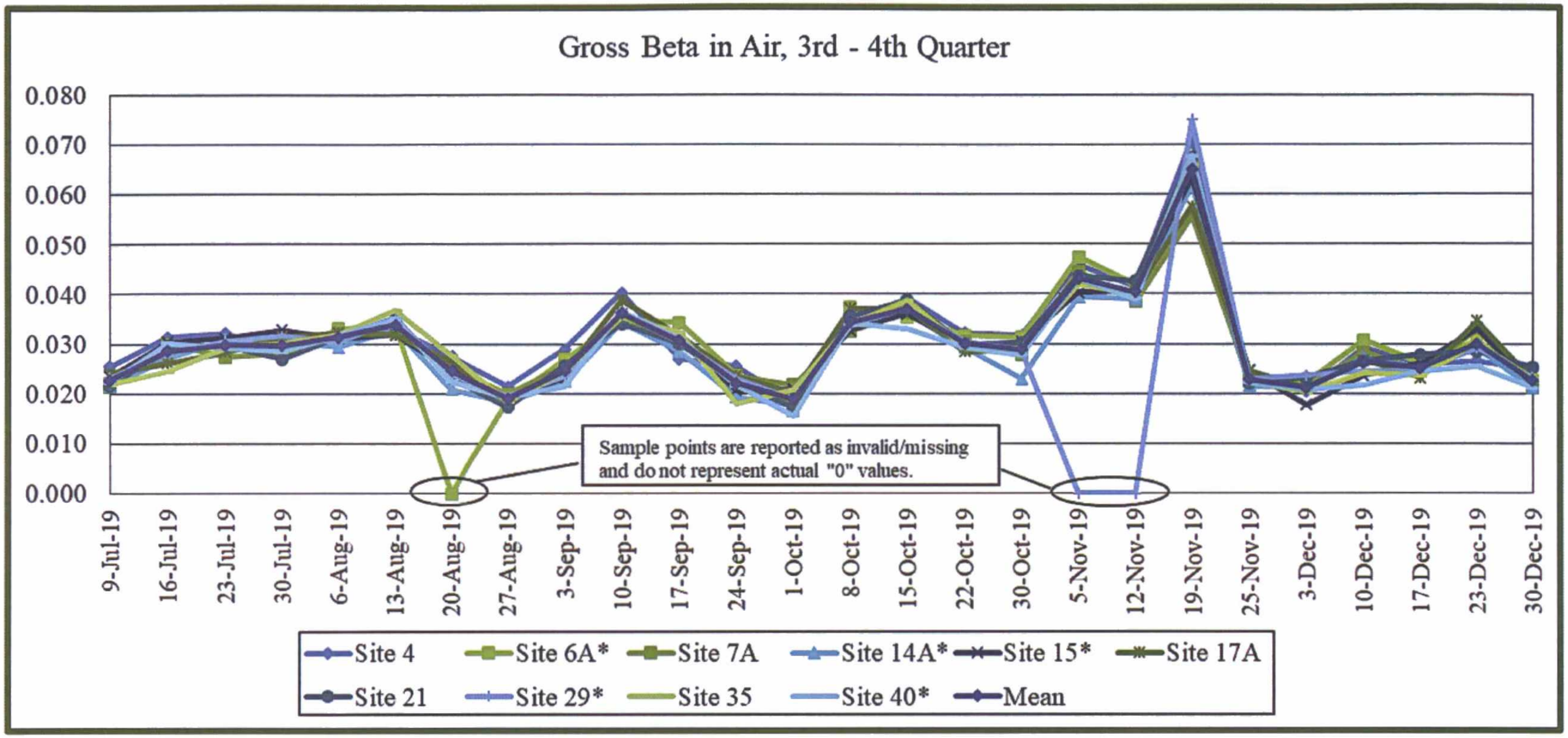



**Figure 8-2 Gross Beta in Air, 3rd-4th Quarter**

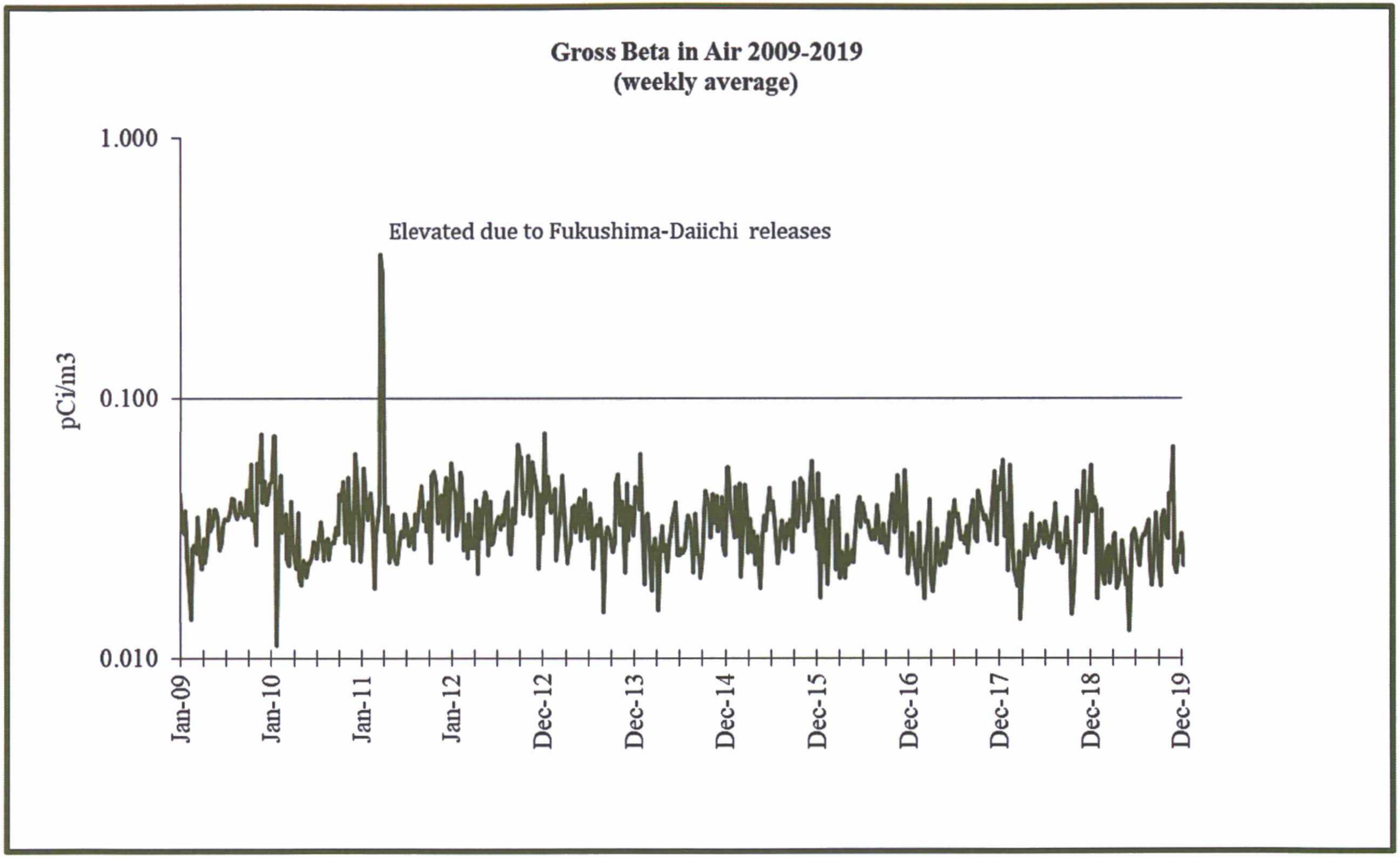



**Figure 8-3 Historical Gross Beta in Air (Weekly System Average)**

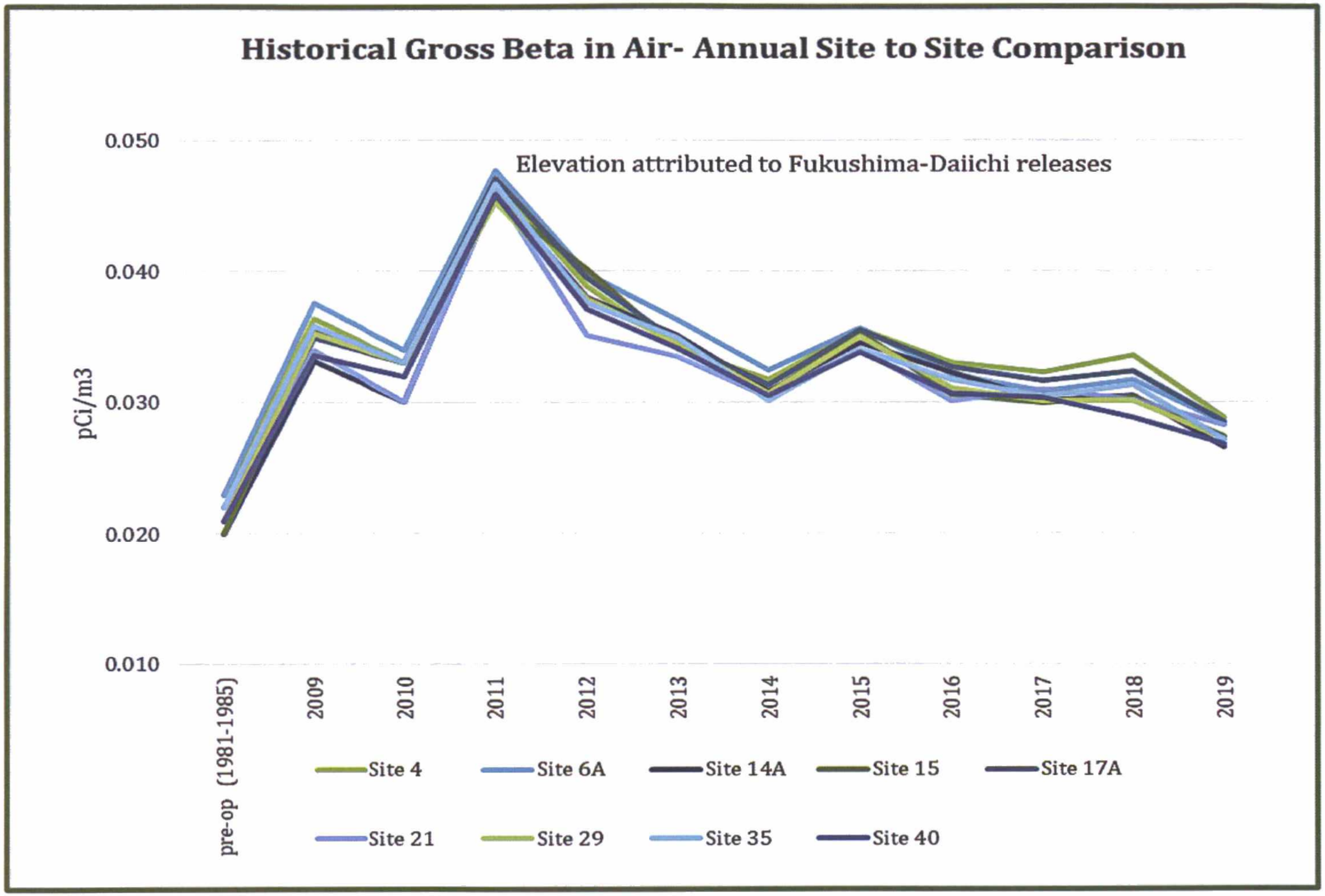



**Figure 8-4 Historical Gross Beta in Air (Annual Site to Site Comparisons) Compared to Pre-Op**

Note: 7A is not included due to the location change since pre-operational period. The elevated 2011 annual average values are attributed to the Fukushima-Daiichi release.

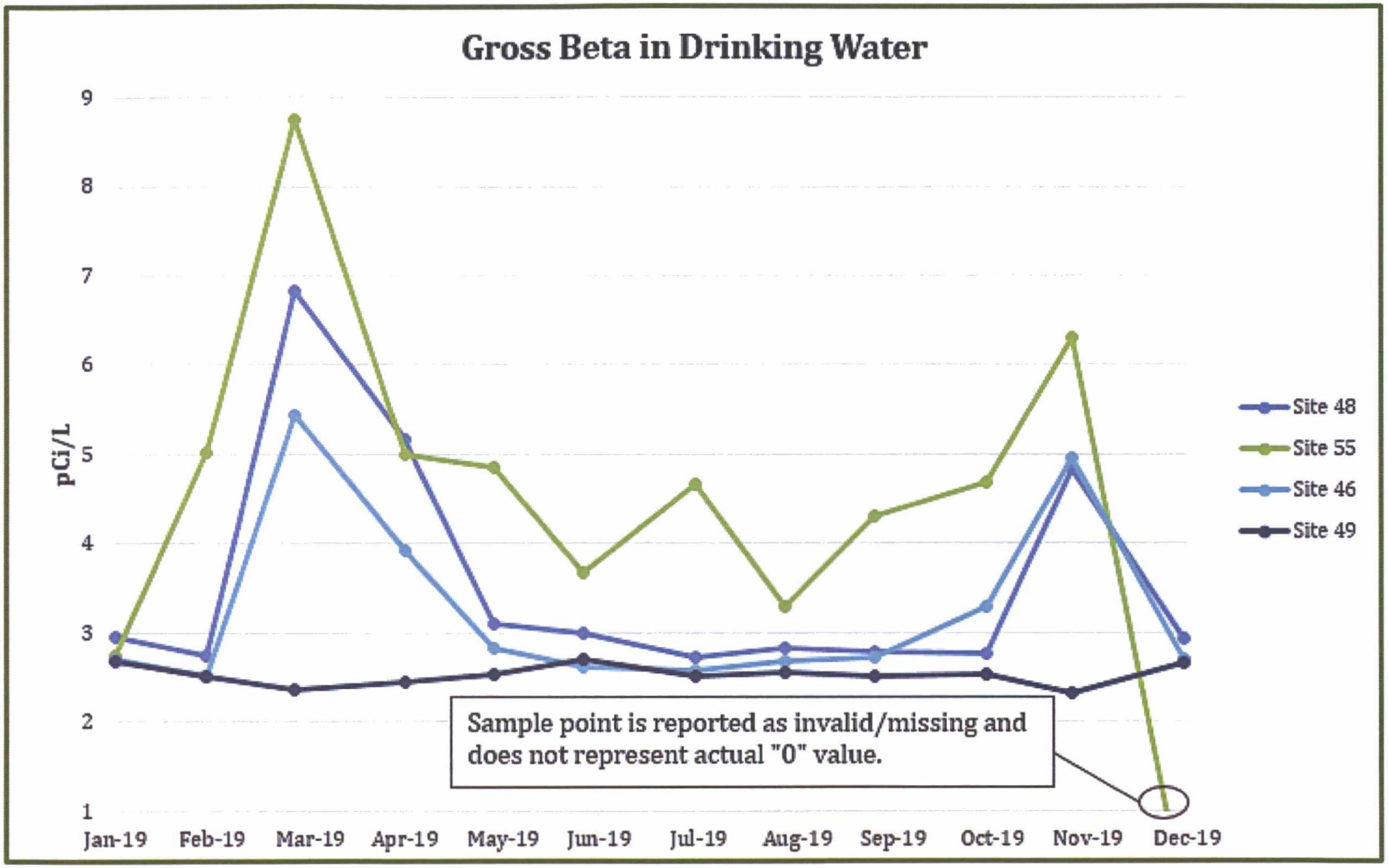



**Figure 8-5 Gross Beta in Drinking Water**

Notes: MDA values are plotted as activity (i.e. <2.3 is plotted as 2.3)
The action level is 30 pCi/liter

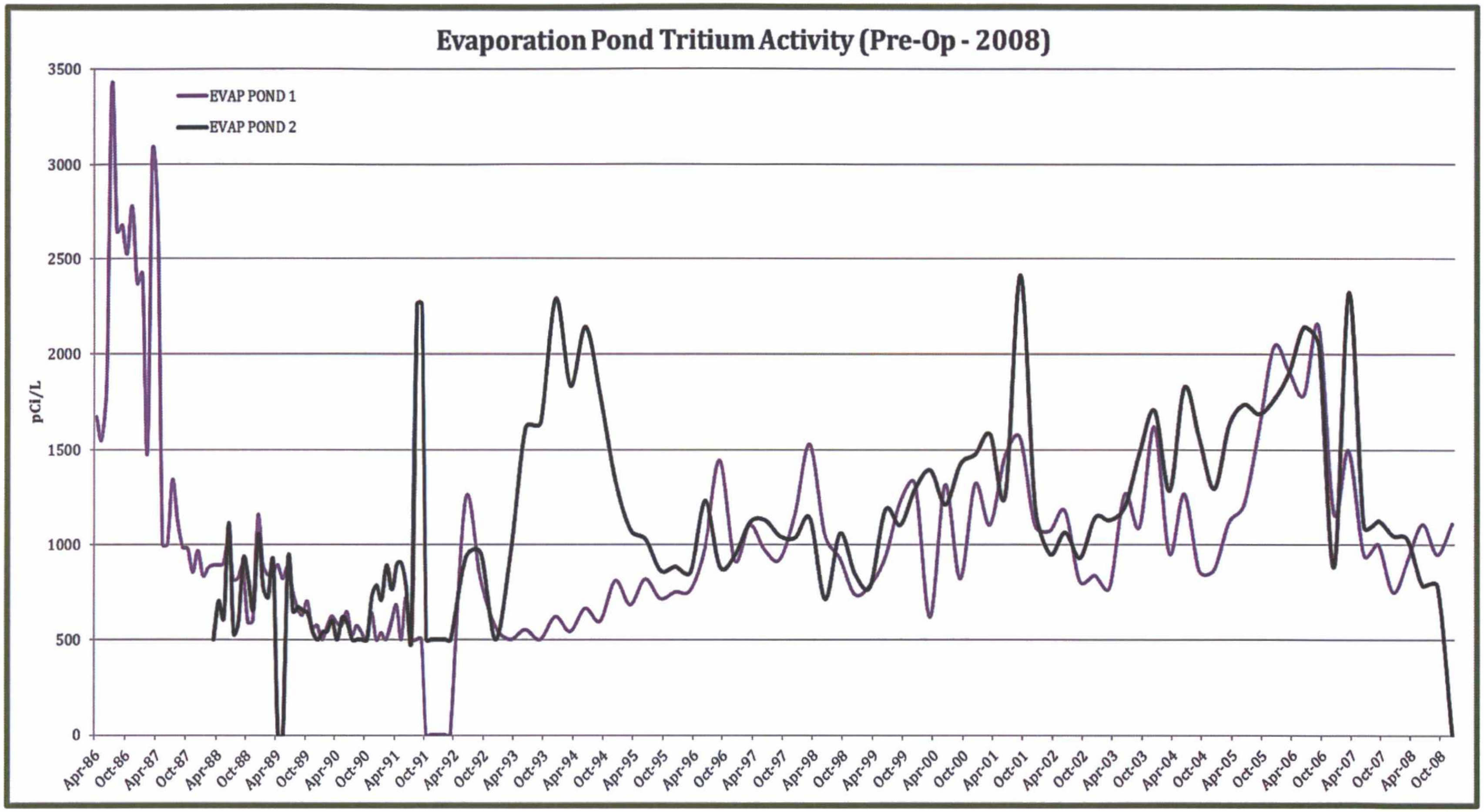



**Figure 8-6 Evaporation Pond Tritium Activity (Pre-Op- 2008)**

Note: Zero values represent no sample taken for sampling period, per procedural guidance or lack of sample material.

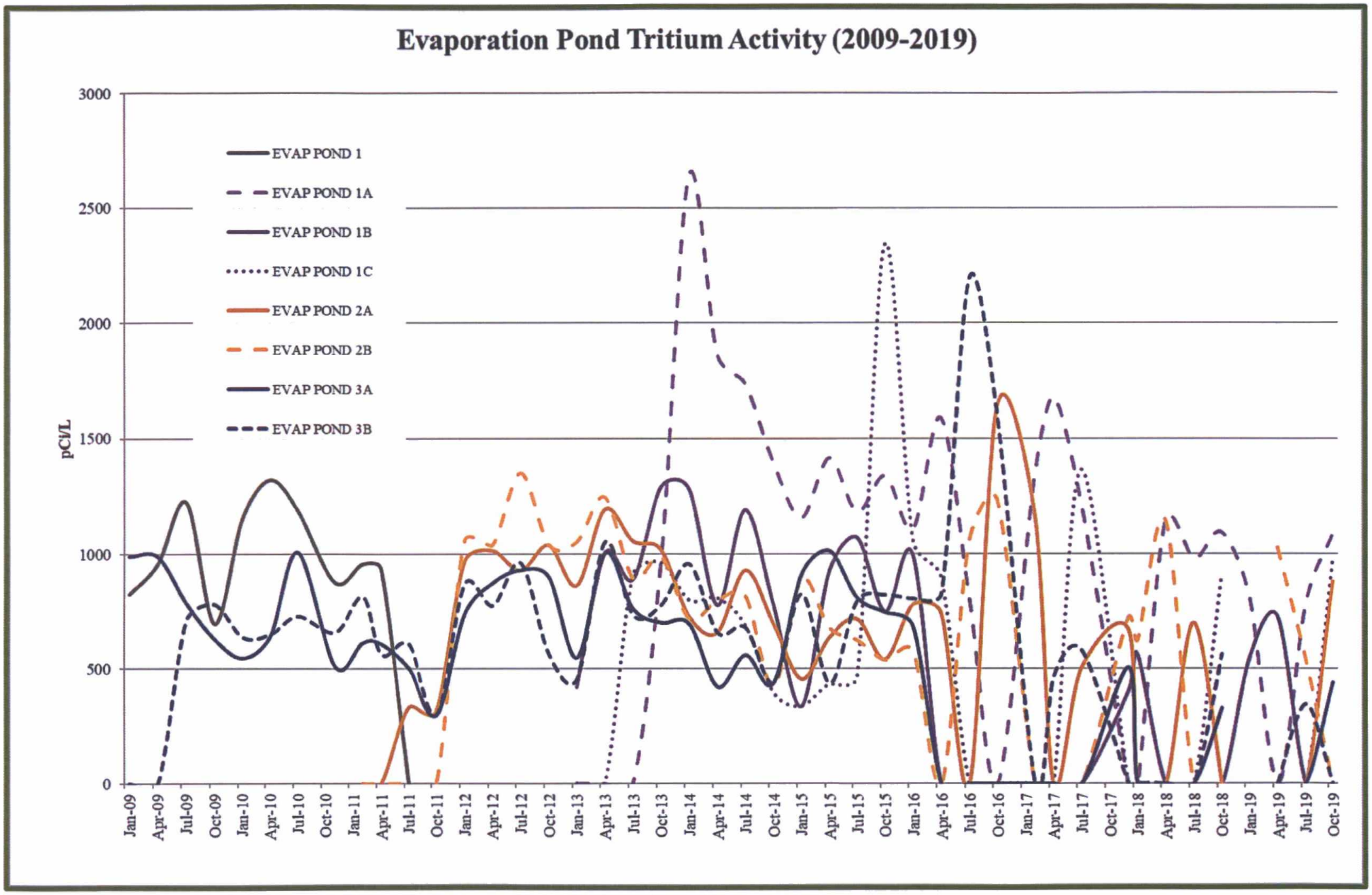



**Figure 8-7 Evaporation Pond Tritium Activity (2009-2019)**

Note: Zero values represent no sample taken for sampling period, per procedural guidance or lack of sample material.

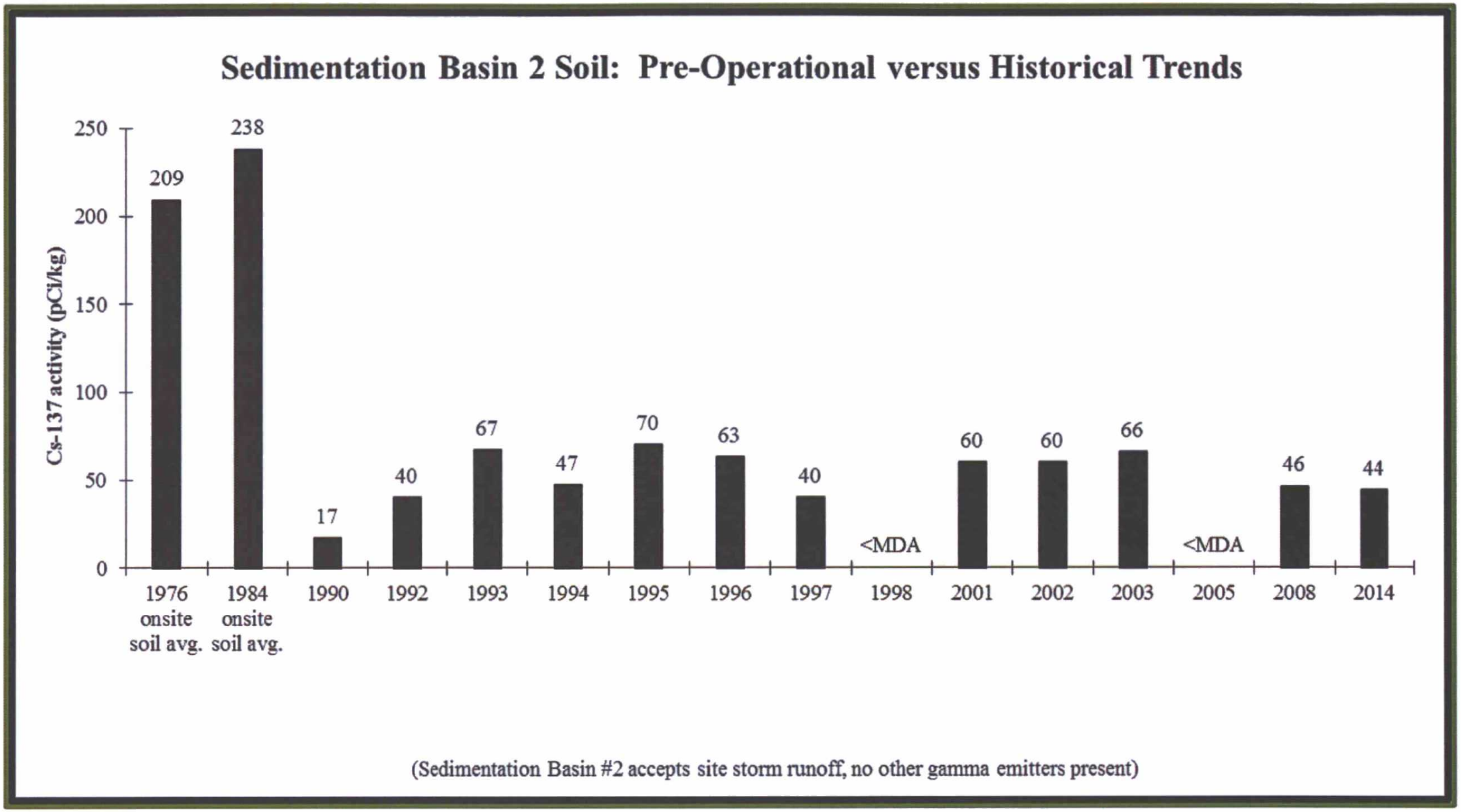



**Figure 8-8 Sedimentation Basin 2 Cs-137**

# 9. Thermoluminescent Dosimeter (TLD) Results and Data

The environmental TLD used at PVNGS is the Panasonic Model 812 Dosimeter. The Model 812 is a multi-element dosimeter combining two elements of lithium borate and two elements of calcium sulfate under various filters.

TLDs were placed in fifty locations from one to thirty-five miles from the PVNGS. TLD locations are shown in Figure 2-1 and Figure 2-2 and are described in Table 9-1. TLD results for 2019 are presented in Table 9-2. Definitions for Table 9-2 are as follows:

$MDD_Q$: Minimum differential dose, quarterly, 3 times $90^{th}$ percentile sQ determined from analysis (mRem).

$MDD_A$: Minimum differential dose, annual, 3 times $90^{th}$ percentile sA determined from analysis (mRem).

$B_Q$: Quarterly baseline (mRem) (average of previous 5 years)

$M_Q$: Locations 91 day standard quarter normalized dose (mRem per standard quarter)

$L_Q$: Quarterly investigation level dose (mRem)

$B_A$: Baseline background dose (mRem) (annual)

$M_A$: Annual monitoring data – MA determined by normalizing available quarterly data to 4 full quarters

$L_A$: Annual investigation level dose (mRem)

ND: Non Detectable

The baseline is calculated as the average of the previous 5 year measurements. The minimum differential dose (MDD) is calculated as 3 times the $90^{th}$ percentile standard deviation of the data from the previous 5 years; quarterly MDD is calculated using the quarterly data and annual MDD is calculated using the annual summation of the quarterly data. Investigation level is calculated by the difference of the data measurement and the baseline; results less than, or equal to the MDD are Non Detectable (ND) and any result exceeding the MDD meets the threshold for the investigation level. Locations exceeding the investigation level will be evaluated for cause and impact to the public and environment.

Historical environmental gamma radiation results for 1985 through 2019 are presented in graphical form on Figure 9-1 (excluding transit control TLD #45). Figure 9-2 depicts the environmental TLD results from 2019 as compared to the pre-operational TLD results (excluding sites #41 and #43, as they were deleted and later assigned to a new location, and #46-50, as they had no pre-op TLD at the location for comparison). The site to site comparisons indicate a direct correlation with respect to pre-operational results. It is indicated that the offsite dose, as measured by TLDs, has not changed since Palo Verde became operational.

**Table 9-1 TLD Site Locations**

(Distance and direction are relative to Unit 2 in miles)

| TLD # | Location | Distance from Unit 2 | TLD # | Location | Distance from Unit 2 | TLD # | Location | Distance from Unit 2 |
|---|---|---|---|---|---|---|---|---|
| 1 | E30 | 29.13 | 18 | ESE2 | 1.48 | 35 | NNW8 | 7.86 |
| 2 | ENE24 | 24.18 | 19 | SE2 | 1.35 | 36 | N5 | 4.32 |
| 3 | E21 | 21.87 | 20 | SSE2 | 2.04 | 37 | NNE5 | 4.69 |
| 4 | E16 | 16.05 | 21 | S3 | 2.68 | 38 | NE5 | 4.21 |
| 5 | ESE11 | 11.14 | 22 | SSW3 | 2.74 | 39 | ENE5 | 4.71 |
| 6 | SSE31 | 31.47 | 23 | W5 | 4.17 | 40 | N2 | 2.37 |
| 7 | SE7 | 6.87 | 24 | SW4 | 3.75 | 41 | ESE3 | 3.39 |
| 8 | SSE4 | 4.33 | 25 | WSW5 | 4.88 | 42 | N8 | 7.24 |
| 9 | S5 | 4.63 | 26 | SSW4 | 4.13 | 43 | NE5 | 4.60 |
| 10 | SE5 | 3.91 | 27 | SW1 | 0.93 | 44 | ENE35 | 35.00 |
| 11 | ESE5 | 5.14 | 28 | WSW1 | 0.66 | 45 | Onsite | 0.18 |
| 12 | E5 | 4.85 | 29 | W1 | 0.64 | 46 | ENE30 | 7.23 |
| 13 | N1 | 0.85 | 30 | WNW1 | 0.74 | 47 | E35 | 32.35 |
| 14 | NNE2 | 155 | 31 | NW1 | 1.03 | 48 | E24 | 22.76 |
| 15 | NE2 | 1.63 | 32 | NNW1 | 0.90 | 49 | ENE11 | 11.32 |
| 16 | ENE2 | 1.59 | 33 | NW4 | 4.05 | 50 | WNW5 | 4.24 |
| 17 | E2 | 1.39 | 34 | NNW5 | 4.84 | | | |

*Site #6 and site #44 are the control locations.
**Site #45 is the transit control TLD (stored in lead pig).

## Table 9-2 Environmental TLD Results

**Palo Verde 2019 $MDD_Q$: 5 mrem** **Palo Verde 2019 $MDD_A$: 10 mrem**

| Site | Quarterly (mrem) | | | | | | | | | Annual (mrem) | | | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $B_Q$ | $M_QQ1$ | $M_QQ2$ | $M_QQ3$ | $M_QQ4$ | $L_QQ1$ | $L_QQ2$ | $L_QQ3$ | $L_QQ4$ | $B_A$ | $M_A$ | $L_A$ | |
| 1 | 24.8 | 23.9 | 25.4 | 26.2 | 24.2 | ND | ND | ND | ND | 99.3 | 99.7 | ND | |
| 2 | 22.1 | 21.7 | 22.5 | 22.4 | 22.3 | ND | ND | ND | ND | 88.5 | 88.9 | ND | |
| 3 | 23.9 | 23.5 | 24.3 | 27.8 | 23.5 | ND | ND | ND | ND | 95.5 | 99.1 | ND | |
| 4 | 24.6 | 24.3 | 25.9 | 25.3 | 23.7 | ND | ND | ND | ND | 98.5 | 99.2 | ND | |
| 5 | 21.0 | 21.3 | 20.9 | 20.7 | 20.4 | ND | ND | ND | ND | 83.9 | 83.3 | ND | |
| 6 | 26.7 | 25.3 | 27.2 | 27.2 | 29.3 | ND | ND | ND | ND | 106.6 | 108.9 | ND | |
| 7 | 25.7 | 26.6 | 26.7 | 26.2 | 24.7 | ND | ND | ND | ND | 102.8 | 104.3 | ND | |
| 8 | 24.1 | 24.5 | 24.5 | 25.7 | 24.3 | ND | ND | ND | ND | 96.5 | 99.0 | ND | |
| 9 | 28.3 | 27.9 | 29.4 | 28.3 | 29.4 | ND | ND | ND | ND | 113.0 | 114.9 | ND | |
| 10 | 24.1 | 24.0 | 26.8 | 24.4 | 22.7 | ND | ND | ND | ND | 96.2 | 98.0 | ND | |
| 11 | 25.0 | 26.7 | 25.5 | 26.0 | 24.9 | ND | ND | ND | ND | 99.9 | 103.1 | ND | |
| 12 | 23.6 | 23.5 | 26.0 | 24.6 | 23.0 | ND | ND | ND | ND | 94.6 | 97.0 | ND | |
| 13 | 25.6 | 26.3 | 27.2 | 27.5 | 25.2 | ND | ND | ND | ND | 102.6 | 106.3 | ND | |
| 14 | 25.2 | 24.6 | 26.4 | 26.5 | 25.4 | ND | ND | ND | ND | 100.6 | 102.9 | ND | |
| 15 | 23.6 | 24.1 | 26.0 | 24.3 | 24.3 | ND | ND | ND | ND | 94.5 | 98.7 | ND | |
| 16 | 22.9 | 24.1 | 24.6 | 25.3 | 24.7 | ND | ND | ND | ND | 91.7 | 98.6 | ND | |
| 17 | 24.7 | 25.1 | 27.4 | 25.5 | 24.6 | ND | ND | ND | ND | 98.8 | 102.6 | ND | |
| 18 | 23.5 | 24.6 | 26.1 | 24.0 | 23.1 | ND | ND | ND | ND | 94.0 | 97.7 | ND | |
| 19 | 25.3 | 25.5 | 27.1 | 25.0 | 25.7 | ND | ND | ND | ND | 101.0 | 103.3 | ND | |
| 20 | 24.4 | 25.8 | 26.8 | 24.2 | 24.3 | ND | ND | ND | ND | 97.7 | 101.1 | ND | |
| 21 | 25.8 | 26.1 | 28.5 | 26.7 | 25.9 | ND | ND | ND | ND | 103.3 | 107.2 | ND | |
| 22 | 26.0 | 26.8 | 28.2 | 28.3 | 26.6 | ND | ND | ND | ND | 103.8 | 109.9 | ND | |
| 23 | 23.1 | 24.1 | 25.5 | 24.9 | 23.3 | ND | ND | ND | ND | 92.5 | 97.8 | ND | |
| 24 | 22.8 | 23.3 | 24.5 | 22.9 | 21.7 | ND | ND | ND | ND | 91.2 | 92.3 | ND | |
| 25 | 23.5 | 24.0 | 26.1 | 24.2 | 24.4 | ND | ND | ND | ND | 94.2 | 98.7 | ND | |
| 26 | 27.8 | 28.0 | 31.0 | 28.2 | 27.9 | ND | ND | ND | ND | 111.1 | 115.0 | ND | |
| 27 | 27.0 | 27.9 | 28.9 | 28.4 | 27.8 | ND | ND | ND | ND | 107.8 | 113.0 | ND | |
| 28 | 25.7 | 26.2 | 28.6 | 26.4 | 25.4 | ND | ND | ND | ND | 103.0 | 106.5 | ND | |
| 29 | 24.3 | 24.4 | 26.2 | 24.9 | 23.1 | ND | ND | ND | ND | 97.2 | 98.6 | ND | |
| 30 | 26.0 | 24.9 | 26.6 | 27.1 | 26.4 | ND | ND | ND | ND | 104.1 | 105.0 | ND | |
| 31 | 23.4 | 24.2 | 23.9 | 25.2 | 23.1 | ND | ND | ND | ND | 93.7 | 96.4 | ND | |
| 32 | 25.5 | 25.1 | 26.2 | 25.4 | 24.5 | ND | ND | ND | ND | 102.1 | 101.1 | ND | |
| 33 | 26.4 | 25.2 | 27.2 | 24.6 | 25.4 | ND | ND | ND | ND | 105.5 | 102.4 | ND | |
| 34 | 28.4 | 29.4 | 29.1 | 29.7 | 28.0 | ND | ND | ND | ND | 113.5 | 116.2 | ND | |
| 35 | 31.5 | 29.8 | 31.7 | 32.8 | 31.4 | ND | ND | ND | ND | 126.0 | 125.7 | ND | |
| 36 | 25.8 | 26.5 | 26.3 | 26.2 | 25.2 | ND | ND | ND | ND | 103.4 | 104.3 | ND | |
| 37 | 24.2 | 23.2 | 25.5 | 24.4 | 24.2 | ND | ND | ND | ND | 96.8 | 97.3 | ND | |
| 38 | 27.8 | 27.5 | 27.5 | 27.6 | 28.5 | ND | ND | ND | ND | 111.1 | 111.1 | ND | |
| 39 | 24.2 | 24.7 | 25.4 | 24.5 | 24.2 | ND | ND | ND | ND | 96.9 | 98.8 | ND | |
| 40 | 25.3 | 25.2 | 26.1 | 26.1 | 26.1 | ND | ND | ND | ND | 101.3 | 103.5 | ND | |
| 41 | 26.7 | 28.2 | 27.6 | 26.3 | 28.0 | ND | ND | ND | ND | 106.7 | 110.1 | ND | |
| 42 | 27.2 | 26.6 | 28.0 | 26.6 | 26.2 | ND | ND | ND | ND | 109.0 | 107.5 | ND | |
| 43 | 27.8 | 26.7 | 28.5 | 27.3 | 27.9 | ND | ND | ND | ND | 111.3 | 110.4 | ND | |
| 44 | 23.8 | 23.8 | 24.6 | 24.4 | 23.5 | ND | ND | ND | ND | 95.2 | 96.3 | ND | |
| 45 | 5.5 | 6.3 | 5.9 | 4.4 | 5.1 | ND | ND | ND | ND | 22.2 | 21.6 | ND | |
| 46 | 23.8 | 23.8 | 25.1 | 25.2 | 24.1 | ND | ND | ND | ND | 95.2 | 98.2 | ND | |
| 47 | 23.7 | * | 26.3 | 24.1 | 23.2 | * | ND | ND | ND | 71.0 | 73.6 | ND | 1 |
| 48 | 24.4 | 24.5 | 26.8 | 24.3 | 22.1 | ND | ND | ND | ND | 97.5 | 97.7 | ND | |
| 49 | 22.7 | 22.7 | 25.3 | 23.7 | 22.8 | ND | ND | ND | ND | 90.6 | 94.4 | ND | |
| 50 | 19.7 | 20.8 | 21.0 | 19.8 | 19.0 | ND | ND | ND | ND | 78.6 | 80.6 | ND | |

Note 1: * The 2 TLDs used for monitoring location 47 were missing at the time of the Second Quarter, 2019 exchange. The MA and LA were calculated using Second, Third and Fourth Quarter data. BA was calculated using BQ*3

**Figure 9-1 Network Environmental TLD Exposure Rates**

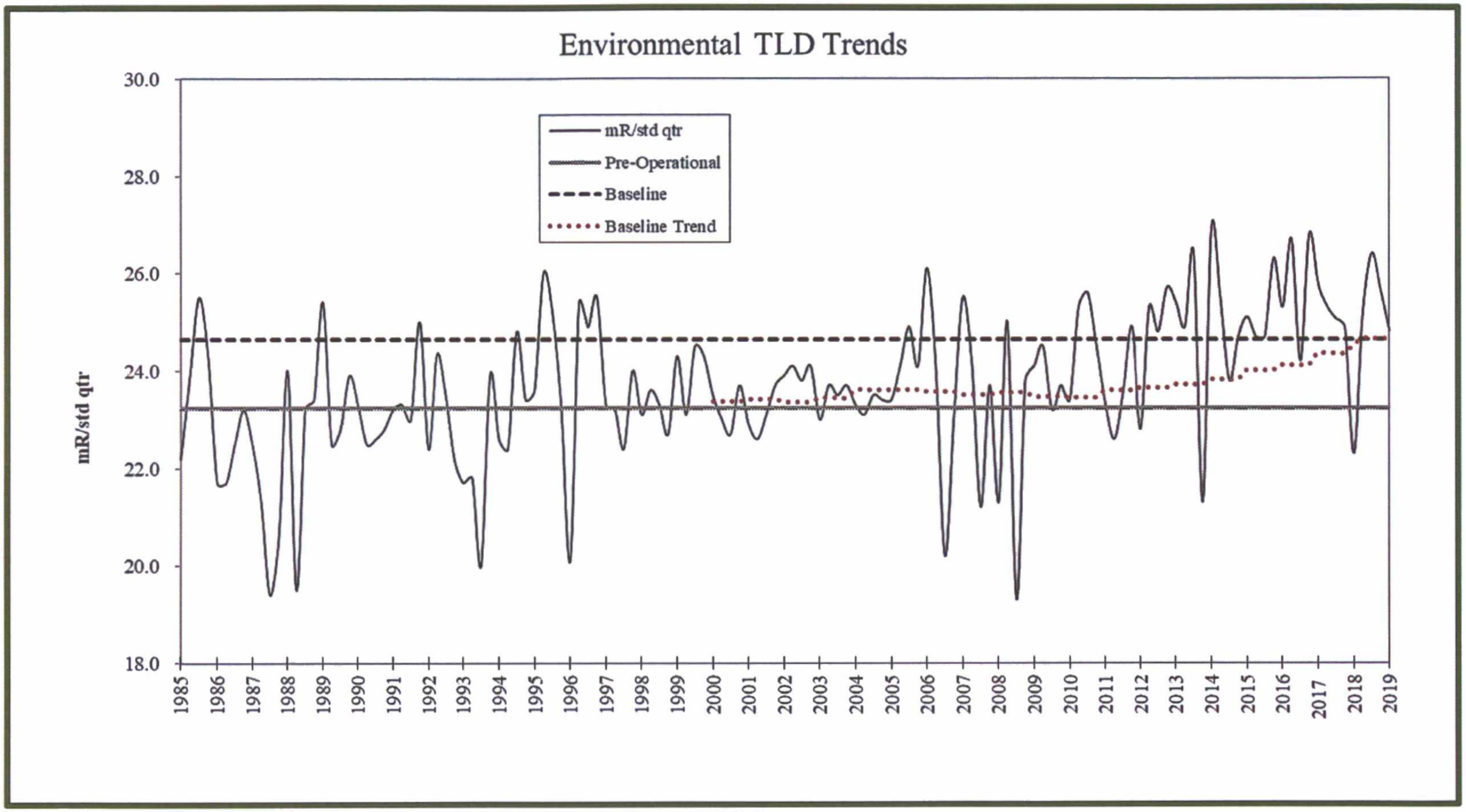
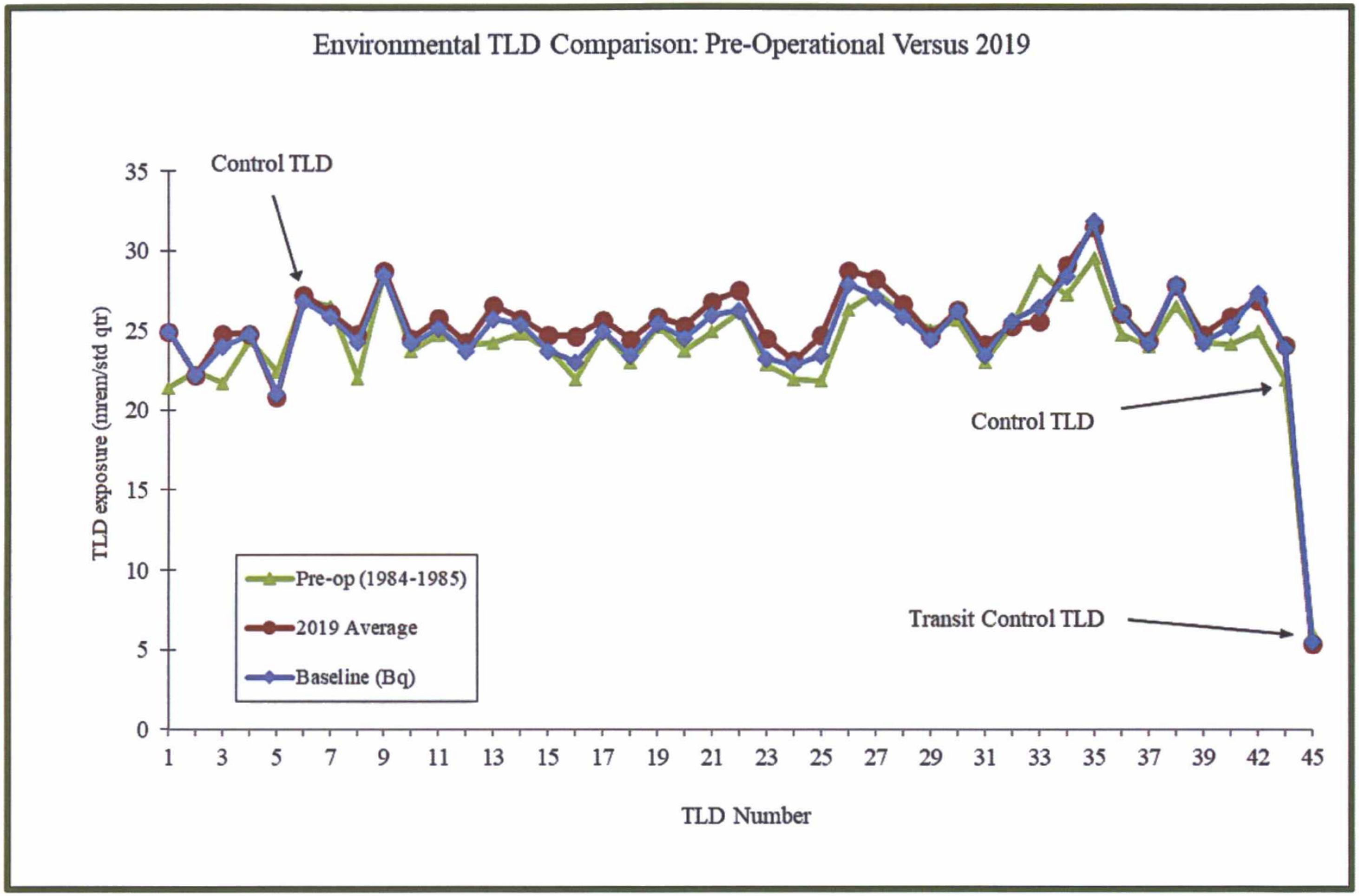


**Figure 9-2 Environmental TLD Comparison: Pre-Operational versus 2019**




The following TLDs are not included on this graph:
TLD #41 monitoring location was deleted in June, 2000 due to school closing (this TLD was replaced at a new school in 2004)
TLD #43 monitoring location was deleted in 1994 due to school closing (this TLD was placed at a new school in 2007)
TLDs #46-50 are not included since they were not included in the pre-op monitoring program.

# 10. Land Use Census

## 10.1 Introduction

In accordance with the PVNGS ODCM, Section 6.2, the field portion of the annual Land Use Census was performed by June 2019.

Observations were made in each of the 16 meteorological sectors to determine the nearest milking animals, residences, and gardens of greater than 500 square feet. This census was completed by driving the roads and speaking with residents.

The results of the Land Use Census are presented in Table 10-1 and discussed below. The directions and distances listed are in sectors and miles from the Unit 2 containment.

## 10.2 Census Results

The 2019 Land Use Census results identified new potential Radiological Effluent Release Report dose receptor locations. Each location was evaluated. The changes identified, and the evaluation results, are described below.

**Nearest Resident**

There was one (1) change in nearest resident status from the previous year. Dose calculations indicated the highest dose to be 0.697 mrem.

**Milk Animal**

There were four (4) changes in milk animal status from the previous year. There were six (6) of the locations that were identified in the census which had the potential for having a dose greater than 20% that of our current sampling location with the lowest dose potential. The locations were visited by the REMP manager to evaluate program participation potential. As of October, 2019, five (5) of the locations no longer had goats, and one (1) location had only male goats. Dose calculations indicated the highest dose to be 0.737 mrem.

**Vegetable Gardens**

There was no change in the nearest gardens identified in the previous year. Dose calculations indicated the highest dose to be 0.239 mrem.

See Table 10-1 for a summary of the specific results and Table 2-1 for current sample locations. Figure 10-1 through Figure 10-3 provide graphs depicting historical calculated doses for nearest residents, nearest milk receptor, and nearest garden receptor locations in each sector.

Differences in calculated doses are the result of many variables, including;

- Changes in receptor locations from year to year (proximity to the power plant)
- Changes in local meteorology (wind direction, wind speed, precipitation, and temperature)
- Concurrent meteorology at the time of effluent releases
- Exposure pathways

**Table 10-1 Land Use Census**

(Distance and direction are relative to Unit 2 in miles)

| Sector | Nearest Resident | Nearest Garden | Nearest Milk Animal (Cow/Goat) | Calculated Dose (mrem) | Change from 2018 |
|---|---|---|---|---|---|
| N | 1.55 | 3.10 | 3.25 | Resident 4.68E-2<br>Garden 1.17E-1<br>Milk 1.26E-1 | Milk |
| NNE | 1.52 | NONE | 2.82 | Resident 9.04E-2<br>Milk 2.66E-1 | |
| NE | 2.16 | NONE | 4.62 | Resident 1.25E-1<br>Milk 1.21E-1 | Milk |
| ENE | 2.05 | 4.84 | 2.05 | Resident 6.97E-1<br>Garden 2.39E-1<br>Milk 6.97E-1 | Milk |
| E | 2.81 | NONE | 4.28 | Resident 9.31E-2<br>Milk 2.39E-1 | |
| ESE | 3.06 | NONE | 3.37 | Resident 1.34E-1<br>Milk 6.10E-1 | |
| SE | 3.39 | NONE | 4.41 | Resident 1.34E-1<br>Milk 7.37E-1 | |
| SSE | NONE | NONE | NONE | NA | |
| S | NONE | NONE | NONE | NA | Resident |
| SSW | NONE | NONE | NONE | NA | |
| SW | 1.39 | NONE | NONE | Resident 1.45E-1 | |
| WSW | 0.83 | NONE | NONE | Resident 8.69E-2 | |
| W | 0.76 | NONE | NONE | Resident 5.45E-2 | |
| WNW | NONE | NONE | NONE | NA | |
| NW | 0.93 | NONE | NONE | Resident 4.96E-2 | |
| NNW | 1.31 | 4.34 | 5.03 | Resident 3.31E-2<br>Garden 4.51E-2<br>Milk 3.37E-2 | Milk |

Comments:

Dose calculations were performed using GASPAR code and 2018 meteorological data and source term. Dose reported for each location is the total for all three PVNGS Units and is the highest individual critical organ dose identified.

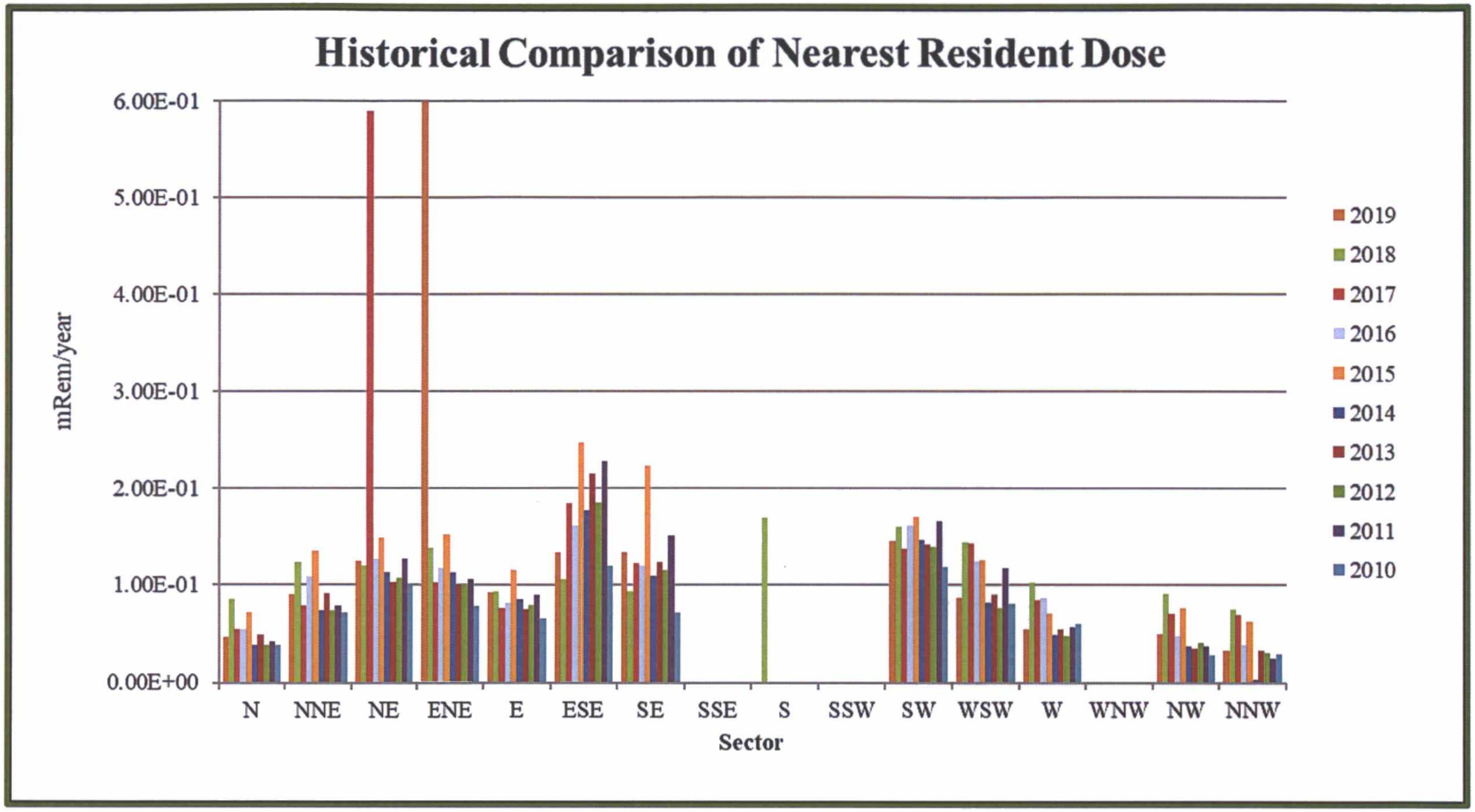



**Figure 10-1 Historical Comparison of Nearest Resident Dose**

Historical annual average most prevalent wind direction is from the SW; the next highest is from the N. This contributes to the higher doses assigned to residents in the S sector. The 2017 Land Use Census identified potential garden pathway for the nearest resident in the NE Sector and the 2019 Land Use Census identified a potential garden pathway for the nearest resident in the ENE sector; dose is reflective of the assumption of direct radiation and ingestion pathway.

Historical annual average least prevalent wind direction is from the SE; the second least prevalent is from the ESE. This contributes to the lower doses assigned to the residents in the WNW, NW, and NNW sectors.

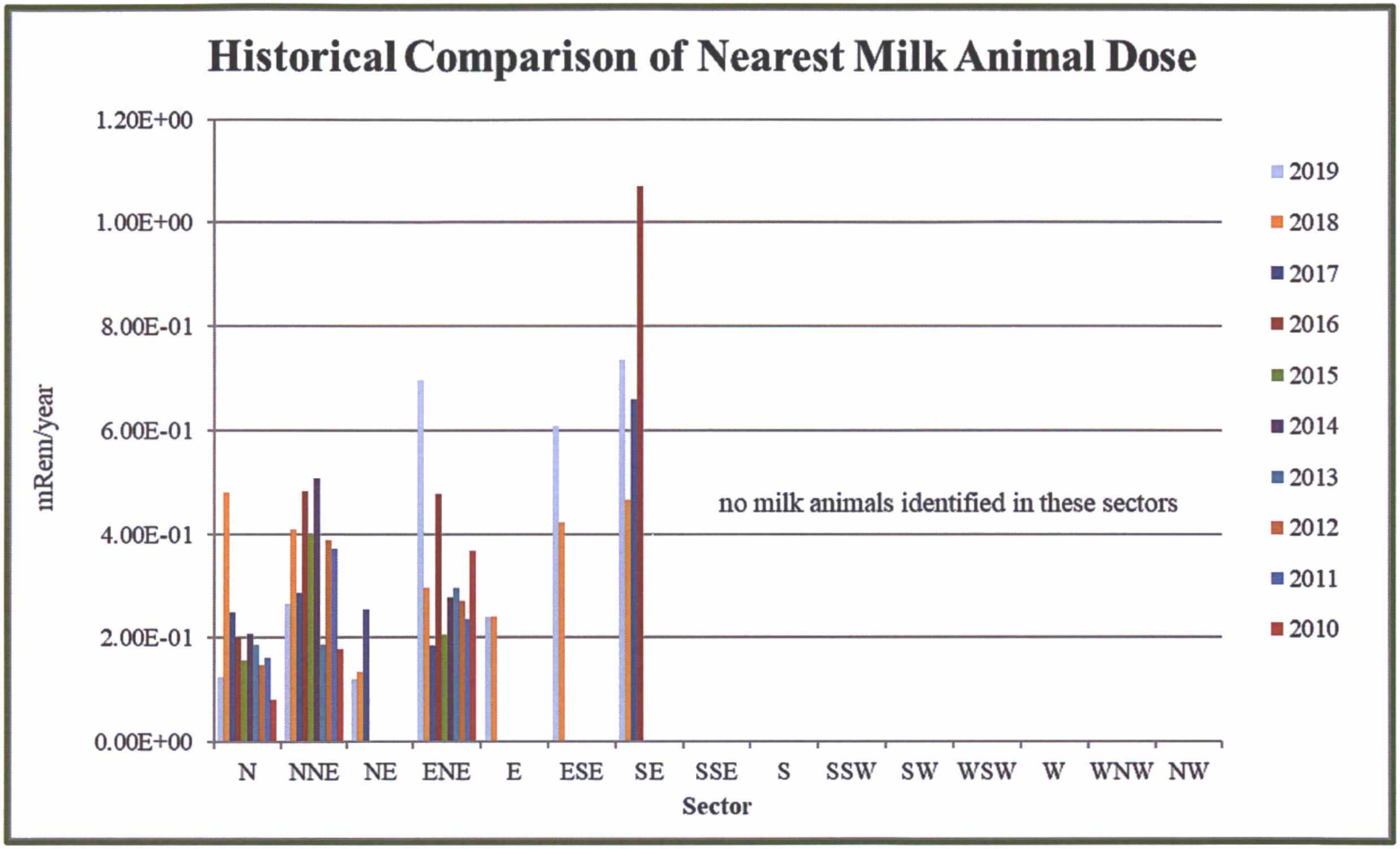



**Figure 10-2 Historical Comparison of Nearest Milk Animal Dose**

Milk animals include goats and/or cows. No milk samples have indicated any plant-related radionuclides. Additionally, milk animals in the desert environment are normally fed stored feed and are not on pasture. The calculated doses are conservative due to the inclusion of pastured feed as part of the calculation.

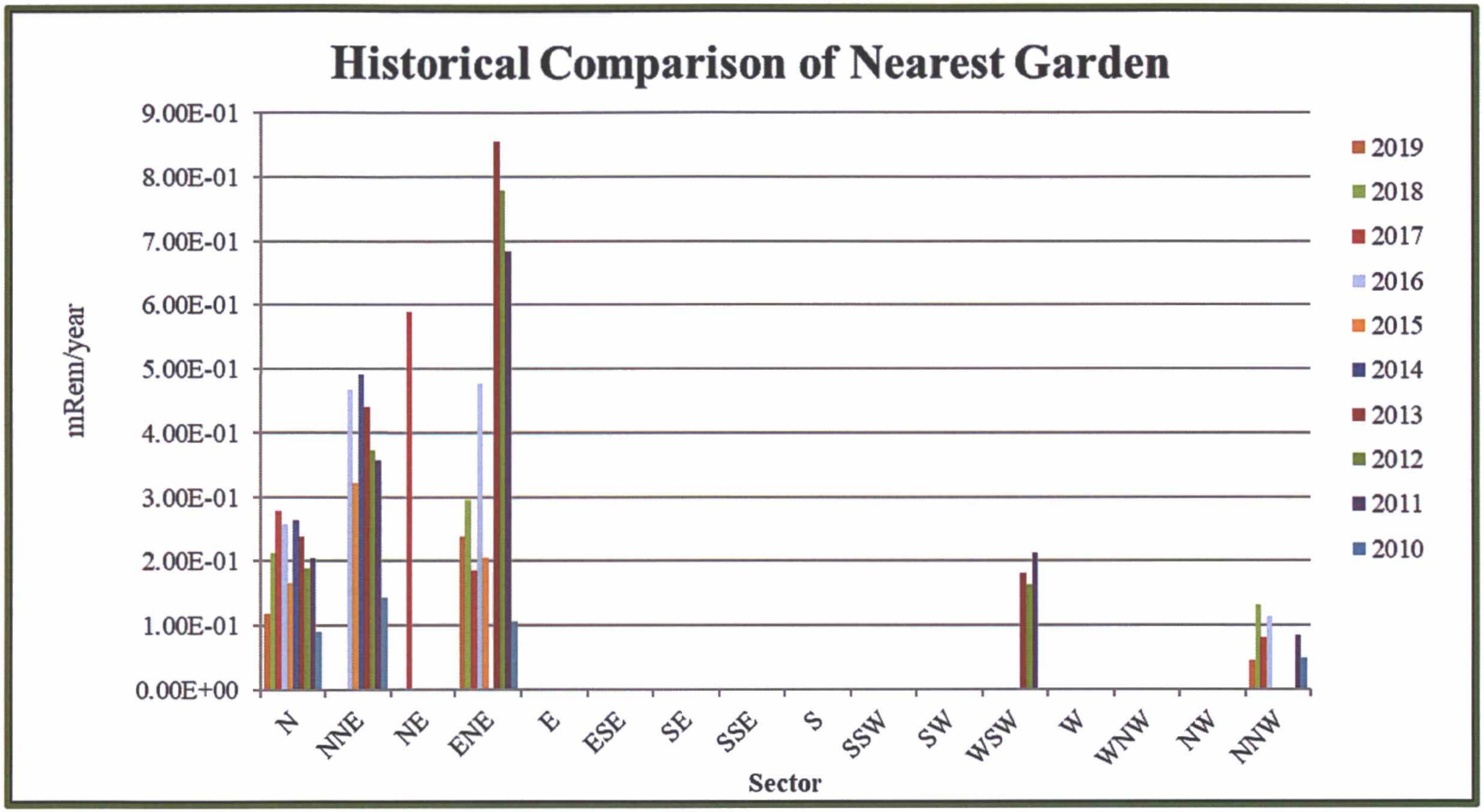



**Figure 10-3 Historical Comparison of Nearest Garden Dose**

Gardens have been sporadically identified from year to year. Gardening is not prevalent in the desert environment.

# 11. Summary and Conclusions

### Summary

The conclusions are based on a review of the radioassay results and environmental gamma radiation measurements for the 2019 calendar year. Where possible, the data were compared to pre-operational sample data.

All sample results for 2019 are presented in Table 8-1 through Table 8-12 and do not include observations of naturally occurring radionuclides, with the exception of gross beta in air and gross beta in drinking water. Table 11-1 summarizes the ODCM required samples and is in the format required by the NRC BTP on Environmental Monitoring.

I-131 identified in the evaporation ponds, Water Resources influent, Water Resources centrifuge sludge, and reservoirs is the result of offsite sources and appears in the effluent sewage from Phoenix. The levels of I-131 detected in these locations are consistent with levels identified in previous years.

Cs-137 was detected in one Evaporation Pond 3A sample. The sample result was 41 pCi/L +/- 9 pCi/L. The required lower limit of detection for Cs-137 in water is 18 pCi/L; the action level for Cs-137 in water is 50 pCi/L. Evaporation Pond 3A has not received any influent during 2019 and is being drained to another evaporation pond to make repairs to the top liner. The water inventory in Evaporation Pond 3A is low, such that sediment that has collected in the pond was unavoidably collected in the sample. Cs-137 is known to bind to sediment, and the levels detected in the water sample is consistent with what was found in the preoperational soils in the surrounding area as a result of atmospheric bomb testing.

Tritium concentrations identified in surface water onsite have been attributed to PVNGS permitted gaseous effluent releases and secondary plant releases. These concentrations are consistent with historical values.

Environmental radiation levels are consistent with measurements reported in previous Pre-operational and Operational Radiological Environmental annual reports, References 1 and 2.

### Conclusion

There was no measurable radiological impact on the environment in 2019 resulting from the operation of PVNGS.

## Table 11-1 Environmental Radiological Monitoring Program Annual Summary

**TABLE 11.1 ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM ANNUAL SUMMARY**

Palo Verde Nuclear Generating Station — Docket Nos. STN 50-528/529/530
Maricopa County, Arizona — Calendar Year 2019

| Medium or Pathway Sampled (Unit of Measurement) | Type and Total Number of Analyses Performed | Lower Limit of Detection (LLD) (from Table 6.1) | All Indicator Locations<br>Mean (f)[a]<br>Range | Location with Highest Annual Mean<br>Name<br>Distance and Direction | <br>Mean (f)[a]<br>Range | Control Locations<br>Mean (f)[a]<br>Range | Number of Nonroutine Reported Measurements |
|---|---|---|---|---|---|---|---|
| Direct Radiation (mrem/std. qtr.) | TLD - 199 | NA | 25.5 (187/188)<br>19.0 – 32.8 | Site #35<br>8 miles 330° | 31.4 (4/4)<br>29.8 – 32.8 | 25.6 (8/8)<br>23.5 – 29.3 | 0 |
| Air Particulates ($pCi/m^3$) | Gross Beta - 520 | 0.01 | 0.028 (513/520)<br>0.011 - 0.075 | Site # 29<br>1 mile 270° | 0.027 (50/52)<br>0.014 - 0.075 | 0.028 (51/52)<br>0.010 - 0.066 | 0 |
| | Gamma Spec Composite - 40 | | | | | | |
| | Cs-134 (quarterly) | 0.05 | <LLD | NA | <LLD | <LLD | 0 |
| | | | <LLD | NA | <LLD | <LLD | |
| | Cs-137 (quarterly) | 0.06 | <LLD | NA | <LLD | <LLD | 0 |
| | | | <LLD | NA | <LLD | <LLD | |
| Air Radioiodine ($pCi/m^3$) | Gamma Spec. - 519 | | | | | | |
| | I-131 | 0.07 | <LLD | NA | <LLD | <LLD | 0 |
| | | | <LLD | NA | <LLD | <LLD | |
| Broadleaf Vegetation (pCi/Kg-wet) | Gamma Spec. - 30 | | | | | | |
| | I-131 | 60 | <LLD | NA | <LLD | <LLD | 0 |
| | Cs-134 | 60 | <LLD | NA | <LLD | <LLD | 0 |
| | Cs-137 | 80 | <LLD | NA | <LLD | <LLD | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Groundwater (pCi/liter) | H-3 – 12 | 2000 | <LLD | NA | <LLD | NA | 0 |
| | Gamma Spec. - 12 | | | | | | |
| | Mn-54 | 15 | <LLD | NA | <LLD | NA | 0 |
| | Fe-59 | 30 | <LLD | NA | <LLD | NA | 0 |
| | Co-58 | 15 | <LLD | NA | <LLD | NA | 0 |
| | Co-60 | 15 | <LLD | NA | <LLD | NA | 0 |
| | Zn-65 | 30 | <LLD | NA | <LLD | NA | 0 |
| | Zr-95 | 30 | <LLD | NA | <LLD | NA | 0 |
| | Nb-95 | 15 | <LLD | NA | <LLD | NA | 0 |
| | I-131 | 15 | <LLD | NA | <LLD | NA | 0 |
| | Cs-134 | 15 | <LLD | NA | <LLD | NA | 0 |
| | Cs-137 | 18 | <LLD | NA | <LLD | NA | 0 |
| | Ba-140 | 60 | <LLD | NA | <LLD | NA | 0 |
| | La-140 | 15 | <LLD | NA | <LLD | NA | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Drinking Water (pCi/liter) | Gross Beta – 47 | 4 | 3.51 (47/48)<br>2.33 – 8.75 | Site #55<br>3 miles<br>214° | 4.84 (11/12)<br>2.75 -8.75 | NA | 0 |
| | H-3 – 16 | 2000 | <LLD | NA | <LLD | NA | 0 |
| | Gamma Spec. – 47 | | | | | | |
| | Mn-54 | 15 | <LLD | NA | <LLD | NA | 0 |
| | Fe-59 | 30 | <LLD | NA | <LLD | NA | 0 |
| | Co-58 | 15 | <LLD | NA | <LLD | NA | 0 |
| | Co-60 | 15 | <LLD | NA | <LLD | NA | 0 |
| | Zn-65 | 30 | <LLD | NA | <LLD | NA | 0 |
| | Zr-95 | 30 | <LLD | NA | <LLD | NA | 0 |
| | Nb-95 | 15 | <LLD | NA | <LLD | NA | 0 |
| | I-131 | 15 | <LLD | NA | <LLD | NA | 0 |
| | Cs-134 | 15 | <LLD | NA | <LLD | NA | 0 |
| | Cs-137 | 18 | <LLD | NA | <LLD | NA | 0 |
| | Ba-140 | 60 | <LLD | NA | <LLD | NA | 0 |
| | La-140 | 15 | <LLD | NA | <LLD | NA | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Gamma Spec. – 29 | | | | | | |
| Milk | I-131 | 1 | <LLD | NA | <LLD | <LLD | 0 |
| (pCi/liter) | | | <LLD | NA | <LLD | <LLD | |
| | Cs-134 | 15 | <LLD | NA | <LLD | <LLD | 0 |
| | | | <LLD | NA | <LLD | <LLD | |
| | Cs-137 | 18 | <LLD | NA | <LLD | <LLD | 0 |
| | | | <LLD | NA | <LLD | <LLD | |
| | Ba-140 | 60 | <LLD | NA | <LLD | <LLD | 0 |
| | La-140 | 15 | <LLD | NA | <LLD | <LLD | 0 |
| | Gamma Spec. - 18 | | | | | | |
| | Mn-54 | 15 | <LLD | NA | <LLD | NA | 0 |
| | Fe-59 | 30 | <LLD | NA | <LLD | NA | 0 |
| | Co-58 | 15 | <LLD | NA | <LLD | NA | 0 |
| | Co-60 | 15 | <LLD | NA | <LLD | NA | 0 |
| | Zn-65 | 30 | <LLD | NA | <LLD | NA | 0 |
| | Zr-95 | 30 | <LLD | NA | <LLD | NA | 0 |
| | Nb-95 | 15 | <LLD | NA | <LLD | NA | 0 |
| Surface Water (pCi/liter) | I-131 | 15 | 15 (3/18) | Site #59 | 17 (1/6) | NA | 0 |
| | | | 13-17 | Onsite 180° | 17-17 | | |
| | Cs-134 | 15 | <LLD | NA | <LLD | NA | 0 |
| | Cs-137 | 18 | 41(1/18) | Site #64 | 41 (1/2) | NA | 1 |
| | | | 41-41 | Onsite 190° | 41-41 | | |
| | Ba-140 | 60 | <LLD | NA | <LLD | NA | 0 |
| | La-140 | 15 | <LLD | NA | <LLD | NA | 0 |
| | H-3 - 25 | 3000 | 781 (11/18) | Site #59 | 820 (6/6) | NA | 0 |
| | | | 439-1086 | Onsite 180° | 549-1086 | | |

(a) Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses. (f)

**NOTE: Miscellaneous samples that are not listed on Tables 2.1 and 9.1 (not ODCM required) are not included on this table.**

# 12. References


1. Pre-Operational Radiological Monitoring Program, Summary Report 1979-1985

2. 1985-2018 Annual Radiological Environmental Operating Reports, Palo Verde Nuclear Generating Station

3. Palo Verde Nuclear Generating Station Technical Specifications and Technical Reference Manual

4. Offsite Dose Calculation Manual, Revision 27, PVNGS Units 1, 2, and 3

5. Offsite Dose Calculation Manual, Revision 28, PVNGS Units 1, 2, and 3

6. Regulatory Guide 4.1, Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants

7. Regulatory Guide 4.8, Environmental Technical Specifications for Nuclear Power Plants

8. NRC Radiological Assessment Branch Technical Position on Environmental Monitoring, Revision 1, November 1979 (Incorporated into NUREG-1301)

9. NEI 07-07, Nuclear Energy Institute, Industry Ground Water Protection Initiative – Final Guidance Document, August 2007

10. "Sources of Radiation." *NRC: Sources of Radiation*. Nuclear Regulatory Commission, 2 Oct. 2017. Web. 31 Jan. 2020.

11. "NCRP Report No. 160: Ionizing Radiation Exposure of the Population of the United States." *Journal of Radiological Protection J. Radiol. Prot.* 29.3 (2009): 465. Web.

12. NEI 07-07, Nuclear Energy Institute, Industry Groundwater Protection Initiative – Final Guidance Document, Rev. 1, March 2019

13. Offsite Dose Calculation Manual, Revision 29, PVNGS Units 1, 2, and 3
    - Editorial changes made in March, 2020 to correct corrupted equations in Revision 28. No Technical changes were made.