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

10 CFR 50.4

**SUSQUEHANNA STEAM ELECTRIC STATION
ANNUAL RADIOLOGICAL ENVIRONMENTAL
OPERATING REPORT
PLA-7859**

**Docket No. 50-387
50-388**

In accordance with the Susquehanna Steam Electric Station (SSES) Units 1 and 2 Technical Specification 5.6.2, the SSES Annual Radiological Environmental Operating Report is hereby submitted for the 2019 calendar year.

There are no new or revised regulatory commitments contained in this submittal.

If you have any questions regarding this report, please contact Ms. Melisa Krick, Manager – Nuclear Regulatory Affairs, at (570) 542-1818.

A handwritten signature in black ink, appearing to read "Kevin Cimorelli".

Kevin Cimorelli

Attachment: 2019 Annual Radiological Environmental Operating Report

Copy: NRC Region I
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Ms. L. H. Micewski, NRC Sr. Resident Inspector
Mr. M. Shields, PA DEP/BRP
Mr. R. Rolph, NRC Region 1

Attachment to PLA-7859

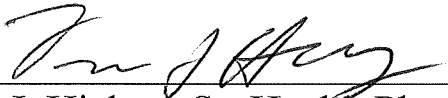
**2019 Annual Radiological Environmental
Operating Report**

**SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 and 2**

Annual Radiological
Environmental Operating Report

2019

Prepared by:



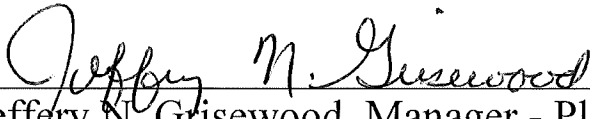
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SUSQUEHANNA STEAM ELECTRIC STATION

Units 1 & 2

2019 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

JANUARY 1 TO DECEMBER 31, 2019

Susquehanna Nuclear, LLC
Berwick, PA
April, 2020

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I. Summary

During normal operations of a nuclear power generating station there are permitted releases of small amounts of radioactive material to the environment. To monitor and determine the effects of these releases a Radiological Environmental Monitoring Program (REMP) has been established around the Susquehanna Steam Electric Station (SSES). The results of the REMP are published annually, providing a summary and interpretation of the data collected.

Applied Ecoscience, Inc. was responsible for the collection of environmental samples during 2019. Teledyne Brown Engineering (TBE) was responsible for the analysis of environmental samples during 2019. The results are discussed in this report. Landauer provided the dosimetry services for SSES during 2019.

This Annual Radiological Environmental Operating Report (AREOR) conducted for SSES covers the period January 1, 2019 through December 31, 2019. During that time period, 1330 analyses were performed on 1139 samples.

Tritium (H-3) is the only man-made radionuclide detected in the environment by the Susquehanna Steam Electric Station (SSES) Radiological Environmental Monitoring Program (REMP) that is attributable to station operations. The whole body and organ dose to members of the public attributable to tritium identified in REMP cooling tower blowdown samples was 1.67E-04 mRem. Tritium was included in the dose calculation because it was identified in the REMP samples of permitted water being discharged to the Susquehanna River. The 2019 average concentration of tritium in the cooling tower blowdown water and the 2019 average cooling tower blowdown flow were used to determine the amount of tritium released. The presumed exposure pathways to the public from this radionuclide were

drinking water taken from the Susquehanna River at Danville, PA and eating fish caught near the SSES discharge to the river. Dose from ground plane deposition (shoreline exposure) is not applicable because tritium does not emit gamma radiation and the beta radiation emitted by tritium is not sufficiently penetrating to reach an individual on the shore.

Based on the above outlined methodology, the total tritium activity released from the SSES to the Susquehanna River in 2019 was 12.4 curies.

The 2019 average dilution factor for the Susquehanna River was 1,124, based on the annual average river flow of $8.24\text{E}+06$ gpm and the annual average cooling tower blowdown flow of $7.33\text{E}+03$ gpm.

The REMP Sample Equipment Operability and year-to-year trend comparison is located in Appendix E, Table E-1.

The REMP was conducted in accordance with the SSES Technical Requirements Manual (TRM) and the respective station Offsite Dose Calculation Manual (ODCM) which are based on the design objectives in 10CFR Part 50, Appendix I, Sections IV.B.2, IV.B.3 and IV.C. The Lower Limit of Detection (LLD) values required by the TRM and SSES ODCM were achieved for the 2019 reporting period. The REMP objectives were also met during this period. The concentration of radioactive material in the environment that could be attributable to SSES operations was only a small fraction of the concentration of naturally occurring and man-made radioactivity. Since these results were comparable to the results obtained during the preoperational phase of the program and combined with historical results collected since commercial operation, it can be concluded that the levels and fluctuations were as expected and that the operation of the SSES had no significant radiological impact on the environment. Additionally, the REMP sample results for 2019 verify the adequacy of the SSES radioactive effluent control systems.

Samples of air particulates, air iodine, milk, groundwater, drinking water, vegetation, surface water, fish and sediment were collected and analyzed. External radiation dose measurements were also made in the vicinity of SSES using passive dosimeters.

Air particulate samples were analyzed for concentrations of gross beta weekly and gamma emitting nuclides quarterly. Gross beta and cosmogenically produced beryllium-7 (Be-7) were detected at levels consistent with those detected in previous years. No fission or activation products were detected.

High sensitivity iodine-131 (I-131) analyses were performed on weekly air samples. All results were less than the minimum detectable concentration.

Environmental gamma radiation measurements were performed quarterly using optically stimulated luminescent dosimeters (OSLD). The levels of radiation detected were consistent with those observed in previous years.

Cow milk samples were analyzed for concentrations of I-131 and gamma emitting nuclides. All I-131 results were below the minimum detectable concentration. Naturally occurring potassium-40 (K-40) was detected at levels consistent with those detected in previous years. No fission or activation products were detected.

Groundwater samples were analyzed for concentrations of tritium and gamma emitting nuclides. Tritium activities were detected at levels consistent with those detected in previous years. No fission or activation products were detected.

Drinking water samples were analyzed for concentrations of tritium, gross beta and gamma emitting nuclides. Gross beta activities detected were consistent with those detected in previous years. No fission or activation

products were detected.

Food product (fruits, vegetables and broadleaf vegetation) samples were analyzed for concentrations of gamma emitting nuclides. Naturally occurring Be-7 and K-40 were detected at levels consistent with those detected in previous years. No fission or activation products were detected.

Surface water samples were analyzed for concentrations of tritium and gamma emitting nuclides. Tritium activities detected were consistent with those detected in previous years. Naturally occurring thorium-228 (Th-228) was detected in one sample at a level consistent with results in previous years. No fission or activation products were detected.

Fish and shoreline sediment samples were analyzed for concentrations of gamma emitting nuclides. Naturally occurring K-40 was detected at levels consistent with those detected in previous years. Naturally occurring actinium-228 (Ac-228) and Th-228 were detected in shoreline sediment at levels consistent with results in previous years. No fission or activation products were detected in fish or sediment samples.

II. The Radiological Environmental Monitoring Program

The Susquehanna Steam Electric Station (SSES) is a nuclear electrical generating facility with two boiling-water reactors and generators located just west of the Susquehanna River, approximately 5 miles northeast of Berwick, in Luzerne County, Pennsylvania. The station was constructed in the 1970's, with Unit 1 beginning commercial operation on June 8, 1983, and Unit 2 beginning commercial operation on February 12, 1985. Units 1 and 2 each generate a net 1,350 megawatts (MWe), for a total station output of 2,700 MWe.

In total Susquehanna Nuclear, LLC presently owns 2,347 acres of land on both sides of the Susquehanna River. Generally, this land is characterized by open deciduous woodlands interspersed with grasslands.

On the west side of the river, 1,605 (1,670 minus 65 acre Gould Island) acres of land is jointly owned between Susquehanna Nuclear, LLC (90%) and Allegheny Electric Cooperative (10%). The land use on the west side of the river includes generation and associated maintenance facilities, laydown areas, parking lots, roads, a nature preserve (the Susquehanna Riverlands), and agricultural leases to local farmers.

To the north of the station along the river, Susquehanna Nuclear, LLC owns 100% of the 65-acre Gould Island. On the east side of the river, and across the river from the station, Susquehanna Nuclear, LLC is the 100% owner of 677 acres that are maintained as undeveloped land, natural recreational areas, wildlife areas, and leases to local farmers.

More specific information on the demography, hydrology, meteorology, and land use characteristics of the area in the vicinity of the SSES can be found in the Environmental Report [Reference 1], the Final Safety Analysis Report

[Reference 2] and the Final Environmental Statement [Reference 3] for the SSES.

Radioanalytical data from samples collected under the REMP were compared with results from the preoperational phase and historical results during operations. Differences between these periods were examined statistically to determine the effects of station operations. This report presents the results from January 1 through December 31, 2019, for the SSES Radiological Environmental Monitoring Program (REMP).

A. Objectives of the Operational REMP

The objectives of the Operational REMP are to:

1. Document compliance with SSES REMP Technical Requirements and radiological environmental surveillances.
2. Verify proper implementation of SSES radiological effluent controls.
3. Identify, measure and evaluate trends of radionuclide concentrations in environmental pathways near SSES.
4. Assess impact of SSES Effluents on the Environment and the public.
5. Verify that SSES operations have no detrimental effects on the health and safety of the public or on the environment.

B. Implementation of the Objectives

1. In order to meet the objectives, an operational REMP was developed. Samples of various media were selected for monitoring due to the radiological dose impact to humans and other organisms. The selection of samples was based on:

- (a) Established critical pathways for the transfer of radionuclides through the environment to man, and
 - (b) Experience gained during the preoperational phase. Sampling locations were determined based on site meteorology, Susquehanna River hydrology, local demography, and land uses.
2. Sampling locations were divided into two classes, indicator and control. Indicator locations were sited where it is expected that radiation and radioactive material that might originate from the station would be detectable. Control locations were selected in areas where they would be unaffected by station operations (i.e. Susquehanna River upstream from the station, >10 miles from the station in least prevalent wind directions). Fluctuations in the levels of radionuclides and direct radiation at indicator locations were evaluated with respect to analogous fluctuations at control locations. Indicator and control location data were also evaluated relative to preoperational data.
 3. Appendix A, Program Summary, describes and summarizes the analytical results in accordance with the SSES Technical Specifications.
 4. Appendix B, Sample Designation and Locations, describes the coding system which identifies sample type and location. Table B-1 lists the location codes, locations, latitude, longitude, and the types of samples collected at each location. Table B-2 contains sample medium, analysis and sampling details.

5. The sampling locations are indicated on the following maps:

Map B-1, Direct Radiation Monitoring Locations Within One Mile

Map B-2, Direct Radiation Monitoring Locations From One to Five Miles

Map B-3, Direct Radiation Monitoring Locations Greater Than Five Miles

Map B-4, Environmental Sampling Locations Within One Mile

Map B-5, Environmental Sampling Locations From One to Five Miles

Map B-6, Environmental Sampling Locations Greater Than Five Miles

III. Program Description

A. Data Interpretation

Results of analyses are grouped according to sample type and presented in Appendix C, Data Tables. All results above the Lower Limit of Detection (LLD) are at a confidence level of ± 2 sigma. This represents the range of values into which 95% of repeated analyses of the same sample should fall. As defined in U.S. Nuclear Regulatory Commission Regulatory Guide 4.8, LLD is the smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability, with only 5% probability of falsely concluding that a blank observation represents a "real signal." LLD is normally calculated as 4.66 times the standard deviation of the background counting rate, or of the blank sample count, as appropriate, divided by counting efficiency, sample size, 2.22 (dpm per picocurie), the radiochemical yield when applicable, the radioactive decay constant and the elapsed time

between sample collection and time of counting. LLD represents the capability of the measurement system.

The Minimum Detectable Concentration (MDC) is defined as the smallest concentration of radioactive material that can be detected at a given confidence level. The MDC differs from the LLD in that the MDC takes into consideration the interference caused by the presence of other nuclides while the LLD does not. MDC is an indicator of the performance of the measurement system. The MDC is set to be below the LLD.

Summaries of the radionuclide average picocurie activities and ranges are included in Table A. If a radionuclide was not detected, zero was used for that isotope in dose calculations and the activity is listed as “<MDC” (less than the minimum detectable concentration) in Table A. <MDC indicates that no activity was positively detected in any sample when samples were analyzed with techniques which achieved the required Lower Limits of Detection (LLD). The following are typical measurement laboratory MDCs for airborne and waterborne REMP samples.

Airborne REMP Typical MDCs

<u>Radionuclide</u>	<u>MDC (pCi/cu.m.)</u>
Mn-54	1.2 E-03
Fe-59	7.5 E-03
Co-58	1.9 E-03
Co-60	1.3 E-03
Zn-65	3.0 E-03
Cs-134	1.2 E-03
Cs-137	1.0 E-03
I-131	3.7 E-01

Waterborne REMP Typical MDCs

<u>Radionuclide</u>	<u>MDC (pCi/L.)</u>
H-3 (DIST)	1.4 E+02
Mn-54	3.7 E+00
Fe-59	1.1 E+01
Co-58	3.8 E+00
Co-60	4.0 E+00
Zn-65	7.8 E+00
Cs-134	3.6 E+00
Cs-137	3.9 E+00
I-131	1.1 E+01
H-3	1.4 E+02
Gross Beta	1.9 E+00

The grouped data were averaged and standard deviations calculated. Thus, the ± 2 sigma of the averaged data represent sample and not analytical variability. For reporting and calculation of averages, any result occurring at or below the LLD is considered to be at the LLD level.

B. Program Exceptions

See Exceptions Table 2019 REMP Atypical Sampling Occurrences

C. Program Changes

There were no program changes in 2019.

Exceptions Table

2019 REMP Atypical Sampling Occurrences

Date	Sample Type	Location Code(s)	Sample Period Reason for Occurrence(s)	Corrective Action
JAN	Air	10S3	01/09/19 to 01/16/19 Timer box failed to advance for sample period. Timer box malfunction did not affect normal sample collection. Continuous sampling during sample period.	CA #19-02 CR 2019-00772 01/16/19: Timer box was reset and monitored to ensure advancement. 01/16/19: Operability verified @ 0938 hours. <i>Ideal sample collected for sample period: 23,100 cf.</i>
	Air	12S1	01/16/19 to 01/23/19 (loss of 1.4 hours) 12kV power outage occurred @ 1511 hours on 01/17/19. Loss of 1.4 hours as determined by timer box. Non-continuous sampler operation.	CA #19-03 CR 2019-00850 01/17/19: No action required. Air monitor resumed normal operation when power was restored. 01/18/19: Operability verified @ 0840 hours. <i>Ideal sample collected for sample period: 23,400 cf.</i>
MAR	Air	9B1	03/06/19 to 03/13/19 (loss of 0.5 hours) Power outage date and time unknown. Loss of 0.5 hours as determined by timer box during weekly collection. Non-continuous sampler operation.	CA #19-04 CR 2019-03341 03/13/19: No action required. Air monitor resumed normal operation when power was restored. 03/13/19: Operability verified @ 1153 hours. <i>Ideal sample collected for sample period: 21,200 cf.</i>

Exceptions Table (continued)

Date	Sample Type	Location Code(s)	Sample Period Reason for Occurrence(s)	Corrective Action
APR	Air	10S3	<p>04/10/19 to 04/17/19 (loss of 55.7 hours) Air monitor was not operational upon arrival or departure on 04/17/19 due to local power outage. Power outage began on 04/15/19 @ 0120 hours as determined by timer box.</p> <p>Non-continuous sampler operation.</p>	<p>CA #19-05 CR 2019-05462 04/17/19: Power restored @1142 hours and air monitor resumed normal operation. 04/17/19: Operability verified @ 1306 hours</p> <p><i>Less than ideal sample collected for sample period: 14,800 cf (04/10/19 to 04/17/19).</i></p> <p><i>Volume adequate to support required analysis.</i></p>
	Air	8G1	<p>04/10/19 to 04/17/19 (loss of 0.5 hours) Power outage due to downed pole maintenance. Loss of 0.5 hours as determined by timer box during weekly collection, and notification from PPL System Facilities Center.</p> <p>Non-continuous sampler operation.</p>	<p>CA #19-06 CR 2019-05464 04/17/19: No action required. Air monitor resumed normal operation when power was restored. 04/17/19: Operability verified @ 1100 hours.</p> <p><i>Ideal sample collected for sample period: 22,100 cf.</i></p>
	Air	10S3	<p>04/17/19 to 04/24/19 (loss of 10.6 hours) Power outage date and time unknown. Loss of 10.6 hours as determined by timer box during weekly collection.</p> <p>Non-continuous sampler operation.</p>	<p>CA #19-07 CR 2019-05858 04/24/19: No action required. Air monitor resumed normal operation when power was restored. 04/24/19: Operability verified @ 1127 hours.</p> <p><i>Ideal sample collected for sample period: 20,200 cf.</i></p>

Exceptions Table (continued)

Date	Sample Type	Location Code(s)	Sample Period Reason for Occurrence(s)	Corrective Action
MAY	Air	13S6	05/01/19 to 05/08/19 (loss of 5.2 hours) Power outage date and time unknown. Loss of 5.2 hours as determined by timer box during weekly collection. Non-continuous sampler operation.	CA #19-08 CR 2019-06501 05/08/19: No action required. Air monitor resumed normal operation when power was restored. 05/08/19: Operability verified @ 0828 hours. <i>Ideal sample collected for sample period: 21,000 cf.</i>
JUN	Surface Water	2S7	06/10/19 to 08/27/19 (week 2 June-week 4 August) CTBD auto composite sampling switched to weekly grab sampling due to line unavailability. Composite sampling turned off 06/10/19 @ 0933 hours. Line work completed under PCWO 2168089.	CA #19-09 CR 2019-07896 & CR 2019-07882 08/27/19: Line work completed and flow restored to auto composite sampler. 08/27/19: Operability verified @ 1032 hours. <i>Grab samples collected for sample periods.</i>
JUN	Air	12S1	06/05/19 to 06/12/19 (loss of 0.2 hours) 12kV power outage occurred on 06/10/19. Repair work to the 12kV line caused an additional power outage on 06/11/19. Loss of 0.2 hours total as determined by timer box. Non-continuous sampler operation.	CA #19-10 CR 2019-07921 06/10/19 & 06/11/19: No action required. Air monitor resumed normal operation when power was restored. 06/11/19: Operability verified @ 0821 hours and @ 1400 hours. <i>Ideal sample collected for sample period: 21,600 cf.</i>

Exceptions Table (continued)

Date	Sample Type	Location Code(s)	Sample Period Reason for Occurrence(s)	Corrective Action
JUL	Drinking Water	12H2	<p>06/25/19 to 07/02/19 (week 1 July) Contractor replacing chlorine lines @ Danville Water Company shut off valve to automatic composite sampler (ACS) on 06/26/19 (time unknown). Early stop for week 1 July composite.</p> <p>Non-continuous sampler operation.</p>	<p>CA #19-11 CR 2019-08837 07/02/19: Flow restored to ACS @ 0720 hours. 07/02/19: Operability verified @ 0721 hours. 07/02/19: Grab sample collected @ 1238 hours, as per procedure. Valve to ACS tagged directing that Applied Ecoscience is to be notified immediately of any changes to valve or sampler.</p> <p><i>Less than ideal sample volume collected for sample period. Grab sample collected.</i></p>
	Air	12S1	<p>07/17/19 to 07/24/19 (momentary losses of 12kV power) Momentary losses of power on 07/17/19 @ 1653 hours & 07/21/19 @ 1934 hours. No loss of sampling time as determined by timer box during weekly collection.</p> <p>Non-continuous sampler operation.</p>	<p>CA #19-12 CR 2019-09436, 2019-09438, & 2019-09544 07/17/19 & 07/21/19: No action required. Air monitor resumed normal operation when power was restored. 07/18/19: Operability verified @ 0903 hours. 07/22/19: Operability verified @ 0856 hours.</p> <p><i>Ideal sample collected for sample period: 21,100 cf.</i></p>
AUG	Air	12S1	<p>08/07/19 to 08/14/19 (momentary loss of 12kV power) Momentary loss of power on 08/11/19. No loss of sampling time as determined by timer box during weekly collection.</p> <p>Non-continuous sampler operation.</p>	<p>CA #19-13 CR 2019-10348 08/11/19: No action required. Air monitor resumed normal operation when power was restored. 08/11/19: Operability verified @ 1502 hours.</p> <p><i>Ideal sample collected for sample period: 21,800 cf.</i></p>

Exceptions Table (continued)

Date	Sample Type	Location Code(s)	Sample Period Reason for Occurrence(s)	Corrective Action
AUG (cont.)	Air	12S1	<p>08/14/19 to 08/21/19 (loss of 0.5 hours) 12kV power outages occurred on 08/16/19 due to maintenance on the 12kV line from approximately 08:10-08:30 and 12:31-12:49. Loss of 0.5 hours total as determined by timer box and known outage times.</p> <p>Non-continuous sampler operation.</p>	<p>CA #19-14 CR 2019-10587 08/16/19: No action required. Air monitor resumed normal operation when power was restored. 08/16/19: Operability verified @ 1140 hours & 1343 hours.</p> <p><i>Ideal sample collected for sample period: 21,300 cf.</i></p>
	Air	10S3	<p>08/14/19 to 08/21/19 (loss of 2.0 hours) Power outage date and time unknown. Loss of 2.0 hours as determined by timer box during weekly collection.</p> <p>Non-continuous sampler operation.</p>	<p>CA #19-15 CR 2019-10773 08/21/19: No action required. Air monitor resumed normal operation when power was restored. 08/21/19: Operability verified @ 0825 hours.</p> <p><i>Ideal sample collected for sample period: 20,700 cf.</i></p>
	Air	12S1	<p>08/28/19 to 09/04/19 (loss of 9.1 hours) 12kV power outage occurred on 08/31/19 due to maintenance on the 12kV line. Loss of 9.1 hours total as determined by timer box.</p> <p>Non-continuous sampler operation.</p>	<p>CA #19-16 CR 2019-11016 08/31/19: No action required. Air monitor resumed normal operation when power was restored. 08/31/19: Operability verified @ 1743 hours.</p> <p><i>Ideal sample collected for sample period: 20,700 cf.</i></p>

Exceptions Table (continued)

Date	Sample Type	Location Code(s)	Sample Period Reason for Occurrence(s)	Corrective Action
OCT	Air	12S1	10/02/19 to 10/09/19 (momentary loss of 12kV power) Momentary loss of power on 10/02/19. No loss of sampling time as determined by timer box during weekly collection. Non-continuous sampler operation.	CA #19-17 CR 2019-12465 10/02/19: No action required. Air monitor resumed normal operation when power was restored. 10/03/19: Operability verified @ 0856 hours. <i>Ideal sample collected for sample period: 22,500 cf.</i>
	Air	12S1	10/23/19 to 10/30/19 (loss of 0.7 hours) 12kV power outage occurred on 10/25/19 due to maintenance on the 12kV line. Loss of 0.7 hours total as determined by timer box. Non-continuous sampler operation.	CA #19-18 CR 2019-13468 10/25/19: No action required. Air monitor resumed normal operation when power was restored. 10/25/19: Operability verified @ 1645 hours. <i>Ideal sample collected for sample period: 22,600 cf.</i>
NOV	Surface Water	6S6	10/29/19 to 11/05/19 (week 1 November composite) Diminished sample flow (<0.5 gpm) at ACS as discovered during weekly collection.	CA #19-19 CR 2019-14030 11/05/19: Adequate sample volume collected during sample period. Maintenance requested. 11/06/19: Maintenance performed by I&C and sample flow restored to 1.5 gpm. 11/12/19: Operability verified @ 1111 hours. <i>Ideal sample collected for sample periods.</i>

D. Quality Assurance Program

Teledyne Brown Engineering

The quality of the results obtained by TBE is ensured by the implementation of the Quality Assurance Program as described in the Teledyne Brown Engineering Quality Assurance Manual and the Teledyne Brown Engineering Procedure Manual.

E. Summary of Results – Inter-Laboratory Comparison Program

The TBE Laboratory analyzed Performance Evaluation (PE) samples of air particulate, air iodine, milk, soil, vegetation, and water matrices for various analytes. The PE samples supplied by Analytics Inc., Environmental Resource Associates (ERA) and Department of Energy (DOE) Mixed Analyte Performance Evaluation Program (MAPEP), were evaluated against the following pre-set acceptance criteria:

1. Analytics Evaluation Criteria

Analytics' evaluation report provides a ratio of TBE's result and Analytics' known value. Since flag values are not assigned by Analytics, TBE evaluates the reported ratios based on internal QC requirements based on the DOE MAPEP criteria.

2. ERA Evaluation Criteria

ERA's evaluation report provides an acceptance range for control and warning limits with associated flag values. ERA's acceptance limits are established per the USEPA, National Environmental Laboratory Accreditation Conference (NELAC), state-specific Performance Testing (PT) program requirements or ERA's SOP for

the Generation of Performance Acceptance Limits, as applicable. The acceptance limits are either determined by a regression equation specific to each analyte or a fixed percentage limit promulgated under the appropriate regulatory document.

3. DOE Evaluation Criteria

MAPEP's evaluation report provides an acceptance range with associated flag values. MAPEP defines three levels of performance:

- Acceptable (flag = "A") - result within $\pm 20\%$ of the reference value
- Acceptable with Warning (flag = "W") - result falls in the $\pm 20\%$ to $\pm 30\%$ of the reference value
- Not Acceptable (flag = "N") – bias is greater than 30% of the reference value

Note: The Department of Energy (DOE) Mixed Analyte Performance Evaluation Program (MAPEP) samples are created to mimic conditions found at DOE sites which do not resemble typical environmental samples obtained at commercial nuclear power facilities.

Teledyne Brown Engineering

For the TBE laboratory, 119 out of 129 analyses performed met the specified acceptance criteria. Ten analyses did not meet the specified acceptance criteria for the following reasons and were addressed through the TBE Corrective Action Program.

1. The ERA April 2019 water Cs-134 result was evaluated as Not Acceptable. The reported value was 15.2 pCi/L (error 2.82 pCi/L) and the known result was 12.1 pCi/L (acceptance range

of 8.39 - 14.4 pCi/L). With the error, the reported result overlaps the acceptable range. This sample was run as the workgroup duplicate on a different detector with a result of 10.7 pCi/L (within acceptable range). (NCR 19-10)

2. The ERA April 2019 water Sr-89 result was evaluated as Not Acceptable. The reported value was 44.9 pCi/L and the known result was 33.3 pCi/L (acceptance range of 24.5 - 40.1 pCi/L). The sample was only counted for 15 minutes instead of 200 minutes. The sample was re-prepped in duplicate and counted for 200 minutes with results of 30.7 ± 5.37 pCi/L and 33.0 ± 8.71 pCi/L. This was the 1st "high" failure for Sr-89 in 5 years. (NCR 19-11)
3. The MAPEP February 2019 soil Sr-90 result was not submitted and therefore evaluated as Not Acceptable. The sample was run in duplicate, with results of -1.32 ± 4.09 Bq/kg (<6.87) and -1.030 ± 3.55 Bq/kg (<5.97). The known result was a false positive test (no significant activity). TBE did not submit a result because it appeared that the results may not be accurate. TBE analyzed a substitute soil Sr-90 sample from another vendor, with a result within the acceptable range. (NCR 19-12)
4. The MAPEP February 2019 water Am-241 result was evaluated as Not Acceptable. The reported value was 0.764 ± 0.00725 Bq/L with a known result of 0.582 Bq/L (acceptable range 0.407 - 0.757 Bq/L). TBE's result falls within the upper acceptable range with the error. It appeared that a non-radiological interference was added and lead to an increased mass and higher result. (NCR 19-13)

5. The MAPEP February 2019 vegetation Sr-90 result was evaluated as Not Acceptable. The reported result was -0.1060 ± 0.0328 Bq/kg and the known result was a false positive test (no significant activity). TBE's result was correct in that there was no activity. MAPEP's evaluation was a "statistical failure" at 3 standard deviations. (NCR 19-14)
6. The ERA October 2019 water Gross Alpha result was evaluated as Not Acceptable. TBE's reported result was 40.5 ± 10.3 pCi/L and the known result was 27.6 pCi/L (ratio of TBE to known result at 135%). With the associated error, the result falls within the acceptable range (14.0 - 36.3 pCi/L). The sample was run as the workgroup duplicate on a different detector with a result of 30.8 ± 9.17 pCi/L (within the acceptable range). This was the first failure for drinking water Gr-A since 2012. (NCR 19-23)
7. The ERA October 2019 water Sr-90 result was evaluated as Not Acceptable. TBE's reported result was 32.5 ± 2.12 pCi/L and the known result was 26.5 pCi/L (ratio of TBE to known result at 123%). With the associated error, the result falls within the acceptable range (19.2 - 30.9 pCi/L). The sample was run as the workgroup duplicate on a different detector with a result of 20.0 ± 1.91 pCi/L (within the acceptable range). Both TBE results are within internal QC limits. A substitute "quick response" sample was analyzed with an acceptable result of 20.1 pCi/L (known range of 13.2 - 22.1 pCi/L). (NCR 19-24)
8. The MAPEP August 2019 soil Ni-63 result of 436 ± 22.8 Bq/kg was evaluated as Not Acceptable. The known result was 629 Bq/kg (acceptable range 440 - 818 Bq/kg). With the associated error, the TBE result falls within the lower acceptance range.

All associated QC was acceptable. No reason for failure could be found. This is the first failure for soil Ni-63 since 2012. (NCR 19-25).

9. The MAPEP August 2019 water Am-241 result was not reported and therefore evaluated as Not Acceptable. Initial review of the results showed a large peak where Am-241 should be (same as the February, 2019 sample results). It is believed that Th-228 was intentionally added as an interference. The sample was re-prepped and analyzed using a smaller sample aliquot. The unusual large peak (Th-228) was seen again and also this time a smaller peak (Am-241). The result was 436 ± 22.8 Bq/L (acceptable range 0.365 ± 0.679 Bq/L). Th-228 is not a typical nuclide requested by clients, so there is no analytical purpose to take samples through an additional separation step. TBE will pursue using another vendor for Am-241 water cross-checks that more closely reflects actual customer samples. (NCR 19-26)
10. The Analytics September 2019 soil Cr-51 sample was evaluated as Not Acceptable. TBE's reported result of 0.765 ± 0.135 pCi/g exceeded the upper acceptance range (140% of the known result of 0.547 pCi/g). The TBE result was within the acceptable range (0.63 - 0.90 pCi/g) with the associated error. The Cr-51 result is very close to TBE's normal detection limit. In order to get a reportable result, the sample must be counted for 15 hours (10x longer than client samples). There is no client or regulatory requirement for this nuclide and TBE will remove Cr-51 from the reported gamma nuclides going forward. (NCR 19-27)

The Inter-Laboratory Comparison Program provides evidence of “in control” counting systems and methods, and that the laboratories are producing accurate and reliable data.

IV. Results and Discussion

The analytical results of the 2019 REMP samples are divided into categories based on exposure pathways: atmospheric, direct radiation, terrestrial, and aquatic. The analytical results for the 2019 REMP are summarized in Appendix A, Program Summary. The data for individual samples are presented in Appendix C, Data Tables. The data are compared to the formal preoperational environmental monitoring program data (April 1972 to September 1982) and to data during operations. The data collected demonstrates that the SSES REMP was conducted in compliance with the TRM and the SSES ODCM.

A. Atmospheric

Atmospheric REMP sampling included the collection of air particulates, air iodine and direct radiation samples.

1. Air Particulates

Air particulate samples were collected weekly at six indicator locations (3S2, 9B1, 10S3, 12E1, 12S1 and 13S6) and one control locations (8G1). Each of the samples collected for the year were analyzed for gross beta. Quarterly composites of the weekly samples from each location were analyzed for specific gamma emitters.

Gross Beta

Gross beta activity was detected in 312 of 312 of the indicator location samples at concentrations ranging from 7 to 24 E-3 pCi/m³ with an average concentration of 13 E-3 pCi/m³, and in 52 of 52 of the control location samples at concentrations ranging from 6 to 21 E-3 pCi/m³ with an average of 12 E-3 pCi/m³. The maximum preoperational level detected was 102 E-3 pCi/m³ with an average concentration of 62 E-3 pCi/m³. (Table C-1, Appendix C); Historical levels of gross beta are shown in Figure C-1. Results for gross beta analysis from 1974 to current year are plotted.

Gamma Spectrometry

Gamma spectrometry was performed on each of the 28 quarterly composite samples. Beryllium-7, attributed to cosmic ray activity in the atmosphere, was detected in all 24 indicator location composites at concentrations ranging from 77 E-3 to 160 E-3 pCi/m³ with an average concentration of 114 E-3 pCi/m³, and in the four control location composites ranging in concentration from 93 to 118 E-3 pCi/m³ with an average concentration of 108 E-3 pCi/m³.

The maximum preoperational level detected was 85 E-3 pCi/m³ with an average concentration of 74 E-3 pCi/m³. (Table C-2, Appendix C)

All other gamma emitters were less than the LLD.

2. Air Iodine

Filtered air iodine samples were collected weekly at six

indicator locations (3S2, 9B1, 10S3, 12E1, 12S1, and 13S6) and one control locations (8G1). Each of the samples collected for the year were analyzed for I-131.

Iodine-131

Iodine-131 was not detected in any indicator location samples or control location samples. Preoperational data is not available for comparison. (Table C–3, Appendix C)

B. Direct Radiation

Ambient radiation levels in the environs were measured with a pair of optically stimulated luminescent dosimeters (OSLD) composed of aluminum oxide crystals supplied and processed by Landauer. Packets containing OSLDs for quarterly exposure were placed in the owner-controlled area and around the site at various distances and in each land-based meteorological sector. Emphasis was placed on special interest areas such as population centers, nearby residences, and schools.

A total of 57 locations were monitored for direct radiation during 2019, including 32 site boundary locations, 14 outer distant locations, six special interest locations and five control locations.

The indicator locations annual average dose rate was 16.8 milliroentgen per standard quarter. The annual average dose rate for the control locations was 14.9 milliroentgen per standard quarter. The preoperational average for the quarterly direct radiation readings was 17.6 milliroentgen per standard quarter. The results of the direct radiation measurements for 2019 confirmed that the radiation levels in the vicinity of the SSES were similar to previous years. (Table C–4, Appendix C); Figure C-2 – Ambient Radiation Levels Based on

Environmental Dosimetry Data from 1973 to current year are plotted as quarterly averages.

C. Terrestrial

Terrestrial REMP sampling included the collection of milk, groundwater, drinking water, and vegetation.

1. Milk

Milk samples were collected biweekly when cows were on pasture and monthly when cows were not grazing on pasture. Animals are considered on pasture from April to October of each year. Samples were collected in new polyethylene containers and transported in ice chests with preservatives added to the milk.

Milk samples were collected at local dairy farms from 2 indicator locations (5E2 and 13E3) and one control location (10G1). Each sample was analyzed for I-131 and gamma emitters.

Iodine-131

Iodine-131 was not detected above minimum detectable concentration in any of the 60 samples analyzed.

Preoperational data is not available for comparison. (Table C-5, Appendix C); Figure C-3 – Iodine-131 Activity in Milk results from 1976 to 2019 are plotted.

Gamma Spectrometry

Naturally occurring K-40 was detected in all 60 samples with concentrations for the 40 indicator location samples ranging

from 1,042 to 1,504 pCi/L with an average concentration of 1,277 pCi/L, and the 20 control location sample concentrations ranging from 1,080 to 1,463 pCi/L with an average concentration of 1,330 pCi/L. The maximum preoperational level detected was 1,500 pCi/L with an average concentration of 1,358 pCi/L.

All other gamma emitters were less than the LLD.

2. Groundwater

An expanded groundwater monitoring network was initiated in 2006 for the SSES as part of a site-wide hydrogeological investigation in accordance with the Nuclear Energy Institute (NEI) Groundwater Protection Initiative (GPI). The additional groundwater monitoring wells are sampled as part of the Radiological Environmental Monitoring Program (REMP) to regularly assess groundwater quality and provide early detection of any inadvertent leaks or spills of radioactive materials that could reach groundwater. Groundwater is sampled quarterly and analyzed for H-3 and gamma activity. Additionally, precipitation sampling was initiated in 2007 and analyzed for H-3 activity to assess the influence of station airborne H-3 emissions on groundwater H-3 activities.

Precipitation washout monitoring data is not used in dose calculations; however, the data does give a gross indication of H-3 which makes its way into surface water and soil where it eventually seeps into shallow groundwater. The annual average H-3 concentrations in precipitation, groundwater monitoring wells and surface water are summarized in Table C-7 and graphically depicted in Figure C-4 - Annual Average

Tritium Activity (pCi/L) in Precipitation and Surface Water Versus Groundwater.

Groundwater samples were collected quarterly at 9 indicator locations (1S3, 4S8, 4S9, 8S4, 7S10, 2S8, 6S11A, 6S12 and 7S11) and one control station (13S7). Each sample was analyzed for H-3 and gamma emitters.

Tritium

Tritium activity was detected above the minimum detectable concentration in 12 of the 36 indicator location samples with concentrations ranging from 154 to 343 pCi/L with an average concentration of 209 pCi/L. Two of the four control location samples had tritium activity above the minimum detectable concentration with a range of 150 to 177 pCi/L and a concentration of 164 pCi/L. The maximum preoperational level detected was 119 pCi/L. (Table C-6, Appendix C); Figure C-4 – Annual Average Tritium Activity (pCi/L) in Precipitation and Surface Water Versus Groundwater results from 2007 to 2019 are plotted.

Gamma Spectrometry

Naturally occurring K-40 was not detected in any of the indicator or control samples. Preoperational data is not available for comparison. (Table C-6, Appendix C)

All other gamma emitters were less than the LLD.

3. Drinking Water

Drinking water samples were collected monthly from one location (12H2). Each sample was analyzed for gross beta, H-3 and gamma emitters.

Gross Beta

Gross beta activity was detected in five of the 13 drinking water samples. Sample concentrations ranged from 2.4 to 2.8 pCi/L with an average concentration of 2.6 pCi/L. The maximum preoperational level detected was 2.8 pCi/L with an average concentration of 1.8 pCi/L. (Table C-8, Appendix C); Figure C-5 – Gross Beta Activity in Drinking Water results from 1977 to 2019 are plotted.

Tritium

Tritium activity was not detected in any of the samples. The maximum preoperational level detected was 194 pCi/L with an average of 132 pCi/L. (Table C-8, Appendix C)

Gamma Spectrometry

Naturally occurring K-40 was not detected in any of the samples. Preoperational data is not available for comparison. (Table C-8, Appendix C)

All other gamma emitters were less than the LLD.

4. Food Products

Food products from two indicator locations (11D1 and 11S6) were collected throughout the growing season. All samples (fruit, vegetable, and broadleaf) were analyzed for gamma

emitters and included soy beans, field corn, pumpkin, swiss chard and collards.

Gamma Spectrometry

Naturally occurring Be-7, attributed to cosmic ray activity in the atmosphere, was detected in four of the 13 indicator location samples with concentrations ranging from 352 to 958 pCi/kg wet with an average concentration of 594 pCi/kg wet. Preoperational data is not available for comparison.

Naturally occurring K-40 was detected in all 13 indicator location samples with concentrations ranging from 2,857 to 17,410 pCi/kg wet with an average concentration of 5,325 pCi/kg wet. The maximum preoperational level detected was 4,800 pCi/kg wet with an average concentration of 2,140 pCi/kg wet.

Naturally occurring Ac-228 was not detected in any of the indicator or control locations. Preoperational data is not available for comparison.

Naturally occurring Th-228 was not detected in any of the indicator or control locations. Preoperational data is not available for comparison. (Table C-9, Appendix C)

All other gamma emitters were less than the LLD.

D. Aquatic

Aquatic samples include surface water, fish and sediment samples.

1. Surface Water

Surface water samples were collected routinely at two indicator locations (6S5 and 2S7) and one control location (6S6). Each sample was analyzed for H-3 and gamma emitters.

Tritium

Tritium activity was detected in 12 of 25 indicator location samples with concentrations ranging from 164 to 3,660 pCi/L with an average concentration of 847 pCi/L. The range of H-3 levels in surface water are biased high due to inclusion of samples from the cooling tower blowdown line (CTBD; location 2S7). Routine station operation includes infrequent batch releases of slightly radioactive water which are discharged into the CTBD. When the H-3 concentration from CTBD samples is averaged with those obtained from Susquehanna River downstream monitoring locations, the result is an overall indicator location average that is higher than the actual average H-3 levels of the downstream river water. No radioactivity attributable to station operations was identified above analysis detection levels in any samples from the Susquehanna River in 2019. Tritium was not detected in any of the control location samples. The maximum preoperational level detected was 319 pCi/L, with an average concentration of 140 pCi/L. (Table C-10, Appendix C) Figure C-6 – Tritium Activity in Surface Water, results from 1972 to 2019 are plotted.

Gamma Spectrometry

Naturally occurring K-40 was not detected in any of the indicator location or control location samples. Preoperational data is not available for comparison.

Iodine-131 was not detected in any of the indicator or control samples. The maximum preoperational level detected was 0.43 pCi/L, with an average concentration of 0.33 pCi/L. (Table C-10, Appendix C)

Naturally occurring Th-228 was detected in one indicator location sample with an average concentration of 8.0 pCi/L. Preoperational data is not available for comparison. (Table C-10, Appendix C)

All other gamma emitters were less than the LLD.

2. Fish

Edible species of fish were collected in the spring and fall of 2019 at two indicator locations (IND [Susquehanna River] and LTAW (only collected in the fall)) and one control location (2H [Susquehanna River]). Each sample was analyzed for gamma emitters.

Gamma Spectrometry

Naturally occurring K-40 was detected in all indicator location samples at concentrations ranging from 3,354 to 4,393 pCi/kg wet with an average concentration of 3,946 pCi/kg wet, and in all control location samples at concentrations ranging from 2,889 to 4,485 pCi/kg wet with an average concentration of 3,681 pCi/kg wet. The maximum preoperational level detected

was 3,600 pCi/kg dry with an average concentration of 3,871 pCi/kg dry. (Table C-11, Appendix C)

All other gamma emitters were less than the LLD.

3. Shoreline Sediment

Sediment samples were collected from the Susquehanna River in the spring and fall at two indicator locations (7B and 12F) and one control location (2B). Each sample was analyzed for gamma emitters.

Gamma Spectroscopy

Naturally occurring K-40 was detected in all four of the indicator location samples at concentrations ranging from 8,495 to 13,510 pCi/kg dry with an average concentration of 10,939 pCi/kg dry, and in all of the control location samples with concentrations ranging from 12,590 to 16,100 pCi/kg dry with an average concentration of 14,345 pCi/kg dry. The maximum preoperational level detected was 11,000 pCi/kg dry with an average concentration of 8,500 pCi/kg dry.

Cesium-137 was not detected in any of the indicator or control location samples. The maximum preoperational level detected was 210 pCi/kg dry with an average concentration of 110 pCi/kg dry.

Naturally occurring Ra-226 was not detected in any of the indicator or control location samples. The maximum preoperational level detected was 1,900 pCi/kg dry with an average concentration of 700 pCi/kg dry.

Naturally occurring Ac-228 was detected in all four indicator location samples at concentrations ranging from 870 to 1,305 pCi/kg dry with an average concentration of 1,035 pCi/kg dry, and in both of the control location samples at concentrations ranging from 1,119 to 1,438 pCi/kg dry with an average concentration of 1,279 pCi/kg dry. Preoperational data is not available for comparison. (Table C-12, Appendix C)

Naturally occurring Th-228 was detected in all of the four indicator location samples at concentrations ranging from 953 to 1,111 pCi/kg dry with an average concentration of 1,020 pCi/kg dry, and in both of the control location samples at concentrations ranging from 1,107 and 1,143 pCi/kg dry with an average concentration of 1,125 pCi/kg dry. The maximum preoperational level detected was 3,200 pCi/kg dry with an average concentration of 1,300 pCi/kg dry.

All other gamma emitters were less than the LLD.

E. Land Use Census

SYNOPSIS OF 2019 LAND USE CENSUS

Applied Ecoscience, Inc. conducted a Land Use Census during the 2019 growing season around SSES to comply with the ODCM. The purpose of the survey was to document the nearest milk animal, residence and garden greater than 50 m² (approximately 500 ft²) producing broad leaf vegetation within a distance of 8 km (approximately 5 miles) in each of the 16 meteorological sectors surrounding the SSES.

Distance in Miles from the SUSQUEHANNA NUCLEAR Reactor Buildings				
Meteorological Sector		Nearest Residence Sept, 2019 miles	Nearest Garden Sept, 2019 miles	Nearest Dairy Farm Sept, 2019 miles
1	N	1.3	3.2	>5.0
2	NNE	1.0	2.3 ^{a,c,e}	>5.0
3	NE	0.9	2.7	>5.0
4	ENE	2.1	2.4 ^{a,c}	>5.0
5	E	1.4	4.9	4.5 ^d
6	ESE	0.5	3.1	>5.0
7	SE	0.6	0.6	>5.0
8	SSE	0.7	2.9	>5.0
9	S	1.0	3.5	>5.0
10	SSW	0.9	1.3 ^{a,c}	>5.0 ^d
11	SW	1.5	1.9	>5.0
12	WSW	1.3	1.3	1.7
13	W	1.2	3.2	5.0
14	WNW	1.1	1.9	>5.0
15	NW	0.8	2.3 ^{a,c}	>5.0
16	NNW	0.7	4.0	>5.0

- a Chickens raised for consumption at this location
- b Ducks raised for consumption at this location
- c Eggs consumed from chickens at this location
- d Fruits/vegetables raised for consumption at this location
- e Beef cattle raised for consumption at this location
- f Rabbits raised for consumption at this location.

The 2019 Land Use Census results are summarized in the above table.

V. Annotations to Previous AREOR

There are no annotations to the previous AREOR.

VI. Conclusions

The Radiological Environmental Monitoring Program for SSES was conducted during 2019 in accordance with the SSES TRM and ODCM. The LLD values required by the TRM and ODCM were achieved for this reporting period (See Appendix A and Appendix C). The objectives of the program were also met during this period. The data collected assists in demonstrating that SSES was operated in compliance with TRM and ODCM requirements.

The concentration of radioactive material in the environment that could be attributable to SSES operations was only a small fraction of the concentration of naturally occurring and man-made radioactivity. Since these results were comparable to the results obtained during the preoperational phase of the program, which ran from 1972 to 1982, and with results collected since commercial operation, it is concluded that operation of the SSES had no significant radiological impact on the health and safety of the public or the environment.

From the results obtained, it can be concluded that the levels and fluctuations of radioactivity in environmental samples were as expected for the environment surrounding the SSES.

VII. References

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- [15] NCRP Report No. 160, "Ionizing Radiation Exposure of the Population of the United States", (2009).

APPENDIX A

PROGRAM SUMMARY

TABLE A
SUMMARY OF DATA FOR SSES
OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
NAME OF FACILITY: SUSQUEHANNA STEAM ELECTRIC STATION
LOCATION OF FACILITY: LUZERNE COUNTY, PENNSYLVANIA

Reporting Period: December 28, 2018 to January 01, 2020

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSIS PERFORMED (1)	LOWER LIMIT OF DETECTION (LLD) (2)	ALL INDICATOR LOCATIONS MEAN (3) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN (3) RANGE	CONTROL LOCATION MEAN (3) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS (4)	
Air Particulates (E-3 pCi/m ³)	GR-B	364	10	1.264E+01 (312/312) (6.800E+00 - 2.350E+01)	12E1 4.7 MILES WSW	1.308E+01 (52/52) (7.280E+00 - 2.350E+01)	1.213E+01 (52/52) (6.270E+00 - 2.060E+01)	0
	GAMMA BE-7	28 28	N/A	1.139E+02 (24/24) (7.720E+01 - 1.604E+02)	13S6 0.4 MILES W	1.236E+02 (4/4) (8.970E+01 - 1.604E+02)	1.081E+02 (4/4) (9.277E+01 - 1.182E+02)	0
	K-40	28	N/A	<MDC (0/24)	<MDC	<MDC	<MDC (0/4)	0
	CS-134	28	50	<MDC (0/24)	<MDC	<MDC	<MDC (0/4)	0
	CS-137	28	60	<MDC (0/24)	<MDC	<MDC	<MDC (0/4)	0
Charcoal (E-3 pCi/m ³)	GAMMA I-131	364 364	70	<MDC (0/312)	<MDC	<MDC (0/52)	0	
Ambient Radiation (mR/std. qtr.)	OSLD	228	N/A	1.677E+01 (208/208) (9.777E+00 - 4.188E+01)	9S2 0.2 MILES S	3.554E+01 (4/4) (2.562E+01 - 4.188E+01)	1.492E+01 (20/20) (1.013E+01 - 1.848E+01)	0
Milk (pCi/Liter)	I-131	60	1	<MDC (0/40)	<MDC	<MDC (0/20)	0	
	GAMMA K-40	60 60	N/A	1.277E+03 (40/40) (1.042E+03 - 1.504E+03)	10G1 14 MILES SSW	1.330E+03 (20/20) (1.080E+03 - 1.463E+03)	1.330E+03 (20/20) (1.080E+03 - 1.463E+03)	0
	CS-134	60	15	<MDC (0/40)	<MDC	<MDC (0/20)	0	

TABLE A
SUMMARY OF DATA FOR SSES
OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
NAME OF FACILITY: SUSQUEHANNA STEAM ELECTRIC STATION
LOCATION OF FACILITY: LUZERNE COUNTY, PENNSYLVANIA

Reporting Period: December 28, 2018 to January 01, 2020

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSIS PERFORMED (1)	LOWER LIMIT OF DETECTION (LLD) (2)	ALL INDICATOR LOCATIONS MEAN (3) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN (3) RANGE	CONTROL LOCATION MEAN (3) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS (4)	
Milk (cont'd) (pCi/Liter)	CS-137	60	18	<MDC (0/40)	<MDC	<MDC (0/20)	0	
	BA-140	60	60	<MDC (0/40)	<MDC	<MDC (0/20)	0	
	LA-140	60	15	<MDC (0/40)	<MDC	<MDC (0/20)	0	
	TH-228	60	N/A	<MDC (0/40)	<MDC	<MDC (0/20)	0	
Ground Water (pCi/Liter)	H-3	40	2000	2.091E+02 (12/36) (1.540E+02 - 3.430E+02)	1S3 0.1 MILES N	2.525E+02 (4/4) (1.540E+02 - 3.430E+02)	1.635E+02 (2/4) (1.500E+02 - 1.770E+02)	0
	GAMMA K-40	40	N/A	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	MN-54	40	15	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	CO-58	40	15	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	FE-59	40	30	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	CO-60	40	15	<MDC (0/36)	<MDC	<MDC (0/4)	0	

TABLE A
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OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
NAME OF FACILITY: SUSQUEHANNA STEAM ELECTRIC STATION
LOCATION OF FACILITY: LUZERNE COUNTY, PENNSYLVANIA

Reporting Period: December 28, 2018 to January 01, 2020

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSIS PERFORMED (1)	LOWER LIMIT OF DETECTION (LLD) (2)	ALL INDICATOR LOCATIONS MEAN (3) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN (3) RANGE	CONTROL LOCATION MEAN (3) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS (4)	
Ground Water (cont'd) (pCi/Liter)	ZN-65	40	30	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	NB-95	40	15	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	ZR-95	40	30	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	I-131	40	15	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	CS-134	40	15	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	CS-137	40	18	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	BA-140	40	60	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	LA-140	40	15	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	TH-228	40	N/A	<MDC (0/36)	<MDC	<MDC (0/4)	0	
Drinking Water (pCi/Liter)	GR-B	13	4	2.558E+00 (5/13) (2.380E+00 - 2.760E+00)	12H2 26 MILES WSW	2.558E+00 (5/13) (2.380E+00 - 2.760E+00)	N/A	0
	H-3	13	2000	<MDC (0/12)	<MDC	N/A	0	

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Drinking Water (cont'd) (pCi/Liter)	GAMMA K-40	13 13	N/A	<MDC	(0/12)	<MDC	N/A	0
	MN-54	13	15	<MDC	(0/12)	<MDC	N/A	0
	CO-58	13	15	<MDC	(0/12)	<MDC	N/A	0
	FE-59	13	30	<MDC	(0/12)	<MDC	N/A	0
	CO-60	13	15	<MDC	(0/12)	<MDC	N/A	0
	ZN-65	13	30	<MDC	(0/12)	<MDC	N/A	0
	NB-95	13	15	<MDC	(0/12)	<MDC	N/A	0
	ZR-95	13	30	<MDC	(0/12)	<MDC	N/A	0
	I-131	13	15	<MDC	(0/12)	<MDC	N/A	0
	CS-134	13	15	<MDC	(0/12)	<MDC	N/A	0

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Drinking Water (cont'd) (pCi/Liter)	CS-137	13	18	<MDC (0/12)	<MDC	N/A	0	
	BA-140	13	60	<MDC (0/12)	<MDC	N/A	0	
	LA-140	13	15	<MDC (0/12)	<MDC	N/A	0	
Food/Garden Crops (pCi/kg wet)	GAMMA BE-7	13	N/A	5.942E+02 (4/13) (3.524E+02 - 9.583E+02)	11S6 0.5 MILES SW	5.942E+02 (4/10) (3.524E+02 - 9.583E+02)	N/A	0
	K-40	13	N/A	5.325E+03 (13/13) (2.857E+03 - 1.741E+04)	11D1 3.3 MILES SW	7.743E+03 (3/3) (2.857E+03 - 1.741E+04)	N/A	0
	MN-54	13	N/A	<MDC (0/13)	<MDC	N/A	0	
	CO-58	13	N/A	<MDC (0/13)	<MDC	N/A	0	
	FE-59	13	N/A	<MDC (0/13)	<MDC	N/A	0	
	CO-60	13	N/A	<MDC (0/13)	<MDC	N/A	0	
	ZN-65	13	N/A	<MDC (0/13)	<MDC	N/A	0	

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Food/Garden Crops (cont'd) (pCi/kg wet)	NB-95	13	N/A	<MDC	(0/13)	<MDC	N/A	0
	ZR-95	13	N/A	<MDC	(0/13)	<MDC	N/A	0
	I-131	13	60	<MDC	(0/13)	<MDC	N/A	0
	CS-134	13	60	<MDC	(0/13)	<MDC	N/A	0
	CS-137	13	80	<MDC	(0/13)	<MDC	N/A	0
	BA-140	13	N/A	<MDC	(0/13)	<MDC	N/A	0
	LA-140	13	N/A	<MDC	(0/13)	<MDC	N/A	0
	AC-228	13	N/A	<MDC	(0/13)	<MDC	N/A	0
	TH-228	13	N/A	<MDC	(0/13)	<MDC	N/A	0

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Surface Water (pCi/Liter)	H-3	37	2000	8.465E+02 (12/25) (1.640E+02 - 3.660E+03)	2S7 0.1 MILES NNE	8.465E+02 (12/13) (1.640E+02 - 3.660E+03)	<MDC (0/12)	0
	GAMMA K-40	37	N/A	<MDC (0/25)	<MDC	<MDC (0/12)	0	
	MN-54	37	15	<MDC (0/25)	<MDC	<MDC (0/12)	0	
	CO-58	37	15	<MDC (0/25)	<MDC	<MDC (0/12)	0	
	FE-59	37	30	<MDC (0/25)	<MDC	<MDC (0/12)	0	
	CO-60	37	15	<MDC (0/25)	<MDC	<MDC (0/12)	0	
	ZN-65	37	30	<MDC (0/25)	<MDC	<MDC (0/12)	0	
	NB-95	37	15	<MDC (0/25)	<MDC	<MDC (0/12)	0	
	ZR-95	37	30	<MDC (0/25)	<MDC	<MDC (0/12)	0	
	I-131	37	15	<MDC (0/25)	<MDC	<MDC (0/12)	0	

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Surface Water (cont'd) (pCi/Liter)	CS-134	37	15	<MDC (0/25)	<MDC	<MDC (0/12)	0	
	CS-137	37	18	<MDC (0/25)	<MDC	<MDC (0/12)	0	
	BA-140	37	60	<MDC (0/25)	<MDC	<MDC (0/12)	0	
	LA-140	37	15	<MDC (0/25)	<MDC	<MDC (0/12)	0	
	TH-228	37	N/A	7.982E+00 (1/25) (7.982E+00)	6S5 0.9 MILES ESE	7.982E+00 (1/12) (7.982E+00)	<MDC (0/12)	0
Fish (pCi/kg wet)	GAMMA K-40	14	N/A	3.946E+03 (8/8) (3.354E+03 - 4.393E+03)	LTAW 0.7 MILES NE-ESE	4.086E+03 (2/2) (3.953E+03 - 4.219E+03)	3.681E+03 (6/6) (2.889E+03 - 4.485E+03)	0
	MN-54	14	130	<MDC (0/8)	<MDC	<MDC (0/6)	0	
	CO-58	14	130	<MDC (0/8)	<MDC	<MDC (0/6)	0	
	FE-59	14	260	<MDC (0/8)	<MDC	<MDC (0/6)	0	
	CO-60	14	130	<MDC (0/8)	<MDC	<MDC (0/6)	0	

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Fish (cont'd) (pCi/kg wet)	ZN-65	14	260	<MDC (0/8)	<MDC	<MDC (0/6)	0	
	CS-134	14	130	<MDC (0/8)	<MDC	<MDC (0/6)	0	
	CS-137	14	150	<MDC (0/8)	<MDC	<MDC (0/6)	0	
Sediment (pCi/kg dry)	GAMMA	6						
	K-40	6	N/A	1.094E+04 (4/4) (8.495E+03 - 1.351E+04)	2B 1.6 MILES NNE	1.435E+04 (2/2) (1.259E+04 - 1.610E+04)	1.435E+04 (2/2) (1.259E+04 - 1.610E+04)	0
	CS-134	6	150	<MDC (0/4)	<MDC	<MDC (0/2)	0	
	CS-137	6	180	<MDC (0/4)	<MDC	<MDC (0/2)	0	
	RA-226	6	N/A	<MDC (0/4)	<MDC	<MDC (0/2)	0	
	AC-228	6	N/A	1.035E+03 (4/4) (8.695E+02 - 1.305E+03)	2B 1.6 MILES NNE	1.279E+03 (2/2) (1.119E+03 - 1.438E+03)	1.279E+03 (2/2) (1.119E+03 - 1.438E+03)	0
	TH-228	6	N/A	1.020E+03 (4/4) (9.525E+02 - 1.111E+03)	2B 1.6 MILES NNE	1.125E+03 (2/2) (1.107E+03 - 1.143E+03)	1.125E+03 (2/2) (1.107E+03 - 1.143E+03)	0

1. The total number of analyses does not include duplicates, splits or repeated analyses.
2. The Technical Requirement LLDs are shown when applicable.
3. The mean and range are based on all results above MDC. The ratio indicated in parentheses is the total number of results used to calculate the mean to the total number of samples.
4. USNRC Reporting Levels are specified in the Technical Requirements (i.e., when Reporting Levels in Technical Requirements are exceeded).

APPENDIX B

SAMPLE DESIGNATION AND LOCATIONS

SAMPLE DESIGNATION

All distances from the SSES to monitoring locations are measured from the standby gas treatment vent at 44200/N34117 (Pa. Grid System). The location codes are based on both distance and direction from the SSES. The letters in the location codes indicate if the monitoring locations are on site (within the site boundary) or, if they are not on site, the approximate distances of the location from the SSES as described below:

S	= On site	E	= 4 – 5 miles
A	= < 1 mile	F	= 5 – 10 miles
B	= 1 – 2 miles	G	= 10 – 20 miles
C	= 2 – 3 miles	H	= > 20 miles
D	= 3 – 4 miles		

The numbers preceding the letters in the location codes provide the direction of the monitoring locations from the SSES by indicating the sectors in which they are located. A total number of 16 sectors (numbered one through 16) equally divide an imaginary circle on a map of the SSES and its vicinity, with the SSES at the center of the circle. The middle of sector one is directed due North (N). Moving clockwise from sector one, the sector immediately adjacent to sector one is sector two, the middle of which is directed due north, north east (NNE). Continuing to move clockwise the sector number increases to 16, which is the north northwest sector (NNW).

TABLE B-1

SAMPLING LOCATIONS

Specific information about the individual sampling locations are given in Table B-1. Maps B-1 through B-6 show the locations of sampling stations with respect to the Site. A Portable Global Positioning System (GPS) was used to provide the coordinates of sampling locations.

STATION CODE	STATION LOCATION	LATITUDINAL	LONGITUDINAL	SAMPLE TYPE
LESS THAN ONE MILE FROM THE SSES		DEG.	DEG.	
2S7	0.1 mi.NNE	41.093540	-76.144773	Surface water
6S5	0.9 mi.ESE;	41.084639	-76.130642	Surface water
6S6 **	0.8 mi.ESE;	41.088115	-76.131637	Surface water
LTAW	0.7 mi.NE-ESE;	41.098356	-76.135401	Fish
10S3	0.6 mi. SSW;	41.085264	-76.152128	Air
12S1	0.4 mi.WSW;	41.088436	-76.154314	Air
13S6	0.4 mi.W;	41.091771	-76.153869	Air
3S2	0.5 mi NE;	41.095716	-76.140207	Air
2S8	0.1 mi.NNE;	41.094991	-76..044207	Ground water
6S11A	0.4 mi.ESE;	41.083448	-76.133412	Ground water
6S12	0.8 mi.ESE;	41.083411	-76.116935	Ground water
7S11	0.3 mi.SE;	41.083527	-76.133513	Ground water
1S3	0.1 mi N;	41.093640	-76.146076	Ground water
4S8	0.1 mi.ENE;	41.092306	-76.144283	Ground water
4S9	0.3 mi.E;	41.093369	-76.141644	Ground water
8S4	0.1 mi.SSE;	41.091424	-76.145531	Ground water
7S10	0.3 mi.SE;	41.089736	-76.142783	Ground water
13S7	0.2 mi.W;	41.091236	-76.149647	Ground water
11S6	0.5 mi.SW;	41.085305	-76.152022	Broadleaf
Site 1	0.1 mi.ESE;	41.092275	-76.145022	Precipitation
Site 2	0.1 mi.SSE;	41.091309	-76.145708	Precipitation
Site 3	0.1 mi.WSW;	41.091243	-76.147345	Precipitation
Site 4	0.1 mi.NW;	41.093321	-76.147316	Precipitation

** Control Location

TABLE B-1 (cont'd)
SAMPLING LOCATIONS

STATION CODE	STATION LOCATION	LATITUDINAL DEG.	LONGITUDINAL DEG.	SAMPLE TYPE
FROM ONE to FIVE MILES FROM THE SSES				
IND	0.9 mi.ESE;	41.085141	-76.130174	Fish
IND	1.4 mi.ESE;	41.075618	-76.132682	Fish
2B **	1.6 mi.NNE;	41.112441	-76.134758	Sediment
7B	1.2 mi.SE;	41.078924	-76.131548	Sediment
9B1	1.3 mi. SSW;	41.085264	-76.152128	Air
12E1	4.7 mi.WSW;	41.072418	-76.230554	Air
5E2	4.5 mi.E;	41.085184	-76.061099	Milk
13E3	5.0 mi.W;	41.100259	-76.241102	Milk
11D1	3.3 mi.SW;	41.055212	-76.186797	Food Products
** Control Location				
GREATER THAN FIVE MILES FROM THE SSES				
12H2	26 mi.WSW;	40.947192	-76.604524	Drinking water
2H **	30 mi.NNE;	41.459508	-75.853096	Fish
12F	6.9 mi.WSW;	41.041323	-76.255396	Sediment
8G1 **	12 mi.SSE;	40.928886	-76.055092	Air
10G1 **	14 mi.SSW;	40.934847	-76.284449	Milk

TABLE B-1 (cont'd)
SAMPLING LOCATIONS

STATION CODE	STATION LOCATION	LATITUDINAL	LONGITUDINAL	SAMPLE TYPE
OSLD LOCATIONS				
LESS THAN ONE MILE FROM THE SSES		DEG.	DEG.	
1S2	0.2 mi.N;	41.09566	-76.146121	OSLD
2S2	0.9 mi.NNE;	41.10207	-76.141192	OSLD
2S3	0.2 mi.NNE;	41.09486	-76.144101	OSLD
3S2	0.5 mi.NE;	41.09574	-76.140086	OSLD
3S3	0.9 mi.NE;	41.10183	-76.133127	OSLD
4S3	0.2 mi.ENE;	41.09322	-76.141934	OSLD
4S6	0.7 mi.ENE;	41.09687	-76.133807	OSLD
5S4	0.8 mi.E;	41.09286	-76.131604	OSLD
5S7	0.3 mi.E;	41.09199	-76.141165	OSLD
6S4	0.2 mi.ESE;	41.09132	-76.142616	OSLD
6S9	0.2 mi.ESE;	41.09067	-76.142966	OSLD
7S6	0.2 mi.SE;	41.08972	-76.14359	OSLD
7S7	0.4 mi.SE;	41.08745	-76.142033	OSLD
8S2	0.2 mi.SSE;	41.08907	-76.14437	OSLD
9S2	0.2 mi.S;	41.08952	-76.14322	OSLD
10S1	0.4 mi.SSW;	41.08663	-76.150082	OSLD
10S2	0.2 mi.SSW;	41.08894	-76.147881	OSLD
11S7	0.4 mi.SWN;	41.08832	-76.15297	OSLD
12S1	0.4 mi.WSW;	41.0887	-76.154112	OSLD
12S3	0.4 mi.WSW;	41.08968	-76.153192	OSLD
13S2	0.4 mi.W;	41.09198	-76.153166	OSLD
13S5	0.4 mi.W;	41.09179	-76.153167	OSLD
13S6	0.4 mi.W;	41.09177	-76.154073	OSLD
14S5	0.5 mi.WNW;	41.09503	-76.153787	OSLD
15S5	0.4 mi.NW;	41.09576	-76.15103	OSLD
16S1	0.3 mi.NNW;	41.09611	-76.147388	OSLD
16S2	0.3 mi.NNW;	41.09599	-76.148922	OSLD
6A4 *	0.6 mi.ESE;	41.08791	-76.136795	OSLD

TABLE B-1 (cont'd)
SAMPLING LOCATIONS

STATION CODE	STATION LOCATION	LATITUDINAL DEG.	LONGITUDINAL DEG.	SAMPLE TYPE
LESS THAN ONE MILE FROM THE SSES				
8A3	0.9 mi.SSE;	41.07982	-76.1139078	OSLD
15A3 *	0.9 mi.NW;	41.10003	-76.1585	OSLD
16A2 *	0.8 mi.NNW;	41.1025	-76.151595	OSLD
FROM ONE to FIVE MILES FROM THE SSES				
12S7	1.1 mi.WSW;	41.08621	-76.165914	OSLD
8B2 *	1.4 mi.SSE;	41.07483	-76.130724	OSLD
9B1	1.3 mi.S;	41.07356	-76.147874	OSLD
10B3 *	1.7 mi.SSW;	41.07064	-76.156646	OSLD
1D5	4.0 mi.N;	41.14936	-76.144346	OSLD
8D3	4.0 mi.SSE;	41.03824	-76.121683	OSLD
9D4	3.6 mi.S;	41.04015	-76.144529	OSLD
10D1	3.0 mi.SSW;	41.05446	-76.175026	OSLD
12D2	3.7 mi.WSW;	41.07363	-76.213306	OSLD
14D1	3.6 mi.WNW;	41.10706	-76.211891	OSLD
3E1	4.7 mi NE;	41.13953	-76.082398	OSLD
4E2	4.7 mi.ENE;	41.12157	-76.064115	OSLD
5E2	4.5 mi. E;	41.08539	-76.060486	OSLD
6E1	4.7 mi.ESE;	41.07275	-76.059529	OSLD
7E1	4.2 mi.SE;	41.04891	-76.090309	OSLD
11E1	4.7 mi. SW;	41.05188	-76.218713	OSLD
12E1 *	4.7 mi.WSW;	41.0725	-76.230331	OSLD
13E4	4.1 mi.W;	41.08962	-76.223726	OSLD

* Special Interest Area (other than controls)

TABLE B-1 (cont'd)
SAMPLING LOCATIONS

STATION CODE	STATION LOCATION	LATITUDINAL	LONGITUDINAL	SAMPLE TYPE
GREATER THAN FIVE MILES FROM THE SSES		DEG.	DEG.	
2F1	5.9 mi.NNE;	41.16796	-76.09146	OSLD
15F1	5.4 mi.NW;	41.15595	-76.202506	OSLD
16F1	7.8 mi.NNW;	41.18985	-76.229283	OSLD
3G4 **	17 mi.NE;	41.23431	-76.869061	OSLD
4G1 **	14 mi.ENE;	41.13898	-75.885121	OSLD
7G1 **	14 mi.SE;	40.94636	-76.974184	OSLD
12G1 **	15 mi.WSW;	41.0262	-76.411566	OSLD
12G4 **	10 mi. WSW;	40.03868	-76.327731	OSLD

* Special Interest Area (other than controls)

** Control Location

TABLE B-2**SUSQUEHANNA STEAM ELECTRIC STATION RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM**

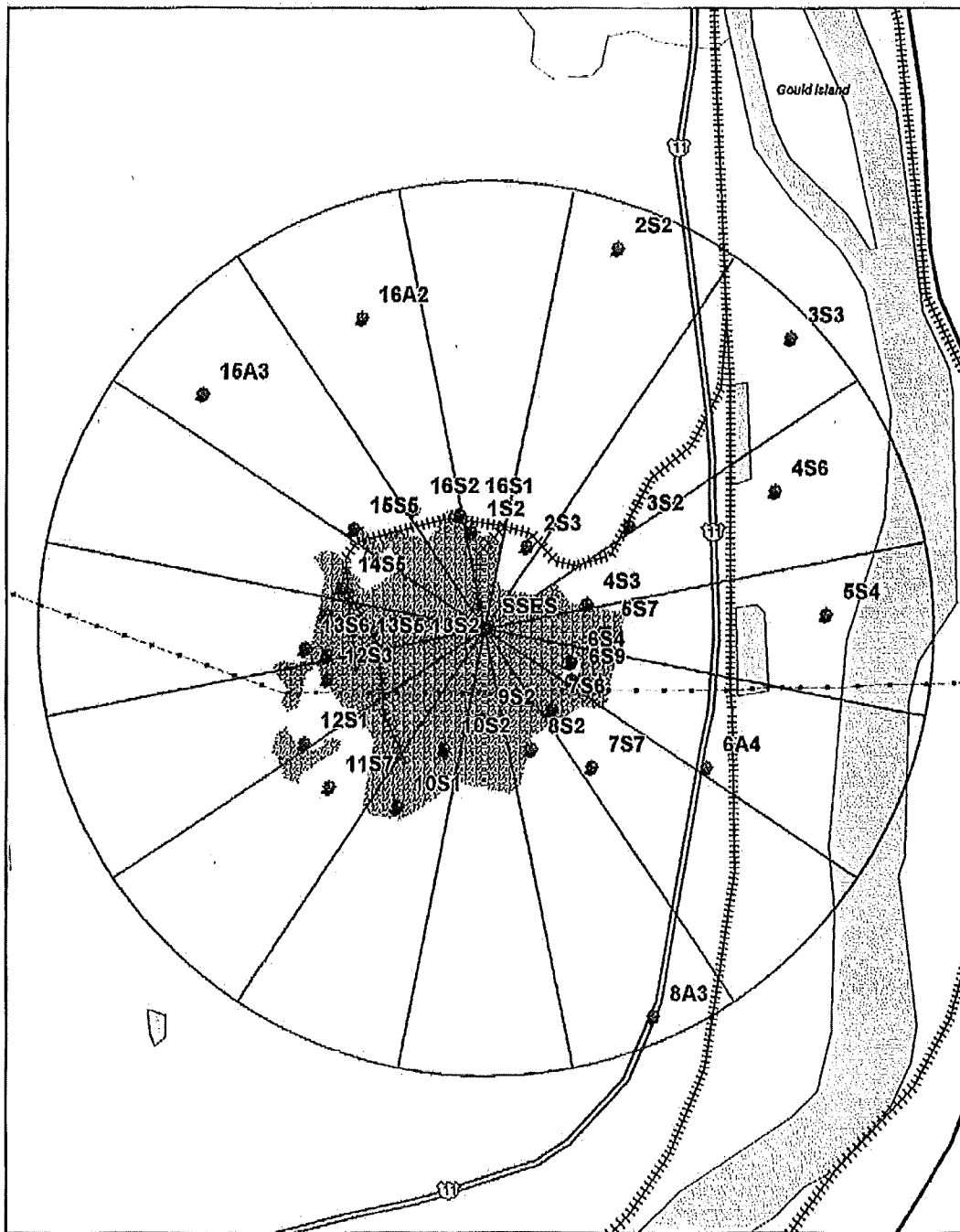
Sample Medium	Analysis	Sampling Method	Collection Procedure Number	Analytical Procedure Number
Ambient Radiation	Dosimeter	Quarterly	SSES, HP-TP-205	Landauer Procedure L313, Inlight Dosimeter Analysis
Air	Gross Beta	Weekly	Applied Ecoscience, Appendix 2	TBE-2008 Gross Alpha and/or Gross Beta Activity in Various Matrices.
Air	I-131	Weekly	Applied Ecoscience, Appendix 2	TBE-2012 Radioiodine in Various Matrices
Air	Gamma	Quarterly	Applied Ecoscience, Appendix 2	TBE-2007 Gamma Emitting Radioisotope Analysis
Drinking Water	Gross Beta	Monthly	Applied Ecoscience, Appendix 5	TBE-2008 Gross Alpha and/or Gross Beta Activity in Various Matrices.
Surface & Drinking Water	Tritium	Monthly	Applied Ecoscience, Appendix 3, 4, 5, 6, & 7	TBE-2010 Tritium and Carbon-14 Analysis by Liquid Scintillation.
Surface & Drinking Water	Gamma	Monthly	Applied Ecoscience, Appendix 3, 4, 5, 6, & 7	TBE-2007 Gamma Emitting Radioisotope Analysis.
Ground Water	Tritium	Quarterly	Applied Ecoscience, Appendix 8	TBE-2010 Tritium and Carbon-14 Analysis by Liquid Scintillation
Ground Water	Gamma	Quarterly	Applied Ecoscience, Appendix 8	TBE-2007 Gamma Emitting Radioisotope Analysis

TABLE B-2 (cont'd)**SUSQUEHANNA STEAM ELECTRIC STATION RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM**

Sample Medium	Analysis	Sampling Method	Collection Procedure Number	Analytical Procedure Number
Precipitation	Tritium	Monthly (Apr – Nov) / Quarterly	Applied Ecoscience, Appendix 10	TBE-2010 Tritium and Carbon-14 Analysis by Liquid Scintillation
Milk	Gamma	Monthly/Bi-Weekly	Applied Ecoscience, Appendix 9	TBE-2007 Gamma Emitting Radioisotope Analysis
Milk	I-131	Monthly/Bi-Weekly	Applied Ecoscience, Appendix 9	TBE-2012 Radioiodine in Various Matrices
Fish	Gamma	Semi-Annually (Spring/Fall)	Applied Ecoscience, Appendix 11	TBE-2007 Gamma Emitting Radioisotope Analysis
Sediment	Gamma	Semi-Annually (Spring/Fall)	Applied Ecoscience, Appendix 12	TBE-2007 Gamma Emitting Radioisotope Analysis
Fruits & Vegetables	Gamma	In Season (When available)	Applied Ecoscience, Appendix 13 Applied Ecoscience, Appendix 15	TBE-2007 Gamma Emitting Radioisotope Analysis

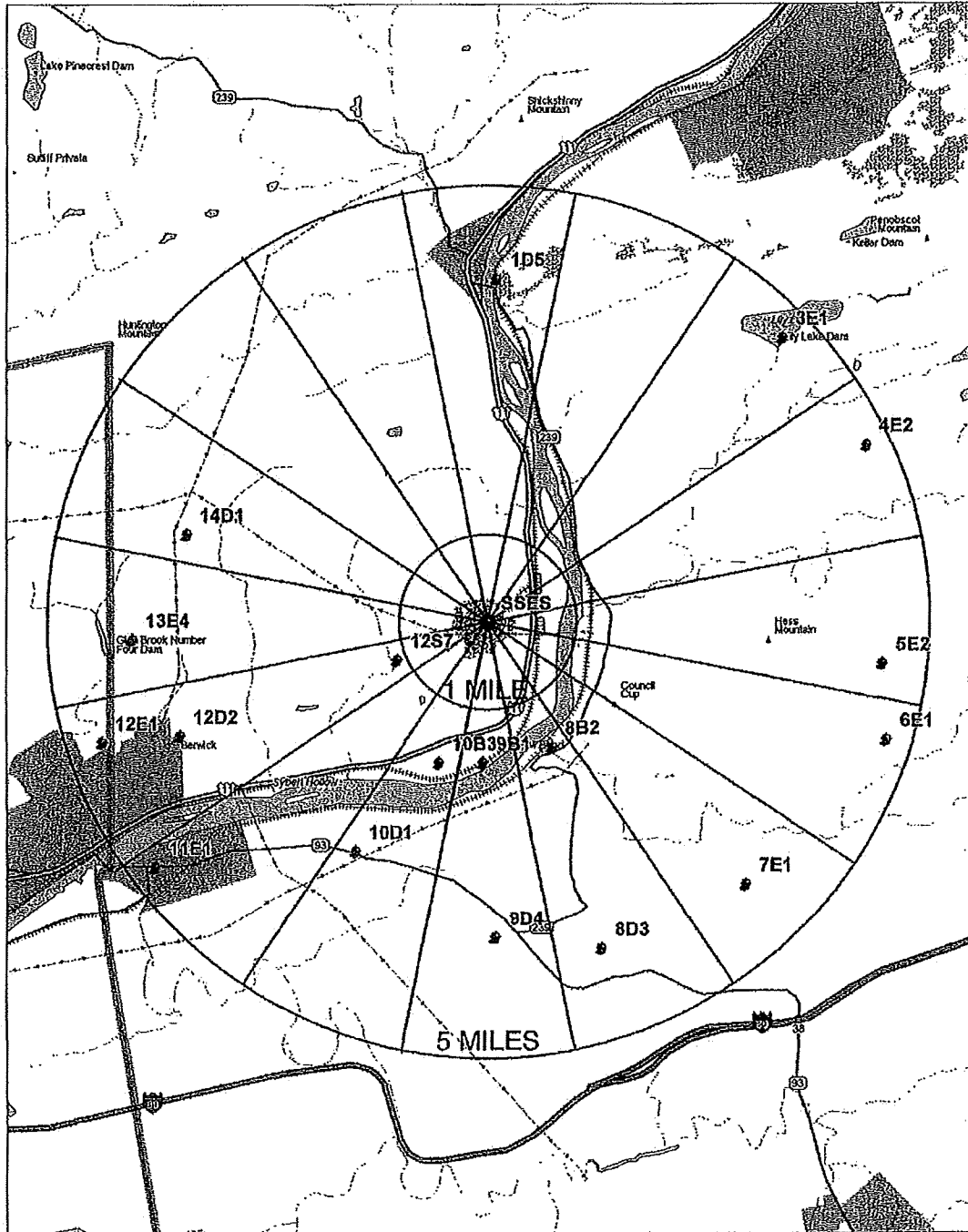
MAP B-1

Direct Radiation Monitoring Locations Within One Mile



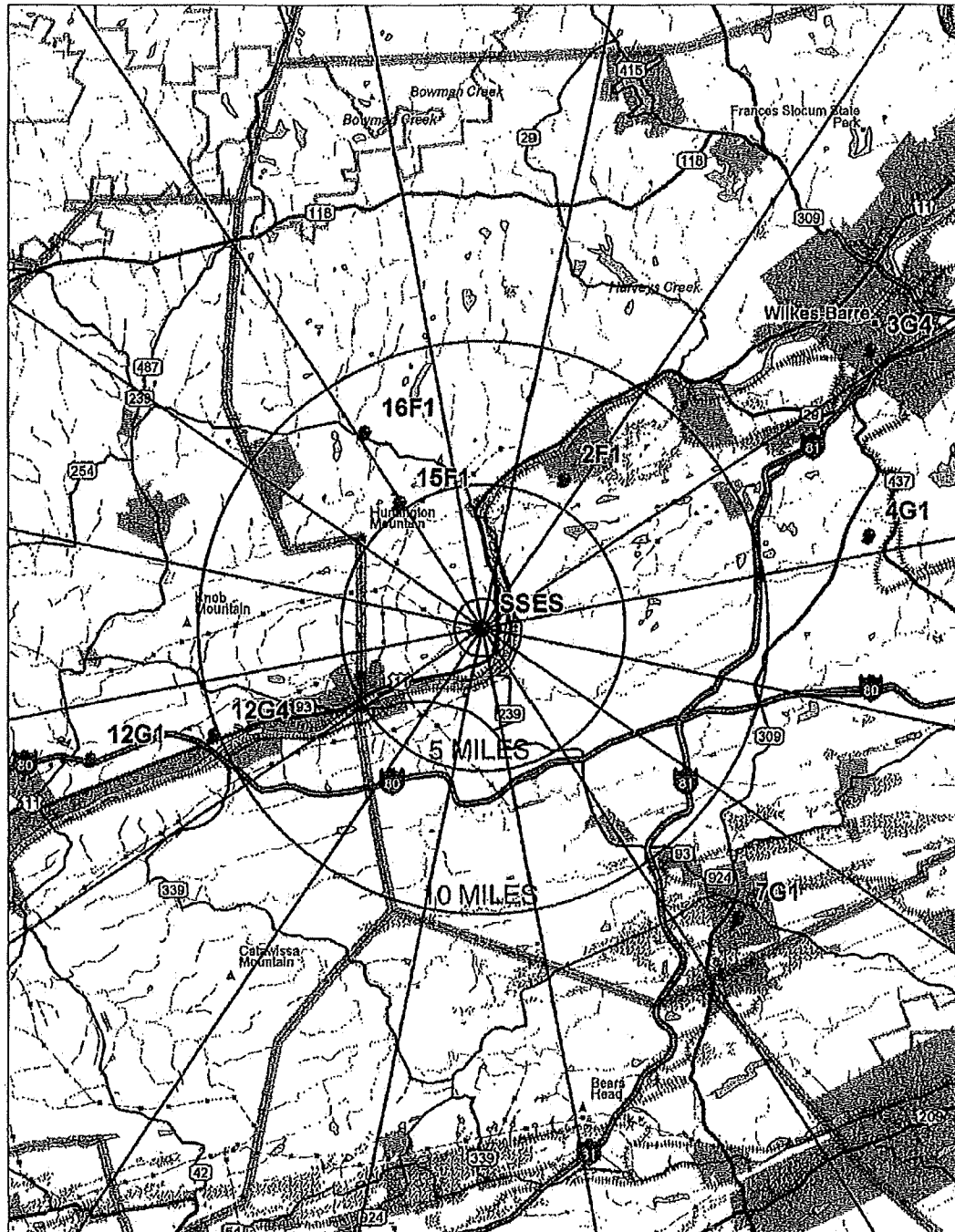
MAP B-2

Direct Radiation Monitoring Locations From One to Five Miles



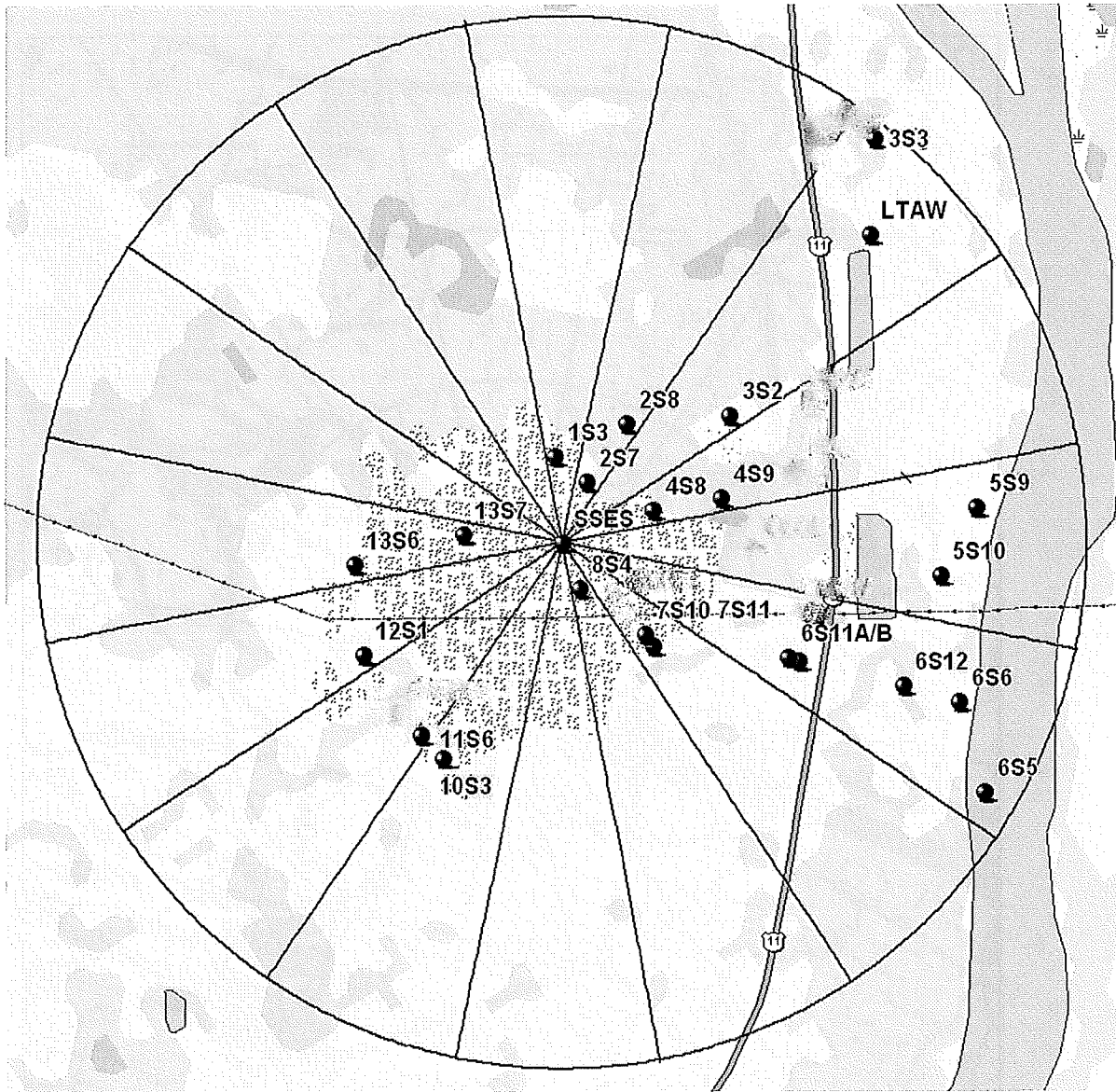
MAP B-3

Direct Radiation Monitoring Locations Greater Than Five Miles

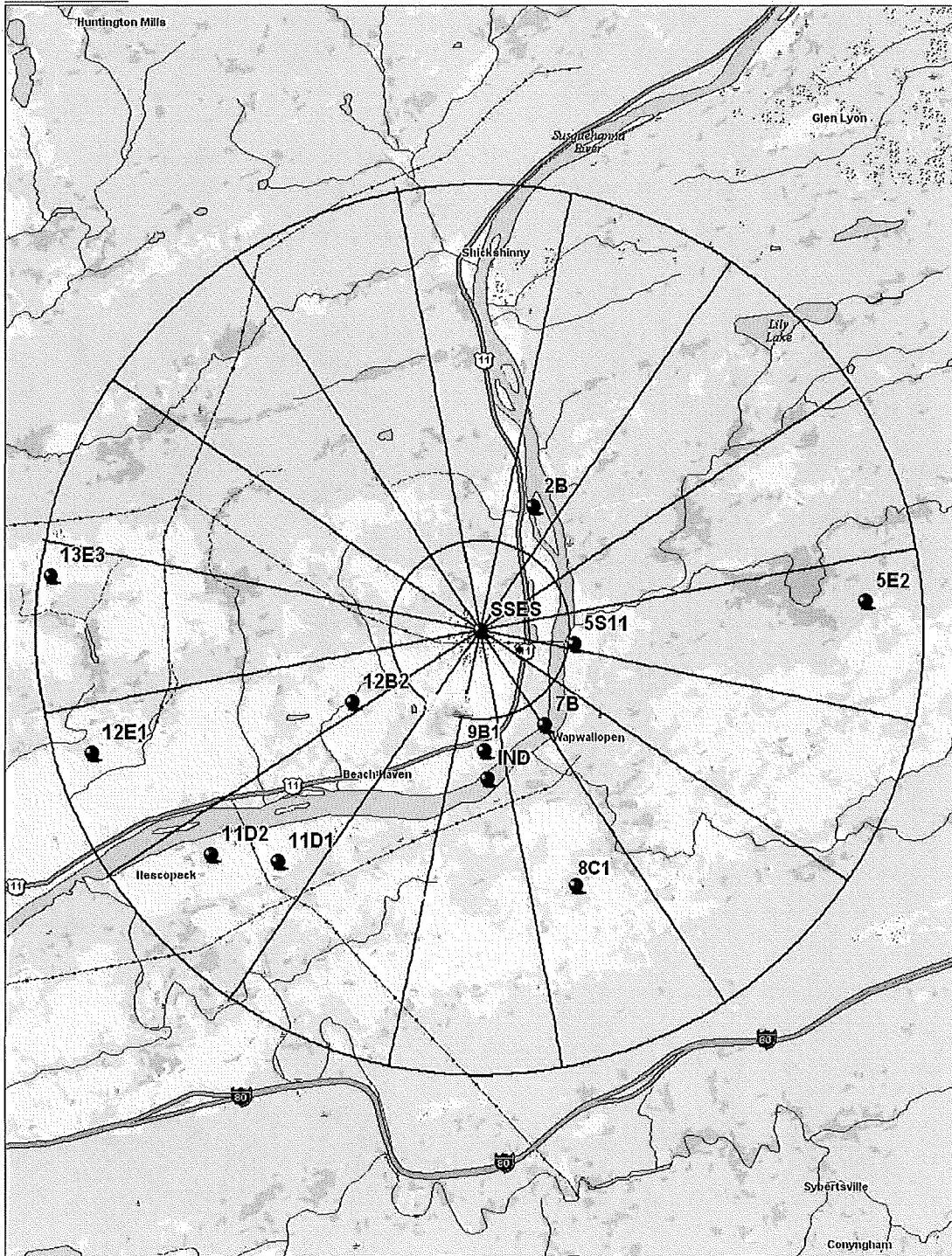


MAP B-4

Environmental Sampling Locations Within One Mile

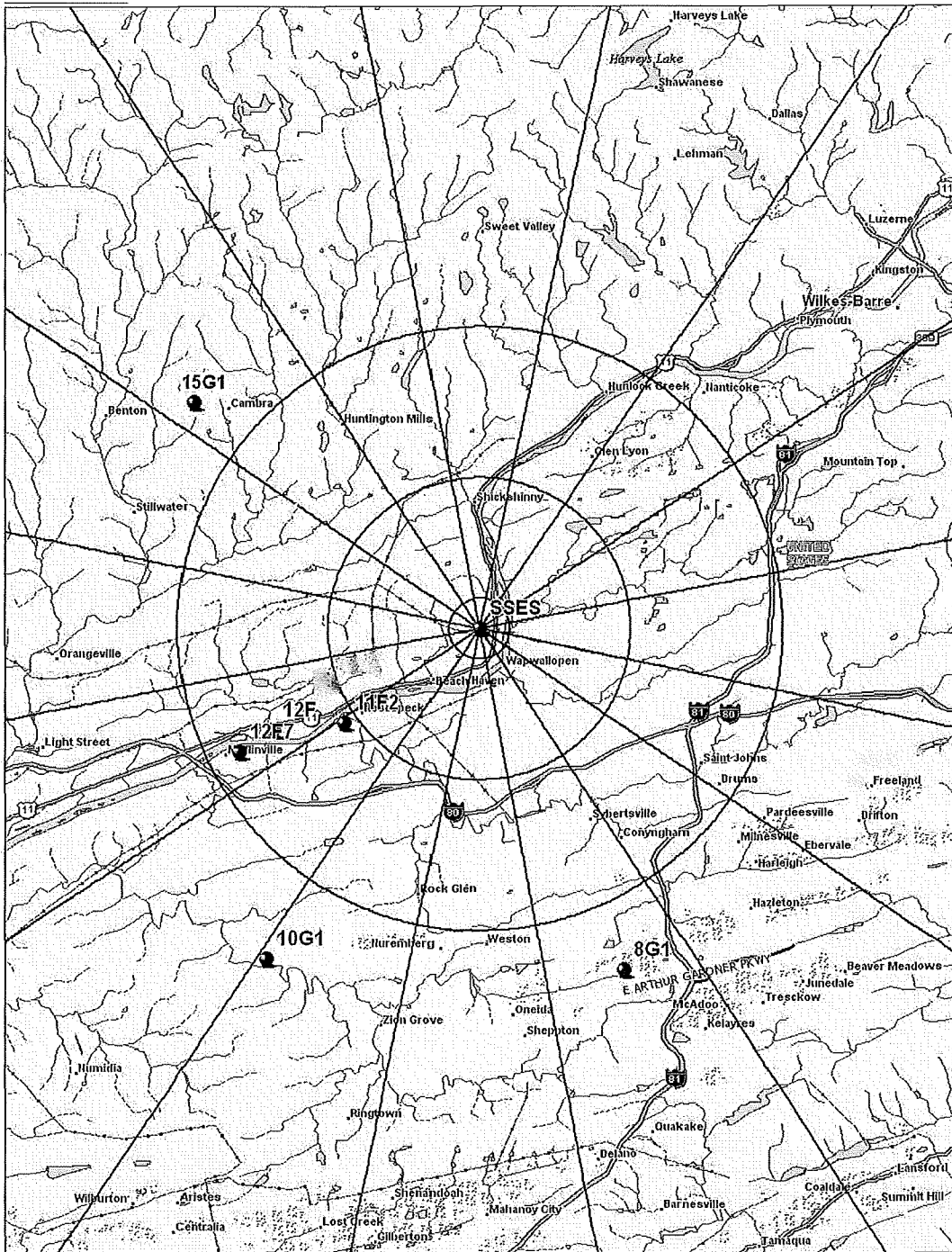


MAP B-5
Environmental Sampling Locations
From One to Five Miles



MAP B-6

Environmental Sampling Locations Greater Than Five Miles



APPENDIX C

DATA TABLES

TABLE C-1

**GROSS BETA ANALYSES OF AIR PARTICULATE FILTERS
SUSQUEHANNA STEAM ELECTRIC STATION, 2019**

Results in units of E-03 pCi/cu.m. \pm 2 sigma

COLLECTION PERIOD	3S2	8G1	12E1	12S1	13S6	9B1
01/02/19 - 01/09/19	12 \pm 2	11 \pm 2	12 \pm 2	11 \pm 2	13 \pm 2	13 \pm 2
01/09/19 - 01/16/19	10 \pm 2	10 \pm 2	11 \pm 2	12 \pm 2	11 \pm 2	9 \pm 2
01/16/19 - 01/23/19	11 \pm 2	11 \pm 2	13 \pm 2	11 \pm 2	11 \pm 2	12 \pm 2
01/23/19 - 01/30/19	15 \pm 2	15 \pm 2	16 \pm 2	13 \pm 2	15 \pm 2	14 \pm 2
01/30/19 - 02/06/19	17 \pm 2	18 \pm 2	21 \pm 3	17 \pm 2	14 \pm 2	16 \pm 2
02/06/19 - 02/13/19	10 \pm 2	10 \pm 2	11 \pm 2	9 \pm 2	11 \pm 2	12 \pm 2
02/13/19 - 02/20/19	14 \pm 2	15 \pm 2	14 \pm 2	13 \pm 2	13 \pm 2	13 \pm 2
02/20/19 - 02/27/19	16 \pm 2	15 \pm 2	18 \pm 3	17 \pm 2	16 \pm 3	18 \pm 3
02/27/19 - 03/06/19	12 \pm 2	11 \pm 2	12 \pm 2	11 \pm 2	10 \pm 2	13 \pm 2
03/06/19 - 03/13/19	16 \pm 2	17 \pm 3	18 \pm 3	17 \pm 2	15 \pm 2	16 \pm 3
03/13/19 - 03/20/19	13 \pm 2	16 \pm 2	17 \pm 3	15 \pm 2	18 \pm 3	15 \pm 2
03/20/19 - 03/27/19	10 \pm 2	11 \pm 2	11 \pm 2	12 \pm 2	14 \pm 2	9 \pm 2
03/27/19 - 04/03/19	11 \pm 2	10 \pm 2	10 \pm 2	11 \pm 2	13 \pm 2	12 \pm 2
04/03/19 - 04/10/19	9 \pm 2	10 \pm 2	11 \pm 2	10 \pm 2	12 \pm 2	11 \pm 2
04/10/19 - 04/17/19	8 \pm 2	7 \pm 2	9 \pm 2	9 \pm 2	10 \pm 2	9 \pm 2
04/17/19 - 04/24/19	8 \pm 2	8 \pm 2	12 \pm 2	12 \pm 2	9 \pm 2	12 \pm 2
04/24/19 - 05/01/19	9 \pm 2	7 \pm 2	9 \pm 2	8 \pm 2	8 \pm 2	7 \pm 2
05/01/19 - 05/08/19	11 \pm 2	7 \pm 2	8 \pm 2	10 \pm 2	8 \pm 2	9 \pm 2
05/08/19 - 05/15/19	8 \pm 2	6 \pm 2	7 \pm 2	8 \pm 2	8 \pm 2	7 \pm 2
05/15/19 - 05/22/19	14 \pm 2	17 \pm 2	16 \pm 2	12 \pm 2	13 \pm 2	13 \pm 2
05/22/19 - 05/29/19	10 \pm 2	9 \pm 2	11 \pm 2	10 \pm 2	10 \pm 2	10 \pm 2
05/29/19 - 06/05/19	9 \pm 2	8 \pm 2	8 \pm 2	10 \pm 2	8 \pm 2	9 \pm 2
06/05/19 - 06/12/19	14 \pm 2	13 \pm 2	12 \pm 2	14 \pm 2	12 \pm 2	12 \pm 2
06/12/19 - 06/19/19	10 \pm 2	11 \pm 2	13 \pm 2	11 \pm 2	11 \pm 2	11 \pm 2
06/19/19 - 06/26/19	11 \pm 2	10 \pm 2	8 \pm 2	11 \pm 2	10 \pm 2	9 \pm 2
06/26/19 - 07/03/19	12 \pm 2	13 \pm 2	15 \pm 2	11 \pm 2	13 \pm 2	13 \pm 2
07/03/19 - 07/10/19	13 \pm 2	11 \pm 2	13 \pm 2	12 \pm 2	12 \pm 2	12 \pm 2
07/10/19 - 07/17/19	9 \pm 2	8 \pm 2	12 \pm 2	9 \pm 2	12 \pm 2	9 \pm 2
07/17/19 - 07/24/19	9 \pm 2	10 \pm 2	11 \pm 2	10 \pm 2	9 \pm 2	9 \pm 2
07/24/19 - 07/31/19	13 \pm 2	18 \pm 2	16 \pm 2	17 \pm 2	18 \pm 3	18 \pm 2
07/31/19 - 08/07/19	15 \pm 2	19 \pm 3	19 \pm 3	17 \pm 2	15 \pm 2	17 \pm 2
08/07/19 - 08/14/19	12 \pm 2	12 \pm 2	11 \pm 2	12 \pm 2	11 \pm 2	13 \pm 2
08/14/19 - 08/21/19	17 \pm 3	21 \pm 3	19 \pm 3	19 \pm 3	20 \pm 3	15 \pm 2
08/21/19 - 08/28/19	10 \pm 2	13 \pm 2	13 \pm 2	12 \pm 2	11 \pm 2	13 \pm 2
08/28/19 - 09/04/19	15 \pm 2	17 \pm 2	15 \pm 2	17 \pm 3	15 \pm 2	15 \pm 2
09/04/19 - 09/11/19	15 \pm 2	12 \pm 2	17 \pm 2	16 \pm 2	14 \pm 2	14 \pm 2
09/11/19 - 09/18/19	17 \pm 2	17 \pm 2	18 \pm 3	19 \pm 3	16 \pm 2	17 \pm 2
09/18/19 - 09/25/19	20 \pm 3	16 \pm 2	16 \pm 2	16 \pm 2	17 \pm 2	17 \pm 2
09/25/19 - 10/02/19	17 \pm 2	15 \pm 2	18 \pm 2	17 \pm 2	16 \pm 2	17 \pm 2
10/02/19 - 10/09/19	10 \pm 2	9 \pm 2	11 \pm 2	11 \pm 2	8 \pm 2	11 \pm 2
10/09/19 - 10/16/19	16 \pm 2	17 \pm 2	17 \pm 2	15 \pm 2	17 \pm 2	16 \pm 2
10/16/19 - 10/23/19	9 \pm 2	7 \pm 2	9 \pm 2	7 \pm 2	9 \pm 2	8 \pm 2
10/23/19 - 10/30/19	14 \pm 2	11 \pm 2	12 \pm 2	13 \pm 2	12 \pm 2	13 \pm 2
10/30/19 - 11/06/19	10 \pm 2	9 \pm 2	9 \pm 2	11 \pm 2	12 \pm 2	12 \pm 2
11/06/19 - 11/13/19	13 \pm 2	13 \pm 2	14 \pm 2	14 \pm 2	11 \pm 2	12 \pm 2
11/13/19 - 11/20/19	13 \pm 2	10 \pm 2	12 \pm 2	12 \pm 2	11 \pm 2	12 \pm 2
11/20/19 - 11/26/19	12 \pm 2	13 \pm 2	11 \pm 2	14 \pm 2	14 \pm 2	13 \pm 2
11/26/19 - 12/04/19	8 \pm 2	7 \pm 1	9 \pm 2	11 \pm 2	8 \pm 2	8 \pm 2
12/04/19 - 12/11/19	12 \pm 2	13 \pm 2	12 \pm 2	13 \pm 2	12 \pm 2	13 \pm 2
12/11/19 - 12/18/19	11 \pm 2	9 \pm 2	9 \pm 2	11 \pm 2	9 \pm 2	11 \pm 2
12/18/19 - 12/26/19	23 \pm 3	19 \pm 2	24 \pm 2	20 \pm 2	21 \pm 2	22 \pm 2
12/26/19 - 01/02/20	13 \pm 2	13 \pm 2	13 \pm 2	15 \pm 2	14 \pm 2	14 \pm 2
AVERAGE	12 \pm 7	12 \pm 7	13 \pm 7	13 \pm 6	13 \pm 6	13 \pm 6

TABLE C-1

**GROSS BETA ANALYSES OF AIR PARTICULATE FILTERS
SUSQUEHANNA STEAM ELECTRIC STATION, 2019**

Results in units of E-03 pCi/cu.m. \pm 2 sigma

COLLECTION PERIOD	10S3
01/02/19 - 01/09/19	15 \pm 2
01/09/19 - 01/16/19	9 \pm 2
01/16/19 - 01/23/19	11 \pm 2
01/23/19 - 01/30/19	16 \pm 2
01/30/19 - 02/06/19	16 \pm 2
02/06/19 - 02/13/19	11 \pm 2
02/13/19 - 02/20/19	15 \pm 2
02/20/19 - 02/27/19	17 \pm 2
02/27/19 - 03/06/19	14 \pm 2
03/06/19 - 03/13/19	17 \pm 2
03/13/19 - 03/20/19	15 \pm 2
03/20/19 - 03/27/19	11 \pm 2
03/27/19 - 04/03/19	13 \pm 2
04/03/19 - 04/10/19	11 \pm 2
04/10/19 - 04/17/19	10 \pm 3
04/17/19 - 04/24/19	12 \pm 2
04/24/19 - 05/01/19	8 \pm 2
05/01/19 - 05/08/19	10 \pm 2
05/08/19 - 05/15/19	8 \pm 2
05/15/19 - 05/22/19	13 \pm 2
05/22/19 - 05/29/19	10 \pm 2
05/29/19 - 06/05/19	8 \pm 2
06/05/19 - 06/12/19	13 \pm 2
06/12/19 - 06/19/19	11 \pm 2
06/19/19 - 06/26/19	12 \pm 2
06/26/19 - 07/03/19	14 \pm 2
07/03/19 - 07/10/19	12 \pm 2
07/10/19 - 07/17/19	10 \pm 2
07/17/19 - 07/24/19	8 \pm 2
07/24/19 - 07/31/19	19 \pm 3
07/31/19 - 08/07/19	17 \pm 2
08/07/19 - 08/14/19	12 \pm 2
08/14/19 - 08/21/19	17 \pm 3
08/21/19 - 08/28/19	13 \pm 2
08/28/19 - 09/04/19	14 \pm 2
09/04/19 - 09/11/19	14 \pm 2
09/11/19 - 09/18/19	18 \pm 3
09/18/19 - 09/25/19	19 \pm 3
09/25/19 - 10/02/19	18 \pm 2
10/02/19 - 10/09/19	9 \pm 2
10/09/19 - 10/16/19	14 \pm 2
10/16/19 - 10/23/19	7 \pm 2
10/23/19 - 10/30/19	12 \pm 2
10/30/19 - 11/06/19	9 \pm 2
11/06/19 - 11/13/19	13 \pm 2
11/13/19 - 11/20/19	12 \pm 2
11/20/19 - 11/26/19	11 \pm 2
11/26/19 - 12/04/19	9 \pm 2
12/04/19 - 12/11/19	11 \pm 2
12/11/19 - 12/18/19	10 \pm 2
12/18/19 - 12/26/19	19 \pm 2
12/26/19 - 01/02/20	18 \pm 2
AVERAGE	13 \pm 7

**TABLE C-2 GAMMA SPECTROSCOPIC ANALYSES OF COMPOSITED AIR PARTICULATE FILTERS
SUSQUEHANNA STEAM ELECTRIC STATION, 2019**

Results in units of E-03 pCi/cu.m. \pm 2 sigma

SITE	COLLECTION PERIOD	Be-7	K-40	Cs-134	Cs-137
8G1	01/02/19 - 04/03/19	104 \pm 21	< 12	< 1	< 1
	04/03/19 - 07/03/19	117 \pm 21	< 10	< 1	< 1
	07/03/19 - 10/02/19	118 \pm 22	< 19	< 1	< 1
	10/02/19 - 01/02/20	93 \pm 15	< 11	< 1	< 1
	AVERAGE	108 \pm 24	-	-	-
3S2	01/02/19 - 04/03/19	99 \pm 20	< 14	< 1	< 1
	04/03/19 - 07/03/19	104 \pm 18	< 15	< 1	< 1
	07/03/19 - 10/02/19	132 \pm 21	< 16	< 1	< 1
	10/02/19 - 01/02/20	106 \pm 19	< 20	< 1	< 1
	AVERAGE	110 \pm 30	-	-	-
12E1	01/02/19 - 04/03/19	116 \pm 27	< 15	< 1	< 1
	04/03/19 - 07/03/19	122 \pm 23	< 11	< 2	< 2
	07/03/19 - 10/02/19	127 \pm 18	< 14	< 1	< 1
	10/02/19 - 01/02/20	86 \pm 17	< 16	< 1	< 1
	AVERAGE	113 \pm 37	-	-	-
12S1	01/02/19 - 04/03/19	113 \pm 21	< 16	< 1	< 1
	04/03/19 - 07/03/19	123 \pm 23	< 19	< 2	< 1
	07/03/19 - 10/02/19	140 \pm 19	< 14	< 1	< 1
	10/02/19 - 01/02/20	81 \pm 16	< 15	< 1	< 1
	AVERAGE	114 \pm 49	-	-	-
13S6	01/02/19 - 04/03/19	160 \pm 28	< 17	< 1	< 1
	04/03/19 - 07/03/19	121 \pm 21	< 19	< 1	< 1
	07/03/19 - 10/02/19	123 \pm 19	< 13	< 1	< 1
	10/02/19 - 01/02/20	90 \pm 17	< 13	< 1	< 1
	AVERAGE	124 \pm 58	-	-	-
9B1	01/02/19 - 04/03/19	125 \pm 22	< 13	< 1	< 1
	04/03/19 - 07/03/19	111 \pm 17	< 16	< 1	< 1
	07/03/19 - 10/02/19	133 \pm 17	< 18	< 1	< 1
	10/02/19 - 01/02/20	77 \pm 15	< 19	< 1	< 1
	AVERAGE	112 \pm 49	-	-	-
10S3	01/02/19 - 04/03/19	119 \pm 25	< 21	< 1	< 1
	04/03/19 - 07/03/19	117 \pm 22	< 12	< 1	< 1
	07/03/19 - 10/02/19	123 \pm 19	< 17	< 1	< 1
	10/02/19 - 01/02/20	85 \pm 19	< 23	< 1	< 1
	AVERAGE	111 \pm 35	-	-	-

TABLE C-3

**IODINE-131 ANALYSES OF AIR IODINE SAMPLES
SUSQUEHANNA STEAM ELECTRIC STATION, 2019**

Results in units of E-03 pCi/cu.m. \pm 2 sigma

COLLECTION PERIOD	3S2	8G1	12E1	12S1	13S6	9B1
01/02/19 - 01/09/19	< 5	< 3	< 8	< 5	< 5	< 8
01/09/19 - 01/16/19	< 19	< 19	< 19	< 19	< 20	< 19
01/16/19 - 01/23/19	< 8	< 5	< 5	< 8	< 8	< 5
01/23/19 - 01/30/19	< 17	< 11	< 14	< 17	< 17	< 14
01/30/19 - 02/06/19	< 7	< 12	< 14	< 7	< 7	< 14
02/06/19 - 02/13/19	< 4	< 18	< 18	< 10	< 10	< 19
02/13/19 - 02/20/19	< 7	< 5	< 5	< 7	< 7	< 6
02/20/19 - 02/27/19	< 3	< 6	< 6	< 7	< 8	< 6
02/27/19 - 03/06/19	< 8	< 5	< 6	< 8	< 8	< 6
03/06/19 - 03/13/19	< 8	< 7	< 7	< 8	< 8	< 7
03/13/19 - 03/20/19	< 6	< 7	< 7	< 6	< 6	< 3
03/20/19 - 03/27/19	< 17	< 15	< 15	< 16	< 18	< 12
03/27/19 - 04/03/19	< 7	< 9	< 9	< 7	< 7	< 4
04/03/19 - 04/10/19	< 16	< 16	< 16	< 13	< 16	< 16
04/10/19 - 04/17/19	< 14	< 18	< 18	< 13	< 13	< 19
04/17/19 - 04/24/19	< 14	< 7	< 8	< 13	< 13	< 8
04/24/19 - 05/01/19	< 17	< 12	< 15	< 16	< 16	< 15
05/01/19 - 05/08/19	< 17	< 16	< 13	< 16	< 16	< 17
05/08/19 - 05/15/19	< 6	< 3	< 7	< 6	< 6	< 7
05/15/19 - 05/22/19	< 8	< 5	< 5	< 3	< 7	< 5
05/22/19 - 05/29/19	< 6	< 4	< 9	< 6	< 6	< 9
05/29/19 - 06/05/19	< 16	< 10	< 10	< 13	< 15	< 10
06/05/19 - 06/12/19	< 19	< 18	< 18	< 18	< 19	< 15
06/12/19 - 06/19/19	< 8	< 8	< 6	< 8	< 8	< 3
06/19/19 - 06/26/19	< 16	< 10	< 10	< 16	< 16	< 4
06/26/19 - 07/03/19	< 6	< 8	< 8	< 6	< 6	< 7
07/03/19 - 07/10/19	< 10	< 11	< 4	< 10	< 10	< 11
07/10/19 - 07/17/19	< 14	< 4	< 16	< 16	< 16	< 10
07/17/19 - 07/24/19	< 15	< 20	< 17	< 17	< 17	< 8
07/24/19 - 07/31/19	< 9	< 15	< 15	< 15	< 16	< 12
07/31/19 - 08/07/19	< 6	< 3	< 7	< 7	< 7	< 7
08/07/19 - 08/14/19	< 16	< 16	< 19	< 19	< 19	< 13
08/14/19 - 08/21/19	< 11	< 8	< 8	< 12	< 12	< 8
08/21/19 - 08/28/19	< 10	< 4	< 9	< 10	< 10	< 10
08/28/19 - 09/04/19	< 18	< 15	< 16	< 19	< 19	< 15
09/04/19 - 09/11/19	< 8	< 19	< 16	< 8	< 8	< 19
09/11/19 - 09/18/19	< 5	< 7	< 7	< 5	< 5	< 3
09/18/19 - 09/25/19	< 15	< 14	< 14	< 15	< 16	< 12
09/25/19 - 10/02/19	< 14	< 6	< 17	< 17	< 17	< 6
10/02/19 - 10/09/19	< 7	< 5	< 7	< 7	< 6	< 12
10/09/19 - 10/16/19	< 9	< 6	< 9	< 4	< 9	< 6
10/16/19 - 10/23/19	< 7	< 3	< 8	< 8	< 7	< 8
10/23/19 - 10/30/19	< 19	< 18	< 19	< 19	< 19	< 15
10/30/19 - 11/06/19	< 18	< 19	< 15	< 18	< 18	< 8
11/06/19 - 11/13/19	< 6	< 6	< 7	< 7	< 7	< 6
11/13/19 - 11/20/19	< 5	< 6	< 5	< 4	< 4	< 3
11/20/19 - 11/26/19	< 11	< 11	< 11	< 10	< 13	< 12
11/26/19 - 12/04/19	< 11	< 4	< 5	< 6	< 11	< 5
12/04/19 - 12/11/19	< 13	< 14	< 18	< 19	< 12	< 19
12/11/19 - 12/18/19	< 14	< 7	< 9	< 10	< 15	< 9
12/18/19 - 12/26/19	< 12	< 14	< 12	< 12	< 9	< 15
12/26/19 - 01/02/20	< 15	< 11	< 17	< 17	< 15	< 4
AVERAGE	-	-	-	-	-	-

TABLE C-3

**IODINE-131 ANALYSES OF AIR IODINE SAMPLES
SUSQUEHANNA STEAM ELECTRIC STATION, 2019**

Results in units of E-03 pCi/cu.m. ± 2 sigma

COLLECTION PERIOD	10S3
01/02/19 - 01/09/19	< 5
01/09/19 - 01/16/19	< 19
01/16/19 - 01/23/19	< 8
01/23/19 - 01/30/19	< 17
01/30/19 - 02/06/19	< 7
02/06/19 - 02/13/19	< 19
02/13/19 - 02/20/19	< 3
02/20/19 - 02/27/19	< 6
02/27/19 - 03/06/19	< 8
03/06/19 - 03/13/19	< 8
03/13/19 - 03/20/19	< 6
03/20/19 - 03/27/19	< 16
03/27/19 - 04/03/19	< 7
04/03/19 - 04/10/19	< 16
04/10/19 - 04/17/19	< 20
04/17/19 - 04/24/19	< 14
04/24/19 - 05/01/19	< 16
05/01/19 - 05/08/19	< 16
05/08/19 - 05/15/19	< 6
05/15/19 - 05/22/19	< 7
05/22/19 - 05/29/19	< 6
05/29/19 - 06/05/19	< 15
06/05/19 - 06/12/19	< 18
06/12/19 - 06/19/19	< 8
06/19/19 - 06/26/19	< 10
06/26/19 - 07/03/19	< 6
07/03/19 - 07/10/19	< 10
07/10/19 - 07/17/19	< 16
07/17/19 - 07/24/19	< 17
07/24/19 - 07/31/19	< 16
07/31/19 - 08/07/19	< 7
08/07/19 - 08/14/19	< 19
08/14/19 - 08/21/19	< 12
08/21/19 - 08/28/19	< 10
08/28/19 - 09/04/19	< 19
09/04/19 - 09/11/19	< 3
09/11/19 - 09/18/19	< 5
09/18/19 - 09/25/19	< 14
09/25/19 - 10/02/19	< 17
10/02/19 - 10/09/19	< 7
10/09/19 - 10/16/19	< 9
10/16/19 - 10/23/19	< 8
10/23/19 - 10/30/19	< 16
10/30/19 - 11/06/19	< 18
11/06/19 - 11/13/19	< 7
11/13/19 - 11/20/19	< 5
11/20/19 - 11/26/19	< 11
11/26/19 - 12/04/19	< 5
12/04/19 - 12/11/19	< 18
12/11/19 - 12/18/19	< 9
12/18/19 - 12/26/19	< 11
12/26/19 - 01/02/20	< 16
AVERAGE	-

**TABLE C-4 ENVIRONMENTAL OPTICALLY STIMULATED LUMINESCENCE DOSIMETRY RESULTS
SUSQUEHANNA STEAM ELECTRIC STATION, 2019**

Results (1) are in mR/std. qtr (2) \pm 2 sigma (3)

LOCATION	First Quarter 1/11/2019 to 3/21/2019	Second Quarter 3/21/2019 to 7/22/2019	Third Quarter 7/22/2019 to 10/9/2019	Fourth Quarter 10/9/2019 to 1/17/2020
ONSITE				
1S2	16.9 \pm 1.0	22.2 \pm 1.4	22.9 \pm 1.8	20.7 \pm 0.7
2S2	12.7 \pm 1.2	12.9 \pm 0.1	12.5 \pm 0.2	13.6 \pm 5.3
2S3	16.4 \pm 0.3	19.2 \pm 1.0	18.8 \pm 0.9	20.9 \pm 4.7
3S2	11.6 \pm 0.2	14.2 \pm 0.2	13.7 \pm 0.6	14.0 \pm 2.1
3S3	10.0 \pm 0.5	14.4 \pm 0.5	13.3 \pm 0.2	11.5 \pm 1.9
4S3	17.9 \pm 1.6	19.9 \pm 0.6	17.6 \pm 0.2	20.2 \pm 2.8
4S6	12.3 \pm 2.6	14.1 \pm 0.3	13.7 \pm 1.1	15.7 \pm 1.6
5S4	10.8 \pm 0.9	12.0 \pm 0.5	12.1 \pm 0.5	13.2 \pm 1.5
5S7	14.1 \pm 0.6	17.4 \pm 0.8	16.8 \pm 0.7	16.2 \pm 1.6
6S4	20.5 \pm 0.0	23.2 \pm 1.1	23.3 \pm 0.3	22.5 \pm 2.3
6S9	17.0 \pm 0.6	21.2 \pm 1.3	23.5 \pm 1.1	22.6 \pm 0.5
7S6	16.9 \pm 0.3	20.5 \pm 0.5	22.4 \pm 0.1	20.8 \pm 2.3
7S7	10.8 \pm 0.0	13.3 \pm 0.5	12.3 \pm 0.6	13.2 \pm 0.8
8S2	19.4 \pm 0.6	21.0 \pm 2.1	23.3 \pm 1.3	24.7 \pm 7.0
9S2	25.6 \pm 1.6	34.5 \pm 0.2	40.1 \pm 1.2	41.9 \pm 1.3
10S1	12.4 \pm 2.2	14.5 \pm 2.0	13.7 \pm 0.7	12.1 \pm 0.1
10S2	25.6 \pm 1.6	30.0 \pm 0.7	29.3 \pm 0.7	30.8 \pm 4.1
11S7	11.0 \pm 1.9	14.0 \pm 1.4	14.7 \pm 0.5	14.9 \pm 1.9
12S1	13.5 \pm 2.7	15.1 \pm 0.5	15.0 \pm 0.3	16.3 \pm 0.3
12S3	17.0 \pm 0.6	20.5 \pm 0.0	17.8 \pm 0.2	20.6 \pm 0.1
12S7	11.7 \pm 0.6	15.0 \pm 1.2	15.5 \pm 0.0	13.3 \pm 2.3
13S2	22.2 \pm 1.1	23.7 \pm 1.5	28.8 \pm 4.7	22.7 \pm 5.7
13S5	22.7 \pm 0.4	26.5 \pm 2.5	29.2 \pm 0.6	28.6 \pm 0.6
13S6	16.5 \pm 1.9	19.5 \pm 0.1	20.8 \pm 0.2	19.1 \pm 0.8
14S5	15.1 \pm 0.4	17.6 \pm 0.8	19.3 \pm 0.3	18.9 \pm 0.5
15S5	15.3 \pm 1.5	15.2 \pm 0.2	14.3 \pm 1.9	14.6 \pm 0.3
16S1	16.6 \pm 1.1	20.6 \pm 2.2	21.0 \pm 1.8	16.0 \pm 3.4
16S2	16.7 \pm 2.0	19.6 \pm 1.1	20.6 \pm 1.1	14.4 \pm 2.7

See the comments at the end of this table.

**TABLE C-4 ENVIRONMENTAL OPTICALLY STIMULATED LUMINESCENCE DOSIMETRY RESULTS
SUSQUEHANNA STEAM ELECTRIC STATION, 2019**

Results (1) are in mR/std. qtr (2) \pm 2 sigma (3)

LOCATION	First Quarter 1/11/2019 to 3/21/2019	Second Quarter 3/21/2019 to 7/22/2019	Third Quarter 7/22/2019 to 10/9/2019	Fourth Quarter 10/9/2019 to 1/17/2020
0-1 MILE OFFSITE				
6A4	14.1 \pm 1.0	17.7 \pm 0.7	16.2 \pm 1.5	15.9 \pm 4.7
8A3	14.1 \pm 0.3	14.7 \pm 0.9	15.1 \pm 0.7	14.7 \pm 1.4
15A3	11.0 \pm 0.2	12.9 \pm 0.9	12.0 \pm 0.4	11.5 \pm 1.4
16A2	9.8 \pm 0.7	12.2 \pm 0.1	12.6 \pm 0.3	10.7 \pm 4.7
1-2 MILES OFFSITE				
8B2	12.9 \pm 1.3	13.5 \pm 0.1	13.1 \pm 4.2	15.3 \pm 2.5
9B1	15.6 \pm 0.2	18.9 \pm 1.5	18.8 \pm 0.2	19.3 \pm 0.3
10B3	12.2 \pm 1.2	13.2 \pm 0.4	12.2 \pm 1.0	11.0 \pm 1.2
3-4 MILES OFFSITE				
1D5	14.3 \pm 0.5	16.2 \pm 0.1	16.6 \pm 0.3	15.5 \pm 1.2
8D3	13.8 \pm 0.7	13.2 \pm 1.1	15.4 \pm 1.2	15.1 \pm 1.3
9D4	14.8 \pm 0.5	15.3 \pm 0.9	18.1 \pm 0.8	16.0 \pm 1.2
10D1	14.0 \pm 0.6	14.9 \pm 1.7	15.0 \pm 0.9	15.1 \pm 0.5
12D2	15.5 \pm 0.6	18.2 \pm 0.7	18.1 \pm 0.5	18.1 \pm 1.7
14D1	11.3 \pm 1.9	15.5 \pm 0.8	14.5 \pm 0.9	16.4 \pm 1.2
4-5 MILES OFFSITE				
3E1	12.1 \pm 0.9	11.2 \pm 0.5	12.8 \pm 1.1	14.7 \pm 1.1
4E2	13.4 \pm 1.0	14.8 \pm 1.0	17.3 \pm 0.1	16.9 \pm 3.8
5E2	14.6 \pm 2.6	15.5 \pm 0.3	16.3 \pm 0.5	15.6 \pm 0.3
6E1	17.1 \pm 1.0	16.4 \pm 0.7	18.4 \pm 0.2	18.3 \pm 1.4
7E1	14.5 \pm 0.1	14.5 \pm 0.7	16.9 \pm 0.0	18.0 \pm 3.5
11E1	10.0 \pm 0.4	10.9 \pm 0.0	12.6 \pm 0.6	13.4 \pm 0.7
12E1	11.3 \pm 1.5	13.0 \pm 0.3	12.0 \pm 0.0	15.5 \pm 0.6
13E4	16.0 \pm 0.3	16.7 \pm 1.1	15.1 \pm 0.2	19.5 \pm 0.8

See the comments at the end of this table.

**TABLE C-4 ENVIRONMENTAL OPTICALLY STIMULATED LUMINESCENCE DOSIMETRY RESULTS
SUSQUEHANNA STEAM ELECTRIC STATION, 2019**

Results (1) are in mR/std. qtr (2) \pm 2 sigma (3)

<u>LOCATION</u>	First Quarter 1/11/2019 to 3/21/2019	Second Quarter 3/21/2019 to 7/22/2019	Third Quarter 7/22/2019 to 10/9/2019	Fourth Quarter 10/9/2019 to 1/17/2020
<u>5-10 MILES OFFSITE</u>				
2F1	12.8 \pm 0.1	14.6 \pm 0.1	16.4 \pm 0.8	12.8 \pm 0.1
15F1	16.0 \pm 1.1	15.9 \pm 2.2	14.7 \pm 0.4	17.3 \pm 0.6
16F1	14.9 \pm 0.3	18.4 \pm 0.3	16.6 \pm 1.1	20.0 \pm 1.0
<u>10-20 MILES OFFSITE</u>				
3G4	15.0 \pm 0.9	15.6 \pm 0.0	17.7 \pm 0.1	17.9 \pm 3.6
4G1	16.9 \pm 0.8	17.0 \pm 0.6	18.3 \pm 1.1	18.5 \pm 0.6
7G1	13.6 \pm 0.9	13.8 \pm 0.2	17.4 \pm 0.6	13.6 \pm 2.3
12G1	10.7 \pm 0.4	12.5 \pm 0.5	15.5 \pm 2.4	10.1 \pm 1.3
12G4	13.4 \pm 0.1	13.7 \pm 0.2	15.1 \pm 1.2	12.1 \pm 0.3

See the comments at the end of this table.

LOCATION

INDICATOR				
Average (5)	14.9 \pm 7.3	17.1 \pm 9.2	17.6 \pm 10.9	17.5 \pm 10.8
CONTROL				
Average (5)	13.9 \pm 4.6	14.7 \pm 4.0	16.8 \pm 2.8	14.5 \pm 7.3

COMMENTS

- (1) Individual monitor location results are normally the average of the elemental doses of four elements from the two dosimeters assigned to each monitoring location.
- (2) A standard (std.) quarter (qtr.) is considered to be 91.25 days. Results obtained for monitoring periods of other durations are normalized by multiplying them by 91.25/x, where x is the actual duration in days of the period.
- (3) Uncertainties for individual monitoring location results are two standard deviations of the elemental doses of four elements from the two dosimeters assigned to each monitoring location, representing the variability between the elemental doses of each of the four dosimeter elements.
- (4) No measurement could be made at this location because the dosimeters were lost, stolen, or damaged. Refer to Section III, Program Description, of the Annual Radiological Environmental Operating Report for an explanation of program exceptions to REMP.
- (5) Uncertainties associated with quarterly indicator and control averages are two standard deviations, representing the variability between the results of the individual monitoring locations.

TABLE C-5

**IODINE-131 AND GAMMA SPECTROSCOPIC ANALYSES OF MILK
SUSQUEHANNA STEAM ELECTRIC STATION, 2019**

Results in pCi/Liter \pm 2 sigma

SITE	COLLECTION DATE	I-131	<-----GAMMA EMITTERS----->					
			K-40	Cs-134	Cs-137	Ba-140	La-140	Th-228
10G1	01/07/19	< 1.0	1384 \pm 164	< 11	< 10	< 38	< 9	< 20
	02/04/19	< 0.3	1281 \pm 134	< 8	< 8	< 25	< 7	< 15
	03/04/19	< 0.8	1411 \pm 144	< 5	< 6	< 27	< 8	< 11
	04/08/19	< 0.7	1356 \pm 147	< 6	< 7	< 24	< 9	< 11
	04/22/19	< 0.4	1463 \pm 207	< 8	< 8	< 28	< 10	< 17
	05/06/19	< 0.5	1348 \pm 159	< 5	< 6	< 22	< 5	< 12
	05/20/19	< 0.7	1408 \pm 152	< 6	< 7	< 20	< 8	< 11
	06/03/19	< 0.5	1257 \pm 207	< 7	< 9	< 40	< 11	< 18
	06/16/19	< 0.7	1209 \pm 148	< 7	< 6	< 26	< 10	< 13
	07/01/19	< 0.9	1433 \pm 147	< 7	< 7	< 31	< 11	< 11
	07/15/19	< 0.9	1301 \pm 174	< 6	< 8	< 30	< 10	< 13
	07/29/19	< 0.9	1080 \pm 182	< 8	< 8	< 30	< 10	< 14
	08/12/19	< 0.6	1372 \pm 176	< 6	< 8	< 39	< 10	< 17
	08/26/19	< 0.9	1274 \pm 215	< 7	< 8	< 39	< 10	< 15
	09/09/19	< 0.9	1429 \pm 219	< 9	< 10	< 47	< 12	< 20
	09/23/19	< 0.7	1377 \pm 185	< 7	< 8	< 36	< 12	< 16
	10/07/19	< 0.7	1324 \pm 179	< 8	< 8	< 27	< 11	< 16
10/21/19	< 0.9	1263 \pm 198	< 7	< 9	< 38	< 10	< 20	
11/04/19	< 0.9	1374 \pm 161	< 6	< 7	< 31	< 8	< 12	
12/09/19	< 0.5	1264 \pm 153	< 6	< 7	< 29	< 9	< 13	
	AVERAGE	-	1330 \pm 183	-	-	-	-	-
13E3	01/07/19	< 0.5	1349 \pm 164	< 6	< 7	< 26	< 8	< 13
	02/04/19	< 0.4	1372 \pm 147	< 10	< 8	< 33	< 9	< 18
	03/04/19	< 0.6	1466 \pm 172	< 6	< 6	< 33	< 10	< 14
	04/08/19	< 0.5	1292 \pm 148	< 5	< 6	< 24	< 6	< 11
	04/22/19	< 0.4	1317 \pm 195	< 6	< 8	< 31	< 7	< 14
	05/06/19	< 0.9	1262 \pm 159	< 6	< 5	< 23	< 4	< 13
	05/20/19	< 0.8	1247 \pm 171	< 5	< 6	< 24	< 7	< 11
	06/03/19	< 0.6	1306 \pm 164	< 8	< 9	< 34	< 11	< 13
	06/16/19	< 0.8	1425 \pm 174	< 7	< 6	< 27	< 6	< 16
	07/01/19	< 0.6	1504 \pm 167	< 6	< 6	< 31	< 10	< 12
	07/15/19	< 0.9	1361 \pm 179	< 6	< 8	< 27	< 9	< 13
	07/29/19	< 0.6	1190 \pm 199	< 8	< 11	< 35	< 12	< 17
	08/12/19	< 1.0	1422 \pm 132	< 4	< 6	< 20	< 6	< 10
	08/26/19	< 0.9	1210 \pm 153	< 8	< 9	< 32	< 9	< 15
	09/09/19	< 0.8	1306 \pm 114	< 6	< 6	< 21	< 8	< 11
	09/23/19	< 0.8	1357 \pm 191	< 8	< 10	< 37	< 8	< 20
	10/07/19	< 0.7	1337 \pm 93	< 3	< 4	< 13	< 4	< 6.9
10/21/19	< 0.8	1227 \pm 128	< 9	< 8	< 34	< 8	< 15	
11/04/19	< 0.8	1275 \pm 166	< 7	< 7	< 28	< 10	< 13	
12/09/19	< 0.5	1313 \pm 182	< 6	< 9	< 29	< 11	< 13	
	AVERAGE	-	1327 \pm 167	-	-	-	-	-

TABLE C-5

**IODINE-131 AND GAMMA SPECTROSCOPIC ANALYSES OF MILK
SUSQUEHANNA STEAM ELECTRIC STATION, 2019**

Results in pCi/Liter \pm 2 sigma

SITE	COLLECTION DATE	I-131	<-----GAMMA EMITTERS----->					
			K-40	Cs-134	Cs-137	Ba-140	La-140	Th-228
5E2	01/07/19	< 0.6	1042 \pm 182	< 9	< 9	< 34	< 12	< 16
	02/04/19	< 0.4	1187 \pm 135	< 9	< 8	< 29	< 10	< 17
	03/04/19	< 0.5	1322 \pm 177	< 6	< 5	< 26	< 8	< 11
	04/08/19	< 0.5	1336 \pm 126	< 4	< 4	< 19	< 5	< 8.3
	04/22/19	< 0.4	1428 \pm 180	< 7	< 8	< 29	< 10	< 15
	05/06/19	< 0.6	1069 \pm 178	< 6	< 6	< 23	< 5	< 12
	05/20/19	< 0.8	1127 \pm 138	< 6	< 7	< 21	< 6	< 11
	06/03/19	< 0.5	1132 \pm 202	< 9	< 9	< 34	< 8	< 17
	06/16/19	< 0.8	1208 \pm 188	< 6	< 9	< 28	< 14	< 14
	07/01/19	< 0.6	1222 \pm 166	< 6	< 6	< 37	< 10	< 14
	07/15/19	< 0.9	1070 \pm 172	< 6	< 5	< 34	< 8	< 10
	07/29/19	< 0.7	1210 \pm 202	< 6	< 8	< 31	< 10	< 18
	08/12/19	< 0.7	1106 \pm 137	< 5	< 5	< 24	< 9	< 12
	08/26/19	< 0.8	1238 \pm 193	< 7	< 7	< 29	< 8	< 17
	09/09/19	< 0.8	1288 \pm 128	< 6	< 7	< 23	< 7	< 13
	09/23/19	< 0.9	1312 \pm 204	< 8	< 11	< 33	< 8	< 17
	10/07/19	< 0.8	1428 \pm 199	< 6	< 8	< 29	< 7	< 15
	10/21/19	< 0.7	1278 \pm 152	< 6	< 7	< 23	< 9	< 13
11/04/19	< 0.8	1411 \pm 178	< 6	< 7	< 28	< 9	< 14	
12/09/19	< 0.8	1146 \pm 156	< 6	< 8	< 24	< 8	< 14	
AVERAGE	-	-	1228 \pm 241	-	-	-	-	-

**TABLE C-6 TRITIUM AND GAMMA SPECTROSCOPIC ANALYSES OF GROUNDWATER
SUSQUEHANNA STEAM ELECTRIC STATION, 2019**

Results in pCi/Liter ± 2 sigma

SITE	COLLECTION DATE	H-3	<-----GAMMA EMITTERS----->													
			K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Th-228
2S8	01/25/19	< 143	< 115	< 6	< 7	< 23	< 6	< 16	< 8	< 11	< 12	< 7	< 5	< 34	< 8	< 13
	04/25/19	< 147	< 73	< 6	< 6	< 16	< 7	< 13	< 7	< 11	< 13	< 6	< 8	< 32	< 10	< 14
	07/18/19	< 142	< 75	< 6	< 6	< 17	< 7	< 17	< 8	< 12	< 11	< 6	< 8	< 29	< 9	< 17
	10/09/19	< 144	< 125	< 5	< 7	< 19	< 8	< 15	< 8	< 15	< 12	< 7	< 6	< 34	< 12	< 12
	AVERAGE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13S7	01/28/19	177 ± 92	< 133	< 5	< 5	< 17	< 7	< 13	< 8	< 12	< 10	< 7	< 6	< 30	< 13	< 12
	04/29/19	< 148	< 58	< 5	< 6	< 14	< 6	< 12	< 6	< 10	< 11	< 5	< 6	< 32	< 8	< 12
	07/16/19	150 ± 95	< 51	< 6	< 6	< 16	< 6	< 12	< 7	< 10	< 9	< 6	< 6	< 29	< 10	< 10
	10/08/19	< 149	< 75	< 7	< 8	< 23	< 7	< 12	< 6	< 12	< 13	< 6	< 6	< 34	< 11	< 12
	AVERAGE	164 ± 38	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1S3	01/28/19	303 ± 100	< 100	< 5	< 6	< 17	< 6	< 11	< 7	< 9	< 8	< 5	< 6	< 24	< 12	< 12
	04/29/19	343 ± 104	< 69	< 8	< 6	< 16	< 7	< 16	< 6	< 12	< 11	< 6	< 6	< 27	< 9	< 13
	07/15/19	210 ± 97	< 137	< 5	< 6	< 18	< 7	< 10	< 7	< 10	< 11	< 6	< 6	< 25	< 10	< 12
	10/08/19	154 ± 97	< 97	< 5	< 7	< 12	< 7	< 10	< 7	< 11	< 11	< 5	< 6	< 30	< 11	< 13
	AVERAGE	253 ± 172	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4S8	01/28/19	205 ± 93	< 114	< 6	< 6	< 18	< 6	< 14	< 8	< 11	< 9	< 5	< 7	< 27	< 6	< 13
	04/29/19	203 ± 98	< 90	< 6	< 6	< 16	< 6	< 11	< 6	< 12	< 10	< 5	< 5	< 29	< 10	< 11
	07/16/19	206 ± 96	< 52	< 6	< 6	< 18	< 7	< 13	< 5	< 11	< 10	< 6	< 6	< 26	< 10	< 11
	10/08/19	169 ± 97	< 105	< 5	< 4	< 12	< 8	< 15	< 9	< 10	< 10	< 6	< 7	< 30	< 15	< 11
	AVERAGE	196 ± 36	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4S9	01/24/19	< 145	< 106	< 6	< 6	< 16	< 6	< 17	< 9	< 12	< 13	< 7	< 7	< 31	< 13	< 14
	04/22/19	< 147	< 59	< 5	< 4	< 10	< 7	< 12	< 5	< 7	< 10	< 6	< 5	< 28	< 12	< 11
	07/17/19	192 ± 95	< 99	< 5	< 5	< 12	< 6	< 12	< 6	< 12	< 10	< 5	< 5	< 26	< 7	< 11
	10/09/19	< 145	< 138	< 4	< 5	< 23	< 8	< 18	< 7	< 11	< 13	< 5	< 8	< 33	< 9	< 14
	AVERAGE	192 ± 0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6S11A	01/25/19	< 145	< 59	< 5	< 6	< 20	< 6	< 12	< 6	< 12	< 13	< 5	< 5	< 38	< 12	< 10
	04/25/19	< 147	< 86	< 5	< 4	< 15	< 6	< 9	< 5	< 8	< 9	< 5	< 5	< 23	< 8	< 9
	07/17/19	< 142	< 44	< 5	< 6	< 17	< 6	< 14	< 6	< 8	< 10	< 5	< 5	< 24	< 10	< 10
	10/09/19	< 143	< 61	< 7	< 8	< 26	< 8	< 14	< 8	< 12	< 13	< 8	< 8	< 36	< 12	< 15
	AVERAGE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

**TABLE C-6 TRITIUM AND GAMMA SPECTROSCOPIC ANALYSES OF GROUNDWATER
SUSQUEHANNA STEAM ELECTRIC STATION, 2019**

Results in pCi/Liter ± 2 sigma

SITE	COLLECTION DATE	H-3	<-----GAMMA EMITTERS----->													
			K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Th-228
6S12	01/24/19	< 142	< 127	< 6	< 8	< 18	< 7	< 15	< 8	< 12	< 11	< 7	< 7	< 38	< 12	< 14
	04/22/19	< 150	< 102	< 6	< 6	< 16	< 6	< 12	< 7	< 11	< 14	< 6	< 7	< 37	< 14	< 12
	07/17/19	< 146	< 57	< 5	< 7	< 16	< 7	< 12	< 7	< 10	< 9	< 6	< 7	< 28	< 9	< 11
	10/09/19	< 145	< 149	< 9	< 8	< 16	< 8	< 20	< 8	< 14	< 14	< 10	< 8	< 38	< 13	< 16
	AVERAGE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7S10	01/24/19	< 144	< 44	< 5	< 5	< 14	< 6	< 10	< 7	< 11	< 11	< 5	< 7	< 29	< 9	< 10
	04/22/19	170 ± 96	< 48	< 6	< 6	< 18	< 6	< 15	< 6	< 11	< 13	< 6	< 6	< 31	< 10	< 12
	07/15/19	< 145	< 110	< 5	< 5	< 13	< 5	< 12	< 6	< 10	< 11	< 5	< 6	< 31	< 9	< 11
	10/07/19	< 145	< 106	< 6	< 5	< 19	< 8	< 14	< 6	< 13	< 14	< 6	< 6	< 31	< 11	< 14
	AVERAGE	170 ± 0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7S11	01/24/19	< 141	< 115	< 5	< 6	< 13	< 6	< 13	< 6	< 11	< 13	< 5	< 6	< 29	< 11	< 11
	04/22/19	< 147	< 135	< 6	< 6	< 19	< 7	< 10	< 9	< 12	< 14	< 5	< 6	< 38	< 8	< 12
	07/15/19	< 141	< 81	< 4	< 5	< 11	< 6	< 8	< 6	< 9	< 10	< 5	< 5	< 21	< 6	< 12
	10/07/19	< 142	< 122	< 5	< 6	< 17	< 6	< 12	< 8	< 11	< 14	< 5	< 6	< 37	< 12	< 12
	AVERAGE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8S4	01/28/19	< 137	< 115	< 6	< 5	< 20	< 7	< 12	< 8	< 11	< 10	< 6	< 5	< 27	< 10	< 13
	04/29/19	195 ± 96	< 114	< 6	< 6	< 18	< 6	< 15	< 6	< 11	< 12	< 7	< 7	< 30	< 9	< 14
	07/16/19	< 134	< 100	< 5	< 5	< 16	< 6	< 11	< 5	< 10	< 10	< 6	< 5	< 25	< 8	< 11
	10/08/19	159 ± 95	< 168	< 8	< 8	< 18	< 6	< 16	< 8	< 12	< 14	< 5	< 7	< 34	< 12	< 15
	AVERAGE	177 ± 51	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-7

**ANNUAL AVERAGE TRITIUM CONCENTRATION IN PRECIPITATION,
MONITORING WELLS AND LAKE TOOK-A-WHILE (LTAW) SURFACE WATER DATA
SUSQUEHANNA STEAM ELECTRIC STATION, 2019**

Results in pCi/Liter \pm 2 sigma

SITE	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Precip Sites 3S2**, 12S1**, 8G1** (offsite, controls)	62*	49	40	38	82	63	51	39	45	32	45	**
Precip Sites 1 and 2 (onsite, East of Station Reactor Bldgs)	370	230*	193	216	242	182	142	250	206	251	325	333
Precipitation Sites 3 and 4 (onsite, West of Station Reactor Bldgs)	414	404*	350	233	169	151	231	258	197	383	494	355
1S3 - MW-1 (43')	248	150	252	131	164	197	115	169	175	130	218	253
4S8 - MW-2 (45')	292	154	190	173	137	202	187	138	154	138	191	196
4S9 - MW-3 (94')	127	54	150	64	80	135	94	180	125	55	109	92
8S4 - MW-4 (111')	172	66	105	68	81	109	60	162	145	91	102	155
7S10 - MW-5 (36')	171	69	96	-6	74	106	68	70	73	51	93	125
13S7 - MW-6 (16')	142	134	143	34	80	111	71	79	111	107	122	120
2S8 - MW-7 (85')	Not installed	Not installed	Not installed	22	54	72	70	70	74	56	37	71
6S11A - MW-8A (14')	177	82	165	58	15	72	103	110	63	38	50	83
6S11B - MW-8B (19')	Dry well	Dry well	Dry well	Dry well	Dry well	Dry well	Dry well	Dry well	Dry well	Dry well	Dry well	Dry well
6S12 - MW-9 (28')	30	-44	45	18	6	60	21	57	70	5	27	50
7S11 - MW-10 (132')	3	-27	-9	1	-1	23	29	55	13	1	33	16
**12F3 - Groundwater Control	26	-53	-2	5	-6	45	-26	20	41	61	82	**
**LTAW- Surface Water	179	104	110	132	132	145	27	73	89	77	135	**

* Revised values to reflect full scope of precipitation data.

** Stations were discontinued after 5/30/18.

TABLE C-8

GROSS BETA, TRITIUM AND GAMMA SPECTROSCOPIC ANALYSES OF DRINKING WATER
SUSQUEHANNA STEAM ELECTRIC STATION, 2019

Results in pCi/Liter ± 2 sigma

SITE	COLLECTION PERIOD		Gr-B	H-3	<-----GAMMA EMITTERS----->												
	START	STOP			K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140
12H2	12/31/18	01/28/19	< 2.0	< 143	< 29	< 2	< 2	< 6	< 2	< 3	< 2	< 4	< 10	< 2	< 2	< 18	< 6
12H2	01/28/19	02/26/19	< 1.8	< 134	< 33	< 1	< 2	< 4	< 2	< 3	< 2	< 3	< 9	< 2	< 2	< 17	< 6
12H2	02/26/19	03/26/19	< 2.1	< 150	< 29	< 2	< 2	< 5	< 2	< 4	< 2	< 3	< 9	< 2	< 2	< 16	< 6
12H2	03/26/19	04/30/19	< 1.7	< 149	< 31	< 2	< 2	< 6	< 2	< 3	< 2	< 3	< 12	< 2	< 2	< 19	< 7
12H2	04/30/19	05/28/19	< 2.0	< 139	< 15	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 10	< 2	< 2	< 17	< 6
12H2	05/28/19	06/25/19	< 2.0	< 141	< 35	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 10	< 2	< 2	< 18	< 6
12H2	06/25/19	07/30/19	2.4 ± 1.4	< 147	< 16	< 2	< 2	< 6	< 2	< 3	< 2	< 3	< 12	< 1	< 2	< 20	< 6
12H2	07/02/19	07/02/19	< 1.9	< 146	< 35	< 2	< 2	< 8	< 2	< 4	< 2	< 4	< 10	< 2	< 2	< 37	< 12
12H2	07/30/19	08/27/19	2.4 ± 1.4	< 133	< 14	< 2	< 2	< 6	< 2	< 4	< 2	< 3	< 10	< 2	< 2	< 18	< 6
12H2	08/27/19	09/24/19	2.7 ± 1.6	< 147	< 16	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 9	< 2	< 2	< 17	< 5
12H2	09/24/19	10/29/19	2.8 ± 1.5	< 141	< 18	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 9	< 1	< 2	< 16	< 6
12H2	10/29/19	11/25/19	2.5 ± 1.3	< 137	< 27	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 9	< 1	< 2	< 16	< 5
12H2	11/25/19	12/31/19	< 1.8	< 138	< 16	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 14	< 2	< 2	< 22	< 8
	AVERAGE		2.6 ± 0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-9

**GAMMA SPECTROSCOPIC ANALYSES OF FOOD PRODUCTS (FRUITS, VEGETABLES AND BROADLEAF)
SUSQUEHANNA STEAM ELECTRIC STATION, 2019**

Results in pCi/kg (wet) \pm 2 sigma

SITE	COLLECTION DATE	Be-7	K-40	I-131	Cs-134	Cs-137	Ac-228	Th-228
11D1	11/26/19	< 196	2857 \pm 449	< 46	< 22	< 24	< 101	< 47
	11/26/19	< 213	17410 \pm 1072	< 52	< 22	< 28	< 115	< 44
	11/26/19	< 185	2962 \pm 584	< 46	< 18	< 23	< 88	< 44
	AVERAGE	-	7743 \pm 16744	-	-	-	-	-
11S6	06/25/19	< 333	5230 \pm 708	< 30	< 23	< 26	< 100	< 52
	06/25/19	< 237	4336 \pm 625	< 34	< 21	< 26	< 72	< 39
	07/15/19	352 \pm 102	4398 \pm 410	< 18	< 15	< 17	< 72	< 23
	07/15/19	< 170	4828 \pm 422	< 20	< 16	< 17	< 62	< 32
	08/19/19	958 \pm 277	4194 \pm 688	< 36	< 28	< 26	< 122	< 42
	08/19/19	461 \pm 201	4681 \pm 621	< 31	< 21	< 23	< 104	< 45
	09/16/19	< 331	4240 \pm 556	< 38	< 40	< 34	< 131	< 57
	09/16/19	< 263	4552 \pm 651	< 30	< 28	< 29	< 89	< 48
	10/14/19	606 \pm 271	5314 \pm 687	< 38	< 26	< 29	< 106	< 47
	10/14/19	< 327	4218 \pm 692	< 39	< 27	< 31	< 145	< 55
AVERAGE	594 \pm 528	4599 \pm 821	-	-	-	-	-	

TABLE C-10

TRITIUM AND GAMMA SPECTROSCOPIC ANALYSES OF SURFACE WATER
SUSQUEHANNA STEAM ELECTRIC STATION, 2019

Results in pCi/Liter ± 2 sigma

SITE	COLLECTION PERIOD	H-3	<-----GAMMA EMITTERS----->													
			K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Th-228
6S6	12/31/18 - 01/28/19	< 146	< 19	< 2	< 2	< 6	< 2	< 4	< 2	< 3	< 10	< 2	< 2	< 18	< 6	< 3
	01/28/19 - 02/26/19	< 147	< 15	< 2	< 2	< 5	< 2	< 4	< 2	< 4	< 10	< 2	< 2	< 18	< 5	< 3
	02/26/19 - 03/26/19	< 148	< 16	< 2	< 2	< 7	< 2	< 4	< 2	< 4	< 10	< 2	< 2	< 20	< 6	< 3
	03/26/19 - 04/30/19	< 149	< 32	< 2	< 2	< 6	< 2	< 3	< 2	< 3	< 12	< 1	< 2	< 19	< 6	< 3
	04/30/19 - 05/28/19	< 140	< 15	< 2	< 2	< 6	< 2	< 4	< 2	< 3	< 10	< 2	< 2	< 18	< 6	< 3
	05/28/19 - 06/25/19	< 141	< 15	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 10	< 2	< 2	< 17	< 5	< 3
	06/25/19 - 07/30/19	< 143	< 17	< 2	< 2	< 5	< 2	< 4	< 2	< 4	< 15	< 2	< 2	< 23	< 7	< 3
	07/30/19 - 08/27/19	< 141	< 15	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 10	< 1	< 2	< 16	< 6	< 3
	08/27/19 - 09/24/19	< 143	< 24	< 1	< 2	< 4	< 2	< 3	< 2	< 3	< 6	< 1	< 1	< 12	< 4	< 3
	09/24/19 - 10/29/19	< 144	< 40	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 9	< 2	< 2	< 17	< 5	< 3
	10/29/19 - 11/25/19	< 140	< 32	< 2	< 2	< 6	< 2	< 3	< 2	< 3	< 10	< 2	< 2	< 16	< 6	< 3
11/25/19 - 12/31/19	< 141	< 33	< 2	< 2	< 6	< 2	< 3	< 2	< 3	< 13	< 2	< 2	< 21	< 7	< 3	
	AVERAGE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2S7	12/31/18 - 01/28/19	342 ± 103	< 15	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 12	< 2	< 2	< 21	< 6	< 4
	01/28/19 - 02/26/19	164 ± 95	< 25	< 1	< 2	< 5	< 1	< 3	< 2	< 3	< 8	< 1	< 2	< 14	< 5	< 3
	02/26/19 - 03/26/19	723 ± 121	< 16	< 2	< 2	< 6	< 2	< 3	< 2	< 3	< 9	< 1	< 2	< 15	< 5	< 3
	03/26/19 - 04/30/19	2050 ± 217	< 16	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 12	< 2	< 2	< 20	< 6	< 3
	04/30/19 - 05/28/19	899 ± 156	< 14	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 11	< 2	< 2	< 18	< 6	< 3
	05/28/19 - 06/10/19	287 ± 102	< 32	< 1	< 2	< 5	< 2	< 3	< 2	< 3	< 14	< 1	< 1	< 22	< 7	< 3
	06/11/19 - 06/25/19	195 ± 98	< 16	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 6	< 2	< 2	< 13	< 4	< 3
	07/02/19 - 07/30/19	312 ± 107	< 18	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 13	< 2	< 2	< 23	< 6	< 4
	08/06/19 - 08/27/19	165 ± 94	< 15	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 8	< 2	< 2	< 16	< 6	< 3
	08/27/19 - 09/24/19	3660 ± 421	< 14	< 1	< 2	< 5	< 2	< 3	< 2	< 3	< 7	< 1	< 2	< 13	< 4	< 3
	09/24/19 - 10/29/19	752 ± 145	< 15	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 8	< 1	< 2	< 15	< 5	< 3
10/29/19 - 11/25/19	609 ± 117	< 17	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 11	< 2	< 2	< 19	< 6	< 3	
11/25/19 - 12/31/19	< 145	< 16	< 2	< 2	< 6	< 2	< 4	< 2	< 3	< 13	< 2	< 2	< 20	< 7	< 3	
	AVERAGE	847 ± 2059	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-10

TRITIUM AND GAMMA SPECTROSCOPIC ANALYSES OF SURFACE WATER
SUSQUEHANNA STEAM ELECTRIC STATION, 2019

Results in pCi/Liter ± 2 sigma

SITE	COLLECTION PERIOD	H-3	<-----GAMMA EMITTERS----->													
			K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Th-228
6S5	01/08/19 - 01/28/19	< 145	< 33	< 3	< 3	< 11	< 4	< 6	< 3	< 5	< 14	< 3	< 3	< 28	< 10	< 5
	02/05/19 - 02/26/19	< 149	< 53	< 3	< 4	< 10	< 3	< 7	< 4	< 6	< 11	< 4	< 4	< 25	< 7	< 7
	03/05/19 - 03/26/19	< 147	< 29	< 2	< 2	< 6	< 2	< 4	< 2	< 3	< 7	< 2	< 2	< 14	< 5	< 3
	04/02/19 - 04/30/19	< 150	< 20	< 2	< 2	< 7	< 2	< 4	< 2	< 4	< 12	< 2	< 2	< 20	< 7	< 4
	05/07/19 - 05/28/19	< 141	< 29	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 7	< 2	< 2	< 14	< 5	< 3
	06/04/19 - 06/25/19	< 145	< 32	< 3	< 4	< 10	< 4	< 7	< 4	< 7	< 13	< 3	< 3	< 28	< 10	< 6
	07/02/19 - 07/30/19	< 147	< 31	< 2	< 2	< 6	< 2	< 3	< 2	< 4	< 10	< 2	< 2	< 17	< 6	< 3
	08/06/19 - 08/27/19	< 139	< 30	< 2	< 2	< 6	< 2	< 4	< 2	< 3	< 8	< 2	< 2	< 15	< 6	< 3
	09/03/19 - 09/24/19	< 145	< 26	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 5	< 1	< 2	< 10	< 4	8 ± 4
	10/01/19 - 10/29/19	< 144	< 25	< 2	< 2	< 6	< 2	< 4	< 2	< 3	< 6	< 2	< 2	< 13	< 5	< 3
	11/05/19 - 11/25/19	< 137	< 32	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 8	< 2	< 2	< 16	< 6	< 4
	12/03/19 - 12/31/19	< 139	< 26	< 1	< 2	< 5	< 2	< 3	< 2	< 3	< 9	< 1	< 2	< 16	< 6	< 3
	AVERAGE		-	-	-	-	-	-	-	-	-	-	-	-	-	8 ± 0

TABLE C-11

GAMMA SPECTROSCOPIC ANALYSIS OF FISH
SUSQUEHANNA STEAM ELECTRIC STATION, 2019

Results in pCi/kg (wet) ± 2 sigma

SITE	COLLECTION DATE	K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Cs-134	Cs-137
2H									
Channel Catfish	05/22/19	3669 ± 803	< 55	< 54	< 149	< 57	< 96	< 48	< 43
Smallmouth Bass	05/22/19	3728 ± 764	< 43	< 42	< 134	< 49	< 95	< 43	< 43
White Sucker	05/22/19	3890 ± 913	< 51	< 40	< 153	< 52	< 104	< 42	< 49
Channel Catfish	10/11/19	2889 ± 988	< 53	< 51	< 175	< 51	< 93	< 53	< 52
Smallmouth Bass	10/11/19	3422 ± 1108	< 65	< 65	< 167	< 66	< 142	< 59	< 76
Shorthead Redhorse	10/11/19	4485 ± 1165	< 76	< 89	< 231	< 67	< 222	< 88	< 77
	AVERAGE	3681 ± 1053	-	-	-	-	-	-	-
IND									
Channel Catfish	05/21/19	4393 ± 957	< 42	< 57	< 182	< 63	< 119	< 52	< 51
White Sucker	05/21/19	3354 ± 909	< 55	< 46	< 201	< 58	< 89	< 47	< 49
Smallmouth Bass	05/21/19	3880 ± 1020	< 67	< 43	< 186	< 60	< 124	< 60	< 50
Shorthead Redhorse	10/10/19	3870 ± 669	< 41	< 45	< 91	< 49	< 66	< 31	< 43
Smallmouth Bass	10/10/19	4034 ± 1129	< 70	< 62	< 202	< 62	< 136	< 64	< 71
Channel Catfish	10/10/19	3863 ± 921	< 33	< 55	< 107	< 54	< 104	< 55	< 44
	AVERAGE	3899 ± 670	-	-	-	-	-	-	-
LTAW									
Largemouth Bass	10/11/19	4219 ± 1036	< 49	< 44	< 177	< 66	< 130	< 51	< 62
Gizzard Shad	10/11/19	3953 ± 1134	< 61	< 76	< 199	< 74	< 170	< 86	< 68
	AVERAGE	4086 ± 376	-	-	-	-	-	-	-

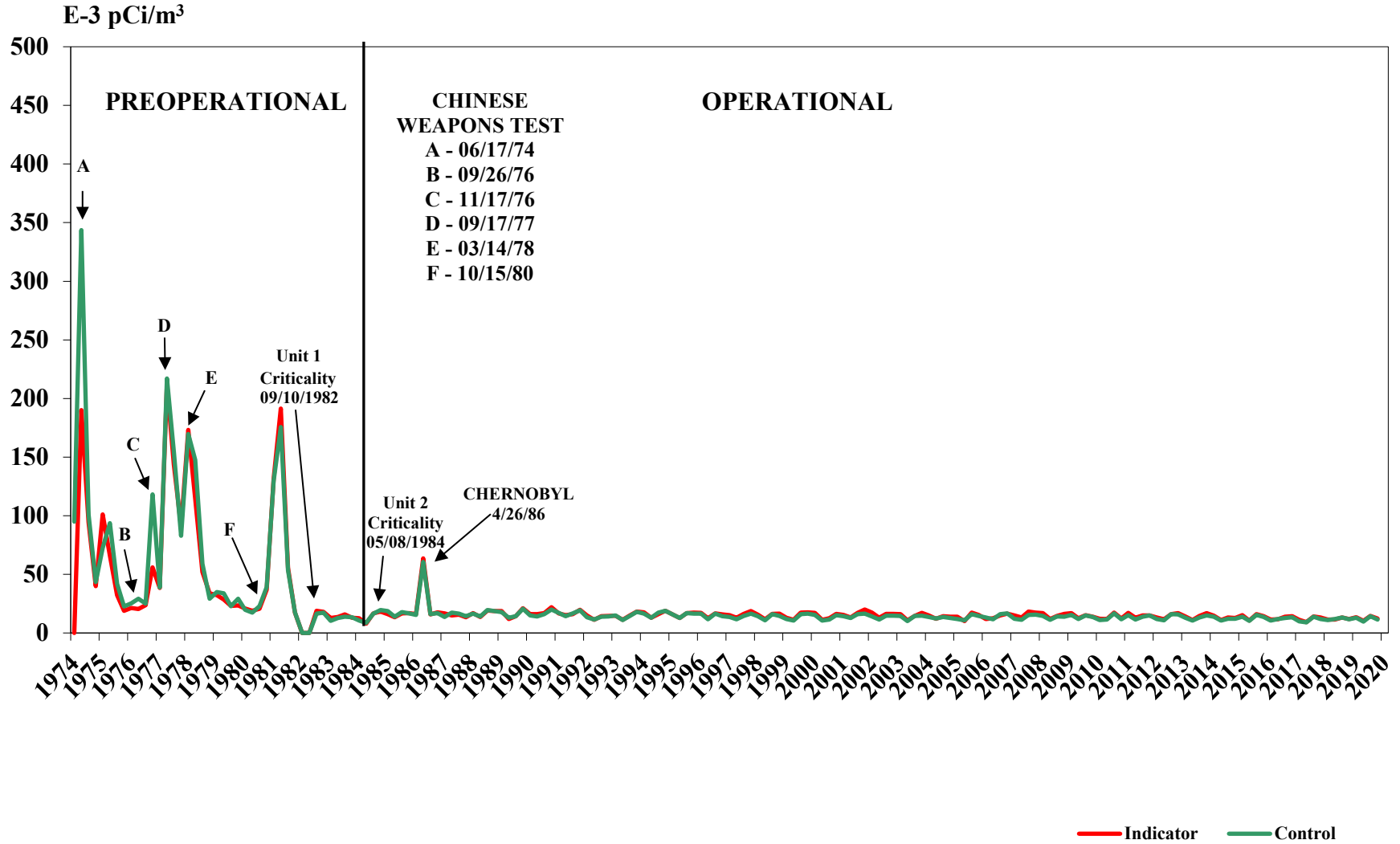
TABLE C-12

**GAMMA SPECTROSCOPIC ANALYSES OF SHORELINE SEDIMENT
SUSQUEHANNA STEAM ELECTRIC STATION, 2019**

Results in pCi/kg (dry) \pm 2 sigma

SITE	COLLECTION DATE	K-40	Cs-134	Cs-137	Ra-226	Ac-228	Th-228
2B	04/30/19	16100 \pm 2265	< 78	< 120	< 1686	1438 \pm 366	1143 \pm 203
	09/30/19	12590 \pm 1434	< 61	< 80	< 1160	1119 \pm 273	1107 \pm 132
	AVERAGE	14345 \pm 4964	-	-	-	1279 \pm 451	1125 \pm 51
7B	04/30/19	13510 \pm 1849	< 78	< 110	< 1882	870 \pm 295	953 \pm 201
	09/30/19	10610 \pm 1392	< 64	< 84	< 1772	965 \pm 347	980 \pm 171
	AVERAGE	12060 \pm 4101	-	-	-	917 \pm 136	966 \pm 38
12F	04/30/19	8495 \pm 1252	< 116	< 94	< 2106	1002 \pm 338	1035 \pm 131
	09/30/19	11140 \pm 1201	< 86	< 85	< 1855	1305 \pm 246	1111 \pm 162
	AVERAGE	9818 \pm 3741	-	-	-	1154 \pm 429	1073 \pm 107

FIGURE C-1 - GROSS BETA ACTIVITY IN AIR PARTICULATES



**FIGURE C-2 - AMBIENT RADIATION LEVELS
BASED ON ENVIRONMENTAL DOSIMETRY DATA**

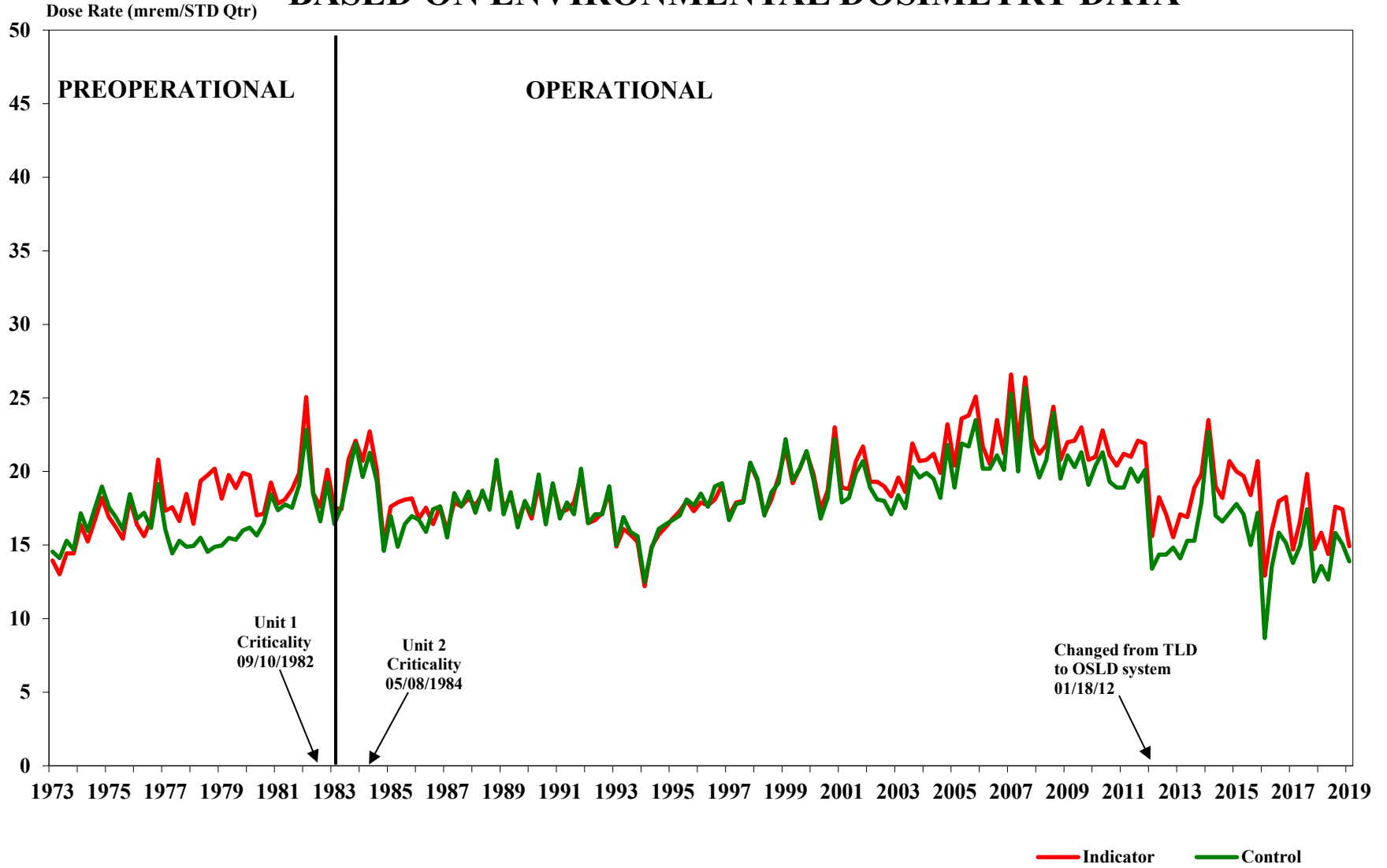
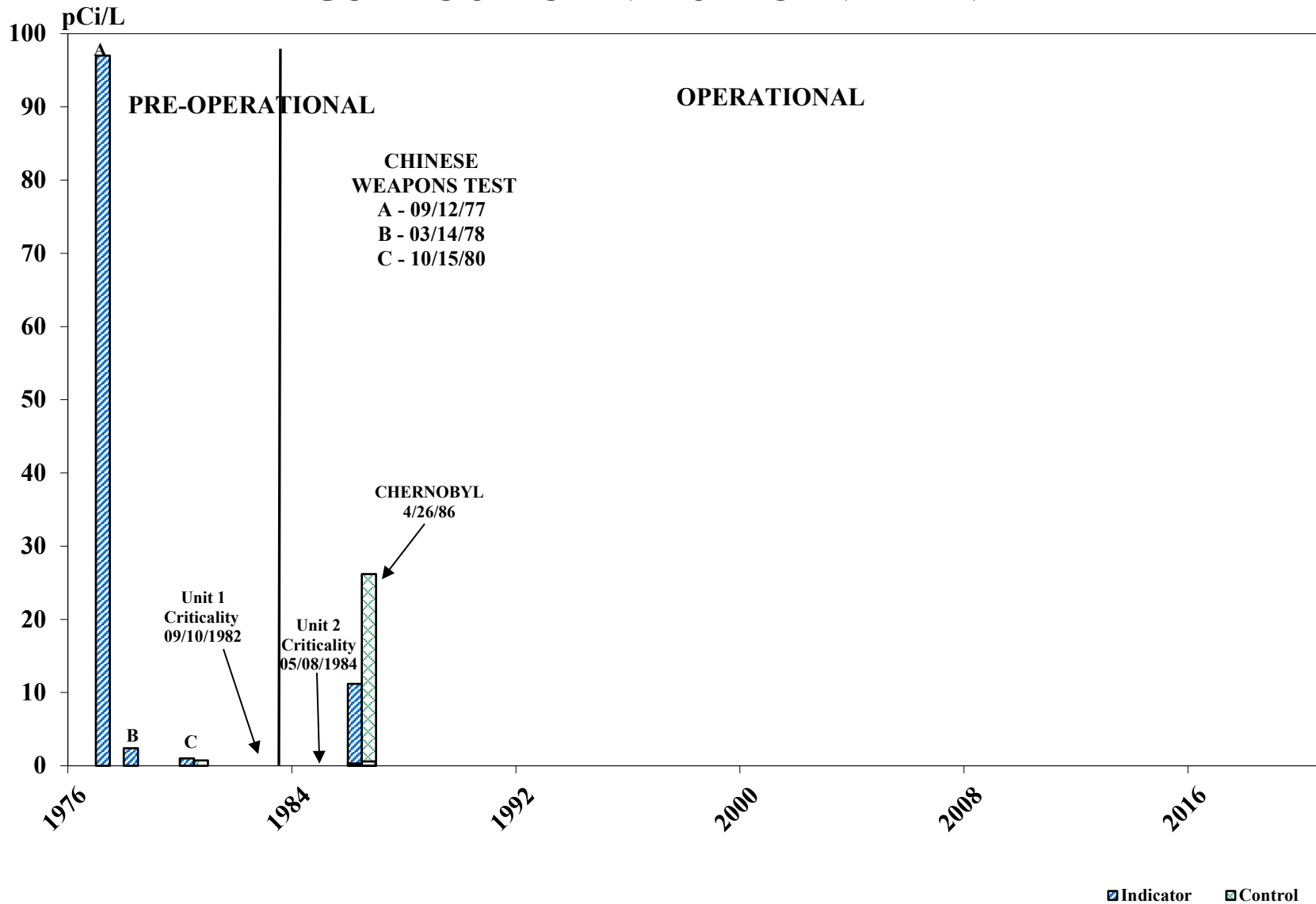


FIGURE C-3 - IODINE-131 ACTIVITY IN MILK



**FIGURE C-4 - ANNUAL AVERAGE TRITIUM ACTIVITY IN
PRECIPITATION AND SURFACE WATER VERSUS GROUND WATER**

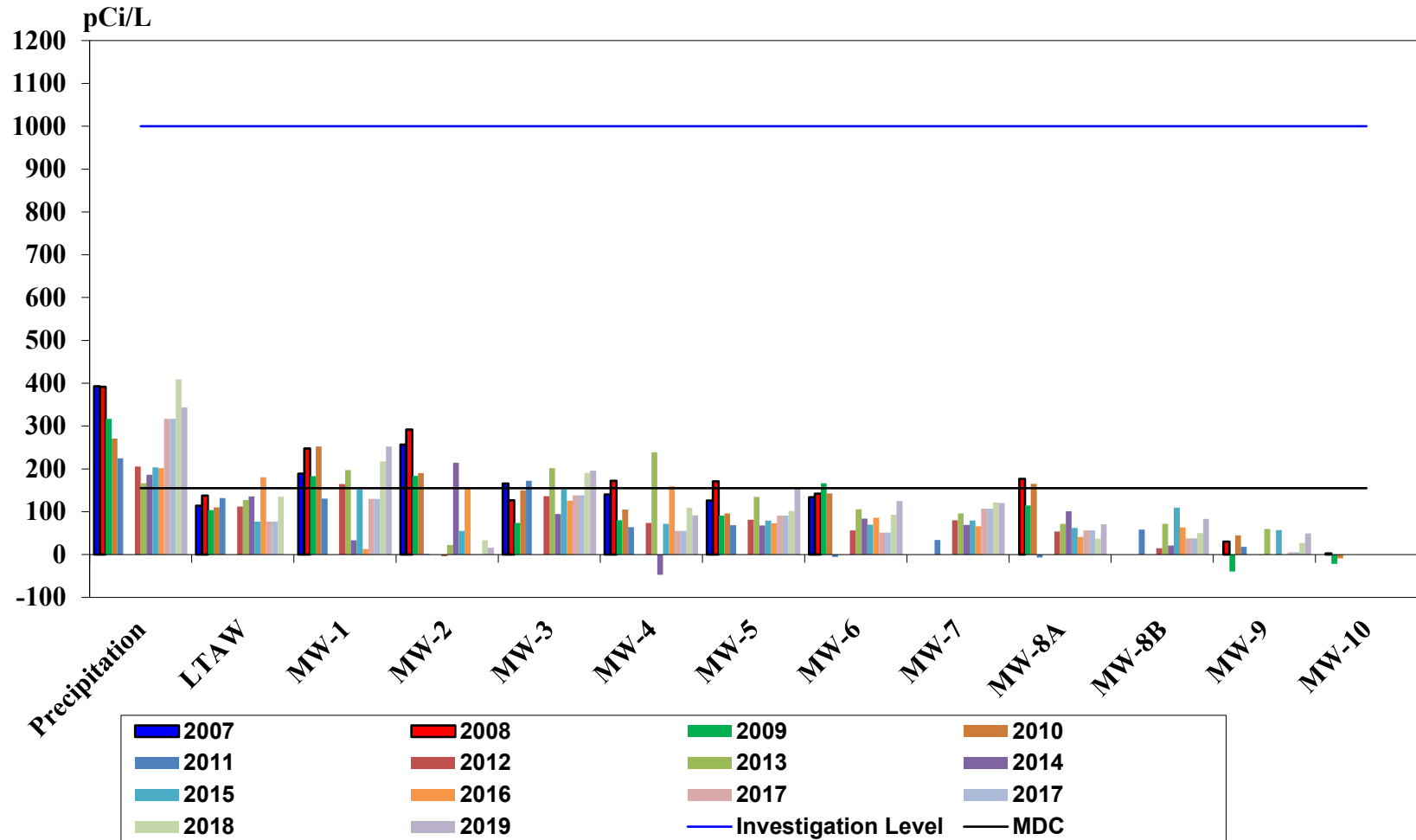


FIGURE C-5 - GROSS BETA ACTIVITY IN DRINKING WATER

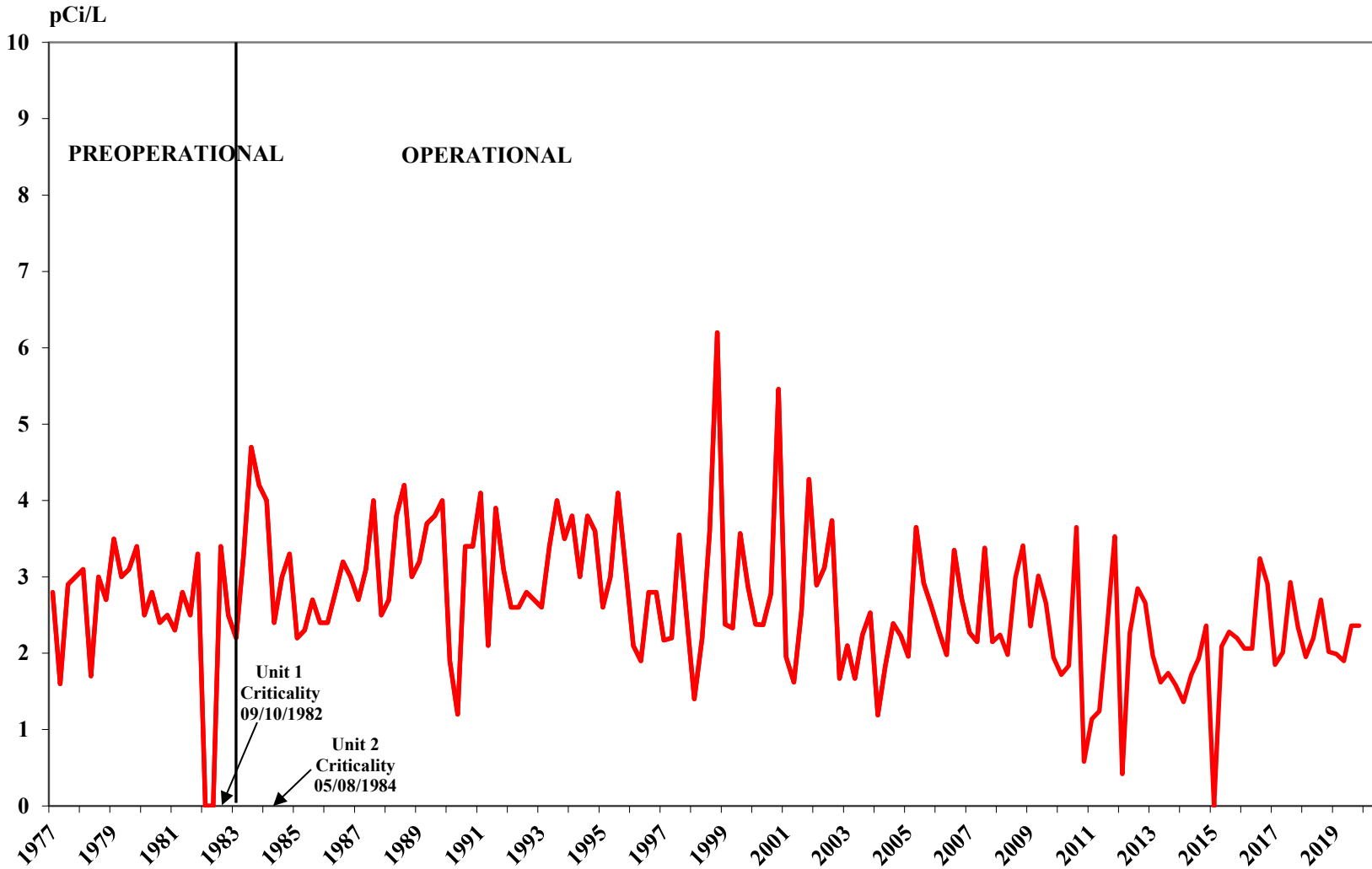
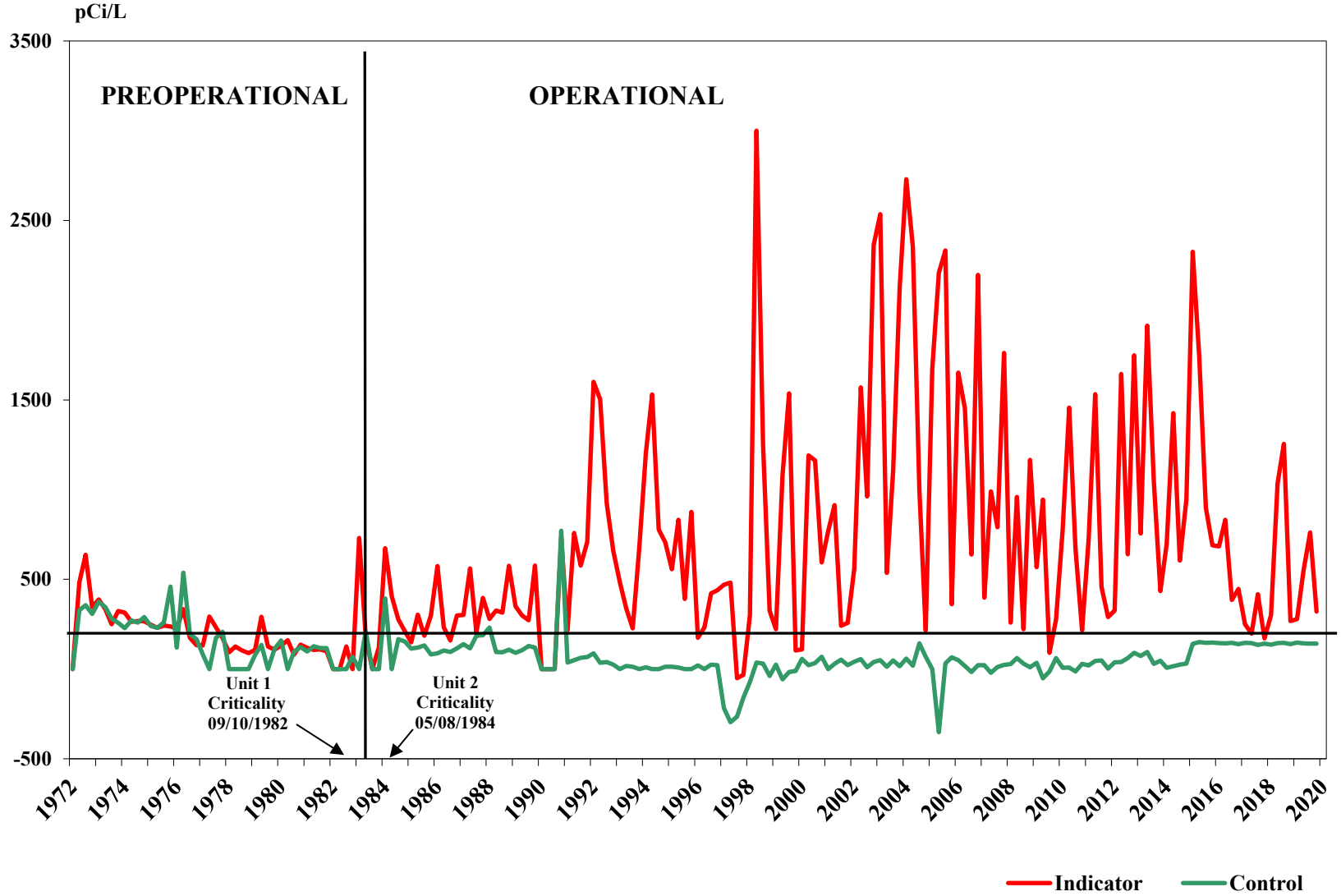


FIGURE C-6 - TRITIUM ACTIVITY IN SURFACE WATER



APPENDIX D

SUMMARY OF RESULTS FROM ANALYTICS, ENVIRONMENTAL RESOURCE ASSOCIATES (ERA), AND DEPARTMENT OF ENERGY (DOE) – MIXED ANALYTE PERFORMANCE EVALUATION PROGRAM (MAPEP)

Table D-1

Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value ^(a)	Ratio of TBE to Analytics Result	Evaluation ^(b)		
March 2019	E12468A	Milk	Sr-89	pCi/L	87.1	96	0.91	A		
			Sr-90	pCi/L	12.6	12.6	1.00	A		
March 2019	E12469A	Milk	Ce-141	pCi/L	113	117	0.97	A		
			Co-58	pCi/L	153	143	1.07	A		
			Co-60	pCi/L	289	299	0.97	A		
			Cr-51	pCi/L	233	293	0.80	A		
			Cs-134	pCi/L	147	160	0.92	A		
			Cs-137	pCi/L	193	196	0.98	A		
			Fe-59	pCi/L	153	159	0.96	A		
			I-131	pCi/L	91.5	89.5	1.02	A		
			Mn-54	pCi/L	149	143	1.04	A		
			Zn-65	pCi/L	209	220	0.95	A		
			E12470	Charcoal	I-131	pCi	77.5	75.2	1.03	A
			March 2019	E12471	AP	Ce-141	pCi	60.7	70.2	0.87
Co-58	pCi	87.9				85.8	1.02	A		
Co-60	pCi	175				179	0.98	A		
Cr-51	pCi	165				176	0.94	A		
Cs-134	pCi	91.2				95.9	0.95	A		
Cs-137	pCi	120				118	1.02	A		
Fe-59	pCi	108				95.3	1.13	A		
Mn-54	pCi	94.2				85.7	1.10	A		
Zn-65	pCi	102				132	0.77	W		
E12472	Water	Fe-55	pCi/L	2230	1920	1.16	A			
March 2019	E12473	Soil	Ce-141	pCi/g	0.189	0.183	1.03	A		
			Co-58	pCi/g	0.209	0.224	0.93	A		
			Co-60	pCi/g	0.481	0.466	1.03	A		
			Cr-51	pCi/g	0.522	0.457	1.14	A		
			Cs-134	pCi/g	0.218	0.250	0.87	A		
			Cs-137	pCi/g	0.370	0.381	0.97	A		
			Fe-59	pCi/g	0.263	0.248	1.06	A		
			Mn-54	pCi/g	0.248	0.223	1.11	A		
			Zn-65	pCi/g	0.371	0.344	1.08	A		
March 2019	E12474	AP	Sr-89	pCi	88.3	95.2	0.93	A		
			Sr-90	pCi	11.7	12.5	0.94	A		
August 2019	E12562	Soil	Sr-90	pCi/g	4.710	6.710	0.70	W		

(a) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) Analytics evaluation based on TBE internal QC limits:

A = Acceptable - reported result falls within ratio limits of 0.80-1.20

W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

Table D-1

Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value ^(a)	Ratio of TBE to Analytics Result	Evaluation ^(b)
September 2019	E12475	Milk	Sr-89	pCi/L	70.0	93.9	0.75	W
			Sr-90	pCi/L	12.0	12.9	0.93	A
	E12476	Milk	Ce-141	pCi/L	150	167	0.90	A
			Co-58	pCi/L	170	175	0.97	A
			Co-60	pCi/L	211	211	1.00	A
			Cr-51	pCi/L	323	331	0.98	A
			Cs-134	pCi/L	180	207	0.87	A
			Cs-137	pCi/L	147	151	0.97	A
			Fe-59	pCi/L	156	148	1.05	A
			I-131	pCi/L	81.1	92.1	0.88	A
			Mn-54	pCi/L	160	154	1.04	A
			Zn-65	pCi/L	303	293	1.03	A
	E12477	Charcoal	I-131	pCi	95.9	95.1	1.01	A
	E12478	AP	Ce-141	pCi	129	138	0.93	A
			Co-58	pCi	128	145	0.88	A
			Co-60	pCi	181	174	1.04	A
			Cr-51	pCi	292	274	1.07	A
			Cs-134	pCi	166	171	0.97	A
			Cs-137	pCi	115	125	0.92	A
			Fe-59	pCi	119	123	0.97	A
			Mn-54	pCi	129	128	1.01	A
	Zn-65	pCi	230	242	0.95	A		
	E12479	Water	Fe-55	pCi/L	1810	1850	0.98	A
	E12480	Soil	Ce-141	pCi/g	0.305	0.276	1.10	A
			Co-58	pCi/g	0.270	0.289	0.93	A
			Co-60	pCi/g	0.358	0.348	1.03	A
			Cr-51	pCi/g	0.765	0.547	1.40	N ⁽¹⁾
			Cs-134	pCi/g	0.327	0.343	0.95	A
			Cs-137	pCi/g	0.308	0.321	0.96	A
			Fe-59	pCi/g	0.257	0.245	1.05	A
Mn-54			pCi/g	0.274	0.255	1.07	A	
Zn-65	pCi/g	0.536	0.485	1.11	A			
E12481	AP	Sr-89	pCi	95.9	91.9	1.04	A	
		Sr-90	pCi	12.3	12.6	0.97	A	
E12563	Soil	Sr-90	pCi/g	0.392	0.360	1.09	A	

(a) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) Analytics evaluation based on TBE internal QC limits:

A = Acceptable - reported result falls within ratio limits of 0.80-1.20

W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

(1) See **NCR 19-27**

Table D-2

DOE's Mixed Analyte Performance Evaluation Program (MAPEP)

Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value ^(a)	Acceptance Range	Evaluation ^(b)
February 2019	19-GrF40	AP	Gross Alpha	Bq/sample	0.184	0.528	0.158 - 0.898	A
			Gross Beta	Bq/sample	0.785	0.948	0.474 - 1.422	A
	19-MaS40	Soil	Ni-63	Bq/kg	420	519.0	363 - 675	A
			Sr-90	Bq/kg			(1)	NR ⁽³⁾
19-MaW40	Water		Am-241	Bq/L	0.764	0.582	0.407 - 0.757	N ⁽⁴⁾
			Ni-63	Bq/L	4.72	5.8	4.1 - 7.5	A
			Pu-238	Bq/L	0.443	0.451	0.316 - 0.586	A
			Pu-239/240	Bq/L	-0.00161	0.0045	(2)	A
19-RdF40	AP		U-234/233	Bq/sample	0.1138	0.106	0.074 - 0.138	A
			U-238	Bq/sample	0.107	0.110	0.077 - 0.143	A
19-RdV40	Vegetation		Cs-134	Bq/sample	2.14	2.44	1.71 - 3.17	A
			Cs-137	Bq/sample	2.22	2.30	1.61 - 2.99	A
			Co-57	Bq/sample	2.16	2.07	1.45 - 2.69	A
			Co-60	Bq/sample	0.02382		(1)	A
			Mn-54	Bq/sample	-0.03607		(1)	A
			Sr-90	Bq/sample	-0.1060		(1)	N ⁽⁵⁾
			Zn-65	Bq/sample	1.35	1.71	1.20 - 2.22	W
August 2019	19-GrF41	AP	Gross Alpha	Bq/sample	0.192	0.528	0.158 - 0.898	W
			Gross Beta	Bq/sample	0.722	0.937	0.469 - 1.406	A
19-MaS41	Soil		Ni-63	Bq/kg	436	629	440 - 818	N ⁽⁶⁾
			Sr-90	Bq/kg	444	572	400 - 744	W
19-MaW41	Water		Am-241	Bq/L				NR ⁽⁷⁾
			Ni-63	Bq/L	7.28	9.7	6.8 - 12.6	W
			Pu-238	Bq/L	0.0207	0.0063	(2)	A
			Pu-239/240	Bq/L	0.741	0.727	0.509 - 0.945	A
19-RdF41	AP		U-234/233	Bq/sample	0.0966	0.093	0.065 - 0.121	A
			U-238	Bq/sample	0.0852	0.096	0.067-0.125	A
19-RdV41	Vegetation		Cs-134	Bq/sample	0.0197		(1)	A
			Cs-137	Bq/sample	3.21	3.28	2.30 - 4.26	A
			Co-57	Bq/sample	4.62	4.57	3.20 - 5.94	A
			Co-60	Bq/sample	4.88	5.30	3.71 - 6.89	A
			Mn-54	Bq/sample	4.54	4.49	3.14 - 5.84	A
			Sr-90	Bq/sample	0.889	1.00	0.70 - 1.30	A
			Zn-65	Bq/sample	2.78	2.85	2.00 - 3.71	A

(a) The MAPEP known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) DOE/MAPEP evaluation:

A = Acceptable - reported result falls within ratio limits of 0.80-1.20

W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

(1) False positive test

(2) Sensitivity evaluation

(3) See NCR 19-12

(4) See NCR 19-13

(5) See NCR 19-14

(6) See NCR 19-25

(7) See NCR 19-26

Table D-3

**ERA Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services**

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value ^(a)	Acceptance Limits	Evaluation ^(b)
April 2019	Rad-117	Water	Ba-133	pCi/L	26.3	24.1	18.6 - 27.8	A
			Cs-134	pCi/L	15.2	12.1	8.39 - 14.4	N ⁽¹⁾
			Cs-137	pCi/L	33.6	33.1	28.8 - 39.4	A
			Co-60	pCi/L	11.9	11.5	8.67 - 15.5	A
			Zn-65	pCi/L	87.1	89.2	80.3 - 107	A
			GR-A	pCi/L	19	19.3	9.56 - 26.5	A
			GR-B	pCi/L	20.2	29.9	19.1 - 37.7	A
			U-Nat	pCi/L	55.5	55.9	45.6 - 61.5	A
			H-3	pCi/L	21500	21400	18700 - 23500	A
			Sr-89	pCi/L	44.9	33.3	24.5 - 40.1	N ⁽²⁾
			Sr-90	pCi/L	24.5	26.3	19.0 - 30.7	A
			I-131	pCi/L	28.9	28.4	23.6 - 33.3	A
October 2019	Rad-119	Water	Ba-133	pCi/L	42.7	43.8	35.7 - 48.8	A
			Cs-134	pCi/L	53.5	55.9	45.2 - 61.5	A
			Cs-137	pCi/L	77.7	78.7	70.8 - 89.2	A
			Co-60	pCi/L	51.5	53.4	48.1 - 61.3	A
			Zn-65	pCi/L	36.6	34.0	28.5 - 43.1	A
			GR-A	pCi/L	40.5	27.6	14.0 - 36.3	N ⁽³⁾
			GR-B	pCi/L	36.3	39.8	26.4 - 47.3	A
			U-Nat	pCi/L	27.66	28.0	22.6 - 31.1	A
			H-3	pCi/L	22800	23400	20500 - 25700	A
			Sr-89	pCi/L	47.1	45.5	35.4 - 52.7	A
			Sr-90	pCi/L	32.5	26.5	19.2 - 30.9	N ⁽⁴⁾
			I-131	pCi/L	26.0	23.9	19.8 - 28.4	A
December 2019	QR 120419D	Water	Sr-90	pCi/L	20.1	18.6	13.2 - 22.1	A

(a) The ERA known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.

(b) ERA evaluation:

A = Acceptable - Reported value falls within the Acceptance Limits

N = Not Acceptable - Reported value falls outside of the Acceptance Limits

(1) See **NCR 19-10**

(2) See **NCR 19-11**

(3) See **NCR 19-23**

(4) See **NCR 19-24**

APPENDIX E

REMP SAMPLE EQUIPMENT OPERABILITY TRENDING

**TABLE E-1
REMP SAMPLING EQUIPMENT OPERABILITY TRENDING
SUSQUEHANNA STEAM ELECTRIC STATION**

Percent (%) Operability

SAMPLING MEDIA	SAMPLE LOCATION	DESCRIPTION	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Air Particulate & Charcoal	3S2	SSES Backup Met. Tower	99.9	99.3	98.9	99.9	100	99	100	99.9	99.9	100.0
	12S1	West Building	99.9	100	99.9	99.9	100	100	100	99.1	99.7	99.9
	13S6	Former Laydown Area, West of Confers Lane	100	99.7	99.1	99.9	100	97	100	100	99.9	99.9
	12E1	Berwick Hospital	100	100	99.9	100.0	100	98	99.1	100	100	100
	6G1	Freeland Substation	100	100	99.9	99.9	100	90*	100	100	100	No longer in service
	8G1	PPL System Facilities Center, Humboldt Industrial Park	99.7	100	99.8	99.9	100	100	99.2	99.9	99.9	99.9
	10S3	E of Confers Lane, S of Towers Club	-	-	-	-	-	-	100	99.5	99.9	99.2
	9B1	Transmission Line, E of Route 11	-	-	-	-	-	-	100	99.9	99.9	99.9
Drinking Water	12H2	Danville Water Company	100	100	100	100.0	100	100	100	100	100	98.1
Surface Water	2S7	Cooling Tower Blowdown Discharge Line	98.0	99.1	98.1	98.1	69**	100	99.1	100	100	99.9
	6S6	River Water Intake Line	100	95.5	93.4	93.2	93	98	99.7	99.9	99.9	99.9

* Planned power outage by Electric Utilities

** Auto- Compsite sampler problems, March through June. New Auto- Compsite sampler installed in July.