

**Kevin Cimorelli**  
Site Vice President

**Susquehanna Nuclear, LLC**  
769 Salem Boulevard  
Berwick, PA 18603  
Tel. 570.542.3795 Fax 570.542.1504  
Kevin.Cimorelli@TalenEnergy.com



April 26, 2021

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-7928**

**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 2020 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: 2020 Annual Radiological Environmental Operating Report

Copy: NRC Region I  
Ms. S. Goetz, NRC Project Manager  
Mr. C. Highley, NRC Senior Resident Inspector  
Mr. M. Shields, PA DEP/BRP  
Mr. H. Anagnostopoulos, NRC Region 1

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**Attachment to PLA-7928**

**2020 Annual Radiological Environmental  
Operating Report**

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

Annual Radiological  
Environmental Operating Report

2020

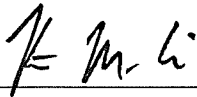
**Prepared by:**



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F. J. Hickey, Sr. Health Physicist

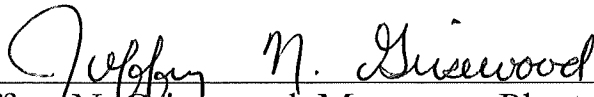
**Reviewed by:**



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K.M. Ervin, Sr. Environmental Scientist

**Approved by:**



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Jeffery N. Grisewood, Manager – Plant Chemistry / Environmental

Susquehanna Nuclear, LLC  
769 Salem Boulevard  
Berwick, Pennsylvania 18603

# SUSQUEHANNA STEAM ELECTRIC STATION

Units 1 & 2

## 2020 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

JANUARY 1 TO DECEMBER 31, 2020

Susquehanna Nuclear, LLC  
Berwick, PA  
April, 2021

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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 2020. Teledyne Brown Engineering (TBE) was responsible for the analysis of environmental samples during 2020. The results are discussed in this report. Landauer provided the dosimetry services for SSES during 2020.

This Annual Radiological Environmental Operating Report (AREOR) conducted for SSES covers the period January 1, 2020 through December 31, 2020. During that time period, 1332 analyses were performed on 1141 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  $5.56E-04$  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 2020 average concentration of tritium in the cooling tower blowdown water and the 2020 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 2020 was 31.0 curies.

The 2020 average dilution factor for the Susquehanna River was 666, based on the annual average river flow of  $6.58\text{E}+06$  gpm and the annual average cooling tower blowdown flow of  $9.874\text{E}+03$  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 2020 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 2020 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. 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 thorium-228 (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, 2020, 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  $\pm 2$  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**

<b><u>Radionuclide</u></b>	<b><u>MDC (pCi/cu.m.)</u></b>
Mn-54	1.2 E-03
Fe-59	6.9 E-03
Co-58	1.8 E-03
Co-60	1.2 E-03
Zn-65	2.9 E-03
Cs-134	1.2 E-03
Cs-137	1.0 E-03
I-131	2.0 E-01

**Waterborne REMP Typical MDCs**

<b><u>Radionuclide</u></b>	<b><u>MDC (pCi/L.)</u></b>
H-3 (DIST)	1.6 E+02
Mn-54	3.4 E+00
Fe-59	1.0 E+01
Co-58	3.7 E+00
Co-60	3.9 E+00
Zn-65	7.4 E+00
Cs-134	3.4 E+00
Cs-137	3.7 E+00
I-131	1.1 E+01
H-3	1.6 E+02
Gross Beta	1.9 E+00

The grouped data were averaged and standard deviations calculated. Thus, the  $\pm 2$  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 2020 REMP Atypical Sampling Occurrences

C. Program Changes

Location 1S4 was added as a groundwater sampling station in 2020.

## 2020 REMP Atypical Sampling Occurrences

Date	Sample Type	Location Code(s)	Sample Period Reason for Occurrence(s)	Corrective Action
<b>MAR</b>	Air	13S6	02/26/20 to 03/04/20 (loss of 0.6 hours) Air monitor was not operational upon arrival or departure on 03/04/20 due to local power outage. Power outage began on 03/04/20 @ 0857 hours, as determined by timer box.  Non-continuous sampler operation.	CA #20-02 CR 2020-03312 03/04/20: Air monitor resumed normal operation when power was restored @ 0934 hours. 03/04/20: Operability verified @ 1152 hours.  <i>Ideal sample collected for sample period: 22,500 cf.</i>
	Air	8G1	03/18/20 to 03/25/20 Pump providing inadequate flow rate upon arrival (<2.0 cfm), below the procedural range of 2.0-2.4 cfm. Fan blades were discovered to have broken off the pump.  Continuous sampling during sample period.	CA #20-03 CR 2020-04198 03/25/20: Pump was replaced, and air flow restored to 2.2 cfm. 03/25/20: Operability verified @ 1301 hours.  <i>Less than ideal sample collected for sample period: 5,000 cf (03/18/20 to 03/25/20). Volume adequate to support required analysis.</i>
<b>APR</b>	Air	12S1	04/15/20 to 04/22/20 (momentary loss of 12kV power) Momentary loss of power on 04/16/20. No loss of sampling time as determined by timer box.  Non-continuous sampler operation.	CA #20-04 CR 2020-05908 04/16/20: No action required. Air monitor resumed normal operation when power was restored. 04/20/20: Operability verified @ 0911 hours.  <i>Ideal sample collected for sample period: 22,500 cf.</i>

## 2020 REMP Atypical Sampling Occurrences (continued)

Date	Sample Type	Location Code(s)	Sample Period Reason for Occurrence(s)	Corrective Action
<b>APR (cont.)</b>	Air	3S2	<p>04/15/20 to 04/22/20 (loss of 54.3 hours) Air monitor was found to be non-operational on 04/21/20 due to a tripped surge protector. Power outage began on 04/16/20, as determined by timer box.</p> <p>Non-continuous sampler operation.</p>	<p>CA #20-05 CR 2020-06304 04/21/20: Surge protector reset @ 1042 hours and air monitor resumed normal operation. 04/21/20: Operability verified @ 1042 hours. 04/22/20: Operability and volume verified @ 0847 hours.</p> <p><i>Less than ideal sample collected for sample period: 7,000 cf (04/15/20 to 04/22/20). Volume adequate to support required analysis.</i></p>
<b>JUN</b>	Air	12S1	<p>06/03/20 to 06/10/20 (momentary losses of 12kV power) Momentary losses of power on 06/05/20 &amp; 06/06/20 for scheduled maintenance. No loss of sampling time as determined by timer box.</p>	<p>CA #20-06 06/05/20 &amp; 06/06/20: No action required. Air monitor resumed normal operation when power was restored. 06/05/20: Operability verified @ 1442 hours. 06/06/20: Operability verified @ 1707 hours.</p> <p><i>Ideal sample collected for sample period: 21,400 cf.</i></p>
	Air	12S1	<p>06/03/20 to 06/10/20 (momentary loss of 12kV power) Momentary loss of power on 06/08/20. No loss of sampling time as determined by timer box.</p> <p>Non-continuous sampler operation.</p>	<p>CA #20-07 CR 2020-08340 06/08/20: No action required. Air monitor resumed normal operation when power was restored. 06/08/20: Operability verified @ 0834 hours.</p> <p><i>Ideal sample collected for sample period: 21,400 cf.</i></p>

## 2020 REMP Atypical Sampling Occurrences (continued)

Date	Sample Type	Location Code(s)	Sample Period Reason for Occurrence(s)	Corrective Action
<b>JUN (cont.)</b>	Air	12S1	06/10/20 to 06/17/20 (loss of 2.5 hours) 12kV power outage occurred on 06/11/20 due to grid disturbance from thunderstorm. Loss of 2.5 hours, as determined by timer box.  Non-continuous sampler operation.	CA #20-08 CR 2020-08533 06/11/20: No action required. Air monitor resumed normal operation when power was restored. 06/11/20: Operability verified @ 0857 hours.  <i>Ideal sample collected for sample period: 21,300 cf.</i>
	Surface Water	6S6	06/09/20 to 06/16/20 (week 3 June composite) No sample flow to ACS as discovered during weekly collection, possibly due to a blocked sample line. Approximately 0.5 gallons of water remained in line upon arrival. Unable to obtain flow rate.	CA #20-09 CR 2020-08721 06/16/20: Adequate sample volume collected during sample period. Composite sample for week 3 June to be used in monthly composite. Requested I&C perform maintenance ASAP. 06/23/20: Sample flow appeared to restore itself (as observed during weekly collection-week 4 June). Operability verified @ 1050 hours. 06/24/20: I&C performed maintenance.  <i>Ideal sample collected for sample period.</i>
	Air	12S1	06/10/20 to 06/17/20 Timer box malfunction due to electrical storm on 06/11/20. Timer box did not advance past 21.0 hours for the sampling period, and would not reset.	CA #20-10 06/17/20: Timer box #3 replaced with timer box #8. Surge protector also replaced. 06/17/20: Operability verified @ 1039 hours.  <i>Ideal sample collected for sample period: 21,300 cf.</i>

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### 2020 REMP Atypical Sampling Occurrences (continued)

Date	Sample Type	Location Code(s)	Sample Period Reason for Occurrence(s)	Corrective Action
<b>JUN (cont.)</b>	Air	8G1	06/10/20 to 06/17/20 (loss of 0.2 hours) Power outage- date and time unknown. Loss of 0.2 hours, as determined by timer box during weekly collection.  Non-continuous sampler operation.	CA #20-11 CR 2020-08787 06/17/20: No action required. Air monitor resumed normal operation when power was restored. 06/17/20: Operability verified @ 1244 hours.  <i>Ideal sample collected for sample period: 21,400 cf.</i>
	Air	12S1	06/17/20 to 06/24/20 (momentary loss of 12kV power) Momentary loss of power on 06/20/20. No loss of sampling time as determined by timer box.  Non-continuous sampler operation.	CA #20-12 CR 2020-08932 06/20/20: No action required. Air monitor resumed normal operation when power was restored. 06/22/20: Operability verified @ 0908 hours.  <i>Ideal sample collected for sample period: 20,600 cf.</i>
<b>JUL</b>	Air	12S1	07/08/20 to 07/15/20 (momentary loss of 12kV power) Momentary loss of power on 07/08/20. No loss of sampling time as determined by timer box.  Non-continuous sampler operation.	CA #20-13 CR 2020-09709 07/08/20: No action required. Air monitor resumed normal operation when power was restored. 07/08/20: Operability verified @ 1316 hours.  <i>Ideal sample collected for sample period: 20,800 cf.</i>



## 2020 REMP Atypical Sampling Occurrences (continued)

Date	Sample Type	Location Code(s)	Sample Period Reason for Occurrence(s)	Corrective Action
<b>JUL (cont.)</b>	Air	12S1	07/15/20 to 07/22/20 (momentary loss of 12kV power) Momentary loss of power on 07/19/20. No loss of sampling time as determined by timer box.  Non-continuous sampler operation.	CA #20-14 CR 2020-10192 07/19/20: No action required. Air monitor resumed normal operation when power was restored. 07/20/20: Operability verified @ 0902 hours.  <i>Ideal sample collected for sample period: 20,800 cf.</i>
	Air	10S3	07/22/20 to 07/29/20 (loss of 93.7 hours) Air monitor was not operational upon arrival or departure on 07/29/20 due to local power outage. Power outage began on 07/25/20 @ 1136 hours, as determined by timer box.  Non-continuous sampler operation.	CA #20-15 CR 2020-10660 07/29/20: Outage reported to PPL outage center. Timer box reset to record delayed start time. Air monitor resumed normal operation when power was restored @ 1226 hours. 07/30/20: Operability verified @ 0950 hours.  <i>Less than ideal sample collected for sample period: 9,100 cf (07/22/20 to 07/29/20). Volume adequate to support required analysis.</i>
<b>AUG</b>	Air	12S1	08/26/20 to 09/02/20 (loss of 5.4 hours) 12kV power outage occurred on 08/29/20. Loss of 5.4 hours as determined by timer box.  Non-continuous sampler operation.	CA #20-16 CR 2020-12081 08/29/20: No action required. Air monitor resumed normal operation when power was restored. 08/30/20: Operability verified @ 1810 hours.  <i>Ideal sample collected for sample period: 21,700 cf.</i>

## 2020 REMP Atypical Sampling Occurrences (continued)

Date	Sample Type	Location Code(s)	Sample Period Reason for Occurrence(s)	Corrective Action
<b>AUG (cont.)</b>	Surface Water	6S6	08/30/20 to 10/13/20 (week 2 September composite through week 2 October composite) ACS removed from service for planned maintenance to install new sampler per EC 1726215.	CA #20-17 CR 2020-12106 08/30/20: Week 1 September sample collected early and sampler taken out of service @ 1840 hours. 10/13/20: New sampler brought to service and operability verified @ 1130 hours.  <i>Grab samples collected for sample periods @ location 5S9.</i>
<b>SEP</b>	Air	12S1	09/02/20 to 09/09/20 (momentary loss of 12kV power) Momentary loss of power on 09/05/20 during planned maintenance evolution. No loss of sampling time as determined by timer box.  Non-continuous sampler operation.	CA #20-18 CR 2020-12406 09/05/20: No action required. Air monitor resumed normal operation when power was restored. 09/07/20: Operability verified @ 1152 hours.  <i>Ideal sample collected for sample period: 21,500 cf.</i>
<b>OCT</b>	Surface Water	2S7	10/15/20 (week 3 October composite) Supply line blockage at ACS as indicated by sampler operation (increased air bubbles in supply line and increased sample volume).  Continuous sampler operation.	CA #20-19 CR 2020-14182 10/15/20: Adequate sample volume collected during sample period. CR submitted to request clearing blockages of sample lines. REMP sampler placed on alternate supply line (on the right side of the unit). 02/04/21: FIN attempted to flush sample lines. One line is unblocked, two lines are available as backup. AR 2021-01902 written to schedule replacement of sample lines.  <i>Ideal sample collected for sample periods.</i>

### 2020 REMP Atypical Sampling Occurrences (continued)

Date	Sample Type	Location Code(s)	Sample Period Reason for Occurrence(s)	Corrective Action
<b>OCT (cont.)</b>	Air	12S1	10/21/20 to 10/28/20 (loss of 0.6 hours) 12kV power outage occurred on 10/26/20. Loss of 0.6 hours, as determined by timer box.  Non-continuous sampler operation.	CA #20-20 CR 2020-14619 10/26/20: No action required. Air monitor resumed normal operation when power was restored. 10/26/20: Operability verified @ 1411 hours.  <i>Ideal sample collected for sample period: 20,900 cf.</i>
	Air	10S3	10/21/20 to 10/28/20 (loss of 0.9 hours) Power outage- date and time unknown. Loss of 0.9 hours, as determined by timer box during weekly collection.  Non-continuous sampler operation.	CA #20-21 CR 2020-14781 10/28/20: No action required. Air monitor resumed normal operation when power was restored. 10/28/20: Operability verified @ 1011 hours.  <i>Ideal sample collected for sample period: 21,600 cf.</i>
	Direct Radiation	13S5	3 <sup>rd</sup> Quarter (10/15/20) Dosimeter holder and dosimeter for location 13S5 were unable to be located during quarterly exchange.	CR 2020-14190 10/15/20: New dosimeter holder installed, along with the 4 <sup>th</sup> quarter 2020 dosimeter.

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## 2020 REMP Atypical Sampling Occurrences (continued)

Date	Sample Type	Location Code(s)	Sample Period Reason for Occurrence(s)	Corrective Action
<b>NOV</b>	Air	12S1	11/11/20 to 11/18/20 (momentary loss of 12kV power) Momentary loss of power on 11/15/20. No loss of sampling time as determined by timer box.  Non-continuous sampler operation.	CA #20-22 CR 2020-15679 11/15/20: No action required. Air monitor resumed normal operation when power was restored. 11/16/20: Operability verified @ 0945 hours.  <i>Ideal sample collected for sample period: 23,700 cf.</i>
<b>DEC</b>	Air	12S1	12/22/20 to 12/30/20 (momentary loss of 12kV power) Momentary loss of power on 12/24/20. No loss of sampling time as determined by timer box.  Non-continuous sampler operation.	CA #20-23 CR 2020-17191 & 2020-17192 12/24/20: No action required. Air monitor resumed normal operation when power was restored. 12/25/20: Operability verified @ 1320 hours.  <i>Ideal sample collected for sample period: 25,300 cf.</i>
	Air	9B1	12/22/20 to 12/30/20 Timer box malfunction. Timer box not advancing on pace. Only 116.2 hours recorded for the week. No effect on monitoring.  Continuous sampler operation.	CA #20-24 CR 2020-17322 12/30/20: Timer box #7 replaced with timer box #9. Equipment restored to service @ 1000 hours. 12/30/20: Operability verified @ 1006 hours.  <i>Ideal sample collected for sample period: 24,800 cf.</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, 126 out of 133 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 MAPEP February 2020 AP U-233/234 and U-238 results were evaluated as Not Acceptable. The reported value for U-233/234 was  $0.0416 \pm 0.0102$  Bq/sample and the known result was 0.075 Bq/sample (acceptance range 0.053 - 0.098). The

reported value for U-238 was  $0.0388 \pm 0.00991$  Bq/sample and the known result was 0.078 Bq/sample (acceptance range 0.055 - 0.101). This sample was run as the workgroup duplicate and had RPD's of 10.4% (U-234) and 11.7% (U-238). After the known results were obtained, the sample was relogged. The filter was completely digested with tracer added originally; the R1 results were almost identical. It was concluded that the recorded tracer amount was actually double, causing the results to be skewed. Lab worksheets have been modified to verify actual tracer amount vs. LIMS data. TBE changed vendors for this cross-check to ERA MRAD during the 2nd half of 2020. Results were acceptable at 97.8% for U-234 and 106% for U-238. (NCR 20-13)

2. The Analytics September 2020 milk Sr-89 result was evaluated as Not Acceptable. The reported value was 62.8 pCi/L and the known result was 95.4 (66%). All QC data was reviewed and there were no anomalies. This was the first failure for milk Sr-89 since 2013 and there have only been 3 upper/lower boundary warnings since that time. It is believed that there may have been some loss during the sample prep (ashing). The December 2020 result was at 92% of the known. (NCR 20-19)
3. The ERA October 2020 water I-131 result was evaluated as Not Acceptable. The reported value was 22.9 pCi/L and the known result was 28.2 (acceptance range 23.5 - 33.1). The reported result was 81% of the known, which passes TBE QC criteria. This was the first failure for water I-131. (NCR 20-17)
4. The ERA October 2020 water Gross Alpha and Gross Beta

results were evaluated as Not Acceptable. The reported/acceptable values and ranges are as follows:

	Reported	Known	Range
Gross Alpha	40.0	26.2	13.3 - 34.7
Gross Beta	47.5	69.1	48.0 - 76.0

All QC data was reviewed with no anomalies and a cause for failure could not be determined. This was the first failure for water Gross Beta. A Quick Response follow-up cross-check was analyzed as soon as possible with acceptable results at 96.8% for Gross Alpha and 102% for Gross Beta. (NCR 20-18)

5. The MAPEP August 2020 soil Ni-63 result was evaluated as Not Acceptable. The reported value was  $438 \pm 21.1$  Bq/kg and the known result was 980 Bq/kg (acceptance range 686 - 1274). It is believed that some Ni-63 loss may have occurred during the sample prep. This investigation is still on-going at this time. (NCR 20-20)

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 2020 REMP samples are divided into categories based on exposure pathways: atmospheric, direct radiation, terrestrial, and aquatic. The analytical results for the 2020 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 6 to 29 E-3 pCi/m<sup>3</sup> with an average concentration of 13 E-3 pCi/m<sup>3</sup>, and in 52 of 52 of the control location samples at concentrations ranging from 6 to 24 E-3 pCi/m<sup>3</sup> with an average of 12 E-3 pCi/m<sup>3</sup>. Elevated gross beta results on both indicator and control stations can be seen the week of 9/23/20-9/30/20. The normal average for gross beta results (indicator and control) is 13 E-3 to 14 E-3 pCi/m<sup>3</sup> whereas the average gross beta results for all locations the week of 9/23/20-9/30/20 was 26.9 E-3 pCi/m<sup>3</sup>. The increase is due to a possible radiological event in an eastern European country and it was seen at many other stations across the USA/Canada. The maximum preoperational level detected was 102 E-3 pCi/m<sup>3</sup> with an average concentration of 62 E-3 pCi/m<sup>3</sup>. (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 68 E-3 to 149 E-3 pCi/m<sup>3</sup> with an average concentration of 112 E-3 pCi/m<sup>3</sup>, and in the four control location composites ranging in concentration from 97 to 129 E-3 pCi/m<sup>3</sup> with an average concentration of 111 E-3 pCi/m<sup>3</sup>.

The maximum preoperational level detected was 85 E-3 pCi/m<sup>3</sup> with an average concentration of 74 E-3 pCi/m<sup>3</sup>. (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 2020, 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 17.6 milliroentgen per standard quarter. The annual average dose rate for the control locations was 15.6 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 2020 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 2020 are plotted.

### Gamma Spectrometry

Naturally occurring K-40 was detected in all 60 samples with concentrations for the 40 indicator location samples ranging from 1,064 to 1,412 pCi/L with an average concentration of 1,248 pCi/L, and the 20 control location sample concentrations ranging from 1,127 to 1,509 pCi/L with an average concentration of 1,297 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 10 indicator locations (1S3, 1S4, 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 9 of the 36 indicator location samples with concentrations ranging from 129 to 281 pCi/L with an average concentration of 215 pCi/L. Two of the four control location

samples had tritium activity above the minimum detectable concentration with a range of 188 to 296 pCi/L and a concentration of 242 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 2020 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 six of the 12 drinking water samples. Sample concentrations ranged from 2.6 to 4.1 pCi/L with an average concentration of 3.2 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 2020 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 three indicator locations (11D1, 11S6, and 12F7) were collected throughout the growing season. All samples (fruit, vegetable, and broadleaf) were analyzed for gamma emitters and included soy beans, field corn, pumpkin, green beans, swiss chard and collards.

#### Gamma Spectrometry

Naturally occurring Be-7, attributed to cosmic ray activity in the atmosphere, was detected in five of the 15 indicator location samples with concentrations ranging from 272 to 446 pCi/kg wet with an average concentration of 332 pCi/kg wet. Preoperational data is not available for comparison.

Naturally occurring K-40 was detected in all 15 indicator location samples with concentrations ranging from 2,490 to 15,000 pCi/kg wet with an average concentration of 4,474 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 two control locations (5S9 and 6S6). Each sample was analyzed for H-3 and gamma emitters. In 2020, a new auto-composite sampler was installed at surface water sample location 6S6. Installation of the new sampler started on August 31, 2020. Initial sampler setup by the vendor was delayed due to the need to obtain additional parts. Further delays with the installation were encountered due to the need to install two (2) new pressure control valves (PCVs). The new auto composite sampler at location 6S6 was placed in service on October 13, 2020.

##### Tritium

Tritium activity was detected in 12 of 26 indicator location samples with concentrations ranging from 165 to 9,190 pCi/L with an average concentration of 1,580 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 2020. Tritium was detected in one of the 12 control location samples with an average concentration of 169 pCi/L. 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 2020 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)

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 2020 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 2,791 to 4,117 pCi/kg wet with an average concentration of 3,547 pCi/kg wet, and in all control location samples at concentrations ranging from 2,629 to 3,759 pCi/kg wet with an average concentration of 3,166 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 9,725 to 15,790 pCi/kg dry with an average concentration of 12,060 pCi/kg dry, and in all of the control location samples with concentrations ranging from 9,175 to 18,220 pCi/kg dry with an

average concentration of 13,700 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 817 to 1,430 pCi/kg dry with an average concentration of 1,092 pCi/kg dry, and in both of the control location samples at concentrations ranging from 989 to 1,411 pCi/kg dry with an average concentration of 1,200 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 773 to 1,114 pCi/kg dry with an average concentration of 990 pCi/kg dry, and in both of the control location samples at concentrations ranging from 856 and 1,339 pCi/kg dry with an average concentration of 1,098 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 2020 LAND USE CENSUS

Applied Ecoscience, Inc. conducted a Land Use Census during the 2020 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 m<sup>2</sup> (approximately 500 ft<sup>2</sup>) 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 July-Aug, 2020 miles	Nearest Garden July-Sept, 2020 miles	Nearest Dairy Farm July-Aug, 2020 miles
1	N	1.3	3.2	>5.0
2	NNE	1.0	2.3 <sup>a,c,e</sup>	>5.0
3	NE	0.9	2.7	>5.0
4	ENE	2.1	2.4 <sup>a,c</sup>	>5.0
5	E	1.6	4.9	4.5 <sup>d</sup>
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 <sup>a,c</sup>	>5.0 <sup>d</sup>
11	SW	1.5	4.2	>5.0
12	WSW	1.3	1.3	1.7
13	W	1.2	3.2	5.0
14	WNW	1.1	3.6	>5.0
15	NW	0.8	2.3	>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 2020 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 2020 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

- [1] Annual Radiological Environmental Operating Report, January 1 to December 31, 2020, prepared by Teledyne Brown Engineering, Knoxville TN.
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- [3] Final Environmental Statement
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- [8] Susquehanna Nuclear, LLC. 2015. Radiological Environmental Monitoring Program, ODCM-QA-008, Rev. 18.
- [9] Susquehanna Steam Electric Station, 5-mile radius aerial photograph, REMPE-182244-0. Susquehanna Nuclear, Berwick, PA
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- [12] United States Nuclear Regulatory Commission. "An Acceptable Radiological Environmental Monitoring Program." Radiological Assessment Branch Technical Position. November 1979, Revision 1. USNRC, Washington, DC.
- [13] Susquehanna Nuclear, "Engineering Study, EC-ENVR-1012 (Revision 2, February 2013)", Interpretation of Environmental Direct Radiation Results.
- [14] Susquehanna Nuclear, Tritium Release REMP Calculation (RETDAS) V.3.6.6) – March 2017.
- [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, 2019 to January 01, 2021

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 <sup>3</sup> )	GR-B	364	10	1.307E+01 (312/312) (5.580E+00 - 2.990E+01)	13S6 0.4 MILES W	1.347E+01 (52/52) (7.250E+00 - 2.700E+01)	1.199E+01 (52/52) (6.460E+00 - 2.430E+01)	0
	GAMMA BE-7	28 28	N/A	1.124E+02 (24/24) (6.842E+01 - 1.494E+02)	9B1 1.3 MILES SSW	1.253E+02 (4/4) (1.041E+02 - 1.359E+02)	1.114E+02 (4/4) (9.680E+01 - 1.291E+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 <sup>3</sup> )	GAMMA I-131	364 364	70	<MDC (0/312)	<MDC	<MDC (0/52)	0	
Ambient Radiation (mR/std. qtr.)	OSLD	227	N/A	1.764E+01 (207/207) (1.009E+01 - 4.628E+01)	9S2 0.2 MILES S	3.998E+01 (4/4) (3.625E+01 - 4.628E+01)	1.559E+01 (20/20) (1.321E+01 - 1.885E+01)	0
Milk (pCi/Liter)	I-131	60	1	<MDC (0/40)	<MDC	<MDC (0/20)	0	
	GAMMA K-40	60 60	N/A	1.248E+03 (40/40) (1.064E+03 - 1.412E+03)	13E3 5.0 MILES W	1.304E+03 (20/20) (1.107E+03 - 1.412E+03)	1.297E+03 (20/20) (1.127E+03 - 1.509E+03)	0
	CS-134	60	15	<MDC (0/40)	<MDC	<MDC (0/20)	0	

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Reporting Period: December 28, 2019 to January 01, 2021

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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	41	2000	2.153E+02 (9/37) (1.290E+02 - 2.810E+02)	13S7 0.2 MILES W	2.420E+02 (2/4) (1.880E+02 - 2.960E+02)	2.420E+02 (2/4) (1.880E+02 - 2.960E+02)	0
	GAMMA K-40	41	N/A	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	MN-54	41	15	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	CO-58	41	15	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	FE-59	41	30	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	CO-60	41	15	<MDC (0/36)	<MDC	<MDC (0/4)	0	

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Ground Water (cont'd) (pCi/Liter)	ZN-65	41	30	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	NB-95	41	15	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	ZR-95	41	30	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	I-131	41	15	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	CS-134	41	15	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	CS-137	41	18	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	BA-140	41	60	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	LA-140	41	15	<MDC (0/36)	<MDC	<MDC (0/4)	0	
	TH-228	41	N/A	<MDC (0/36)	<MDC	<MDC (0/4)	0	
Drinking Water (pCi/Liter)	GR-B	12	4	3.160E+00 (6/12) (2.620E+00 - 4.130E+00)	12H2 26 MILES WSW	3.160E+00 (6/12) (2.620E+00 - 4.130E+00)	N/A	0
	H-3	12	2000	<MDC (0/12)	<MDC	N/A	0	

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

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Drinking Water (cont'd) (pCi/Liter)	CS-137	12	18	<MDC	(0/12)	<MDC	N/A	0		
	BA-140	12	60	<MDC	(0/12)	<MDC	N/A	0		
	LA-140	12	15	<MDC	(0/12)	<MDC	N/A	0		
Food/Garden Crops (pCi/kg wet)	GAMMA BE-7	15	N/A	3.323E+02 (2.717E+02 - 4.459E+02)	(5/15)	11S6 0.5 MILES SW	3.323E+02 (2.717E+02 - 4.459E+02)	(5/10)	N/A	0
	K-40	15	N/A	4.474E+03 (2.490E+03 - 1.500E+04)	(15/15)	11D1 3.3 MILES SW	6.790E+03 (2.490E+03 - 1.500E+04)	(3/3)	N/A	0
	MN-54	15	N/A	<MDC	(0/15)	<MDC	<MDC	N/A	0	
	CO-58	15	N/A	<MDC	(0/15)	<MDC	<MDC	N/A	0	
	FE-59	15	N/A	<MDC	(0/15)	<MDC	<MDC	N/A	0	
	CO-60	15	N/A	<MDC	(0/15)	<MDC	<MDC	N/A	0	
	ZN-65	15	N/A	<MDC	(0/15)	<MDC	<MDC	N/A	0	

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Food/Garden Crops (cont'd) (pCi/kg wet)	NB-95	15	N/A	<MDC	(0/15)	<MDC	N/A	0
	ZR-95	15	N/A	<MDC	(0/15)	<MDC	N/A	0
	I-131	15	60	<MDC	(0/15)	<MDC	N/A	0
	CS-134	15	60	<MDC	(0/15)	<MDC	N/A	0
	CS-137	15	80	<MDC	(0/15)	<MDC	N/A	0
	BA-140	15	N/A	<MDC	(0/15)	<MDC	N/A	0
	LA-140	15	N/A	<MDC	(0/15)	<MDC	N/A	0
	AC-228	15	N/A	<MDC	(0/15)	<MDC	N/A	0
	TH-228	15	N/A	<MDC	(0/15)	<MDC	N/A	0

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Surface Water (pCi/Liter)	H-3	38	2000	1.580E+03 (12/26) (1.650E+02 - 9.190E+03)	2S7 0.1 MILES NNE	1.580E+03 (12/12) (1.650E+02 - 9.190E+03)	1.690E+02 (1/12) (1.690E+02)	0
	GAMMA K-40	38 38	N/A	<MDC (0/26)	<MDC	<MDC	(0/12)	0
	MN-54	38	15	<MDC (0/26)	<MDC	<MDC	(0/12)	0
	CO-58	38	15	<MDC (0/26)	<MDC	<MDC	(0/12)	0
	FE-59	38	30	<MDC (0/26)	<MDC	<MDC	(0/12)	0
	CO-60	38	15	<MDC (0/26)	<MDC	<MDC	(0/12)	0
	ZN-65	38	30	<MDC (0/26)	<MDC	<MDC	(0/12)	0
	NB-95	38	15	<MDC (0/26)	<MDC	<MDC	(0/12)	0
	ZR-95	38	30	<MDC (0/26)	<MDC	<MDC	(0/12)	0
	I-131	38	15	<MDC (0/26)	<MDC	<MDC	(0/12)	0

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Surface Water (cont'd) (pCi/Liter)	CS-134	38	15	<MDC (0/26)	<MDC	<MDC (0/12)	0	
	CS-137	38	18	<MDC (0/26)	<MDC	<MDC (0/12)	0	
	BA-140	38	60	<MDC (0/26)	<MDC	<MDC (0/12)	0	
	LA-140	38	15	<MDC (0/26)	<MDC	<MDC (0/12)	0	
	TH-228	38	N/A	<MDC (0/26)	<MDC	<MDC (0/12)	0	
Fish (pCi/kg wet)	GAMMA K-40	14	N/A	3.547E+03 (8/8) (2.791E+03 - 4.117E+03)	LTAW 0.7 MILES NE-ESE	3.795E+03 (2/2) (3.588E+03 - 4.002E+03)	3.166E+03 (6/6) (2.629E+03 - 3.759E+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 K-40	6	N/A	1.206E+04 (4/4) (9.725E+03 - 1.579E+04)	2B 1.6 MILES NNE	1.370E+04 (2/2) (9.175E+03 - 1.822E+04)	1.370E+04 (2/2) (9.175E+03 - 1.822E+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	1.092E+03 (4/4) (8.167E+02 - 1.430E+03)	12F 6.9 MILES WSW	1.205E+03 (2/2) (9.791E+02 - 1.430E+03)	1.200E+03 (2/2) (9.891E+02 - 1.411E+03)	0
	TH-228	6	N/A	9.902E+02 (4/4) (7.726E+02 - 1.114E+03)	2B 1.6 MILES NNE	1.098E+03 (2/2) (8.561E+02 - 1.339E+03)	1.098E+03 (2/2) (8.561E+02 - 1.339E+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
<b>LESS THAN ONE MILE FROM THE SSES</b>		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
1S4	0.1 mi N;	41.093302	-76.145853	Ground water
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	LONGITUDINAL	SAMPLE TYPE
<b>FROM ONE to FIVE MILES FROM THE SSES</b>		DEG.	DEG.	
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				
<b>GREATER THAN FIVE MILES FROM THE SSES</b>				
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
<b>OSLD LOCATIONS</b>				
<b>LESS THAN ONE MILE FROM THE SSES</b>		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
<b>LESS THAN ONE MILE FROM THE SSES</b>				
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
<b>FROM ONE to FIVE MILES FROM THE SSES</b>				
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 DEG.	LONGITUDINAL DEG.	SAMPLE TYPE
<b>GREATER THAN FIVE MILES FROM THE SSES</b>				
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**

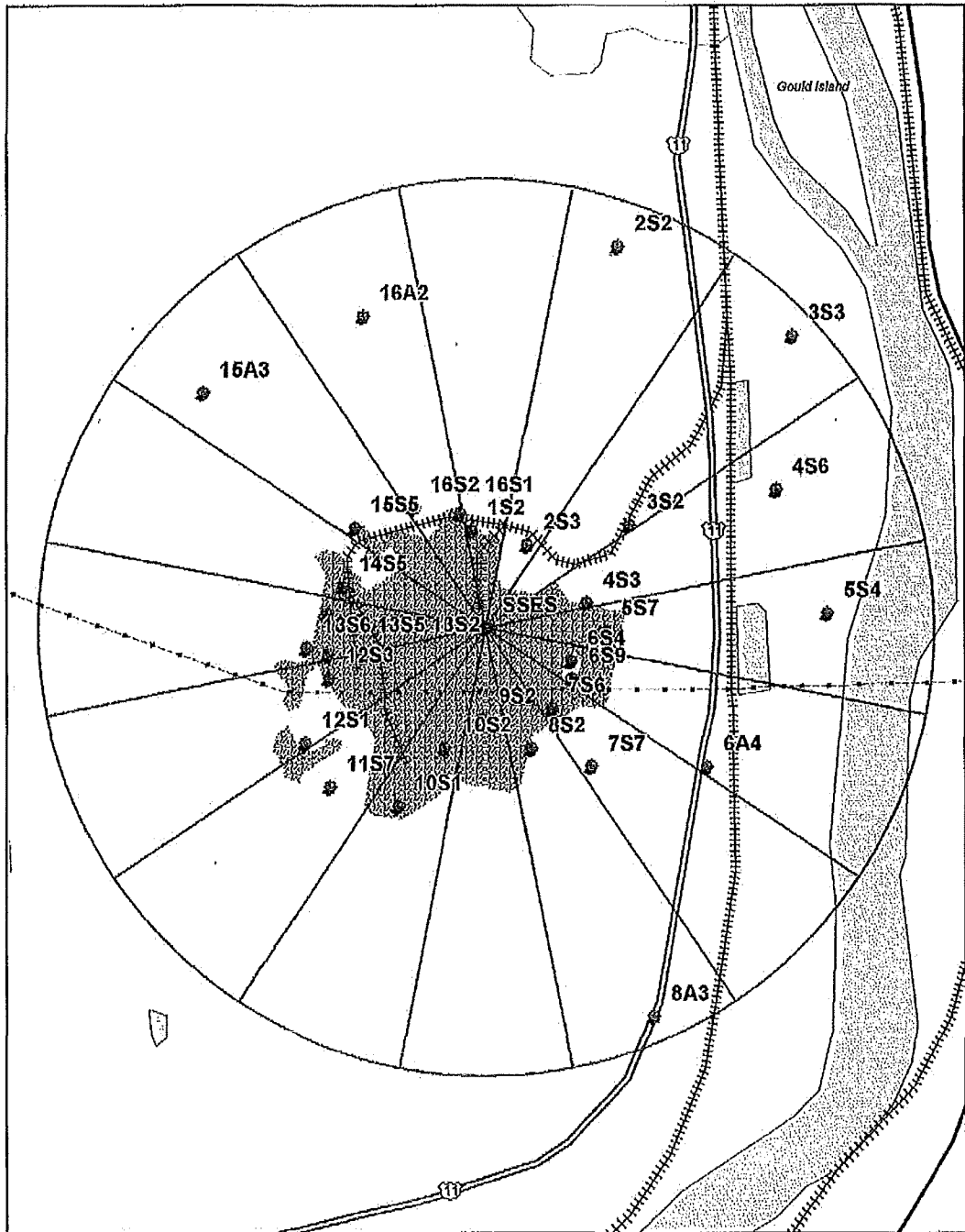
Sample Medium	Analysis	Sampling Method	Collection Procedure Number	Analytical Procedure Number
Ambient Radiation	Dosimeter	Quarterly	SSES, HP-TP-205	Landauer Procedure L313, Inlight Dosimeter Analysis
Air	Gross Beta	Weekly	Applied Ecoscience, Appendix 2	TBE-2008 Gross Alpha and/or Gross Beta Activity 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

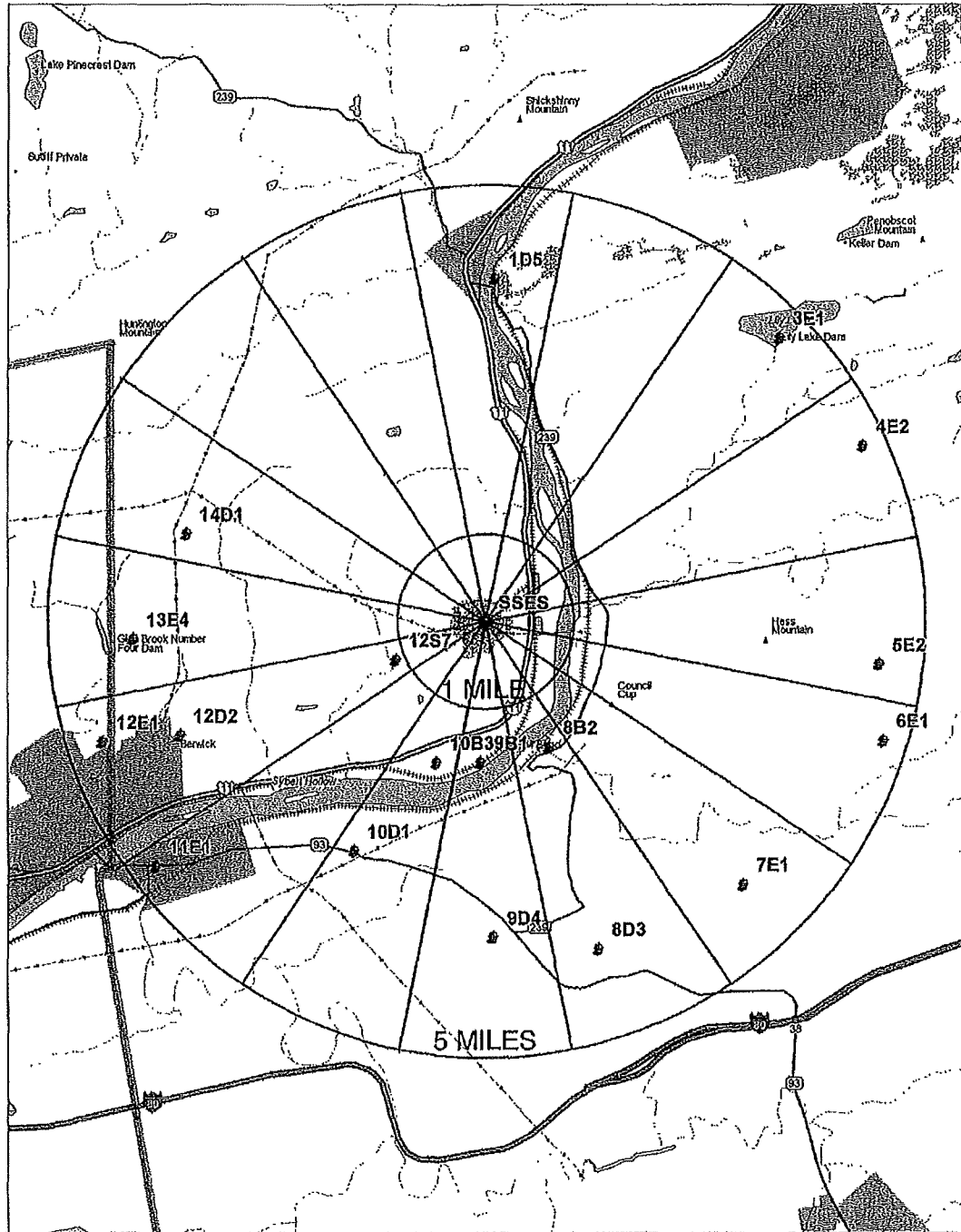
# MAP B-1

## Direct Radiation Monitoring Locations Within One Mile



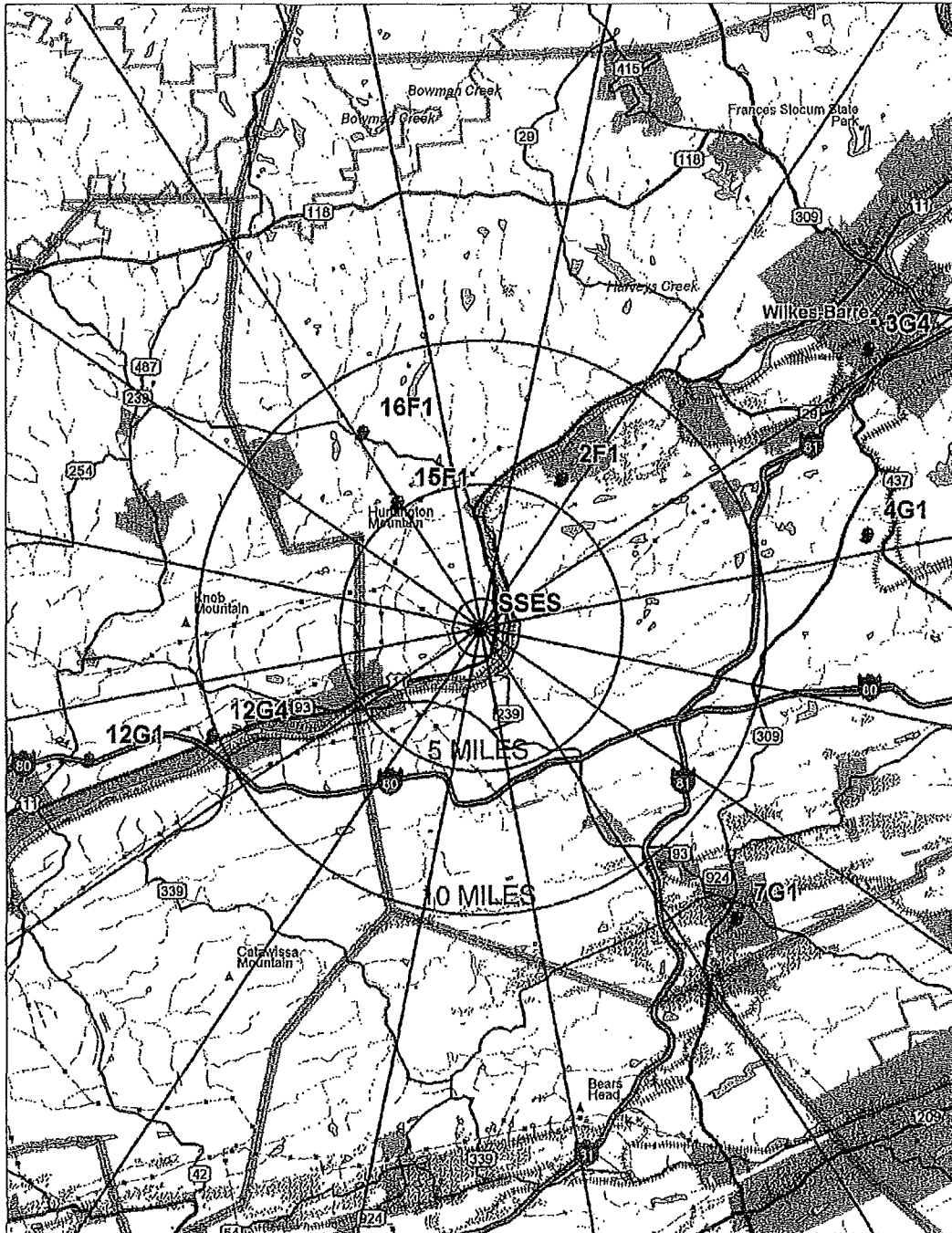
# MAP B-2

## Direct Radiation Monitoring Locations From One to Five Miles



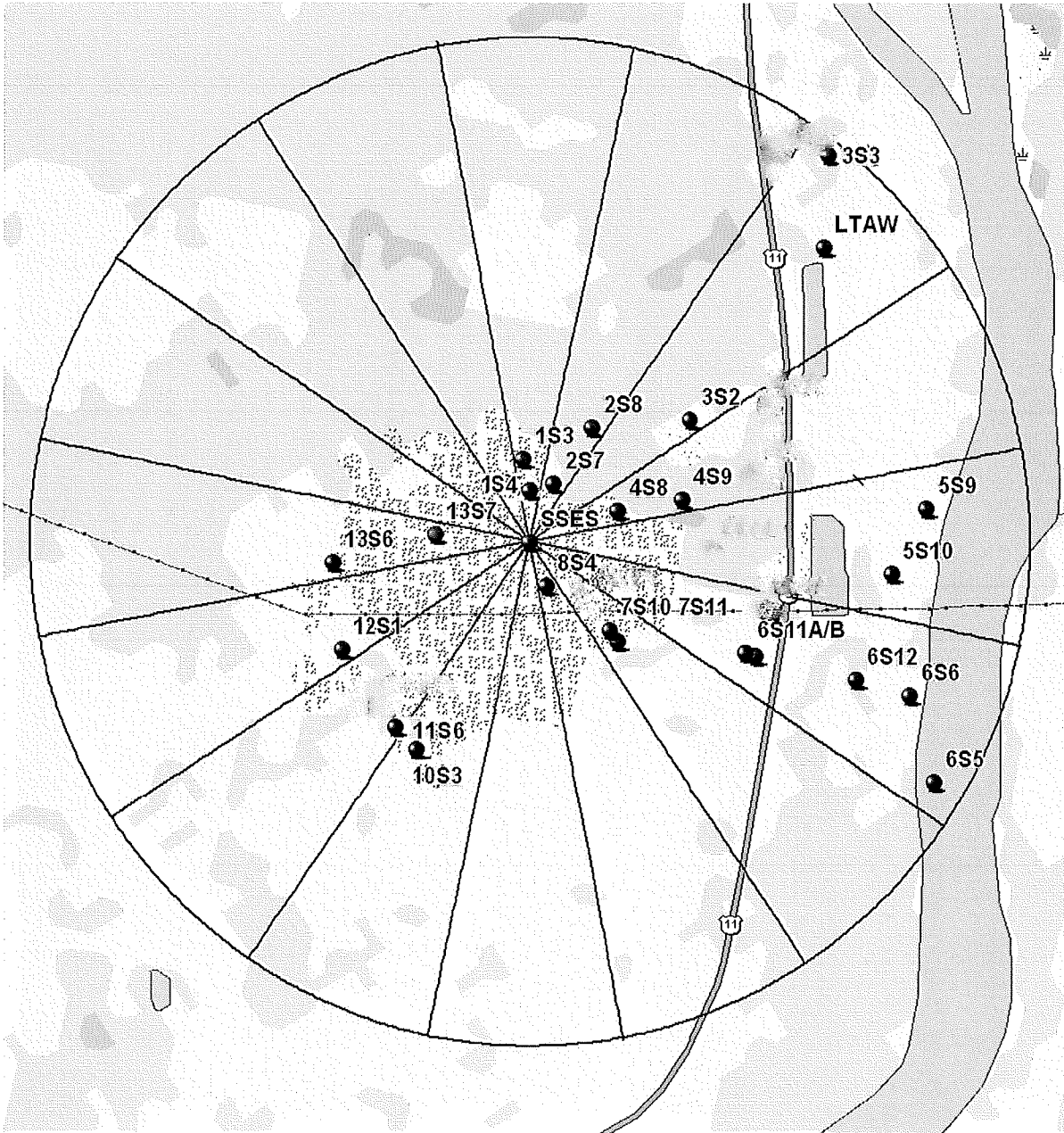
# MAP B-3

## Direct Radiation Monitoring Locations Greater Than Five Miles

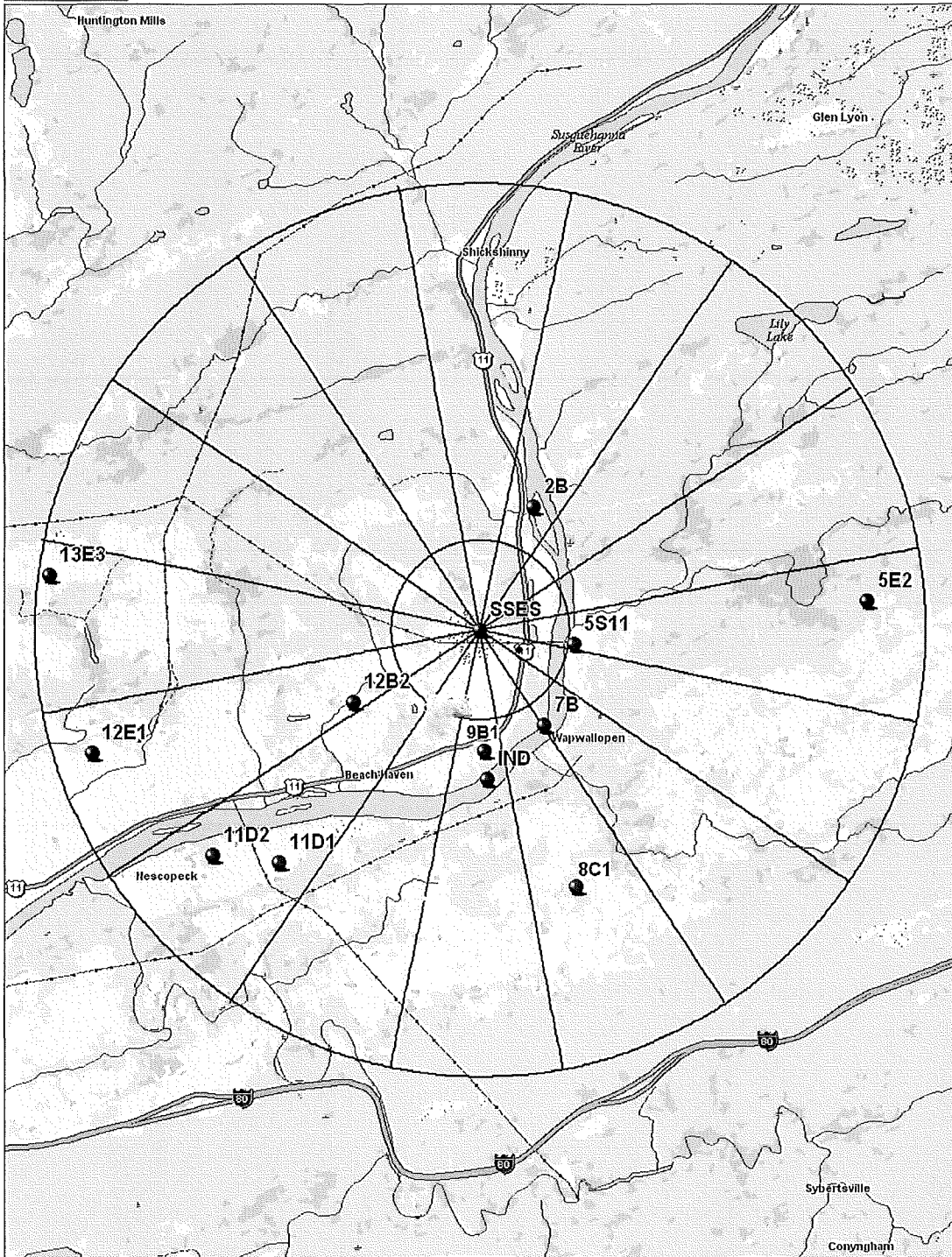


# MAP B-4

## Environmental Sampling Locations Within One Mile

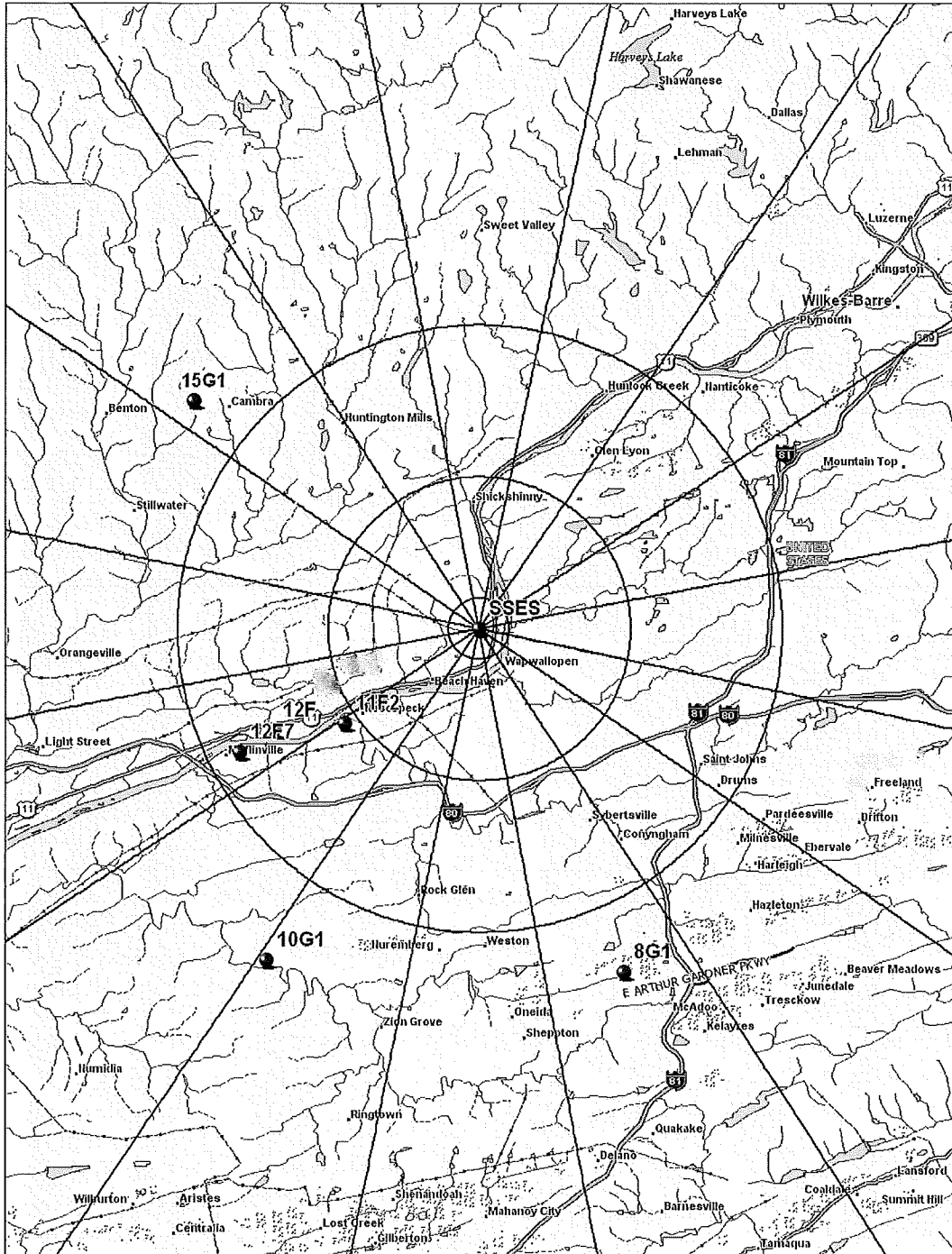


**MAP B-5**  
**Environmental Sampling Locations**  
**From One to Five Miles**



# 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, 2020**

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

COLLECTION PERIOD	3S2	8G1	12E1	12S1	13S6	9B1
01/02/20 - 01/08/20	12 $\pm$ 2	10 $\pm$ 2	14 $\pm$ 3	15 $\pm$ 3	13 $\pm$ 2	12 $\pm$ 2
01/08/20 - 01/15/20	9 $\pm$ 2	8 $\pm$ 2	9 $\pm$ 2	9 $\pm$ 2	10 $\pm$ 2	9 $\pm$ 2
01/15/20 - 01/22/20	14 $\pm$ 2	15 $\pm$ 2	14 $\pm$ 2	19 $\pm$ 3	18 $\pm$ 2	15 $\pm$ 2
01/22/20 - 01/29/20	9 $\pm$ 2	7 $\pm$ 2	9 $\pm$ 2	9 $\pm$ 2	10 $\pm$ 2	9 $\pm$ 2
01/29/20 - 02/05/20	11 $\pm$ 2	11 $\pm$ 2	12 $\pm$ 2	13 $\pm$ 2	11 $\pm$ 2	10 $\pm$ 2
02/05/20 - 02/12/20	10 $\pm$ 2	7 $\pm$ 2	8 $\pm$ 2	10 $\pm$ 2	11 $\pm$ 2	8 $\pm$ 2
02/12/20 - 02/19/20	11 $\pm$ 2	9 $\pm$ 2	14 $\pm$ 2	14 $\pm$ 2	13 $\pm$ 2	12 $\pm$ 2
02/19/20 - 02/26/20	17 $\pm$ 2	19 $\pm$ 3	16 $\pm$ 2	20 $\pm$ 3	20 $\pm$ 3	18 $\pm$ 2
02/26/20 - 03/04/20	12 $\pm$ 2	12 $\pm$ 2	12 $\pm$ 2	11 $\pm$ 2	12 $\pm$ 2	12 $\pm$ 2
03/04/20 - 03/11/20	12 $\pm$ 2	13 $\pm$ 2	12 $\pm$ 2	12 $\pm$ 2	13 $\pm$ 2	12 $\pm$ 2
03/11/20 - 03/18/20	10 $\pm$ 2	11 $\pm$ 2	12 $\pm$ 2	11 $\pm$ 2	11 $\pm$ 2	9 $\pm$ 2
03/18/20 - 03/25/20	11 $\pm$ 2	11 $\pm$ 6	10 $\pm$ 2	10 $\pm$ 2	14 $\pm$ 2	9 $\pm$ 2
03/25/20 - 04/01/20	6 $\pm$ 2	7 $\pm$ 2	6 $\pm$ 2	7 $\pm$ 2	8 $\pm$ 2	6 $\pm$ 2
04/01/20 - 04/08/20	12 $\pm$ 2	9 $\pm$ 2	11 $\pm$ 2	10 $\pm$ 2	12 $\pm$ 2	9 $\pm$ 2
04/08/20 - 04/15/20	12 $\pm$ 2	12 $\pm$ 2	12 $\pm$ 2	12 $\pm$ 2	10 $\pm$ 2	13 $\pm$ 2
04/15/20 - 04/22/20	13 $\pm$ 5	13 $\pm$ 2	12 $\pm$ 2	11 $\pm$ 2	12 $\pm$ 2	13 $\pm$ 2
04/22/20 - 04/29/20	9 $\pm$ 2	7 $\pm$ 2	9 $\pm$ 2	9 $\pm$ 2	8 $\pm$ 2	7 $\pm$ 2
04/29/20 - 05/06/20	8 $\pm$ 2	8 $\pm$ 2	9 $\pm$ 2	12 $\pm$ 2	11 $\pm$ 2	9 $\pm$ 2
05/06/20 - 05/13/20	10 $\pm$ 2	10 $\pm$ 2	9 $\pm$ 2	10 $\pm$ 2	10 $\pm$ 2	11 $\pm$ 2
05/13/20 - 05/20/20	14 $\pm$ 2	13 $\pm$ 2	16 $\pm$ 2	17 $\pm$ 2	16 $\pm$ 2	15 $\pm$ 2
05/20/20 - 05/27/20	8 $\pm$ 2	7 $\pm$ 2	10 $\pm$ 2	8 $\pm$ 2	8 $\pm$ 2	8 $\pm$ 2
05/27/20 - 06/03/20	11 $\pm$ 2	9 $\pm$ 2	12 $\pm$ 2	12 $\pm$ 2	11 $\pm$ 2	10 $\pm$ 2
06/03/20 - 06/10/20	12 $\pm$ 2	10 $\pm$ 2	13 $\pm$ 2	13 $\pm$ 2	13 $\pm$ 2	13 $\pm$ 2
06/10/20 - 06/17/20	8 $\pm$ 2	7 $\pm$ 2	9 $\pm$ 2	8 $\pm$ 2	8 $\pm$ 2	6 $\pm$ 2
06/17/20 - 06/24/20	8 $\pm$ 2	7 $\pm$ 2	6 $\pm$ 2	8 $\pm$ 2	7 $\pm$ 2	8 $\pm$ 2
06/24/20 - 07/01/20	13 $\pm$ 2	12 $\pm$ 2	13 $\pm$ 2	14 $\pm$ 2	13 $\pm$ 2	11 $\pm$ 2
07/01/20 - 07/08/20	16 $\pm$ 2	14 $\pm$ 2	17 $\pm$ 2	16 $\pm$ 2	16 $\pm$ 2	16 $\pm$ 2
07/08/20 - 07/15/20	11 $\pm$ 2	8 $\pm$ 2	10 $\pm$ 2	12 $\pm$ 2	12 $\pm$ 2	9 $\pm$ 2
07/15/20 - 07/22/20	19 $\pm$ 3	19 $\pm$ 3	17 $\pm$ 2	16 $\pm$ 2	18 $\pm$ 3	16 $\pm$ 2
07/22/20 - 07/29/20	18 $\pm$ 3	17 $\pm$ 3	18 $\pm$ 2	16 $\pm$ 3	17 $\pm$ 3	18 $\pm$ 2
07/29/20 - 08/05/20	15 $\pm$ 2	13 $\pm$ 2	13 $\pm$ 2	13 $\pm$ 2	18 $\pm$ 3	16 $\pm$ 2
08/05/20 - 08/12/20	22 $\pm$ 3	21 $\pm$ 3	24 $\pm$ 3	20 $\pm$ 3	21 $\pm$ 3	21 $\pm$ 3
08/12/20 - 08/19/20	17 $\pm$ 2	17 $\pm$ 3	17 $\pm$ 2	19 $\pm$ 3	19 $\pm$ 3	17 $\pm$ 2
08/19/20 - 08/26/20	15 $\pm$ 2	19 $\pm$ 3	18 $\pm$ 2	19 $\pm$ 3	17 $\pm$ 2	17 $\pm$ 2
08/26/20 - 09/02/20	11 $\pm$ 2	12 $\pm$ 2	13 $\pm$ 2	11 $\pm$ 2	10 $\pm$ 2	12 $\pm$ 2
09/02/20 - 09/09/20	17 $\pm$ 2	16 $\pm$ 2	17 $\pm$ 2	16 $\pm$ 2	19 $\pm$ 3	14 $\pm$ 2
09/09/20 - 09/16/20	9 $\pm$ 2	8 $\pm$ 2	10 $\pm$ 2	11 $\pm$ 2	10 $\pm$ 2	10 $\pm$ 2
09/16/20 - 09/23/20	13 $\pm$ 2	14 $\pm$ 2	14 $\pm$ 2	15 $\pm$ 2	15 $\pm$ 2	13 $\pm$ 2
09/23/20 - 09/30/20	25 $\pm$ 3	24 $\pm$ 3	26 $\pm$ 3	30 $\pm$ 3	27 $\pm$ 3	29 $\pm$ 3
09/30/20 - 10/07/20	11 $\pm$ 2	12 $\pm$ 2	15 $\pm$ 2	10 $\pm$ 2	12 $\pm$ 2	11 $\pm$ 2
10/07/20 - 10/14/20	15 $\pm$ 2	14 $\pm$ 2	14 $\pm$ 2	15 $\pm$ 2	14 $\pm$ 2	15 $\pm$ 2
10/14/20 - 10/21/20	18 $\pm$ 2	15 $\pm$ 2	17 $\pm$ 2	17 $\pm$ 2	17 $\pm$ 3	17 $\pm$ 2
10/21/20 - 10/28/20	12 $\pm$ 2	8 $\pm$ 2	11 $\pm$ 2	12 $\pm$ 2	11 $\pm$ 2	11 $\pm$ 2
10/28/20 - 11/04/20	13 $\pm$ 2	13 $\pm$ 2	12 $\pm$ 2	14 $\pm$ 2	13 $\pm$ 2	12 $\pm$ 2
11/04/20 - 11/11/20	22 $\pm$ 3	17 $\pm$ 2	22 $\pm$ 3	22 $\pm$ 3	22 $\pm$ 3	24 $\pm$ 3
11/11/20 - 11/18/20	14 $\pm$ 2	14 $\pm$ 2	14 $\pm$ 2	12 $\pm$ 2	15 $\pm$ 2	15 $\pm$ 2
11/18/20 - 11/24/20	14 $\pm$ 2	12 $\pm$ 2	12 $\pm$ 2	12 $\pm$ 2	13 $\pm$ 2	13 $\pm$ 2
11/24/20 - 12/02/20	9 $\pm$ 2	8 $\pm$ 2	8 $\pm$ 2	9 $\pm$ 2	9 $\pm$ 2	9 $\pm$ 2
12/02/20 - 12/09/20	10 $\pm$ 2	9 $\pm$ 2	10 $\pm$ 2	9 $\pm$ 2	9 $\pm$ 2	11 $\pm$ 2
12/09/20 - 12/15/20	21 $\pm$ 3	20 $\pm$ 3	27 $\pm$ 3	22 $\pm$ 3	22 $\pm$ 3	25 $\pm$ 3
12/15/20 - 12/22/20	8 $\pm$ 2	6 $\pm$ 2	12 $\pm$ 2	10 $\pm$ 2	11 $\pm$ 2	13 $\pm$ 2
12/22/20 - 12/30/20	13 $\pm$ 2	11 $\pm$ 2	12 $\pm$ 2	11 $\pm$ 2	12 $\pm$ 2	13 $\pm$ 2
AVERAGE	13 $\pm$ 8	12 $\pm$ 8	13 $\pm$ 9	13 $\pm$ 9	13 $\pm$ 9	13 $\pm$ 9

TABLE C-1

**GROSS BETA ANALYSES OF AIR PARTICULATE FILTERS  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020**

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

COLLECTION PERIOD	10S3
01/02/20 - 01/08/20	13 $\pm$ 2
01/08/20 - 01/15/20	8 $\pm$ 2
01/15/20 - 01/22/20	15 $\pm$ 2
01/22/20 - 01/29/20	9 $\pm$ 2
01/29/20 - 02/05/20	11 $\pm$ 2
02/05/20 - 02/12/20	8 $\pm$ 2
02/12/20 - 02/19/20	14 $\pm$ 2
02/19/20 - 02/26/20	19 $\pm$ 2
02/26/20 - 03/04/20	14 $\pm$ 2
03/04/20 - 03/11/20	11 $\pm$ 2
03/11/20 - 03/18/20	13 $\pm$ 2
03/18/20 - 03/25/20	9 $\pm$ 2
03/25/20 - 04/01/20	8 $\pm$ 2
04/01/20 - 04/08/20	11 $\pm$ 2
04/08/20 - 04/15/20	11 $\pm$ 2
04/15/20 - 04/22/20	13 $\pm$ 2
04/22/20 - 04/29/20	8 $\pm$ 2
04/29/20 - 05/06/20	10 $\pm$ 2
05/06/20 - 05/13/20	9 $\pm$ 2
05/13/20 - 05/20/20	13 $\pm$ 2
05/20/20 - 05/27/20	8 $\pm$ 2
05/27/20 - 06/03/20	11 $\pm$ 2
06/03/20 - 06/10/20	12 $\pm$ 2
06/10/20 - 06/17/20	7 $\pm$ 2
06/17/20 - 06/24/20	7 $\pm$ 2
06/24/20 - 07/01/20	14 $\pm$ 2
07/01/20 - 07/08/20	18 $\pm$ 2
07/08/20 - 07/15/20	10 $\pm$ 2
07/15/20 - 07/22/20	15 $\pm$ 2
07/22/20 - 07/29/20	17 $\pm$ 4
07/29/20 - 08/05/20	19 $\pm$ 3
08/05/20 - 08/12/20	20 $\pm$ 3
08/12/20 - 08/19/20	17 $\pm$ 2
08/19/20 - 08/26/20	16 $\pm$ 2
08/26/20 - 09/02/20	12 $\pm$ 2
09/02/20 - 09/09/20	15 $\pm$ 2
09/09/20 - 09/16/20	11 $\pm$ 2
09/16/20 - 09/23/20	14 $\pm$ 2
09/23/20 - 09/30/20	28 $\pm$ 3
09/30/20 - 10/07/20	9 $\pm$ 2
10/07/20 - 10/14/20	15 $\pm$ 2
10/14/20 - 10/21/20	16 $\pm$ 2
10/21/20 - 10/28/20	11 $\pm$ 2
10/28/20 - 11/04/20	12 $\pm$ 2
11/04/20 - 11/11/20	23 $\pm$ 3
11/11/20 - 11/18/20	13 $\pm$ 2
11/18/20 - 11/24/20	10 $\pm$ 2
11/24/20 - 12/02/20	9 $\pm$ 2
12/02/20 - 12/09/20	10 $\pm$ 2
12/09/20 - 12/15/20	24 $\pm$ 3
12/15/20 - 12/22/20	11 $\pm$ 2
12/22/20 - 12/30/20	11 $\pm$ 2
AVERAGE	13 $\pm$ 9

**TABLE C-2 GAMMA SPECTROSCOPIC ANALYSES OF COMPOSITED AIR PARTICULATE FILTERS  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020**

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

SITE	COLLECTION PERIOD	Be-7	K-40	Cs-134	Cs-137
8G1	01/02/20 - 04/01/20	103 $\pm$ 24	< 30	< 2	< 2
	04/01/20 - 07/01/20	129 $\pm$ 21	< 20	< 1	< 1
	07/01/20 - 09/30/20	117 $\pm$ 24	< 27	< 1	< 1
	09/30/20 - 12/30/20	97 $\pm$ 17	< 21	< 1	< 1
	AVERAGE	111 $\pm$ 29	-	-	-
3S2	01/02/20 - 04/01/20	83 $\pm$ 16	< 16	< 1	< 1
	04/01/20 - 07/01/20	119 $\pm$ 23	< 20	< 1	< 1
	07/01/20 - 09/30/20	117 $\pm$ 25	< 25	< 2	< 1
	09/30/20 - 12/30/20	91 $\pm$ 17	< 16	< 1	< 1
	AVERAGE	103 $\pm$ 36	-	-	-
12E1	01/02/20 - 04/01/20	91 $\pm$ 16	< 13	< 1	< 1
	04/01/20 - 07/01/20	139 $\pm$ 23	< 24	< 2	< 1
	07/01/20 - 09/30/20	140 $\pm$ 25	< 27	< 2	< 2
	09/30/20 - 12/30/20	102 $\pm$ 17	< 17	< 1	< 1
	AVERAGE	118 $\pm$ 51	-	-	-
12S1	01/02/20 - 04/01/20	68 $\pm$ 25	< 24	< 2	< 2
	04/01/20 - 07/01/20	130 $\pm$ 20	< 15	< 1	< 1
	07/01/20 - 09/30/20	149 $\pm$ 23	< 18	< 1	< 1
	09/30/20 - 12/30/20	94 $\pm$ 18	< 22	< 1	< 1
	AVERAGE	110 $\pm$ 72	-	-	-
13S6	01/02/20 - 04/01/20	107 $\pm$ 20	< 17	< 1	< 1
	04/01/20 - 07/01/20	132 $\pm$ 18	< 16	< 1	< 1
	07/01/20 - 09/30/20	128 $\pm$ 19	< 14	< 1	< 1
	09/30/20 - 12/30/20	87 $\pm$ 18	< 16	< 1	< 1
	AVERAGE	114 $\pm$ 41	-	-	-
9B1	01/02/20 - 04/01/20	104 $\pm$ 20	< 23	< 1	< 1
	04/01/20 - 07/01/20	135 $\pm$ 22	< 25	< 1	< 1
	07/01/20 - 09/30/20	136 $\pm$ 21	< 17	< 1	< 1
	09/30/20 - 12/30/20	126 $\pm$ 21	< 21	< 2	< 1
	AVERAGE	125 $\pm$ 30	-	-	-
10S3	01/02/20 - 04/01/20	93 $\pm$ 20	< 11	< 1	< 1
	04/01/20 - 07/01/20	120 $\pm$ 21	< 12	< 1	< 1
	07/01/20 - 09/30/20	126 $\pm$ 25	< 18	< 1	< 1
	09/30/20 - 12/30/20	80 $\pm$ 18	< 17	< 1	< 1
	AVERAGE	105 $\pm$ 44	-	-	-

TABLE C-3

**IODINE-131 ANALYSES OF AIR IODINE SAMPLES  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020**

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

COLLECTION PERIOD	3S2	8G1	12E1	12S1	13S6	9B1
01/02/20 - 01/08/20	< 9	< 8	< 9	< 9	< 8	< 7
01/08/20 - 01/15/20	< 10	< 10	< 10	< 10	< 10	< 4
01/15/20 - 01/22/20	< 13	< 8	< 11	< 13	< 13	< 8
01/22/20 - 01/29/20	< 17	< 15	< 15	< 15	< 17	< 11
01/29/20 - 02/05/20	< 8	< 15	< 16	< 15	< 19	< 12
02/05/20 - 02/12/20	< 8	< 13	< 13	< 13	< 19	< 10
02/12/20 - 02/19/20	< 5	< 7	< 7	< 7	< 2	< 3
02/19/20 - 02/26/20	< 15	< 18	< 17	< 16	< 18	< 13
02/26/20 - 03/04/20	< 3	< 9	< 9	< 9	< 7	< 7
03/04/20 - 03/11/20	< 4	< 6	< 7	< 8	< 8	< 7
03/11/20 - 03/18/20	< 3	< 5	< 6	< 6	< 7	< 6
03/18/20 - 03/25/20	< 14	< 14	< 8	< 8	< 15	< 7
03/25/20 - 04/01/20	< 3	< 8	< 9	< 4	< 6	< 9
04/01/20 - 04/08/20	< 12	< 8	< 8	< 8	< 14	< 3
04/08/20 - 04/15/20	< 8	< 17	< 11	< 16	< 15	< 17
04/15/20 - 04/22/20	< 10	< 18	< 18	< 18	< 17	< 12
04/22/20 - 04/29/20	< 12	< 14	< 14	< 13	< 19	< 6
04/29/20 - 05/06/20	< 8	< 17	< 17	< 16	< 13	< 9
05/06/20 - 05/13/20	< 16	< 10	< 17	< 17	< 15	< 18
05/13/20 - 05/20/20	< 8	< 11	< 12	< 11	< 7	< 5
05/20/20 - 05/27/20	< 10	< 16	< 9	< 16	< 16	< 17
05/27/20 - 06/03/20	< 11	< 8	< 8	< 8	< 5	< 5
06/03/20 - 06/10/20	< 14	< 12	< 13	< 14	< 14	< 7
06/10/20 - 06/17/20	< 10	< 12	< 10	< 11	< 11	< 5
06/17/20 - 06/24/20	< 8	< 14	< 13	< 14	< 14	< 7
06/24/20 - 07/01/20	< 10	< 6	< 10	< 6	< 10	< 14
07/01/20 - 07/08/20	< 9	< 8	< 8	< 8	< 9	< 4
07/08/20 - 07/15/20	< 10	< 15	< 14	< 16	< 10	< 8
07/15/20 - 07/22/20	< 12	< 9	< 11	< 5	< 12	< 19
07/22/20 - 07/29/20	< 15	< 8	< 17	< 19	< 6	< 18
07/29/20 - 08/05/20	< 11	< 6	< 10	< 11	< 11	< 6
08/05/20 - 08/12/20	< 14	< 10	< 10	< 10	< 9	< 10
08/12/20 - 08/19/20	< 11	< 4	< 11	< 11	< 12	< 5
08/19/20 - 08/26/20	< 6	< 7	< 13	< 14	< 14	< 15
08/26/20 - 09/02/20	< 10	< 7	< 4	< 11	< 10	< 16
09/02/20 - 09/09/20	< 11	< 5	< 11	< 5	< 11	< 12
09/09/20 - 09/16/20	< 14	< 11	< 10	< 11	< 6	< 10
09/16/20 - 09/23/20	< 13	< 7	< 12	< 6	< 12	< 15
09/23/20 - 09/30/20	< 10	< 5	< 9	< 5	< 10	< 11
09/30/20 - 10/07/20	< 9	< 5	< 12	< 12	< 20	< 12
10/07/20 - 10/14/20	< 19	< 13	< 19	< 19	< 10	< 18
10/14/20 - 10/21/20	< 19	< 13	< 19	< 19	< 10	< 18
10/21/20 - 10/28/20	< 20	< 17	< 17	< 12	< 9	< 16
10/28/20 - 11/04/20	< 8	< 5	< 8	< 4	< 9	< 10
11/04/20 - 11/11/20	< 17	< 17	< 17	< 15	< 8	< 7
11/11/20 - 11/18/20	< 13	< 14	< 14	< 13	< 6	< 6
11/18/20 - 11/24/20	< 20	< 12	< 12	< 12	< 14	< 5
11/24/20 - 12/02/20	< 11	< 9	< 9	< 9	< 16	< 4
12/02/20 - 12/09/20	< 19	< 9	< 9	< 10	< 8	< 4
12/09/20 - 12/15/20	< 12	< 6	< 6	< 5	< 12	< 7
12/15/20 - 12/22/20	< 5	< 18	< 10	< 11	< 10	< 19
12/22/20 - 12/30/20	< 12	< 17	< 17	< 18	< 5	< 12
AVERAGE	-	-	-	-	-	-

TABLE C-3

**IODINE-131 ANALYSES OF AIR IODINE SAMPLES  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020**

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

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

**TABLE C-4 ENVIRONMENTAL OPTICALLY STIMULATED LUMINESCENCE DOSIMETRY RESULTS  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020**

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

<u>LOCATION</u>	First Quarter 1/16/2020 to 4/5/2020	Second Quarter 4/5/2020 to 7/10/2020	Third Quarter 7/10/2020 to 10/7/2020	Fourth Quarter 10/7/2020 to 1/7/2021
<b>ONSITE</b>				
1S2	18.5 $\pm$ 0.4	20.1 $\pm$ 1.1	23.3 $\pm$ 0.5	22.5 $\pm$ 1.9
2S2	14.3 $\pm$ 0.2	14.6 $\pm$ 0.6	16.2 $\pm$ 0.2	15.8 $\pm$ 1.0
2S3	17.5 $\pm$ 0.8	18.7 $\pm$ 0.9	18.8 $\pm$ 5.0	15.5 $\pm$ 6.8
3S2	14.3 $\pm$ 0.1	14.4 $\pm$ 0.3	15.1 $\pm$ 0.2	13.9 $\pm$ 1.5
3S3	11.7 $\pm$ 0.8	13.5 $\pm$ 0.7	13.5 $\pm$ 2.9	13.3 $\pm$ 0.4
4S3	18.4 $\pm$ 0.9	20.6 $\pm$ 0.4	20.1 $\pm$ 0.9	20.0 $\pm$ 0.4
4S6	13.3 $\pm$ 0.6	13.9 $\pm$ 0.3	15.4 $\pm$ 0.2	13.5 $\pm$ 0.0
5S4	11.7 $\pm$ 0.0	12.3 $\pm$ 0.0	14.6 $\pm$ 0.8	12.8 $\pm$ 0.4
5S7	15.2 $\pm$ 1.5	16.3 $\pm$ 2.1	19.5 $\pm$ 2.1	16.6 $\pm$ 1.2
6S4	23.0 $\pm$ 0.2	22.2 $\pm$ 1.9	25.9 $\pm$ 3.8	24.0 $\pm$ 0.6
6S9	20.6 $\pm$ 0.4	20.9 $\pm$ 0.1	27.6 $\pm$ 0.1	23.7 $\pm$ 2.7
7S6	19.8 $\pm$ 2.9	21.3 $\pm$ 0.1	23.9 $\pm$ 1.0	20.3 $\pm$ 0.5
7S7	12.9 $\pm$ 0.7	14.4 $\pm$ 0.3	13.2 $\pm$ 1.3	14.9 $\pm$ 2.0
8S2	20.8 $\pm$ 0.4	22.4 $\pm$ 0.4	27.0 $\pm$ 1.1	23.4 $\pm$ 1.0
9S2	37.8 $\pm$ 3.6	39.6 $\pm$ 1.7	46.3 $\pm$ 0.4	36.3 $\pm$ 2.0
10S1	12.7 $\pm$ 0.2	12.4 $\pm$ 0.3	16.0 $\pm$ 0.4	15.2 $\pm$ 0.2
10S2	30.2 $\pm$ 0.9	31.6 $\pm$ 0.5	29.7 $\pm$ 2.3	26.9 $\pm$ 0.4
11S7	12.9 $\pm$ 0.1	14.5 $\pm$ 0.6	16.3 $\pm$ 1.5	15.5 $\pm$ 0.8
12S1	15.1 $\pm$ 1.2	16.0 $\pm$ 1.8	16.5 $\pm$ 0.1	15.0 $\pm$ 2.0
12S3	18.4 $\pm$ 2.5	20.8 $\pm$ 1.1	20.9 $\pm$ 1.0	20.4 $\pm$ 1.1
12S7	13.9 $\pm$ 1.0	15.3 $\pm$ 2.1	14.7 $\pm$ 0.3	14.4 $\pm$ 0.1
13S2	26.3 $\pm$ 1.4	27.6 $\pm$ 0.7	24.1 $\pm$ 0.6	24.0 $\pm$ 1.1
13S5	27.3 $\pm$ 1.0	25.8 $\pm$ 1.1	(4) (4)	21.1 $\pm$ 0.3
13S6	19.2 $\pm$ 1.5	19.9 $\pm$ 0.5	21.4 $\pm$ 0.5	20.3 $\pm$ 0.7
14S5	15.9 $\pm$ 1.4	18.5 $\pm$ 0.9	17.5 $\pm$ 2.8	17.9 $\pm$ 1.2
15S5	16.4 $\pm$ 1.0	16.3 $\pm$ 1.6	18.9 $\pm$ 1.7	16.1 $\pm$ 0.3
16S1	18.8 $\pm$ 0.6	21.1 $\pm$ 1.1	26.5 $\pm$ 0.8	24.8 $\pm$ 0.3
16S2	18.2 $\pm$ 0.9	19.2 $\pm$ 0.1	22.3 $\pm$ 2.3	21.1 $\pm$ 0.6

See the comments at the end of this table.

**TABLE C-4 ENVIRONMENTAL OPTICALLY STIMULATED LUMINESCENCE DOSIMETRY RESULTS  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020**

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

<u>LOCATION</u>	First Quarter 1/16/2020 to 4/5/2020	Second Quarter 4/5/2020 to 7/10/2020	Third Quarter 7/10/2020 to 10/7/2020	Fourth Quarter 10/7/2020 to 1/7/2021
<b>0-1 MILE OFFSITE</b>				
6A4	15.5 $\pm$ 1.7	17.0 $\pm$ 0.3	17.7 $\pm$ 0.3	17.1 $\pm$ 0.4
8A3	16.3 $\pm$ 0.2	15.4 $\pm$ 1.2	17.8 $\pm$ 0.1	15.9 $\pm$ 0.8
15A3	12.6 $\pm$ 0.6	12.2 $\pm$ 0.9	15.0 $\pm$ 1.1	13.4 $\pm$ 0.4
16A2	12.3 $\pm$ 0.4	13.6 $\pm$ 1.3	14.8 $\pm$ 0.8	14.7 $\pm$ 0.2
<b>1-2 MILES OFFSITE</b>				
8B2	12.8 $\pm$ 0.6	14.5 $\pm$ 0.8	14.9 $\pm$ 0.7	15.7 $\pm$ 0.3
9B1	17.6 $\pm$ 0.2	19.0 $\pm$ 0.3	20.5 $\pm$ 0.1	17.1 $\pm$ 1.1
10B3	13.4 $\pm$ 0.1	14.9 $\pm$ 0.9	13.1 $\pm$ 0.3	14.4 $\pm$ 0.8
<b>3-4 MILES OFFSITE</b>				
1D5	13.6 $\pm$ 0.0	17.8 $\pm$ 0.7	16.4 $\pm$ 0.8	16.5 $\pm$ 0.1
8D3	14.4 $\pm$ 0.9	15.1 $\pm$ 2.6	16.2 $\pm$ 0.8	15.7 $\pm$ 0.2
9D4	14.7 $\pm$ 0.0	17.9 $\pm$ 1.1	17.0 $\pm$ 0.6	17.5 $\pm$ 1.4
10D1	12.9 $\pm$ 0.5	14.4 $\pm$ 1.5	15.6 $\pm$ 1.1	13.7 $\pm$ 1.1
12D2	17.8 $\pm$ 1.0	19.6 $\pm$ 1.3	19.0 $\pm$ 1.1	19.9 $\pm$ 1.3
14D1	14.7 $\pm$ 0.6	15.4 $\pm$ 1.1	16.1 $\pm$ 0.4	14.8 $\pm$ 0.1
<b>4-5 MILES OFFSITE</b>				
3E1	12.2 $\pm$ 0.8	12.6 $\pm$ 0.7	12.8 $\pm$ 0.5	12.9 $\pm$ 0.4
4E2	14.3 $\pm$ 0.5	19.1 $\pm$ 3.2	16.6 $\pm$ 1.1	16.9 $\pm$ 0.1
5E2	14.0 $\pm$ 0.0	16.4 $\pm$ 0.7	16.9 $\pm$ 0.5	15.6 $\pm$ 1.6
6E1	15.5 $\pm$ 1.9	17.0 $\pm$ 3.4	17.1 $\pm$ 1.3	14.6 $\pm$ 0.4
7E1	14.1 $\pm$ 1.7	15.5 $\pm$ 1.9	15.9 $\pm$ 0.8	14.7 $\pm$ 0.6
11E1	10.1 $\pm$ 0.4	13.4 $\pm$ 1.8	11.6 $\pm$ 0.5	12.2 $\pm$ 0.8
12E1	11.4 $\pm$ 1.5	14.2 $\pm$ 0.7	13.3 $\pm$ 0.6	13.1 $\pm$ 1.1
13E4	16.0 $\pm$ 0.5	15.6 $\pm$ 3.0	17.7 $\pm$ 0.1	17.6 $\pm$ 0.4

See the comments at the end of this table.



**TABLE C-4 ENVIRONMENTAL OPTICALLY STIMULATED LUMINESCENCE DOSIMETRY RESULTS  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020**

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

<u>LOCATION</u>	First Quarter 1/16/2020 to 4/5/2020	Second Quarter 4/5/2020 to 7/10/2020	Third Quarter 7/10/2020 to 10/7/2020	Fourth Quarter 10/7/2020 to 1/7/2021
<b><u>5-10 MILES OFFSITE</u></b>				
2F1	13.3 $\pm$ 0.1	15.7 $\pm$ 2.3	16.3 $\pm$ 1.1	15.8 $\pm$ 0.5
15F1	17.1 $\pm$ 1.3	17.5 $\pm$ 2.3	17.8 $\pm$ 1.1	17.3 $\pm$ 0.3
16F1	17.3 $\pm$ 2.2	17.8 $\pm$ 0.4	16.4 $\pm$ 0.8	18.0 $\pm$ 0.3
<b><u>10-20 MILES OFFSITE</u></b>				
3G4	16.1 $\pm$ 0.4	16.9 $\pm$ 0.3	17.0 $\pm$ 0.0	18.8 $\pm$ 1.8
4G1	14.4 $\pm$ 0.6	18.6 $\pm$ 0.6	15.8 $\pm$ 2.2	15.9 $\pm$ 0.4
7G1	14.0 $\pm$ 0.3	16.2 $\pm$ 1.3	15.7 $\pm$ 0.4	16.3 $\pm$ 2.3
12G1	13.3 $\pm$ 2.1	13.2 $\pm$ 1.3	13.5 $\pm$ 0.3	14.1 $\pm$ 1.1
12G4	13.8 $\pm$ 2.1	16.1 $\pm$ 0.6	15.5 $\pm$ 0.6	16.4 $\pm$ 0.5

See the comments at the end of this table.

**LOCATION**

**INDICATOR**

Average (5)	16.5 $\pm$ 10.1	17.8 $\pm$ 9.9	18.7 $\pm$ 11.5	17.6 $\pm$ 8.9
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**CONTROL**

Average (5)	14.3 $\pm$ 2.1	16.2 $\pm$ 3.9	15.5 $\pm$ 2.5	16.3 $\pm$ 3.4
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**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 Appendix A 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, 2020**
Results in pCi/Liter  $\pm$  2 sigma

SITE	COLLECTION		<-----GAMMA EMITTERS----->					
	DATE	I-131	K-40	Cs-134	Cs-137	Ba-140	La-140	Th-228
10G1	01/06/20	< 0.4	1303 $\pm$ 169	< 7	< 7	< 24	< 10	< 11
	02/03/20	< 0.8	1301 $\pm$ 173	< 8	< 8	< 32	< 9	< 15
	03/02/20	< 0.8	1298 $\pm$ 159	< 6	< 7	< 30	< 7	< 13
	04/06/20	< 0.6	1166 $\pm$ 182	< 6	< 6	< 23	< 5	< 13
	04/20/20	< 0.8	1203 $\pm$ 191	< 6	< 7	< 26	< 8	< 14
	05/04/20	< 0.7	1298 $\pm$ 162	< 6	< 8	< 25	< 7	< 15
	05/18/20	< 0.9	1127 $\pm$ 209	< 8	< 7	< 31	< 6	< 16
	06/01/20	< 0.7	1365 $\pm$ 157	< 9	< 10	< 33	< 11	< 15
	06/15/20	< 0.8	1283 $\pm$ 166	< 7	< 6	< 28	< 5	< 13
	06/29/20	< 0.7	1303 $\pm$ 176	< 6	< 9	< 30	< 13	< 14
	07/13/20	< 0.8	1383 $\pm$ 186	< 7	< 8	< 29	< 8	< 12
	07/27/20	< 0.6	1293 $\pm$ 148	< 6	< 7	< 22	< 6	< 12
	08/10/20	< 0.6	1387 $\pm$ 200	< 8	< 11	< 35	< 13	< 18
	08/24/20	< 0.7	1162 $\pm$ 182	< 7	< 8	< 30	< 11	< 15
	09/08/20	< 0.9	1337 $\pm$ 224	< 7	< 7	< 28	< 8	< 13
	09/21/20	< 0.8	1274 $\pm$ 174	< 7	< 8	< 30	< 11	< 13
	10/05/20	< 0.8	1218 $\pm$ 177	< 8	< 7	< 33	< 9	< 16
	10/19/20	< 0.8	1419 $\pm$ 195	< 7	< 9	< 30	< 10	< 15
	11/02/20	< 0.8	1312 $\pm$ 192	< 6	< 8	< 30	< 7	< 16
	12/07/20	< 0.8	1509 $\pm$ 166	< 7	< 9	< 32	< 8	< 15
	AVERAGE	-	1297 $\pm$ 185	-	-	-	-	-
13E3	01/06/20	< 0.4	1307 $\pm$ 178	< 7	< 10	< 33	< 12	< 15
	02/03/20	< 0.7	1328 $\pm$ 212	< 7	< 9	< 38	< 12	< 13
	03/03/20	< 0.7	1408 $\pm$ 200	< 7	< 7	< 23	< 12	< 12
	04/06/20	< 0.7	1312 $\pm$ 131	< 4	< 6	< 18	< 6	< 8
	04/20/20	< 0.7	1383 $\pm$ 174	< 7	< 8	< 27	< 8	< 13
	05/04/20	< 0.5	1312 $\pm$ 153	< 6	< 7	< 26	< 10	< 10
	05/18/20	< 0.7	1324 $\pm$ 185	< 8	< 9	< 31	< 11	< 14
	06/01/20	< 0.9	1264 $\pm$ 194	< 8	< 10	< 29	< 11	< 16
	06/15/20	< 0.7	1281 $\pm$ 178	< 6	< 8	< 30	< 9	< 14
	06/29/20	< 0.8	1346 $\pm$ 196	< 7	< 10	< 33	< 11	< 15
	07/13/20	< 0.7	1308 $\pm$ 201	< 7	< 7	< 29	< 10	< 13
	07/27/20	< 0.7	1107 $\pm$ 170	< 7	< 7	< 26	< 8	< 11
	08/10/20	< 0.8	1298 $\pm$ 162	< 6	< 8	< 23	< 5	< 14
	08/24/20	< 0.9	1360 $\pm$ 168	< 6	< 8	< 30	< 7	< 14
	09/08/20	< 0.7	1333 $\pm$ 166	< 6	< 7	< 28	< 9	< 12
	09/21/20	< 0.6	1241 $\pm$ 206	< 7	< 9	< 33	< 13	< 13
	10/05/20	< 0.9	1305 $\pm$ 180	< 7	< 9	< 26	< 10	< 14
	10/19/20	< 0.7	1181 $\pm$ 171	< 9	< 8	< 28	< 9	< 14
	11/02/20	< 0.7	1412 $\pm$ 165	< 6	< 8	< 29	< 8	< 13
	12/07/20	< 0.7	1272 $\pm$ 174	< 7	< 8	< 33	< 12	< 14
	AVERAGE	-	1304 $\pm$ 143	-	-	-	-	-

TABLE C-5

**IODINE-131 AND GAMMA SPECTROSCOPIC ANALYSES OF MILK  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020**

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	01/06/20	< 0.6	1261 $\pm$ 180	< 7	< 8	< 25	< 8	< 13
	02/03/20	< 0.8	1250 $\pm$ 191	< 9	< 11	< 38	< 12	< 15
	03/02/20	< 0.7	1131 $\pm$ 178	< 7	< 9	< 35	< 9	< 17
	04/06/20	< 0.7	1198 $\pm$ 158	< 7	< 6	< 26	< 5	< 14
	04/20/20	< 0.7	1186 $\pm$ 192	< 7	< 9	< 30	< 9	< 17
	05/04/20	< 0.6	1312 $\pm$ 186	< 6	< 7	< 30	< 9	< 14
	05/18/20	< 0.7	1142 $\pm$ 183	< 8	< 7	< 38	< 11	< 16
	06/01/20	< 0.6	1161 $\pm$ 186	< 7	< 10	< 31	< 8	< 17
	06/15/20	< 0.7	1197 $\pm$ 171	< 5	< 6	< 23	< 9	< 13
	06/29/20	< 0.8	1064 $\pm$ 173	< 8	< 10	< 31	< 8	< 16
	07/13/20	< 0.8	1269 $\pm$ 160	< 7	< 7	< 25	< 8	< 13
	07/27/20	< 0.6	1174 $\pm$ 171	< 5	< 9	< 22	< 7	< 13
	08/10/20	< 0.7	1168 $\pm$ 197	< 7	< 8	< 34	< 6	< 16
	08/24/20	< 0.7	1195 $\pm$ 195	< 7	< 8	< 31	< 11	< 15
	09/08/20	< 0.6	1376 $\pm$ 191	< 9	< 10	< 31	< 10	< 14
	09/21/20	< 0.7	1180 $\pm$ 222	< 6	< 11	< 29	< 10	< 11
	10/05/20	< 0.8	1072 $\pm$ 161	< 7	< 8	< 29	< 7	< 15
	10/19/20	< 0.7	1121 $\pm$ 173	< 7	< 9	< 30	< 10	< 16
	11/02/20	< 0.7	1198 $\pm$ 163	< 6	< 7	< 28	< 5	< 12
	12/07/20	< 0.9	1195 $\pm$ 143	< 7	< 7	< 24	< 8	< 11
AVERAGE	-	-	1193 $\pm$ 150	-	-	-	-	-

**TABLE C-6 TRITIUM AND GAMMA SPECTROSCOPIC ANALYSES OF GROUNDWATER  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020**

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	01/15/20	< 145	< 124	< 8	< 8	< 21	< 6	< 11	< 8	< 13	< 13	< 7	< 7	< 31	< 10	< 14
	04/25/20	< 136	< 72	< 4	< 4	< 12	< 4	< 7	< 4	< 7	< 8	< 4	< 4	< 20	< 8	< 7
	07/23/20	< 125	< 83	< 5	< 5	< 15	< 7	< 8	< 4	< 9	< 11	< 4	< 6	< 28	< 9	< 9
	11/05/20	< 148	< 77	< 7	< 8	< 19	< 6	< 17	< 9	< 13	< 13	< 7	< 7	< 41	< 7	< 14
	AVERAGE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13S7	01/14/20	296 ± 99	< 110	< 7	< 7	< 18	< 6	< 13	< 7	< 11	< 11	< 5	< 7	< 33	< 13	< 11
	04/28/20	188 ± 91	< 130	< 5	< 4	< 19	< 5	< 14	< 6	< 12	< 9	< 6	< 7	< 22	< 11	< 11
	07/28/20	< 130	< 129	< 7	< 7	< 19	< 11	< 11	< 7	< 14	< 10	< 7	< 8	< 31	< 5	< 12
	11/03/20	< 144	< 95	< 6	< 5	< 16	< 8	< 7	< 6	< 11	< 11	< 5	< 5	< 32	< 11	< 11
	AVERAGE	242 ± 153	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1S3	01/14/20	248 ± 100	< 107	< 7	< 5	< 17	< 6	< 15	< 8	< 10	< 13	< 5	< 7	< 31	< 13	< 11
	04/28/20	281 ± 101	< 68	< 6	< 7	< 19	< 8	< 15	< 7	< 12	< 12	< 7	< 9	< 32	< 14	< 15
	07/28/20	168 ± 83	< 129	< 5	< 6	< 16	< 11	< 13	< 7	< 9	< 12	< 6	< 6	< 31	< 12	< 13
	11/03/20	< 147	< 114	< 6	< 8	< 19	< 9	< 12	< 7	< 11	< 13	< 6	< 7	< 35	< 8	< 11
	AVERAGE	232 ± 116	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4S8	01/14/20	245 ± 98	< 113	< 4	< 5	< 19	< 6	< 14	< 8	< 11	< 11	< 6	< 5	< 31	< 11	< 12
	04/28/20	274 ± 98	< 125	< 7	< 9	< 24	< 8	< 16	< 9	< 13	< 11	< 7	< 7	< 36	< 13	< 14
	07/28/20	233 ± 86	< 163	< 8	< 8	< 24	< 10	< 17	< 9	< 11	< 14	< 8	< 8	< 37	< 11	< 16
	11/03/20	202 ± 98	< 98	< 5	< 5	< 15	< 5	< 12	< 7	< 10	< 12	< 6	< 7	< 30	< 10	< 11
	AVERAGE	239 ± 60	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4S9	01/15/20	< 144	< 35	< 5	< 7	< 13	< 6	< 13	< 6	< 12	< 11	< 6	< 6	< 30	< 8	< 13
	04/25/20	< 140	< 56	< 3	< 4	< 10	< 3	< 7	< 4	< 5	< 7	< 3	< 4	< 18	< 6	< 6
	07/23/20	< 127	< 105	< 5	< 6	< 12	< 6	< 9	< 6	< 8	< 15	< 5	< 5	< 33	< 10	< 11
	11/05/20	< 145	< 115	< 7	< 6	< 17	< 6	< 13	< 7	< 11	< 10	< 6	< 6	< 27	< 8	< 11
	AVERAGE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6S11A	01/13/20	< 147	< 61	< 6	< 5	< 15	< 5	< 11	< 6	< 11	< 11	< 5	< 7	< 29	< 12	< 11
	04/28/20	< 146	< 127	< 6	< 6	< 17	< 6	< 12	< 6	< 9	< 12	< 6	< 6	< 35	< 12	< 14
	07/27/20	< 128	< 108	< 6	< 5	< 16	< 10	< 15	< 7	< 14	< 13	< 4	< 7	< 32	< 11	< 13
	11/5/2020	< 144	< 59	< 6	< 7	< 15	< 7	< 15	< 7	< 12	< 9	< 6	< 7	< 36	< 15	< 14
	AVERAGE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

**TABLE C-6 TRITIUM AND GAMMA SPECTROSCOPIC ANALYSES OF GROUNDWATER  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020**

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	01/15/20	< 143	< 127	< 7	< 8	< 22	< 7	< 13	< 8	< 13	< 13	< 7	< 6	< 39	< 10	< 14
	04/25/20	< 139	< 135	< 7	< 7	< 16	< 6	< 15	< 7	< 8	< 14	< 6	< 7	< 35	< 12	< 14
	07/27/20	< 127	< 110	< 5	< 7	< 13	< 10	< 12	< 7	< 7	< 9	< 5	< 5	< 21	< 14	< 11
	11/02/20	< 145	< 112	< 5	< 6	< 15	< 6	< 12	< 6	< 10	< 13	< 6	< 5	< 34	< 9	< 12
	AVERAGE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7S10	01/13/20	< 144	< 93	< 4	< 5	< 16	< 7	< 11	< 7	< 7	< 11	< 6	< 6	< 27	< 9	< 12
	04/25/20	< 136	< 120	< 7	< 7	< 16	< 8	< 14	< 8	< 13	< 14	< 8	< 9	< 34	< 12	< 11
	07/23/20	129 ± 82	< 58	< 7	< 5	< 19	< 8	< 12	< 7	< 10	< 15	< 6	< 5	< 35	< 13	< 12
	11/02/20	< 148	< 86	< 5	< 5	< 14	< 4	< 13	< 5	< 9	< 11	< 6	< 5	< 30	< 8	< 11
	AVERAGE	129 ± 0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7S11	01/13/20	< 140	< 89	< 4	< 6	< 15	< 7	< 9	< 6	< 10	< 11	< 5	< 4	< 30	< 13	< 11
	04/25/20	< 139	< 95	< 6	< 6	< 15	< 7	< 13	< 7	< 9	< 10	< 5	< 6	< 34	< 12	< 11
	07/23/20	< 126	< 73	< 5	< 5	< 10	< 5	< 10	< 5	< 7	< 13	< 5	< 4	< 29	< 11	< 9
	11/25/20	< 147	< 98	< 6	< 7	< 23	< 9	< 12	< 7	< 11	< 10	< 4	< 5	< 29	< 10	< 12
	AVERAGE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8S4	01/14/20	< 149	< 102	< 7	< 6	< 16	< 5	< 14	< 5	< 10	< 10	< 7	< 7	< 32	< 5	< 13
	04/28/20	< 142	< 127	< 3	< 7	< 15	< 7	< 12	< 7	< 13	< 11	< 7	< 9	< 28	< 13	< 12
	07/28/20	158 ± 83	< 101	< 6	< 8	< 13	< 9	< 10	< 7	< 9	< 10	< 6	< 7	< 25	< 10	< 14
	11/03/20	< 141	< 119	< 6	< 7	< 13	< 7	< 11	< 7	< 11	< 13	< 6	< 7	< 26	< 9	< 14
	AVERAGE	158 ± 0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1S4	11/30/20	< 143	< 146	< 6	< 8	< 24	< 9	< 13	< 10	< 13	< 11	< 7	< 7	< 33	< 7	< 16
	AVERAGE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-7

**ANNUAL AVERAGE TRITIUM CONCENTRATION IN PRECIPITATION,  
MONITORING WELLS AND LAKE TOOK-A-WHILE (LTAW) SURFACE WATER DATA  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020**

Results in pCi/Liter  $\pm$  2 sigma

SITE	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
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	252
Precipitation Sites 3 and 4 (onsite, West of Station Reactor Bldgs)	414	404*	350	233	169	151	231	258	197	383	494	355	350
1S3 - MW-1 (43')	248	150	252	131	164	197	115	169	175	130	218	253	200
1S4 - Tap Water Sample	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	28
4S8 - MW-2 (45')	292	154	190	173	137	202	187	138	154	138	191	196	239
4S9 - MW-3 (94')	127	54	150	64	80	135	94	180	125	55	109	92	77
8S4 - MW-4 (111')	172	66	105	68	81	109	60	162	145	91	102	155	96
7S10 - MW-5 (36')	171	69	96	-6	74	106	68	70	73	51	93	125	86
13S7 - MW-6 (16')	142	134	143	34	80	111	71	79	111	107	122	120	150
2S8 - MW-7 (85')	Not installed	Not installed	Not installed	22	54	72	70	70	74	56	37	71	63
6S11A - MW-8A (14')	177	82	165	58	15	72	103	110	63	38	50	83	72
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	Dry well
6S12 - MW-9 (28')	30	-44	45	18	6	60	21	57	70	5	27	50	47
7S11 - MW-10 (132')	3	-27	-9	1	-1	23	29	55	13	1	33	16	3
**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, 2020

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	12/31/19	01/28/20	4.1 ± 1	< 136	< 13	< 1	< 2	< 4	< 1	< 3	< 2	< 3	< 7	< 1	< 1	< 13	< 5
12H2	01/28/20	02/25/20	< 1.6	< 124	< 34	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 10	< 2	< 2	< 18	< 6
12H2	02/25/20	03/31/20	< 1.9	< 139	< 26	< 2	< 2	< 6	< 2	< 4	< 2	< 3	< 9	< 2	< 2	< 16	< 5
12H2	03/31/20	04/27/20	2.7 ± 1.2	< 143	< 24	< 1	< 2	< 5	< 2	< 3	< 2	< 3	< 8	< 1	< 2	< 15	< 5
12H2	04/27/20	05/26/20	< 2.3	< 143	< 16	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 9	< 2	< 2	< 17	< 6
12H2	05/26/20	06/30/20	< 2.1	< 129	< 15	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 11	< 2	< 2	< 18	< 6
12H2	06/30/20	07/28/20	2.8 ± 1.4	< 127	< 18	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 14	< 2	< 2	< 23	< 8
12H2	07/28/20	08/25/20	2.6 ± 1.6	< 148	< 32	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 9	< 2	< 2	< 16	< 6
12H2	08/25/20	09/29/20	2.7 ± 1.5	< 143	< 37	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 10	< 2	< 2	< 16	< 5
12H2	09/29/20	10/27/20	< 1.9	< 139	< 25	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 9	< 2	< 2	< 15	< 5
12H2	10/27/20	11/23/20	4.1 ± 1.4	< 146	< 28	< 2	< 2	< 6	< 2	< 3	< 2	< 3	< 9	< 2	< 2	< 17	< 6
12H2	11/23/20	12/29/20	< 2.2	< 131	< 29	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 14	< 2	< 2	< 23	< 9
	AVERAGE		3.2 ± 1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-9

**GAMMA SPECTROSCOPIC ANALYSES OF FOOD PRODUCTS (FRUITS, VEGETABLES AND BROADLEAF)  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020**

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	11/24/20	< 286	2879 $\pm$ 757	< 58	< 26	< 37	< 105	< 57
	11/24/20	< 208	2490 $\pm$ 446	< 49	< 20	< 21	< 106	< 42
	11/24/20	< 261	15000 $\pm$ 1091	< 54	< 24	< 36	< 141	< 41
	AVERAGE	-	6790 $\pm$ 14226	-	-	-	-	-
11S6	06/29/20	< 180	3713 $\pm$ 423	< 19	< 18	< 22	< 74	< 38
	06/29/20	336 $\pm$ 178	4701 $\pm$ 479	< 19	< 17	< 16	< 75	< 33
	07/27/20	< 229	4567 $\pm$ 502	< 23	< 17	< 20	< 82	< 35
	07/27/20	319 $\pm$ 163	3959 $\pm$ 486	< 23	< 19	< 20	< 83	< 36
	08/24/20	< 210	4530 $\pm$ 535	< 26	< 22	< 21	< 88	< 47
	08/24/20	< 186	5706 $\pm$ 590	< 26	< 21	< 19	< 96	< 41
	09/28/20	289 $\pm$ 185	3904 $\pm$ 497	< 31	< 23	< 25	< 101	< 43
	09/28/20	< 248	3421 $\pm$ 532	< 27	< 20	< 25	< 118	< 41
	10/26/20	446 $\pm$ 130	3999 $\pm$ 416	< 18	< 15	< 16	< 69	< 28
	10/26/20	272 $\pm$ 131	3042 $\pm$ 321	< 16	< 14	< 16	< 58	< 28
	AVERAGE	332 $\pm$ 136	4154 $\pm$ 1507	-	-	-	-	-
12F7	07/30/20	< 373	2694 $\pm$ 759	< 47	< 42	< 38	< 166	< 62
	12/04/20	< 174	2511 $\pm$ 458	< 28	< 19	< 24	< 87	< 32
	AVERAGE	-	2603 $\pm$ 259	-	-	-	-	-



TABLE C-10

TRITIUM AND GAMMA SPECTROSCOPIC ANALYSES OF SURFACE WATER  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020

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	12/31/19 - 01/28/20	< 137	< 25	< 2	< 2	< 6	< 2	< 4	< 2	< 3	< 9	< 2	< 2	< 17	< 6	< 3
	01/28/20 - 02/25/20	< 130	< 16	< 1	< 2	< 5	< 2	< 3	< 2	< 3	< 9	< 2	< 2	< 15	< 5	< 3
	02/25/20 - 03/31/20	< 142	< 23	< 1	< 2	< 5	< 2	< 3	< 2	< 3	< 8	< 1	< 2	< 14	< 4	< 3
	03/31/20 - 04/27/20	< 143	< 31	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 10	< 2	< 2	< 17	< 6	< 3
	04/27/20 - 05/26/20	< 144	< 33	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 10	< 2	< 2	< 16	< 6	< 3
	05/26/20 - 06/30/20	< 131	< 17	< 2	< 2	< 7	< 2	< 4	< 2	< 4	< 15	< 2	< 2	< 25	< 8	< 3
	06/30/20 - 07/28/20	< 127	< 29	< 2	< 2	< 8	< 2	< 5	< 3	< 4	< 14	< 2	< 2	< 25	< 8	< 4
	07/28/20 - 08/25/20	< 149	< 15	< 1	< 2	< 5	< 2	< 3	< 2	< 3	< 8	< 1	< 1	< 15	< 5	< 3
	08/25/20 - 08/30/20	< 148	< 31	< 1	< 2	< 6	< 1	< 3	< 2	< 3	< 12	< 1	< 2	< 34	< 11	< 3
	10/13/20 - 10/27/20	169 ± 90	< 86	< 4	< 5	< 17	< 6	< 9	< 6	< 9	< 14	< 5	< 5	< 31	< 11	< 10
	10/27/20 - 11/23/20	< 144	< 16	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 9	< 1	< 2	< 15	< 5	< 3
	11/23/20 - 12/29/20	< 135	< 15	< 2	< 2	< 6	< 2	< 3	< 2	< 3	< 14	< 2	< 2	< 21	< 7	< 3
		AVERAGE	169 ± 0	-	-	-	-	-	-	-	-	-	-	-	-	-
2S7	12/31/19 - 01/28/20	230 ± 98	< 32	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 9	< 2	< 2	< 18	< 6	< 3
	01/28/20 - 02/25/20	3750 ± 427	< 26	< 1	< 2	< 5	< 2	< 3	< 2	< 3	< 7	< 1	< 1	< 15	< 5	< 3
	02/25/20 - 03/31/20	238 ± 98	< 36	< 2	< 2	< 5	< 2	< 4	< 2	< 3	< 9	< 2	< 2	< 18	< 5	< 3
	03/31/20 - 04/27/20	1050 ± 173	< 15	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 10	< 2	< 2	< 17	< 6	< 3
	04/27/20 - 05/26/20	9190 ± 975	< 8	< 1	< 1	< 2	< 1	< 2	< 1	< 2	< 4	< 1	< 1	< 8	< 2	< 2
	05/26/20 - 06/30/20	695 ± 132	< 26	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 13	< 2	< 2	< 20	< 6	< 3
	06/30/20 - 07/28/20	194 ± 87	< 30	< 2	< 2	< 5	< 2	< 3	< 2	< 4	< 11	< 2	< 2	< 18	< 6	< 3
	07/28/20 - 08/25/20	725 ± 147	< 14	< 2	< 2	< 6	< 2	< 3	< 2	< 3	< 9	< 1	< 2	< 16	< 5	< 3
	08/25/20 - 09/29/20	1350 ± 201	< 25	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 9	< 1	< 1	< 15	< 5	< 3
	09/29/20 - 10/27/20	854 ± 150	< 17	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 9	< 2	< 2	< 18	< 6	< 3
	10/27/20 - 11/23/20	165 ± 96	< 30	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 10	< 2	< 2	< 18	< 7	< 3
	11/23/20 - 12/29/20	520 ± 103	< 15	< 2	< 2	< 5	< 1	< 3	< 2	< 3	< 14	< 1	< 2	< 21	< 7	< 3
		AVERAGE	1580 ± 5176	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-10

TRITIUM AND GAMMA SPECTROSCOPIC ANALYSES OF SURFACE WATER  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020

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	01/07/20 - 01/28/20	< 139	< 27	< 2	< 2	< 6	< 2	< 3	< 2	< 3	< 6	< 2	< 2	< 13	< 5	< 3
	02/04/20 - 02/25/20	< 123	< 17	< 2	< 2	< 5	< 2	< 4	< 2	< 4	< 8	< 2	< 2	< 15	< 4	< 3
	03/03/20 - 03/31/20	< 142	< 32	< 2	< 2	< 6	< 2	< 4	< 2	< 3	< 7	< 2	< 2	< 14	< 4	< 3
	04/07/20 - 04/27/20	< 144	< 30	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 7	< 2	< 2	< 16	< 6	< 3
	05/05/20 - 05/26/20	< 148	< 28	< 2	< 2	< 6	< 2	< 4	< 2	< 3	< 7	< 2	< 2	< 15	< 6	< 3
	06/02/20 - 06/30/20	< 128	< 39	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 12	< 2	< 2	< 22	< 6	< 3
	07/07/20 - 07/28/20	< 127	< 28	< 2	< 2	< 5	< 2	< 3	< 2	< 3	< 9	< 1	< 2	< 16	< 5	< 3
	08/04/20 - 08/25/20	< 148	< 28	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 7	< 2	< 2	< 15	< 6	< 3
	09/01/20 - 09/29/20	< 145	< 40	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 8	< 2	< 2	< 16	< 5	< 3
	10/06/20 - 10/27/20	< 141	< 19	< 2	< 2	< 7	< 2	< 4	< 2	< 4	< 9	< 2	< 2	< 19	< 6	< 4
	11/03/20 - 11/23/20	< 148	< 32	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 8	< 2	< 2	< 16	< 6	< 3
	12/01/20 - 12/29/20	< 137	< 30	< 2	< 2	< 6	< 2	< 4	< 2	< 4	< 11	< 2	< 2	< 20	< 6	< 3
	AVERAGE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5S9	09/08/20 - 09/29/20	< 146	< 32	< 1	< 2	< 5	< 2	< 3	< 2	< 3	< 6	< 1	< 2	< 12	< 4	< 3
	10/06/20 - 10/13/20	< 140	< 32	< 2	< 2	< 6	< 2	< 3	< 2	< 3	< 13	< 1	< 2	< 20	< 7	< 3
		AVERAGE	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C-11

**GAMMA SPECTROSCOPIC ANALYSIS OF FISH  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020**

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

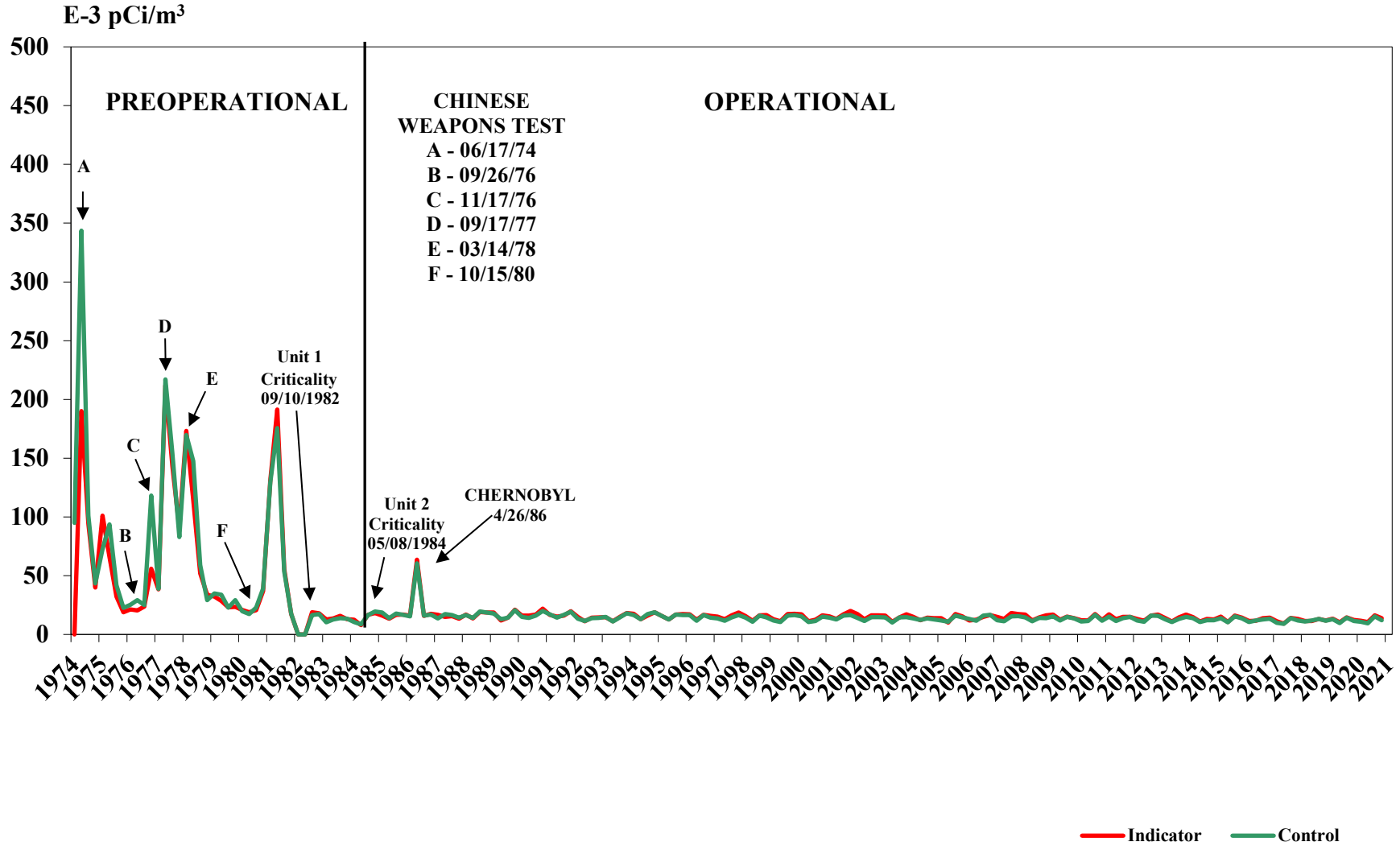
SITE	COLLECTION DATE	K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Cs-134	Cs-137
<b>2H</b>									
Quillback	05/13/20	3250 $\pm$ 822	< 49	< 41	< 159	< 42	< 87	< 45	< 40
Walleye	05/13/20	3241 $\pm$ 981	< 54	< 48	< 138	< 47	< 59	< 47	< 53
Smallmouth Bass	05/13/20	3231 $\pm$ 1137	< 76	< 89	< 173	< 85	< 162	< 93	< 63
Walleye	10/31/20	3759 $\pm$ 997	< 64	< 57	< 174	< 36	< 116	< 53	< 71
Quillback	10/31/20	2883 $\pm$ 788	< 59	< 53	< 128	< 74	< 116	< 65	< 68
Smallmouth Bass	10/31/20	2629 $\pm$ 1017	< 83	< 96	< 215	< 69	< 201	< 91	< 91
	AVERAGE	3166 $\pm$ 768	-	-	-	-	-	-	-
<b>IND</b>									
Quillback	05/12/20	3537 $\pm$ 860	< 40	< 44	< 206	< 37	< 141	< 52	< 60
Walleye	05/12/20	4117 $\pm$ 1144	< 70	< 70	< 194	< 65	< 132	< 57	< 73
Smallmouth Bass	05/12/20	3648 $\pm$ 745	< 44	< 42	< 124	< 47	< 98	< 49	< 50
Walleye	10/30/20	3092 $\pm$ 906	< 64	< 49	< 101	< 63	< 124	< 51	< 69
Smallmouth Bass	10/30/20	3601 $\pm$ 1100	< 52	< 63	< 165	< 38	< 111	< 46	< 47
Quillback	10/30/20	2791 $\pm$ 1040	< 60	< 69	< 163	< 62	< 137	< 64	< 56
	AVERAGE	3464 $\pm$ 928	-	-	-	-	-	-	-
<b>LTAW</b>									
Gizzard Shad	10/31/20	3588 $\pm$ 828	< 53	< 50	< 118	< 44	< 120	< 59	< 46
Largemouth Bass	10/31/20	4002 $\pm$ 960	< 62	< 56	< 110	< 64	< 122	< 52	< 57
	AVERAGE	3795 $\pm$ 585	-	-	-	-	-	-	-

**TABLE C-12                    GAMMA SPECTROSCOPIC ANALYSES OF SHORELINE SEDIMENT  
SUSQUEHANNA STEAM ELECTRIC STATION, 2020**

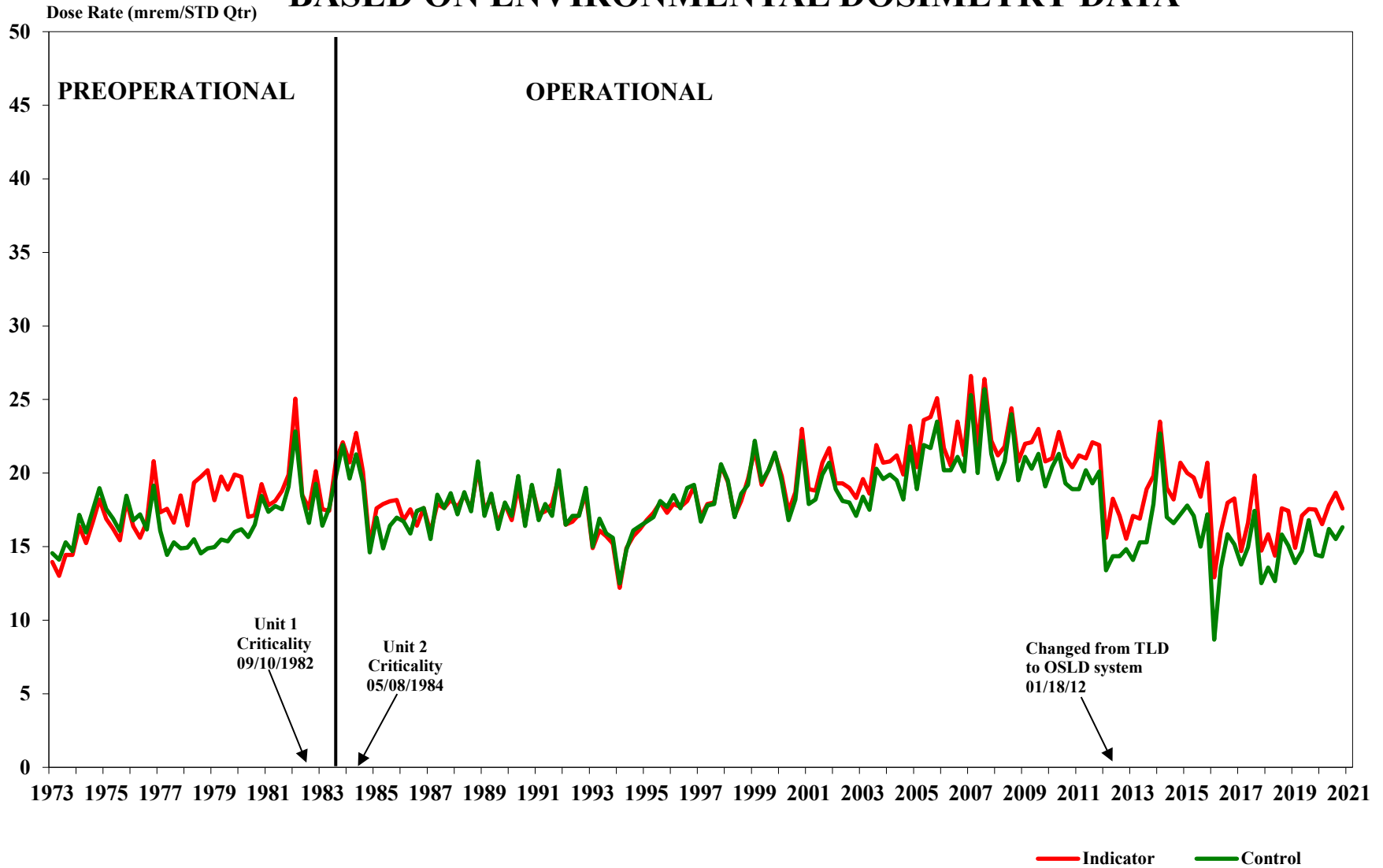
Results in pCi/kg (dry) ± 2 sigma

SITE	COLLECTION		K-40	Cs-134	Cs-137	Ra-226	Ac-228	Th-228
	DATE							
2B	04/17/20		18220 ± 2198	< 81	< 113	< 1691	1411 ± 373	1339 ± 154
	09/28/20		9175 ± 1757	< 81	< 103	< 2142	989 ± 300	856 ± 185
	AVERAGE		13698 ± 12792	-	-	-	1200 ± 597	1098 ± 683
7B	04/17/20		11770 ± 1619	< 75	< 59	< 1663	1143 ± 285	1077 ± 118
	09/28/20		9725 ± 1384	< 67	< 78	< 1852	817 ± 373	773 ± 125
	AVERAGE		10748 ± 2892	-	-	-	980 ± 461	925 ± 430
12F	04/17/20		10960 ± 1634	< 83	< 94	< 1885	979 ± 301	1114 ± 191
	09/28/20		15790 ± 2498	< 121	< 170	< 3183	1430 ± 678	997 ± 318
	AVERAGE		13375 ± 6831	-	-	-	1205 ± 638	1056 ± 165

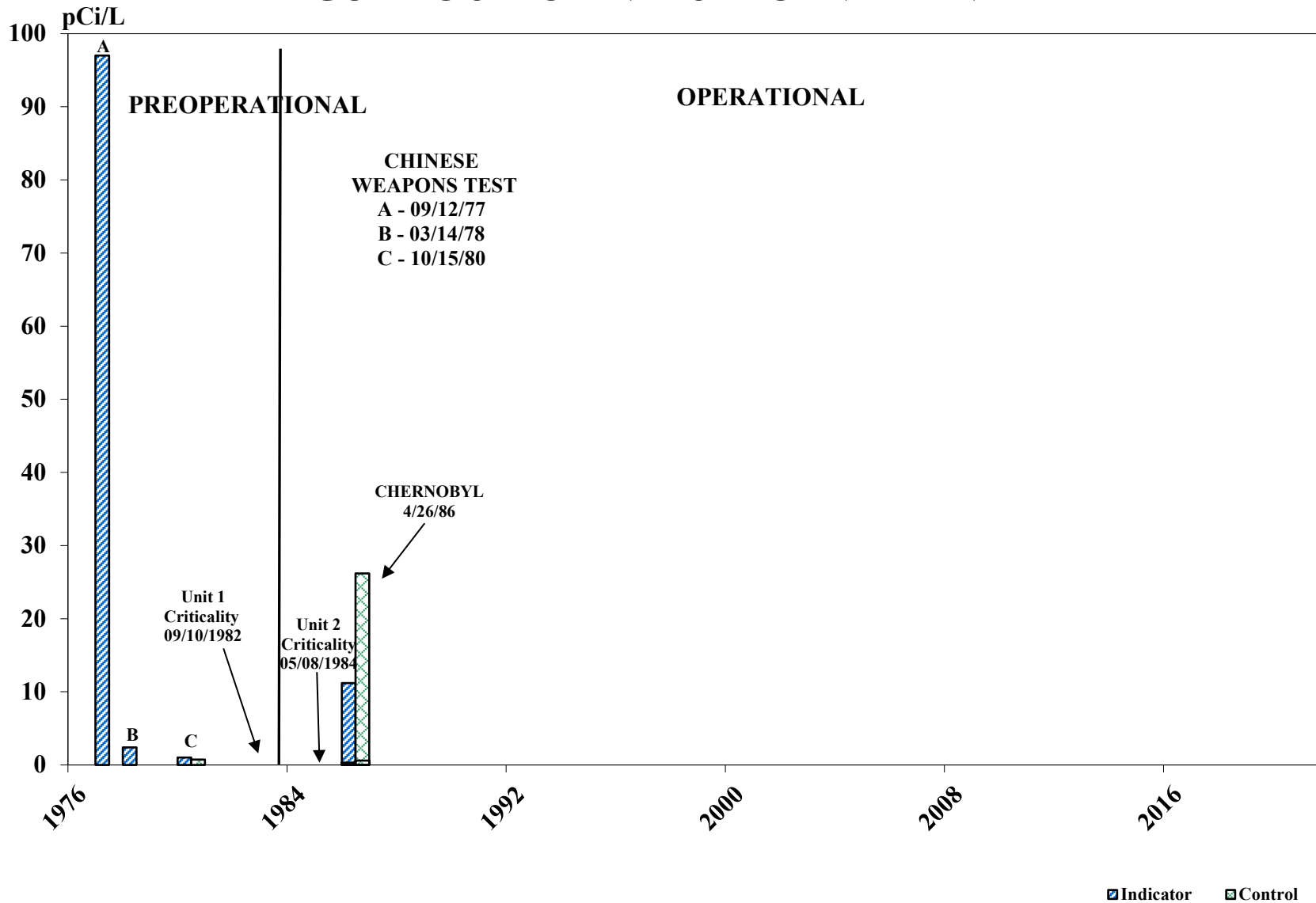
# FIGURE C-1 - GROSS BETA ACTIVITY IN AIR PARTICULATES



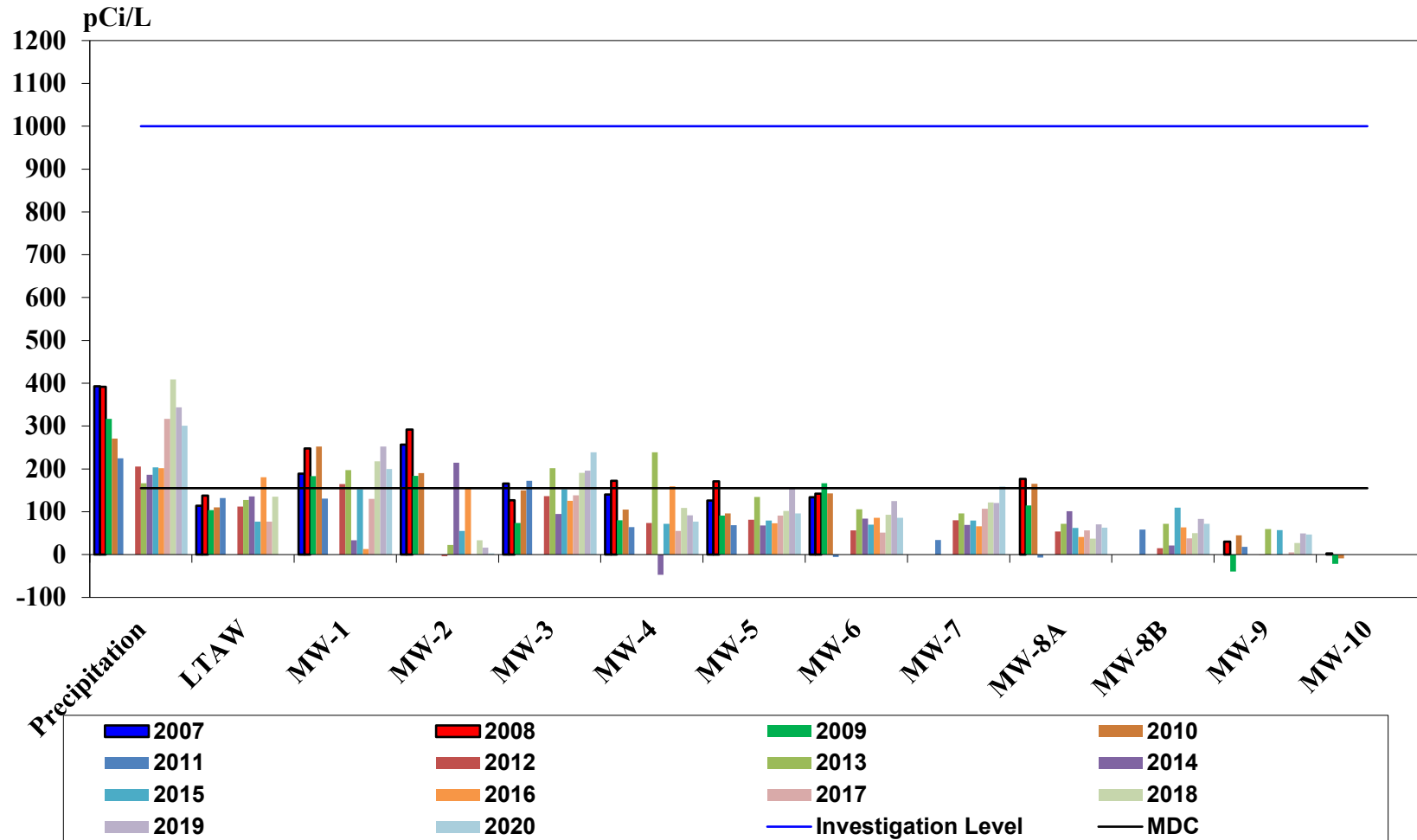
**FIGURE C-2 - AMBIENT RADIATION LEVELS  
BASED ON ENVIRONMENTAL DOSIMETRY DATA**



**FIGURE C-3 - IODINE-131 ACTIVITY IN MILK**

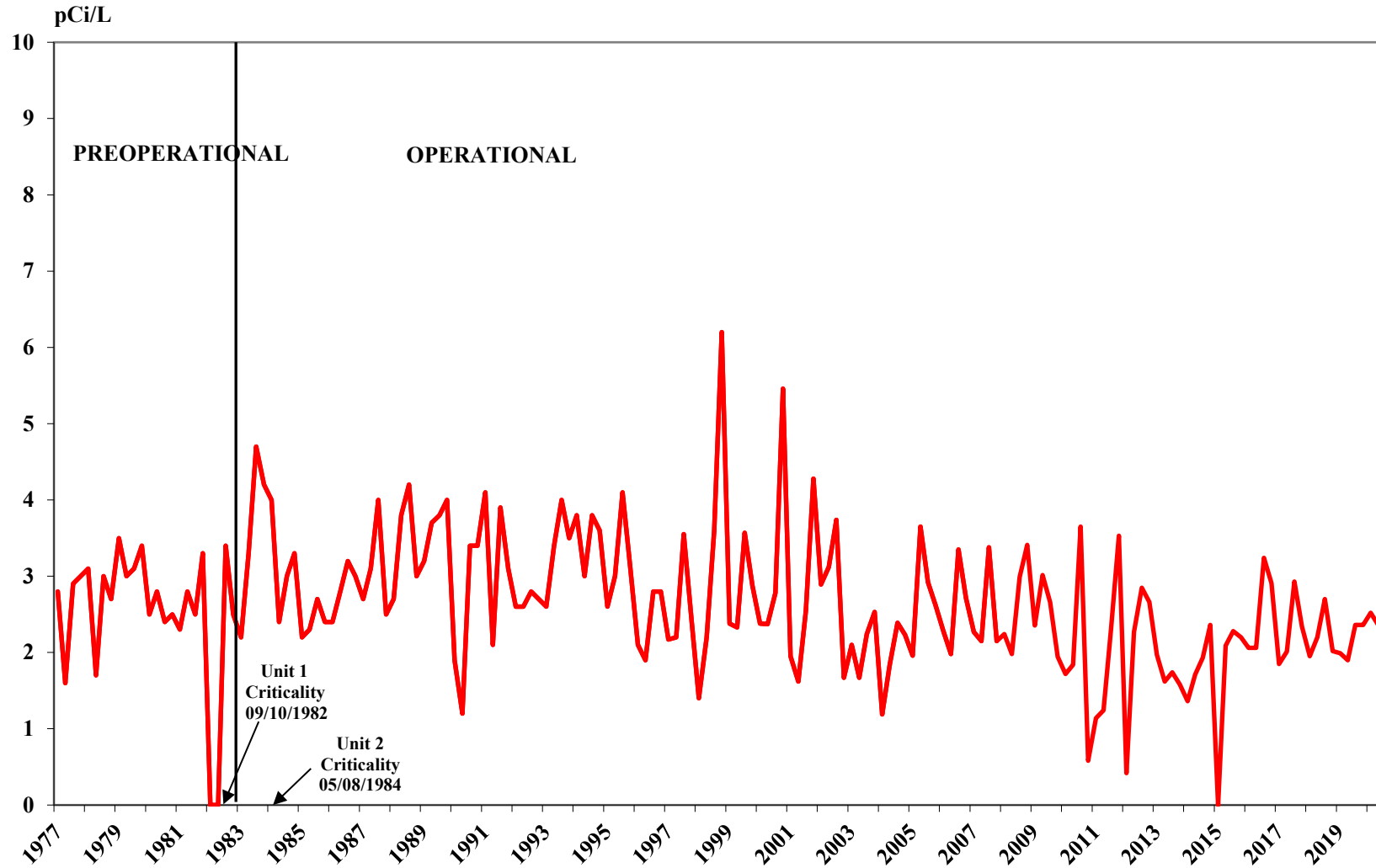


**FIGURE C-4 - ANNUAL AVERAGE TRITIUM ACTIVITY IN  
PRECIPITATION AND SURFACE WATER VERSUS GROUND WATER**

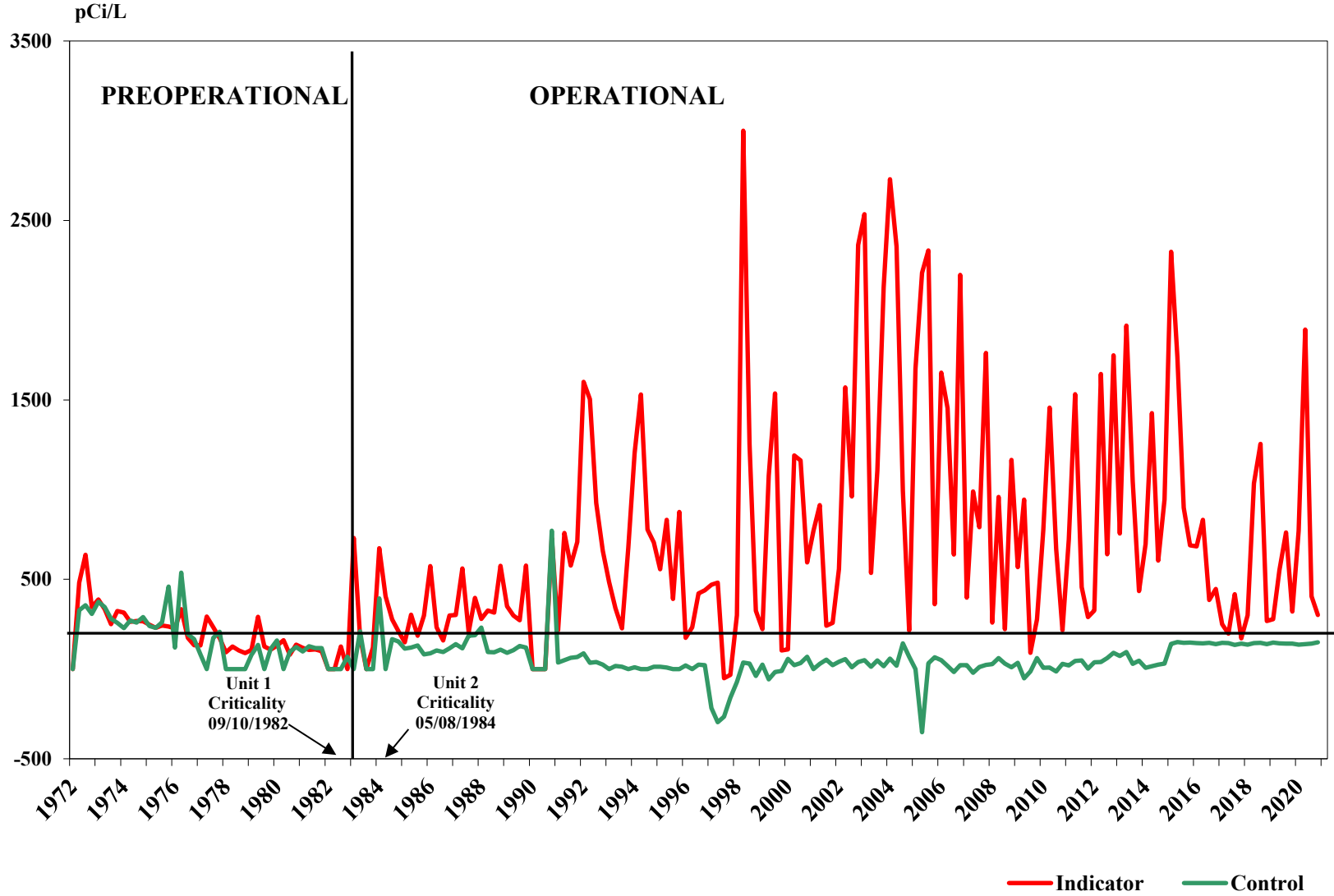




**FIGURE C-5 - GROSS BETA ACTIVITY IN DRINKING WATER**



**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 Value	Known Value <sup>(a)</sup>	Ratio of TBE to Known Result	Evaluation <sup>(b)</sup>
September 2020	E13247	Milk	Sr-89	pCi/L	62.8	95.4	0.66	N <sup>(1)</sup>
			Sr-90	pCi/L	12.0	12.8	0.94	A
September 2020	E13248	Milk	Ce-141	pCi/L	156	150	1.04	A
			Co-58	pCi/L	172	180	0.96	A
			Co-60	pCi/L	369	379	0.97	A
			Cr-51	pCi/L	372	372	1.00	A
			Cs-134	pCi/L	171	200	0.85	A
			Cs-137	pCi/L	241	250	0.96	A
			Fe-59	pCi/L	217	200	1.08	A
			I-131	pCi/L	84.6	95.0	0.89	A
			Mn-54	pCi/L	175	180	0.97	A
			Zn-65	pCi/L	252	270	0.93	A
			September 2020	E13249	Charcoal	I-131	pCi	70.2
September 2020	E13250	AP	Ce-141	pCi	101	101	1.00	A
			Co-58	pCi	111	120	0.92	A
			Co-60	pCi	249	254	0.98	A
			Cr-51	pCi	287	249	1.15	A
			Cs-134	pCi	114	134	0.85	A
			Cs-137	pCi	159	168	0.95	A
			Fe-59	pCi	127	134	0.95	A
			Mn-54	pCi	114	121	0.94	A
September 2020	E13251	Soil	Ce-141	pCi/g	0.241	0.191	1.26	W
Co-58			pCi/g	0.211	0.228	0.93	A	
Co-60			pCi/g	0.466	0.481	0.97	A	
Cr-51			pCi/g	0.450	0.472	0.95	A	
Cs-134			pCi/g	0.273	0.254	1.07	A	
Cs-137			pCi/g	0.370	0.390	0.95	A	
Fe-59			pCi/g	0.233	0.254	0.92	A	
Mn-54			pCi/g	0.217	0.229	0.95	A	
September 2020	E13252	AP	Sr-89	pCi	79.9	100.0	0.80	A
Sr-90			pCi	12.1	13.4	0.90	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 20-19**

Table D-1

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

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Value	Known Value <sup>(a)</sup>	Ratio of TBE to Known Result	Evaluation <sup>(b)</sup>
December 2020	E13254	Milk	Sr-89	pCi/L	82.2	89.7	0.92	A
			Sr-90	pCi/L	12.4	13.0	0.96	A
	E13255	Milk	Ce-141	pCi/L	91.1	100	0.91	A
			Co-58	pCi/L	77.5	84.3	0.92	A
			Co-60	pCi/L	147	152	0.97	A
			Cr-51	pCi/L	259	253	1.02	A
			Cs-134	pCi/L	97.1	108	0.90	A
			Cs-137	pCi/L	117	127	0.92	A
			Fe-59	pCi/L	114	112	1.02	A
			I-131	pCi/L	84.3	91.9	0.92	A
			Mn-54	pCi/L	137	143	0.96	A
			Zn-65	pCi/L	175	190	0.92	A
	E13256	Charcoal	I-131	pCi	70.2	78.2	0.90	A
	E13257A	AP	Ce-141	pCi	67.4	74.6	0.90	A
			Co-58	pCi	57.9	62.9	0.92	A
			Co-60	pCi	108	113	0.95	A
			Cr-51	pCi	162	189	0.86	A
			Cs-134	pCi	68.1	80.4	0.85	A
			Cs-137	pCi	82.4	95.0	0.87	A
			Fe-59	pCi	80.5	83.7	0.96	A
			Mn-54	pCi	102	107	0.95	A
	E13258	Soil	Ce-141	pCi/g	0.167	0.170	0.98	A
			Co-58	pCi/g	0.125	0.143	0.87	A
			Co-60	pCi/g	0.245	0.257	0.95	A
			Cr-51	pCi/g	0.393	0.429	0.92	A
			Cs-134	pCi/g	0.147	0.183	0.80	A
			Cs-137	pCi/g	0.260	0.288	0.90	A
			Fe-59	pCi/g	0.199	0.190	1.05	A
			Mn-54	pCi/g	0.229	0.243	0.94	A
	E13259	AP	Sr-89	pCi	85.0	78.6	1.08	A
			Sr-90	pCi	13.1	11.4	1.15	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

Table D-2

**DOE's Mixed Analyte Performance Evaluation Program (MAPEP)**  
**Teledyne Brown Engineering Environmental Services**

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Value	Known Value <sup>(a)</sup>	Acceptance Range	Evaluation <sup>(b)</sup>
February 2020	20-GrF42	AP	Gross Alpha	Bq/sample	0.676	1.24	0.37 - 2.11	A
			Gross Beta	Bq/sample	2.03	2.00	1.00 - 3.00	A
	20-MaS42	Soil	Ni-63	Bq/kg	0.01		(1)	A
			Sr-90	Bq/kg	348	340	238 - 442	A
	20-MaW42	Water	Ni-63	Bq/L	11.6	11.1	7.8 - 14.4	A
			Pu-238	Bq/L	0.926	0.94	0.66 - 1.22	A
			Pu-239/240	Bq/L	0.712	0.737	0.516 - 0.958	A
	20-RdF42	AP	U-234/233	Bq/sample	0.0416	0.075	0.053 - 0.098	N <sup>(3)</sup>
			U-238	Bq/sample	0.0388	0.078	0.055 - 0.101	N <sup>(3)</sup>
	20-RdV42	Vegetation	Cs-134	Bq/sample	3.23	3.82	2.67 - 4.97	A
			Cs-137	Bq/sample	2.64	2.77	1.94 - 3.60	A
			Co-57	Bq/sample	0.0281		(1)	A
			Co-60	Bq/sample	2.62	2.79	1.95 - 3.63	A
			Mn-54	Bq/sample	4.3	4.58	3.21 - 5.95	A
			Sr-90	Bq/sample	0.396	0.492	0.344 - 0.640	A
Zn-65			Bq/sample	3.93	3.79	2.65 - 4.93	A	
August 2020	20-GrF43	AP	Gross Alpha	Bq/sample	0.267	0.528	0.158 - 0.989	A
			Gross Beta	Bq/sample	0.939	0.915	0.458 - 1.373	A
	20-MaS43	Soil	Ni-63	Bq/kg	438	980	686 - 1274	N <sup>(4)</sup>
			Tc-99	Bq/kg	1.11		(1)	A
	20-MaW43	Water	Ni-63	Bq/L	0.175		(1)	A
			Tc-99	Bq/L	8.8	9.4	6.6 - 12.2	A
	20-RdV43	Vegetation	Cs-134	Bq/sample	3.635	4.94	3.46 - 6.42	W
			Cs-137	Bq/sample	0.0341		(1)	A
			Co-57	Bq/sample	5.855	6.67	4.67 - 8.67	W
			Co-60	Bq/sample	3.122	4.13	2.89 - 5.37	W
			Mn-54	Bq/sample	4.524	5.84	4.09 - 7.59	A
			Sr-90	Bq/sample	1.01	1.39	0.97 - 1.81	W
	Zn-65	Bq/sample	4.706	6.38	4.47 - 8.29	W		

(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 20-13**

(4) See **NCR 20-20**

**Table D-3**

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

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Value	Known Value <sup>(a)</sup>	Acceptance Limits	Evaluation <sup>(b)</sup>	
March 2020	MRAD-32	Water	Am-241	pCi/L	52.5	45.3	31.1 - 57.9	A	
			Fe-55	pCi/L	155	152	89.3 - 221	A	
			Pu-238	pCi/L	34.0	36.4	21.9 - 47.2	A	
			Pu-239	pCi/L	30.9	33.6	20.8 - 41.4	A	
April 2020	RAD-121	Water	Ba-133	pCi/L	41.8	41.8	34.0 - 46.7	A	
			Cs-134	pCi/L	42.9	46.3	37.1 - 50.9	A	
			Cs-137	pCi/L	226	234	211 - 259	A	
			Co-60	pCi/L	52.4	50.3	45.3 - 57.9	A	
			Zn-65	pCi/L	83.3	86.8	78.1 - 104	A	
			GR-A	pCi/L	20.1	23.6	11.9 - 31.6	A	
			GR-B	pCi/L	45.6	60.5	41.7 - 67.2	A	
			U-Nat	pCi/L	18.45	18.6	14.9 - 20.9	A	
			H-3	pCi/L	14200	14100	12300 - 15500	A	
			Sr-89	pCi/L	58.0	60.1	48.3 - 67.9	A	
			Sr-90	pCi/L	34.1	44.7	33.0 - 51.2	A	
I-131	pCi/L	27.4	28.9	24.1 - 33.8	A				
September 2020	MRAD-33	Soil	Sr-90	pCi/Kg	4360	4980	1550 - 7760	A	
			AP	Fe-55	pCi/Filter	189	407	149 - 649	A
				U-234	pCi/Filter	17.9	18.3	13.6 - 21.4	A
				U-238	pCi/Filter	19.1	18.1	13.7 - 21.6	A
		Water	Am-241	pCi/L	160	176	121 - 225	A	
			Fe-55	pCi/L	299	298	175 - 433	A	
			Pu-238	pCi/L	200	191	115 - 247	A	
			Pu-239	pCi/L	105	100	61.9 - 123	A	
October 2020	RAD-123	Water	Ba-133	pCi/L	37.1	37.0	29.8 - 41.6	A	
			Cs-134	pCi/L	50.6	52.7	42.5 - 58.0	A	
			Cs-137	pCi/L	131	131	118 - 146	A	
			Co-60	pCi/L	62.9	60.5	54.4 - 69.1	A	
			Zn-65	pCi/L	167	162	146 - 191	A	
			GR-A	pCi/L	40.0	26.2	13.3 - 34.7	N <sup>(1)</sup>	
			GR-B	pCi/L	47.5	69.1	48.0 - 76.0	N <sup>(1)</sup>	
			U-Nat	pCi/L	17.2	20.3	16.3 - 22.7	A	
			H-3	pCi/L	23800	23200	20,300 - 25,500	A	
			Sr-89	pCi/L	41.1	43.3	33.4 - 50.5	A	
			Sr-90	pCi/L	28.5	30.2	22.0 - 35.0	A	
I-131	pCi/L	22.9	28.2	23.5 - 33.1	N <sup>(2)</sup>				
November 2020	QR111920K	Water	GR-A	pCi/L	50.7	52.4	27.3 - 65.6	A	
			GR-B	pCi/L	24.9	24.3	15.0 - 32.3	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 20-18**

(2) See **NCR 20-17**

# **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	2020
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	99.4
	12S1	West Building	99.9	100	99.9	99.9	100	100	100	99.1	99.7	99.9	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	99.9
	12E1	Berwick Hospital	100	100	99.9	100.0	100	98	99.1	100	100	100	100.0
	6G1	Freeland Substation	100	100	99.9	99.9	100	90*	100	100	100	No longer in service	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	99.9
	10S3	E of Confers Lane, S of Towers Club	-	-	-	-	-	-	100	99.5	99.9	99.2	98.9
	9B1	Transmission Line, E of Route 11	-	-	-	-	-	-	100	99.9	99.9	99.9	100.0
	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	99.9
	6S6	River Water Intake Line	100	95.5	93.4	93.2	93	98	99.7	99.9	99.9	99.9	88.1***

\* Planned power outage by Electric Utilities

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

\*\*\* Auto- Compsite sampler taken OOS 8/30/20. New Auto- Compsite sampler installed, placed in service 10/13/20.