Constellation

TS 6.9.1.7

LG-22-033

April 29, 2022

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

Limerick Generating Station, Units 1 and 2
Renewed Facility Operating License Nos. NPF-39 and NPF-85
NRC Docket Nos. 50-352 and 50-353

Subject: 2021 Annual Radiological Environmental Operating Report

In accordance with the requirements of Section 6.9.1.7 of Limerick Generating Station (LGS) Units 1 and 2 Technical Specifications (TS), and Section 6.1 of the LGS Units 1 and 2 Offsite Dose Calculation Manual (ODCM), this letter submits the 2021 Annual Radiological Environmental Operating Report. This report provides the 2021 results for the Radiological Environmental Monitoring Program (REMP), as called for in the ODCM.

In assessing the data collected for the REMP, it has been concluded that the operation of LGS, Units 1 and 2 had no adverse impact on the environment. No plant-produced fission or activation products were found in any pathway modeled by the REMP. The results of the groundwater protection program are also included in this report.

There are no commitments contained in this letter.

If you have any questions or require additional information, please contact Amanda Sborz at 610-718-2700.

Respectfully,

Digitally signed by
Sturniolo, Frank
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Frank Sturniolo
Site Vice President – Limerick Generating Station
Constellation Energy Generation, LLC

Attachment: 2021 Annual Radiological Environmental Operating Report

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ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT FOR THE LIMERICK GENERATING STATION

UNITS 1 AND 2

January 1 - December 31, 2021

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EXELON GENERATION
EXELON NUCLEAR GENERATION

APRIL 2022

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I. SUMMARY

The following sections of the summary are meant to help define key concepts, provide clarity, and give context of the monitoring program and results to the readers of this report.

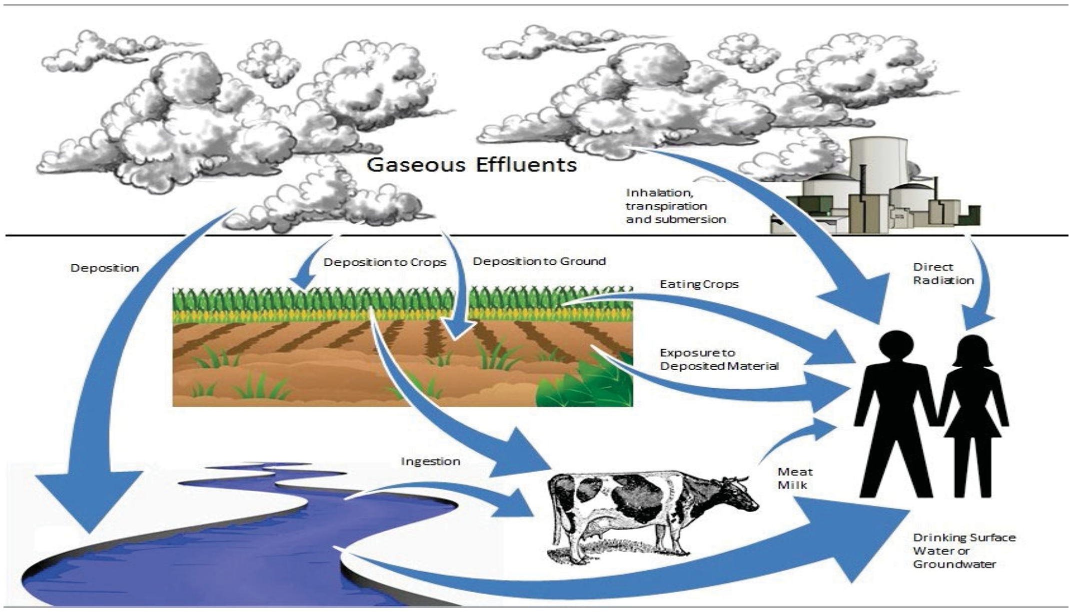
Annual Reports

The Nuclear Regulatory Commission (NRC) is the federal agency who has the role to protect public health and safety related to nuclear energy. Nuclear Power Plants have made many commitments to the NRC to ensure the safety of the public. As part of these commitments, they provide two reports annually to specifically address how the station's operation impacts the environment of the local communities. The NRC then reviews these reports and makes them available to the public. The names of the reports are the Annual Radioactive Effluent Release Report (ARERR) and the Annual Radiological Environmental Operating Report (AREOR).

The ARERR reports the results of the analyses of samples taken from the effluent release paths at the station. An effluent is a liquid or gaseous waste, containing plant-related radioactive material emitted at the boundary of the facility.

The AREOR reports the results of the analyses of samples obtained in the environment surrounding the station. Environmental samples include air, water, vegetation, and other sample types that are identified as potential pathways radioactivity can reach humans.

Graphic 1. Examples of Gaseous and Liquid Effluent Pathways

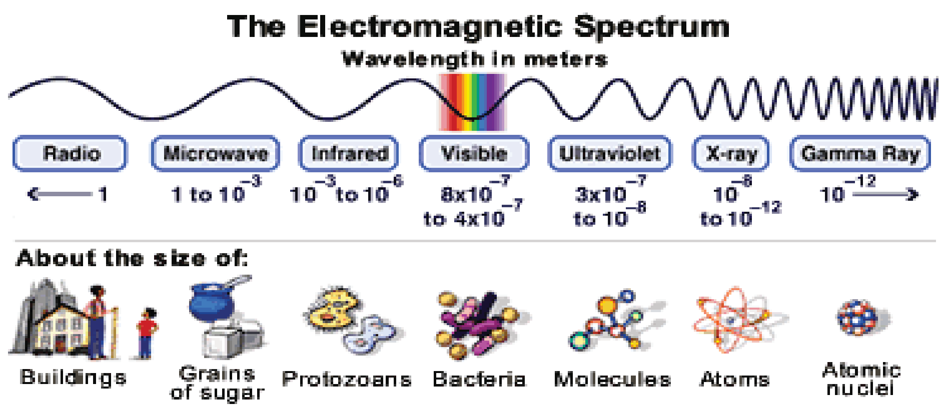


Graphic 1 demonstrates some potential exposure pathways from Limerick Generating Station. The ARERR and AREOR together ensure Nuclear Power Plants are operating in a manner that is within established regulatory commitments meant to adequately protect the public.

Understanding Radiation

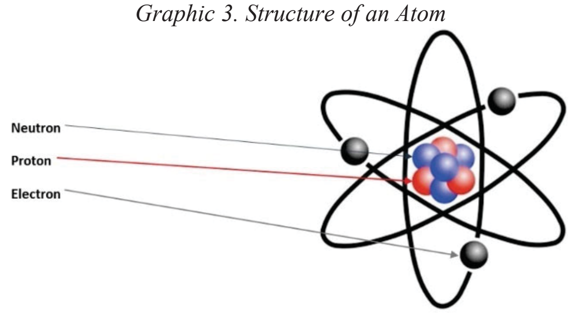
Generally radiation is defined as emitted energy in the form of waves or particles. radiation has enough energy to displace electrons from an atom it is termed “ionizing”, otherwise it is “non-ionizing”. Non-Ionizing radiation includes light, heat given off from a stove, radiowaves and microwaves. Ionizing radiation occurs in atoms, particles too small for the eye to see. So, what are atoms and how does radiation come from them?

Graphic 2. Types of Radiation, from NASA Hubblesite



An atom is the smallest part of an element that maintains the characteristics of that element. Atoms are made up of three parts: protons, neutrons, and electrons.

Graphic 3. Structure of an Atom



The number of protons in an atom determines the element. For example, a hydrogen atom will always have one proton while an oxygen atom will always have eight protons. The protons are clustered with the neutrons forming the nucleus at the center of the atom. Orbiting around the nucleus are the relatively small electrons.

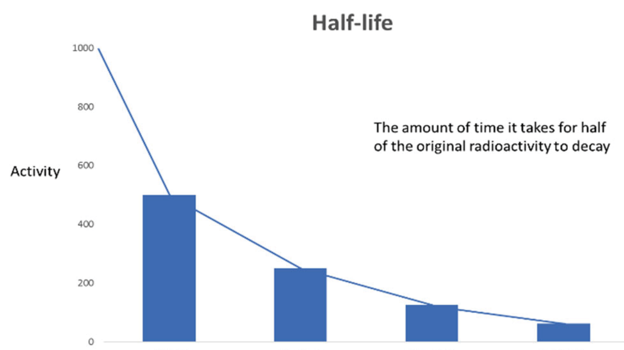
Isotopes are atoms that have the same number of protons but different numbers of neutrons. Different isotopes of an element will all have the same chemical properties and many isotopes are radioactive while other isotopes are not radioactive. A radioactive isotope can emit radiation because it contains excess energy in its nucleus. Radioactive atoms and isotopes are also referred to as radionuclides and radioisotopes.

There are two basic ways that radionuclides are produced at a nuclear power plant. The first is fission, which creates radionuclides that are called *fission products*.
Fission occurs when a very large atom, such as uranium-235 (U-235) or plutonium- 239 (Pu-239), absorbs a neutron into its nucleus making the atom unstable. The unstable atom can then split into smaller atoms. When fission occurs, there is a large amount of energy released in the form of heat. A nuclear power plant uses the heat generated to boil water that spins turbines to produce electricity.

The second way a radionuclide is produced at a nuclear power plant is through a process called activation and the radionuclides produced in this method are termed *activation products*. Pure water that passes over the fissioning atoms is used to cool the reactor and also produce steam to turn the turbines. Although this water is considered to be very pure, there are always some contaminants within the water from material used in the plant's construction and operation. These contaminants are exposed to the fission process and may become activation products. The atoms in the water itself can also become activated and create radionuclides.

Over time, radioactive atoms will reach a stable state and no longer be radioactive. To do this they must release their excess energy. This release of excess energy is called radioactive decay. The time it takes for a radionuclide to become stable is measured in units called half-lives. A half-life is the amount of time it takes for half of the original radioactivity to decay. Each radionuclide has a specific half-life.
Some half-lives can be very long and measured in years while others may be very short and measured in seconds.

Graphic 4. Radioactive Decay Half-Life



In the annual reports you will see both man made and naturally occurring radionuclides listed, for example potassium-40 (K-40, natural) and cobalt-60 (Co-60, man-made). We are mostly concerned about man-made radionuclides because they can be produced as by-products when generating electricity at a nuclear power plant. It is important to note that there are also other ways man-made radionuclides are produced, such as detonating nuclear weapons. Weapons testing has deposited some of the same man-made radionuclides into the environment as those generated by nuclear power, and some are still present today because of long half-lives.

Measuring Radiation

There are four different but interrelated units for measuring radioactivity, exposure, absorbed dose, and dose equivalent. Together, they are used to scientifically report the amount of radiation and its effects on humans.

- Radioactivity refers to the amount of ionizing radiation released by a material. The units of measure for radioactivity used within the AREOR and ARERR are the Curie (Ci). Small fractions of the Ci often have a prefix, such as the microCurie (μCi), which means 1/1,000,000 of a Curie.

- Exposure describes the amount of radiation traveling through the air. The units of measure for exposure used within the AREOR and ARERR are the Roentgen (R). Traditionally direct radiation monitors placed around the site are measured milliRoentgen (mR), 1/1,000 of one R.

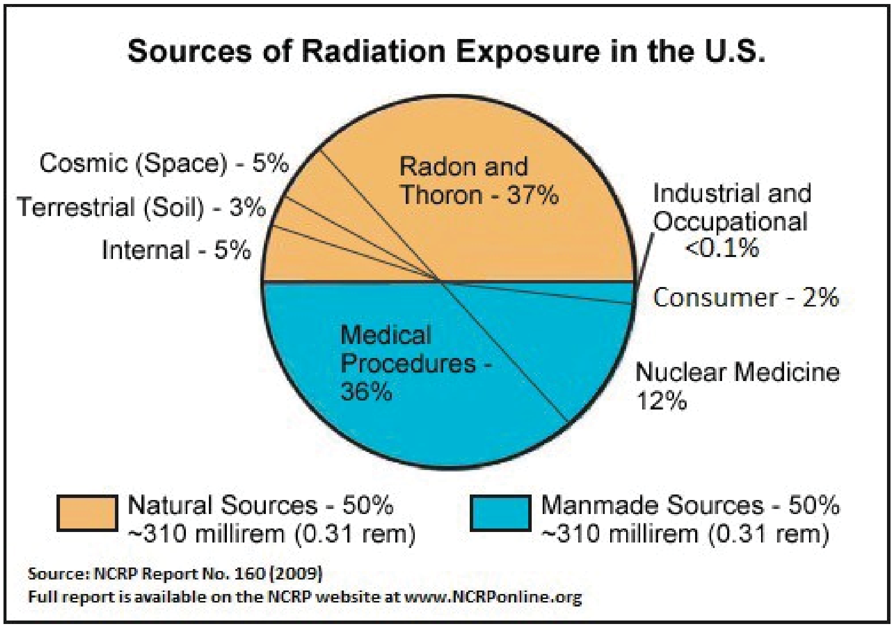
- Absorbed dose describes the amount of radiation absorbed by an object or person. The units of measure for absorbed dose used within the AREOR and ARERR are the rad. Noble gas air doses are reported by the site are measured in millirad (mrad), 1/1,000 of one rad.

- Dose equivalent (or effective dose) combines the amount of radiation absorbed and the health effects of that type of radiation. The units used within the AREOR and ARERR are the Roentgen equivalent man (rem). Regulations require doses to the whole body, specific organ, and direct radiation to be reported in millirem (mrem), 1/1,000 of one rem.

Sources of Radiation

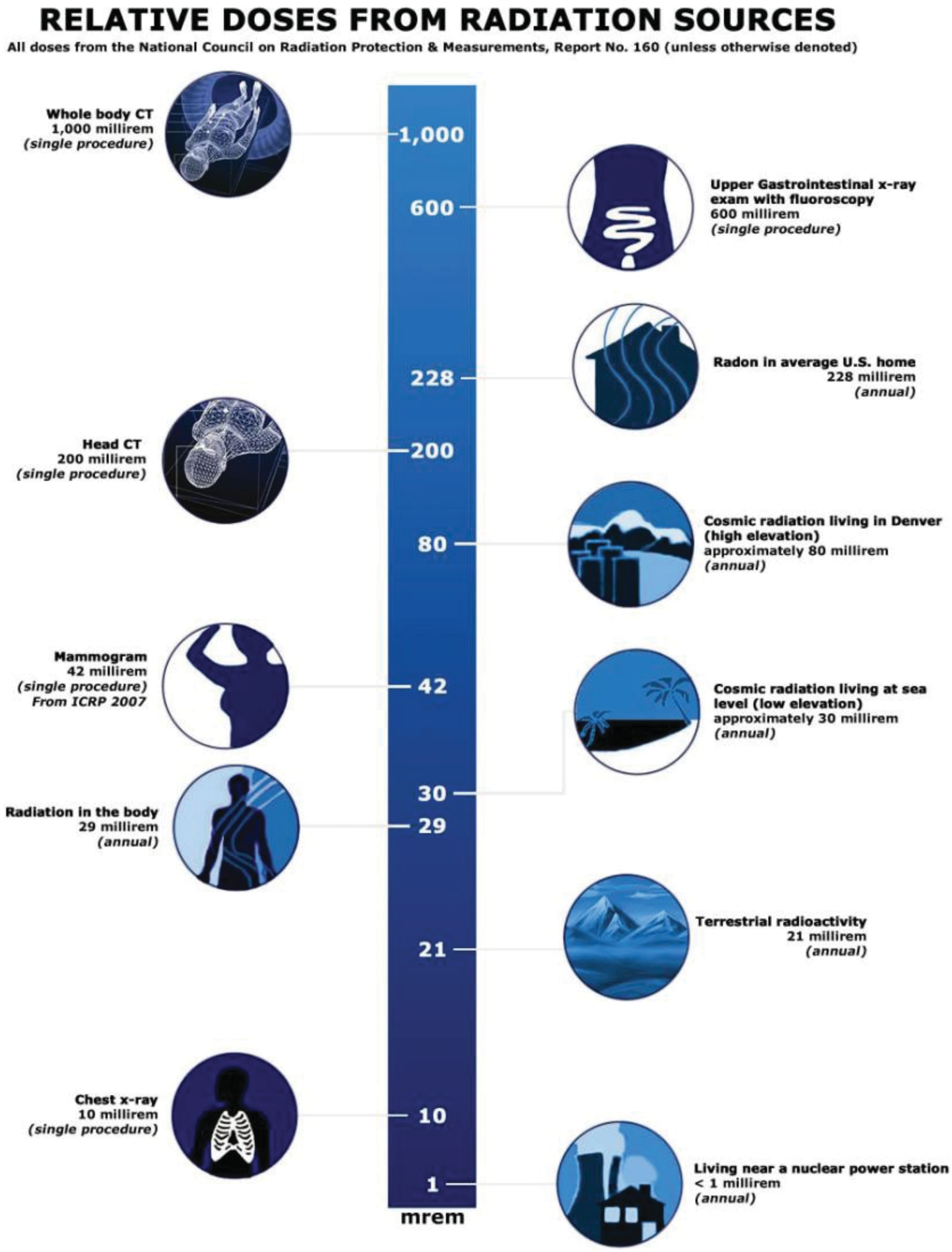
People are exposed to radiation every day of their lives and have been since the dawn of mankind. Some of this radiation is naturally occurring while some is man- made. There are many factors that will determine the amount of radiation individuals will be exposed to such as where they live, medical treatments, etc. The average person in the United States is exposed to approximately 620 mrem each year. 310 mrem comes from natural sources and 310 from man-made sources. The Graphic 5 shows what the typical sources of radiation are for an individual over a calendar year:

Graphic 5. Sources of Radiation Exposure in the U.S., from NCRP Report No. 160



The radiation from a nuclear power plant is included in the chart as part of the “Industrial and Occupational” fraction, <0.1%. The largest natural source of radiation is from radon, because radon gas travels in the air we breathe. Perhaps you know someone who had a CT scan at a hospital to check his or her bones, brain, or heart. CT scans are included in the chart as “Medical Procedures”, which make up the next largest fraction. Graphic 6 on the following page shows some of the common doses humans receive from radiation every year.

Graphic 6 .Relative Doses from Radiation Sources, from EPA Radiation Doses and Sources

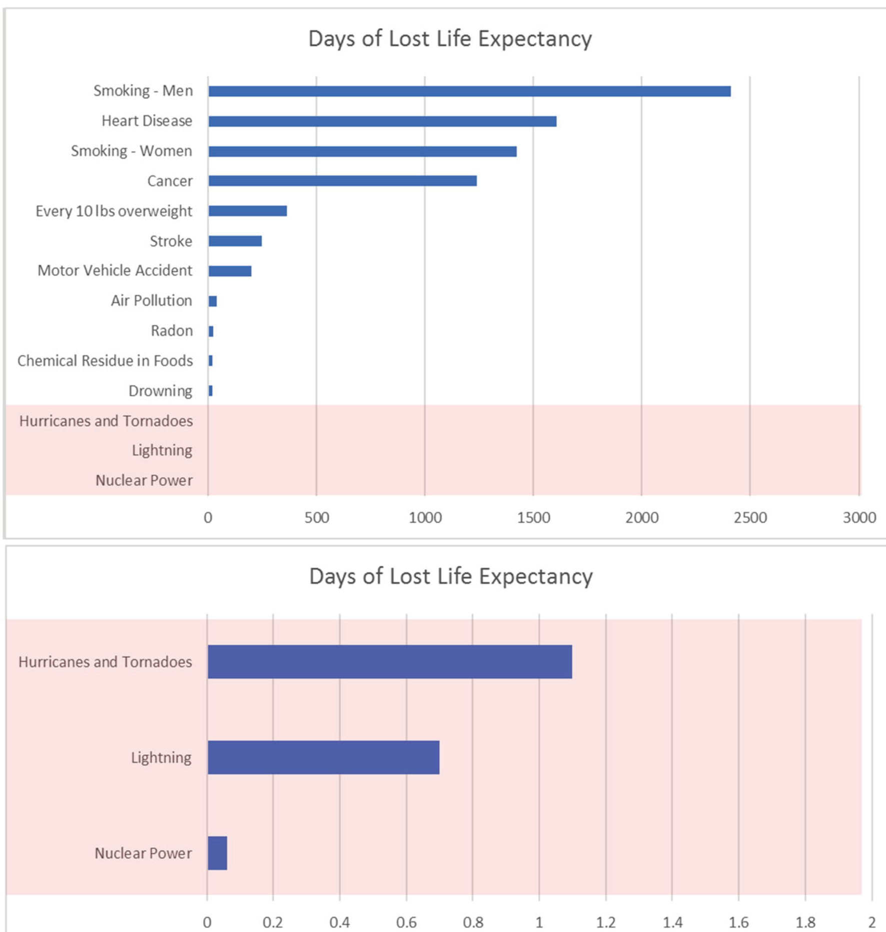


<u>Radiation Risk</u>

Current science suggests there is some risk from any exposure to radiation. However, it is very hard to tell whether cancers or deaths can be attributed to very low doses of radiation or by something else. U.S. radiation protection standards are based on the premise that any radiation exposure carries some risk.

The following graph is an example of one study that tries to relate risk from many different factors. This graph represents risk as "Days of Lost Life Expectancy". All the categories are averaged over the entire population except Male Smokers, Female Smokers, and individuals that are overweight. Those risks are only for people that fall into those categories. The category for Nuclear Power is a government estimate based on all radioactivity releases from nuclear power, including accidents and wastes.

Graphic 7. Days of Lost Life Expectancy, Adapted from the Journal of American Physicians and Surgeons Volume 8 Number 2 Summer 2003



In 2021, the Limerick Generating Station released to the environment through the radioactive effluent liquid and gaseous pathways approximately 132 curies of noble gas, fission and activation products and approximately 36 curies of tritium. The dose from both liquid and gaseous effluents was conservatively calculated for the Maximum Exposed Member of the Public. The results of those calculations and their comparison to the allowable limits were as follows:

Summary of Gaseous and Liquid Effluent Doses to Members of the Public at the Highest Dose Receptors						
Maximum Individual Noble Gas	**Applicable Dose**	**Estimated Dose**	**Age Group**	**% of Applicable Limit**	**Limit**	**Unit**
Nearest Residence	Gamma Air Dose	1.97E-02	All	9.85E-02	20	mRad
Nearest Residence	Beta Air Dose	1.26E-02	All	3.15E-02	40	mRad
Nearest Residence	Total Body	1.89E-02	All	1.89E-01	10	Mrem
Nearest Residence	Skin	3.26E-02	All	1.09E-01	30	Mrem
Iodine, Particulate, C-14 & Tritium						
Vegetation	Bone	1.27E+00	Child	4.24E+00	30	Mrem
Liquid						
Aqua PA	Total Body	7.84E-02	Child	1.31E+00	6	Mrem
Aqua PA	Thyroid	7.90E-02	Child	3.95E-01	20	Mrem

The calculated doses, from the radiological effluents released from Limerick, were a very small percentage of the allowable limits.

This report on the Radiological Environmental Monitoring Program conducted for the Limerick Generating Station (LGS) by Exelon covers the period 1 January 2021 through 31 December 2021. During that time period, 1,514 analyses were performed on 1,370 samples.

Surface and drinking water samples were analyzed for concentrations of tritium (H-3), low level iodine-131 (I-131) and gamma-emitting nuclides. Drinking water samples were also analyzed for concentrations of total gross beta. Total gross beta activities detected were consistent with those detected in previous years. No other fission or activation products were detected.

Fish (predator and bottom feeder) samples were analyzed for concentrations of gamma-emitting nuclides. Concentrations of naturally occurring potassium-40

(K-40) were consistent with those detected in previous years. No fission or activation products were detected in fish.

Sediment samples were analyzed for concentrations of gamma-emitting nuclides. No station-produced fission or activation products were found in sediment. For results, discussion, and dose to member of the public calculation see Section II.B.6.

Air particulate samples were analyzed for concentrations of gross beta and gamma- emitting nuclides**.** Gross beta and cosmogenic, naturally occurring beryllium-7
(Be-7) were detected at levels consistent with those detected in previous years. No fission or activation products were detected.
High-sensitivity I-131 analyses were performed on weekly air samples. All results were less than the minimum detectable concentration.

The air monitoring systems employed in the nuclear industry have proven to be capable of detecting very low levels of activity in the atmosphere, as activity from both the Chernobyl and Fukushima events was detected at many of the world's nuclear power plants, including Limerick Generating Station.

Cow milk samples were analyzed for concentrations of I-131 and gamma-emitting nuclides. Concentrations of naturally occurring K-40 were consistent with those detected in previous years. No fission or activation products were found.

Broadleaf vegetation samples were analyzed for gamma-emitting nuclides. Only naturally occurring activity was detected. K-40 was detected in all samples. Be-7 was found in 30 of 33 samples. Radium-226 (Ra-226) was found in 11 of 33 samples.
Thorium-228 (Th-228) was found in 18 of 32 samples. No activity due to plant operations were detected.

Review of the gamma spectroscopy results from the surface water samples located at the Limerick intake (24S1) and downstream of the 10 CFR 20.2002 permitted storage area showed no evidence of offsite radionuclide transport from the 2002 permitted storage area.

Environmental ambient gamma radiation measurements were performed quarterly using Dosimeters of Legal Record (DLR). Levels detected were consistent with those observed in previous years and no facility-related dose was detected. A review of the dosimetry data for the nearest residence to the Independent Spent Fuel Storage Installation (ISFSI) indicates no direct dose was received.

A Radiological Groundwater Protection Program (RGPP) was established in 2006 as part of an Exelon Nuclear fleetwide assessment of potential groundwater intrusion from the operation of the Station. Results and Discussion of groundwater samples are covered in Appendix E.

In assessing the data gathered for this report and comparing these results with preoperational data, it was concluded that the operation of LGS had no adverse radiological impact on the environment.

II. LIMERICK GENERATING STATION RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

II.A. INTRODUCTION

The Limerick Generating Station (LGS), consisting of two 3,515 MW boiling water reactors owned and operated by Exelon Corporation, is located adjacent to the Schuylkill River in Montgomery County, Pennsylvania. Unit No. 1 went critical on 22 December 1984. Unit No. 2 went critical on 11 August 1989. The site is located in Piedmont countryside, transversed by numerous valleys containing small tributaries that feed into the Schuylkill River. On the eastern riverbank, elevation rises from approximately 110 to 300 feet mean sea level (MSL). On the western riverbank elevation rises to approximately 50 feet MSL to the western site boundary.

A Radiological Environmental Monitoring Program (REMP) for LGS was initiated in 1971. Review of the 1971 through 1977 REMP data resulted in the modification of the program to comply with changes in the Environmental Report Operating License Stage (EROL) and the Branch Technical Position Paper (Rev. 1, 1979). The preoperational period for most media covers the periods 1 January 1982 through 21 December 1984 and was summarized in a separate report. This report covers those analyses performed by Exelon Industrial Services (EIS), Mirion Technologies, and Teledyne Brown Engineering (TBE)/GEL Laboratories (GEL) on samples collected during the period 1 January 2021 through 31 December 2021.

On 6 July 1996, a 10 CFR 20.2002 permit was issued to Limerick for storage of slightly contaminated soils, sediments and sludges obtained from the holding pond, cooling tower and spray pond systems. These materials will decay to background while in storage. Final disposition will be determined at Station decommissioning.

On 21 July 2008, an ISFSI pad was put into service. The ISFSI is dry cask storage, where spent nuclear fuel is stored.

II.B. PROGRAM

II.B.1 Objectives

A. Objective of the REMP

The objectives of the REMP are to:

1. Provide data on measurable levels of radiation and radioactive materials in the site environs;

2. Validate the radioactive effluent control program by evaluating the relationship between quantities of radioactive material released from the plant and resultant radiation doses to individuals from principal pathways of exposure.

B. Implementation of the Objectives

The implementation of the objectives is accomplished by:

1. Identifying significant exposure pathways
2. Establishing baseline radiological data of media within those pathways
3. Continuously monitoring those media before and during station operation to assess station radiological effects (if any) on man and the environment

II.B.2 Sample Collection and Analysis

Samples for the LGS REMP were collected for Exelon Nuclear by contractors to, or personnel of, EIS according to applicable procedures (Ref 6,12,13). Control locations are sample locations that are not expected to be impacted by plant operations and are used to determine a baseline in the environment for each type of sample. This section describes the general collection methods used to obtain environmental samples for the LGS REMP in 2021.

The locations of the individual sampling stations are listed in Table A-1 and A-2 and shown in Figures A-1, A-2, and A-3.

Analyses are performed in accordance with applicable procedures (Ref 7,10,11,13) and results are provided in Appendix B for primary REMP Analysis. Analysis results for quality assurance are provided in Appendix C. Analysis results for LGS RGPP are provided in Appendix E.

All Samples were collected and analyzed as required except as noted in section II.B.4 Program exceptions.

II.B.2.a Aquatic Environment

The aquatic environment was evaluated by performing radiological analyses on samples of surface water, drinking water, fish, and sediment. Two-gallon water samples were collected monthly from composite samplers located at two surface water locations (13B1 and 24S1) and four drinking water locations (15F4, 15F7, 16C2, and 28F3). Control locations were 24S1, and 28F3. All samples were collected in new unused plastic bottles, which were rinsed at least twice with source water prior to collection. Fish samples comprising of the flesh of two groups, bottom feeder (Carp / Northern Hogsucker / Norther Sucker / White Sucker) and predator (American Eel / Black Crappie / Bluegill / Brown Trout / Channel Catfish / Flathead Catfish / Green Sunfish / Smallmouth Bass / Yellow Perch), were collected semiannually at two locations, 16C5 and 29C1 (control). Sediment samples composed of recently deposited substrate were collected at three locations semiannually, 16B2, 16C4, and 33A2 (control).

II.B.2.b Atmospheric Environment

The atmospheric environment was evaluated by performing radiological analyses on samples of air particulate, airborne iodine, and milk. Airborne iodine and particulate samples were collected and analyzed weekly at seven locations (6C1, 10S3, 11S1, 13S4, 14S1, 15D1, and 22G1). The control location was 22G1. Airborne iodine and particulate samples were obtained at each location, using a vacuum pump with charcoal and glass fiber filters attached. The pumps were run continuously and sampled air at the rate of approximately one cubic foot per minute. The filters were replaced weekly and sent to the laboratory for analysis.

II.B.2.c Terrestrial Environment

Milk samples were collected biweekly at four locations (18E1, 19B1, 23F1, and 25C1) from April through November, and monthly from December through March. Location 23F1 was the control. All samples were collected in new unused two gallon plastic bottles from the bulk tank at each location, preserved with sodium bisulfite, and shipped promptly to the laboratory.
Broadleaf vegetation was collected monthly, during the growing season, at three locations (11S3, 13S3, and 31G1). The control location was 31G1.
Twelve different kinds of vegetation samples were collected and placed in new unused plastic bags and sent to the laboratory for analysis.

II.B.2.d Ambient Gamma Radiation

Direct Radiation measurements were made using thermoluminescent dosimeters. The DLR locations were placed on and around the LGS site as follows:

A site boundary ring consisting of 16 locations (36S2, 3S1, 5S1, 7S1, 10S3, 11S1, 13S2, 14S1, 18S2, 21S2, 23S2, 25S2, 26S3, 29S1, 31S1, and 34S2)
near and within the site perimeter representing fence post doses (i.e., at locations where the doses will be potentially greater than maximum annual off–site doses) from LGS releases.

An intermediate distance ring consisting of 16 locations (36D1, 2E1, 4E1, 7E1, 10E1, 10F3, 13E1, 16F1, 19D1, 20F1, 24D1, 25D1, 28D2, 29E1, 31D2,
and 34E1) extending to approximately 5 miles from the site designed to measure possible exposures to close-in population.
The balance of eight locations (5H1, 6C1, 9C1, 13C1, 15D1, 17B1, 20D1, and 31D1) representing control and special interest areas such as population centers, schools, etc.

The balance of eight locations (5H1, 6C1, 9C1, 13C1, 15D1, 17B1, 20D1, and 31D1) representing control and special interest areas such as population centers, schools, etc.

The specific dosimetry locations were determined by the following criteria:

1. The presence of relatively dense population,
2. Site meteorological data taking into account distance and elevation for each of the sixteen–22 1/2-degree sectors around the site, where estimated annual dose from LGS, if any, would be most significant,
3. On hills free from local obstructions and within sight of the vents (where practical);
4. And near the closest dwelling to the vents in the prevailing downwind direction.

Two dosimeters were placed at each location in a mesh basket tube located approximately three feet above ground level. The dosimeters were exchanged quarterly and sent to Mirion Technologies for analysis.

II.B.2.e 10 CFR 20.2002 Permit Storage Area

In 1996, the Limerick Generating Station received NRC approval to store slightly contaminated soils, sludges, and sediments on site per the requirements of 10 CFR 20.2002. These materials will be stored until end of the site's renewed operating license. At that time the material will be evaluated along with the site for decommissioning. The area is approximately 1.5 acres in size and was evaluated to hold a maximum of 1.12E+06 cubic feet with no more than 7E+04 cubic feet added to the area in any single year. After each material placement on the storage area, the area is graded and seeded to prevent erosion. Since all groundwater movement is to the river, the use of the REMP surface water sampling program is used as a check on potential groundwater movement from the pad. In 2021, 0 cubic feet of cooling water sludge was placed on the permitted storage area.

II.B.2.f Independent Spent Fuel Storage Installation (ISFSI)

The results from the dosimeter locations 36S2 and 3S1 were used to determine the direct radiation exposure to the nearest residence from the ISFSI pad.

II.B.3 Data Interpretation

The radiological and direct radiation data collected prior to LGS becoming operational was used as a baseline with which these operational data were compared. For the purpose of this report, LGS was considered operational at initial criticality. In addition, data were compared to previous years' operational data for consistency and trending. Several factors were important in the interpretation of the data:

1. Lower Limit of Detection and Minimum Detectable Concentration
   The lower limit of detection (LLD) is defined as the smallest concentration of radioactive material in a sample that would yield a net count (above background) that would be detected with only a 5% probability of falsely concluding that a blank observation represents a "real" signal. The LLD is intended as a before the fact estimate of a system (including instrumentation, procedure, and sample type) and not as an after the fact criteria for the

presence of activity. All analyses are designed to achieve the required LGS detection limits for environmental sample analysis.

2. Reporting of Results

Gamma spectroscopy analyzes samples for the full range of nuclides. All nuclides that identified positive results for non-natural gamma emitters are reported. Each type of sample also looks for specific nuclides which must meet LLD requirements as described above. The required nuclides and their LLDs for each type of sample are provided in Table C-3.

Means and standard deviations of positive results were calculated. The standard deviations represent the variability of measured results for different samples rather than single analysis uncertainty.

3. Minimum Detectable Activity

Many results in environmental monitoring occur at or below the minimum detectable activity (MDA). In this report, all results at or below the relevant MDA are reported as being "<MDA" indicating less than the MDA value of all non-natural gamma emitters.

II.B.4 Program Exceptions

For 2021 the LGS REMP had a sample recovery rate of greater than 99%. Program exceptions are listed below:

1. "2021 REMP Self-assessment Gap 1" that questions why a particular milk control location was not located for the REMP program.

   An exception to ODCM Table 3.3-1 for control milk sample was found in the 2020 AREOR. Milk control location does not meet the specifications described in the ODCM. The ODCM requires 1 sample from milking animals at a control location (15-30km distance) and in the least prevalent wind direction. We currently have two control locations for milk, the distances for the two locations are 7.58km and 8.08km. The annual land use survey required by the ODCM determined that there are no milk farms available at 15-30km in the least prevalent wind direction. (IR 04446062)

2. Telemetry indicated that power supply was lost on 5/24/21 at LGS REMP air station 13S4, located on Long View across from the substation. It was determined that power supply was lost from the pole to the sampler housing. Insufficient sample volume was collected for the week ending 06/01/21. Site electricians restored power and no further loss of sampling occurred. (IR 04426002)

3. On 8/9/21 during a routine weekly water collection it was discovered that there was a fire at the Phoenixville Water Treatment Plant on 8/7/21. This caused the basement to

fill with approximately 4ft of water. The 15F7 ISCO water sampler was overturned and possibly submerged during the flood. This caused the sample to be lost and no grab sample was able to be collected as the plant was not processing drinking water due to damage. The missed sample is allowed by the ODCM under Table 3.3-1 “Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons (IR 04440941).

4. Vegetation samples at 31G1 were unavailable for collection on 09/20/21 due to plants being tilled in by the farm owner. (IR 04447818)

Each program exception was reviewed to understand the causes of the program exception. Occasional equipment breakdowns were unavoidable. The overall sample recovery rate indicates that the appropriate procedures and equipment are in place to assure reliable program implementation.

II.B.5 Program Changes

Revision 33 was approved and implemented on 12/14/21. Major changes include removal of the information center, addition of the hold pond as a release point, and an update to the X/Q factor for the milk receptor.

II.B.6 Compliance with 40CFR 190 Limits

1. Dose to Members of the Public at or Beyond Site Boundary

Per the ODCM Control 6.2, the Annual Radioactive Effluent Release Report shall include an assessment of the radiation doses to the hypothetically highest exposed MEMBER OF THE PUBLIC from reactor releases and other nearby uranium fuel cycle sources. The ODCM does not require population doses to be calculated. For purposes of this calculation the following assumptions were made:

- Long term annual average meteorology X/Q and D/Q and
- actual gaseous effluent releases were used.
- Gamma air dose, Beta air dose, Total Body and Skin doses were attributed to noble gas releases.
- Critical organ and age group dose attributed to iodine, particulate, Carbon-14 and tritium releases.
- 100 percent occupancy factor was assumed.
- Dosimetry measurements obtained from the REMP for the nearest residence to the Independent Spent Fuel Storage Installation (ISFSI) was used to determine direct radiation exposure.
- The highest doses from the critical organ and critical age group for each release pathway was summed and added to the net dosimetry measurement from nearest residence to the ISFSI for 40 CFR 190 compliance.

<u>40 CFR 190 Compliance</u>:
The maximum calculated dose to a real individual would not exceed 0.26 mRem (total body), 1.27 mRem (organ), or 0.26 mRem (thyroid).

All doses calculated were below all ODCM and 40 CFR Part 190 limits to a real individual.

40 CFR 190 Compliance								
	Gaseous Effluents		Liquid Effluents	Net Direct Radiation	Total	% of Applicable Limit	Limit	Unit
	Noble Gas	Particulate, Iodine, C-14 & Tritium						
Total Body Dose	1.89E-02	2.55E-01	7.83E-02	0.00E+00	3.52E-01	1.41E+00	25	mrem
Organ Dose	3.26E-02	1.27E+00	7.84E-02	0.00E+00	1.38E+00	5.52E+00	25	mrem
Thyroid Dose	NA	2.56E-01	7.89E-02	0.00E+00	3.35E-01	4.47E-01	75	mrem

II.C. RESULTS AND DISCUSSIONS

All the environmental samples collected during the year were analyzed using Exelon Industrial Services laboratory procedures CY-ES-205 and CY-ES-206, except Tritium which was analyzed by GEL Laboratories (GL-RAD-A-002 REV# 24), in accordance with analytical method EPA 906.0 Modified, and Dosimetry analysis by Mirion Technologies. The analytical results for this reporting period are presented in Appendix B and are also summarized in Table 2. For discussion, the analytical results are divided into four categories. The categories are Aquatic Environment, Atmospheric Environment, Terrestrial Environment, and Direct Radiation. These categories are further divided into subcategories according to sample type (e.g. Surface Water/Drinking Water and Aquatic Organisms for Aquatic Environment).

II.C.1 Aquatic Environment

The aquatic environment was evaluated by performing radiological analyses on samples of surface water, drinking water, fish, and sediment. Two-gallon water samples were collected monthly from composite samplers located at two surface water locations (13B1 and 24S1) and four drinking water locations (15F4, 15F7, 16C2, and 28F3). Control locations were 24S1, and 28F3. All samples were collected in new unused plastic bottles, which were rinsed at least twice with source water prior to collection. Fish samples comprising of the flesh of two groups, bottom feeder (Northern Hognose Sucker / Quillback / White Sucker) and predator (American Eel /

Black Crappie / Channel Catfish / Flathead Catfish / Red-Breast Sunfish / Rock Bass / Smallmouth Bass / Yellow Bullhead / White Perch), were collected semiannually at two locations, 16C5 and 29C1 (control). Sediment samples composed of recently deposited substrate were collected at three locations semiannually, 16B2, 16C4, and 33A2 (control).

II.C.1.a Surface and Drinking Water

Surface and drinking water samples were analyzed for concentrations of tritium (H-3), low level iodine-131 (I-131) and gamma-emitting nuclides. Drinking water samples were also analyzed for concentrations of total gross beta. Total gross beta activities detected were consistent with those detected in previous years. No other fission or activation products were detected.

Gamma and gross beta analysis were performed on all water samples on a monthly basis Composites are made from the weekly samples. Results for all water Gamma and gross beta analyses are listed in Table B-1.

Tritium analysis was performed on all water samples on a quarterly basis. Composites are made from the weekly samples. Tritium data is given in Table B-1.

Review of the gamma spectroscopy results from the surface water samples located at the Limerick intake (24S1) and downstream of the 10 CFR 20.2002 permitted storage area showed no evidence of offsite radionuclide transport from the 2002 permitted storage area.

A Radiological Groundwater Protection Program (RGPP) was established in 2006 as part of an Exelon Nuclear fleetwide assessment of potential groundwater intrusion from the operation of the Station. Results and Discussion of groundwater samples are covered in Appendix E.

II.C.1.b Aquatic Organisms

Fish (predator and bottom feeder) samples were analyzed for concentrations of gamma-emitting nuclides. Concentrations of naturally occurring potassium-40 (K-40) were consistent with those detected in previous years. No fission or activation products were detected in fish.

II.C.1.c Shoreline Sediment

Sediment samples were analyzed for concentrations of gamma-emitting nuclides. No station-produced fission or activation products were found in sediment. For results, discussion, and dose to member of the public calculation see Section II.B.6.

II.C.2 Atmospheric Environment

The atmospheric environment was evaluated by performing radiological analyses on samples of air particulate, airborne iodine, and milk. Airborne iodine and particulate samples were collected and analyzed weekly at seven locations (6C1, 10S3, 11S1, 13S4, 14S1, 15D1, and 22G1). The control location was 22G1. Airborne iodine and particulate samples were obtained at each location, using a vacuum pump with charcoal and glass fiber filters attached. The pumps were run continuously and sampled air at the rate of approximately one cubic foot per minute. The filters were replaced weekly and sent to the laboratory for analysis.

II.C.2.a Air Particulate Filters

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

Based on weekly comparisons, there was no statistical difference between the Control and Indicator radioactive particulate concentrations. The averages for the control samples were 0.021 pCi/m^3, and the averages for the indicators were 0.021 pCi/m^3 for the period of January to December, 2021. Maximum weekly concentrations for each station were less than 0.039 pCi/m^3.

The particulate filters from each sampling location were saved and a 13 week composite was made. A gamma isotopic analysis was performed for each sampling location and corrected for decay. The results of these analyses are listed in Table B-6

II.C.2.b Air Iodine

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

The air monitoring systems employed in the nuclear industry have proven to be capable of detecting very low levels of activity in the atmosphere, as activity from both the Chernobyl and Fukushima events was detected at many of the world's nuclear power plants, including Limerick Generating Station.

Radioiodine cartridges are placed at seven locations. These cartridges are changed and analyzed each week. No positive analytical results were found on any sample. A list of values for these cartridges is given in Table B-4.

II.C.3 Terrestrial Environment

II.C.3.a Vegetation

Broadleaf vegetation was collected monthly, during the growing season, at three locations (11S3, 13S3, and 31G1). The control location was 31G1.
Eleven different kinds of vegetation samples were collected and placed in new unused plastic bags and sent to the laboratory for analysis.

Broadleaf vegetation samples were analyzed for gamma-emitting nuclides. Only naturally occurring activity was detected. K-40 was detected in all samples. Be-7 was found in 30 of 33 samples. Radium-226 (Ra-226) was found in 11 of 33 samples.
Thorium-228 (Th-228) was found in 10 of 33 samples. No activity due to plant operations were detected.

Data for Non Natural Gamma Emitters is given in Table B-7.

II.C.3.b Milk

Milk samples were collected biweekly at four locations (18E1, 19B1, 23F1, and 25C1) from April through November, and monthly from December through March. Location 23F1 was the control. All samples were collected in new unused two gallon plastic bottles from the bulk tank at each location, preserved with sodium bisulfite, and shipped promptly to the laboratory.

Cow milk samples were analyzed for concentrations of I-131 and gamma-emitting nuclides. Concentrations of naturally-occurring K-40 were consistent with those detected in previous years. No fission or activation products were found.

Gamma isotopic data is given in Table B-8.

II.C.4 Direct Radiation

Environmental ambient gamma radiation measurements were performed quarterly using Dosimeters of Legal Record (DLR). Levels detected were consistent with those observed in previous years and no facility-related dose was detected. A review of the dosimetry data for the nearest residence to the Independent Spent Fuel Storage Installation (ISFSI) indicates no direct dose was received.

Ambient Gamma Radiation

Direct Radiation measurements were made using thermoluminescent dosimeters. The DLR locations were placed on and around the LGS site as follows:

A site boundary ring consisting of 16 locations (36S2, 3S1, 5S1, 7S1, 10S3, 11S1, 13S2, 14S1, 18S2, 21S2, 23S2, 25S2, 26S3, 29S1, 31S1, and 34S2)
near and within the site perimeter representing fence post doses (i.e., at locations where the doses will be potentially greater than maximum annual off–site doses) from LGS releases.

An intermediate distance ring consisting of 16 locations (36D1, 2E1, 4E1, 7E1, 10E1, 10F3, 13E1, 16F1, 19D1, 20F1, 24D1, 25D1, 28D2, 29E1, 31D2,
and 34E1) extending to approximately 5 miles from the site designed to measure possible exposures to close-in population.

The balance of eight locations (5H1, 6C1, 9C1, 13C1, 15D1, 17B1, 20D1, and 31D1) representing control and special interest areas such as population centers, schools, etc.

The specific dosimetry locations were determined by the following criteria:

1. The presence of relatively dense population,
2. Site meteorological data taking into account distance and elevation for each of the sixteen–22 ½-degree sectors around the site, where estimated annual dose from LGS, if any, would be most significant.
3. On hills free from local obstructions and within sight of the vents (where practical),
4. And near the closest dwelling to the vents in the prevailing downwind direction.

Two dosimeters were placed at each location in a mesh basket tube located approximately three feet above ground level. The dosimeters were exchanged quarterly and sent to Mirion Technologies for analysis.

10 CFR 20.2002 Permit Storage Area

In 1996, the Limerick Generating Station received NRC approval to store slightly contaminated soils, sludges, and sediments on site per the requirements of 10 CFR 20.2002. These materials will be stored until end of the site's renewed operating license. At that time the material will be evaluated along with the site for decommissioning. The area is approximately
1.5 acres in size and was evaluated to hold a maximum of 1.12E+06 cubic feet with no more than 7E+04 cubic feet added to the area in any single year. After each material placement on the storage area, the area is graded and seeded to prevent erosion. Since all groundwater movement is to the river, the use of the REMP surface water sampling program is used as a check on potential groundwater movement from the pad. In 2021, 0 cubic feet of cooling water sludge was placed on the permitted storage area.

Independent Spent Fuel Storage Installation (ISFSI)

The results from the dosimeter locations 36S2 and 3S1 were used to determine the direct radiation exposure to the nearest residence from the ISFSI pad.

II.D. CONCLUSION

In assessing the data gathered for this report and comparing these results with preoperational data, it was concluded that the operation of LGS had no adverse radiological impact on the environment.

In 2021, the Limerick Generating Station released to the environment through the radioactive effluent liquid and gaseous pathways approximately 132 curies of noble gas, fission and activation products and approximately 36 curies of tritium. The dose from both liquid and gaseous effluents was conservatively calculated for the Maximum Exposed Member of the Public.

Table 1

Synopsis of 2021 Limerick Generating Station Radiological Environmental Monitoring Program

Sample Type	Sampling Frequency[1]	Number of Locations	Number Collected	Analysis	Analysis Frequency[1]	Number Analyzed
Aquatic Environment						
Surface Water, Drinking Water	MC	6	72	Gamma	MC	72
				Gross Beta	MC	48
				Tritium	QC	24
Fish[2]	SA	2	8	Gamma	SA	8
Shoreline Sediment	SA	3	3	Gamma	SA	3
Atmospheric Environment						
Air Iodine[3]	W	7	370	I-131	W	370
Air Particulates[4]	W	7	370	Gross Beta	W	370
				Gamma	QC	28

Table 1

Synopsis of 2021 Limerick Generating Station Radiological Environmental Monitoring Program

Sample Type	Sampling Frequency[1]	Number of Locations	Number Collected	Analysis	Analysis Frequency[1]	Number Analyzed
Terrestrial Environment						
Milk[5]	M/BW	4	88	Gamma	W	88
Vegetation[6]	M	3	33	Gamma	M	33
Dosimetry	Q	40	320	Direct Radiation	Q	320

[1] W=Weekly, BW=BiWeekly (15 days), M=Monthly (31 days), Q=Quarterly (92 days), SA=Semiannual, A=Annual, C=Composite
[2] Twice during fishing season including at least four species
[3] The collection device contains activated charcoal
[4] Beta counting is performed >= 24 hours following filter change. Gamma spectroscopy performed on quarterly composite of weekly samples
[5] Bi-Weekly during growing season.
[6] Monthly during growing season. Samples include broad leaf vegetation

Table 2

Annual Summary of Radioactivity in the Environs of the Limerick Generating Station

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analyses Performed	Lower Limit of Detection (LLD)	Indicator Locations Mean (F)/Range[1]	Location with Highest Annual Mean Name/Distance & Direction[2]	Highest Annual Mean (F) / Range[1]	Control Locations Mean (F)/Range
Aquatic Environment						
Surface Water, Drinking Water (pCi/L)	Gross Beta (48)	4	3 (36/36) (1.43-4.38)	AQUA Water 15F4 13.9 km	3 (12/12) (1.94-4.38)	3 (12/12) (2.44-4.45)
Atmospheric Environment						
Air Particulates (10^{-2} pCi/m^3)	Gross Beta (370)	1.0	2.1 (317/317) (0.9-3.9)	Spring City Sub. 15D1 5.14 km SE	2.3 (52/52) (1.2-3.8)	2.1 (53/53) (1.0-3.6)
Dosimetry (mrem/Qtr)	Thermoluminescent Dosimetry (320)	NA	17.9(312/312) (11.5-27.5)	500KV Substation 13S2 0.04 km SE	22.6 (8/8) (14.5-27.5)	22.1 (8/8) (19.6-24.7)

[1] Mean and range based upon detectable measurements only. Fraction (F) of detectable measurements at specified location is indicated in parentheses
[2] From the centerpoint of the containment building

V. REFERENCES

(1) Environmental Report Operating License Stage, Limerick Generating Station, Units 1 and 2, Volumes 1–5 Philadelphia Electric Company

(2) NUREG-1302 Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors

(3) Branch Technical Position Paper, Regulatory Guide 4.8, Revision 1, November 1979

(4) Pre-operational Radiological Environmental Monitoring Program Report, Limerick Generating Station Units 1 and 2, 1 January 1982 through 21 December 1984, Teledyne Isotopes and Radiation Management Corporation

(5) CY-LG-170-301 Current Revision, Limerick Generating Station Units 1 and 2 Offsite Dose Calculation Manual

(6) Exelon Industrial Services Sampling Procedures

a. CY-ES-214, Collection of RGPP Water Samples for Radiological Analysis
b. CY-ES-237, Air Iodine and Air Particulate Sample Collection for Radiological
c. CY-ES-239, EIS Collection Exchange of Field Dosimeters for Radiological Analysis
d. CY-ES-241, Vegetation Sample Collection for Radiological Analysis
e. CY-ES-242, Soil and Sediment Sample Collection for Radiological Analysis
f. CY-ES-247, Precipitation Sampling and Collection for Radiological Analysis

(7) Exelon Industrial Services Analytical Procedures
a. CY-ES-204, Sample Preparation for Gamma Analysis
b. CY-ES-205, Operation of HPGE Detectors with the Genie PC Counting System
c. CY-ES-206, Operation of the Tennelec S5E Proportional Counter
d. CY-ES-246, Sample Preparation for Gross Beta Analysis

(8) Limerick Generating Station 2021 Land use Survey

(9) CY-AA-170-1000, Radiological Environmental Monitoring Program (REMP) and Meteorological Program Implementation.

(10) Teledyne Browne Engineering, (TBE) 2018 Analysis Procedures Current Revisions
a. TBE-2001 Alpha Isotopic and Pu-241
b. TBE-2006 Iron-55 Activity in Various Matrices
c. TBE-2007 Gamma Emitting Radioisotope Analysis
d. TBE-2008 Gross Alpha and/or Gross Beta Activity in Various Matrices
d. TBE-2011 Tritium Analysis in Drinking Water by Liquid Scintillation
e. TBE-2013 Radionickel Activity in Various Matrices

f. TBE-2019 Radiostrontium Analysis by Ion Exchange

(11) GEL Laboratory Procedures
a. GL-RAD-A-002 Tritium
b. GL-RAD-A-022 Ni-63
c. GL-RAD-A-004 Sr89/90, Liquid
d. GL-RAD-A-040 Fe-55

(12) Normandeau Associates, Inc. (NAI) Sampling Procedures Current Revisions
a. Procedure No. ER20 Collection of Bottom Sediment for Radiological Analysis

(13) Mirion Technologies, Proprietary procedures

(14) Teledyne Browne Engineering Environmental Services, 4th Quarter 2021 Quality Assurance Report, January – December 2021

(15) GEL 2021 Annual Environmental QA Report

APPENDIX A

Sample Locations for the REMP

Appendix A contains information concerning the environmental samples which were collected during this operating period.

Sample locations and specific information about individual locations for the Limerick Generating Station are given in Table A-1 and A-2. Figure A-1 shows the Environmental Sampling Locations within 1 mile of the Limerick Generating Station. Figures A-2 shows the Environmental Sampling Locations Between 1 and 5 miles and A-3 shows the locations Greater than 5 miles from Limerick Generating Station

TABLE OF CONTENTS - SAMPLING LOCATIONS

TABLE A-1

Locations of Environmental Sampling Stations for the Limerick Generating Station

Station	Description	Distance and Direction from Site (KM)	(Miles)	(Sector)
10S3	10S3	0.8	0.5	E
11S1	11S1	0.6	0.4	ESE
11S3	Training Center	0.6	0.3	ESE
13B1	PA American	2.8	1.7	SE
13S3	500 Kv Sub	0.4	0.2	SE
13S4	13S4	0.4	0.2	SE
14S1	14S1	1.0	0.6	SSE
15D1	15D1	5.1	3.2	SE
15F4	15F4	13.9	8.6	SE
15F7	15F7	10.2	6.3	SSE
16B2	16B2	2.2	1.3	SSE
16C2	16C2	4.3	2.7	SSE
16C4	16C4	3.5	2.2	SSE
16C5	16C5	--	--	Downstream of Discharge
18E1	18E1	6.8	4.2	S
19B1	19B1	3.1	2.0	SSW
22G1	22G1 (Control)	28.5	17.7	SW
23F1	23F1 (Control)	8.1	5.0	SW
24S1	24S1 (Control)	0.3	0.2	SW
25C1	25C1	4.3	2.7	WSW
28F3	28F3 (Control)	9.4	5.8	WNW
29C1	29C1 (Control)	--	--	Upstream of Intake
31G1	31G1 (Control)	21.9	13.6	NW
33A2	33A2 (Control)	1.4	0.8	NNW
6C1	6C1	3.4	2.1	Ne
11S2	11S2 (QC collocated with 11S1)	0.6	0.4	ESE

TABLE A-2

Locations of Environmental Dosimetry for the Limerick Generating Station

Location	Location Description	Distance and Direction from Site (KM)	(Miles)	(Sector)
Inner Ring				
	36S2 Evergreen & Sanatoga Road	1.0	0.6	N
	3S1 Sanatoga Road	0.7	0.4	NNE
	5S1 Possum Hollow Road	0.7	0.4	NE
	7S1 LGS Training Center	0.9	0.6	ENE
	10S3 Keen Road	0.8	0.5	E
	11S1 LGS Information Center	0.6	0.4	ESE
	13S2 500 KV Substation	0.7	0.4	SE
	14S1 Longview Road	1.0	0.6	SSE
	18S2 Rail Line along Longview Road	0.4	0.3	S
	21S2 Near Intake Building	0.3	0.2	SSW
	23S2 Transmission Tower	0.9	0.5	SW
	25S2 Sector Site Boundary	0.7	0.5	WSW
	26S3 Met. Tower #2	0.6	0.4	W
	29S1 Sector Site Boundary	0.9	0.5	WNW
	31S1 Sector Site Boundary	0.4	0.3	NW
	34S2 Met. Tower #1	0.9	0.6	NNW
Outer Ring	*36D1 Siren Tower No. 147	5.6	3.5	N
	*2E1 Laughing Waters GSC	7.7	4.8	NNE
	*4E1 Neiffer Road	7.7	4.8	NE
	*7E1 Pheasant Road	6.9	4.3	ENE
	*10E1 Royersford Road	6.3	4.0	E
	*10F3 Trappe Substation	9.0	5.6	ESE
	*13E1 Vaughn Substation	6.9	4.3	SE
	*16F1 Pikeland Substation	8.1	5.0	SSE
	*19D1 Snowden Substation	5.6	3.5	S
	*20F1 Sheeder Substation	8.4	5.2	SSW
	*24D1 Porters Mill Substation	6.4	4.0	SW
	*25D1 Hoffecker & Keim Streets	6.4	4.0	WSW
	*28D2 W. Cedarville Road	6.2	4.0	W
	*29E1 Prince Street	8.0	5.0	WNW
	*31D2 Popular Substation	6.2	4.0	NW
	34E1 Varnell Road	7.4	4.6	NNW
Control & Special Interest	5H1 C Birch Substation (control)	40.0	24.8	NE
	6C1 Limerick Airport	3.4	2.1	NE
	9C1 Reed Road	3.5	2.2	E
	13C1 King Road	4.6	2.8	SE
	15D1 Spring City Substation	5.1	3.2	SE
	17B1 Linfield Substation	2.6	1.6	S
	20D1 Ellis Woods Road	5.0	3.0	SSW
	31D1 Lincoln Substation	4.8	3.0	WNW

Figure A-1

Limerick Generating Station Sample Locations
Environmental Sampling Locations Within 1 mile of the
Limerick Generating Station, 2021

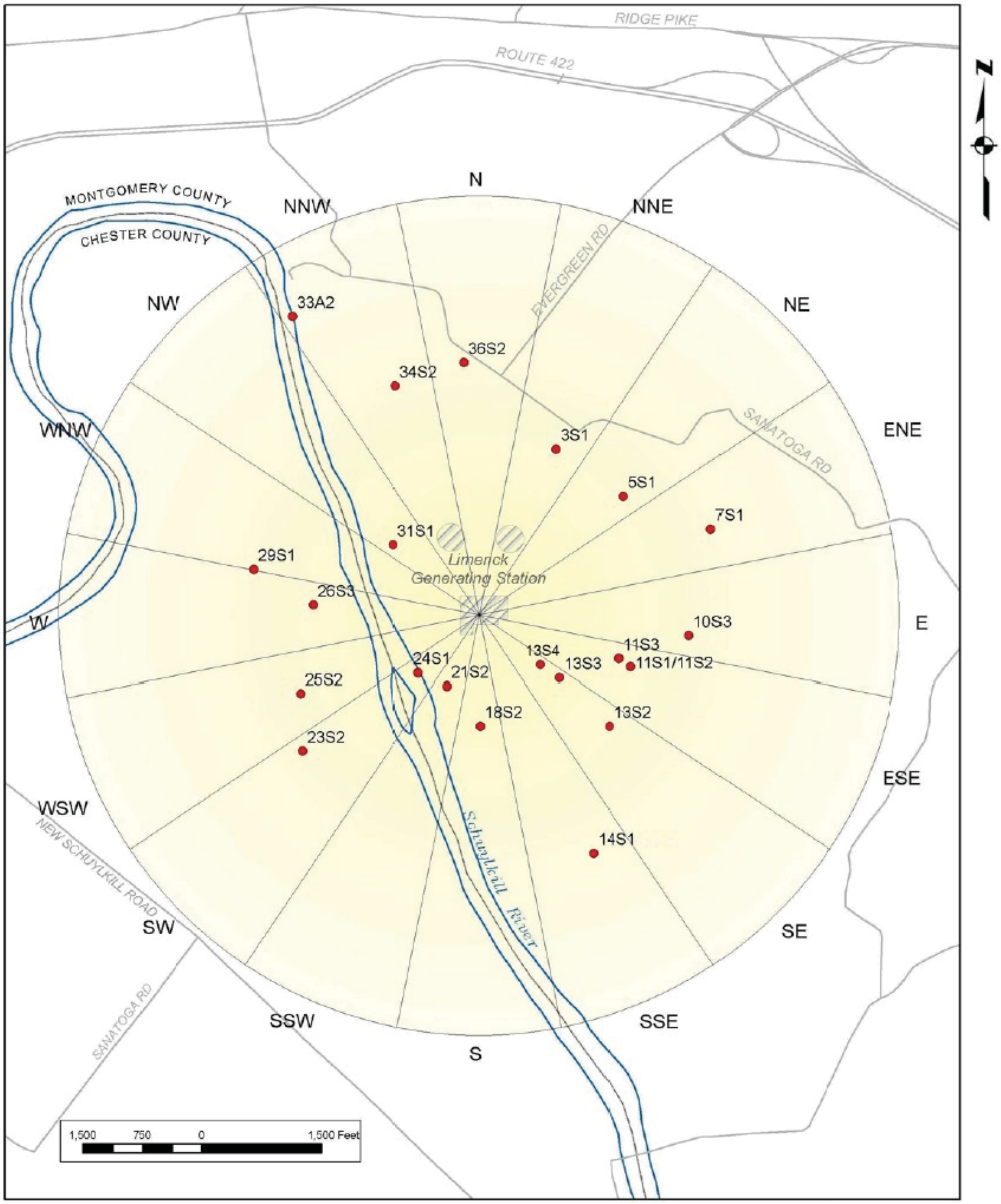


Figure A-2

Limerick Generating Station Sample Locations
Environmental Sampling Locations Between 1 and 5 miles from the Limerick Generating Station, 2021

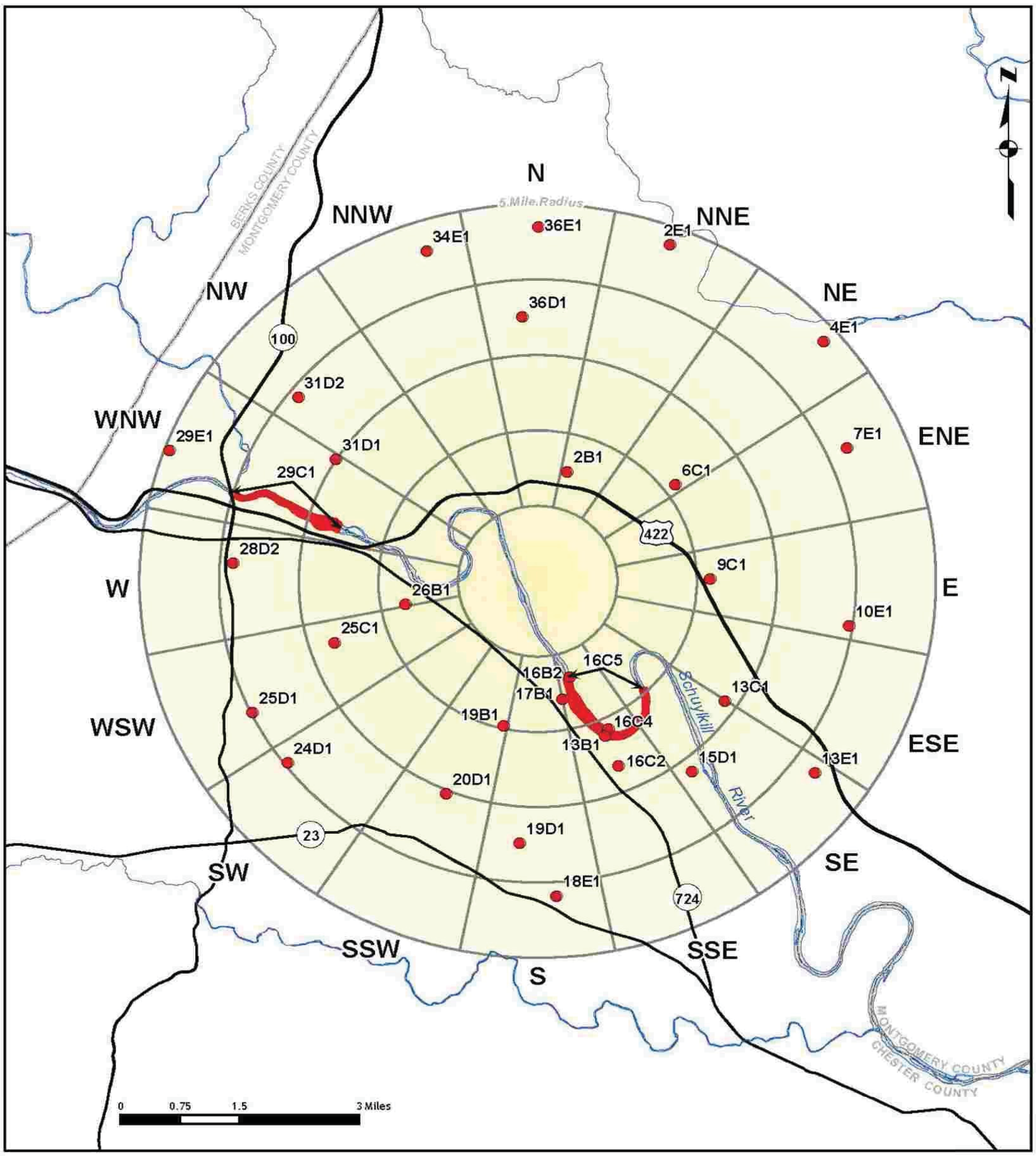


Figure A-3

Limerick Generating Station Sample Locations
Environmental Sampling Locations Greater than 5 miles from the
Limerick Generating Station, 2021

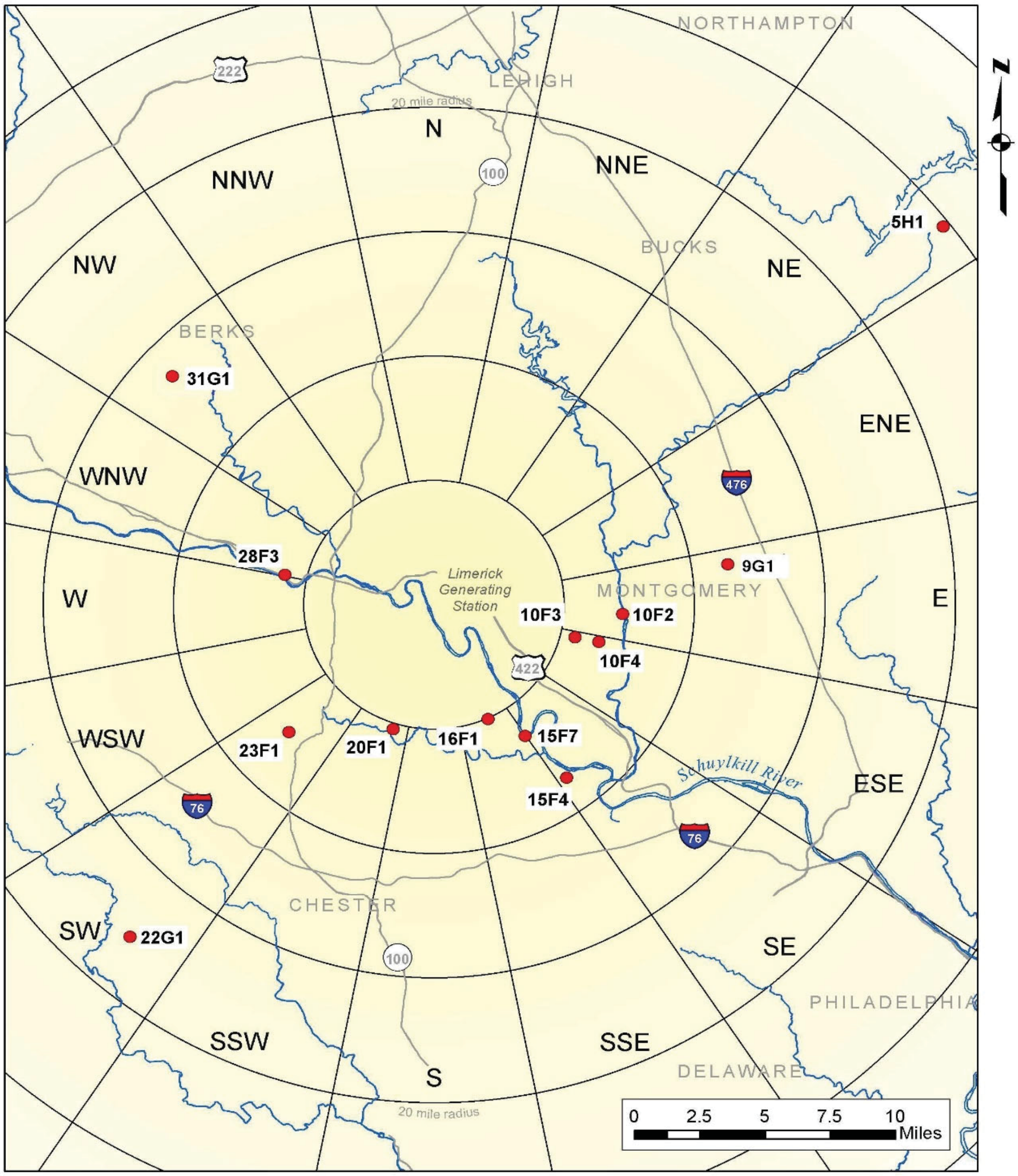


Figure A-4

Gross Beta in Public Water for the Last Ten Years

2012-2021

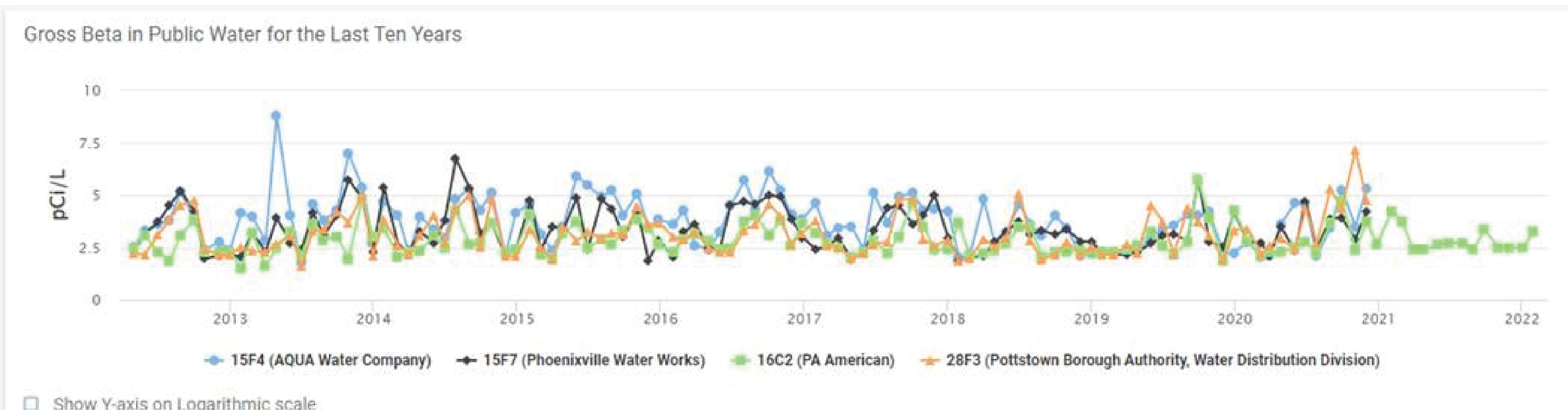


Figure A-5

Gross Beta in Air for the Last Ten Years

2012-2021

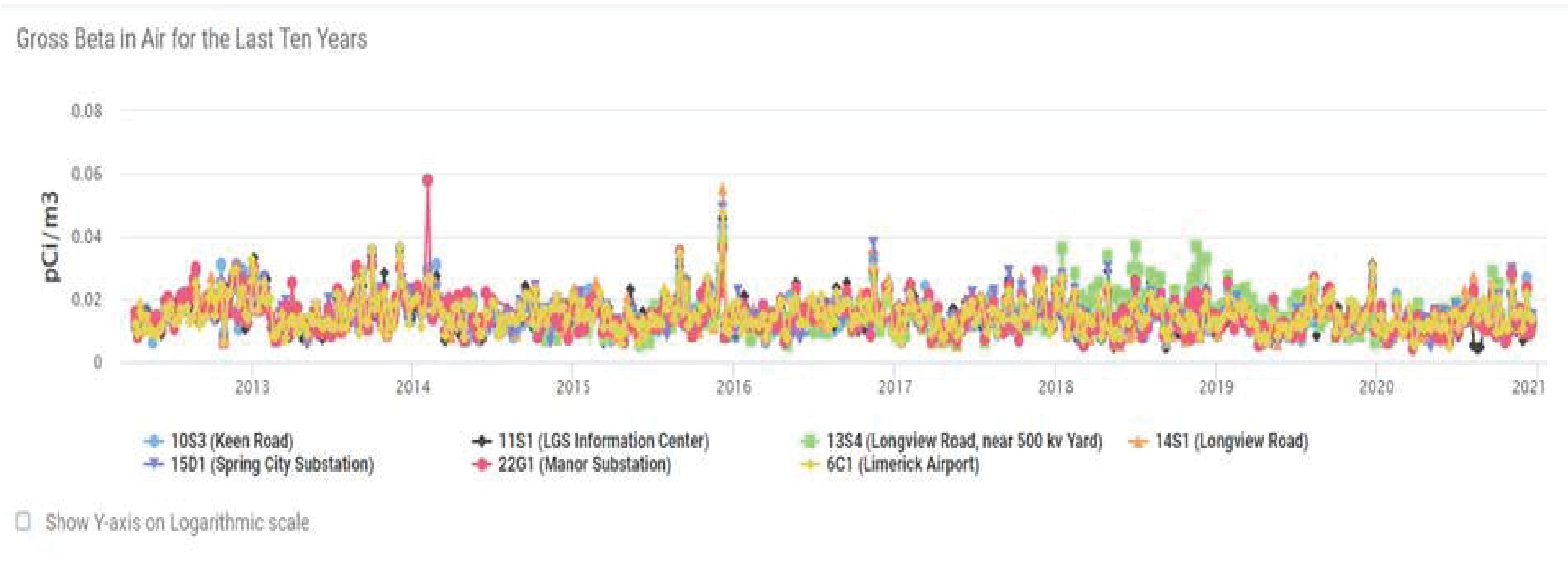


Figure A-6
Annual Trending of Air Activity (Gross Beta)

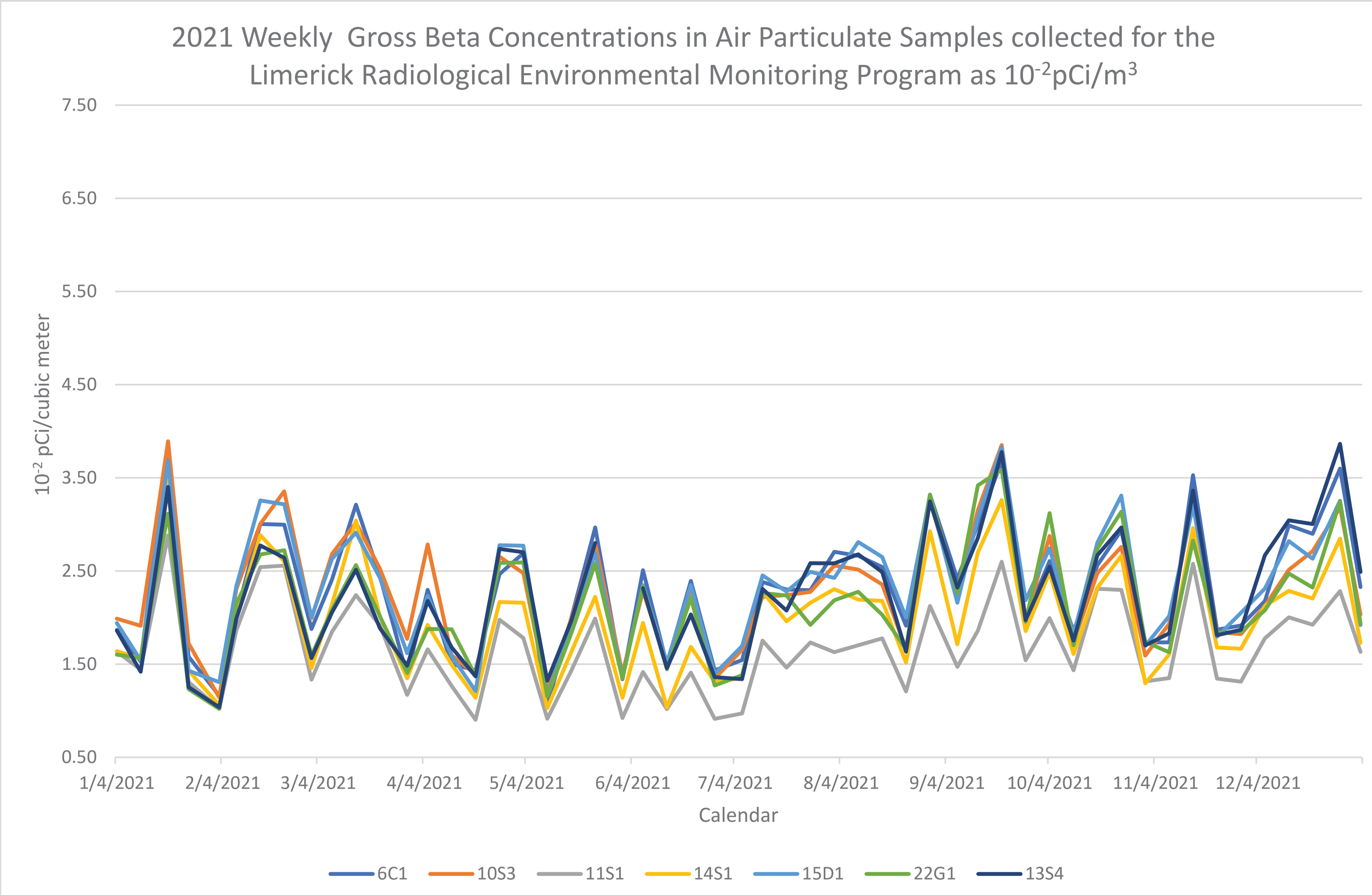


Figure A-7
2021 Monthly Gross Beta Concentrations in Drinking Water, (16C2)
Split between EIS and TBE

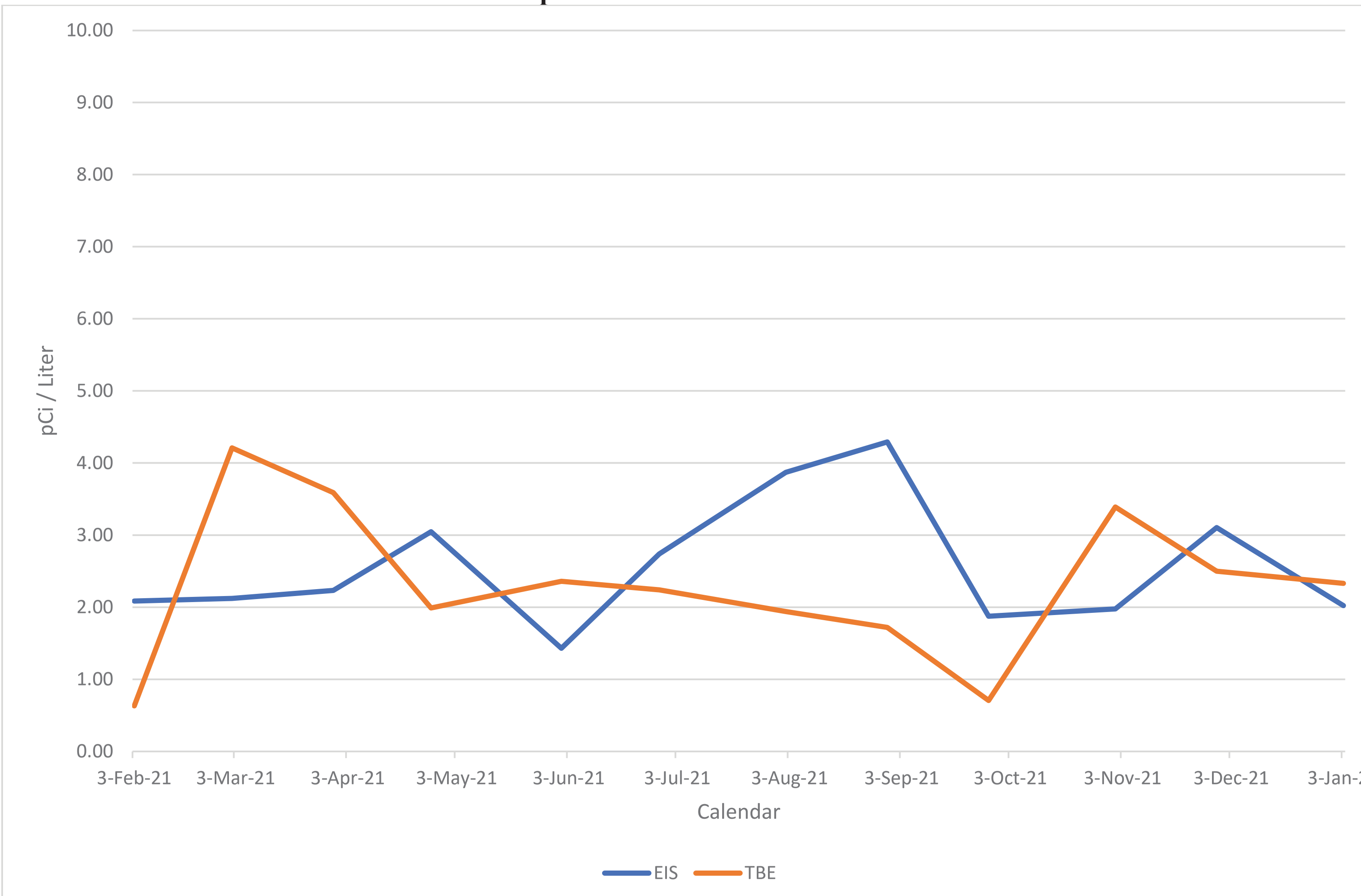
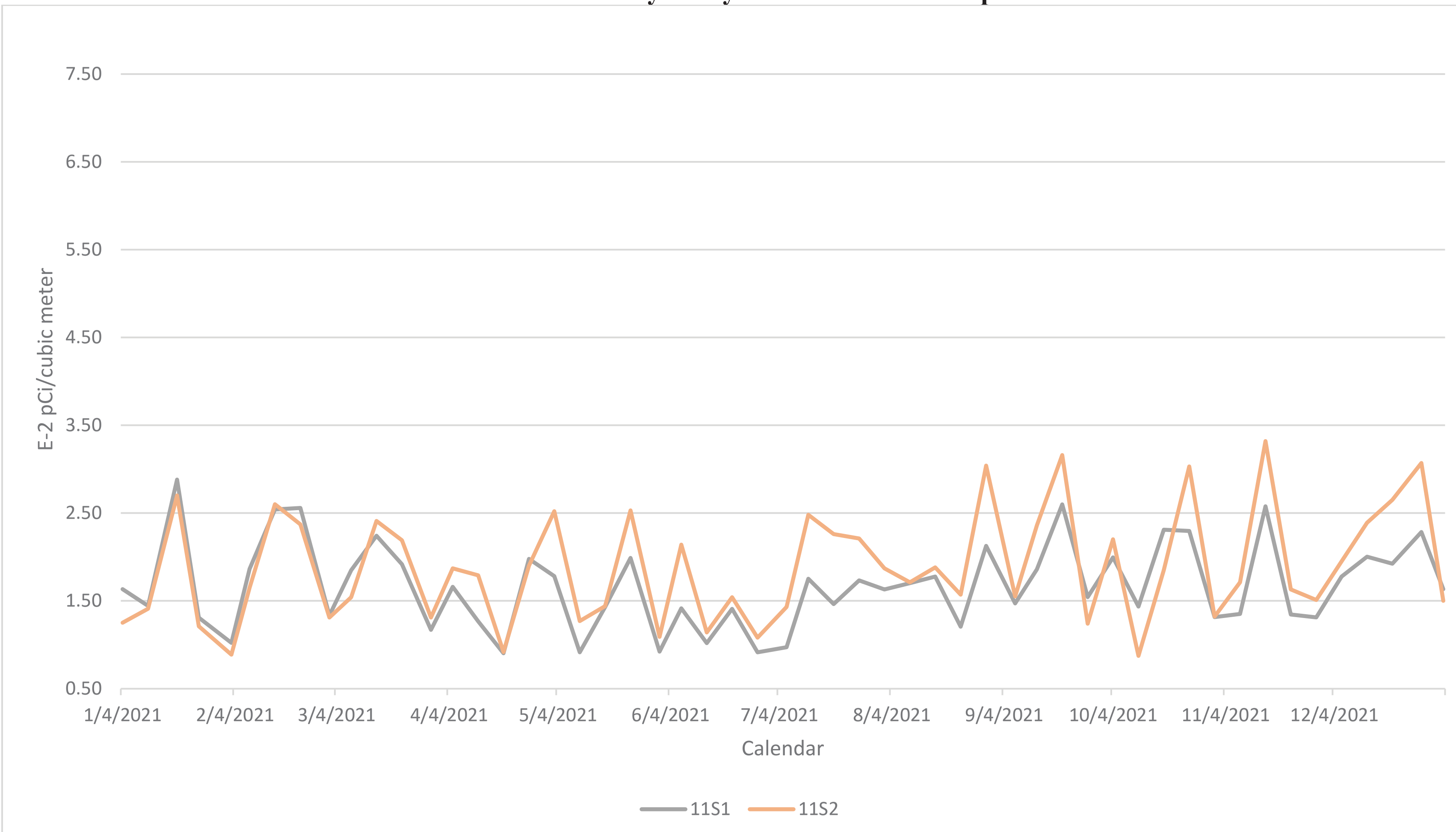


Figure A-8
2021 Weekly Gross Beta Concentrations in Air Particulate Samples from Co-Located Air samplers 11S1 and 11S2 analyzed by EIS and TBE as 10^{-2}pCi/m^3



APPENDIX B

Analysis Results for the REMP

Appendix B is a presentation of the analytical results for the Limerick Generating Station radiological environmental monitoring programs.

TABLE OF CONTENTS - ANALYTICAL RESULTS

Table B-1

Concentration of Gamma Emitters, Tritium, and Gross Beta in Surface and Drinking Water

(Results in units of pCi/L +/- 2σ)

Sample Code	Sample Date	Gamma Emitters	Tritium[2]	Gross Beta[3]
13B1				
Vincent Dam	2/3/2021	*		ND
	3/2/2021	*		ND
	3/30/2021	*	<124	ND
	4/26/2021	*		ND
	6/1/2021	*		ND
	6/28/2021	*	<118	ND
	8/2/2021	*		ND
	8/30/2021	*		ND
	9/27/2021	*	<118	ND
	11/1/2021	*		ND
	11/29/2021	*		ND
	1/3/2022	*	<115	ND
15F4				
AQUA Water	2/3/2021	*		1.94 +/- 0.77
	3/2/2021	*		3.07 +/- 0.91
	3/30/2021	*	<122	2.64 +/- 0.81
	4/26/2021	*		3.03 +/- 0.85
	6/1/2021	*		2.18 +/- 0.82
	6/28/2021	*	<117	3.37 +/- 0.92
	8/2/2021	*		4.38 +/- 0.93
	8/30/2021	*		4.38 +/- 0.89
	9/27/2021	*	<123	3.75 +/- 0.90
	11/1/2021	*		3.94 +/- 0.89
	11/29/2021	*		3.78 +/- 0.92
	1/3/2022	*	<131	2.50 +/- 0.83
15F7				
Phoenixville	2/3/2021	*		2.33 +/- 0.80
	3/2/2021	*		2.90 +/- 0.89
	3/30/2021	*	<121	2.27 +/- 0.78
	4/26/2021	*		2.76 +/- 0.82
	6/1/2021	*		2.32 +/- 0.83
	6/28/2021	*	<125	2.44 +/- 0.86
	8/2/2021	*		3.59 +/- 0.88
	8/30/2021	*		3.36 +/- 0.82
	9/27/2021	*	<118	3.15 +/- 0.85
	11/1/2021	*		3.89 +/- 0.89
	11/29/2021	*		2.94 +/- 0.87
	1/3/2022	*	<124	2.19 +/- 0.81
16C2				
PA American	2/3/2021	*		2.09 +/- 0.79
	3/2/2021	*		2.12 +/- 0.85
	3/30/2021	*	<128	2.23 +/- 0.79
	4/26/2021	*		3.05 +/- 0.84

Table B-1

Concentration of Gamma Emitters, Tritium, and Gross Beta in Surface and Drinking Water

(Results in units of pCi/L +/- 2σ)

Sample Code	Sample Date	Gamma Emitters	Tritium[2]	Gross Beta[3]
	6/1/2021	*		1.43 +/- 0.77
	6/28/2021	*	<117	2.74 +/- 0.89
	8/2/2021	*		3.87 +/- 0.91
	8/30/2021	*		4.29 +/- 0.89
	9/27/2021	*	<123	1.87 +/- 0.78
	11/1/2021	*		1.98 +/- 0.77
	11/29/2021	*		3.11 +/- 0.89
	1/3/2022	*	<126	2.02 +/- 0.81
24S1[1]				
LGS Intake	2/3/2021	*		ND
	3/2/2021	*		ND
	3/30/2021	*	<123	ND
	4/26/2021	*		ND
	6/1/2021	*		ND
	6/28/2021	*	<114	ND
	8/2/2021	*		ND
	8/30/2021	*		ND
	9/27/2021	*	<117	ND
	11/1/2021	*		ND
	11/29/2021	*		ND
	1/3/2022	*	<113	ND
28F3[1]				
Pottstown	2/3/2021	*		2.55 +/- 0.81
	3/2/2021	*		2.44 +/- 0.86
	3/30/2021	*	<125	2.55 +/- 0.80
	4/26/2021	*		2.88 +/- 0.84
	6/1/2021	*		2.74 +/- 0.85
	6/28/2021	*	<124	3.38 +/- 0.92
	8/2/2021	*		3.18 +/- 0.85
	8/30/2021	*		4.45 +/- 0.90
	9/27/2021	*	<123	3.29 +/- 0.87
	11/1/2021	*		3.12 +/- 0.84
	11/29/2021	*		3.03 +/- 0.87
	1/3/2022	*	<121	2.47 +/- 0.83

[1] Control Location
[2] Tritium result for the quarterly composite
[3] ND, No Data, analysis not required
* All Non-Natural Gamma Emitters <MDA

Table B-2

Concentration of Gamma Emitters in the Flesh of Edible Fish

(Results in units of pCi/kg (wet) +/- 2σ)

Sample Code	Sample Date	Sample Type	Gamma Emitters
16C5			
SE Sector	5/14/2021	Bottom Feeder Fish	*
	5/14/2021	Predator Fish	*
	11/4/2021	Bottom Feeder Fish	*
	11/4/2021	Predator Fish	*
29C1[1]			
WNW Sector	5/11/2021	Bottom Feeder Fish	*
	5/11/2021	Predator Fish	*
	11/5/2021	Bottom Feeder Fish	*
	11/5/2021	Predator Fish	*

[1] Control Location
* All Non-Natural Gamma Emitters <MDA

Table B-3

Concentration of Gamma Emitters in Sediment

(Results in units of pCi/kg (wet) +/- 2σ)

Sample Code	Sample Date	Gamma Emitters
16B2 SSE Sector	6/11/2021	*
16C4 SSE Sector	6/11/2021	*
33A2[1] NNW Sector	6/11/2021	*

[1] Control Location
* All Non-Natural Gamma Emitters <MDA

Table B-4
Concentration of Iodine-131 in Filtered Air
(Results in units of 10^{-3} pCi/m^3 +/- 2σ)

Start Coll date	End Coll date	6C1	10S3	11S1	14S1	15D1	22G1[1]	13S4
12/28/2020	1/4/2021	*	*	*	*	*	*	*
1/4/2021	1/11/2021	*	*	*	*	*	*	*
1/11/2021	1/19/2021	*	*	*	*	*	*	*
1/19/2021	1/25/2021	*	*	*	*	*	*	*
1/25/2021	2/3/2021	*	*	*	*	*	*	*
2/3/2021	2/8/2021	*	*	*	*	*	*	*
2/8/2021	2/15/2021	*	*	*	*	*	*	*
2/15/2021	2/22/2021	*	*	*	*	*	*	*
2/22/2021	3/2/2021	*	*	*	*	*	*	*
3/2/2021	3/8/2021	*	*	*	*	*	*	*
3/8/2021	3/15/2021	*	*	*	*	*	*	*
3/15/2021	3/22/2021	*	*	*	*	*	*	*
3/22/2021	3/30/2021	*	*	*	*	*	*	*
3/30/2021	4/5/2021	*	*	*	*	*	*	*
4/5/2021	4/12/2021	*	*	*	*	*	*	*
4/12/2021	4/19/2021	*	*	*	*	*	*	*
4/19/2021	4/26/2021	*	*	*	*	*	*	*
4/26/2021	5/3/2021	*	*	*	*	*	*	*
5/3/2021	5/10/2021	*	*	*	*	*	*	*
5/10/2021	5/17/2021	*	*	*	*	*	*	*
5/17/2021	5/24/2021	*	*	*	*	*	*	*
5/24/2021	6/1/2021	*	*	*	*	*	*	[2]
6/1/2021	6/7/2021	*	*	*	*	*	*	*
6/7/2021	6/14/2021	*	*	*	*	*	*	*
6/14/2021	6/21/2021	*	*	*	*	*	*	*
6/21/2021	6/28/2021	*	*	*	*	*	*	*
6/28/2021	7/6/2021	*	*	*	*	*	*	*

Start Coll date	End Coll date	6C1	10S3	11S1	14S1	15D1	22G1[1]	13S4
7/6/2021	7/12/2021	*	*	*	*	*	*	*
7/12/2021	7/19/2021	*	*	*	*	*	*	*
7/19/2021	7/26/2021	*	*	*	*	*	*	*
7/26/2021	8/2/2021	*	*	*	*	*	*	*
8/2/2021	8/9/2021	*	*	*	*	*	*	*
8/9/2021	8/16/2021	*	*	*	*	*	*	*
8/16/2021	8/23/2021	*	*	*	*	*	*	*
8/23/2021	8/30/2021	*	*	*	*	*	*	*
8/30/2021	9/7/2021	*	*	*	*	*	*	*
9/7/2021	9/13/2021	*	*	*	*	*	*	*
9/13/2021	9/20/2021	*	*	*	*	*	*	*
9/20/2021	9/27/2021	*	*	*	*	*	*	*
9/27/2021	10/4/2021	*	*	*	*	*	*	*
10/4/2021	10/11/2021	*	*	*	*	*	*	*
10/11/2021	10/18/2021	*	*	*	*	*	*	*
10/18/2021	10/25/2021	*	*	*	*	*	*	*
10/25/2021	11/1/2021	*	*	*	*	*	*	*
11/1/2021	11/8/2021	*	*	*	*	*	*	*
11/8/2021	11/15/2021	*	*	*	*	*	*	*
11/15/2021	11/22/2021	*	*	*	*	*	*	*
11/22/2021	11/29/2021	*	*	*	*	*	*	*
11/29/2021	12/6/2021	*	*	*	*	*	*	*
12/6/2021	12/13/2021	*	*	*	*	*	*	*
12/13/2021	12/20/2021	*	*	*	*	*	*	*
12/20/2021	12/28/2021	*	*	*	*	*	*	*
12/28/2021	1/3/2022	*	*	*	*	*	*	*

[1] Control Location
[2] Lost Sample- power failure
* <MDA (I-131)

Table B-5
Concentration of Beta Emitters in Air Particulates
(Results in units of 10^{-2} pCi/m^3 +/- 2σ)

Start Date	End Date	6C1	10S3	11S1	14S1	15D1	22G1[1]	13S4
12/28/2020	1/4/2021	1.87 ± 0.20	1.99 ± 0.21	1.63 ± 0.20	1.64 ± 0.20	1.94 ± 0.21	1.60 ± 0.19	1.86 ± 0.20
1/4/2021	1/11/2021	1.53 ± 0.21	1.91 ± 0.21	1.44 ± 0.19	1.56 ± 0.19	1.54 ± 0.19	1.57 ± 0.19	1.42 ± 0.19
1/11/2021	1/19/2021	3.85 ± 0.25	3.89 ± 0.25	2.88 ± 0.22	3.47 ± 0.24	3.68 ± 0.24	3.12 ± 0.22	3.40 ± 0.24
1/19/2021	1/25/2021	1.58 ± 0.22	1.72 ± 0.22	1.31 ± 0.20	1.43 ± 0.21	1.43 ± 0.21	1.23 ± 0.20	1.25 ± 0.20
1/25/2021	2/3/2021	1.16 ± 0.15	1.14 ± 0.15	1.02 ± 0.15	1.06 ± 0.14	1.31 ± 0.15	1.02 ± 0.14	1.04 ± 0.14
2/3/2021	2/8/2021	2.03 ± 0.27	2.31 ± 0.27	1.86 ± 0.25	2.02 ± 0.26	2.34 ± 0.27	2.15 ± 0.27	1.99 ± 0.26
2/8/2021	2/15/2021	3.00 ± 0.24	3.01 ± 0.24	2.54 ± 0.22	2.89 ± 0.23	3.26 ± 0.24	2.68 ± 0.23	2.77 ± 0.23
2/15/2021	2/22/2021	3.00 ± 0.25	3.35 ± 0.25	2.56 ± 0.23	2.60 ± 0.23	3.22 ± 0.25	2.72 ± 0.23	2.64 ± 0.23
2/22/2021	3/2/2021	1.88 ± 0.19	1.99 ± 0.19	1.33 ± 0.17	1.46 ± 0.17	2.00 ± 0.19	1.59 ± 0.17	1.56 ± 0.18
3/2/2021	3/8/2021	2.41 ± 0.25	2.68 ± 0.25	1.85 ± 0.22	2.14 ± 0.23	2.63 ± 0.24	2.08 ± 0.22	2.06 ± 0.22
3/8/2021	3/15/2021	3.21 ± 0.24	3.02 ± 0.24	2.24 ± 0.21	3.04 ± 0.24	2.91 ± 0.23	2.56 ± 0.22	2.51 ± 0.22
3/15/2021	3/22/2021	2.44 ± 0.22	2.53 ± 0.22	1.92 ± 0.20	2.01 ± 0.21	2.43 ± 0.22	2.01 ± 0.21	1.89 ± 0.21
3/22/2021	3/30/2021	1.38 ± 0.18	1.77 ± 0.18	1.17 ± 0.16	1.35 ± 0.16	1.62 ± 0.17	1.40 ± 0.18	1.48 ± 0.17
3/30/2021	4/5/2021	2.30 ± 0.26	2.79 ± 0.26	1.66 ± 0.22	1.92 ± 0.23	2.23 ± 0.24	1.88 ± 0.23	2.18 ± 0.24
4/5/2021	4/12/2021	1.50 ± 0.19	1.59 ± 0.19	1.27 ± 0.18	1.50 ± 0.19	1.59 ± 0.19	1.88 ± 0.20	1.68 ± 0.19
4/12/2021	4/19/2021	1.43 ± 0.19	1.39 ± 0.19	0.90 ± 0.17	1.14 ± 0.18	1.21 ± 0.18	1.37 ± 0.19	1.37 ± 0.19
4/19/2021	4/26/2021	2.47 ± 0.22	2.65 ± 0.22	1.98 ± 0.20	2.17 ± 0.21	2.78 ± 0.23	2.59 ± 0.22	2.74 ± 0.23
4/26/2021	5/3/2021	2.69 ± 0.22	2.48 ± 0.22	1.78 ± 0.20	2.16 ± 0.21	2.77 ± 0.23	2.59 ± 0.22	2.70 ± 0.23
5/3/2021	5/10/2021	1.05 ± 0.18	1.21 ± 0.18	0.91 ± 0.17	1.03 ± 0.17	1.16 ± 0.18	1.15 ± 0.18	1.32 ± 0.18
5/10/2021	5/17/2021	1.99 ± 0.20	1.99 ± 0.20	1.43 ± 0.18	1.63 ± 0.19	1.93 ± 0.20	1.83 ± 0.20	1.96 ± 0.20
5/17/2021	5/24/2021	2.97 ± 0.24	2.80 ± 0.24	1.99 ± 0.21	2.22 ± 0.22	2.69 ± 0.24	2.58 ± 0.24	2.80 ± 0.24
5/24/2021	6/1/2021	1.34 ± 0.17	1.40 ± 0.17	0.92 ± 0.15	1.14 ± 0.16	1.37 ± 0.16	1.35 ± 0.16	[2]

Table B-5

Concentration of Beta Emitters in Air Particulates
(Results in units of 10^{-2} pCi/m^3 +/- 2σ)

Start Date	Stop Date	6C1	10S3	11S1	14S1	15D1	22G1[1]	13S4
6/1/2021	6/7/2021	2.51 ± 0.25	2.29 ±	0.21	1.94 ± 0.23	2.35 ± 0.25	2.33 ± 0.24	2.32 ± 0.25
6/7/2021	6/14/2021	1.50 ± 0.18	1.50 ± 0.18	1.02 ± 0.16	1.04 ± 0.17	1.52 ± 0.18	1.44 ± 0.19	1.46 ± 0.18
6/14/2021	6/21/2021	2.39 ± 0.22	2.27 ± 0.22	1.41 ± 0.19	1.69 ± 0.20	2.35 ± 0.22	2.21 ± 0.21	2.03 ± 0.21
6/21/2021	6/28/2021	1.43 ± 0.18	1.35 ± 0.18	0.91 ± 0.16	1.31 ± 0.18	1.40 ± 0.18	1.27 ± 0.18	1.36 ± 0.18
7/6/2021	7/12/2021	2.38 ± 0.24	2.22 ± 0.24	1.75 ± 0.22	2.28 ± 0.24	2.45 ± 0.25	2.26 ± 0.23	2.31 ± 0.24
7/12/2021	7/19/2021	2.30 ± 0.22	2.24 ± 0.22	1.46 ± 0.19	1.96 ± 0.21	2.28 ± 0.22	2.24 ± 0.22	2.08 ± 0.21
7/19/2021	7/26/2021	2.29 ± 0.22	2.28 ± 0.22	1.73 ± 0.20	2.16 ± 0.21	2.49 ± 0.22	1.92 ± 0.20	2.58 ± 0.23
7/26/2021	8/2/2021	2.71 ± 0.23	2.56 ± 0.23	1.63 ± 0.20	2.31 ± 0.22	2.43 ± 0.23	2.19 ± 0.22	2.58 ± 0.23
8/2/2021	8/9/2021	2.66 ± 0.22	2.52 ± 0.22	1.70 ± 0.19	2.19 ± 0.21	2.81 ± 0.23	2.28 ± 0.22	2.68 ± 0.23
8/9/2021	8/16/2021	2.54 ± 0.21	2.36 ± 0.21	1.78 ± 0.20	2.18 ± 0.21	2.65 ± 0.23	2.03 ± 0.20	2.49 ± 0.23
8/16/2021	8/23/2021	1.91 ± 0.20	1.66 ± 0.20	1.21 ± 0.18	1.52 ± 0.19	2.00 ± 0.21	1.66 ± 0.21	1.63 ± 0.20
8/23/2021	8/30/2021	3.32 ± 0.25	3.25 ± 0.25	2.13 ± 0.21	2.93 ± 0.24	3.30 ± 0.25	3.32 ± 0.25	3.25 ± 0.25
8/30/2021	9/7/2021	2.41 ± 0.20	2.26 ± 0.20	1.47 ± 0.17	1.71 ± 0.18	2.16 ± 0.20	2.26 ± 0.20	2.32 ± 0.20
9/7/2021	9/13/2021	3.00 ± 0.27	3.15 ± 0.27	1.86 ± 0.24	2.70 ± 0.25	3.07 ± 0.27	3.42 ± 0.28	2.86 ± 0.26
9/13/2021	9/20/2021	3.68 ± 0.26	3.85 ± 0.26	2.60 ± 0.22	3.26 ± 0.24	3.83 ± 0.26	3.59 ± 0.26	3.78 ± 0.26
9/20/2021	9/27/2021	1.99 ± 0.20	1.97 ± 0.20	1.54 ± 0.18	1.85 ± 0.20	2.19 ± 0.21	1.95 ± 0.20	1.97 ± 0.20
9/27/2021	10/4/2021	2.61 ± 0.24	2.88 ± 0.24	1.99 ± 0.21	2.49 ± 0.23	2.74 ± 0.23	3.12 ± 0.24	2.55 ± 0.23
10/4/2021	10/11/2021	1.85 ± 0.20	1.73 ± 0.20	1.43 ± 0.19	1.61 ± 0.20	1.81 ± 0.20	1.70 ± 0.20	1.75 ± 0.20
10/11/2021	10/18/2021	2.56 ± 0.22	2.48 ± 0.22	2.31 ± 0.21	2.32 ± 0.21	2.80 ± 0.23	2.74 ± 0.23	2.67 ± 0.23
10/18/2021	10/25/2021	2.94 ± 0.24	2.76 ± 0.24	2.30 ± 0.22	2.66 ± 0.23	3.31 ± 0.25	3.14 ± 0.25	2.97 ± 0.24
10/25/2021	11/1/2021	1.73 ± 0.20	1.59 ± 0.20	1.31 ± 0.19	1.29 ± 0.19	1.70 ± 0.20	1.74 ± 0.21	1.70 ± 0.20

11/1/2021	11/8/2021	1.73 ± 0.20	1.93 ± 0.20	1.35 ± 0.18	1.60 ± 0.19	2.02 ± 0.20	1.63 ± 0.19	1.83 ± 0.20
11/8/2021	11/15/2021	3.53 ± 0.25	3.23 ± 0.25	2.58 ± 0.23	2.96 ± 0.24	3.20 ± 0.25	2.83 ± 0.23	3.36 ± 0.25
11/15/2021	11/22/2021	1.87 ± 0.21	1.84 ± 0.21	1.34 ± 0.19	1.68 ± 0.20	1.79 ± 0.21	1.84 ± 0.21	1.81 ± 0.21
11/22/2021	11/29/2021	1.91 ± 0.20	1.82 ± 0.20	1.31 ± 0.18	1.67 ± 0.20	2.05 ± 0.21	1.85 ± 0.21	1.87 ± 0.20
11/29/2021	12/6/2021	2.18 ± 0.21	2.12 ± 0.21	1.78 ± 0.20	2.13 ± 0.21	2.31 ± 0.22	2.08 ± 0.21	2.67 ± 0.24
12/6/2021	12/13/2021	2.99 ± 0.23	2.51 ± 0.23	2.00 ± 0.21	2.29 ± 0.22	2.82 ± 0.23	2.47 ± 0.22	3.04 ± 0.24
12/13/2021	12/20/2021	2.90 ± 0.23	2.71 ± 0.23	1.92 ± 0.20	2.20 ± 0.21	2.63 ± 0.22	2.32 ± 0.22	3.00 ± 0.24
12/20/2021	12/28/2021	3.60 ± 0.23	3.18 ± 0.23	2.28 ± 0.20	2.85 ± 0.22	3.25 ± 0.23	3.25 ± 0.22	3.87 ± 0.25
12/28/2021	1/3/2022	2.33 ± 0.22	2.03 ± 0.22	1.63 ± 0.21	1.73 ± 0.21	1.92 ± 0.22	1.94 ± 0.22	2.49 ± 0.24

[1] Control Location
[2] Lost Sample- power failure

Table B-6

Concentration of Gamma Emitters in Air Particulates

(Results in units of 10^{-3} pCi/m^3 +/- 2σ)

Start Date	Stop Date	6C1	10S3	11S1	14S1	15D1	22G1[1]	13S4
12/28/2020	3/30/2021	*	*	*	*	*	*	*
3/30/2021	6/28/2021	*	*	*	*	*	*	*
6/28/2021	9/27/2021	*	*	*	*	*	*	*
9/27/2021	1/3/2022	*	*	*	*	*	*	*

[1] Control Location
* All Non-Natural Gamma Emitters <MDA

Table B-7

Concentration of Gamma Emitters in Vegetation Samples

(Results in units of pCi/kg (wet) +/- 2σ)

Sample Code	Sample Date	Sample Type	Gamma Emitters
11S3			
LGS	6/15/2021	Chard	*
Information Ctr	6/15/2021	Kale	*
	6/15/2021	Cabbage	*
	7/13/2021	Chard	*
	7/13/2021	Cabbage	*
	7/13/2021	Kale	*
	8/17/2021	Chard	*
	8/17/2021	Kale	*
	8/17/2021	Cantaloupe Leaves	*
	9/20/2021	Broccoli	*
	9/20/2021	Cabbage	*
	9/20/2021	Chard	*
13S3			
LGS	6/15/2021	Chard	*
500 KV Yard	6/15/2021	Kale	*
	6/15/2021	Broccoli	*
	7/13/2021	Chard	*
	7/13/2021	Kale	*
	7/13/2021	Cabbage	*
	8/17/2021	Chard	*
	8/17/2021	Zucchini Leaves	*
	8/17/2021	Squash Leaves	*
	9/20/2021	Chard	*
	9/20/2021	Zucchini Leaves	*
	9/20/2021	Cucumbers	*
31G1[1]			
Jollyview Farm	6/15/2021	Broccoli	*
	6/15/2021	Cabbage	*
	6/15/2021	Cauliflower	*
	7/13/2021	Broccoli	*
	7/13/2021	Cabbage	*
	7/13/2021	Cauliflower	*
	8/17/2021	Kale	*
	8/17/2021	Eggplant Leaves	*
	8/17/2021	Radish Leaves	*
	9/20/2021	NA	[2]
	9/20/2021	NA	[2]
	9/20/2021	NA	[2]

[1] Control Location
[2] NCR, Lost Sample, Insufficient vegetation available to sample,
* All Non-Natural Gamma Emitters <MDA

Table B-8
Concentration of Gamma Emitters (including I-131) in Milk
(Results in units of pCi/Liter +/- 2σ

Sample Code	Sample Date	Gamma Emitters
18E1		
Miller Farm	1/12/2021	*
	2/9/2021	*
	3/9/2021	*
	4/6/2021	*
	4/19/2021	*
	5/4/2021	*
	5/18/2021	*
	6/1/2021	*
	6/15/2021	*
	6/29/2021	*
	7/13/2021	*
	7/27/2021	*
	8/10/2021	*
	8/24/2021	*
	9/7/2021	*
	9/20/2021	*
	10/5/2021	*
	10/19/2021	*
	11/1/2021	*
	11/15/2021	*
	11/29/2021	*
	12/20/2021	*
19B1		
Kolb Farm	1/12/2021	*
	2/9/2021	*
	3/9/2021	*
	4/6/2021	*
	4/19/2021	*
	5/4/2021	*
	5/18/2021	*
	6/1/2021	*
	6/15/2021	*
	6/29/2021	*
	7/13/2021	*
	7/27/2021	*
	8/10/2021	*
	8/24/2021	*
	9/7/2021	*
	9/20/2021	*
	10/5/2021	*
	10/19/2021	*
	11/1/2021	*
	11/15/2021	*
	11/29/2021	*
	12/20/2021	*

Table B-8
Concentration of Gamma Emitters (including I-131) in Milk
(Results in units of pCi/Liter +/- 2σ

Sample Code	Sample Date	Gamma Emitters
23F1[1]		
Guest Farm	1/12/2021	*
	2/9/2021	*
	3/9/2021	*
	4/6/2021	*
	4/19/2021	*
	5/4/2021	*
	5/18/2021	*
	6/1/2021	*
	6/15/2021	*
	6/29/2021	*
	7/13/2021	*
	7/27/2021	*
	8/10/2021	*
	8/24/2021	*
	9/7/2021	*
	9/20/2021	*
	10/5/2021	*
	10/19/2021	*
	11/1/2021	*
	11/15/2021	*
	11/29/2021	*
	12/20/2021	*
25C1		
Kulp Farm	1/12/2021	*
	2/9/2021	*
	3/9/2021	*
	4/6/2021	*
	4/19/2021	*
	5/4/2021	*
	5/18/2021	*
	6/1/2021	*
	6/15/2021	*
	6/29/2021	*
	7/13/2021	*
	7/27/2021	*
	8/10/2021	*
	8/24/2021	*
	9/7/2021	*
	9/20/2021	*
	10/5/2021	*
	10/19/2021	*
	11/1/2021	*
	11/15/2021	*
	11/29/2021	*
	12/20/2021	*

[1] Control Location
* All Non-Natural Gamma Emitters <MDA

Table B-9

Typical MDA Ranges for Gamma Spectrometry

Selected Nuclides	Air Particulates (10^{-3} pCi/m^3)	Surface Water, Drinking Water (pCi/L)	Fish (pCi/kg) Wet	Ground water (pCi/L)	Milk (pCi/L)	Oysters (pCi/kg)	Shoreline Sediment (pCi/kg)Dry	Soil (pCi/kg) Dry	Vegetation (pCi/kg) Wet
K-40	5.65 - 24.6	16 - 182	2,747 - 4,505	21.5 -66.4	1,286 - 1,529	1,269 - 2,069	781 - 13,761	789 - 10,713	671 - 11,829
Mn-54	0.32 - 1.16	2.7 - 5.6	9.8 - 19.6	2.86 - 5.14	3.6 - 6.6	10.8 - 16.4	41.4 - 67.1	37.4 - 91.9	10.3 - 53.0
Fe-59	1.01 - 8.52	5.6 - 13.2	31.6 - 93.2	6.04 - 11.7	9.2 - 15.9	29.3 - 56.7	142 - 251	96.4 – 389	22.0 - 151
Co-58	0.38 - 2.07	2.7 - 5.6	10.9 - 28.3	2.86 - 5.27	3.7 - 6.3	10.5 - 19.3	53.7 - 82.9	44.6 – 133	10.9 - 59.8
Co-60	0.28 - 1.09	2.8 - 5.5	10.9 - 24.3	3.01 - 5.38	4.1 - 7.2	11.7 - 17.0	38.6 - 57.9	32.8 - 85.8	12.9 - 55.0
Zn-65	0.81 - 3.10	5.5 - 11.4	23.3 - 57.2	6.41 - 14.4	9.4 - 16.1	22.0 - 43.3	112 - 198	96.4 – 275	24.7 - 116
Ag-110m	0.33 – 1.06	2.42 - 4.96	8.2 – 18.1	2.79 - 5.06	3.26- 5.64	8.7 - 16.0	36.6 - 175	40.7 – 99.4	10.1 - 61.4
Zr-95	0.72 - 3.88	4.7 - 10.2	20.0 - 47.1	5.62 - 8.75	5.8 - 11.5	19.0 - 34.0	93.5 - 151	84.6 – 261	19.3 - 116
Nb-95	0.56 - 4.91	2.9 - 6.0	13.7 - 42.7	3.3 - 5.88	3.9 - 6.5	13.9 - 24.3	82.1 - 157	61.5 – 227	10.9 - 90.5
Ru-106	3.00 - 12.1	23.8 - 48.1	77.1 - 197	25.6 - 45.3	29.3 - 51.8	88.0 - 141	327.0 – 570	314.0 – 840	92.9 - 541
I-131[1]	2.73 - 914	0.52 - 11.7	21.4 - 2,340	4.87 - 9.04	0.5 - 7.03	22.4 - 107	470 - 2,040	139 - 8,060	13.4 - 854
Cs-134	0.47 - 0.88	3.2 - 5.7	7.8 - 16.0	2.92 - 5.48	4.09 - 4.82	9.7 - 16.5	43.3 - 82.4	33.4 - 109	11.1 - 58.1
Cs-137	0.46 - 0.88	3.7 - 5.9	3.8 - 17.5	2.97 - 5.43	4.08 - 5.29	10.0 - 16.7	38.4 - 65.4	39.1 - 135	11.1 - 62.3
La-140	2.01 – 116	5.05 - 11.5	15.9 - 444	4.87 - 10.3	4.89 - 6.28	24.1 - 80.4	368 - 773	136 - 1,820	9.1 - 388
Ba-140	2.01 - 116	5.05 - 11.5	15.9 - 444	5.86 - 26.0	4.89 - 6.28	24.1 - 80.4	368 – 773	136 - 1,820	9.1 - 388
Ce-144	1.12 - 3.27	16.8 - 36.7	38.1 - 70.9	17.8 - 32.0	20.5 - 31.0	42.6 - 72.6	208 - 279	191 - 414	46.6 - 289
Cr-51	4.90 - 45.0	23.2 - 50.6	93.0 - 395	26.7 - 42.1	30.4 - 46.8	97.0 - 199	711 - 1,110	489 - 1,810	93.9 - 850
Na-22	0.34 - 1.33	2.7 - 6.0	12.1 - 28.0	2.78 - 5.94	4.9 - 8.5	13.4 - 19.5	46.4 - 77.4	36.4 - 92.4	8.9 - 54.1

[1] This MDA range for I-131 on a charcoal cartridge is typically 5.22×10^{-3} to 1.37×10^{-2} pCi/m^3

Table B-10

Typical LLDs for Gamma Spectrometry

Selected Nuclides	Air Particulates 10-3 pCi/m3	Surface Water, Drinking Water pCi/L	Fish pCi/kg (wet)	Ground water pCi/L	Oysters pCi/kg (wet)	Milk pCi/L	Soil pCi/kg (dry)	Vegetation pCi/kg (wet)
Na-22	5	5.3	12	5.3	12	9.1	78	27
Cr-51	74	37	76	37	76	62	452	174
Mn-54	4.6	4.7	13	4.7	13	7.4	63	19
Co-58	6.7	4.3	12	4.3	12	8.2	78	23
Fe-59	20	11	27	11	27	18	123	57
Co-60	3.5	4.8	12	4.8	12	7.5	59	24
Zn-65	8.9	11	27	11	27	17	162	55
Nb-95	9.8	4.5	13	4.5	13	9.5	73	25
Zr-95	11	7.9	18	7.9	18	14	117	34
Ru-106	43	38	111	38	111	62	624	174
Ag-110m	4.2	4.3	11	4.3	11	6	65	20
Te-129m	101	56	118	56	118	90	833	263
I-131*	90	0.8	11	6.4	11	0.8	58	42
Cs-134	4.7	4.7	11	4.7	11	6.7	66	18
Cs-137	4.2	5.1	11	5.1	11	6.9	78	21
Ba-140	47	23	39	23	39	46	103	111
La-140	47	9.2	15	9.2	15	13	103	30
Ce-144	15	23	45	23	45	37	288	70

* The LLD for I-131 measured on a Charcoal cartridge is 3.7 $x10^{-2}$ pCi/m^3

Table B-11

Direct Radiation

(Results in Units of mR/91 days ± 2σ)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Normalized Annual Dose, MA (mrem/yr)	BA	BA + MDDA	Annual Facility Dose, FA (mrem)	Annual Facility Dose, FA >10 mrem
10E1	16.4	21.0	18.8	20.0	76.2	71.0	82.7	ND	No
10F3	15.1	20.7	19.3	21.6	76.7	69.7	81.4	ND	No
10S3	16.6	20.5	18.8	21.1	77.0	70.9	82.6	ND	No
11S1	19.4	22.9	21.4	14.1	77.8	83.1	94.8	ND	No
13C1[1]	12.4	14.7	14.0	11.5	52.5	49.8	61.5	ND	No
13E1	17.8	20.2	20.1	14.5	72.5	70.1	81.8	ND	No
13S2	23.2	27.5	25.2	14.5	90.4	112.1	123.8	ND	No
14S1	15.4	18.5	17.0	15.4	66.3	63.2	74.9	ND	No
15D1[1]	16.1	19.7	18.8	22.0	76.6	72.5	84.2	ND	No
16F1[1]	16.1	20.5	18.3	20.6	75.4	73.4	85.1	ND	No
17B1	15.4	19.0	17.6	12.4	64.5	66.8	78.5	ND	No
18S2	17.9	21.7	20.6	18.0	78.2	78.4	90.1	ND	No
19D1	16.2	19.7	16.8	19.1	71.8	66.3	78.0	ND	No
20D1[1]	15.6	18.2	17.3	16.9	68.0	63.0	74.7	ND	No

Table B-11

Direct Radiation

(Results in Units of mR/91 days ± 2σ)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Normalized Annual Dose, MA (mrem/yr)	BA	BA + MDDA	Annual Facility Dose, FA (mrem)	Annual Facility Dose, FA >10 mrem
20F1	16.4	19.9	17.9	20.8	75.1	67.5	79.2	ND	No
21S2	15.2	17.9	17.1	16.0	66.2	64.1	75.8	ND	No
23S2	15.4	19.2	17.5	15.8	67.9	63.9	75.6	ND	No
24D1	14.7	18.0	15.0	18.5	66.3	59.7	71.4	ND	No
25D1	14.4	16.2	15.1	14.2	59.9	56.5	68.2	ND	No
25S2	14.9	18.4	15.6	11.8	60.7	58.1	69.8	ND	No
26S3	15.6	18.0	16.1	14.6	64.3	60.4	72.1	ND	No
28D2	16.8	18.4	16.5	18.4	70.0	63.5	75.2	ND	No
29E1	16.4	19.5	17.0	14.6	67.5	62.3	74.0	ND	No
29S1	16.4	18.4	16.6	14.3	65.7	61.4	73.1	ND	No
2E1	17.9	20.9	17.9	20.7	77.4	71.9	83.6	ND	No
31D1[1]	18.8	23.5	21.1	18.3	81.6	83.0	94.7	ND	No
31D2	18.3	21.5	18.4	19.9	78.1	71.2	82.9	ND	No
31S1	17.6	21.5	19.6	16.1	74.8	71.6	83.3	ND	No
34E1	16.8	18.5	17.8	21.2	74.3	67.0	78.7	ND	No

Table B-11

Direct Radiation

(Results in Units of mR/91 days ± 2σ)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Normalized Annual Dose, MA (mrem/yr)	BA	BA + MDDA	Annual Facility Dose, FA (mrem)	Annual Facility Dose, FA >10 mrem
34S2	18.1	19.7	17.5	11.5	66.7	71.6	83.3	ND	No
36D1	13.4	15.8	16.0	14.9	60.0	62.1	73.8	ND	No
36S2	18.8	22.2	19.4	18.0	78.4	73.4	85.1	ND	No
3S1	16.6	20.9	18.8	14.2	70.4	70.1	81.8	ND	No
4E1	12.9	14.5	14.3	15.3	57.0	51.4	63.1	ND	No
5H1[1]	19.6	24.7	22.2	22.0	88.6	86.3	98.0	ND	No
5S1	19.3	22.7	21.1	21.1	84.2	80.0	91.7	ND	No
6C1[1]	17.8	18.9	19.6	14.5	70.7	69.5	81.2	ND	No
7E1	17.4	20.7	20.8	17.4	76.3	74.6	86.3	ND	No
7S1	17.1	20.4	19.1	17.0	73.6	73.1	84.8	ND	No
9C1[1]	17.4	20.0	18.3	19.9	75.6	68.1	79.8	ND	No

1 Control & Special Interest Locations

APPENDIX C

Quality Assurance Program

Appendix C is a summary of Exelon Industrial Services (EIS) laboratory's quality assurance program. It consists of Table C-1 which is a compilation of the results of the EIS laboratory's participation in an interlaboratory comparison program with Environmental Resource Associates (ERA) located in Arvada, Colorado and Eckert and Ziegler Analytics, Inc. (EZA) located in Atlanta, Georgia. It also includes Table C-2, which is a compilation of the results of the Exelon Industrial Services (EIS) Laboratory's participation in a split sample program with Teledyne Brown Engineering located in Knoxville, Tennessee and Table C-3, which is a list of the Site Specific LLDs required by the ODCM.

The EIS laboratory's results contained in Table C-1, intercomparison results, are in full agreement when they were evaluated using the NRC Resolution Test Criteria [1] except as noted in the Pass/Fail column and described below. The EIS Laboratory's results are provided with their analytical uncertainties of 2 sigma. When evaluating with the NRC Resolution Test a one sigma uncertainty is used to determine Pass or Fail and noted accordingly. There were no failures of crosscheck studies in 2021. All results reported passed their respective vendor acceptance ranges and NRC Resolution Test Criteria [1]

The vendor laboratories used by EIS for subcontracting and interlaboratory comparison samples, GEL Laboratories and Teledyne Brown Engineering, also participate in the ERA and EZA interlaboratory comparison program. A presentation of their full data report is provided in their Annual Environmental Quality Assurance Program Reports, (Ref 14,15). In summary Gel and TBE reported results met vendor and laboratory acceptance ranges with the following exceptions discussed here:

1. TBE results for Gross Beta in Drinking water submitted in October 2021 failed the upper acceptance limit specified by the vendor. The laboratory investigated and the study results were within the acceptable range specified in TBE's QA plan, 70-130% of True Value. A repeat study was analyzed in December 2021 and also failed the vendor's upper acceptance limit. In both cases TBE's published QA requirements of acceptable range being 70-130% of True value were met. The lab's performance is within the acceptable range specified in their QA plan. This same range is considered acceptable by Exelon Nuclear Quality Assurance Requirements as well. TBE states in their investigation that there was no impact to sample data and no further action is warranted.

2. GEL results for MRAD-34, Fe-55 in water did not meet vendor acceptance criteria. The laboratory review of this analysis revealed loose fittings and

cracked tubing in the transfer rig. Upon replacement of worn parts, the laboratory successfully completed Study RAD-126.

3. GEL results for RAD-126 Sr-90 failed vendor acceptance criteria, exceeding the maximum range by 0.1pCi/L. The laboratory review did not reveal any gross errors or possible contributors to the high bias. The reported value is 115% of the reference value which is within the laboratory's standard acceptance criteria of +/- 25% for Laboratory Control Samples.

The Inter and Intra laboratory results contained in Table C-2 are intercomparison results for routine samples analyzed for replicate and split analyses and evaluated for beta and non-natural gamma emitters. The EIS laboratory's results are provided with their analytical uncertainties of 2 sigma. When evaluating with the NRC Resolution Test a one sigma uncertainty is used to determine Pass or Fail and noted accordingly. In the event there are no non-natural isotopes detected, the samples are reported <MDA and designated as Pass.

All the results contained in Table C-2 agree with their respective EIS laboratory original, replicate and/or Teledyne Brown Engineering's split laboratory samples.

The original analysis of soil collected on March 15, 2021, at SFS5 indicated low level, Non Plant related Cs-137 just above the analyses Minimum Detectable Activity. The replicate and split samples did not indicate Cs-137 above the Minimum Detectable Activity, MDA, of the analysis. In this case the original, replicate and split results pass the NRC Resolution Test Criteria[1], as specified in the rule. When compared to the MDA of the replicate and split analysis, the positive result is less than five times the MDA value. The low-level Cs-137 observed in these soil analyses is consistent with weapons related fallout previously identified in the environs around Limerick Nuclear Power Plant.

All air particulate samples contain Beta emitters and are reported with a 2sigma uncertainty. The original and replicate analyses are evaluated for agreement using the NRC Resolution Test Criteria[1]. These samples must be composited for further analysis and this precludes them from being split for analysis of beta emitters. Filters and other samples whose nature generally preclude sample splitting are marked "**" in the Split Analysis column.

TABLE OF CONTENTS -Appendix C ANALYTICAL RESULTS

Table C-1
Results of Participation in Cross Check Programs

Sample Date	Study ID	Sample Type and Units	Isotope Observed	Reported Laboratory's Results			Cross Check Lab Results	Pass/Fail
3/11/2021	E13390	Milk Gamma pCi/L	I-131	105	±	18.0	86.9	Pass
			Cs-134	145	±	7.1	151	Pass
			Cs-137	116	±	10.3	110	Pass
			Ce-141	122	±	12.4	125	Pass
			Cr-51	257	±	83.6	242	Pass
			Mn-54	122	±	10.3	112	Pass
			Co-58	126	±	12.4	128	Pass
			Fe-59	116	±	14.6	109	Pass
			Co-60	155	±	9.5	154	Pass
			Zn-65	195	±	21.7	211	Pass
3/11/2021	E13390	Milk Gamma pCi/L	I-131	89	±	17.8	86.9	Pass
			Cs-134	134	±	7.9	151	Pass
			Cs-137	111	±	11.3	110	Pass
			Ce-141	127	±	15.2	125	Pass
			Cr-51	302	±	79.7	242	Pass
			Mn-54	118	±	10.7	112	Pass
			Co-58	118	±	11.1	128	Pass
			Fe-59	121	±	14.7	109	Pass
			Co-60	147	±	8.9	154	Pass
			Zn-65	190	±	22.2	211	Pass

3/11/2021	E13391	Water Beta pCi/L	Cs-137	250	±	4.7	283	Pass
3/11/2021	E13392	Cartridge Gamma pCi	I-131	80	±	5.7	88.2	Pass
3/11/2021	E13392	Cartridge Gamma pCi	I-131	79	±	5.3	88.2	Pass
4/5/2021	RAD 125	Water Beta pCi/L	Cs-137	58	±	2.3	67.5	Pass
4/5/2021	RAD 125	Water Gamma pCi/L	I-131	29	±	3.6	26.7	Pass
6/3/2021	E13395	Filter Gamma pCi	Cs-134	136	±	4.6	156	Pass
			Cs-137	138	±	7.0	138	Pass
			Ce-141	146	±	6.1	132	Pass
			Cr-51	416	±	36.0	390	Pass
			Mn-54	204	±	8.7	183	Pass
			Co-58	133	±	7.0	131	Pass
			Fe-59	161	±	10.0	134	Pass
			Co-60	171	±	6.2	158	Pass
			Zn-65	255	±	17.0	220	Pass

6/3/2021	E13395	Filter Gamma pCi	Cs-134	138	±	4.6	156	Pass
			Cs-137	142	±	7.2	138	Pass
			Ce-141	141	±	6.1	132	Pass
			Cr-51	426	±	39.4	390	Pass
			Mn-54	208	±	8.8	183	Pass
			Co-58	136	±	6.8	131	Pass
			Fe-59	163	±	9.2	134	Pass
			Co-60	164	±	6.1	158	Pass
			Zn-65	230	±	15.2	220	Pass
6/3/2021	E13396	Filter Beta pCi	Cs-137	166	±	2.7	143	Pass
6/3/2021	E13396	Filter Beta pCi	Cs-137	163	±	2.7	143	Pass
6/3/2021	E13394	Water Gamma pCi	Ce-141	201	±	20.2	180	Pass
			Co-58	168	±	15.5	179	Pass
			Co-60	226	±	12.9	215	Pass
			Cr-51	521	±	98.0	533	Pass
			Cs-134	193	±	10.6	213	Pass
			Cs-137	187	±	16.6	188	Pass
			Fe-59	199	±	19.4	183	Pass
			I-131	91	±	17.2	92	Pass
			Mn-54	247	±	18.4	249	Pass
			Zn-65	275	±	30.9	300	Pass

6/3/2021	E13394	Water Gamma pCi	Ce-141	176	±	18.8	180	Pass
			Co-58	173	±	15.2	179	Pass
			Co-60	216	±	12.6	215	Pass
			Cr-51	514	±	80.6	533	Pass
			Cs-134	195	±	10.1	213	Pass
			Cs-137	193	±	15.9	188	Pass
			Fe-59	181	±	19.4	183	Pass
			I-131	94	±	22.1	92	Pass
			Mn-54	236	±	18.4	249	Pass
			Zn-65	298	±	33.6	300	Pass
6/3/2021	E13394	Water Gamma pCi	Ce-141	161	±	18.4	180	Pass
			Co-58	176	±	17.9	179	Pass
			Co-60	222	±	13.9	215	Pass
			Cr-51	506	±	95.7	533	Pass
			Cs-134	198	±	10.6	213	Pass
			Cs-137	193	±	16.6	188	Pass
			Fe-59	202	±	21.8	183	Pass
			I-131	103	±	20.2	92	Pass
			Mn-54	250	±	19.7	249	Pass
			Zn-65	304	±	35.8	300	Pass
6/3/2021	E13393	Water Beta pCi	Cs-137	225	±	4.5	250	Pass
9/9/2021	E13397	Filter Beta pCi	Cs-137	220	±	3.1	217	Pass
9/9/2021	E13397	Filter Beta pCi	Cs-137	211	±	3.0	217	Pass

9/20/2021	MRAD035	Filter Gamma pCi	Cs-134	218	±	7.1	241	Pass
			Cs-137	210	±	10.4	187	Pass
			Co-60	356	±	11.4	310	Pass
			Zn-65	411	±	28.3	366	Pass
10/6/2021	RAD127	Water Gamma pCi	Ba-133	84	±	4.7	87.5	Pass
			Cs-134	67	±	3.1	70.1	Pass
			Cs-137	152	±	7.1	156	Pass
			Co-60	83	±	4.3	85.9	Pass
			Zn-65	142	±	11.2	145	Pass
10/6/2021	RAD127	Water Gamma pCi	I-131	30	±	6.1	26.4	Pass
12/2/2021	E13398	Filter Gamma pCi	Ce-141	92	±	6.4	99.7	Pass
			Co-58	79	±	7.7	86.6	Pass
			Co-60	167	±	7.8	169	Pass
			Cr-51	190	±	40.4	222	Pass
			Cs-134	98	±	4.7	126	Pass
			Cs-137	79	±	6.2	88.7	Pass
			Fe-59	85	±	10.6	85.3	Pass
			Mn-54	110	±	8.0	115	Pass
			Zn-65	180	±	17.9	195	Pass

12/2/2021	E13398	Filter Gamma pCi	Cs-134	95	±	4.1	126	Pass
			Cs-137	76	±	5.8	88.7	Pass
			Ce-141	95	±	6.3	99.7	Pass
			Cr-51	212	±	41.7	222	Pass
			Mn-54	110	±	7.3	115	Pass
			Co-58	80	±	6.7	86.6	Pass
			Fe-59	93	±	8.7	85.3	Pass
			Co-60	154	±	6.7	169	Pass
			Zn-65	182	±	15.9	195	Pass
12/2/2021	E13399	Water Beta pCi	Cs-137	287	±	5.0	281	Pass
12/2/2021	E13400	Cartridge Gamma pCi	I-131	92	±	13.2	94.3	Pass
12/2/2021	E13400	Cartridge Gamma pCi	I-131	89	±	5.9	94.3	Pass
12/2/2021	E13400	Cartridge Gamma pCi	I-131	89	±	6.8	94.3	Pass

12/2/2021	E13401	Milk Gamma pCi	I-131	84	±	21.1	90.3	Pass
			Cs-134	160	±	8.1	166	Pass
			Cs-137	114	±	12.3	117	Pass
			Ce-141	131	±	16.0	132	Pass
			Cr-51	285	±	76.5	293	Pass
			Mn-54	156	±	13.7	152	Pass
			Co-58	104	±	14.1	114	Pass
			Fe-59	125	±	18.1	113	Pass
			Co-60	224	±	12.5	223	Pass
			Zn-65	253	±	28.0	257	Pass
12/2/2021	E13401	Milk Gamma pCi	I-131	95	±	16.6	90.3	Pass
			Cs-134	161	±	8.1	166	Pass
			Cs-137	116	±	12.2	117	Pass
			Ce-141	115	±	13.3	132	Pass
			Cr-51	265	±	77.6	293	Pass
			Mn-54	164	±	12.9	152	Pass
			Co-58	106	±	11.5	114	Pass
			Fe-59	119	±	14.9	113	Pass
			Co-60	232	±	11.2	223	Pass
			Zn-65	261	±	26.1	257	Pass

12/2/2021	E13401	Milk Gamma pCi	I-131	84	±	21.1	90.3	Pass
			Cs-134	160	±	8.1	166	Pass
			Cs-137	114	±	12.3	117	Pass
			Ce-141	131	±	16.0	132	Pass
			Cr-51	285	±	76.5	293	Pass
			Mn-54	156	±	13.7	152	Pass
			Co-58	104	±	14.1	114	Pass
			Fe-59	125	±	18.1	113	Pass
			Co-60	224	±	12.5	223	Pass
			Zn-65	261	±	26.1	257	Pass

[1] See discussion at the beginning of the Appendix

Table C-2

Results of Quality Assurance Program

Sample Type and Location	Sample Date	Type of Analysis	Result Units	Original Analysis	Replicate Analysis	Split Analysis	Pass/Fail (Replicate)	Pass/Fail (Split)
Water-16C2	02/03/21	Gross Beta	pCi/L	2.09 +/- 0.8	NA	<2.67	NA	PASS
Water-16C2	02/03/21	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Milk-19B1	1/12/2021	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Milk-25C1	1/12/2021	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Milk-19B1	1/12/2021	I-131	pCi/L	<MDA	NA	<MDA	NA	PASS
Milk-25C1	1/12/2021	I-131	pCi/L	<MDA	NA	<MDA	NA	PASS
Air Filter - A1	01/25/21	Gross Beta	10^{-2} pCi/m^3	1.8 +/- 0.1	1.7 +/- 0.1	**	PASS	NA
Air Filter - A2	01/25/21	Gross Beta	10^{-2} pCi/m^3	1.7 +/- 0.1	1.7 +/- 0.1	**	PASS	NA
Air Filter - A3	01/25/21	Gross Beta	10^{-2} pCi/m^3	1.7 +/- 0.1	1.6 +/- 0.1	**	PASS	NA
Air Filter - A4	01/25/21	Gross Beta	10^{-2} pCi/m^3	1.9 +/- 0.1	1.8 +/- 0.1	**	PASS	NA
Air Filter - A5	01/25/21	Gross Beta	10^{-2} pCi/m^3	1.6 +/- 0.1	1.6 +/- 0.1	**	PASS	NA
Air Filter - SFA1	01/25/21	Gross Beta	10^{-2} pCi/m^3	1.5 +/- 0.1	1.6 +/- 0.1	**	PASS	NA
Air Filter - SFA2	01/25/21	Gross Beta	10^{-2} pCi/m^3	1.7 +/- 0.1	1.8 +/- 0.1	**	PASS	NA
Air Filter - SFA3	01/25/21	Gross Beta	10^{-2} pCi/m^3	1.7 +/- 0.1	1.7 +/- 0.1	**	PASS	NA
Air Filter - SFA4	01/25/21	Gross Beta	10^{-2} pCi/m^3	1.7 +/- 0.1	1.8 +/- 0.1	**	PASS	NA
Air Iodine - A1	02/15/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A2	02/15/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A3	02/15/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A4	02/15/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA

Air Iodine - A5	02/15/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA1	02/15/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine – SFA2	02/15/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine – SFA3	02/15/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine – SFA4	02/15/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Water-16C2	03/02/21	Gross Beta	pCi/L	2.12 +/- 0.8	NA	4.21+/- 1.7	NA	PASS
Water-16C2	03/02/21	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Air Filter – STATION-02	03/29/21	Gross Beta	10^{-2} pCi/m^3	1.7 +/- 0.1	1.7 +/- 0.1	**	PASS	NA
Air Filter – STATION-03	03/29/21	Gross Beta	10^{-2} pCi/m^3	1.8 +/- 0.1	1.7 +/- 0.1	**	PASS	NA
Air Filter – STATION-04	03/29/21	Gross Beta	10^{-2} pCi/m^3	1.6 +/- 0.2	1.6 +/- 0.2	**	PASS	NA
Air Filter – STATION-05	03/29/21	Gross Beta	10^{-2} pCi/m^3	1.6 +/- 0.1	1.7 +/- 0.1	**	PASS	NA
Air Filter – STATION-06	03/29/21	Gross Beta	10^{-2} pCi/m^3	1.8 +/- 0.1	1.7 +/- 0.1	**	PASS	NA
Air Filter – STATION-07	03/29/21	Gross Beta	10^{-2} pCi/m^3	1.8 +/- 0.1	1.8 +/- 0.1	**	PASS	NA
Air Filter – STATION-08	03/29/21	Gross Beta	10^{-2} pCi/m^3	2.1 +/- 0.2	2.2 +/- 0.2	**	PASS	NA
Air Filter – STATION-09	03/29/21	Gross Beta	10^{-2} pCi/m^3	1.9 +/- 0.1	1.7 +/- 0.2	**	PASS	NA
Air Filter – STATION-10	03/29/21	Gross Beta	10^{-2} pCi/m^3	1.7 +/- 0.1	1.8 +/- 0.1	**	PASS	NA
Air Filter – STATION-11	03/29/21	Gross Beta	10^{-2} pCi/m^3	1.6 +/- 0.1	1.6 +/- 0.1	**	PASS	NA
Air Filter – STATION-12	03/29/21	Gross Beta	10^{-2} pCi/m^3	1.7 +/- 0.1	1.6 +/- 0.1	**	PASS	NA

Air Filter – STATION-13	03/29/21	Gross Beta	10^{-2} pCi/m^3	1.7 +/- 0.1	1.7 +/- 0.1	**	PASS	NA
Water-16C2	03/30/21	Gross Beta	pCi/L	2.23 +/- 0.8	NA	<3.74	NA	PASS
Water-16C2	03/30/21	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Soil – SFS1	03/15/21	Gamma	pCi/kg	<MDA	<MDA	<MDA	PASS	PASS
Soil – SFS5[1]	03/15/21	Cs-137	pCi/kg	87.2 +/- 37.6	<MDA	<MDA	PASS	PASS
Soil – WB1	03//2921	Gamma	pCi/kg	<MDA	<MDA	<MDA	PASS	PASS
Milk-19B1	4/06/2021	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Milk-25C1	4/06/2021	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Milk-19B1	4/06/2021	I-131	pCi/L	<MDA	NA	<MDA	NA	PASS
Milk-25C1	4/06/2021	I-131	pCi/L	<MDA	NA	<MDA	NA	PASS
Water-16C2	04/26/21	Gross Beta	pCi/L	3.05 +/- 0.8	NA	<2.39	NA	PASS
Water-16C2	04/26/21	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Air Iodine - A1	04/26/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A2	04/26/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A3	04/26/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A4	04/26/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A5	04/26/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA1	04/26/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA2	04/26/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA3	04/26/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA4	04/26/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA

Air Iodine - A1	05/10/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A2	05/10/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A3	05/10/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A4	05/10/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A5	05/10/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA1	05/10/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA2	05/10/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA3	05/10/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA4	05/10/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Predator-16C5	5/14/21	Gamma	pCi/kg	<MDA	NA	<MDA	NA	PASS
Bottom Feeder-16C5	5/14/21	Gamma	pCi/kg	<MDA	NA	<MDA	NA	PASS
Predator-29C1	5/11/21	Gamma	pCi/kg	<MDA	NA	<MDA	NA	PASS
Bottom Feeder-29C1	5/11/21	Gamma	pCi/kg	<MDA	NA	<MDA	NA	PASS
Air Filter – STATION-02	05/03/21	Gross Beta	10^{-2} pCi/m^3	2.6 +/- 0.1	2.5 +/- 0.1	**	PASS	NA
Air Filter – STATION-03	05/03/21	Gross Beta	10^{-2} pCi/m^3	2.5 +/- 0.2	2.5 +/- 0.2	**	PASS	NA
Air Filter – STATION-04	05/03/21	Gross Beta	10^{-2} pCi/m^3	2.6 +/- 0.3	2.7 +/- 0.3	**	PASS	NA
Air Filter – STATION-05	05/03/21	Gross Beta	10^{-2} pCi/m^3	2.6 +/- 0.2	2.6 +/- 0.2	**	PASS	NA
Air Filter – STATION-06	05/03/21	Gross Beta	10^{-2} pCi/m^3	2.5 +/- 0.1	2.5 +/- 0.1	**	PASS	NA
Air Filter – STATION-07	05/03/21	Gross Beta	10^{-2} pCi/m^3	2.5 +/- 0.2	2.5 +/- 0.2	**	PASS	NA
Air Filter – STATION-08	05/03/21	Gross Beta	10^{-2} pCi/m^3	3.4 +/- 0.2	3.3 +/- 0.2	**	PASS	NA

Air Filter – STATION-09	05/03/21	Gross Beta	10^{-2} pCi/m^3	2.7 +/- 0.2	2.6 +/- 0.2	**	PASS	NA
Air Filter – STATION-10	05/03/21	Gross Beta	10^{-2} pCi/m^3	2.6 +/- 0.1	2.4 +/- 0.1	**	PASS	NA
Air Filter – STATION-11	05/03/21	Gross Beta	10^{-2} pCi/m^3	2.4 +/- 0.2	2.5 +/- 0.2	**	PASS	NA
Air Filter – STATION-12	05/03/21	Gross Beta	10^{-2} pCi/m^3	2.6 +/- 0.2	2.5 +/- 0.2	**	PASS	NA
Air Filter – STATION-13	05/03/21	Gross Beta	10^{-2} pCi/m^3	2.6 +/- 0.1	2.5 +/- 0.2	**	PASS	NA
Water – WA2	6/01/2021	Gamma	pCi/L	<MDA	<MDA	<MDA	PASS	PASS
Water – WA1	6/01/2021	Gamma	pCi/L	<MDA	<MDA	<MDA	PASS	PASS
Water-16C2	06/01/21	Gross Beta	pCi/L	1.43 +/- 0.8	NA	<2.38	NA	PASS
Water-16C2	06/01/21	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Air Iodine - A1	06/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A2	06/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A3	06/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A4	06/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A5	06/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA1	06/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA2	06/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA3	06/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA4	06/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Filter - A1	6/28/21	Gamma	pCi/m^3	<MDA	<MDA	<MDA	PASS	PASS
Air Filter - A2	6/28/21	Gamma	pCi/m^3	<MDA	<MDA	<MDA	PASS	PASS
Air Filter - A3	6/28/21	Gamma	pCi/m^3	<MDA	<MDA	<MDA	PASS	PASS

Air Filter - A4	6/28/21	Gamma	pCi/m^3	<MDA	<MDA	<MDA	PASS	PASS
Air Filter - A5	6/28/21	Gamma	pCi/m^3	<MDA	<MDA	<MDA	PASS	PASS
Air Filter - SFA1	6/28/21	Gamma	pCi/m^3	<MDA	<MDA	<MDA	PASS	PASS
Air Filter - SFA2	6/28/21	Gamma	pCi/m^3	<MDA	<MDA	<MDA	PASS	PASS
Air Filter - SFA3	6/28/21	Gamma	pCi/m^3	<MDA	<MDA	<MDA	PASS	PASS
Air Filter - SFA4	6/28/21	Gamma	pCi/m^3	<MDA	<MDA	<MDA	PASS	PASS
Water-16C2	06/28/21	Gross Beta	pCi/L	2.74 +/- 0.8	NA	<2.64	NA	PASS
Water-16C2	06/28/21	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Air Filter - A1	07/19/21	Gross Beta	10^{-2} pCi/m^3	2.1 +/- 0.1	2.1 +/- 0.1	**	PASS	NA
Air Filter - A2	07/19/21	Gross Beta	10^{-2} pCi/m^3	2.0 +/- 0.1	1.8 +/- 0.1	**	PASS	NA
Air Filter - A3	07/19/21	Gross Beta	10^{-2} pCi/m^3	2.0 +/- 0.1	2.0 +/- 0.1	**	PASS	NA
Air Filter - A4	07/19/21	Gross Beta	10^{-2} pCi/m^3	1.9 +/- 0.1	1.8 +/- 0.1	**	PASS	NA
Air Filter - A5	07/19/21	Gross Beta	10^{-2} pCi/m^3	2.0 +/- 0.1	2.1 +/- 0.1	**	PASS	NA
Air Filter - SFA1	07/19/21	Gross Beta	10^{-2} pCi/m^3	1.8 +/- 0.1	1.8 +/- 0.1	**	PASS	NA
Air Filter - SFA2	07/19/21	Gross Beta	10^{-2} pCi/m^3	1.8 +/- 0.1	1.8 +/- 0.1	**	PASS	NA
Air Filter - SFA3	07/19/21	Gross Beta	10^{-2} pCi/m^3	2.2 +/- 0.1	2.1 +/- 0.1	**	PASS	NA
Air Filter - SFA4	07/19/21	Gross Beta	10^{-2} pCi/m^3	2.3 +/- 0.2	2.4 +/- 0.2	**	PASS	NA
Air Iodine - A1	07/06/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A2	07/06/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A3	07/06/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A4	07/06/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine – A5	07/06/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA1	07/06/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA2	07/06/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA3	07/06/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine – SFA4	07/06/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA

Milk-19B1	7/13/2021	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Milk-25C1	7/13/2021	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Milk-19B1	7/13/2021	I-131	pCi/L	<MDA	NA	<MDA	NA	PASS
Milk-25C1	7/13/2021	I-131	pCi/L	<MDA	NA	<MDA	NA	PASS
Kale - IB4	7/27/2020	Gamma	pCi/kg	<MDA	<MDA	<MDA	PASS	NA
Kale - IB7	7/27/2020	Gamma	pCi/kg	<MDA	<MDA	<MDA	PASS	NA
Kale - IB10	7/27/2020	Gamma	pCi/kg	<MDA	<MDA	<MDA	PASS	NA
Water-16C2	08/02/21	Gross Beta	pCi/L	3.87 +/- 0.9	NA	<2.72	NA	PASS
Water-16C2	08/02/21	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Spot – IA1	08/24/21	Gamma	pCi/kg	<MDA	<MDA	<MDA	PASS	PASS
Spot – IA5	08/24/21	Gamma	pCi/kg	<MDA	<MDA	<MDA	PASS	PASS
Oysters – IA3	08/24/21	Gamma	pCi/kg	<MDA	<MDA	<MDA	PASS	PASS
Oysters – IA6	08/24/21	Gamma	pCi/kg	<MDA	<MDA	<MDA	PASS	PASS
Air Filter - A1	08/30/21	Gross Beta	10^{-2} pCi/m^3	2.9 +/- 0.2	3.0 +/- 0.2	**	PASS	NA
Air Filter - A2	08/30/21	Gross Beta	10^{-2} pCi/m^3	2.8 +/- 0.2	3.2 +/- 0.2	**	PASS	NA
Air Filter - A3	08/30/21	Gross Beta	10^{-2} pCi/m^3	2.7 +/- 0.2	2.9 +/- 0.2	**	PASS	NA
Air Filter - A4	08/30/21	Gross Beta	10^{-2} pCi/m^3	2.6 +/- 0.2	3.1 +/- 0.2	**	PASS	NA
Air Filter - A5	08/30/21	Gross Beta	10^{-2} pCi/m^3	2.6 +/- 0.1	3.0 +/- 0.2	**	PASS	NA
Air Filter - SFA1	08/30/21	Gross Beta	10^{-2} pCi/m^3	2.8 +/- 0.2	3.5 +/- 0.2	**	PASS	NA
Air Filter - SFA2	08/30/21	Gross Beta	10^{-2} pCi/m^3	2.4 +/- 0.1	2.8 +/- 0.2	**	PASS	NA
Air Filter - SFA3	08/30/21	Gross Beta	10^{-2} pCi/m^3	2.9 +/- 0.2	3.5 +/- 0.2	**	PASS	NA
Air Filter - SFA4	08/30/21	Gross Beta	10^{-2} pCi/m^3	2.5 +/- 0.1	2.4 +/- 0.1	**	PASS	NA

Air Iodine - A1	08/16/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A2	08/16/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A3	08/16/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A4	08/16/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A5	08/16/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA1	08/16/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA2	08/16/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA3	08/16/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Water-16C2	08/30/21	Gross Beta	pCi/L	4.29 +/- 0.9	NA	<2.71	NA	PASS
Water-16C2	08/30/21	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Pears - Albion	09/02/21	Gamma	pCi/kg	<MDA	<MDA	<MDA	PASS	NA
Grapes - East	09/02/21	Gamma	pCi/kg	<MDA	<MDA	<MDA	PASS	NA
Swiss Chard-IB4	09/20/21	Gamma	pCi/kg	<MDA	<MDA	<MDA	PASS	NA
Swiss Chard-IB10	09/20/21	Gamma	pCi/kg	<MDA	<MDA	<MDA	PASS	NA
Air Iodine - A1	09/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A2	09/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A3	09/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A4	09/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A5	09/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA1	09/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA2	09/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA3	09/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA4	09/14/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA

Water-16C2	09/27/21	Gross Beta	pCi/L	1.87 +/- 0.8	NA	<2.38	NA	PASS
Water-16C2	09/27/21	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Air Filter - A1	10/04/21	Gross Beta	10^{-2} pCi/m^3	3.0 +/- 0.2	3.1 +/- 0.2	**	PASS	NA
Air Filter - A2	10/04/21	Gross Beta	10^{-2} pCi/m^3	3.0 +/- 0.2	3.1 +/- 0.2	**	PASS	NA
Air Filter - A3	10/04/21	Gross Beta	10^{-2} pCi/m^3	3.1 +/- 0.2	2.9 +/- 0.2	**	PASS	NA
Air Filter - A4	10/04/21	Gross Beta	10^{-2} pCi/m^3	3.0 +/- 0.2	3.1 +/- 0.2	**	PASS	NA
Air Filter - A5	10/04/21	Gross Beta	10^{-2} pCi/m^3	3.5 +/- 0.2	3.4 +/- 0.2	**	PASS	NA
Air Filter - SFA1	10/04/21	Gross Beta	10^{-2} pCi/m^3	3.5 +/- 0.2	3.5 +/- 0.2	**	PASS	NA
Air Filter - SFA2	10/04/21	Gross Beta	10^{-2} pCi/m^3	2.7 +/- 0.2	2.7 +/- 0.1	**	PASS	NA
Air Filter - SFA3	10/04/21	Gross Beta	10^{-2} pCi/m^3	3.5 +/- 0.2	3.4 +/- 0.2	**	PASS	NA
Air Filter - SFA4	10/04/21	Gross Beta	10^{-2} pCi/m^3	3.0 +/- 0.2	3.2 +/- 0.2	**	PASS	NA
Air Iodine - A1	10/04/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A2	10/04/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A3	10/04/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A4	10/04/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A5	10/04/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA1	10/04/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA3	10/04/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA4	10/04/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Milk-19B1	10/05/21	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Milk-25C1	10/05/21	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Milk-19B1	10/05/21	I-131	pCi/L	<MDA	NA	<MDA	NA	PASS
Milk-25C1	10/05/21	I-131	pCi/L	<MDA	NA	<MDA	NA	PASS

Air Filter – STATION-02	10/26/21	Gross Beta	10^{-2} pCi/m^3	2.9 +/- 0.2	2.8 +/- 0.2	**	PASS	NA
Air Filter – STATION-03	10/26/21	Gross Beta	10^{-2} pCi/m^3	2.9 +/- 0.2	3.0 +/- 0.2	**	PASS	NA
Air Filter – STATION-04	10/26/21	Gross Beta	10^{-2} pCi/m^3	2.8 +/- 0.2	2.8 +/- 0.2	**	PASS	NA
Air Filter – STATION-05	10/26/21	Gross Beta	10^{-2} pCi/m^3	2.8 +/- 0.2	2.8 +/- 0.2	**	PASS	NA
Air Filter – STATION-06	10/26/21	Gross Beta	10^{-2} pCi/m^3	2.9 +/- 0.2	2.8 +/- 0.2	**	PASS	NA
Air Filter – STATION-07	10/26/21	Gross Beta	10^{-2} pCi/m^3	4.1 +/- 0.3	3.9 +/- 0.3	**	PASS	NA
Air Filter – STATION-08	10/26/21	Gross Beta	10^{-2} pCi/m^3	2.8 +/- 0.3	2.7 +/- 0.3	**	PASS	NA
Air Filter – STATION-09	10/26/21	Gross Beta	10^{-2} pCi/m^3	2.6 +/- 0.1	2.7 +/- 0.1	**	PASS	NA
Air Filter – STATION-10	10/26/21	Gross Beta	10^{-2} pCi/m^3	2.9 +/- 0.2	2.9 +/- 0.2	**	PASS	NA
Air Filter – STATION-11	10/26/21	Gross Beta	10^{-2} pCi/m^3	2.9 +/- 0.2	3.0 +/- 0.2	**	PASS	NA
Air Filter – STATION-12	10/26/21	Gross Beta	10^{-2} pCi/m^3	3.0 +/- 0.2	3.0 +/- 0.2	**	PASS	NA
Air Filter – STATION-13	10/26/21	Gross Beta	10^{-2} pCi/m^3	2.7 +/- 0.1	2.6 +/- 0.1	**	PASS	NA
Water-16C2	11/01/21	Gross Beta	pCi/L	1.98 +/- 0.8	NA	3.39 +/- 1.6	NA	PASS
Water-16C2	11/01/21	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS
Water-16C2	11/29/21	Gross Beta	pCi/L	3.11 +/- 0.9	NA	2.5 +/- 1.3	NA	PASS
Water-16C2	11/29/21	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS

Air Iodine - A1	12/28/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A2	12/28/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A3	12/28/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A4	12/28/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - A5	12/28/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA1	12/28/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA2	12/28/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA3	12/28/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Air Iodine - SFA4	12/28/21	I-131	pCi/m^3	<MDA	<MDA	**	PASS	NA
Water-16C2	01/03/22	Gross Beta	pCi/L	2.02 +/- 0.8	NA	<2.48	NA	PASS
Water-16C2	01/03/22	Gamma	pCi/L	<MDA	NA	<MDA	NA	PASS

[1] See discussion at the beginning of the Appendix
** The nature of these samples precluded splitting them with an independent laboratory.

Table C-2a

Results of Quality Assurance Program
Co-Located Air Samplers 11S1 and 11S2

Concentration of Iodine-131 in Filtered Air
(Results in units of 10^{-3} pCi/m^3 ± 2σ)

Start Date	Stop Date	Isotope Observed	11S1 Analysis	11S2 Analysis	NRC Acceptance
12/28/2020	1/4/2021	I-131	<MDA	<MDA	Pass
1/4/2021	1/11/2021	I-131	<MDA	<MDA	Pass
1/11/2021	1/19/2021	I-131	<MDA	<MDA	Pass
1/19/2021	1/25/2021	I-131	<MDA	<MDA	Pass
1/25/2021	2/3/2021	I-131	<MDA	<MDA	Pass
2/3/2021	2/8/2021	I-131	<MDA	<MDA	Pass
2/8/2021	2/15/2021	I-131	<MDA	<MDA	Pass
2/15/2021	2/22/2021	I-131	<MDA	<MDA	Pass
2/22/2021	3/2/2021	I-131	<MDA	<MDA	Pass
3/2/2021	3/8/2021	I-131	<MDA	<MDA	Pass
3/8/2021	3/15/2021	I-131	<MDA	<MDA	Pass
3/15/2021	3/22/2021	I-131	<MDA	<MDA	Pass
3/22/2021	3/30/2021	I-131	<MDA	<MDA	Pass
3/30/2021	4/5/2021	I-131	<MDA	<MDA	Pass
4/5/2021	4/12/2021	I-131	<MDA	<MDA	Pass
4/12/2021	4/19/2021	I-131	<MDA	<MDA	Pass
4/19/2021	4/26/2021	I-131	<MDA	<MDA	Pass
4/26/2021	5/3/2021	I-131	<MDA	<MDA	Pass
5/3/2021	5/10/2021	I-131	<MDA	<MDA	Pass
5/10/2021	5/17/2021	I-131	<MDA	<MDA	Pass

Table C-2a

Results of Quality Assurance Program
Co-Located Air Samplers 11S1 and 11S2

Concentration of Iodine-131 in Filtered Air
(Results in units of 10^{-3} pCi/m^3 ± 2σ)

Start Date	Stop Date	Isotope Observed	11S1 Analysis	11S2 Analysis	NRC Acceptance
5/17/2021	5/24/2021	I-131	<MDA	<MDA	Pass
5/24/2021	6/1/2021	I-131	<MDA	<MDA	Pass
6/1/2021	6/7/2021	I-131	<MDA	<MDA	Pass
6/7/2021	6/14/2021	I-131	<MDA	<MDA	Pass
6/14/2021	6/21/2021	I-131	<MDA	<MDA	Pass
6/21/2021	6/28/2021	I-131	<MDA	<MDA	Pass
6/28/2021	7/6/2021	I-131	<MDA	<MDA	Pass
7/6/2021	7/12/2021	I-131	<MDA	<MDA	Pass
7/12/2021	7/19/2021	I-131	<MDA	<MDA	Pass
7/19/2021	7/26/2021	I-131	<MDA	<MDA	Pass
7/26/2021	8/2/2021	I-131	<MDA	<MDA	Pass
8/2/2021	8/9/2021	I-131	<MDA	<MDA	Pass
8/9/2021	8/16/2021	I-131	<MDA	<MDA	Pass
8/16/2021	8/23/2021	I-131	<MDA	<MDA	Pass
8/23/2021	8/30/2021	I-131	<MDA	<MDA	Pass
8/30/2021	9/7/2021	I-131	<MDA	<MDA	Pass
9/7/2021	9/13/2021	I-131	<MDA	<MDA	Pass
9/13/2021	9/20/2021	I-131	<MDA	<MDA	Pass
9/20/2021	9/27/2021	I-131	<MDA	<MDA	Pass
9/27/2021	10/4/2021	I-131	<MDA	<MDA	Pass

Table C-2a

Results of Quality Assurance Program
Co-Located Air Samplers 11S1 and 11S2

Concentration of Iodine-131 in Filtered Air
(Results in units of 10^{-3} pCi/m^3 ± 2σ)

Start Date	Stop Date	Isotope Observed	11S1 Analysis	11S2 Analysis	NRC Acceptance
10/4/2021	10/11/2021	I-131	<MDA	<MDA	Pass
10/11/2021	10/18/2021	I-131	<MDA	<MDA	Pass
10/18/2021	10/25/2021	I-131	<MDA	<MDA	Pass
10/25/2021	11/1/2021	I-131	<MDA	<MDA	Pass
11/1/2021	11/8/2021	I-131	<MDA	<MDA	Pass
11/8/2021	11/15/2021	I-131	<MDA	<MDA	Pass
11/15/2021	11/22/2021	I-131	<MDA	<MDA	Pass
11/22/2021	11/29/2021	I-131	<MDA	<MDA	Pass
11/29/2021	12/6/2021	I-131	<MDA	<MDA	Pass
12/6/2021	12/13/2021	I-131	<MDA	<MDA	Pass
12/13/2021	12/20/2021	I-131	<MDA	<MDA	Pass
12/20/2021	12/28/2021	I-131	<MDA	<MDA	Pass
12/28/2021	1/3/2022	I-131	<MDA	<MDA	Pass

Table C-2b

Results of Quality Assurance Program

Co-Located Air Samplers 11S1 and 11S2

Concentration of Beta Emitters in Air Particulates

(Results in units of 10^{-2} pCi/m^3 ± 2σ)

Start Date	Stop Date	11S1 Analysis by EIS	11S2 Analysis by TBE	NRC Acceptance
12/28/2020	1/4/2021	1.6 ± 0.2	1.3 ± 0.4	PASS
1/4/2021	1/11/2021	1.4 ± 0.2	1.4 ± 0.4	PASS
1/11/2021	1/19/2021	2.9 ± 0.2	2.7 ± 0.4	PASS
1/19/2021	1/25/2021	1.3 ± 0.2	1.2 ± 0.4	PASS
1/25/2021	2/3/2021	1.0 ± 0.1	0.9 ± 0.3	PASS
2/3/2021	2/8/2021	1.9 ± 0.3	1.7 ± 0.5	PASS
2/8/2021	2/15/2021	2.5 ± 0.2	2.6 ± 0.5	PASS
2/15/2021	2/22/2021	2.6 ± 0.2	2.4 ± 0.4	PASS
2/22/2021	3/2/2021	1.3 ± 0.2	1.3 ± 0.3	PASS
3/2/2021	3/8/2021	1.8 ± 0.2	1.5 ± 0.4	PASS
3/8/2021	3/15/2021	2.2 ± 0.2	2.4 ± 0.4	PASS
3/15/2021	3/22/2021	1.9 ± 0.2	2.2 ± 0.4	PASS
3/22/2021	3/30/2021	1.2 ± 0.2	1.3 ± 0.4	PASS
3/30/2021	4/5/2021	1.7 ± 0.2	1.9 ± 0.5	PASS
4/5/2021	4/12/2021	1.3 ± 0.2	1.8 ± 0.4	PASS
4/12/2021	4/19/2021	0.9 ± 0.2	0.9 ± 0.3	PASS
4/19/2021	4/26/2021	2.0 ± 0.2	1.9 ± 0.4	PASS
4/26/2021	5/3/2021	1.8 ± 0.2	2.5 ± 0.5	PASS

Table C-2b

Results of Quality Assurance Program

Co-Located Air Samplers 11S1 and 11S2

Concentration of Beta Emitters in Air Particulates

(Results in units of 10^{-2} pCi/m^3 ± 2σ)

Start Date	Stop Date	11S1 Analysis by EIS			11S2 Analysis by TBE			NRC Acceptance
5/3/2021	5/10/2021	0.9	±	0.2	1.3	±	0.4	PASS
5/10/2021	5/17/2021	1.4	±	0.2	1.4	±	0.4	PASS
5/17/2021	5/24/2021	2.0	±	0.2	2.5	±	0.5	PASS
5/24/2021	6/1/2021	0.9	±	0.1	1.1	±	0.3	PASS
6/1/2021	6/7/2021	1.4	±	0.2	2.1	±	0.5	PASS
6/7/2021	6/14/2021	1.0	±	0.2	1.1	±	0.4	PASS
6/14/2021	6/21/2021	1.4	±	0.2	1.5	±	0.4	PASS
6/21/2021	6/28/2021	0.9	±	0.2	1.1	±	0.4	PASS
6/28/2021	7/6/2021	1.0	±	0.2	1.4	±	0.4	PASS
7/6/2021	7/12/2021	1.8	±	0.2	2.5	±	0.5	PASS
7/12/2021	7/19/2021	1.5	±	0.2	2.3	±	0.4	PASS
7/19/2021	7/26/2021	1.7	±	0.2	2.2	±	0.4	PASS
7/26/2021	8/2/2021	1.6	±	0.2	1.9	±	0.4	PASS
8/2/2021	8/9/2021	1.7	±	0.2	1.7	±	0.4	PASS
8/9/2021	8/16/2021	1.8	±	0.2	1.9	±	0.4	PASS
8/16/2021	8/23/2021	1.2	±	0.2	1.6	±	0.4	PASS
8/23/2021	8/30/2021	2.1	±	0.2	3.0	±	0.5	PASS
8/30/2021	9/7/2021	1.5	±	0.2	1.6	±	0.4	PASS
9/7/2021	9/13/2021	1.9	±	0.2	2.4	±	0.5	PASS
9/13/2021	9/20/2021	2.6	±	0.2	3.2	±	0.5	PASS
9/20/2021	9/27/2021	1.5	±	0.2	1.2	±	0.4	PASS

Table C-2b

Results of Quality Assurance Program

Co-Located Air Samplers 11S1 and 11S2

Concentration of Beta Emitters in Air Particulates

(Results in units of 10^{-2} pCi/m^3 ± 2σ)

Start Date	Stop Date	11S1 Analysis by EIS	11S2 Analysis by TBE	NRC Acceptance
9/27/2021	10/4/2021	2.0 ± 0.2	2.2 ± 0.5	PASS
10/4/2021	10/11/2021	1.4 ± 0.2	0.9 ± 0.4	PASS
10/11/2021	10/18/2021	2.3 ± 0.2	1.9 ± 0.4	PASS
10/18/2021	10/25/2021	2.3 ± 0.2	3.0 ± 0.5	PASS
10/25/2021	11/1/2021	1.3 ± 0.2	1.3 ± 0.4	PASS
11/1/2021	11/8/2021	1.4 ± 0.2	1.7 ± 0.4	PASS
11/8/2021	11/15/2021	2.6 ± 0.2	3.3 ± 0.5	PASS
11/15/2021	11/22/2021	1.3 ± 0.2	1.6 ± 0.4	PASS
11/22/2021	11/29/2021	1.3 ± 0.2	1.5 ± 0.4	PASS
11/29/2021	12/6/2021	1.8 ± 0.2	2.0 ± 0.4	PASS
12/6/2021	12/13/2021	2.0 ± 0.2	2.4 ± 0.5	PASS
12/13/2021	12/20/2021	1.9 ± 0.2	2.7 ± 0.5	PASS
12/20/2021	12/28/2021	2.3 ± 0.2	3.1 ± 0.5	PASS
12/28/2021	1/3/2022	1.6 ± 0.2	1.5 ± 0.5	PASS

TABLE C-3

Limerick Generating Station ODCM Required LLDs

Selected Nuclides	Water pCi/l	Fish/Shellfish pCi/kg	Milk pCi/L	Sediment pCi/kg	Vegetation pCi/kg	Particulates[1] pCi/m³
H-3	2000	--	--	--	--	--
Mn-54	15	130	--	--	--	--
Co-58	15	130	--	--	--	--
Fe-59	30	260	--	--	--	--
Co-60	15	130	--	--	--	--
Zn-65	30	260	--	--	--	--
Zr-95/Nb-95	15	--	--	--	--	--
I-131	15	--	1	--	60	0.07[2]
Cs-134	15	130	15	150	60	0.05
Cs-137	18	150	18	180	80	0.06
Ba-140	60	--	60	--	--	--
La-140	15	--	15	--	--	--

[1]Gross Beta activity LLD = 0.01pCi/m^3
[2] Air samples for I-131 are collected separately on a charcoal radioiodine cannister

APPENDIX D

Land Use Survey

Appendix D contains the results of a Land Use Survey conducted in the fall of 2021 around Limerick Generating Station (LGS), performed by Exelon Industrial Services to comply with Bases 3.3.2 of the Limerick's Offsite Dose Calculation Manual. The purpose of the land use survey is to look for all potential pathways of radiation to a person. This is accomplished by documenting the nearest resident, milk- producing animal and garden of greater than 500 ft^2 in each of the sixteen 22 ½ degree sectors out to five miles around the site. The distance and direction of all locations from the LGS reactor buildings were positioned using Global Positioning System (GPS) technology.

The 2021 Land Use Survey identified differences in locations for gardens and meat animals between 2020 and 2021. Nine (9) new gardens were located this year in sectors N, NNE, NW, and WSW meteorological sectors. Gardens planted in sectors ESE and SE that are maintained for the REMP program were not included in the survey because of location on LGS property. These REMP program gardens are used as the sample locations for the REMP program. A new garden observed in the NNE sector was identified as the closest in the sector.

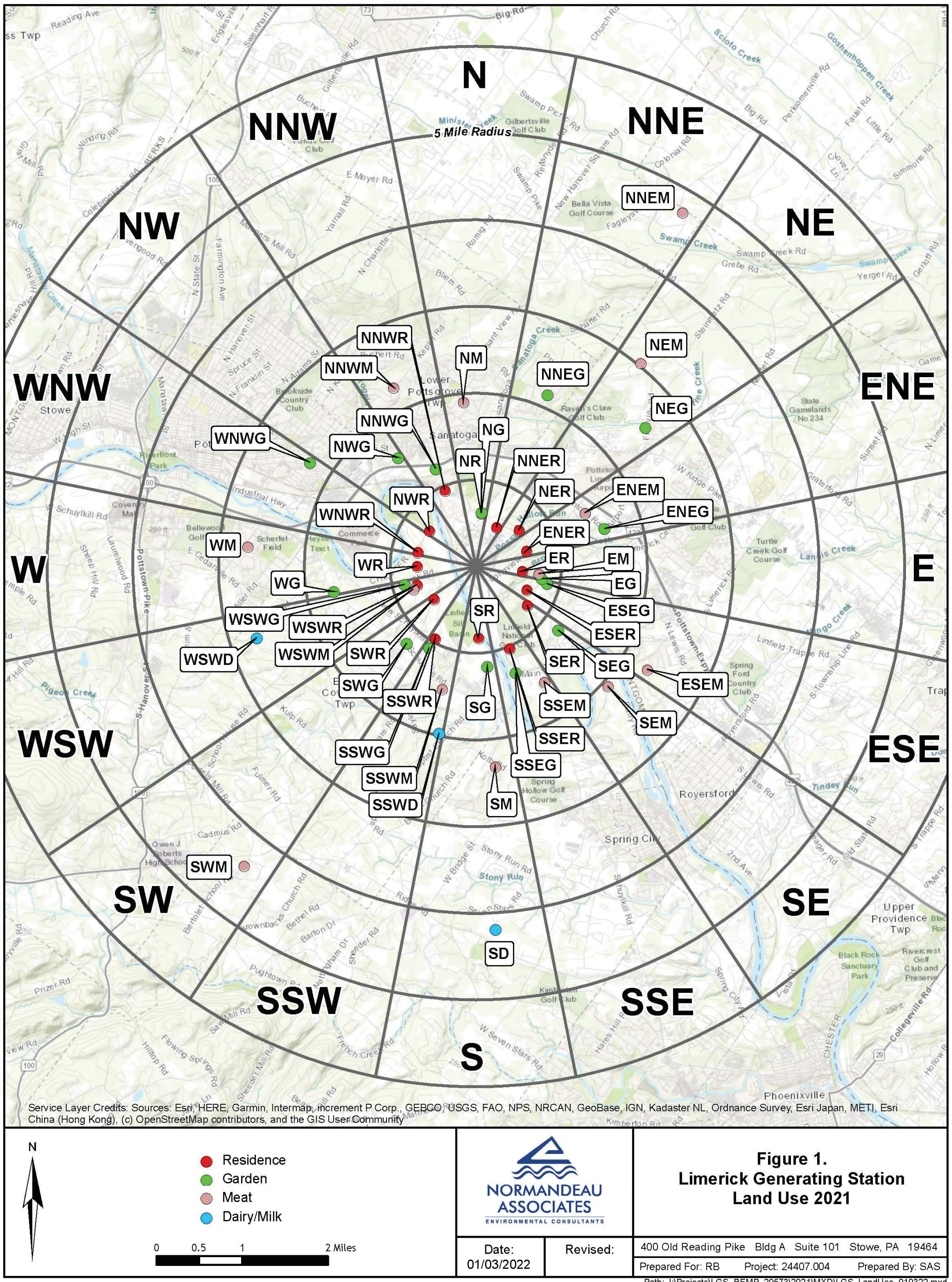
There were six (6) new meat sites identified this year in NE, E, SSW, and WSW sectors. All other locations were the same as in the 2020 report. The new locations in the E, and SSW were identified as the closest meat animals in that sector. There were no changes required to the LGS REMP as a result of this survey. There was no observed water usage for agricultural irrigation of root vegetables drawn directly from the Schuylkill River downriver from Limerick Generation Station. The results of this survey are summarized in Table D-1

Table D-1
Distance of the Nearest Residence, Garden, Dairy,
Meat Animal within a Five Mile Radius of
Limerick Generating Station
(Distance in feet)
2021

Sector	Residence	Garden (1)	Dairy Animal	Meat Animal
N	3,109	3,333	24,775*	10,077
NNE	2,706	11,378	-	13,418
NE	3,469	13,452	-	16,044
ENE	3,231	8,241	-	7,451
E	2,864	4,117	-	3,890
ESE	3,434	3,434	-	12,264
SE	3,928	6,376	-	10,903
SSE	5,403	6,912	-	8,177
S	4,347	6,103	22,114*	12,210
SSW	5,063	5,732	10,390*	7,729
SW	3,251	6,319	-	23,145
WSW	3,799	4,507	14,177*	4,084
W	3,627	8,886	-	14,123
WNW	3,685	12,022	-	-
NW	3,619	8,200	-	-
NNW	5,050	6,473	-	12,065

* Denotes current REMP Dairy sample location

Figure D-1
Limerick Generating Station Land Use Census



APPENDIX E

Annual Radiological Groundwater Protection Program Report

For Limerick Generating Station

This report on the Radiological Groundwater Protection Program (RGPP) conducted for the Limerick Generating Station (LGS) by Exelon Nuclear covers the period 01 January 2021 through 31 December 2021. During that time period:

59 analyses were performed on 24 samples from 13 groundwater locations and 20 analyses were performed on 12 precipitation water locations collected from the environment, both on and off station property in 2021.

Groundwater samples were analyzed for tritium. Low levels of tritium were detected at 3 of the 13 groundwater monitoring locations. All other results were less than the required Exelon-specified LLD of 200 pCi/L.

Groundwater samples were analyzed for strontium-89 (Sr-89) and strontium-90 (Sr-90). All Sr-89 and Sr-90 results were less than the MDC.

Hard-To-Detect (HTD) analyses are routinely performed on a once per five year frequency for all groundwater monitoring locations. HTD analyses were performed in 2021 for 7 samples. All HTD results were less than the MDC.

Precipitation water samples were analyzed for tritium. Tritium was detected at 8 of 12 precipitation locations sampled.

In assessing all the data gathered for this report, it was concluded that the operation of Limerick Generating Station had no adverse radiological impact on the environment offsite of LGS. Additionally, there does not appear to be an active source of tritium to groundwater at the Station.

II. Introduction

The Limerick Generating Station (LGS), consisting of two 3515 MW boiling water reactors owned and operated by Exelon Corporation, is located adjacent to the Schuylkill River in Montgomery County, Pennsylvania. Unit No. 1 went critical on 22 December 1984. Unit No. 2 went critical on 11 August 1989.

The site is located in Piedmont countryside, transversed by numerous valleys containing small tributaries that feed into the Schuylkill River. On the eastern riverbank elevation rises from approximately 110 to 300 feet mean sea level (MSL). On the western riverbank elevation rises to approximately 50 feet MSL.

This report covers those analyses performed by Teledyne Brown Engineering (TBE) on samples collected in 2021 and analysis for replicate samples performed by GEL Laboratories.

In 2006, Exelon instituted a comprehensive program to evaluate the impact of station operations on groundwater and surface water in the vicinity of Limerick Generating Station. This evaluation involved numerous station personnel and contractor support personnel.

A. Objective of the RGPP

The long-term objectives of the RGPP are as follows:

1. Identify suitable locations to monitor and evaluate potential impacts from station operations before significant radiological impact to the environment and potential drinking water sources.
2. Understand the local hydrogeologic regime in the vicinity of the station and maintain up-to-date knowledge of flow patterns on the surface and shallow subsurface.
3. Perform routine water sampling and radiological analysis of water from selected locations.
4. Report new leaks, spills, or other detections with potential radiological significance to stakeholders in a timely manner.
5. Regularly assess analytical results to identify adverse trends.
6. Take necessary corrective actions to protect groundwater resources.

B. Implementation of the Objectives

The objectives identified have been implemented at Limerick Generating Station as discussed below:

1. Exelon and its consultant identified locations as described in the 2006 Phase 1 study. The Phase 1 study results and conclusions were made available to state and federal regulators in station specific reports.
2. The Limerick Generating Station reports describe the local hydrogeologic regime. Periodically, the flow patterns on the surface and shallow subsurface are updated based on ongoing measurements.
3. Limerick Generating Station will continue to perform routine sampling and radiological analysis of water from selected locations.
4. Limerick Generating Station has procedures to identify and report new leaks, spills, or other detections with potential radiological significance in a timely manner.
5. Limerick Generating Station staff and consulting hydrogeologist assess analytical results on an ongoing basis to identify adverse trends.

C. Program Description

Samples for the ongoing ground water monitoring program were collected by Exelon Industrial Services (EIS). This section describes the general collection methods used to obtain environmental samples for the LGS RGPP in 2021. Sample locations can be found in Table E–1, Appendix E.

1. Sample Collection

Groundwater

Samples of groundwater were collected, managed, transported and analyzed in accordance with approved procedures following EPA methods. Sample locations, sample collection frequencies and analytical frequencies were controlled in accordance with approved station procedures. Contractor and/or station personnel were trained in the collection, preservation management, and shipment of samples, as well as in documentation of sampling events. Analytical laboratories were subject to internal quality assurance programs, industry cross- check programs, as well as nuclear industry audits. Station personnel reviewed and evaluated all analytical data deliverables as data were received. Both station personnel and an independent hydrogeologist reviewed analytical data results for adverse trends or changes to hydrogeological conditions.

Precipitation

A five-gallon precipitation collection bucket fitted with a funnel was installed at four locations around the Limerick Generating Station. Three collection buckets were located on site in the highest prevalent wind sectors and one located on site in the least prevalent wind sector.

D. Characteristics of Tritium (H-3)

Tritium (chemical symbol H-3) is a radioactive isotope of hydrogen. The most common form of tritium is tritium oxide, which is also called "tritiated water." The chemical properties of tritium are essentially those of ordinary hydrogen.

Tritiated water behaves the same as ordinary water in both the environment and the body. Tritium can be taken into the body by drinking water, breathing air, eating food, or absorption through skin. Once tritium enters

the body, it disperses quickly and is uniformly distributed throughout the body. Tritium is excreted primarily through urine with a clearance rate characterized by an effective biological half-life of about 14 days. Within one month or so after ingestion, essentially all tritium is cleared. Organically bound tritium (tritium that is incorporated in organic compounds) can remain in the body for a longer period.

Tritium is produced naturally in the upper atmosphere when cosmic rays strike air molecules. Tritium is also produced during nuclear weapons explosions, as a by-product in reactors producing electricity, and in special production reactors, where the isotopes lithium-7 and/or boron-10 are activated to produce tritium. Like normal water, tritiated water is colorless and odorless. Tritiated water behaves chemically and physically like non- tritiated water in the subsurface, and therefore tritiated water will travel at the same velocity as the average groundwater velocity.

Tritium has a half-life of approximately 12.3 years. It decays spontaneously to helium-3 (3He). This radioactive decay releases a beta particle (low- energy electron). The radioactive decay of tritium is the source of the health risk from exposure to tritium. Tritium is one of the least dangerous radionuclides because it emits very weak radiation and leaves the body relatively quickly. Since tritium is almost always found as water, it goes directly into soft tissues and organs. The associated dose to these tissues

is generally uniform and is dependent on the water content of the specific tissue.

III. Program Description

A. Sample Analysis

This section lists the analyses performed by TBE and GEL Laboratories, LLC (GEL) on environmental samples for the LGS RGPP in 2021. The analytical procedures used by the laboratories are listed in the AREOR References.

In order to achieve the stated objectives, the current program includes the following analyses:

1. Concentrations of tritium in groundwater and precipitation water
2. Concentrations of gross alpha (dissolved and suspended) in groundwater
3. Concentrations of gamma-emitters (Be-7, K-40, Mn-54, Co-58, Fe-59, Co-60, Zn-65, Nb-95, Zr-95, I-131, Cs-134, Cs-137, Ba-140, and La-140) in groundwater
4. Concentrations of strontium (Sr-89 and Sr-90) in groundwater

B. Data Interpretation

The radiological data collected prior to Limerick Generating Station becoming operational were used as a baseline with which these operational data were compared. For the purpose of this report, Limerick Generating Station was considered operational at initial criticality. Several factors were important in the interpretation of the data:

1. <u>Lower Limit of Detection and Minimum Detectable Concentration</u>

The lower limit of detection (LLD) is defined as the smallest concentration of radioactive material in a sample that would yield a net count (above background) that would be detected with only a 5% probability of falsely concluding that a blank observation represents a "real" signal. The LLD is intended as a before the fact estimate of a system (including instrumentation, procedure and sample type) and not as an after the fact criterion for the presence of activity. All analyses were designed to achieve the required LGS detection capabilities for environmental sample analysis.

The minimum detectable concentration (MDC) is defined above with the exception that the measurement is an after the fact estimate of the presence of activity.

2. LaboratoryMeasurementsUncertainty

The estimated uncertainty in measurement of tritium in environmental samples is frequently on the order of 50% of the measurement value.

Statistically, the exact value of a measurement is expressed as a range with a stated level of confidence. The convention is to report results with a 95% level of confidence. The uncertainty comes from calibration standards, sample volume or weight measurements, sampling uncertainty and other factors. Exelon reports the uncertainty of a measurement created by statistical process (counting error) as well as all sources of error (Total Propagated Uncertainty or TPU). Each result has two values calculated. Exelon reports the TPU by following the result with plus or minus (±) the estimated sample standard deviation, as TPU, that is obtained by propagating all sources of analytical uncertainty in measurements.

Analytical uncertainties are reported at the 95% confidence level in this report for reporting consistency with the AREOR.

C. Background Analysis

A pre-operational radiological environmental monitoring program (pre-operational REMP) was conducted to establish background radioactivity levels prior to operation of the Station. The environmental media sampled and analyzed during the pre-operational REMP were atmospheric radiation, fall-out, domestic water, surface water, aquatic life, and foodstuffs. The results of the monitoring were detailed in the report entitled *Pre-operational Radiological Environmental Monitoring Program Report, Limerick Generating Station Units 1 and 2, 1 January 1982 through 21 December*

1984, Teledyne Isotopes and Radiation Management Corporation.

The pre-operational REMP contained analytical results from samples collected from both surface water and groundwater.

Monthly surface water sampling began in 1982, and the samples were analyzed for tritium as well as other radioactive analytes. During the preoperational program tritium was detected at a maximum concentration of

420 pCi/L, indicating that these preoperational results were from nuclear weapons testing and is radioactively decaying as predicted. Gamma isotopic results from the preoperational program were all less than or at the minimum detectable concentration (MDC) level.

1. Background Concentrations of Tritium

The purpose of the following discussion is to summarize background measurements of tritium in various media performed by others. Additional detail may be found by consulting references.

a. Tritium Production

Tritium is created in the environment from naturally occurring processes both cosmic and subterranean, as well as from anthropogenic (i.e., man-made) sources. In the upper atmosphere, “Cosmogenic” tritium is produced from the bombardment of stable nuclides and combines with oxygen to form tritiated water, which will then enter the hydrologic cycle. Below ground, “lithogenic” tritium is produced by the bombardment of natural lithium present in crystalline rocks by neutrons produced by the radioactive decay of naturally abundant uranium and thorium. Lithogenic production of tritium is usually negligible compared to other sources due to the limited abundance of lithium in rock. The lithogenic tritium is introduced directly to groundwater.

A major anthropogenic source of tritium and Sr-90 comes from the former atmospheric testing of thermonuclear weapons. Levels of tritium in precipitation increased significantly during the 1950s and early 1960s, and later with additional testing, resulting in the release of significant amounts of tritium to the atmosphere. The Canadian heavy water nuclear power reactors, other commercial power reactors, nuclear research and weapons production continue to influence tritium concentrations in the environment.

b. Precipitation Data

Precipitation samples are routinely collected at stations around the world for the analysis of tritium and other radionuclides. Two publicly available databases that provide tritium concentrations in precipitation are Global Network of Isotopes in Precipitation (GNIP) and USEPA’s RadNet database. GNIP provides tritium precipitation concentration data for samples collected worldwide since 1960. RadNet provides tritium precipitation concentration data for samples collected at stations throughout the U.S. Based on GNIP data for sample stations located in the U.S. Midwest, tritium concentrations peaked around 1963. This peak, which approached 10,000 pCi/L for some stations, coincided with the atmospheric testing of thermonuclear weapons. Tritium concentrations in surface water showed a sharp decline up until

1975 followed by a gradual decline since that time. Tritium concentrations have typically been below 100 pCi/L since approximately 1980. Tritium concentrations in wells may still be above the 200 pCi/L detection limit from the external causes described above.

Water from previous years was naturally captured in groundwater. As a result, some well water sources today are affected by the surface water from the 1960s that contained elevated tritium activity.

c. Surface Water Data

Tritium concentrations are routinely measured in the Schuylkill and Delaware Rivers. Pennsylvania surface water data are typically less than 100 pCi/L.

The USEPA RadNet surface water data typically has a reported

'Combined Standard Uncertainty' of 35 to 50 pCi/L. According to USEPA, this corresponds to a ±70 to 100 pCi/L 95% confidence bound on each given measurement. Therefore, the typical background data provided may be subject to measurement uncertainty of approximately ± 70 to 100 pCi/L.

The radioanalytical laboratory is counting tritium results to an Exelon specified LLD of 200 pCi/L. Typically, the lowest positive measurement will be reported within a range of 40 – 240 pCi/L or

140 ± 100 pCi/L. Clearly, these sample results cannot be

distinguished as different from background at this concentration. The surface water data ends in 1999 as the USEPA RadNet surface water program was terminated in March 1999.

The Exelon fleet-wide and Limerick RGPP was modified at the beginning of 2020. Changes to the RGPP included sample locations, frequency and the removal of surface water sampling.

IV. Results and Discussion

A. Groundwater Results

Samples were collected from onsite wells throughout the year in accordance with the station Radiological Groundwater Protection Program. Analytical results and anomalies are discussed below:

Tritium

Samples from 13 locations were analyzed for tritium activity. (Appendix E, Table E–6) Tritium values ranged from non-detectable to 2190 pCi/L. Although no drinking water pathway is available from groundwater, the theoretical dose via the drinking water pathway was calculated at 0.130 mrem to a child (total body), which represents 2.159% of the 10 CFR 50, Appendix I dose limit of 6 mrem.

Strontium

Samples were analyzed for Sr-89 and Sr-90. All results were below the required LLDs. (Appendix E, Table E–5)

GrossAlpha(dissolvedandsuspended)

No analyses for gross alpha were performed in 2021

GammaEmitters

No analyses for gamma emitting nuclides were performed in 2021

Hard-To-Detect

HTD analyses were performed in 2021 on 7 groundwater locations. There were no detects and all results were below the required LLDs (Appendix E, Table E-4)

B. Precipitation Sample Results

Tritium

Tritium activity was detected in 8 of 12 precipitation water locations analyzed. The concentrations ranged from 200 to 1200 pCi/L. These concentrations are consistent with historical values observed. (Appendix E, Table E-7)

C. Drinking Water Well Survey

In April, 2019, GHD (formerly Conestoga Rover Associates) conducted a comprehensive database search (PaGWIS) for private and public wells within one mile of the Station. The detailed results of the 2019 well search are presented in Appendix C of the 2019 Hydrogeologic Investigation Report for Limerick Generating Station. In general, the well depths range from 45 to 585 feet below ground surface, (bgs), and yield between 2 and 65 gpm. All wells are completed in the Brunswick Formation. In the GHD report, Figure 2.3 presents the approximate locations of the water wells that surround the Station.

A review of the PaGWIS database table reveals the following type and associated number of off-Station wells within the on-mile radius of the Station:

- Domestic = 41 wells (68%)
- Industrial = 5 wells (8%)
- Observation = 9 wells (15%)
- Abandoned = 5 wells (8%)
- Total = 60 wells

One well was identified at the active quarry, which is approximately 2,000 feet to the northwest of the Station. The PaGWIS database search identifies the quarry well as constructed to a depth of 100 feet bgs, and reportedly yields at least 50,400 gpd (35 gpm). A well inventory included in the Station's USFAR cites the total depth of the quarry supply well as 130 feet bgs, with a yield of 100 gpm, and typical operation of 50 gpm for ten hours a day.

The Station has one potable supply well and one fire water well. The potable supply well is constructed as an open-rock borehole. Groundwater was measured at a depth 102 feet bgs during a well pump replacement in

2014. The pump was placed at a depth of approximately 294 feet bgs. The total well depth and the depth of the steel casing are approximately 310 feet bgs. The well is located approximately 175 feet east of the Reactor Building. The potable supply well is sampled as part of the RGPP and designated as DW-LR-1. In 2019, DW-LR-1 pumped 6,785,500 gallons.

The fire water well is constructed as an open-rock borehole. Groundwater was encountered at 121 feet bgs during a well pump replacement in 2004. The well pump was placed at a depth of approximately 399 feet bgs. The total well depth and the depth of the steel casing are unknown. The well is located approximately 500 feet east of the cooling towers. The well is used in an emergency fire situation and for system testing and flushing. In 2019, 1,709,275 gallons were pumped from the well.

D. Summary of Results- Inter-Laboratory Comparison Program

Inter-Laboratory Comparison Program results for TBE are presented in the Annual Radiological Environmental Operating Report. In addition, the results for interlaboratory comparison RGPP samples are included in the data tables in Appendix E.

E. Leaks, Spill, and Releases

There were no spills to ground containing radioactive material in 2021.

F. Trends

Low level tritium detections in monitoring well MW-LR-9 are being trended.

G. Investigations

Intermittent, low-level tritium detections in monitoring well MW-LR-9 are currently being investigated.

H. Actions Taken

1. Compensatory Actions

   There have been no station events requiring compensatory actions at the Limerick Generating Station.

2. Installation of Monitoring Wells

   No new monitoring wells.

3. Actions to Recover/Reverse Plumes

   No actions were required to recover or reverse groundwater plumes.

V. References

1. GHD, Inc. Hydrogeologic Investigation Report, Limerick Generating Station, 3146 Sanatoga Road, Pottstown, Pennsylvania, Ref. No. 11189800(1), December 2019

2. Pre-operational Radiological Environmental Monitoring Program Report, Limerick Generating Station Units 1 and 2, 1 January 1982 through 21 December 1984, Teledyne Isotopes and Radiation Management Corporation

3. 2021 Annual RGPP Monitoring Report Summary of Results and Conclusions, Limerick Generating Station, AMO Environmental Decisions, Pottstown, Pennsylvania, Feb28, 2022

TABLE OF CONTENTS - ANALYTICAL RESULTS

TABLE E-1

Locations of Onsite Radiological Groundwater Protection Program

Limerick Generating Station, 2021

RGPP	Description
MW-LR-1	Monitoring Well
MW-LR-2	Monitoring Well
MW-LR-3	Monitoring Well
MW-LR-4	Monitoring Well
MW-LR-5	Monitoring Well
MW-LR-6	Monitoring Well
MW-LR-7	Monitoring Well
MW-LR-8	Monitoring Well
MW-LR-9	Monitoring Well
MW-LR-10	Monitoring Well
P3	Monitoring Well
P11	Monitoring Well
P14	Monitoring Well
P17	Monitoring Well
DW-LR-1	Monitoring Well
36S3	Precipitation Water
E-5	Precipitation Water
ESE-6	Precipitation Water
RS-1	Precipitation Water
RS-2	Precipitation Water
RS-3	Precipitation Water
RS-4	Precipitation Water
RS-5	Precipitation Water
RS-6	Precipitation Water
RS-7	Precipitation Water
RS-8	Precipitation Water
SE-7	Precipitation Water

Figure E-2
Routine Well Water Sample Locations for the Radiological Groundwater Protection Program, Limerick Generating Station, 2021

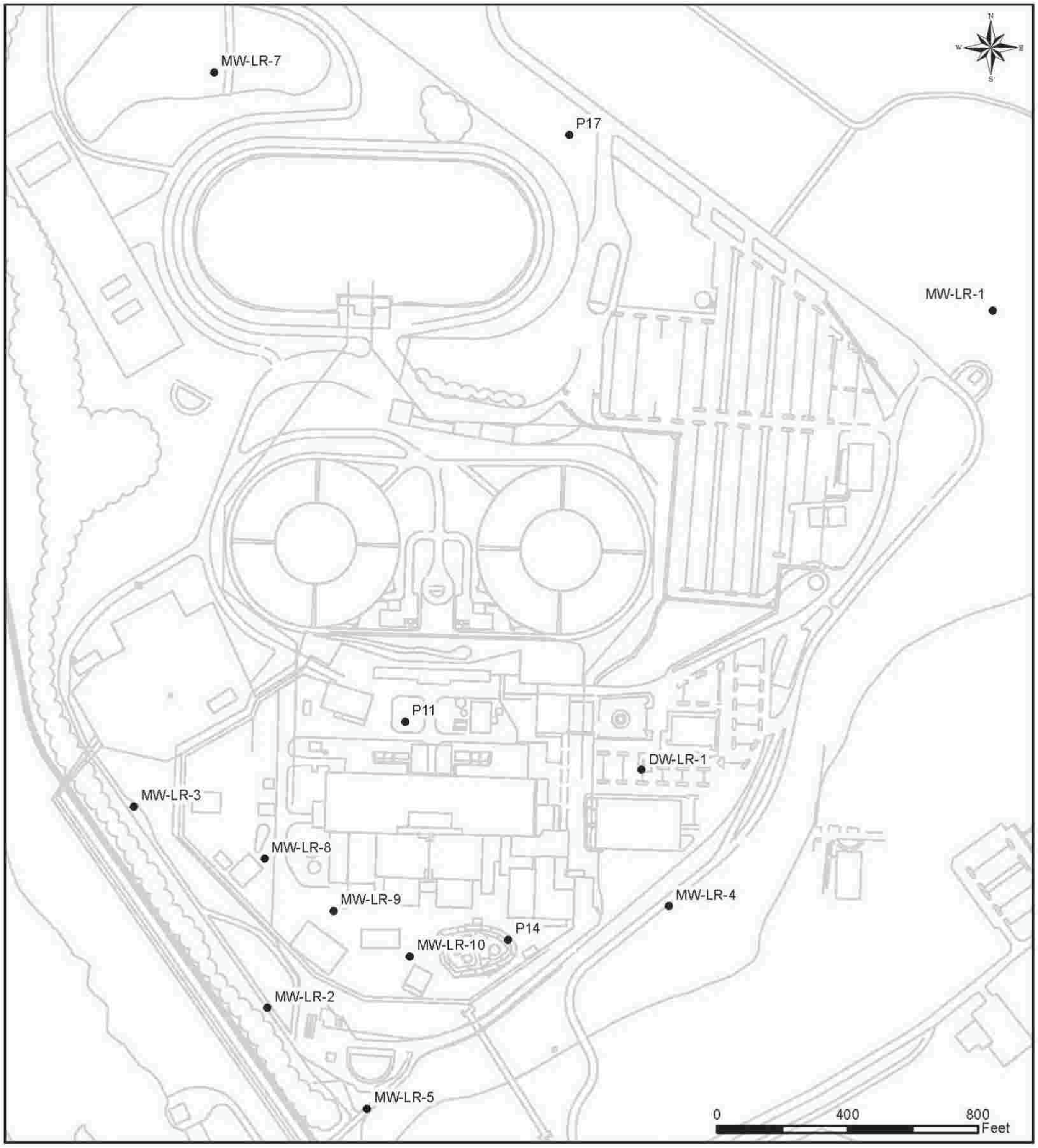
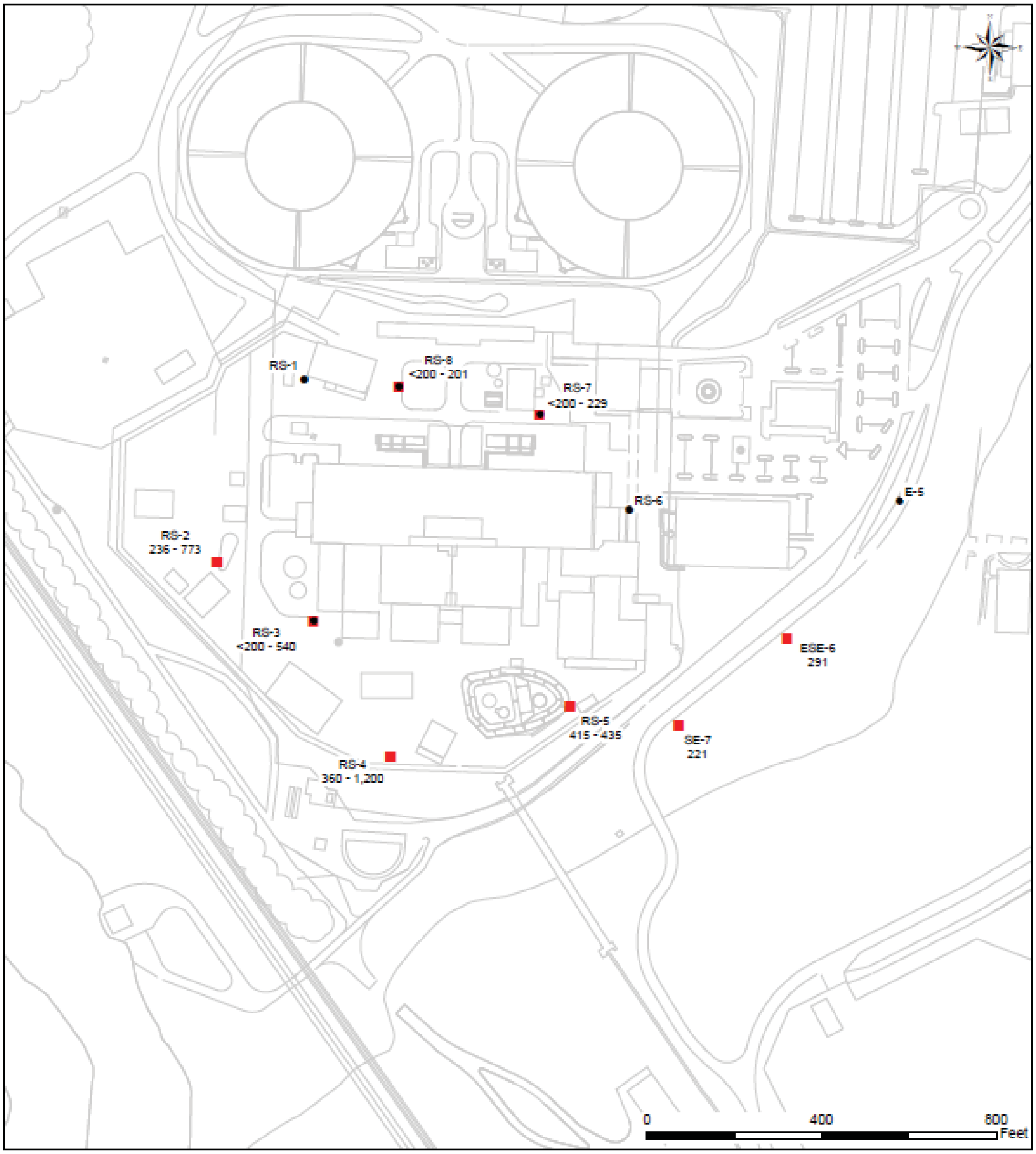


Figure E-3

Routine Precipitation Sample Locations for the Radiological Groundwater Protection Program, Limerick Generating Station, 2021



Explanation:
2021 Precipitation Recapture Sample Locations
■ Result >200 pCi/L
● Result <200 pCi/L
415 - 435 - Tritium concentration range in pCi/L in 2021
- Precipitation recapture samples collected in February and October 2021.

Figure 3
2021 Precipitation Recapture
Sample Locations
Exelon Corporation
Limerick Generating Station

Table E-4

Hard to Detects in Groundwater
(Results in units of pCi/L ± 2σ)

Station	Sample Date	Fe-55	Ni-63
MW-LR-4	4/20/2021	<190	<4.47
MW-LR-1	4/22/2021	<105	<4.31
MW-LR-8	4/22/2021	<57.6	<4.48
MW-LR-8(Dup)	4/22/2021	<179	<4.02
MW-LR-8(QA)	4/22/2021	<52.8	<20.9
MW-LR-9	4/22/2021	<118.1	<4.94
MW-LR-10	4/22/2021	<116.5	<4.66
P11	4/22/2021	<41.28	<4.18
P14	4/22/2021	<108.7	<4.96

Table E-5

Concentration of Radiostrontium in Groundwater
(Results in units of pCi/L ± 2σ)

Station	Sample Date	SR-89 (pCi/L)	SR-90 (pCi/L)
MW-LR-4	4/20/21	<5.95	<.599
MW-LR-1	4/22/21	<6.74	<.595
MW-LR-8	4/22/21	<7.9	<.582
MW-LR-8(Dup)	4/22/21	<8.71	<.6
MW-LR-8(QA)	4/22/21	<1.07	<0.84
MW-LR-9	4/22/21	<4.03	<.623
MW-LR-10	4/22/21	<6.85	<.589
P11	4/22/21	<6.1	<.639
P14	4/22/21	<6.72	<.636

Table E-6

Concentration of Tritium in Groundwater
(Results in units of pCi/L ± 2σ)

LOCATION	01/27/2021	4/20/21	4/22/21	5/7/21	6/4/21	7/21/21	9/3/21	9/29/21	10/27/21	11/24/21	12/17/21
DW-LR-1	<185	<179	<178	ND	ND	<177	ND	ND	<188	ND	ND
DW-LR-1(Dup)	ND	<177	<177	ND	ND	ND	ND	ND	ND	ND	ND
DW-LR-1(QA)	ND	<179	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-LR-2	ND	ND	<176	ND	ND	ND	ND	ND	ND	ND	ND
MW-LR-3	ND	ND	<173	ND	ND	ND	ND	ND	ND	ND	ND
MW-LR-4	<184	<179	ND	ND	ND	<178	ND	ND	<196	ND	ND
MW-LR-5	ND	194± 118	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-LR-7	ND	<178	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-LR-8	340± 124	ND	420±131	ND	ND	376±125	ND	ND	383±132	ND	ND
MW-LR-8 (Dup)	ND	ND	493±133	ND	ND	406±128	ND	ND	387±135	ND	ND
MW-LR-8 (QA)	ND	ND	271±94	ND	ND	405±100	ND	ND	288±124	ND	ND
MW-LR-9	721 ± 151	ND	2080±270	1960±282	2190±287	2020±269	1890±252	1910±260	1290±206	1620±233	1610±225
MW-LR-9(Dup)	606 ± 143	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-LR-9(QA)	701± 251	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-LR-10	<182	ND	<180	ND	ND	<181	ND	ND	<190	ND	ND
LR-P11	<181	ND	<181	ND	ND	<195	ND	ND	<197	ND	ND
LR-P14	<185	ND	<178	ND	ND	<174	ND	ND	<192	ND	ND
LR-P17	ND	<177	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND – No Data, Sample obtained as required
(Dup) –Sample analyzed in duplicate by TBE
(QA) –Additional sample collected and analyzed for Quality Assurance by GEL Laboratories

Table E-7

Concentration of Tritium in Surface Water, Precipitation, and Subsurface Drainage
(Results in units of pCi/L ± 2σ)

LOCATION	2/15/22	01/03/22
RS-1	<174	<182
RS-2	773 ±147	236±124
RS-3	540±134	200±118
RS-4	1200±185	360±132
RS-5	435±127	415±141
RS-6	<182	<176
RS-7	<179	229±122
RS-8	<183	201±124
SE-7	ND	221±119
ESE-6	ND	291±126
E-5	ND	<177
36S3	ND	<177