Exelon Generation®

TS 6.9.1.7

LG-20-045

April 29, 2020

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: 2019 Annual Radiological Environmental Operating Report

In accordance with the requirements of Section 6.9.1.7 of Limerick Generating Station (LGS) Unit 1 and Unit 2 Technical Specifications (TS), and Section 6.1 of the LGS Units 1 and 2 Offsite Dose Calculation Manual (ODCM), this letter submits the 2019 Annual Radiological Environmental Operating Report. This report provides the 2019 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, with the exception of CS-137, were found in any pathway modeled by the REMP. The detected CS-137 was concluded to not be from LGS. 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 Orlando Credendino at 610-718-2701.

Respectfully,

Digitally signed by Frank Sturniolo
Date: 2020.04.30 09:25:11 -04'00'

Frank Sturniolo
Vice President-Limerick Generating Station
Exelon Generation Company, LLC

Attachment: 2019 Annual Radiological Environmental Operating Report

cc: Administrator, Region I, USNRC (w/attachment)
LGS USNRC Senior Resident Inspector (w/attachment)
H. Anagnostopoulos, Inspector Region I, USNRC (w/attachment)
V. Sreenivas, LGS Senior Project Manager-NRR, USNRC (w/attachment)

ATTACHMENT

2019 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

Docket No: 50-352
50-353

LIMERICK GENERATING STATION
UNITS 1 AND 2

Annual Radiological Environmental Operating Report

1 January through 31 December 2019

Prepared By
Teledyne Brown Engineering
Environmental Services

Exelon Generation®

Limerick Power Station
Pottstown, PA 19464

April 2020

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Appendices

I. Preface

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

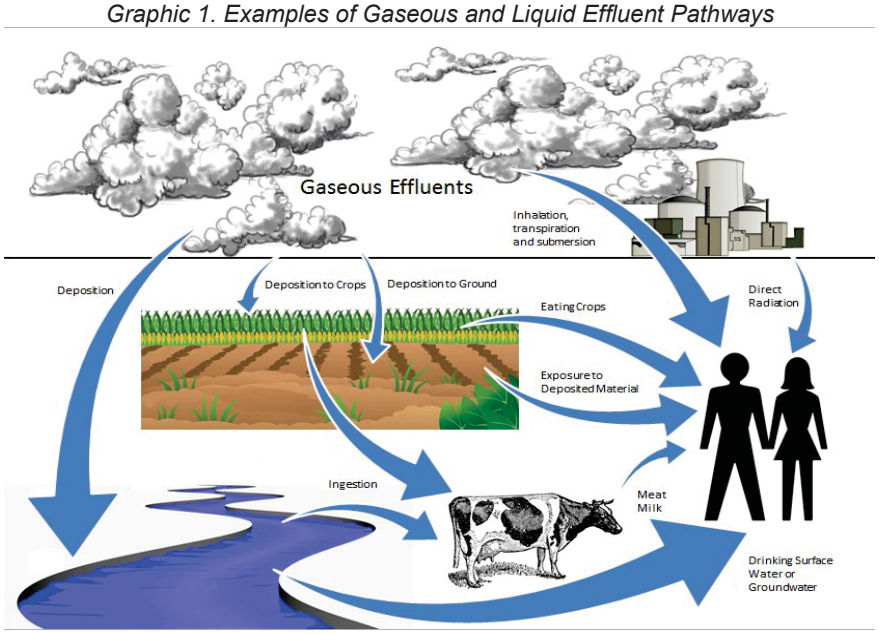
Annual Reports

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.

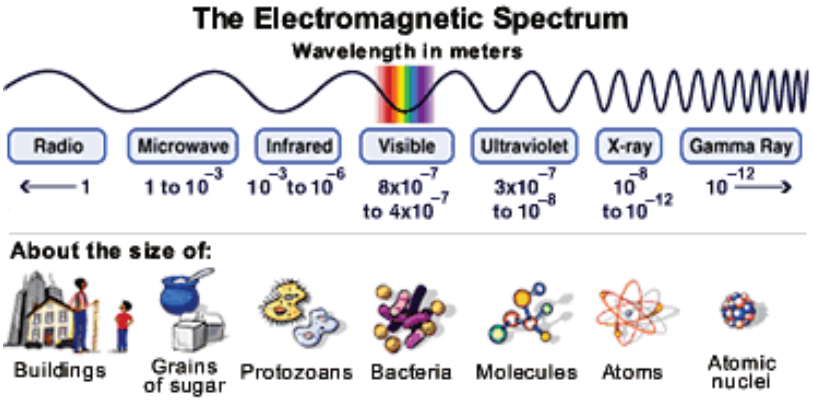
Graphic 1. Examples of Gaseous and Liquid Effluent Pathways



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.

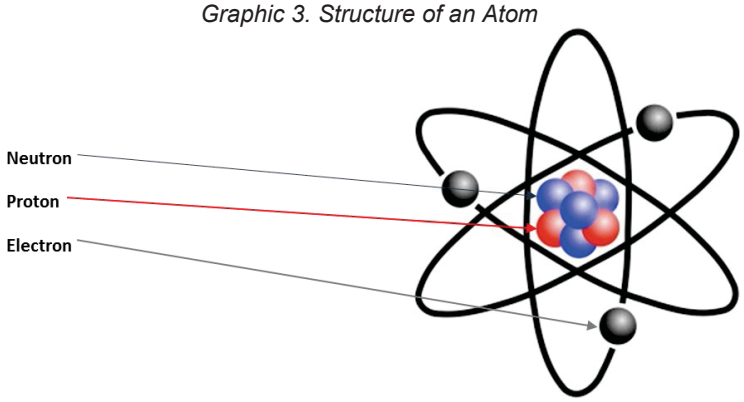
Generally radiation is defined as emitted energy in the form of waves or particles. If radiation has enough energy to displace electrons from an atom it is termed "ionizing", otherwise it is "non-ionizing". Non-Ionizing radiation includes light, heat given off from a stove, radiowaves and microwaves. 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.

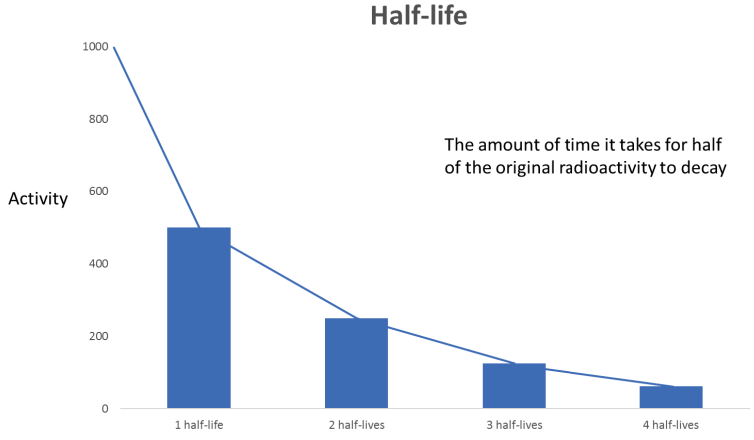
Isotopes are atoms that have the same number of protons but different numbers of neutrons. Different isotopes of an element will all have the same chemical properties and many isotopes are radioactive while other isotopes are not radioactive. A radioactive isotope can emit radiation because it contains 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 radionucides 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 ocurring 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.

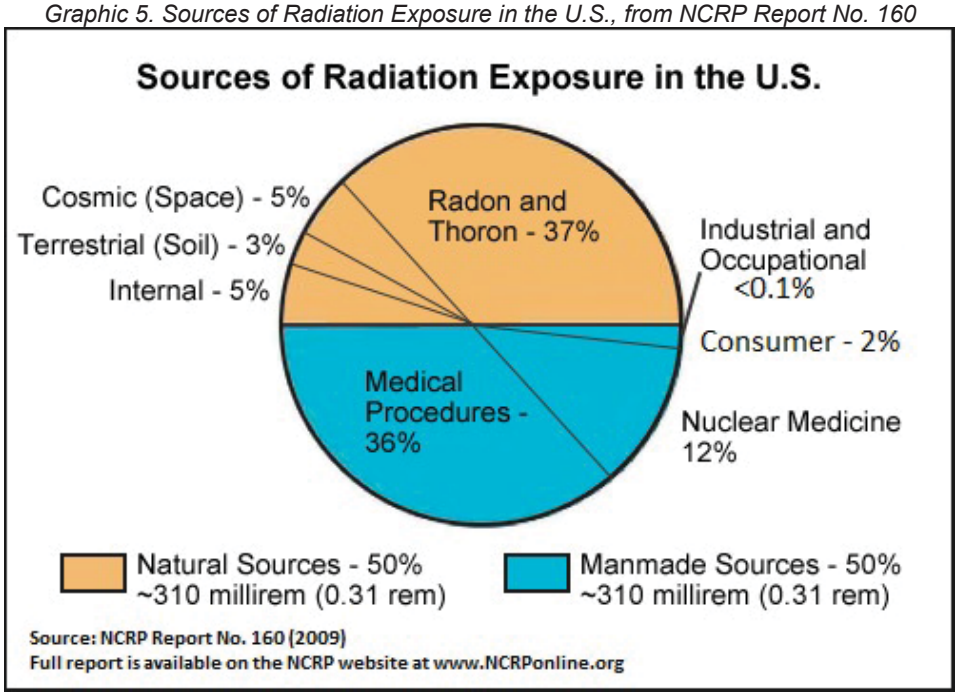
- Absorbed dose describes the amount of radiation absorbed by an object or person. The units of measure for absorbed dose used within the AREOR and ARERR are the rad. Noble gas air doses are reported by the site are measured in millirad (mrad), 1/1,000 of one rad.

- 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

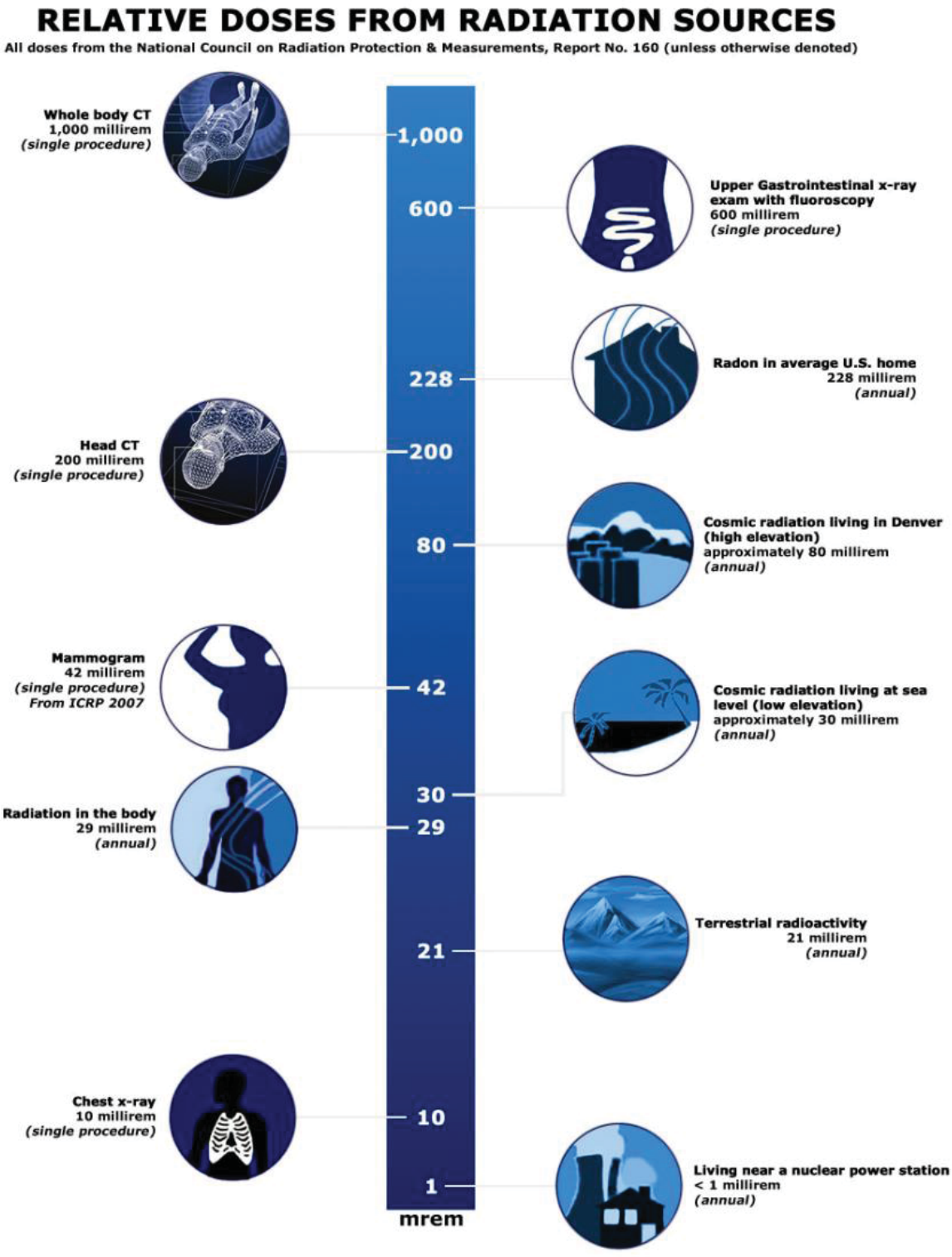
People are exposed to radiation every day of their lives and have been since the dawn of mankind. Some of this radiation is naturally occurring while some is man-made. There are many factors that will determine the amount of radiation individuals will be exposed to such as where they live, medical treatments, 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

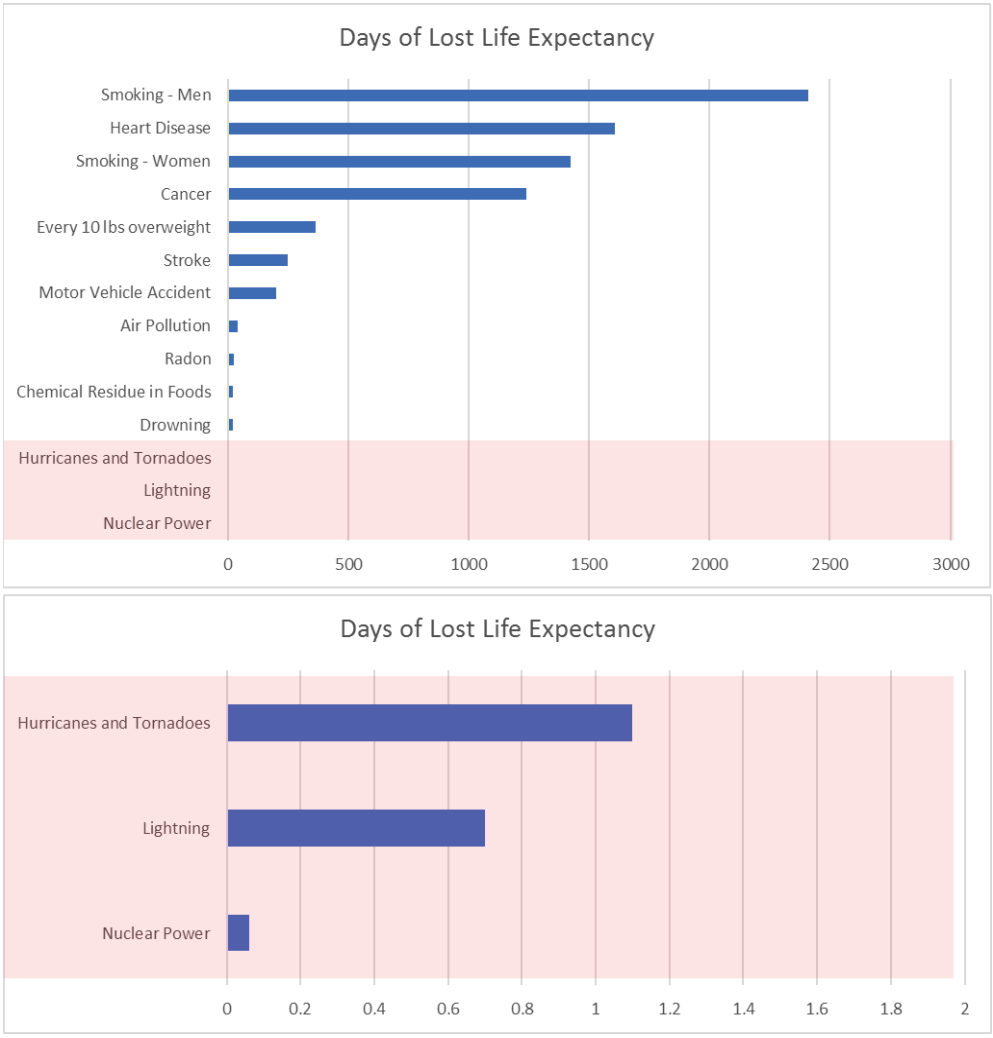


Radiation Risk

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



II. Summary and Conclusions

In 2019, the Limerick Generating Station released to the environment through the radioactive effluent liquid and gaseous pathways approximately 48 curies of noble gas, fission and activation products and approximately 99 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:

Gaseous and Liquid Radiation Doses to Members of the Public at the Highest Dose Receptor						
Maximum Individual Noble Gas	**Applicable Dose**	**Estimated Dose**	**Age Group**	**% of Applicable Limit**	**Limit**	**Unit**
Nearest Residence	Gamma Air Dose	1.03E-03	All	5.15E-03	20	mRad
Nearest Residence	Beta Air Dose	6.12E-04	All	1.53E-03	40	mRad
Nearest Residence	Total Body	9.79E-04	All	9.79E-03	10	mrem
Nearest Residence	Skin	1.62E-03	All	5.40E-03	30	mrem
Iodine, Particulate, C-14 & Tritium						
Vegetation Pathway	Bone	1.26E+00	Child	4.22E+00	30	mrem
Liquid						
LGS Outfall	Total Body	9.63E-03	Adult	1.61E-01	6	mrem
LGS Outfall	Liver	1.23E-02	Teen	6.17E-02	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 2019 through 31 December 2019. During that time period, 1,503 analyses were performed on 1,254 samples.

Surface and drinking water samples were analyzed for concentrations of tritium, low level Iodine-131 (I-131) and gamma-emitting nuclides. Drinking water samples were also analyzed for concentrations of total gross beta. Iodine-131 was not detected in primary laboratory samples nor in the secondary laboratory for drinking water. 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. Samples collected upstream of the discharge had Cesium-137 (Cs-137) concentrations that were consistent with those detected in previous years. The Cs-137 identified in sediment is attributed to weapons testing fallout partly due to the fact that there is no Cs-134 identified, which would be expected if related to plant

effluents. No other station-produced fission or activation products were found in sediment. For results, discussion and dose to member of the public calculation see Section IV.A.4.

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 Potassium-40 (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. Be-7 and K-40 were detected in all samples. Radium-226 (Ra-226) was found in 8 of 34 samples. Thorium-228 (Th-228) was found in 17 of 34 samples. Thorium-232 (Th-232) was found in 2 of 34 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. In 2019, well water samples were analyzed for tritium (H-3), strontium-89 (Sr-89), strontium-90 (Sr-90), gross alpha, gross beta, and gamma emitters. Surface water samples were analyzed for tritium, Sr-89, Sr-90 and gamma emitters. Precipitation water samples were analyzed for tritium. Most of the tritium values for well water, surface water and precipitation water were less than the lower limit of detection of 200 pCi/L. Results and Discussion of groundwater samples are covered in Appendix G.

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.

III. 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 river bank, elevation rises from approximately 110 to 300 feet mean sea level (MSL). On the western river bank 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 Teledyne Brown Engineering (TBE), Mirion Technologies, and Exelon Industrial Services (EIS)/GEL Laboratories (GEL) on samples collected during the period 1 January 2019 through 31 December 2019.

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.

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

IV. Program Description

A. Sample Collection

Samples for the LGS REMP were collected for Exelon Nuclear by Exelon Industrial Services (EIS) and Normandeau Associates, Inc. (NAI). This section describes the general collection methods used to obtain environmental samples for the LGS REMP in 2019. Sample locations and descriptions can be found in Tables B–1 and B–2, and Figures B–1 through B–3, Appendix B. The collection procedures used by EIS are listed in Table B-3. 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.

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 hogsucker/ white hogsucker/carp) and predator (smallmouth bass/American eel/rock bass/bluegill sunfish/redbreast sunfish, black crappie), 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).

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.

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. One additional location (36E1) was sampled quarterly. Locations 36E1 and 23F1 were controls. 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.

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 interests 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.

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 2019, 2,835 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.

B. Sample Analysis

This section lists the analyses performed by the primary laboratory, Teledyne Brown Engineering (TBE), the secondary laboratories, Exelon Industrial Services, LLC (EIS) and GEL Laboratories, LLC (GEL) and also Mirion Technologies on environmental samples for the LGS REMP in 2019. The analytical procedures used by the laboratories are listed in Appendix B Table B-3. Analysis results from TBE are provided in Appendix C. Analysis results from EIS and GEL Laboratories are provided in Appendix D of this report.

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

1. Concentrations of beta emitters in drinking water and air particulates
2. Concentrations of gamma emitters in surface and drinking water, air particulates, milk, fish, broad leaf vegetation, and sediment
3. Concentrations of tritium in surface and drinking water
4. Concentrations of I-131 in air, milk, and drinking water
5. Ambient gamma radiation levels at various site environs

C. 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.

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

2. Net Activity Calculation and Reporting of Results

Net activity for a sample was calculated by subtracting background activity from the sample activity. Since the REMP measures extremely small changes in radioactivity in the environment, background variations may result in sample activity being lower than the background activity affecting a negative number. An MDC was reported in all cases where positive activity was not detected.

Gamma spectroscopy analyzes samples for the full range of nuclides. All nuclides that identified positive results are reported. Each type of sample also looks for specific nuclides and the results for each type of sample were reported as follows:

For surface and drinking water, twelve nuclides, 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 were reported

For broadleaf vegetation, eleven nuclides, Be-7, K-40, Mn-54, Co-58, Co-60, I-131, Cs-134, Cs-137, Ra-226, Th-228, and Th-232 were reported

For fish, nine nuclides, K-40, Mn-54, Co-58, Fe-59, Co-60, Zn-65, I-131, Cs-134, and Cs-137 were reported

For sediment, eight nuclides, Be-7, K-40, Mn-54, Co-58, Co-60, I-131, Cs-134, and Cs-137 were reported

For air particulates, six nuclides, Be-7, Mn-54, Co-58, Co-60, Cs-134, and Cs-137 were reported

For milk, five nuclides, K-40, Cs-134, Cs-137, Ba-140, and La-140 were reported

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.

D. Program Exceptions

For 2019 the LGS REMP had a sample recovery rate of greater than 99%. Exceptions are listed below:

1. Air sample from location 15D1 for the week of 04/02/20 - 04/08/19 was not available due to the pump not running due to broken vanes. The vanes were replaced, and the pump was returned to service. (IR 4271443)
2. Air sample from location 13S4 for the week of 05/28/19 - 06/03/19 was not available due not available due to the pump not running due to broken vanes. The vanes were replaced, and the pump was returned to service. (IR 4271443)
3. Air sample from location 14S1 for the week of 06/03/19 - 06/11/19 was not available due to the pump not running due to a blown fuse caused by a bad bearing. The pump and fuse were replaced, and the sampler was returned to service. (IR 4271447)

   NOTE: As part of the corrective actions for air sample pumps not running, telemetry was installed at all air sample stations to notify station personnel when any of the stations is involved in a loss of power incident.
4. Drinking water sample from location 16C2 did not have enough sample for the QC split sample for low-level iodine analysis. This was due to a human performance error while acidifying the weekly samples for gamma analysis. This error only impacted the QC split sample as there was enough sample for the required monthly sample. (IR 4293514)

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.

E. Program Changes

Revision 32 of the Offsite Dose Calculation Manual (ODCM) was implemented in 2019. A summary of changes are:

- Page 84, Section 1.2.2 under LIQUID EFFLUENT MONITOR SETPOINT DETERMINATION there is discussion for the monitor setpoint calculation which describes default values and has values listed for the default values. This change is removing the listed default values and changing the wording to station procedurally controlled default values to allow a blowdown line value lower than the current listed value of 5,000 gpm when conditions are such that a minimum 5,000 gpm blowdown flow rate cannot be achieved. There is NO change to the actual setpoint calculation in step 1.2.1.1

- Page 327, Figure A-2 was updated to show the entire section of river used for REMP sample locations 29C1 and 16C5 for fish sampling. (Administrative Change)

A complete copy of ODCM Revision 32 is included with the Limerick 2019 Annual Radioactive Effluent Release Report.

F. Compliance to 40 CFR 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.

40 CFR 190 Compliance:
The maximum calculated dose to a real individual would not exceed 0.27 mRem (total body), 1.28 mRem (organ), or 0.26 mRem (thyroid).

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

Table 1: 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	9.79E-04	2.56E-01	9.63E-03	0.00E+00	2.66E-01	1.06E+00	25	mRem
Organ Dose	1.62E-03	1.26E+00	1.23E-02	0.00E+00	1.28E+00	5.11E+00	25	mRem
Thyroid Dose	6.12E-04	2.56E-01	2.92E-04	0.00E+00	2.56E-01	3.42E-01	75	mRem

V. Results and Discussion

A. Aquatic Environment

1. Surface Water

Samples were taken from a continuous sampler at two locations (13B1 and 24S1) on a monthly schedule. Of these locations only 13B1 located downstream, could be affected by Limerick's effluent releases. The following analyses were performed:

Tritium

Monthly samples from all locations were composited quarterly and analyzed for tritium activity (Appendix C, Table C–I.1). All results were below the required LLD.

Iodine-131

Monthly samples were taken from location 24S1 and analyzed for low-level I-131 activity (Appendix C, Table C–I.2). All results were below the required LLD.

Gamma Spectrometry

Samples from all locations were analyzed for gamma-emitting nuclides (Appendix C, Table C–I.3). All nuclides were below the required LLDs.

2. Drinking Water

Monthly samples were collected from continuous water samplers at four locations (15F4, 15F7, 16C2, and 28F3). Three locations (15F4, 15F7, and 16C2) could be affected by Limerick's effluent releases. The following analyses were performed:

Gross Beta

Samples from all locations were analyzed for concentrations of total gross beta (Appendix C, Tables C–II.1). The values ranged from 2.2 to 5.8 pCi/L and total gross beta was detected at all sample locations. Concentrations detected were consistent with those detected in previous years (Appendix C, Figure C–1).

Tritium

Monthly samples from all locations were composited quarterly and analyzed for tritium activity. All results were below required LLD (Appendix C, Table C–II.2).

Iodine-131

Monthly samples were taken from all locations and analyzed for I-131 activity (Appendix C, Table C–II.3). All results were below the required LLD.

Gamma Spectrometry

Samples from all locations were analyzed for gamma-emitting nuclides (Appendix C, Table C–II.4). All results were below the required LLDs.

3. Fish

Fish samples comprised of bottom feeder (northern hogsucker/white hogsucker/carp) and predator (smallmouth bass/American eel/rock bass/bluegill sunfish/redbreast sunfish, black crappie) were collected at two locations (16C5 and 29C1) in the spring and fall season. Location 16C5 could be affected by Limerick's effluent releases. The following analysis was performed:

Gamma Spectrometry

The edible portion of fish samples from both locations was analyzed for gamma-emitting nuclides (Appendix C, Table C–III.1). Naturally-occurring K-40 was found at all stations and ranged from 1,804 to 3,713 pCi/kg wet and was consistent with levels detected in previous years. No other activity was detected and the required LLD was met.

4. Sediment

Aquatic sediment samples were collected at three locations (16B2, 16C4 and 33A2) semiannually. Two of these locations (16B2 and 16C4) could be affected by Limerick's effluent releases. The following analysis was performed:

Gamma Spectrometry

Sediment samples from all three locations were analyzed for gamma-emitting nuclides (Appendix C, Table C–IV.1). Nuclides detected were naturally-occurring Be-7 and K-40, as well as the fission product Cs-137.

Be-7 was found at two locations and ranged from 1,366 to 3,474 pCi/kg dry. K-40 was found at all locations and ranged from 12,230 to 16,030 pCi/kg dry. The fission product Cs-137 was found at one location at a concentration of 100 pCi/kg dry.

The very low level of Cs-137 activity detected was consistent with those detected in the pre–operational years and can be attributed to weapons

testing fallout. The downstream location, 16C4, showed no activity. Therefore, at 16B2, the Cs-137 activity found is not attributed to LGS radioactive effluent releases. However, the dose to a teenager's skin and whole body was conservatively calculated at 1.94E-03 mRem and 1.66E-03 mRem, respectively. This dose represents 9.69E-03% and 2.77E-02%, of the Appendix I to 10 CFR Part 50 dose limits, respectively. No other Limerick fission or activation products were found.

B. Atmospheric Environment

1. Airborne

a. Air Particulates

Continuous air particulate samples were collected from seven locations on a weekly basis. The seven locations were separated into three groups: Group I represents locations within the LGS site boundary (10S3, 11S1, 13S4, and 14S1), Group II represents the locations at an intermediate distance from the LGS site (6C1 and 15D1), and Group III represents the control location at a remote distance from LGS (22G1). The following analyses were performed:

Gross Beta

Weekly samples were analyzed for concentrations of beta emitters (Appendix C, Table C–V.1 and C–V.2).Detectable gross beta activity was observed at all locations as expected. The results from the on-site locations (Group I) ranged from 6E-03 to 31E-03 pCi/m^3 with a mean of 15E-03 pCi/m^3. The results from the intermediate distance location (Group II) ranged from 5E-03 to 30E-03 pCi/m^3 with a mean of 14E-03 pCi/m^3. The results from the remote distance locations (Group III) ranged from 8E-03 to 27E-03 pCi/m^3 with a mean of 14E-03 pCi/m^3. Comparison of the 2019 air particulate data with previous year’s data indicates no effects from the operation of LGS (Appendix C, Figure C–2). In addition, a comparison of the weekly mean values for 2019 indicates no notable differences among the three groups. (Appendix C, Figure C–3).

Gamma Spectrometry

Weekly samples were composited quarterly and analyzed for gamma-emitting nuclides. Naturally-occurring Be-7 was detected in all 28 samples and is attributed to cosmic ray activity (cosmogenic). These values ranged from 43E-03 to 115E-03 pCi/m^3. All other nuclides were below the required LLDs. (Appendix C, Table C–V.3)

b. Airborne Iodine

Continuous air samples were collected from seven locations (6C1, 10S3, 11S1, 13S4, 14S1, 15D1, and 22G1) and analyzed weekly for

I-131. All results were below the required LLD.
(Appendix C, Table C–VI.1)

2. Terrestrial

a. Milk

Samples were collected from four locations (18E1, 19B1, 23F1, and 25C1) biweekly April through November and monthly December through March. Samples from one additional location (36E1) were taken quarterly. The following analyses were performed:

Iodine-131

Milk samples from all locations were analyzed for concentrations of I-131. All results were below the required LLD.
(Appendix C, Table C–VII.1)

Gamma Spectrometry

Each milk sample was analyzed for concentrations of gamma-emitting nuclides (Appendix C, Table C–VII.2).

Naturally-occurring K-40 activity was found in all samples and ranged from 875 to 1,521 pCi/L. All other nuclides were below the required LLDs.

b. Broadleaf Vegetation

Twelve types of broadleaf vegetation samples were collected from three locations (11S3, 13S3, and 31G1) monthly from June through September. The following analysis was performed:

Gamma Spectrometry

Each broadleaf vegetation sample was analyzed for concentrations of gamma-emitting nuclides (Appendix C, Table C-VIII.1).

Cosmogenic, naturally-occurring Be-7 was found in 23 of 34 samples and ranged from 153 to 3,719 pCi/kg wet. Naturally-occurring K-40 was found in all samples and ranged from 2,885 to 9,170 pCi/kg wet. Naturally-occurring Ra-226 was found in 8 of 34 samples and ranged from 797 to 2,871 pCi/kg wet. Naturally-occurring Th-228 was found in 17 of 34 samples and ranged from 51 to 244 pCi/kg wet. Naturally-occurring Thorium-232 was found in 2 of 34 samples and ranged from 91 to 107 pCi/kg wet. All other nuclides were below the required LLDs.

C. Ambient Gamma Radiation

Ambient gamma radiation levels were measured utilizing Panasonic 814 (CaSO4) thermoluminescent dosimeters. Forty dosimeter locations were established around the site. Results of dosimeter measurements are listed in Appendix C, Table C–IX.1. Dosimeter measurements were reported in mR/standard month. All dosimeter measurements were below 26 mR/standard month, with a range of 11.3 to 25.4 mR/standard month. A comparison of the Site Boundary and Intermediate Distance data to the Control Location (5H1) data indicate that the ambient gamma radiation levels from the Control Location were consistently higher than all other locations, except 13S2. Location 13S2 historically shows higher ambient gamma radiation, which is due to the rock substrate. The area that this dosimeter is located in has been determined to emanate radon prodigy. *NRC Regulatory Guide 4.13, Revision 2* was released in 2019 and provided a new methodology for determining facility-related dose. Exelon procedures were revised to adopt the new methodology and starting in this report, results will be reported per this revision.

D. 10 CFR 20.2002 Permit Storage Area

The results of the surface water aquatic monitoring program from Location 24S1 were used to determine if radioactivity from the permit storage area had made it to the Schuylkill River. The data obtained from the gamma analysis program did not detect any migration of radioactivity from the permit storage area.

E. Independent Spent Fuel Storage Installation

The results of the ambient gamma radiation level at dosimeter locations 36S2 and 3S1 were used to determine the direct radiation exposure to the nearest residence from the ISFSI pad. The data did not identify any facility-related dose as a result of operation of the ISFSI pad.

F. Land Use Survey

A Land Use Survey conducted in the fall of 2019 around Limerick Generating Station (LGS) was 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 2019 Land Use Survey identified differences in locations for gardens and meat animals between 2018 and 2019. Twelve (12) new gardens were located this year in sectors N, S, SSW, WSW, W, and NNW 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. There were eight (8) new meat sites identified this year in N, NNW, ESE, SSW, WSW and W sectors. All other locations were the same as in the 2018 report. 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 below:

Distance in feet from the LGS Reactor Buildings (Out to 26,400 feet)

Sector		Residence Feet	Garden Feet	Milk Farm Feet	Meat Animal Feet
1	N	3,109	3,333	24,775	10,077
2	NNE	2,706	12,399	-	13,418
3	NE	3,469	13,452	-	16,044
4	ENE	3,231	8,241	-	7,451
5	E	2,864	7,868	-	-
6	ESE	3,434	3,434	-	12,264
7	SE	3,928	7,139	-	10,903
8	SSE	5,403	6,912	-	8,177
9	S	4,347	6,103	22,114	12,210
10	SSW	5,063	5,732	10,390	10,390
11	SW	3,251	6,319	-	23,145
12	WSW	3,799	4,507	14,177	4,506
13	W	3,627	8,886	-	14,123
14	WNW	3,685	12.022	-	-
15	NW	3,619	8,200	-	-
16	NNW	5,050	6,473	-	12,065

G. Summary of Results – Inter-laboratory Comparison Program

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

- Analytics Evaluation Criteria

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

❖ ERA Evaluation Criteria

ERA's evaluation report provides an acceptance range for control and warning limits with associated flag values. ERA's acceptance limits are established per the USEPA, National Environmental Laboratory Accreditation Conference (NELAC), state-specific Performance Testing (PT) program requirements or ERA's SOP for the Generation of Performance Acceptance Limits, as applicable. The acceptance limits are either determined by a regression equation specific to each analyte or a fixed percentage limit promulgated under the appropriate regulatory document.

❖ DOE Evaluation Criteria

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

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

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

1. TBE Laboratory Results

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

a) The ERA April 2019 water Cs-134 result was evaluated as *Not Acceptable*. The reported value was 15.2 pCi/L (error 2.82 pCi/L) and the known result was 12.1 pCi/L (acceptance range of 8.39 - 14.4 pCi/L). With the error, the reported result overlaps the acceptable range. This sample was run as the workgroup duplicate on a different detector with a result of 10.7 pCi/L (within acceptable range). (NCR 19-10)

b) The ERA April 2019 water Sr-89 result was evaluated as *Not Acceptable*. The reported value was 44.9 pCi/L and the known result was 33.3 pCi/L (acceptance range of 24.5 - 40.1 pCi/L). The sample was only counted for 15 minutes instead of 200 minutes. The sample

was re-prepped in duplicate and counted for 200 minutes with results of 30.7 ± 5.37 pCi/L and 33.0 ± 8.71 pCi/L. This was the 1st "high" failure for Sr-89 in 5 years. (NCR 19-11)

c) The MAPEP February 2019 soil Sr-90 result was not submitted and therefore evaluated as *Not Acceptable*. The sample was run in duplicate, with results of -1.32 ± 4.09 Bq/kg (<6.87) and -1.030 ± 3.55 Bq/kg (<5.97). The known result was a false positive test (no significant activity). TBE did not submit a result because it appeared that the results may not be accurate. TBE analyzed a substitute soil Sr-90 sample from another vendor, with a result within the acceptable range. (NCR 19-12)

d) The MAPEP February 2019 water Am-241 result was evaluated as *Not Acceptable*. The reported value was 0.764 ± 0.00725 Bq/L with a known result of 0.582 Bq/L (acceptable range 0.407 - 0.757 Bq/L). TBE's result falls within the upper acceptable range with the error. It appeared that a non-radiological interference was added and lead to an increased mass and higher result. (NCR 19-13)

e) The MAPEP February 2019 vegetation Sr-90 result was evaluated as *Not Acceptable*. The reported result was -0.1060 ± 0.0328 Bq/kg and the known result was a false positive test (no significant activity). TBE's result was correct in that there was no activity. MAPEP's evaluation was a "statistical failure" at 3 standard deviations. (NCR 19-14)

f) The ERA October 2019 water Gross Alpha result was evaluated as *Not Acceptable*. TBE's reported result was 40.5 ± 10.3 pCi/L and the known result was 27.6 pCi/L (ratio of TBE to known result at 135%). With the associated error, the result falls within the acceptable range (14.0 - 36.3 pCi/L). The sample was run as the workgroup duplicate on a different detector with a result of 30.8 ± 9.17 pCi/L (within the acceptable range). This was the first failure for drinking water Gr-A since 2012. (NCR 19-23)

g) The ERA October 2019 water Sr-90 result was evaluated as *Not Acceptable*. TBE's reported result was 32.5 ± 2.12 pCi/L and the known result was 26.5 pCi/L (ratio of TBE to known result at 123%). With the associated error, the result falls within the acceptable range (19.2 - 30.9 pCi/L). The sample was run as the workgroup duplicate on a different detector with a result of 20.0 ± 1.91 pCi/L (within the acceptable range). Both TBE results are within internal QC limits. A substitute "quick response" sample was analyzed with an acceptable result of 18.6 pCi/L (known range of 13.2 - 22.1 pCi/L). (NCR 19-24)

h) The MAPEP August 2019 soil Ni-63 result of 436 ± 22.8 Bq/kg was evaluated as Not Acceptable. The known result was 629 Bq/kg

(acceptable range 440 - 818 Bq/sample). With the associated error, the TBE result falls within the lower acceptance range. All associated QC was acceptable. No reason for failure could be found. This is the first failure for soil Ni-63 since 2012. (NCR 19-25).

i) The MAPEP August 2019 water Am-241 result was not reported and therefore evaluated as *Not Acceptable*. Initial review of the results showed a large peak where Am-241 should be (same as the February, 2019 sample results). It is believed that Th-228 was intentionally added as an interference. The sample was re-prepped and analyzed using a smaller sample aliquot. The unusual large peak (Th-228) was seen again and also this time a smaller peak (Am-241). The result was 436 ± 22.8 Bq/L (acceptable range 0.365 ± 0.679 Bq/L). Th-228 is not a typical nuclide requested by clients, so there is no analytical purpose to take samples through an additional separation step. TBE will pursue using another vendor for Am-241 water cross-checks that more closely reflects actual customer samples. (NCR 19-26)

j) The Analytics September 2019 soil Cr-51 sample was evaluated as *Not Acceptable*. TBE's reported result of 0.765 ± 0.135 pCi/g exceeded the upper acceptance range (140% of the known result of 0.547 pCi/g). The TBE result was within the acceptable range (0.63 - 0.90 pCi/g) with the associated error. The Cr-51 result is very close to TBE's normal detection limit. In order to get a reportable result, the sample must be counted for 15 hours (10x longer than client samples). There is no client or regulatory requirement for this nuclide and TBE will remove Cr-51 from the reported gamma nuclides going forward. (NCR 19-27)

2. EIS Laboratory Results

For secondary QC samples, EIS laboratory analyzed gross beta, gamma and low-level I-131. For the EIS Laboratory, 114 out of 114 analyses performed met the specified acceptance criteria.

3. GEL Laboratory Results

For the secondary QC samples, GEL laboratory analyzed only H-3 for LGS.REMP. GEL also analyzed gamma, gross alpha/beta, H-3, and Sr-89/90 for LGS RGPP. For these analyses, 107 of 112 cross-check samples met the specified acceptance criteria. All failures were addressed through GEL's Corrective Action Program and the pertinent failures are described below:

a) Two ERA 1st quarter 2019 water Sr-89 results were evaluated as *Not Acceptable*. The reported values were 78.5 pCi/L and 76.5 pCi/L. The known result was 66.9 pCi/L, with an acceptance range of 54.4 - 75.0 pCi/L. A review of the data as well as of the preparation

processes did not reveal any errors or possible contributors to the high bias. The Laboratory has concluded that this positive bias was an isolated occurrence and that the overall process is within control. In addition, the reported value is 117% of the reference value, which is within the lab's standard acceptance criteria of +/- 25% for Laboratory Control Samples. No permanent corrective or preventative actions or improvements made at the time. The laboratory will continue to monitor the recoveries to ensure that there are no continued issues in the process. (CARR190225-1192)

b) The ERA 2nd quarter 2019 vegetation Sr-90 result was evaluated as *Not Acceptable*. The reported value was 4670 pCi/kg and the known result was 3530 pCi/kg (acceptance range of 1990 - 4600 pCi/L). The reanalysis was performed using the same processes as the original reported analysis. The reanalysis result met the acceptance range with 96% recovery. No permanent corrective or preventative actions or improvements made at the time. The laboratory will continue to monitor the recoveries to ensure that there are no continued issues in the process. (CARR190530-1211)

c) One of the two ERA 3rd quarter 2019 water Sr-89 results was evaluated as *Not Acceptable*. The reported value was 69.4 pCi/L and the known result was 58.7 pCi/L (acceptance range of 47.1 - 66.5 pCi/L). A review of the data as well as of the preparation processes did not reveal any errors or possible contributors to the high bias. The Laboratory has concluded that this positive bias was an isolated occurrence and that the overall process is within control. In addition, the reported value is 118% of the reference value, which is within the lab's standard acceptance criteria of +/- 25% for Laboratory Control Samples. In addition, a duplicate sample was run using separation resin and that result was within the acceptance range. The results from the two methods compared with a relative percent difference (RPD) of 11.1%, which meets the lab's duplicate acceptance criteria. The Laboratory has concluded that these positive biases were isolated occurrences and that the overall process is within control. The lab will complete PT studies for these parameters as they become available to verify that these were isolated incidences. (CARR190826-1250)

d) One of the two ERA 3rd quarter 2019 water gross alpha results was evaluated as *Not Acceptable*. The reported value was 88.7 pCi/L and the known result was 70.6 pCi/L (acceptance range of 37.1 - 87.1 pCi/L). The analysis data was reviewed and no errors were found. The investigation into the sample preparation did not result in any contributors to the high bias. This analysis was performed by Co-Precipitation. The Laboratory also reported the gross alpha analysis by the evaporation method (EPA 900.0) and had an

acceptable result. The lab's alpha results between the two methods compared with a relative percent difference (RPD) of 9.45%, which meets the lab's duplicate acceptance criteria. The Laboratory has concluded that these positive biases were isolated occurrences and that the overall process is within control. The lab will complete PT studies for these parameters as they become available to verify that these were isolated incidences. (CARR190826-1250)

The Inter-Laboratory Comparison Program provides evidence of "in control" counting systems and methods, and that the laboratories are producing accurate and reliable data. Interlaboratory Comparison results may be found in Appendix E.

VI. References

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

B. NUREG-1302 Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors

C. Branch Technical Position Paper, Regulatory Guide 4.8, Revision 1, November 1979

D. 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

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APPENDIX A

RADIOLOGICAL ENVIRONMENTAL MONITORING REPORT SUMMARY

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TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR THE LIMERICK GENERATING STATION, 2019

NAME OF FACILITY:	LIMERICK GENERATING STATION			DOCKET NUMBER:		50-352 & 50-353		
LOCATION OF FACILITY:	MONTGOMERY, PA			REPORTING PERIOD:		2019		
				INDICATOR LOCATIONS	CONTROL LOCATION	LOCATION WITH HIGHEST ANNUAL MEAN (M)		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
SURFACE WATER *(PCI/LITER)*	**H-3**	8	**200**	<LLD	<LLD	-		0
	GAMMA	25						
	MN-54		**15**	<LLD	<LLD	-		0
	CO-58		**15**	<LLD	<LLD	-		0
	FE-59		**30**	<LLD	<LLD	-		0
	CO-60		**15**	<LLD	<LLD	-		0
	ZN-65		**30**	<LLD	<LLD	-		0
	NB-95		**15**	<LLD	<LLD	-		0
	ZR-95		**30**	<LLD	<LLD	-		0
	I-131		**15**	<LLD	<LLD	-		0
	CS-134		**15**	<LLD	<LLD	-		0
	CS-137		**18**	<LLD	<LLD	-		0
	BA-140		**60**	<LLD	<LLD	-		0
	LA-140		**15**	<LLD	<LLD	-		0
	I-131 (LOW LVL)	13	**1**	<LLD	<LLD			0
DRINKING WATER *(PCI/LITER)*	**GR-B**	48	**4**	3.3 (23/36) *2.2 - 5.8*	3.5 (7/12) *2.6 - 4.5*	3.6 (5/12) *2.6 - 5.7*	16C2 INDICATOR CITIZENS HOME WATER COMPANY 2.66 MILES SSE OF SITE	0
	H-3	16	**200**	<LLD	<LLD	-		0
	I-131 (LOW LVL)	48	**1**	<LLD	<LLD	-		0

TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR THE LIMERICK GENERATING STATION, 2019

NAME OF FACILITY:	LIMERICK GENERATING STATION			DOCKET NUMBER:		50-352 & 50-353		
LOCATION OF FACILITY:	MONTGOMERY, PA			REPORTING PERIOD:		2019		
				INDICATOR LOCATIONS	CONTROL LOCATION	LOCATION WITH HIGHEST ANNUAL MEAN (M)		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
DRINKING WATER	**GAMMA**	48						
(PCI/LITER)	*MN-54*		**15**	<LLD	<LLD	-		0
	CO-58		**15**	<LLD	<LLD	-		0
	FE-59		**30**	<LLD	<LLD	-		0
	CO-60		**15**	<LLD	<LLD	-		0
	ZN-65		**30**	<LLD	<LLD	-		0
	NB-95		**15**	<LLD	<LLD	-		0
	ZR-95		**30**	<LLD	<LLD	-		0
	CS-134		**15**	<LLD	<LLD	-		0
	CS-137		**18**	<LLD	<LLD	-		0
	BA-140		**60**	<LLD	<LLD	-		0
	LA-140		**15**	<LLD	<LLD	-		0
FISH - BOTTOM FEEDER	**GAMMA**	4						
(PCI/KG WET)	*K-40*		*NA*	3055 (2/2) *3004 - 3105*	3114 (2/2) *2975 - 3252*	3114 (2/2) *2975 - 3252*	29C1 CONTROL POTTSTOWN VICINITY UPSTREAM OF INTAKE	0
	MN-54		**130**	<LLD	<LLD	-		0
	CO-58		**130**	<LLD	<LLD	-		0
	FE-59		**260**	<LLD	<LLD	-		0
	CO-60		**130**	<LLD	<LLD	-		0
	ZN-65		**260**	<LLD	<LLD	-		0
	I-131		*NA*	<LLD	<LLD	-		0
	CS-134		**130**	<LLD	<LLD	-		0
	CS-137		**150**	<LLD	<LLD	-		0

TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR THE LIMERICK GENERATING STATION, 2019

NAME OF FACILITY:	LIMERICK GENERATING STATION			DOCKET NUMBER:		50-352 & 50-353		
LOCATION OF FACILITY:	MONTGOMERY, PA			REPORTING PERIOD:		2019		
				INDICATOR LOCATIONS	CONTROL LOCATION	LOCATION WITH HIGHEST ANNUAL MEAN (M)		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
FISH - PREDATOR	**GAMMA**	4						
(PCI/KG WET)	*K-40*		*NA*	3401	2502	3401	16C5 INDICATOR	0
				(2/2)	(2/2)	(2/2)	VINCENT POOL	
				3088 - 3713	*1804 - 3200*	*3088 - 3713*	DOWNSTREAM OF DISCHARGE	
	MN-54		**130**	<LLD	<LLD	-		0
	CO-58		**130**	<LLD	<LLD	-		0
	FE-59		**260**	<LLD	<LLD	-		0
	CO-60		**130**	<LLD	<LLD	-		0
	ZN-65		**260**	<LLD	<LLD	-		0
	I-131		*NA*	<LLD	<LLD	-		0
	CS-134		**130**	<LLD	<LLD	-		0
	CS-137		**150**	<LLD	<LLD	-		0
SEDIMENT	**GAMMA**	9						
(PCI/KG DRY)	*BE-7*		*NA*	2367	<LLD	2420	16B2 INDICATOR	0
				(3/6)		(2/3)	LINFIELD BRIDGE	
				1366 - 3474		*1366 - 3474*	1.35 MILES SSE OF SITE	
	K-40		*NA*					0
				14677	13373	15333	16C4 INDICATOR	
				(6/6)	*(3/3)*	*(3/3)*	VINCENT DAM	
	MN-54		*NA*	13680 - 16030	12230 - 15100	14590 - 16030	2.18 MILES SSE OF SITE	0
	CO-58		*NA*	<LLD	<LLD	-		0
	CO-60		*NA*	<LLD	<LLD	-		0
	I-131		*NA*	<LLD	<LLD	-		0
	CS-134		**150**	<LLD	<LLD	-		0
	CS-137		**180**	100	<LLD	100	16B2 INDICATOR	0
				(1/6)		(1/3)	LINFIELD BRIDGE	
							1.35 MILES SSE OF SITE	

TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR THE LIMERICK GENERATING STATION, 2019

NAME OF FACILITY:	LIMERICK GENERATING STATION			DOCKET NUMBER:		50-352 & 50-353		
LOCATION OF FACILITY:	MONTGOMERY, PA			REPORTING PERIOD:		2019		
				INDICATOR LOCATIONS	CONTROL LOCATION	LOCATION WITH HIGHEST ANNUAL MEAN (M)		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	MEAN (M) (F) *RANGE*	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
AIR PARTICULATE	**GR-B**	361	**10**	14	14	16	13S4 INDICATOR	0
(E-03 PCI/CU.METER)				(308/309)	(51/52)	(51/51)	LONGVIEW ROAD	
				5 - 31	*8 - 27*	*8 - 27*	1186 FEET SE OF SITE	
	GAMMA	28						
	BE-7		*NA*	74	80	88	13S4 INDICATOR	0
				(24/24)	(4/4)	(4/4)	LONGVIEW ROAD	
				43 - 115	*74 - 94*	*66 - 115*	1186 FEET SE OF SITE	
	MN-54		*NA*	<LLD	<LLD	-		0
	CO-58		*NA*	<LLD	<LLD	-		0
	CO-60		*NA*	<LLD	<LLD	-		0
	CS-134		**50**	<LLD	<LLD	-		0
	CS-137		**60**	<LLD	<LLD	-		0
AIR IODINE	**GAMMA**	361						
(E-03 PCI/CU.METER)	*I-131 (GELI)*		**70**	<LLD	<LLD	-		0
MILK	**I-131 (LOW LVL)**	92	**1**	<LLD	<LLD	-		0
(PCI/LITER)								
	GAMMA	92						
	K-40		*NA*	1242	1273	1303	23F1 CONTROL	0
				(66/66)	(26/26)	(22/22)		
				875 - 1521	*1020 - 1505*	*1038 - 1505*	5.02 MILES SW OF SITE	
	CS-134		**15**	<LLD	<LLD	-		0
	CS-137		**18**	<LLD	<LLD	-		0
	BA-140		**60**	<LLD	<LLD	-		0
	LA-140		**15**	<LLD	<LLD	-		0

TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR THE LIMERICK GENERATING STATION, 2019

NAME OF FACILITY: LIMERICK GENERATING STATION | **DOCKET NUMBER:** 50-352 & 50-353

LOCATION OF FACILITY: MONTGOMERY, PA | **REPORTING PERIOD:** 2019

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	INDICATOR LOCATIONS MEAN (M) (F) *RANGE*	CONTROL LOCATION MEAN (M) (F) *RANGE*	LOCATION WITH HIGHEST ANNUAL MEAN (M) MEAN (M) (F) *RANGE*	LOCATION WITH HIGHEST ANNUAL MEAN (M) STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
VEGETATION	**GAMMA**	34						
(PCI/KG WET)	*BE-7*		*NA*	1130 (13/22) *335 - 3332*	1645 (10/12) *153 - 3719*	1645 (10/12) *153 - 3719*	31G1 CONTROL PROUTS'S JOLLYVIEW FARM (CONTROL) 71,808 FEET NW	0
	K-40		*NA*	5460 (22/22) *3358 - 9170*	5367 (12/12) *2885 - 8971*	5635 (11/11) *3358 - 8816*	11S3 INDICATOR LGS INFORMATION CENTER 0.35 MILES ESE OF SITE	0
	MN-54		*NA*	<LLD	<LLD	-		0
	CO-58		*NA*	<LLD	<LLD	-		0
	CO-60		*NA*	<LLD	<LLD	-		0
	I-131		**60**	<LLD	<LLD	-		0
	CS-134		**60**	<LLD	<LLD	-		0
	CS-137		**80**	<LLD	<LLD	-		0
	RA-226		*NA*	1680 (8/22) *797 - 2871*	<LLD	1680 (8/11) *797 - 2871*	13S3 INDICATOR VINCENT DAM 0.24 MILES SE OF SITE	0
	TH-228		*NA*	106 (9/22) *51 - 244*	131 (8/12) 86 - 218	131 (8/12) 86 - 218	31G1 CONTROL PROUTS'S JOLLYVIEW FARM (CONTROL) 71,808 FEET NW	0
	TH-232		*NA*	<LLD	99 (2/12) 91 - 107	99 (2/12) 91 - 107	31G1 CONTROL PROUTS'S JOLLYVIEW FARM (CONTROL) 71,808 FEET NW	0 0
DIRECT RADIATION	**OSLD-QUARTERLY**	320	*NA*	17.1 (312/312) *11.3 - 17.1*	22.3 (8/8) *21.3 - 24.0*	24.6 (8/8) *23.4 - 25.4*	13S2 INDICATOR 500 KV SUBSTATION 0.41 MILES SE	0
(MILLI-ROENTGEN/STD.MO.)								

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APPENDIX B

LOCATION DESIGNATION, DISTANCE & DIRECTION, AND SAMPLE COLLECTION & ANALYTICAL METHODS

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TABLE B-1: Location Designation and Identification System for the Limerick Generating Station

XXYZ - General code for identification of locations, where:

XX - Angular Sector of Sampling Location. The compass is divided into 36 sectors of 10 degrees each with center at Limerick's Units 1 and 2 off-gas vents. Sector 36 is centered due North, and others are numbered in a clockwise direction.

Y - Radial Zone of Sampling Location (in this report, the radial distance from the Limerick vent for all regional stations).

S : on-site location
A : 0-5,280 feet off-site
B : 5,280-10,560 feet off-site
C : 10,560-15,840 feet off-site
D : 15,840-21,120 feet off-site
E : 21,120-26,400 feet off-site
F : 26,400-52,800 feet off-site
G : 52,800-105,600 feet off-site
H : 105,600-528,000 feet off-site

Z - Station's Numerical Designation within sector and zone, using 1, 2, 3... in each sector and zone.

TABLE B-2: Radiological Environmental Monitoring Program - Sampling Locations, Distance and Direction
Limerick Generating Station, 2019

Location	Location Description	Distance & Direction From Site
A.	Surface Water	
13B1	Vincent Dam	9,225 feet SE
24S1	Limerick Intake (control)	1,058 feet SW
B.	Drinking (Potable) Water	
15F4	AQUA Water Company	45,514 feet SE
15F7	Phoenixville Water Works	33,400 feet SSE
16C2	PA American	14,034 feet SSE
28F3	Pottstown Borough Authority, Water Distribution Division (control)	30,811 feet WNW
C.	Milk - bi-weekly / monthly	
10F4		34,848 feet ESE
18E1		22,229 feet S
19B1		10,317 feet SSW
23F1	Control	26,505 feet SW
25C1		14,224 feet WSW
D.	Milk - quarterly	
36E1	Control	24,816 feet N
E.	Air Particulates / Air Iodine	
10S3	Keen Road	2,648 feet E
11S1	LGS Information Center	2,017 feet ESE
11S2	LGS Information Center (quality control)	2,017 feet ESE
13S4	Longview Road, near 500 KV Yard	1,186 feet SE
14S1	Longview Road	3,319 feet SSE
15D1	Spring City Substation	16,877 feet SE
22G1	Manor Substation (control)	93,619 feet SW
6C1	Limerick Airport	11,305 feet NE
F .	Fish	
16C5	Vincent Pool	Downstream of Discharge
29C1	Pottstown Vicinity (control)	Upstream of Intake
G.	Sediment	
16B2	Linfield Bridge	7,128 feet SSE
16C4	Vincent Dam	11,510 feet SSE
33A2	Upstream of Intake (control)	4,435 feet NNW
H.	Broad Leaf Vegetation	
11S3	LGS Information Center	1,848 feet ESE
13S3	LGS 500 KV Yard	1,267 feet SE
31G1	Prout's Jollyview Farm (control)	71,808 feet NW

TABLE B-2: Radiological Environmental Monitoring Program - Sampling Locations, Distance and Direction
Limerick Generating Station, 2019

Location	Location Description	Distance & Direction From Site
I.	Environmental Dosimetry - DLR	
	Site Boundary	
36S2	Evergreen & Sanatoga Road	3,183 feet N
3S1	Sanatoga Road	2,301 feet NNE
5S1	Possum Hollow Road	2,350 feet NE
7S1	LGS Training Center	3,099 feet ENE
10S3	Keen Road	2,648 feet E
11S1	LGS Information Center	2,017 feet ESE
13S2	500 KV Substation	2,149 feet SE
14S1	Longview Road	3,319 feet SSE
18S2	Rail Line along Longview Road	1,390 feet S
21S2	Near Intake Building	977 feet SSW
23S2	Transmission Tower	2,793 feet SW
25S2	Sector Site Boundary	2,445 feet WSW
26S3	Met. Tower #2	2,088 feet W
29S1	Sector Site Boundary	2,886 feet WNW
31S1	Sector Site Boundary	1,395 feet NW
34S2	Met. Tower #1	3,071 feet NNW
	Intermediate Distance	
36D1	Siren Tower No. 147	18,527 feet N
2E1	Laughing Waters GSC	25,112 feet NNE
4E1	Neiffer Road	25,221 feet NE
7E1	Pheasant Road	22,489 feet ENE
10E1	Royersford Road	20,826 feet E
10F3	Trappe Substation	29,442 feet ESE
13E1	Vaughn Substation	22,772 feet SE
16F1	Pikeland Substation	26,608 feet SSE
19D1	Snowden Substation	18,439 feet S
20F1	Sheeder Substation	27,648 feet SSW
24D1	Porters Mill Substation	20,972 feet SW
25D1	Hoffecker & Keim Streets	21,044 feet WSW
28D2	W. Cedarville Road	20,231 feet W
29E1	Prince Street	26,110 feet WNW
31D2	Poplar Substation	20,446 feet NW
34E1	Varnell Road	24,243 feet NNW
	Control and Special Interest	
5H1	Birch Substation (control)	130,742 feet NE
6C1	Limerick Airport	11,305 feet NE
9C1	Reed Road	11,377 feet E
13C1	King Road	14,980 feet SE
15D1	Spring City Substation	16,877 feet SE
17B1	Linfield Substation	8,462 feet S
20D1	Ellis Woods Road	16,157 feet SSW
31D1	Lincoln Substation	15,853 feet WNW

TABLE B-3: Radiological Environmental Monitoring Program – Summary of Sample Collection and Analytical Methods, Limerick Generating Station, 2019

Sample Medium	Analysis	Sampling Method	Collection Procedure Number	Sample Size	Analytical Procedure Number
Surface Water	Gamma Spectroscopy	Monthly composite from a continuous water compositor	CY-ES-240 EIS Collection of water samples for Radiological Analysis (Limerick Generating Station)	2 gallon	TBE, TBE-2007 Gamma-Emitting Radioisotope Analysis EIS, CY-ES-205 Gamma Counting Using the HPGe Detector with the Genie PC Counting System
Surface Water	Tritium	Quarterly composite from a continuous water compositor	CY-ES-240 EIS Collection of water samples for Radiological Analysis (Limerick Generating Station)	500 ml	TBE, TBE-2011 Tritium Analysis in Drinking Water by Liquid Scintillation GEL, EPA906.0 Mod for Tritium analysis by Liquid Scintillation
Drinking Water	Gross Beta	Monthly composite from a continuous water compositor	CY-ES-240 EIS Collection of water samples for Radiological Analysis (Limerick Generating Station)	2 gallon	TBE, TBE-2008 Gross Alpha and/or Gross Beta Activity in Various Matrices EIS, CY-ES-206, Operation of the Tennelec S5E Proportional Counter
Drinking Water	I-131	Monthly composite from a continuous water compositor	CY-ES-240 EIS Collection of water samples for Radiological Analysis (Limerick Generating Station)	2 gallon	TBE, TBE-2012 Radioiodine in Various Matrices EIS, CY-ES-205 Gamma Counting Using the HPGe Detector with the Genie PC Counting System
Drinking Water	Gamma Spectroscopy	Monthly composite from a continuous water compositor	CY-ES-240 EIS Collection of water samples for Radiological Analysis (Limerick Generating Station)	2 gallon	TBE, TBE-2007 Gamma-Emitting Radioisotope Analysis EIS, CY-ES-205 Gamma Counting Using the HPGe Detector with the Genie PC Counting System
Drinking Water	Tritium	Quarterly composite from a continuous water compositor	CY-ES-240 EIS Collection of water samples for Radiological Analysis (Limerick Generating Station)	500 ml	TBE, TBE-2011 Tritium Analysis in Drinking Water by Liquid Scintillation GEL, EPA906.0 Mod for Tritium analysis by Liquid Scintillation
Fish	Gamma Spectroscopy	Semi-annual samples collected via electroshocking or other techniques	RMC-ER6 Collection of fish samples for radiological analysis (Limerick Generating Station)	1000 grams (wet)	TBE-2007 Gamma-Emitting Radioisotope Analysis
Sediment	Gamma Spectroscopy	Semi-annual grab samples	RMC-ER7 Collection of sediment samples for radiological analysis (Limerick Generating Station)	500 grams (dry)	TBE, TBE-2007 Gamma-Emitting Radioisotope Analysis

TABLE B-3: Radiological Environmental Monitoring Program – Summary of Sample Collection and Analytical Methods, Limerick Generating Station, 2019

Sample Medium	Analysis	Sampling Method	Collection Procedure Number	Sample Size	Analytical Procedure Number
Air Particulates	Gross Beta	One-week composite of continuous air sampling through glass fiber filter paper	CY-ES-237 Sample Collection of Air Iodine and Air Particulate for Radiological Analysis (Limerick Generating Station)	1 filter (approximately 280 cubic meters weekly)	TBE, TBE-2008 Gross Alpha and/or Gross Beta Activity in Various Matrices EIS, CY-ES-206 Operation of the Tennelec S5E Proportional Counter
Air Particulates	Gamma Spectroscopy	Quarterly composite of each station	TBE, TBE-2023 Compositing of Samples CY-ES-204 Sample Preparation for Gamma and Beta Counting	13 filters (approximately 3600 cubic meters)	TBE, TBE-2007 Gamma-Emitting Radioisotope Analysis EIS, CY-ES-205 Gamma Counting Using the HPGe Detector with the Genie PC Counting System
Air Iodine	Gamma Spectroscopy	One-week composite of continuous air sampling through charcoal filter	CY-ES-237 Sample Collection of Air Iodine and Air Particulate for Radiological Analysis (Limerick Generating Station)	1 filter (approximately 280 cubic meters weekly)	TBE, TBE-2007 Gamma-Emitting Radioisotope Analysis EIS, CY-ES-205 Gamma Counting Using the HPGe Detector with the Genie PC Counting System
Milk	I-131	Bi-weekly grab sample when cows are on pasture; Monthly all other times	CY-ES-238 EIS Sample Collection for Gamma Counting - Milk (Limerick Generating Station)	2 gallon	TBE, TBE-2012 Radioiodine in Various Matrices EIS, CY-ES-205 Gamma Counting Using the HPGe Detector with the Genie PC Counting System
Milk	Gamma Spectroscopy	Bi-weekly grab sample when cows are on pasture; Monthly all other times	CY-ES-238 EIS Sample Collection for Gamma Counting - Milk (Limerick Generating Station)	2 gallon	TBE, TBE-2007 Gamma-Emitting Radioisotope Analysis EIS, CY-ES-205 Gamma Counting Using the HPGe Detector with the Genie PC Counting System
DLR	Thermoluminescent Dosimetry	Quarterly DLRs comprised of two dosimeter elements	CY-ES-239 EIS Sample Collection for OSLD for Radiological Analysis (Limerick Generating Station)	2 dosimeters	Mirion Technologies

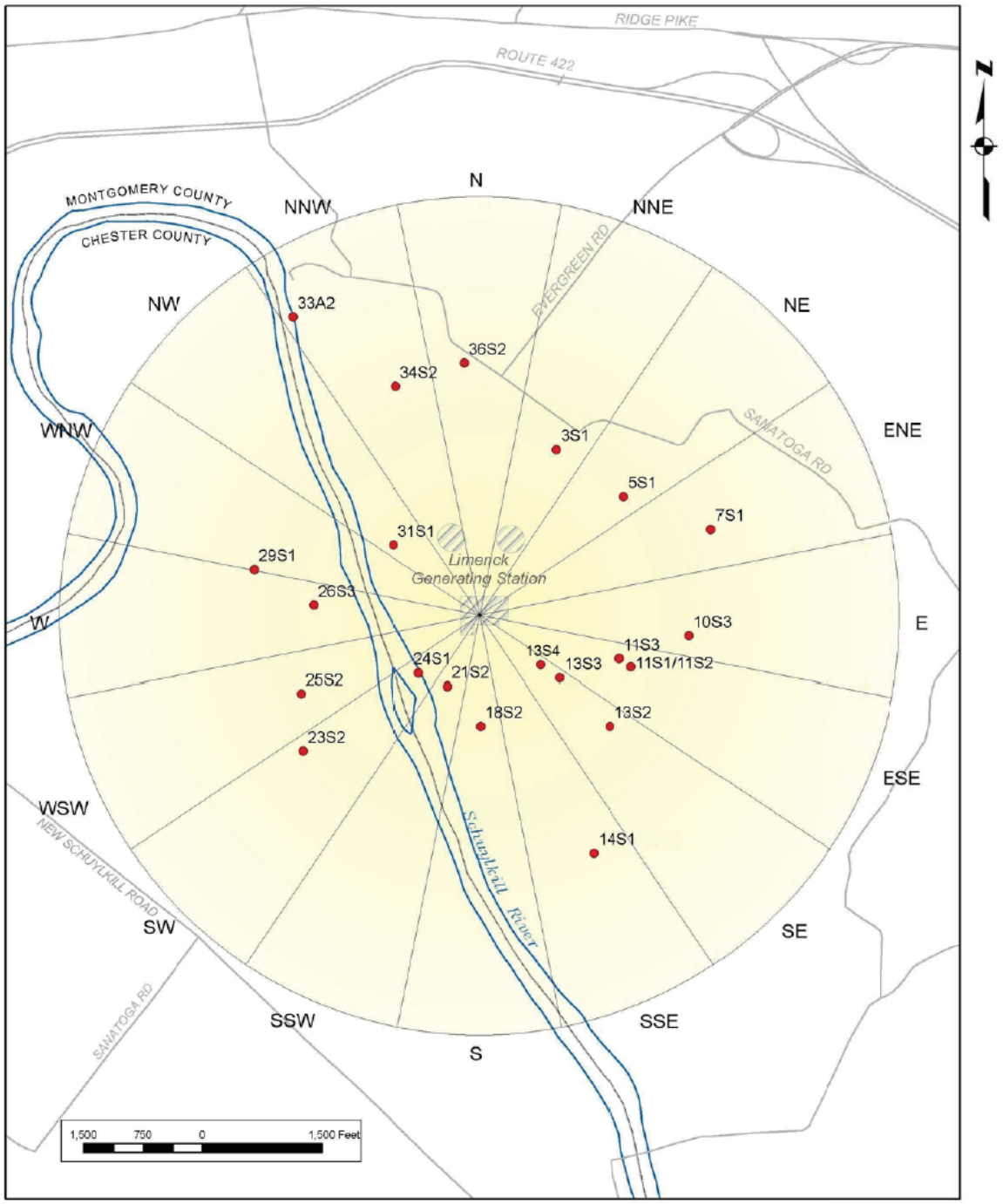

Figure B-1
Environmental Sampling Locations Within 5,280 Feet
of the Limerick Generating Station, 2019

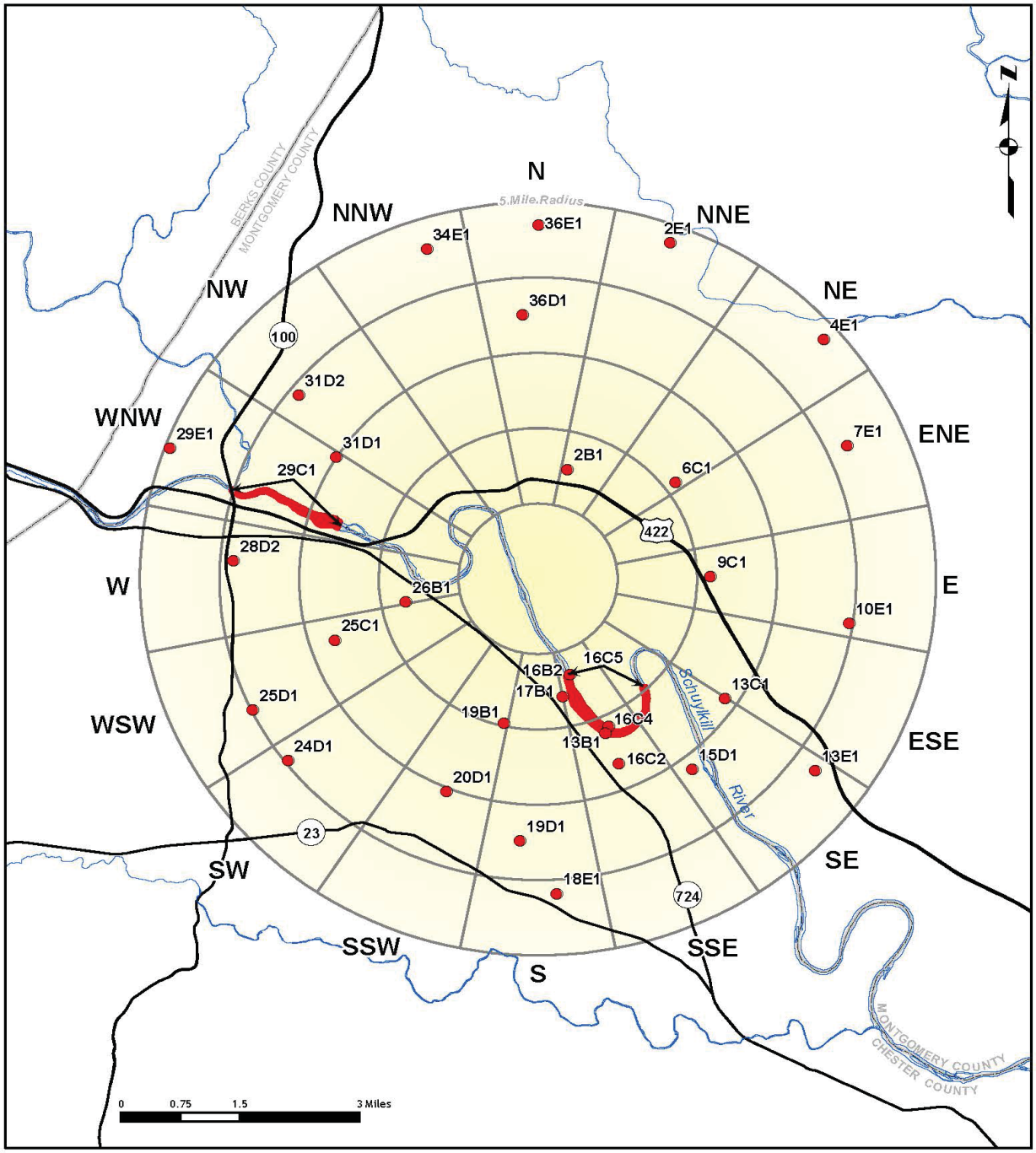

Figure B-2
Environmental Sampling Locations Between 5,280 and 26,400 Feet
from the Limerick Generating Station, 2019

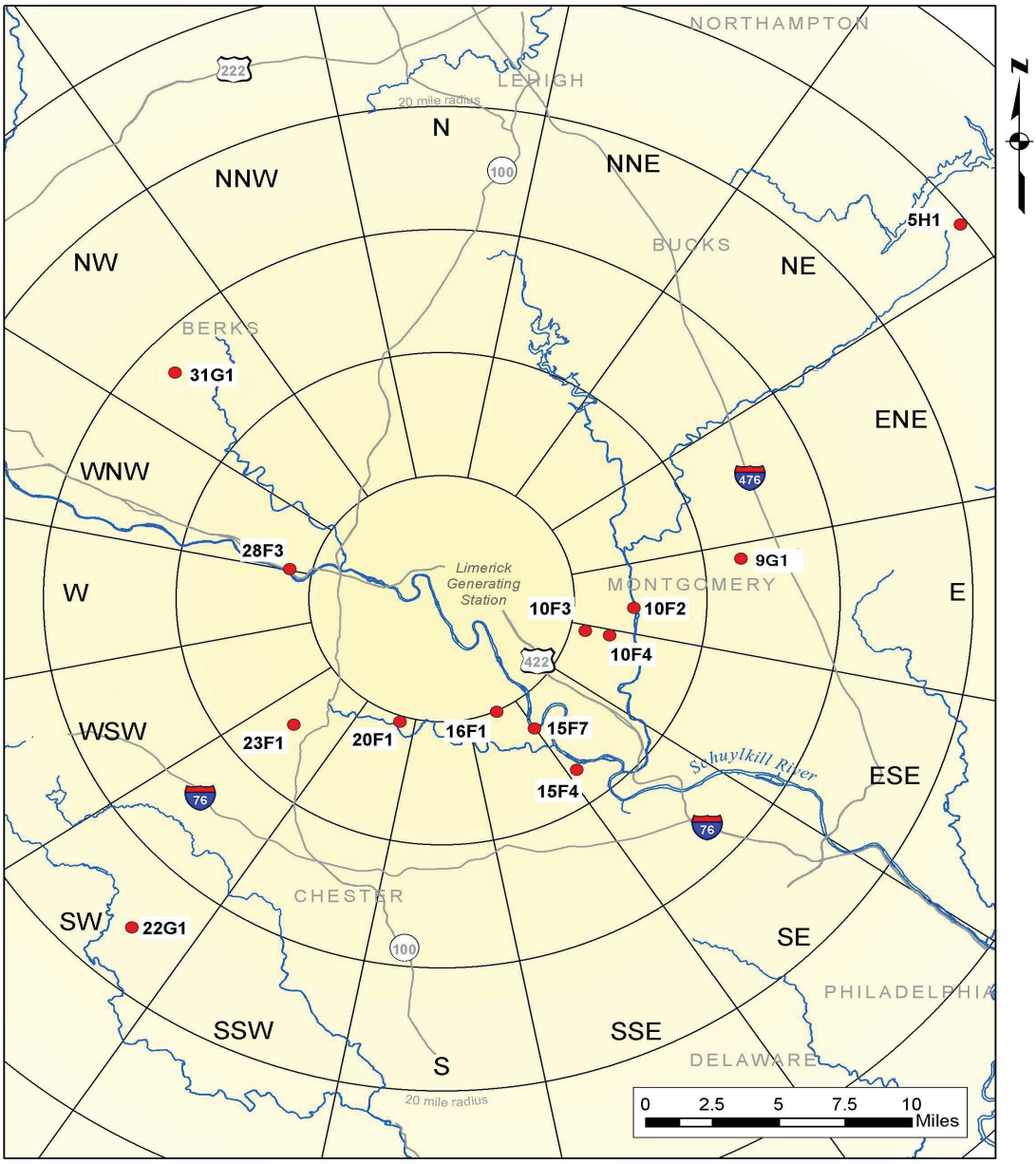

Figure B-3
Environmental Sampling Locations Greater than 26,400 Feet
from the Limerick Generating Station, 2019

APPENDIX C

DATA TABLES AND FIGURES

PRIMARY LABORATORY

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Table C-I.1 **CONCENTRATIONS OF TRITIUM IN SURFACE WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	13B1	24S1
01/02/19 - 04/02/19	< 194	< 189
04/02/19 - 07/02/19	< 191	< 190
07/02/19 - 09/30/19	< 184	< 184
09/30/19 - 12/30/19	< 188	< 187
MEAN	-	-

Table C-I.2 **CONCENTRATIONS OF I-131 IN SURFACE WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	24S1
01/02/19 - 01/28/19	< 0.7
01/28/19 - 02/26/19	< 0.6
02/26/19 - 04/02/19	< 1.0
04/02/19 - 04/29/19	< 0.7
04/29/19 - 06/03/19	< 0.8
06/03/19 - 07/02/19	< 0.8
07/02/19 - 07/30/19	< 0.8
07/30/19 - 09/03/19	< 0.9
09/03/19 - 09/30/19	< 0.8
09/30/19 - 10/28/19	< 0.9
10/28/19 - 12/03/19	< 0.7
11/25/19 - 12/03/19	< 0.6
12/03/19 - 12/30/19	< 0.7
MEAN	-

Table C-I.3 **CONCENTRATIONS OF GAMMA EMITTERS IN SURFACE WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140
13B1	01/02/19 - 01/28/19	< 7	< 8	< 19	< 8	< 20	< 7	< 13	< 12	< 7	< 7	< 32	< 12
	01/28/19 - 02/26/19	< 7	< 7	< 13	< 9	< 14	< 7	< 11	< 12	< 9	< 7	< 32	< 12
	02/26/19 - 04/02/19	< 6	< 3	< 12	< 4	< 6	< 7	< 11	< 11	< 7	< 6	< 30	< 12
	04/02/19 - 04/29/19	< 4	< 6	< 10	< 4	< 9	< 6	< 10	< 10	< 7	< 6	< 27	< 11
	04/29/19 - 06/03/19	< 4	< 5	< 14	< 5	< 9	< 4	< 9	< 12	< 6	< 6	< 27	< 9
	06/03/19 - 07/02/19	< 5	< 6	< 11	< 6	< 11	< 6	< 9	< 10	< 6	< 6	< 26	< 7
	07/02/19 - 07/30/19	< 6	< 7	< 11	< 7	< 13	< 7	< 15	< 12	< 8	< 8	< 30	< 10
	07/30/19 - 09/03/19	< 7	< 5	< 13	< 8	< 13	< 9	< 12	< 14	< 9	< 8	< 29	< 14
	09/03/19 - 09/30/19	< 8	< 8	< 15	< 7	< 15	< 9	< 9	< 13	< 8	< 8	< 36	< 13
	09/30/19 - 10/28/19	< 7	< 6	< 14	< 9	< 12	< 6	< 9	< 11	< 7	< 6	< 28	< 14
	10/28/19 - 12/03/19	< 7	< 4	< 13	< 7	< 10	< 6	< 12	< 11	< 6	< 5	< 25	< 11
	12/03/19 - 12/30/19	< 7	< 7	< 15	< 7	< 15	< 7	< 14	< 13	< 6	< 7	< 35	< 6
	MEAN	-	-	-	-	-	-	-	-	-	-	-	-
24S1	01/02/19 - 01/28/19	< 6	< 7	< 17	< 6	< 14	< 7	< 14	< 10	< 6	< 8	< 32	< 13
	01/28/19 - 02/26/19	< 7	< 8	< 15	< 7	< 15	< 7	< 14	< 15	< 9	< 7	< 37	< 13
	02/26/19 - 04/02/19	< 4	< 6	< 14	< 7	< 17	< 6	< 13	< 13	< 7	< 7	< 29	< 9
	04/02/19 - 04/29/19	< 4	< 6	< 12	< 5	< 9	< 7	< 11	< 11	< 7	< 6	< 31	< 12
	04/29/19 - 06/03/19	< 6	< 6	< 10	< 6	< 10	< 5	< 8	< 13	< 6	< 5	< 33	< 6
	06/03/19 - 07/02/19	< 5	< 6	< 9	< 7	< 10	< 7	< 10	< 9	< 7	< 7	< 27	< 10
	07/02/19 - 07/30/19	< 7	< 8	< 15	< 7	< 14	< 8	< 11	< 12	< 8	< 8	< 38	< 10
	07/30/19 - 09/03/19	< 6	< 6	< 12	< 6	< 11	< 7	< 13	< 14	< 6	< 6	< 33	< 10
	09/03/19 - 09/30/19	< 7	< 6	< 18	< 7	< 14	< 8	< 12	< 12	< 8	< 8	< 31	< 12
	09/30/19 - 10/28/19	< 6	< 6	< 14	< 6	< 12	< 9	< 12	< 14	< 8	< 5	< 37	< 11
	10/28/19 - 12/03/19	< 6	< 6	< 13	< 8	< 13	< 7	< 10	< 9	< 8	< 7	< 32	< 12
	11/25/19 - 12/03/19	< 8	< 6	< 16	< 8	< 17	< 7	< 11	< 9	< 8	< 8	< 27	< 6
	12/03/19 - 12/30/19	< 7	< 6	< 13	< 6	< 12	< 7	< 12	< 14	< 6	< 7	< 34	< 12
	MEAN	-	-	-	-	-	-	-	-	-	-	-	-

Table C-II.1 **CONCENTRATIONS OF GROSS BETA IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	15F4	15F7	16C2	28F3
01/02/19 - 01/28/19	2.4 ± 1.5	2.8 ± 1.5	< 2.3	2.6 ± 1.5
01/28/19 - 02/26/19	< 2.3	2.2 ± 1.5	< 2.3	< 2.2
02/26/19 - 04/02/19	< 2.3	< 2.2	< 2.3	< 2.2
04/02/19 - 04/29/19	2.4 ± 1.6	< 2.2	< 2.4	2.6 ± 1.6
04/29/19 - 06/03/19	< 2.3	< 2.3	2.6 ± 1.7	< 2.2
06/03/19 - 07/02/19	3.1 ± 1.6	2.7 ± 1.6	3.2 ± 1.7	4.5 ± 1.8
07/02/19 - 07/30/19	3.3 ± 1.6	3.1 ± 1.7	2.6 ± 1.7	3.7 ± 1.7
07/30/19 - 09/03/19	3.6 ± 1.6	3.1 ± 1.5	< 2.2	< 2.2
09/03/19 - 09/30/19	4.1 ± 2.0	2.8 ± 1.9	< 2.8	4.4 ± 2.0
09/30/19 - 10/28/19	4.0 ± 1.7	5.8 ± 1.8	5.7 ± 1.8	3.8 ± 1.6
10/28/19 - 12/03/19	4.2 ± 1.7	2.8 ± 1.6	3.9 ± 1.6	3.1 ± 1.6
12/03/19 - 12/30/19	2.2 ± 1.3	2.6 ± 1.4	< 1.9	< 1.9
MEAN ± 2 STD DEV	3.2 ± 1.6	3.1 ± 2.1	3.6 ± 2.6	3.5 ± 1.6

Table C-II.2 **CONCENTRATIONS OF TRITIUM IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	15F4	15F7	16C2	28F3
01/02/19 - 04/02/19	< 192	< 195	< 195	< 189
04/02/19 - 07/02/19	< 188	< 193	< 190	< 187
07/02/19 - 09/30/19	< 185	< 182	< 188	< 186
09/30/19 - 12/30/19	< 188	< 187	< 188	< 185
MEAN	-	-	-	-

Table C-II.3 **CONCENTRATIONS OF I-131 IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	15F4	15F7	16C2	28F3
01/02/19 - 01/28/19	< 0.8	< 0.8	< 0.8	< 0.9
01/28/19 - 02/26/19	< 0.5	< 0.7	< 0.7	< 0.7
02/26/19 - 04/02/19	< 1.0	< 0.9	< 0.9	< 1.0
04/02/19 - 04/29/19	< 0.9	< 0.7	< 0.8	< 0.7
04/29/19 - 06/03/19	< 0.7	< 0.9	< 0.8	< 0.7
06/03/19 - 07/02/19	< 0.8	< 0.7	< 0.7	< 0.9
07/02/19 - 07/30/19	< 0.8	< 0.8	< 0.6	< 0.8
07/30/19 - 09/03/19	< 0.9	< 0.8	< 0.9	< 0.9
09/03/19 - 09/30/19	< 0.8	< 0.9	< 0.9	< 0.8
09/30/19 - 10/28/19	< 0.9	< 0.8	< 0.7	< 0.9
10/28/19 - 12/03/19	< 0.9	< 0.9	< 0.7	< 0.8
12/03/19 - 12/30/19	< 0.9	< 0.8	< 0.7	< 0.7
MEAN	-	-	-	-

THE MEAN AND TWO STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

Table C-II.4 CONCENTRATIONS OF GAMMA EMITTERS IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019

RESULTS IN UNITS OF PCI/LITER + SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
15F4	01/02/19 - 01/28/19	< 5	< 5	< 12	< 6	< 12	< 7	< 9	< 5	< 6	< 27	< 9
	01/28/19 - 02/26/19	< 6	< 6	< 11	< 6	< 12	< 5	< 10	< 7	< 7	< 30	< 8
	02/26/19 - 04/02/19	< 7	< 6	< 14	< 8	< 11	< 7	< 11	< 7	< 5	< 34	< 8
	04/02/19 - 04/29/19	< 5	< 5	< 13	< 5	< 10	< 6	< 8	< 8	< 6	< 27	< 10
	04/29/19 - 06/03/19	< 6	< 6	< 15	< 7	< 12	< 8	< 11	< 7	< 6	< 30	< 14
	06/03/19 - 07/02/19	< 6	< 5	< 14	< 6	< 13	< 7	< 10	< 7	< 6	< 27	< 9
	07/02/19 - 07/30/19	< 6	< 5	< 12	< 6	< 16	< 7	< 10	< 6	< 7	< 28	< 10
	07/30/19 - 09/03/19	< 5	< 7	< 13	< 6	< 13	< 7	< 9	< 7	< 6	< 34	< 10
	09/03/19 - 09/30/19	< 5	< 7	< 9	< 6	< 14	< 6	< 11	< 6	< 7	< 34	< 11
	09/30/19 - 10/28/19	< 5	< 7	< 14	< 8	< 16	< 9	< 14	< 7	< 7	< 35	< 11
	10/28/19 - 12/03/19	< 7	< 6	< 15	< 8	< 15	< 7	< 11	< 8	< 7	< 33	< 12
	12/03/19 - 12/30/19	< 6	< 6	< 13	< 7	< 14	< 6	< 9	< 5	< 5	< 31	< 12
	MEAN	-	-	-	-	-	-	-	-	-	-	-
15F7	01/02/19 - 01/28/19	< 8	< 7	< 13	< 8	< 11	< 9	< 10	< 5	< 7	< 37	< 12
	01/28/19 - 02/26/19	< 5	< 6	< 11	< 6	< 12	< 6	< 10	< 6	< 6	< 30	< 8
	02/26/19 - 04/02/19	< 7	< 7	< 13	< 8	< 15	< 6	< 12	< 7	< 7	< 35	< 13
	04/02/19 - 04/29/19	< 4	< 6	< 8	< 7	< 10	< 6	< 10	< 6	< 5	< 26	< 9
	04/29/19 - 06/03/19	< 6	< 6	< 14	< 5	< 10	< 5	< 10	< 5	< 7	< 37	< 10
	06/03/19 - 07/02/19	< 6	< 5	< 17	< 11	< 13	< 7	< 10	< 8	< 7	< 33	< 13
	07/02/19 - 07/30/19	< 6	< 5	< 11	< 7	< 15	< 8	< 13	< 6	< 7	< 27	< 9
	07/30/19 - 09/03/19	< 6	< 7	< 13	< 7	< 10	< 8	< 9	< 6	< 7	< 37	< 12
	09/03/19 - 09/30/19	< 7	< 4	< 12	< 7	< 13	< 6	< 10	< 8	< 5	< 31	< 8
	09/30/19 - 10/28/19	< 7	< 8	< 12	< 8	< 14	< 8	< 12	< 7	< 7	< 37	< 7
	10/28/19 - 12/03/19	< 6	< 6	< 18	< 9	< 15	< 6	< 11	< 6	< 6	< 34	< 9
	12/03/19 - 12/30/19	< 6	< 6	< 14	< 6	< 14	< 6	< 13	< 8	< 6	< 34	< 14
	MEAN	-	-	-	-	-	-	-	-	-	-	-

Table C-II.4 CONCENTRATIONS OF GAMMA EMITTERS IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019

RESULTS IN UNITS OF PCI/LITER + SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
16C2	01/02/19 - 01/28/19	< 6	< 7	< 14	< 6	< 13	< 5	< 10	< 6	< 5	< 31	< 13
	01/28/19 - 02/26/19	< 6	< 5	< 13	< 8	< 12	< 6	< 12	< 9	< 8	< 31	< 7
	02/26/19 - 04/02/19	< 7	< 5	< 12	< 6	< 13	< 7	< 11	< 7	< 6	< 31	< 8
	04/02/19 - 04/29/19	< 4	< 7	< 14	< 7	< 10	< 6	< 10	< 7	< 6	< 31	< 10
	04/29/19 - 06/03/19	< 6	< 5	< 14	< 7	< 15	< 7	< 10	< 4	< 5	< 37	< 13
	06/03/19 - 07/02/19	< 7	< 6	< 10	< 6	< 12	< 6	< 11	< 6	< 6	< 31	< 9
	07/02/19 - 07/30/19	< 8	< 7	< 13	< 7	< 15	< 9	< 15	< 9	< 8	< 36	< 13
	07/30/19 - 09/03/19	< 7	< 7	< 12	< 6	< 13	< 8	< 11	< 8	< 7	< 39	< 12
	09/03/19 - 09/30/19	< 6	< 6	< 9	< 7	< 20	< 6	< 11	< 6	< 7	< 36	< 14
	09/30/19 - 10/28/19	< 7	< 7	< 13	< 7	< 17	< 7	< 12	< 7	< 8	< 35	< 15
	10/28/19 - 12/03/19	< 5	< 7	< 13	< 8	< 13	< 6	< 12	< 9	< 7	< 28	< 8
	12/03/19 - 12/30/19	< 4	< 5	< 11	< 7	< 13	< 6	< 8	< 6	< 6	< 29	< 12
	MEAN	-	-	-	-	-	-	-	-	-	-	-
28F3	01/02/19 - 01/28/19	< 7	< 7	< 16	< 6	< 16	< 9	< 10	< 7	< 7	< 28	< 10
	01/28/19 - 02/26/19	< 8	< 7	< 13	< 7	< 13	< 7	< 13	< 8	< 7	< 32	< 12
	02/26/19 - 04/02/19	< 6	< 5	< 15	< 8	< 16	< 6	< 13	< 6	< 7	< 36	< 14
	04/02/19 - 04/29/19	< 4	< 5	< 10	< 6	< 10	< 5	< 11	< 6	< 5	< 25	< 9
	04/29/19 - 06/03/19	< 6	< 6	< 13	< 6	< 11	< 5	< 10	< 5	< 6	< 31	< 10
	06/03/19 - 07/02/19	< 7	< 6	< 15	< 7	< 15	< 7	< 10	< 7	< 7	< 30	< 10
	07/02/19 - 07/30/19	< 4	< 5	< 10	< 10	< 14	< 6	< 12	< 8	< 8	< 28	< 15
	07/30/19 - 09/03/19	< 6	< 5	< 12	< 6	< 10	< 5	< 10	< 6	< 5	< 27	< 14
	09/03/19 - 09/30/19	< 5	< 4	< 14	< 9	< 14	< 7	< 10	< 7	< 7	< 31	< 15
	09/30/19 - 10/28/19	< 5	< 6	< 9	< 7	< 10	< 8	< 11	< 7	< 7	< 34	< 11
	10/28/19 - 12/03/19	< 6	< 8	< 14	< 7	< 12	< 7	< 12	< 6	< 7	< 27	< 11
	12/03/19 - 12/30/19	< 5	< 5	< 10	< 7	< 13	< 5	< 12	< 6	< 7	< 34	< 10
	MEAN	-	-	-	-	-	-	-	-	-	-	-

Table C-III.1 **CONCENTRATIONS OF GAMMA EMITTERS IN PREDATOR AND BOTTOM FEEDER (FISH) SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/KG WET ± 2 SIGMA

SITE	COLLECTION PERIOD	K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	I-131	Cs-134	Cs-137
16C5	PREDATOR									
	06/07/19	3713 ± 837	< 48	< 52	< 139	< 60	< 130	< 131	< 56	< 56
	11/05/19	3088 ± 641	< 46	< 36	< 81	< 43	< 84	< 63	< 49	< 44
	MEAN ± 2 STD DEV	3401 ± 884	-	-	-	-	-	-	-	-
16C5	BOTTOM FEEDER									
	06/07/19	3004 ± 775	< 59	< 58	< 128	< 55	< 114	< 110	< 64	< 49
	11/05/19	3105 ± 734	< 36	< 36	< 85	< 36	< 86	< 53	< 47	< 43
	MEAN ± 2 STD DEV	3055 ± 143	-	-	-	-	-	-	-	-
29C1	PREDATOR									
	05/10/19	3200 ± 946	< 54	< 55	< 137	< 54	< 115	< 67	< 38	< 45
	11/07/19	1804 ± 678	< 44	< 41	< 95	< 42	< 87	< 85	< 61	< 54
	MEAN ± 2 STD DEV	2502 ± 1974	-	-	-	-	-	-	-	-
29C1	BOTTOM FEEDER									
	05/10/19	3252 ± 1095	< 58	< 53	< 103	< 61	< 125	< 81	< 53	< 55
	11/07/19	2975 ± 977	< 48	< 55	< 122	< 49	< 98	< 64	< 44	< 53
	MEAN ± 2 STD DEV	3114 ± 392	-	-	-	-	-	-	-	-

THE MEAN AND 2-STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

Table C-IV.1 **CONCENTRATIONS OF GAMMA EMITTERS IN SEDIMENT SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/KG DRY ± 2 SIGMA

SITE	COLLECTION PERIOD	Be-7	K-40	Mn-54	Co-58	Co-60	I-131	Cs-134	Cs-137
16B2	06/12/19	3474 ± 780	13680 ± 1535	< 89	< 79	< 89	< 98	< 117	100 ± 54
	12/04/19	1366 ± 888	14030 ± 2110	< 125	< 113	< 94	< 146	< 142	< 137
	12/04/19	< 856	14350 ± 1904	< 102	< 87	< 91	< 128	< 130	< 125
	MEAN ± 2 STD DEV	2420 ± 2981	14020 ± 670	-	-	-	-	-	100 ± 0
16C4	06/12/19	2261 ± 515	15380 ± 1288	< 65	< 61	< 75	< 68	< 86	< 77
	12/04/19	< 681	16030 ± 2143	< 102	< 87	< 101	< 105	< 104	< 83
	12/04/19	< 783	14590 ± 1880	< 102	< 81	< 78	< 125	< 128	< 95
	MEAN ± 2 STD DEV	2261 ± 0	15333 ± 1442	-	-	-	-	-	-
33A2	06/12/19	< 550	12790 ± 1512	< 84	< 57	< 76	< 77	< 96	< 66
	12/04/19	< 737	15100 ± 1840	< 94	< 83	< 78	< 144	< 115	< 91
	12/04/19	< 848	12230 ± 1904	< 109	< 80	< 99	< 139	< 112	< 107
	MEAN ± 2 STD DEV	-	13373 ± 3043	-	-	-	-	-	-

THE MEAN AND 2-STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

Table C-V.1 **CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF E-03 PCI/CU METER ± 2 SIGMA

COLLECTION	GROUP I				GROUP II		GROUP III
PERIOD	10S3	11S1	13S4	14S1	6C1	15D1	22G1
01/02/19 - 01/07/19	16 ± 5	8 ± 5	16 ± 5	13 ± 5	13 ± 5	15 ± 5	15 ± 5
01/07/19 - 01/14/19	11 ± 4	12 ± 4	15 ± 4	9 ± 3	11 ± 4	12 ± 4	10 ± 4
01/14/19 - 01/22/19	11 ± 4	13 ± 4	18 ± 4	14 ± 4	13 ± 4	15 ± 4	11 ± 4
01/22/19 - 01/28/19	19 ± 5	12 ± 4	17 ± 5	15 ± 5	15 ± 5	16 ± 5	14 ± 5
01/28/19 - 02/04/19	23 ± 5	16 ± 2	27 ± 5	21 ± 5	20 ± 5	16 ± 4	25 ± 5
02/04/19 - 02/11/19	17 ± 4	14 ± 4	20 ± 4	15 ± 4	15 ± 4	17 ± 4	17 ± 4
02/11/19 - 02/18/19	17 ± 4	15 ± 4	23 ± 4	17 ± 4	14 ± 4	15 ± 4	10 ± 4
02/18/19 - 02/26/19	17 ± 4	20 ± 5	22 ± 4	18 ± 4	18 ± 4	21 ± 4	16 ± 4
02/26/19 - 03/04/19	19 ± 5	20 ± 5	19 ± 5	17 ± 4	18 ± 5	14 ± 4	18 ± 4
03/04/19 - 03/11/19	15 ± 4	16 ± 4	21 ± 4	18 ± 4	16 ± 4	15 ± 4	13 ± 4
03/11/19 - 03/18/19	19 ± 4	17 ± 4	24 ± 4	16 ± 4	19 ± 4	12 ± 4	17 ± 4
03/18/19 - 03/25/19	12 ± 4	13 ± 4	17 ± 4	10 ± 4	13 ± 4	10 ± 4	11 ± 4
03/25/19 - 04/02/19	13 ± 4	16 ± 4	20 ± 4	12 ± 3	15 ± 4	15 ± 4	14 ± 4
04/02/19 - 04/08/19	12 ± 4	13 ± 4	17 ± 5	12 ± 4	12 ± 4	*(1)*	12 ± 4
04/08/19 - 04/15/19	6 ± 4	< 5	8 ± 4	7 ± 4	8 ± 4	8 ± 4	< 5
04/15/19 - 04/22/19	8 ± 4	9 ± 4	12 ± 4	6 ± 3	7 ± 3	5 ± 3	8 ± 4
04/22/19 - 04/29/19	6 ± 3	7 ± 4	16 ± 4	10 ± 4	8 ± 4	7 ± 4	12 ± 4
04/29/19 - 05/07/19	7 ± 3	8 ± 3	10 ± 3	7 ± 3	6 ± 3	7 ± 3	8 ± 3
05/07/19 - 05/13/19	12 ± 4	13 ± 4	15 ± 4	11 ± 4	13 ± 4	6 ± 4	11 ± 4
05/13/19 - 05/20/19	15 ± 4	17 ± 4	20 ± 4	15 ± 4	15 ± 4	14 ± 4	20 ± 5
05/20/19 - 05/28/19	10 ± 4	7 ± 3	14 ± 4	6 ± 3	8 ± 3	11 ± 4	9 ± 3
05/28/19 - 06/03/19	8 ± 5	12 ± 5	*(1)*	13 ± 5	11 ± 5	7 ± 5	9 ± 5
06/03/19 - 06/11/19	10 ± 3	13 ± 4	14 ± 4	*(1)*	11 ± 3	11 ± 4	13 ± 4
06/11/19 - 06/17/19	11 ± 4	12 ± 5	12 ± 5	10 ± 4	11 ± 4	10 ± 4	12 ± 5
06/17/19 - 06/24/19	8 ± 4	9 ± 4	14 ± 4	10 ± 4	8 ± 4	10 ± 4	11 ± 4
06/24/19 - 07/02/19	9 ± 4	12 ± 4	19 ± 4	11 ± 4	12 ± 4	7 ± 4	8 ± 4
07/02/19 - 07/08/19	12 ± 4	14 ± 5	21 ± 5	12 ± 4	12 ± 4	17 ± 5	15 ± 5
07/08/19 - 07/15/19	12 ± 4	14 ± 4	21 ± 5	11 ± 4	14 ± 4	12 ± 4	14 ± 4
07/15/19 - 07/22/19	9 ± 4	9 ± 4	12 ± 4	10 ± 4	11 ± 4	9 ± 4	9 ± 3
07/22/19 - 07/30/19	16 ± 4	14 ± 4	13 ± 3	13 ± 4	13 ± 4	17 ± 4	14 ± 3
07/30/19 - 08/05/19	22 ± 5	19 ± 5	22 ± 5	22 ± 5	17 ± 5	17 ± 5	20 ± 5
08/05/19 - 08/12/19	13 ± 4	18 ± 4	15 ± 4	16 ± 4	15 ± 4	16 ± 4	17 ± 4
08/12/19 - 08/19/19	23 ± 5	25 ± 5	23 ± 4	25 ± 5	26 ± 5	21 ± 4	27 ± 5
08/19/19 - 08/26/19	12 ± 4	8 ± 4	16 ± 4	16 ± 4	18 ± 4	13 ± 4	16 ± 4
08/26/19 - 09/03/19	13 ± 4	12 ± 3	12 ± 4	14 ± 4	13 ± 4	12 ± 3	14 ± 4
09/03/19 - 09/10/19	14 ± 4	17 ± 4	14 ± 4	17 ± 4	16 ± 4	15 ± 4	16 ± 4
09/10/19 - 09/16/19	19 ± 4	23 ± 5	19 ± 4	23 ± 5	20 ± 5	20 ± 4	21 ± 5
09/16/19 - 09/23/19	22 ± 4	22 ± 4	21 ± 4	23 ± 4	20 ± 4	18 ± 4	24 ± 4
09/23/19 - 09/30/19	15 ± 4	17 ± 4	15 ± 4	16 ± 4	22 ± 4	18 ± 4	18 ± 4
09/30/19 - 10/07/19	9 ± 3	8 ± 3	8 ± 3	9 ± 3	10 ± 3	9 ± 3	9 ± 3
10/07/19 - 10/14/19	14 ± 4	17 ± 4	14 ± 4	12 ± 4	16 ± 4	14 ± 4	13 ± 4
10/14/19 - 10/21/19	14 ± 4	14 ± 4	14 ± 4	15 ± 4	13 ± 3	12 ± 3	13 ± 4
10/21/19 - 10/28/19	12 ± 4	12 ± 4	12 ± 4	10 ± 4	9 ± 4	8 ± 4	13 ± 4
10/28/19 - 11/05/19	9 ± 3	9 ± 3	8 ± 3	10 ± 3	9 ± 3	9 ± 3	9 ± 3
11/05/19 - 11/11/19	16 ± 4	14 ± 4	19 ± 4	12 ± 4	20 ± 4	16 ± 4	15 ± 4
11/11/19 - 11/18/19	13 ± 4	14 ± 4	9 ± 3	17 ± 4	14 ± 4	11 ± 4	16 ± 4
11/18/19 - 11/25/19	14 ± 4	13 ± 4	11 ± 4	15 ± 4	18 ± 4	11 ± 4	14 ± 4
11/25/19 - 12/03/19	11 ± 3	9 ± 3	8 ± 3	11 ± 3	11 ± 3	10 ± 3	11 ± 3
12/03/19 - 12/09/19	16 ± 4	12 ± 4	12 ± 4	15 ± 4	13 ± 4	11 ± 4	14 ± 4
12/09/19 - 12/16/19	13 ± 3	14 ± 3	12 ± 3	15 ± 4	15 ± 4	15 ± 4	16 ± 4
12/16/19 - 12/23/19	16 ± 4	19 ± 4	15 ± 4	18 ± 4	21 ± 4	16 ± 4	18 ± 4
12/23/19 - 12/30/19	27 ± 5	31 ± 5	23 ± 4	30 ± 5	30 ± 5	29 ± 5	24 ± 4
MEAN ± 2 STD DEV	14 ± 9	14 ± 10	16 ± 9	14 + 10	14 ± 9	13 ± 9	14 ± 9

THE MEAN AND 2-STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

(1) SEE PROGRAM EXCEPTIONS SECTION FOR EXPLANATION

Table C-V.2

MONTHLY AND YEARLY MEAN VALUES OF GROSS BETA CONCENTRATIONS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019

RESULTS IN UNITS OF E-03 PCI/CU METER ± 2 SIGMA

GROUP I - ON-SITE LOCATIONS				GROUP II - INTERMEDIATE DISTANCE LOCATIONS				GROUP III - CONTROL LOCATIONS			
COLLECTION PERIOD	MIN	MAX	MEAN ± 2SD	COLLECTION PERIOD	MIN	MAX	MEAN ± 2SD	COLLECTION PERIOD	MIN	MAX	MEAN ± 2SD
01/02/19 - 02/04/19	8	27	15 ± 9	01/02/19 - 02/04/19	11	20	15 ± 5	01/02/19 - 02/04/19	10	25	15 ± 12
02/04/19 - 02/26/19	14	23	18 ± 6	02/04/19 - 02/26/19	14	21	17 ± 5	02/04/19 - 02/26/19	10	17	14 ± 7
02/26/19 - 04/02/19	10	24	17 ± 7	02/26/19 - 04/02/19	10	19	15 ± 6	02/26/19 - 04/02/19	11	18	15 ± 6
04/02/19 - 04/29/19	6	17	10 ± 7	04/02/19 - 04/29/19	5	12	8 ± 4	04/02/19 - 04/29/19	8	12	11 ± 4
04/29/19 - 06/03/19	6	20	12 ± 8	04/29/19 - 06/03/19	6	15	10 ± 7	04/29/19 - 06/03/19	8	20	11 ± 10
06/03/19 - 07/02/19	8	19	12 ± 6	06/03/19 - 07/02/19	7	12	10 ± 3	06/03/19 - 07/02/19	8	13	11 ± 4
07/02/19 - 07/30/19	9	21	13 ± 7	07/02/19 - 07/30/19	9	17	13 ± 6	07/02/19 - 07/30/19	9	15	13 ± 6
07/30/19 - 09/03/19	8	25	17 ± 10	07/30/19 - 09/03/19	12	26	17 ± 8	07/30/19 - 09/03/19	14	27	19 ± 10
09/03/19 - 09/30/19	14	23	18 ± 7	09/03/19 - 09/30/19	15	22	19 ± 5	09/03/19 - 09/30/19	16	24	20 ± 7
09/30/19 - 10/28/19	8	17	12 ± 5	09/30/19 - 10/28/19	8	16	11 ± 5	09/30/19 - 10/28/19	9	13	12 ± 4
10/28/19 - 12/03/19	8	19	12 ± 6	10/28/19 - 12/03/19	9	20	13 ± 8	10/28/19 - 12/03/19	9	16	13 ± 6
12/03/19 - 12/30/19	12	31	18 ± 13	12/03/19 - 12/30/19	11	30	19 ± 14	12/03/19 - 12/30/19	14	24	18 ± 9
01/02/19 - 12/30/19	6	31	15 ± 10	01/02/19 - 12/30/19	5	30	14 ± 9	01/02/19 - 12/30/19	8	27	14 ± 9

Table C-V.3 CONCENTRATIONS OF GAMMA EMITTERS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019

RESULTS IN UNITS OF E-03 PCI/CU METER ± 2 SIGMA

SITE	COLLECTION PERIOD	Be-7	Mn-54	Co-58	Co-60	Cs-134	Cs-137
10S3	01/02/19 - 04/02/19	91 ± 21	< 3	< 3	< 3	< 3	< 3
	04/02/19 - 07/02/19	78 ± 23	< 3	< 4	< 3	< 3	< 2
	07/02/19 - 09/30/19	84 ± 19	< 2	< 2	< 2	< 2	< 2
	09/30/19 - 12/30/19	42 ± 14	< 2	< 2	< 2	< 1	< 2
MEAN ± 2 STD DEV		74 ± 43	-	-	-	-	-
11S1	01/02/19 - 04/02/19	81 ± 19	< 2	< 2	< 3	< 2	< 2
	04/02/19 - 07/02/19	75 ± 31	< 2	< 3	< 3	< 4	< 3
	07/02/19 - 09/30/19	67 ± 20	< 2	< 2	< 3	< 2	< 1
	09/30/19 - 12/30/19	45 ± 17	< 3	< 2	< 3	< 2	< 3
MEAN ± 2 STD DEV		67 ± 31	-	-	-	-	-
13S4	01/02/19 - 04/02/19	115 ± 22	< 3	< 3	< 3	< 4	< 3
	04/02/19 - 07/02/19	94 ± 23	< 2	< 2	< 2	< 2	< 2
	07/02/19 - 09/30/19	77 ± 19	< 2	< 2	< 3	< 2	< 2
	09/30/19 - 12/30/19	66 ± 41	< 8	< 8	< 8	< 9	< 7
MEAN ± 2 STD DEV		88 ± 43	-	-	-	-	-
14S1	01/02/19 - 04/02/19	88 ± 20	< 2	< 3	< 2	< 3	< 3
	04/02/19 - 07/02/19	69 ± 20	< 2	< 3	< 2	< 3	< 2
	07/02/19 - 09/30/19	70 ± 18	< 2	< 2	< 3	< 2	< 1
	09/30/19 - 12/30/19	54 ± 16	< 2	< 1	< 2	< 2	< 2
MEAN ± 2 STD DEV		70 ± 28	-	-	-	-	-
15D1	01/02/19 - 04/02/19	87 ± 26	< 4	< 3	< 3	< 3	< 4
	04/02/19 - 07/02/19	64 ± 23	< 3	< 3	< 3	< 3	< 3
	07/02/19 - 09/30/19	92 ± 23	< 2	< 3	< 3	< 3	< 2
	09/30/19 - 12/30/19	50 ± 13	< 2	< 1	< 2	< 2	< 2
MEAN ± 2 STD DEV		73 ± 40	-	-	-	-	-
22G1	01/02/19 - 04/02/19	93 ± 20	< 2	< 2	< 1	< 2	< 2
	04/02/19 - 07/02/19	77 ± 27	< 3	< 3	< 2	< 2	< 2
	07/02/19 - 09/30/19	74 ± 22	< 2	< 2	< 2	< 3	< 3
	09/30/19 - 12/30/19	76 ± 20	< 3	< 3	< 2	< 2	< 3
MEAN ± 2 STD DEV		80 ± 18	-	-	-	-	-
6C1	01/02/19 - 04/02/19	75 ± 18	< 2	< 2	< 2	< 2	< 2
	04/02/19 - 07/02/19	72 ± 21	< 3	< 3	< 3	< 3	< 2
	07/02/19 - 09/30/19	81 ± 21	< 2	< 3	< 3	< 2	< 2
	09/30/19 - 12/30/19	65 ± 18	< 2	< 3	< 2	< 2	< 3
MEAN ± 2 STD DEV		73 ± 14	-	-	-	-	-

THE MEAN AND 2-STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

Table C-VI.1

CONCENTRATIONS OF I-131 IN AIR IODINE SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019

RESULTS IN UNITS OF E-03 PCI/CU METER + 2 SIGMA

COLLECTION	GROUP I				GROUP II		GROUP III
PERIOD	10S3	11S1	13S4	14S1	6C1	15D1	22G1
01/02/19 - 01/07/19	< 57	< 57	< 25	< 57	< 56	< 28	< 28
01/07/19 - 01/14/19	< 36	< 36	< 58	< 35	< 35	< 65	< 66
01/14/19 - 01/22/19	< 43	< 43	< 18	< 43	< 43	< 21	< 21
01/22/19 - 01/28/19	< 56	< 56	< 25	< 56	< 56	< 27	< 26
01/28/19 - 02/04/19	< 47	< 47	< 38	< 42	< 25	< 42	< 44
02/04/19 - 02/11/19	< 48	< 48	< 31	< 48	< 48	< 35	< 36
02/11/19 - 02/18/19	< 45	< 45	< 63	< 45	< 44	< 67	< 64
02/18/19 - 02/26/19	< 18	< 20	< 12	< 18	< 18	< 10	< 24
02/26/19 - 03/04/19	< 29	< 29	< 45	< 47	< 24	< 47	< 45
03/04/19 - 03/11/19	< 29	< 29	< 44	< 29	< 29	< 46	< 46
03/11/19 - 03/18/19	< 37	< 37	< 18	< 19	< 36	< 19	< 19
03/18/19 - 03/25/19	< 36	< 36	< 32	< 36	< 36	< 34	< 34
03/25/19 - 04/02/19	< 20	< 8	< 13	< 20	< 20	< 14	< 15
04/02/19 - 04/08/19	< 42	< 42	< 46	< 41	< 42	*(1)*	< 45
04/08/19 - 04/15/19	< 28	< 29	< 12	< 28	< 28	< 30	< 30
04/15/19 - 04/22/19	< 44	< 45	< 32	< 44	< 44	< 33	< 33
04/22/19 - 04/29/19	< 39	< 39	< 28	< 38	< 38	< 30	< 30
04/29/19 - 05/07/19	< 24	< 25	< 26	< 25	< 13	< 24	< 28
05/07/19 - 05/13/19	< 35	< 35	< 41	< 34	< 35	< 45	< 42
05/13/19 - 05/20/19	< 22	< 22	< 15	< 22	< 22	< 16	< 17
05/20/19 - 05/28/19	< 51	< 51	< 33	< 35	< 50	< 29	< 34
05/28/19 - 06/03/19	< 48	< 49	*(1)*	< 19	< 48	< 20	< 20
06/03/19 - 06/11/19	*< 57*	< 57	< 35	*(1)*	< 56	< 36	< 35
06/11/19 - 06/17/19	< 29	< 30	< 17	< 30	< 29	< 17	< 17
06/17/19 - 06/24/19	< 34	< 33	< 22	< 33	< 14	< 34	< 22
06/24/19 - 07/02/19	< 48	< 49	*< 25*	< 48	< 47	< 20	< 24
07/02/19 - 07/08/19	< 15	< 15	< 20	< 15	< 8	< 16	< 20
07/08/19 - 07/15/19	< 34	< 34	< 22	< 33	< 18	< 34	< 23
07/15/19 - 07/22/19	< 11	< 11	< 29	< 12	< 10	< 12	< 25
07/22/19 - 07/30/19	< 26	< 26	< 34	< 26	< 14	< 26	< 11
07/30/19 - 08/05/19	< 24	< 25	< 25	< 20	< 23	< 24	< 13
08/05/19 - 08/12/19	< 18	< 22	< 33	< 20	< 21	< 20	< 33
08/12/19 - 08/19/19	< 14	< 20	< 19	< 19	< 14	< 8	< 21
08/19/19 - 08/26/19	< 11	< 12	< 21	< 20	< 10	< 8	< 21
08/26/19 - 09/03/19	< 10	< 16	< 16	< 15	< 10	< 15	< 6
09/03/19 - 09/10/19	< 25	< 26	< 16	< 25	< 11	< 25	< 16
09/10/19 - 09/16/19	< 48	< 50	< 24	< 46	< 21	< 46	< 31
09/16/19 - 09/23/19	< 11	< 12	< 15	< 11	< 12	< 15	< 15
09/23/19 - 09/30/19	< 14	< 20	< 20	< 19	< 12	< 19	< 16
09/30/19 - 10/07/19	< 24	< 21	< 29	< 23	< 24	< 23	< 27
10/07/19 - 10/14/19	< 17	< 16	< 27	< 15	< 17	< 25	< 26
10/14/19 - 10/21/19	< 29	< 13	< 24	< 29	< 28	< 28	< 24
10/21/19 - 10/28/19	< 12	< 24	< 28	< 24	< 23	< 23	< 26
10/28/19 - 11/05/19	< 34	< 26	< 12	< 27	< 33	< 27	< 28
11/05/19 - 11/11/19	< 25	< 12	< 12	< 25	< 25	< 25	< 25
11/11/19 - 11/18/19	< 38	< 38	< 23	< 17	< 38	< 41	< 20
11/18/19 - 11/25/19	< 21	*< 27*	< 23	< 25	< 25	< 26	< 27
11/25/19 - 12/03/19	< 20	< 20	< 24	< 20	< 19	< 21	< 23
12/03/19 - 12/09/19	< 23	< 23	< 22	< 21	< 21	< 10	< 15
12/09/19 - 12/16/19	< 23	< 23	< 33	< 22	< 20	< 23	< 33
12/16/19 - 12/23/19	< 30	< 30	< 15	< 25	< 30	< 36	< 39
12/23/19 - 12/30/19	< 37	< 16	< 26	< 37	< 37	< 37	< 21
MEAN	-	-	-	-	-	-	-

(1) SEE PROGRAM EXCEPTIONS SECTION FOR EXPLANATION

Table C-VII.1 **CONCENTRATIONS OF I-131 IN MILK SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION	CONTROL FARM		INDICATOR FARM		
PERIOD	23F1	36E1	18E1	19B1	25C1
01/15/19	< 0.5	< 0.7	< 0.7	< 0.9	< 0.4
02/12/19	< 0.6		< 0.5	< 0.7	< 0.9
03/05/19	< 0.7		< 0.4	< 0.7	< 0.8
04/01/19	< 0.7	< 0.8	< 0.9	< 1.0	< 0.7
04/16/19	< 0.7		< 0.6	< 0.7	< 0.8
04/29/19	< 0.7		< 0.7	< 0.6	< 0.6
05/14/19	< 0.5		< 0.7	< 0.6	< 0.7
05/28/19	< 0.8		< 0.6	< 0.5	< 0.7
06/11/19	< 0.8		< 1.0	< 0.7	< 0.9
06/24/19	< 0.7		< 0.6	< 0.8	< 0.7
07/09/19	< 0.8	< 0.9	< 0.8	< 0.9	< 0.9
07/22/19	< 0.9		< 0.9	< 0.8	< 0.8
08/06/19	< 0.6		< 0.8	< 0.9	< 0.6
08/21/19	< 0.9		< 0.7	< 0.7	< 0.7
09/03/19	< 0.7		< 0.7	< 0.8	< 0.7
09/16/19	< 0.7		< 0.8	< 0.7	< 0.7
10/01/19	< 0.7	< 0.8	< 0.7	< 0.9	< 0.8
10/15/19	< 0.9		< 0.8	< 0.8	< 0.9
10/29/19	< 0.9		< 0.9	< 0.8	< 0.7
11/12/19	< 0.5		< 0.8	< 0.7	< 0.6
11/25/19	< 0.8		< 0.8	< 0.8	< 0.9
12/10/19	< 0.8		< 0.9	< 0.9	< 0.9
MEAN	-	-	-	-	-

Table C-VII.2 **CONCENTRATIONS OF GAMMA EMITTERS IN MILK SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	K-40	Cs-134	Cs-137	Ba-140	La-140
18E1	01/15/19	1196 ± 185	< 7	< 8	< 29	< 10
	02/12/19	1206 ± 172	< 8	< 8	< 25	< 10
	03/05/19	1145 ± 181	< 8	< 8	< 38	< 10
	04/01/19	1290 ± 162	< 11	< 10	< 36	< 10
	04/16/19	1288 ± 111	< 7	< 6	< 25	< 7
	04/29/19	1233 ± 140	< 6	< 6	< 25	< 5
	05/14/19	1155 ± 157	< 7	< 6	< 22	< 9
	05/28/19	1347 ± 173	< 7	< 5	< 25	< 5
	06/11/19	1241 ± 177	< 8	< 7	< 40	< 11
	06/24/19	1276 ± 189	< 8	< 10	< 30	< 7
	07/08/19	1129 ± 152	< 8	< 7	< 24	< 7
	07/22/19	1195 ± 180	< 9	< 9	< 35	< 8
	08/05/19	1143 ± 201	< 10	< 6	< 26	< 8
	08/20/19	1167 ± 181	< 9	< 8	< 43	< 13
	09/03/19	1321 ± 172	< 7	< 9	< 29	< 13
	09/16/19	1019 ± 140	< 9	< 9	< 31	< 10
	10/01/19	1124 ± 116	< 8	< 7	< 24	< 7
	10/15/19	1226 ± 187	< 8	< 9	< 32	< 12
	10/29/19	1056 ± 190	< 9	< 10	< 34	< 9
	11/12/19	1104 ± 190	< 7	< 9	< 26	< 10
	11/25/19	1218 ± 201	< 9	< 9	< 33	< 12
	12/10/19	1259 ± 150	< 6	< 6	< 23	< 8
	MEAN ± 2 STD DEV	1197 ± 168	-	-	-	-
19B1	01/15/19	1117 ± 166	< 10	< 9	< 41	< 12
	02/12/19	1205 ± 204	< 5	< 7	< 28	< 8
	03/05/19	1202 ± 139	< 10	< 9	< 40	< 13
	04/01/19	1136 ± 150	< 11	< 11	< 39	< 8
	04/16/19	1124 ± 184	< 8	< 7	< 28	< 9
	04/29/19	1365 ± 202	< 9	< 9	< 31	< 10
	05/14/19	1303 ± 150	< 6	< 6	< 24	< 6
	05/28/19	1213 ± 140	< 6	< 7	< 29	< 6
	06/11/19	1198 ± 151	< 7	< 7	< 31	< 9
	06/24/19	1287 ± 150	< 9	< 9	< 28	< 9
	07/08/19	1181 ± 192	< 7	< 7	< 29	< 5
	07/22/19	1280 ± 201	< 8	< 8	< 27	< 11
	08/05/19	1401 ± 196	< 9	< 5	< 20	< 8
	08/20/19	1197 ± 174	< 8	< 8	< 41	< 11
	09/03/19	1165 ± 194	< 9	< 9	< 29	< 9
	09/16/19	1029 ± 191	< 8	< 6	< 21	< 6
	10/01/19	1247 ± 145	< 8	< 6	< 22	< 7
	10/15/19	1253 ± 118	< 6	< 6	< 18	< 6
	10/29/19	1261 ± 160	< 13	< 12	< 39	< 9
	11/12/19	1268 ± 183	< 8	< 7	< 28	< 4
	11/25/19	1448 ± 197	< 9	< 7	< 37	< 10
	12/10/19	1253 ± 123	< 5	< 5	< 20	< 8
	MEAN ± 2 STD DEV	1233 ± 192	-	-	-	-

THE MEAN AND TWO STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

Table C-VII.2 **CONCENTRATIONS OF GAMMA EMITTERS IN MILK SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	K-40	Cs-134	Cs-137	Ba-140	La-140
23F1	01/15/19	1210 ± 228	< 7	< 7	< 24	< 6
	02/12/19	1356 ± 159	< 6	< 5	< 21	< 7
	03/05/19	1038 ± 189	< 8	< 8	< 29	< 9
	04/01/19	1347 ± 169	< 12	< 11	< 41	< 10
	04/16/19	1270 ± 176	< 7	< 7	< 22	< 6
	04/29/19	1485 ± 178	< 8	< 7	< 29	< 11
	05/14/19	1262 ± 142	< 8	< 7	< 23	< 6
	05/28/19	1181 ± 124	< 7	< 6	< 28	< 8
	06/11/19	1359 ± 164	< 7	< 7	< 31	< 7
	06/24/19	1360 ± 137	< 6	< 6	< 24	< 6
	07/08/19	1146 ± 188	< 7	< 7	< 31	< 9
	07/22/19	1471 ± 191	< 7	< 7	< 26	< 9
	08/05/19	1261 ± 203	< 8	< 9	< 31	< 10
	08/20/19	1154 ± 190	< 7	< 7	< 39	< 8
	09/03/19	1381 ± 216	< 7	< 9	< 34	< 10
	09/16/19	1496 ± 191	< 8	< 7	< 25	< 8
	10/01/19	1315 ± 152	< 6	< 7	< 19	< 5
	10/15/19	1250 ± 99.1	< 7	< 7	< 25	< 7
	10/29/19	1505 ± 206	< 9	< 9	< 31	< 9
	11/12/19	1443 ± 202	< 10	< 9	< 33	< 8
	11/25/19	1260 ± 162	< 7	< 7	< 25	< 8
	12/10/19	1119 ± 153	< 6	< 6	< 19	< 6
	MEAN ± 2 STD DEV	1303 ± 262	-	-	-	-
25C1	01/15/19	875 ± 144	< 6	< 6	< 25	< 5
	02/12/19	1305 ± 179	< 7	< 7	< 32	< 6
	03/05/19	1472 ± 171	< 9	< 8	< 35	< 11
	04/01/19	1397 ± 217	< 8	< 10	< 34	< 13
	04/16/19	1375 ± 201	< 8	< 7	< 24	< 5
	04/29/19	1521 ± 197	< 7	< 8	< 28	< 10
	05/14/19	1335 ± 198	< 8	< 9	< 38	< 11
	05/28/19	1431 ± 175	< 8	< 8	< 33	< 11
	06/11/19	1516 ± 155	< 6	< 6	< 28	< 8
	06/24/19	1464 ± 118	< 6	< 5	< 19	< 6
	07/08/19	1235 ± 187	< 9	< 8	< 29	< 10
	07/22/19	993 ± 187	< 8	< 7	< 28	< 9
	08/06/19	1365 ± 170	< 4	< 6	< 24	< 7
	08/21/19	1315 ± 202	< 10	< 10	< 36	< 10
	09/03/19	1310 ± 172	< 7	< 7	< 29	< 10
	09/16/19	1261 ± 165	< 7	< 7	< 27	< 9
	10/01/19	1158 ± 152	< 7	< 7	< 23	< 8
	10/15/19	1146 ± 123	< 5	< 5	< 16	< 6
	10/29/19	1372 ± 176	< 7	< 7	< 23	< 9
	11/12/19	1216 ± 200	< 7	< 8	< 31	< 9
	11/25/19	1345 ± 152	< 7	< 7	< 34	< 10
	12/10/19	1062 ± 139	< 6	< 6	< 22	< 7
	MEAN ± 2 STD DEV	1294 ± 334	-	-	-	-
36E1	01/15/19	1055 ± 176	< 6	< 7	< 27	< 8
	04/01/19	1163 ± 183	< 12	< 11	< 40	< 10
	07/09/19	1198 ± 188	< 7	< 6	< 26	< 10
	10/01/19	1020 ± 163	< 7	< 6	< 22	< 7
	MEAN ± 2 STD DEV	1109 ± 170	-	-	-	-

THE MEAN AND TWO STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

TABLE C-VIII.1

CONCENTRATIONS OF GAMMA EMITTERS IN BROAD LEAFY VEGETATION SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019

RESULTS IN UNITS OF PCI/KG WET ± 2 SIGMA

SITE	COLLECTION PERIOD		Be-7	K-40	Mn-54	Co-58	Co-60	I-131	Cs-134	Cs-137	Ra-226	Th-228	Th-232
11S3	06/25/19	*Swiss Chard leaves*	335 ± 172	5513 ± 533	< 15	< 19	< 20	< 21	< 23	< 23	< 385	55 ± 28	< 78
	06/25/19	*Collard leaves*	< 228	3573 ± 531	< 27	< 27	< 33	< 30	< 33	< 27	< 642	54 ± 47	< 137
	06/25/19	*Kale leaves*	< 184	4846 ± 642	< 24	< 25	< 25	< 24	< 25	< 22	< 623	< 43	< 101
	07/23/19	*Swiss Chard leaves*	663 ± 247	8816 ± 728	< 24	< 25	< 35	< 30	< 26	< 28	< 549	< 54	< 96
	07/23/19	*Collard leaves*	866 ± 209	5173 ± 580	< 19	< 21	< 25	< 23	< 19	< 22	< 433	< 34	< 104
	07/23/19	*Kale leaves*	1190 ± 222	3389 ± 523	< 24	< 18	< 26	< 24	< 21	< 18	< 610	< 49	< 80
	08/19/19	*Swiss Chard leaves*	537 ± 242	8068 ± 886	< 25	< 26	< 23	< 27	< 34	< 29	< 697	< 66	< 139
	08/19/19	*Collard leaves*	1180 ± 275	5236 ± 701	< 25	< 28	< 24	< 30	< 28	< 23	< 632	< 60	< 103
	08/19/19	*Kale leaves*	1419 ± 350	3358 ± 532	< 24	< 24	< 34	< 20	< 25	< 28	< 628	51 ± 40	< 112
	09/24/19	*Swiss Chard leaves*	< 307	7037 ± 1014	< 32	< 27	< 37	< 32	< 40	< 31	< 622	128 ± 60	< 126
	09/24/19	*Eggplant leaves*	981 ± 373	6978 ± 962	< 33	< 26	< 42	< 41	< 39	< 38	< 927	244 ± 71	< 152
		MEAN ± 2 STD DEV	896 ± 736	5635 ± 3758	-	-	-	-	-	-	-	106 ± 167	-
13S3	06/25/19	*Swiss Chard leaves*	< 448	7248 ± 1058	< 46	< 42	< 34	< 37	< 49	< 45	< 896	< 72	< 202
	06/25/19	*Collard leaves*	< 438	3808 ± 780	< 45	< 41	< 47	< 42	< 49	< 48	1531 ± 1004	108 ± 64	< 167
	06/25/19	*Kale leaves*	< 334	3646 ± 833	< 52	< 38	< 55	< 48	< 48	< 41	1419 ± 918	91 ± 69	< 193
	07/23/19	*Eggplant leaves*	3332 ± 243	5018 ± 431	< 19	< 19	< 18	< 23	< 20	< 20	797 ± 500	< 41	< 87
	07/23/19	*Collard leaves*	1233 ± 350	3752 ± 600	< 33	< 29	< 35	< 37	< 33	< 31	2871 ± 803	< 58	< 139
	07/23/19	*Kale leaves*	767 ± 237	3822 ± 568	< 27	< 28	< 22	< 24	< 22	< 26	1626 ± 663	< 48	< 81
	08/19/19	*Kale leaves*	1140 ± 324	4260 ± 649	< 33	< 30	< 31	< 38	< 30	< 32	2639 ± 914	94 ± 56	< 165
	08/19/19	*Collard leaves*	1041 ± 296	4613 ± 817	< 45	< 33	< 30	< 41	< 41	< 35	1408 ± 846	< 74	< 176
	08/19/19	*Swiss Chard leaves*	< 565	6889 ± 1116	< 54	< 46	< 43	< 57	< 59	< 56	1146 ± 924	< 107	< 234
	09/24/19	*Eggplant leaves*	< 414	5911 ± 689	< 34	< 28	< 39	< 39	< 38	< 41	< 946	124 ± 57	< 157
	09/24/19	*Swiss Chard leaves*	< 497	9170 ± 1132	< 39	< 40	< 47	< 55	< 51	< 46	< 1256	< 100	< 194
		MEAN ± 2 STD DEV	1503 ± 2075	5285 ± 3625	-	-	-	-	-	-	1680 ± 1428	104 ± 31	-
31G1	06/25/19	*Cabbage leaves*	799 ± 251	3692 ± 616	< 27	< 24	< 32	< 24	< 31	< 29	< 671	159 ± 39	< 115
	06/25/19	*Cauliflower leaves*	299 ± 143	3426 ± 414	< 17	< 14	< 21	< 19	< 23	< 20	< 461	101 ± 34	91 ± 35
	06/25/19	*Asparagus leaves*	153 ± 136	2885 ± 409	< 17	< 18	< 21	< 18	< 20	< 21	< 383	138 ± 39	< 77
	07/23/19	*Yellow Squash leaves*	2891 ± 349	6264 ± 654	< 23	< 25	< 24	< 26	< 30	< 26	< 550	86 ± 43	< 134
	07/23/19	*Cucumber leaves*	1902 ± 333	5515 ± 665	< 26	< 26	< 26	< 36	< 31	< 29	< 660	< 53	107 ± 46
	07/23/19	*Watermelon leaves*	2560 ± 354	3827 ± 673	< 31	< 22	< 27	< 39	< 46	< 32	< 748	< 62	< 161
	08/19/19	*Sunflower leaves*	3719 ± 490	7950 ± 882	< 35	< 23	< 40	< 32	< 39	< 38	< 881	100 ± 71	< 132
	08/19/19	*Swiss Chard leaves*	795 ± 374	5983 ± 870	< 34	< 33	< 48	< 32	< 35	< 29	< 782	117 ± 55	< 139
	08/19/19	*Eggplant leaves*	1053 ± 347	6084 ± 744	< 39	< 32	< 28	< 34	< 43	< 37	< 838	218 ± 74	< 157
	09/24/19	*Sunflower leaves*	2280 ± 365	8971 ± 812	< 36	< 32	< 37	< 41	< 36	< 33	< 785	< 62	< 147
	09/24/19	*Swiss Chard leaves*	< 327	6311 ± 798	< 28	< 32	< 33	< 33	< 28	< 33	< 796	126 ± 56	< 109
	09/24/19	*Rhubarb leaves*	< 274	3492 ± 699	< 27	< 26	< 28	< 25	< 25	< 27	< 557	< 57	< 108
		MEAN ± 2 STD DEV	1645 ± 2403	5367 ± 3856	-	-	-	-	-	-	-	131 ± 84	99 ± 23

THE MEAN AND 2-STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

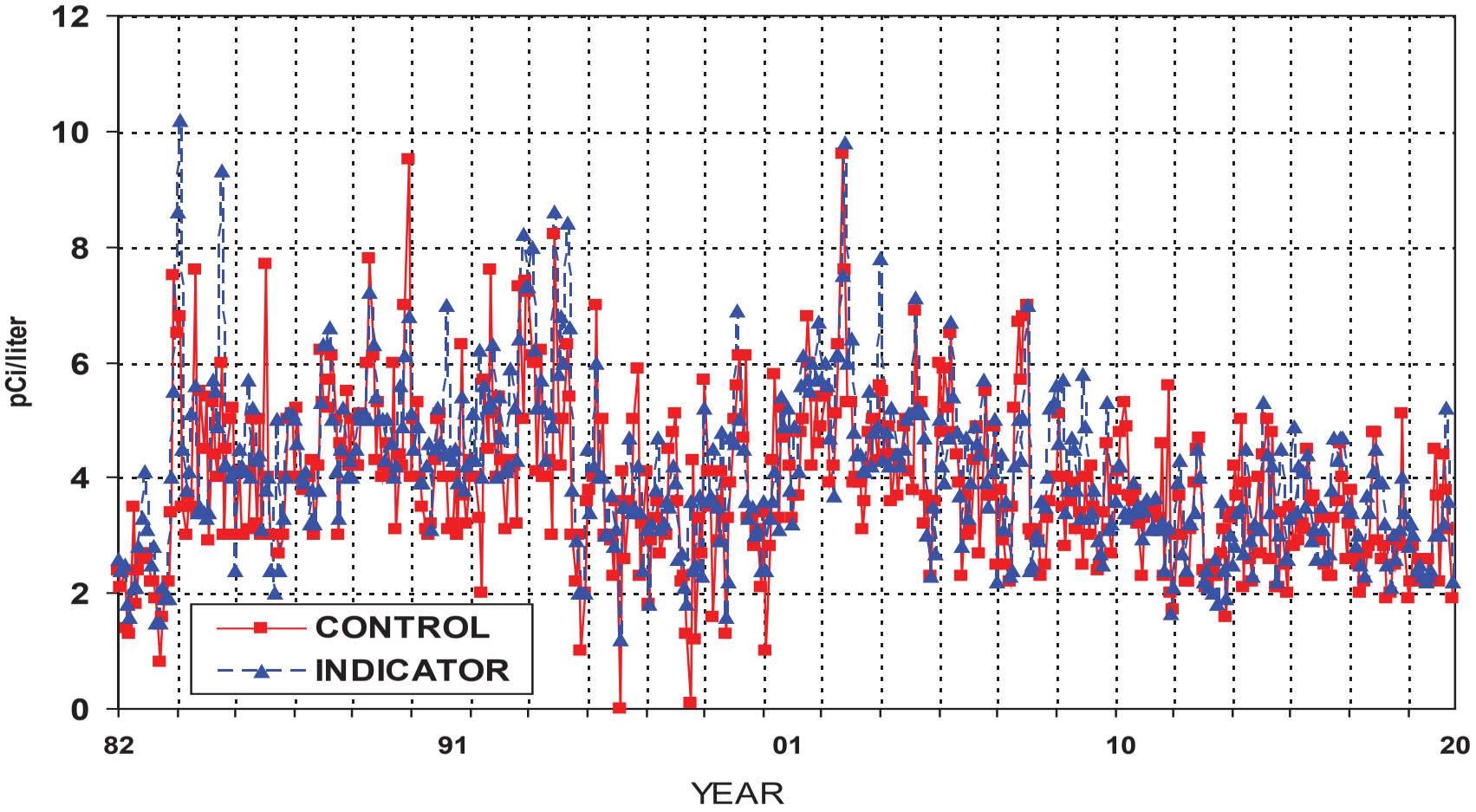
Table C-IX.1 QUARTERLY DLR RESULTS FOR LIMERICK GENERATING STATION, 2019

Location	Qtr 1 (mrem)	Qtr 2 (mrem)	Qtr 3 (mrem)	Qtr 4 (mrem)	Normalized Annual Dose, M_A (mrem/yr)	B_A[(1)]	B_A + MDD_A[(2)]	Annual Facility Dose, F_A (mrem)	Annual Facility Dose, F_A >10 mrem
10E1	16.4	19.1	20.3	17.6	73.4	71.0	82.7	ND	No
10F3	15.5	17.5	19.3	17.1	69.5	69.7	81.4	ND	No
10S3	15.8	18.1	18.0	17.4	69.3	70.9	82.6	ND	No
11S1	18.3	21.0	20.6	19.9	79.8	83.1	94.8	ND	No
13C1	11.7	13.6	11.3	11.3	47.9	49.8	61.5	ND	No
130	16.7	18.6	19.6	18.7	73.6	70.1	81.8	ND	No
13S2	23.4	24.8	25.4	24.7	98.3	112.1	123.8	ND	No
14S1	14.8	17.0	15.8	15.4	63.1	63.2	74.9	ND	No
15D1	16.4	18.5	18.5	18.2	71.7	72.5	84.2	ND	No
16F1	16.1	17.9	17.6	16.6	68.3	73.4	85.1	ND	No
17B1	14.8	14.9	17.3	16.9	64.0	66.8	78.5	ND	No
18S2	17.4	18.3	21.1	19.0	75.8	78.4	90.1	ND	No
19D1	15.6	15.7	17.4	15.8	64.4	66.3	78.0	ND	No
20D1	14.2	16.4	16.1	15.7	62.4	63.0	74.7	ND	No
20F1	15.4	16.8	18.4	16.3	66.9	67.5	79.2	ND	No
21S2	15.2	15.4	17.4	15.3	63.3	64.1	75.8	ND	No
23S2	15.2	17.3	17.9	15.6	66.0	63.9	75.6	ND	No
24D1	14.1	15.2	16.3	14.3	59.8	59.7	71.4	ND	No
25D1	12.9	14.6	14.6	14.0	56.0	56.5	68.2	ND	No
25S2	14.2	15.0	16.9	13.7	59.8	58.1	69.8	ND	No
26S3	14.0	15.7	17.0	15.0	61.7	60.4	72.1	ND	No
28D2	15.2	16.9	15.4	15.6	63.1	63.5	75.2	ND	No
29E1	15.0	16.1	18.3	14.8	64.2	62.3	74.0	ND	No
29S1	14.0	14.7	15.4	14.4	58.5	61.4	73.1	ND	No
2E1	17.3	18.0	20.3	17.8	73.4	71.9	83.6	ND	No
31D1	20.9	19.6	20.8	20.0	81.3	83.0	94.7	ND	No
31D2	18.4	18.3	19.5	17.2	73.4	71.2	82.9	ND	No
31S1	18.5	17.4	20.2	18.1	74.1	71.6	83.3	ND	No
34E1	16.7	16.0	18.7	16.8	68.1	67.0	78.7	ND	No
34S2	15.9	17.6	17.8	16.1	67.4	71.6	83.3	ND	No
36D1	14.5	15.1	16.8	14.4	60.9	62.1	73.8	ND	No
36S2	17.1	19.0	20.6	17.9	74.6	73.4	85.1	ND	No
3S1	17.8	18.1	19.8	17.4	73.0	70.1	81.8	ND	No
4E1	13.6	13.7	14.7	12.4	54.4	51.4	63.1	ND	No
5H1	21.9	22.0	24.0	21.3	89.2	86.3	98.0	ND	No
5S1	19.6	20.1	21.7	18.1	79.5	80.0	91.7	ND	No
6C1	17.8	18.1	20.4	16.0	72.3	69.5	81.2	ND	No
7E1	17.8	18.9	20.1	16.9	73.6	74.6	86.3	ND	No
7S1	16.8	18.5	20.1	17.5	72.9	73.1	84.8	ND	No
9C1	15.4	14.8	19.3	16.0	65.4	68.1	79.8	ND	No

(1) **Baseline background dose (BB_A):** The estimated mean background radiation dose at each field monitoring location annually based on historical measurements, excluding any dose contribution from the monitored facility

(2) **Minimum differential dose (MDD_A)**: The smallest amount of facility related dose at each monitored location annually above the baseline background dose that can be reliably detected by an environmental dosimetry system

FIGURE C-1
MEAN MONTHLY TOTAL GROSS BETA CONCENTRATIONS IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LGS, 1982 - 2019



Note: 2005 analysis changed from Insoluble & Soluble to Total Gross Beta

LGS CRITICALITY
UNIT NO. 1: 12/22/84
UNIT NO. 2: 08/11/89

LGS CHANGED TO TOTAL GROSS BETA AT THE BEGINNING OF 2005.
PREVIOUS DATA INCLUDED SUMMATION OF LESS THAN VALUES.

FIGURE C-2
MEAN MONTHLY GROSS BETA CONCENTRATIONS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LGS, 1982 – 2019

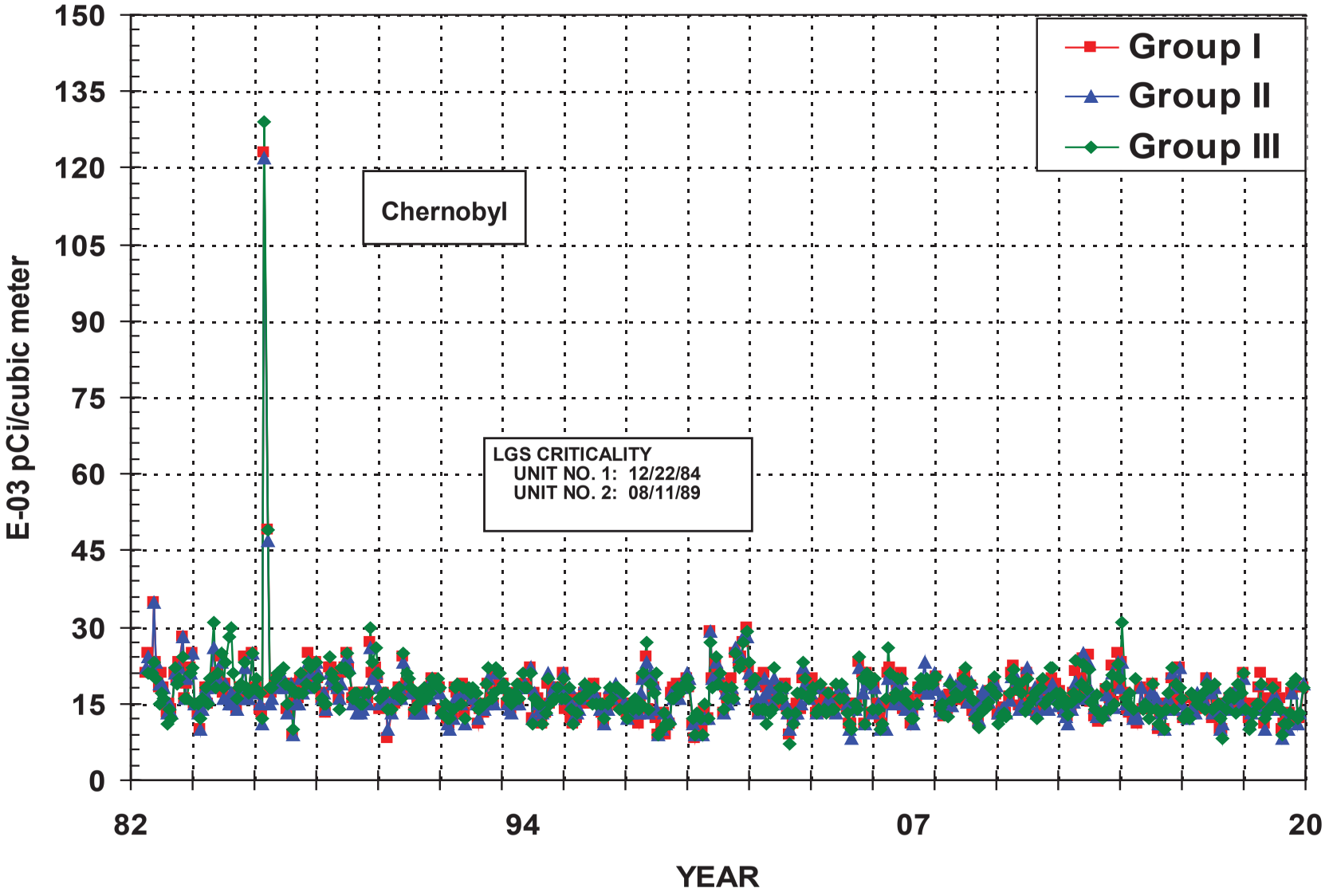


FIGURE C-3
MEAN WEEKLY GROSS BETA CONCENTRATIONS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LGS, 2019

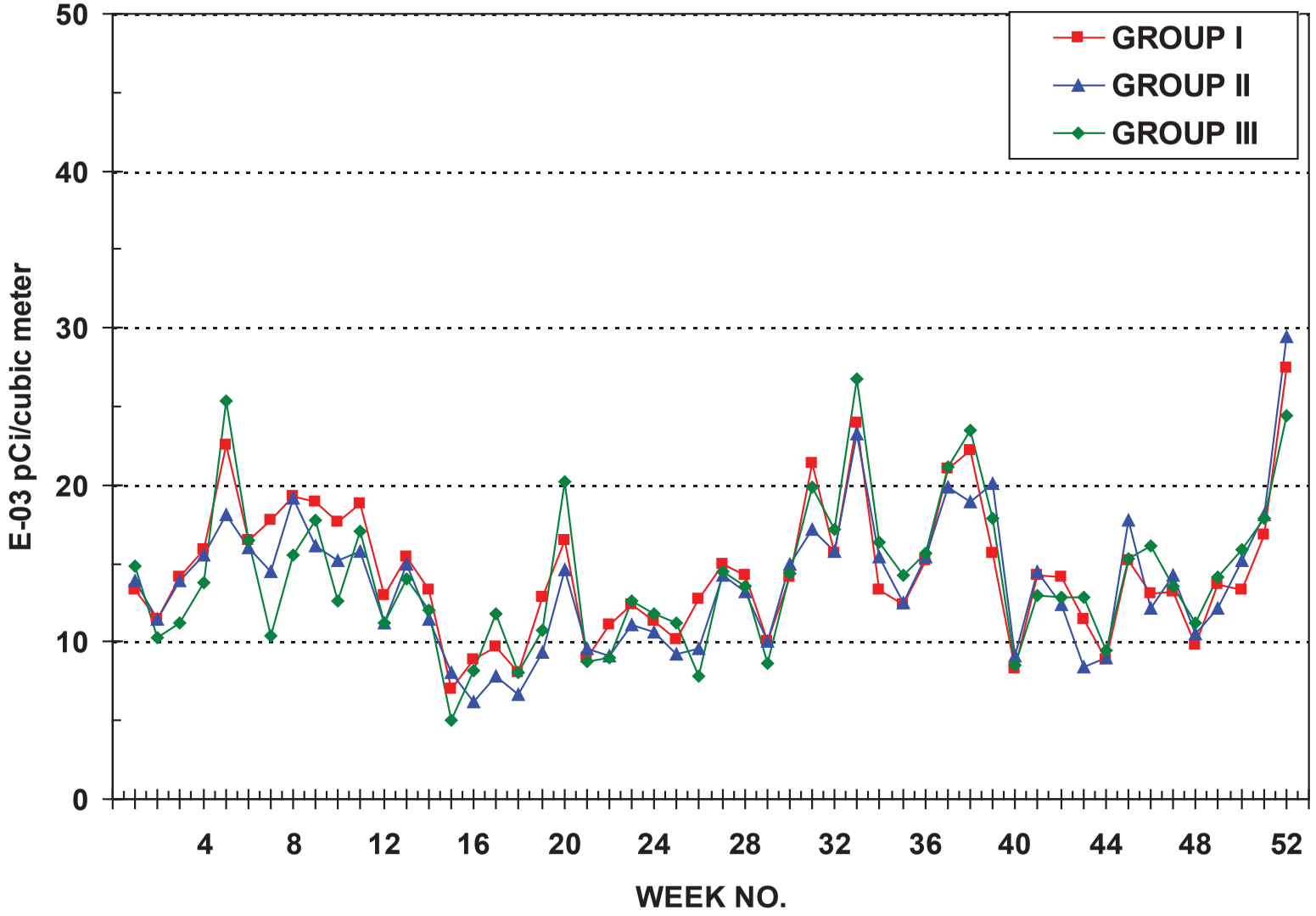
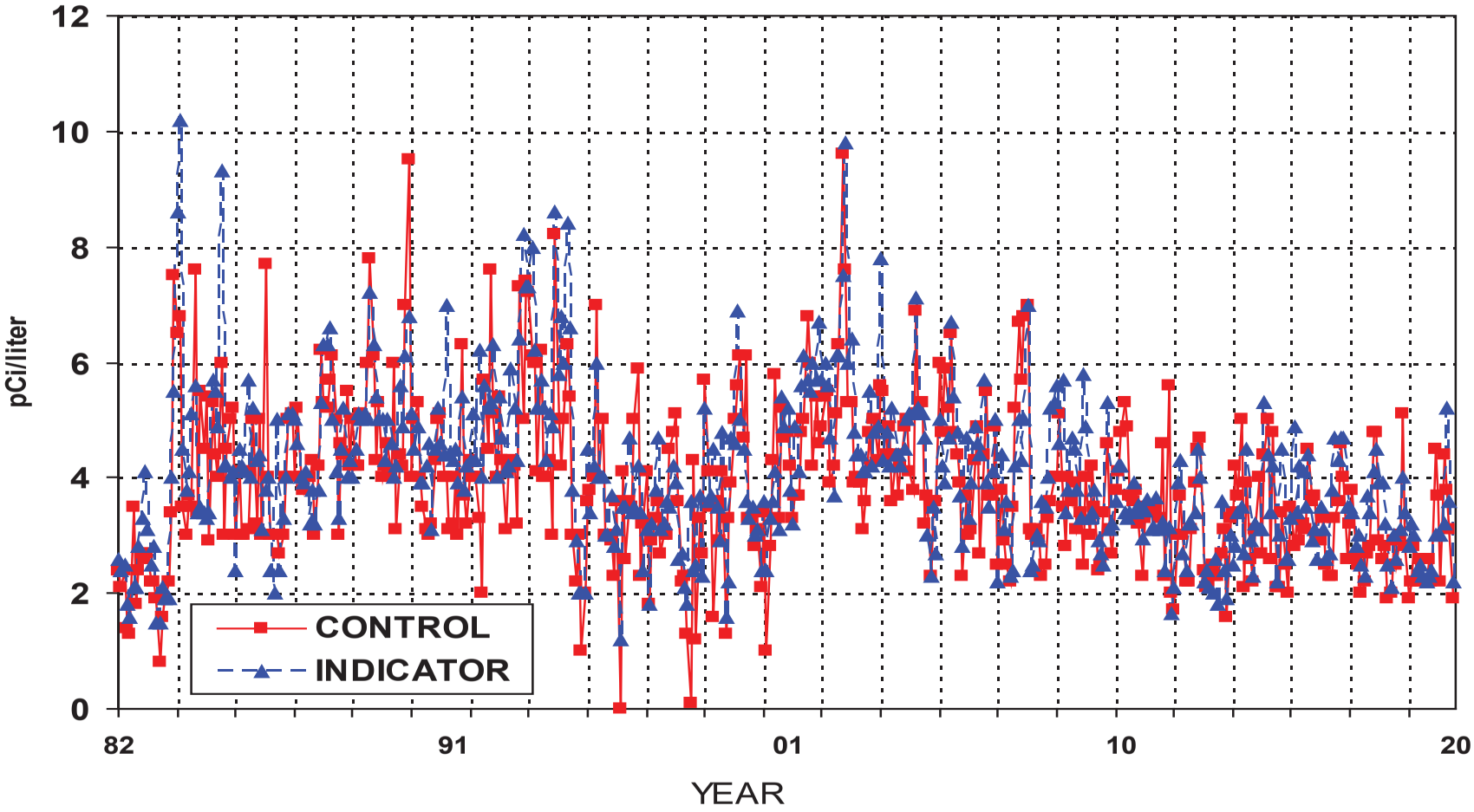


FIGURE C-1
MEAN MONTHLY TOTAL GROSS BETA CONCENTRATIONS IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LGS, 1982 - 2019



Note: 2005 analysis changed from Insoluble & Soluble to Total Gross Beta

LGS CRITICALITY
UNIT NO. 1: 12/22/84
UNIT NO. 2: 08/11/89

LGS CHANGED TO TOTAL GROSS BETA AT THE BEGINNING OF 2005.
PREVIOUS DATA INCLUDED SUMMATION OF LESS THAN VALUES.

FIGURE C-2
MEAN MONTHLY GROSS BETA CONCENTRATIONS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LGS, 1982 – 2019

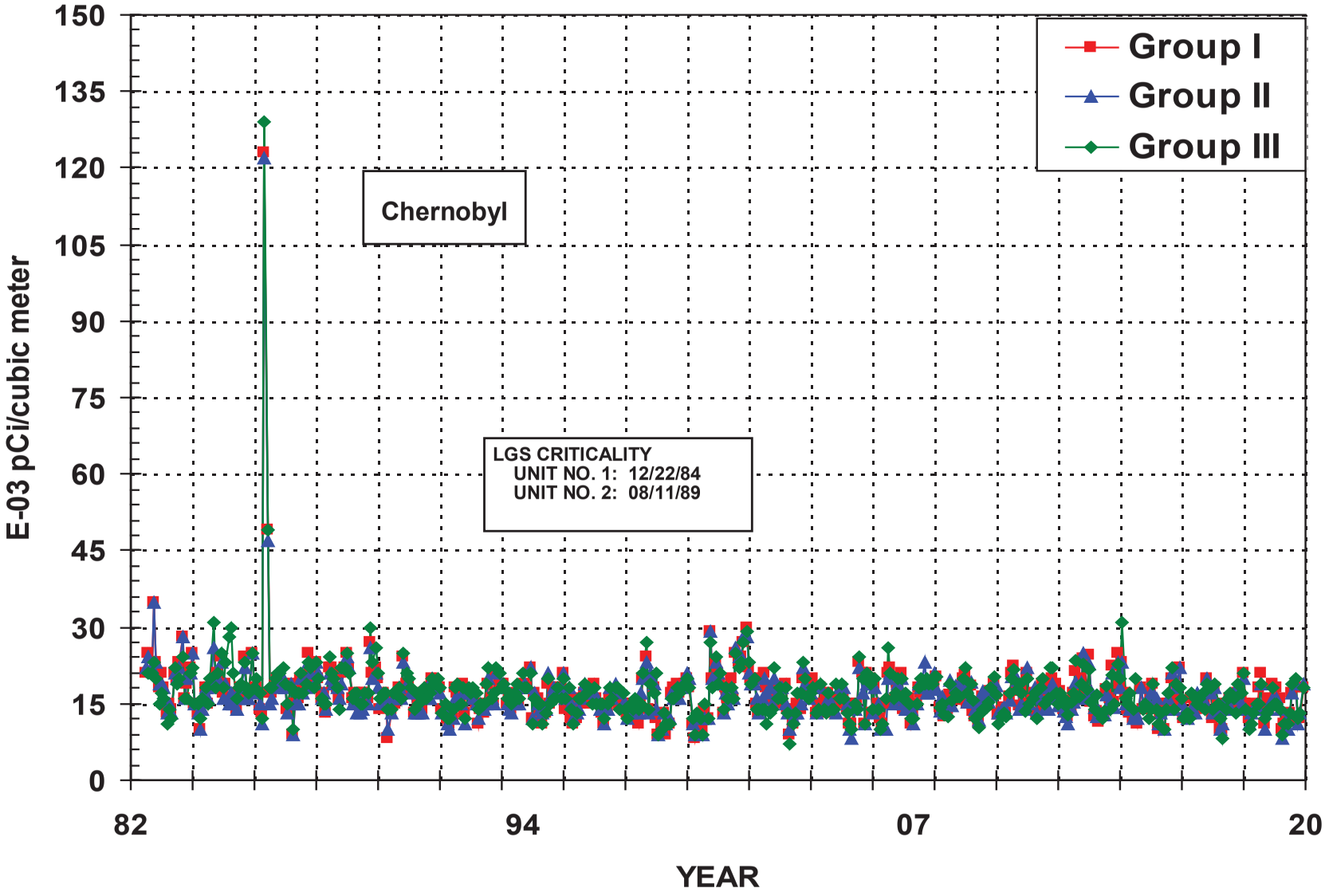
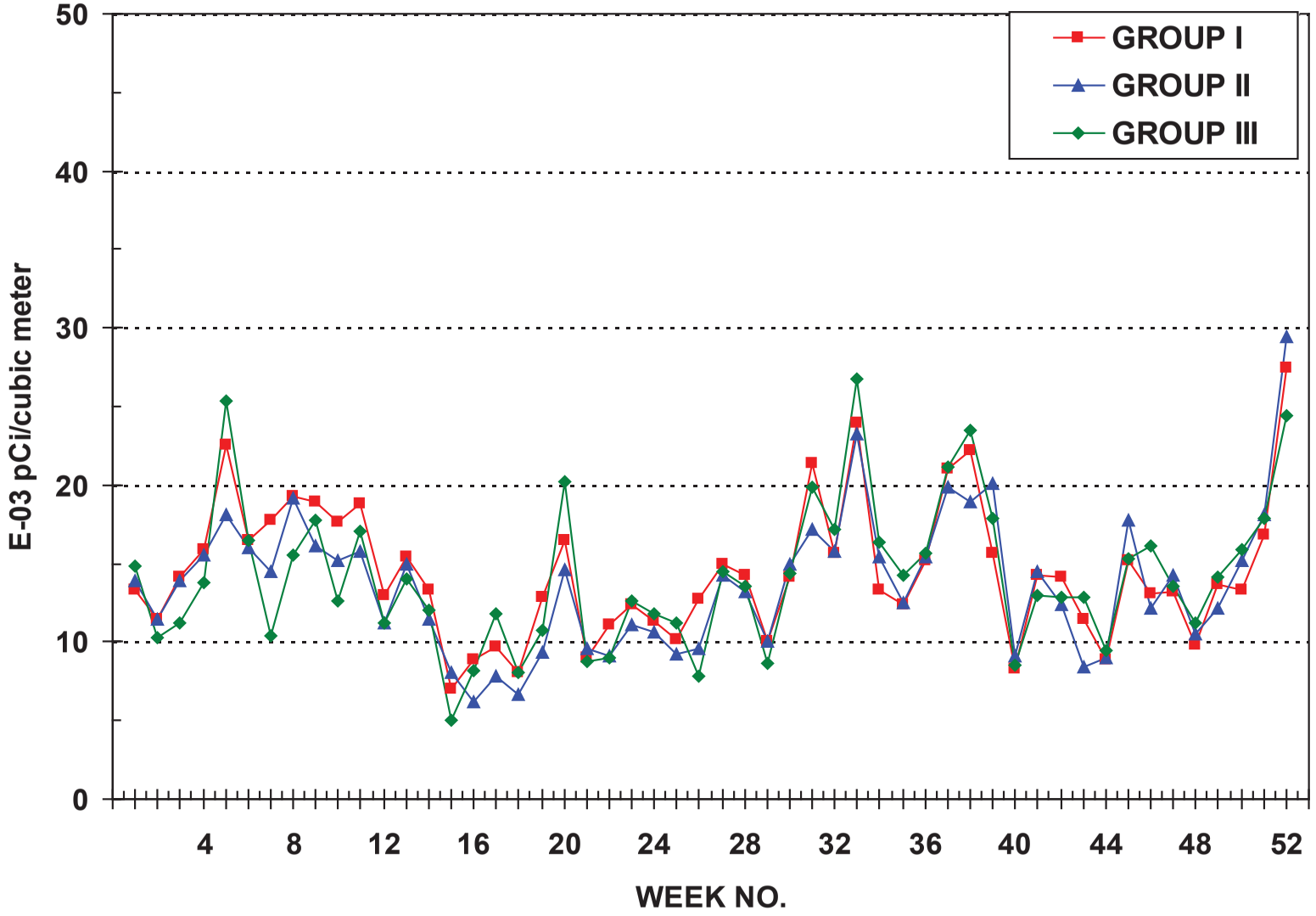


FIGURE C-3
MEAN WEEKLY GROSS BETA CONCENTRATIONS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LGS, 2019



APPENDIX D

DATA TABLES AND FIGURES
COMPARISON LABORATORY

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TABLE D-I.1 CONCENTRATIONS OF TOTAL GROSS BETA IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	16C2
01/02/19 - 01/28/19	1.9 ± 0.7
01/28/19 - 02/26/19	2.2 ± 0.7
02/26/19 - 04/02/19	1.2 ± 0.6
04/02/19 - 04/29/19	1.1 ± 0.7
04/29/19 - 06/03/19	1.1 ± 0.8
06/03/19 - 07/02/19	1.3 ± 0.6
07/02/19 - 07/30/19	1.7 ± 0.6
07/30/19 - 09/03/19	2.2 ± 0.7
09/03/19 - 09/30/19	3.1 ± 0.7
09/30/19 - 10/28/19	2.7 ± 0.7
10/28/19 - 12/03/19	2.6 ± 0.7
12/03/19 - 12/30/19	3.3 ± 7.7
MEAN ± 2 STD DEV	2.0 ± 1.6

TABLE D-I.2 CONCENTRATIONS OF I-131 IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	16C2
01/02/19 - 01/28/19	< 0.6
01/28/19 - 02/26/19	< 0.6
02/26/19 - 04/02/19	< 0.8
04/02/19 - 04/29/19	< 0.7
04/29/19 - 06/03/19	< 0.8
06/03/19 - 07/02/19	< 0.8
07/02/19 - 07/30/19	< 0.8
07/30/19 - 09/03/19	< 0.7
09/03/19 - 09/30/19	< 0.6
09/30/19 - 10/28/19	*(1)*
10/28/19 - 12/03/19	< 0.9
12/03/19 - 12/30/19	< 0.7
MEAN	-

TABLE D-I.3 CONCENTRATIONS OF TRITIUM IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	16C2
01/02/19 - 04/02/19	< 119
04/02/19 - 07/02/19	< 138
07/02/19 - 09/30/19	< 139
09/30/19 - 12/30/19	< 166
MEAN	-

THE MEAN AND TWO STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES
(1) SEE PROGRAM EXCEPTIONS SECTION FOR EXPLANATION

TABLE D-I.4 **CONCENTRATIONS OF GAMMA EMITTERS IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140
16C2	01/02/19 - 01/28/19	< 5	< 5	< 11	< 5	< 10	< 5	< 8	< 9	< 4	< 5	< 22	< 12
	01/28/19 - 02/26/19	< 3	< 3	< 6	< 3	< 7	< 3	< 5	< 5	< 3	< 3	< 14	< 5
	02/26/19 - 04/02/19	< 3	< 3	< 7	< 3	< 6	< 4	< 6	< 9	< 3	< 3	< 22	< 9
	04/02/19 - 04/29/19	< 3	< 3	< 7	< 3	< 6	< 4	< 6	< 7	< 3	< 3	< 18	< 7
	04/29/19 - 06/03/19	< 4	< 5	< 12	< 5	< 11	< 5	< 8	< 9	< 4	< 5	< 28	< 10
	06/03/19 - 07/02/19	< 3	< 3	< 7	< 3	< 7	< 4	< 6	< 7	< 3	< 3	< 18	< 7
	07/02/19 - 07/30/19	< 3	< 4	< 8	< 3	< 7	< 4	< 6	< 12	< 3	< 3	< 26	< 9
	07/30/19 - 09/03/19	< 3	< 3	< 6	< 3	< 6	< 3	< 5	< 5	< 3	< 3	< 16	< 5
	09/03/19 - 09/30/19	< 5	< 4	< 11	< 4	< 9	< 5	< 8	< 8	< 4	< 4	< 19	< 8
	09/30/19 - 10/28/19	< 5	< 5	< 9	< 5	< 8	< 5	< 8	< 7	< 5	< 4	< 22	< 8
	10/28/19 - 12/03/19	< 4	< 4	< 9	< 4	< 8	< 4	< 6	< 6	< 4	< 4	< 18	< 7
	12/03/19 - 12/30/19	< 5	< 5	< 10	< 6	< 9	< 5	< 8	< 7	< 5	< 5	< 19	< 10
	MEAN	-	-	-	-	-	-	-	-	-	-	-	-

TABLE D-II.1 CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATE AND I-131 IN AIR IODINE SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019

RESULTS IN UNITS OF E-03 PCI/CU METER ± 2 SIGMA

COLLECTION PERIOD	11S2 GROSS BETA	11S2 I-131
01/02/19 - 01/07/19	24 ± 3	< 18
01/07/19 - 01/14/19	18 ± 2	< 16
01/14/19 - 01/22/19	21 ± 2	< 15
01/22/19 - 01/28/19	24 ± 3	< 18
01/28/19 - 02/04/19	30 ± 3	< 22
02/04/19 - 02/11/19	20 ± 2	< 20
02/11/19 - 02/18/19	24 ± 2	< 41
02/18/19 - 02/26/19	27 ± 2	< 13
02/26/19 - 03/04/19	21 ± 3	< 26
03/04/19 - 03/11/19	23 ± 2	< 18
03/11/19 - 03/18/19	31 ± 3	< 13
03/18/19 - 03/25/19	19 ± 2	< 13
03/25/19 - 04/02/19	19 ± 2	< 10
04/02/19 - 04/08/19	21 ± 3	< 18
04/08/19 - 04/15/19	13 ± 2	< 10
04/15/19 - 04/22/19	15 ± 2	< 13
04/22/19 - 04/29/19	14 ± 2	< 20
04/29/19 - 05/07/19	11 ± 2	< 11
05/07/19 - 05/13/19	13 ± 2	< 13
05/13/19 - 05/20/19	21 ± 2	< 13
05/20/19 - 05/28/19	13 ± 2	< 14
05/28/19 - 06/03/19	18 ± 2	< 17
06/03/19 - 06/11/19	14 ± 2	< 8
06/11/19 - 06/17/19	14 ± 2	< 16
06/17/19 - 06/24/19	15 ± 2	< 12
06/24/19 - 07/02/19	20 ± 2	< 19
07/02/19 - 07/08/19	24 ± 3	< 15
07/08/19 - 07/15/19	21 ± 2	< 12
07/15/19 - 07/22/19	22 ± 2	< 20
07/22/19 - 07/30/19	24 ± 2	< 18
07/30/19 - 08/05/19	29 ± 3	< 14
08/05/19 - 08/12/19	14 ± 2	< 16
08/12/19 - 08/19/19	22 ± 2	< 10
08/19/19 - 08/26/19	19 ± 2	< 9
08/26/19 - 09/03/19	13 ± 2	< 12
09/03/19 - 09/10/19	13 ± 2	< 10
09/10/19 - 09/16/19	15 ± 2	< 12
09/16/19 - 09/23/19	19 ± 2	< 20
09/23/19 - 09/30/19	15 ± 2	< 13
09/30/19 - 10/07/19	12 ± 2	< 17
10/07/19 - 10/14/19	16 ± 2	< 12
10/14/19 - 10/21/19	25 ± 2	< 15
10/21/19 - 10/28/19	18 ± 2	< 13
10/28/19 - 11/05/19	11 ± 2	< 12
11/05/19 - 11/11/19	21 ± 2	< 19
11/11/19 - 11/18/19	21 ± 2	< 9
11/18/19 - 11/25/19	18 ± 2	< 18
11/25/19 - 12/03/19	14 ± 2	< 12
12/03/19 - 12/09/19	17 ± 2	< 13
12/09/19 - 12/16/19	16 ± 2	< 8
12/16/19 - 12/23/19	22 ± 2	< 10
12/23/19 - 12/30/19	37 ± 3	< 20
MEAN ± 2 STD DEV	19 ± 11	-

THE MEAN AND TWO STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUE

TABLE D-II.2 CONCENTRATIONS OF GAMMA EMITTERS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019

RESULTS IN UNITS OF E-03 PCI/CU METER ± 2 SIGMA

SITE	COLLECTION PERIOD	Be-7	Mn-54	Co-58	Co-60	Cs-134	Cs-137
11S2	01/02/19 - 04/02/19	76 ± 13	< 1.6	< 1.6	< 1.2	< 1.3	< 1.5
	04/02/19 - 07/02/19	83 ± 13	< 1.6	< 1.6	< 1.0	< 1.3	< 1.2
	07/02/19 - 09/30/19	52 ± 9	< 0.9	< 1.0	< 1.2	< 0.9	< 1.2
	09/30/19 - 12/30/19	57 ± 12	< 1.5	< 1.4	< 1.3	< 1.1	< 1.4
	MEAN ± 2 STD DEV	67 ± 30	-	-	-	-	-

THE MEAN AND TWO STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

TABLE D-III.1 CONCENTRATIONS OF I-131 BY CHEMICAL SEPARATION AND GAMMA EMITTERS IN MILK SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2019

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	I-131	K-40	Cs-134	Cs-137	Ba-140	La-140
19B1	01/15/19	< 0.9	1250 ± 113	< 5	< 5	< 31	< 10
	04/01/19	< 0.6	1280 ± 111	< 5	< 6	< 27	< 11
	07/08/19	< 0.8	1270 ± 110	< 5	< 6	< 23	< 10
	10/01/19	< 0.8	1330 ± 89	< 4	< 5	< 22	< 9
MEAN ± 2 STD DEV		-	1283 ± 68	-	-	-	-
25C1	01/15/19	< 0.6	1160 ± 106	< 4	< 5	< 19	< 6
	04/01/19	< 0.4	1450 ± 120	< 5	< 5	< 20	< 8
	07/08/19	< 0.7	1330 ± 93	< 5	< 3	< 22	< 7
	10/01/19	< 0.7	1410 ± 87	< 3	< 4	< 19	< 7
MEAN ± 2 STD DEV		-	1338 ± 257	-	-	-	-

THE MEAN AND TWO STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

FIGURE D-1
COMPARISON OF MONTHLY TOTAL GROSS BETA CONCENTRATIONS IN DRINKING WATER SAMPLES SPLIT BETWEEN ENV AND TBE, 2019

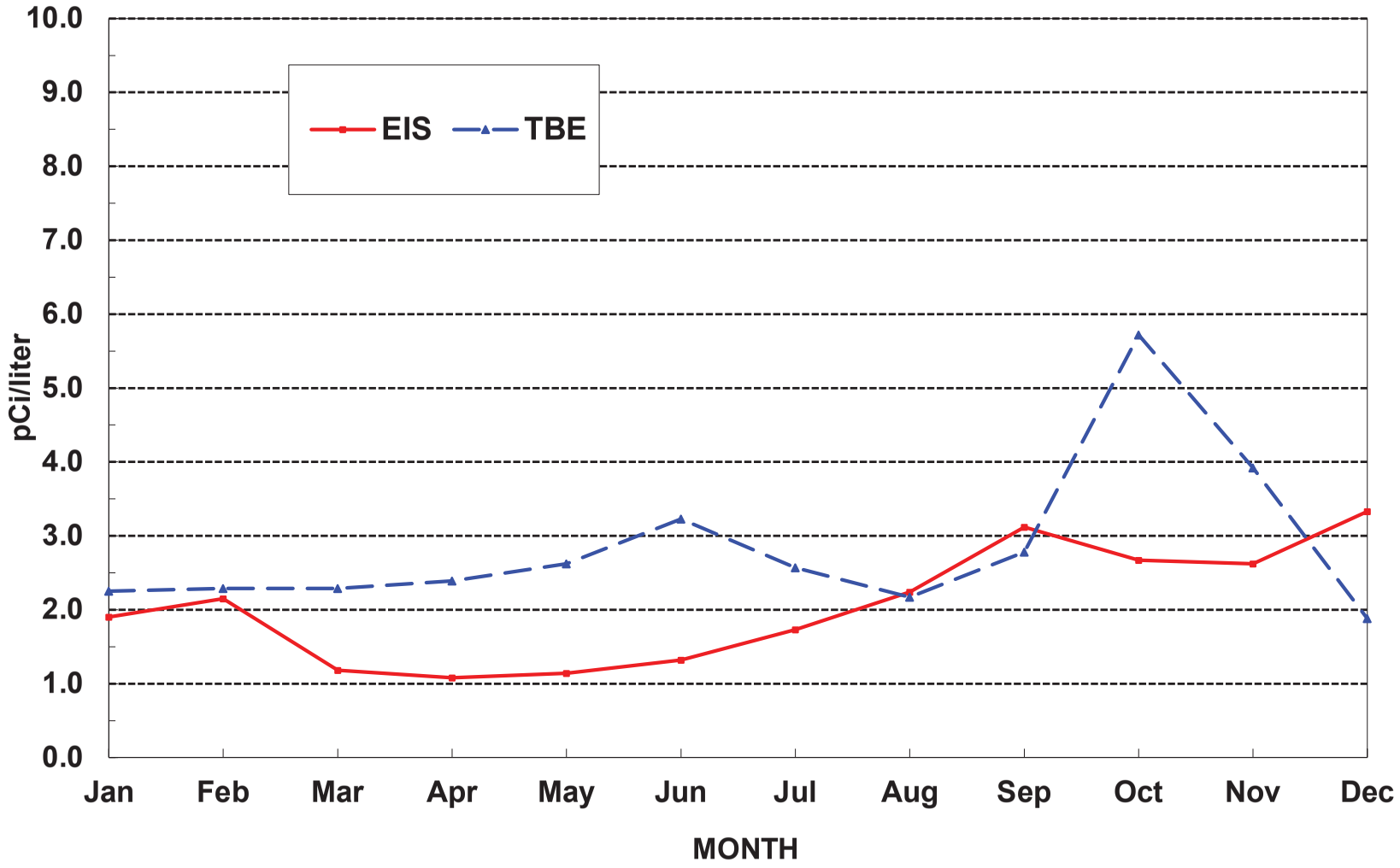
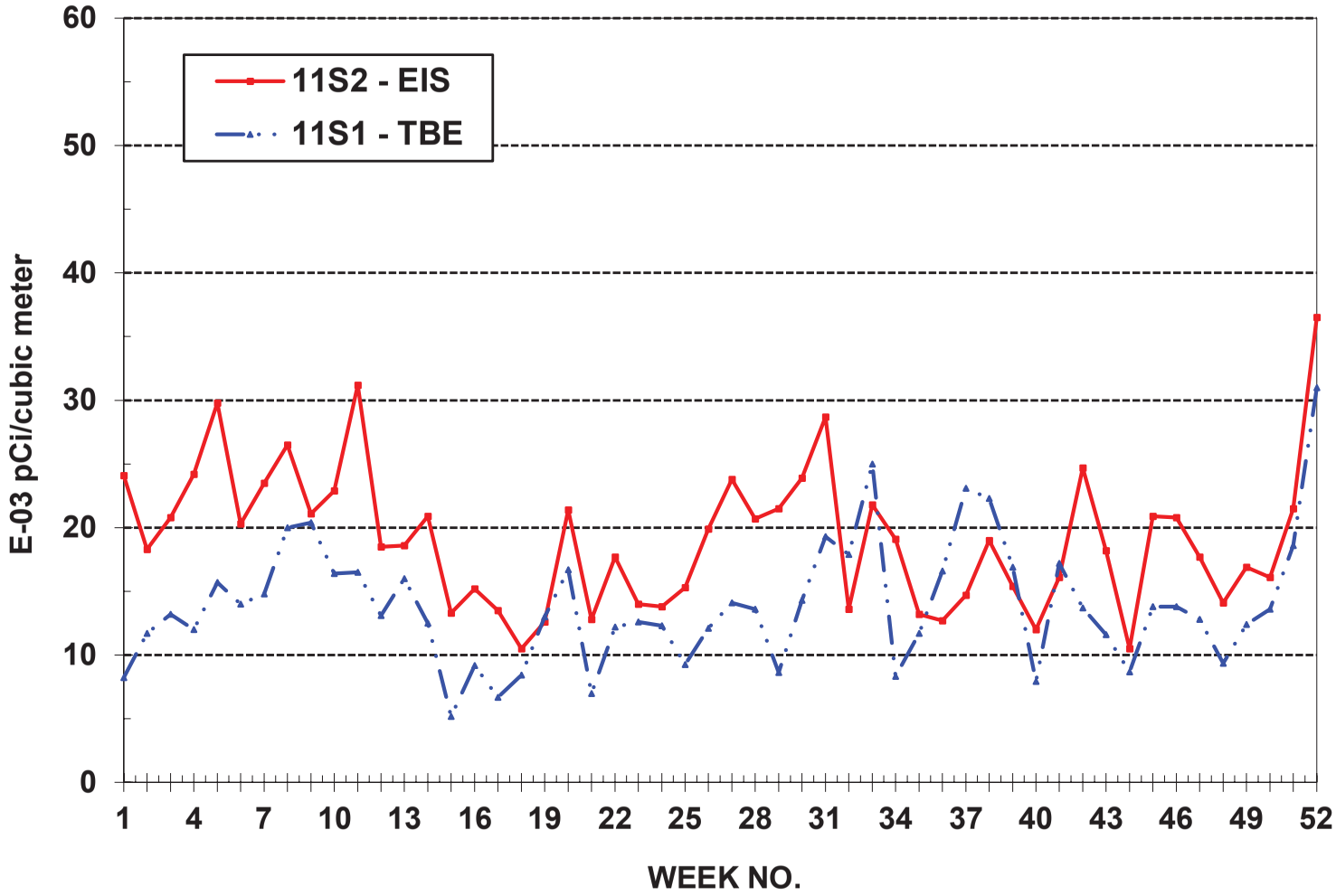


FIGURE D-2
COMPARISON OF WEEKLY GROSS BETA CONCENTRATIONS IN AIR PARTICULATE SAMPLES COLLECTED FROM LGS COLLOCATED LOCATIONS 11S1 AND 11S2, 2019



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APPENDIX E

INTER-LABORATORY COMPARISON PROGRAM

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Table E.1 **Analytics Environmental Radioactivity Cross Check Program**
Teledyne Brown Engineering Environmental Services

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

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

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

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

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

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

Table E.1 **Analytics Environmental Radioactivity Cross Check Program**
Teledyne Brown Engineering Environmental Services

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

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

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

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

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

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

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

Table E.2 **DOE's Mixed Analyte Performance Evaluation Program (MAPEP)**
Teledyne Brown Engineering Environmental Services

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

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

(b) DOE/MAPEP evaluation:
A = Acceptable - reported result falls within ratio limits of 0.80-1.20
W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30
N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

(1) False positive test
(2) Sensitivity evaluation
*(3) See **NCR 19-12***
*(4) See **NCR 19-13***
*(5) See **NCR 19-14***
*(6) See **NCR 19-25***
*(7) See **NCR 19-26***

Table E.3

ERA Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

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

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

(b) ERA evaluation:
A = Acceptable - Reported value falls within the Acceptance Limits
N = Not Acceptable - Reported value falls outside of the Acceptance Limits

*(1) See **NCR 19-10***
*(2) See **NCR 19-11***
*(3) See **NCR 19-23***
*(4) See **NCR 19-24***

TABLE E.4 Analytics Environmental Radioactivity Cross Check Program
Exelon Industrial Services (2019)

Month/Year	Identification Number	Matrix	Nuclide	Units	EIS Reported Value	Known Value [a]	Ratio of Analytics to EIS Result	Evaluation [b]
March 2019	E 12379	Water	Gr-B	pCi/L	264	288	92	Pass
	E 12380	Charcoal	I-131	pCi	73.0	75.6	97	Pass
	E 12378A	Milk	I-131	pCi/L	92	89.5	103	Pass
			Ce-141	pCi/L	101	117	86	Pass
			Cr-51	pCi/L	227	293	77	Pass
			Cs-134	pCi/L	138	160	86	Pass
			Cs-137	pCi/L	184	196	94	Pass
			Co-58	pCi/L	128	143	90	Pass
			Mn-54	pCi/L	141	143	99	Pass
			Fe-59	pCi/L	149	159	94	Pass
			Zn-65	pCi/L	177	220	80	Pass
			Co-60	pCi/L	262	299	88	Pass
June 2019	E12383	AP	Ce-141	pCi/Filter	97.7	88	111	Pass
			Cr-51	pCi/Filter	222	223	100	Pass
			Cs-134	pCi/Filter	80.9	93	87	Pass
			Cs-137	pCi/Filter	119	111	107	Pass
			Co-58	pCi/Filter	77.7	74	105	Pass
			Mn-54	pCi/Filter	142	126	113	Pass
			Fe-59	pCi/Filter	121	93.5	129	Pass
			Zn-65	pCi/Filter	185	164	113	Pass
			Co-60	pCi/Filter	139	131	106	Pass
	E12382	Water	I-131	pCi/L	115	89.1	129	Pass
			Ce-141	pCi/L	142	145	98	Pass
			Cr-51	pCi/L	327	368	89	Pass
			Cs-134	pCi/L	139	153	91	Pass
			Cs-137	pCi/L	186	184	101	Pass
			Co-58	pCi/L	115	122	94	Pass
			Mn-54	pCi/L	214	207	103	Pass
			Fe-59	pCi/L	154	154	100	Pass
			Zn-65	pCi/L	257	270	95	Pass
			Co-60	pCi/L	216	216	100	Pass
	E12381	Water	Gr-B	pCi/L	199	199	100	Pass
September 2019	E12384	AP	Gr-B	pCi	270.7	221	122	Pass
December 2019	E12386	Water	Gr-B	pCi/L	260	269	97	Pass
	E12387	Cartridge Detector 2	I-131	pCi	79.0	88.2	90	Pass
	E12387	Cartridge Detector 3	I-131	pCi	79.1	88.2	90	Pass
	E12387	Cartridge Detector 4	I-131	pCi	79.2	88.2	90	Pass
December 2019	E12385	AP Detector 2	Ce-141	pCi/Filter	98.5	99.1	99	Pass
			Cr-51	pCi/Filter	246	288	85	Pass
			Cs-134	pCi/Filter	123	135.0	91	Pass
			Cs-137	pCi/Filter	128	121.0	106	Pass
			Co-58	pCi/Filter	117	107.0	109	Pass
			Mn-54	pCi/Filter	170	155.0	110	Pass
			Fe-59	pCi/Filter	124	104.0	119	Pass

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

(b) Analytics evaluation based on EIS internal QC limits in accordance with the NRC Resolution Test criteria

TABLE E.4 Analytics Environmental Radioactivity Cross Check Program
Exelon Industrial Services (2019)

Month/Year	Identification Number	Matrix	Nuclide	Units	EIS Reported Value	Known Value [(a)]	Ratio of Analytics to EIS Result	Evaluation [(b)]
December 2019	E12385	AP	Zn-65	pCi/Filter	194	190	102	Pass
		Detector 2	Co-60	pCi/Filter	139	138	101	Pass
	E12385	AP	Ce-141	pCi/Filter	95.7	99.1	97	Pass
		Detector 3	Cr-51	pCi/Filter	257.1	288	89	Pass
			Cs-134	pCi/Filter	128	135.0	95	Pass
			Cs-137	pCi/Filter	128	121.0	105	Pass
			Co-58	pCi/Filter	111	107.0	104	Pass
			Mn-54	pCi/Filter	173	155.0	112	Pass
			Fe-59	pCi/Filter	121.7	104.0	117	Pass
			Zn-65	pCi/Filter	203	190	107	Pass
			Co-60	pCi/Filter	147.5	138	107	Pass
	E12385	AP	Ce-141	pCi/Filter	102	99.1	103	Pass
		Detector 4	Cr-51	pCi/Filter	299	288	104	Pass
			Cs-134	pCi/Filter	122	135.0	90	Pass
			Cs-137	pCi/Filter	122	121.0	101	Pass
			Co-58	pCi/Filter	102	107.0	95	Pass
			Mn-54	pCi/Filter	167	155.0	108	Pass
			Fe-59	pCi/Filter	132	104.0	127	Pass
			Zn-65	pCi/Filter	195	190	103	Pass
			Co-60	pCi/Filter	146	138	106	Pass
	E12388	Milk	I-131	pCi/L	100	94.5	106	Pass
		Detector 2	Ce-141	pCi/L	82.4	83.0	99	Pass
			Cr-51	pCi/L	271	241	112	Pass
			Cs-134	pCi/L	112	113	99	Pass
			Cs-137	pCi/L	123	102	121	Pass
			Co-58	pCi/L	84.9	89.9	94	Pass
			Mn-54	pCi/L	128	130	98	Pass
			Fe-59	pCi/L	95.5	87	110	Pass
			Zn-65	pCi/L	148	159	93	Pass
			Co-60	pCi/L	119	115	103	Pass
	E12388	Milk	I-131	pCi/L	99.3	94.5	105	Pass
		Detector 3	Ce-141	pCi/L	80.7	83.0	97	Pass
			Cr-51	pCi/L	227.9	241	95	Pass
			Cs-134	pCi/L	103.4	113	92	Pass
			Cs-137	pCi/L	109.2	102	107	Pass
			Co-58	pCi/L	101.9	89.9	113	Pass
			Mn-54	pCi/L	140.8	130	108	Pass
			Fe-59	pCi/L	102.1	87	117	Pass
			Zn-65	pCi/L	166.2	159	105	Pass
			Co-60	pCi/L	111	115	97	Pass
	E12388	Milk	I-131	pCi/L	104	94.5	110	Pass
		Detector 4	Ce-141	pCi/L	78.3	83.0	94	Pass
			Cr-51	pCi/L	235.4	241	98	Pass
			Cs-134	pCi/L	114	113	101	Pass
			Cs-137	pCi/L	105	102	103	Pass
			Co-58	pCi/L	92	89.9	102	Pass
			Mn-54	pCi/L	143	130	110	Pass
			Fe-59	pCi/L	104	87	119	Pass
			Zn-65	pCi/L	164	159	103	Pass
			Co-60	pCi/L	123	115	107	Pass

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

(b) Analytics evaluation based on EIS internal QC limits in accordance with the NRC Resolution Test criteria

TABLE E.5 ERA Environmental Radioactivity Cross Check Program
Exelon Industrial Services (2019)

Month/Year	ID Number	Matrix	Nuclide	Units	EIS Reported Value	Known Value [a]	Acceptance Ratio of ERA to EIS Result	Evaluation [b]
April 2019	RAD-117	Water	Ba-133	pCi/L	23.0	24.1	95	Pass
			Cs-134	pCi/L	10.8	12.1	89	Pass
			Cs-137	pCi/L	34	33.1	104	Pass
			Co-60	pCi/L	11.3	11.5	98	Pass
			Zn-65	pCi/L	88.0	89.2	99	Pass
			I-131	pCi/L	25.3	28.4	89	Pass
			GR-B	pCi/L	28.8	29.9	96	Pass
			H-3	pCi/L	20,766	21,400	97	Pass
July 2019	RAD-118	Water	H-3	pCi/L	17,684	16,700	106	Pass
September 2019	MRAD-31	AP	Am-241	pCi/Filter	28.4	32	89	Pass
			Cs-134	pCi/Filter	60.7	59	103	Pass
			Cs-137	pCi/Filter	440	437	101	Pass
			Co-60	pCi/Filter	57.5	58.4	98	Pass
			Zn-65	pCi/Filter	381	364	105	Pass
October 2019	RAD-119	Water	Ba-133	pCi/L	37.2	43.8	85	Pass
			Cs-134	pCi/L	52.2	55.9	93	Pass
			Cs-137	pCi/L	80.3	78.7	102	Pass
			Co-60	pCi/L	54.8	53.4	103	Pass
			Zn-65	pCi/L	39.3	34	116	Pass
			I-131	pCi/L	25.4	23.9	106	Pass

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

(b) ERA evaluation based on EIS internal QC limits in accordance with the NRC Resolution Test criteria

TABLE E.6 DOE's Mixed Analyte Performance Evaluation Program (MAPEP)
GEL Laboratories (Gamma, Gross Alpha/Beta, H-3 & Sr-90)

Quarter/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value [(a)]	Acceptance Range	Evaluation [(b)]
2nd/2019	19-GrW40	Water	Gr-A	Bq/L	0.819	0.840	0.25 - 1.43	A
			Gr-B	Bq/L	2.39	2.33	1.17 - 3.50	A
	19-MaS40	Soil	Sr-90	Bq/Kg	3.44			A
	19-MaW40	Water	H-3	Bq/L	389	421	295 - 547	A
			Sr-90	Bq/L	5.86	6.35	4.45 - 8.26	A
			Cs-134	Bq/L	5.32	5.99	4.19 - 7.79	A
			Cs-137	Bq/L	0		False Positive Test	A
			Co-60	Bq/L	6.7	6.7	4.7 - 8.7	A
			Fe-55	Bq/L	0.0173		False Positive Test	A
			Mn-54	Bq/L	8.8	8.4	5.9 - 10.9	A
			Zn-65	Bq/L	-0.0318		False Positive Test	A
	19-RdF40	AP	Sr-90	Bq/sample	0.616	0.662	0.463 - 0.861	A
	19-RdV40	Veg	Sr-90	Bq/sample	0.00951		False Positive Test	A
4th/2019	19-MaS41	Soil	S-90	Bq/Kg	609	572	400 - 744	A
	19-MaW41	Water	H-3	Bq/L	166	175	123 - 228	A
			Sr-90	Bq/L	9.34	10.6	7.4 - 13.8	A
			Cs-134	Bq/L	0.0266		False Positive Test	A
			Cs-137	Bq/L	19.7	18.4	12.9 - 23.9	A
			Co-60	Bq/L	9.01	8.8	6.2 - 11.4	A
			Fe-55	Bq/L	13.8	15.70	11.0 - 20.4	A
			Mn-54	Bq/L	22.6	20.6	14.4 - 26.8	A
			Zn-65	Bq/L	23.1	20.3	5.27 - 9.79	A
	19-RdF41	AP	Sr-90	Bq/sample	0.442	0.498	0.349 - 0.647	A
	19-RdV41	Veg	Sr-90	Bq/sample	0.847	1.00	0.70 - 1.30	A

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

(b) DOE/MAPEP evaluation:

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

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

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

TABLE E.7 **ERA Environmental Radioactivity Cross Check Program**
GEL Laboratories (Gamma, Gross Alpha/Beta, H-3 & Sr-89/90)

Quarter/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value [a]	Acceptance Limits	Evaluation [b]
1st/2019	RAD-116	Water	Cs-134	pCi/L	48.2	49.1	39.5 - 54.0	A
			Cs-137	pCi/L	128	125	112 - 140	A
			Co-60	pCi/L	104	96.4	86.8 - 108	A
			Zn-65	pCi/L	88.1	77.4	69.5 - 93.2	A
			Gr-A	pCi/L	22.3	21.8	10.9 - 29.5	A
			Gr-A	pCi/L	23.5	21.8	10.9 - 29.5	A
			Gr-B	pCi/L	43.6	55.7	38.1 - 62.6	A
			H-3	pCi/L	2,160	2,110	1,740 - 2,340	A
			H-3	pCi/L	1,920	2,110	1,740 - 2,340	A
			Sr-89	pCi/L	78.5	66.9	54.4 - 75.0	N(1)
			Sr-89	pCi/L	76.5	66.9	54.4 - 75.0	N(1)
			Sr-90	pCi/L	40.1	41.0	30.2 - 47.1	A
			Sr-90	pCi/L	42.2	41.0	30.2 - 47.1	A
2nd/2019	MRAD-30	Soil	Sr-90	pCi/kg	1,220	1,350	420 - 2,100	A
		Veg	Sr-90	pCi/kg	4,670	3,530	1,900 - 4,600	N(2)
		AP	Sr-90	pCi	169	181	114 - 246	A
		Water	Sr-90	pCi/L	365	315	227 - 389	A
			Gr-A	pCi/L	79.8	68.5	25.0 - 94.5	A
			Gr-B	pCi/L	140	151	75.5 - 208	A
			H-3	pCi/L	22,200	23,700	17,900 - 28,800	A
			Cs-134	pCi/L	116	123	92.9 - 135	A
			Cs-137	pCi/L	126	125	107 - 142	A
			Co-60	pCi/L	1,200.0	1,100	949 - 1,260	A
			Fe-55	pCi/L	1,310	1,320	776 - 1,920	A
			Mn-54	pCi/L	<5.6	<100	<100	A
			Zn-65	pCi/L	1,990	1,780	1,580 - 2,250	A
	RAD-116	Water	Sr-89	pCi/L	35.9	33.3	24.5 - 40.2	A
			Sr-89	pCi/L	34.4	33.3	24.5 - 40.2	A
3rd/2019	RAD-118	Water	Cs-134	pCi/L	30.4	32.0	25.1 - 35.2	A
			Cs-137	pCi/L	23	21	17.6 - 26.7	A
			Co-60	pCi/L	102	95.1	85.6 - 107	A
			Zn-65	pCi/L	49.2	41.2	35.3 - 51.4	A
			Gr-A	pCi/L	88.7	70.6	37.1 - 87.1	N(3)
			Gr-A	pCi/L	80.7	70.6	37.1 - 87.1	A
			Gr-B	pCi/L	57.7	63.9	44.2 - 70.5	A
			H-3	pCi/L	14,700	16,700	14,600 - 18,400	A
			H-3	pCi/L	14,700	16,700	14,600 - 18,400	A
			H-3	pCi/L	15,000	16,700	14,600 - 18,400	A
			Sr-89	pCi/L	69.4	58.7	47.1 - 66.5	N(3)
			Sr-89	pCi/L	62.1	58.7	47.1 - 66.5	A
			Sr-90	pCi/L	34.3	38.5	28.3 - 44.3	A
			Sr-90	pCi/L	33.4	38.5	28.3 - 44.3	A
4th/2019	MRAD-31	Soil	Sr-90	pCi/kg	1,660	1,910	594 - 2,980	A
		Veg	Sr-90	pCi/kg	4,010	3,940	2,220 - 5,130	A
		AP	Sr-90	pCi	34.8	34.5	21.8 - 47.0	A
		Water	Sr-90	pCi/L	508	481	346 - 595	A
			Gr-A	pCi/L	147	124	45.3 - 17	A
			Gr-B	pCi/L	72.9	68.0	34.0 - 93.6	A
			H-3	pCi/L	20,900	22,300	16,800 - 27,100	A
			Cs-134	pCi/L	1,820	1,960	1,480 - 2,160	A
			Cs-137	pCi/L	1,820	1,840	1,580 - 2,090	A
			Co-60	pCi/L	1,970	1,870	1,610 - 2,150	A
			Fe-55	pCi/L	1,410	1,460	858 - 2,120	A
			Mn-54	pCi/L	<7.24	<100	<100	A
			Zn-65	pCi/L	1,490	1,370	1,220 - 1,730	A

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

(b) ERA evaluation: A = Acceptable - Reported value falls within the Acceptance Limits
N = Not Acceptable - Reported value falls outside of the Acceptance Limits

(1) ***CARR190225-1192*** *(2)* ***CARR190530-1211*** *(3)* ***CARR190826-1250***

TABLE E.8 Analytics Environmental Radioactivity Cross Check Program
GEL Laboratories (Gamma and Sr-89/90 only)

Quarter/Year	Identification Number	Matrix	Nuclide	Units	Reported Value	Known Value [a]	Acceptance Limits	Evaluation [b]
1st/2019	E12367	Water	Cs-134	pCi/L	143	155	0.92	A
			Cs-137	pCi/L	209	191	1.10	A
			Co-58	pCi/L	143	139	1.03	A
			Co-60	pCi/L	318	290	1.10	A
			Fe-59	pCi/L	176	154	1.14	A
			M:n-54	pCi/L	155	139	1.12	A
			Zn-65	pCi/L	244	214	1.14	A
2nd/2019	E12361	Milk	Sr-89	pCi/L	101	82.9	1.22	A
			Sr-90	pCi/L	12.1	13.5	0.90	A
	E12363	Water	Cs-134	pCi/L	137	153	0.89	A
			Cs-137	pCi/L	190	184	1.03	A
			Co-58	pCi/L	122	122	1.00	A
			Co-60	pCi/L	222	216	1.03	A
			Fe-59	pCi/L	173	154	1.12	A
			Mn-54	pCi/L	227	270	1.10	A
			Zn-65	pCi/L	301	270	1.11	A
3rd/2019	E12369	Milk	Sr-89	pCi/L	87.1	93.9	0.93	A
			Sr-90	pCi/L	7.02	12.9	0.54	A
	E12371	Water	Cs-134	pCi/L	150	157	0.96	A
			Cs-137	pCi/L	122	114	1.07	A
			Co-58	pCi/L	136	133	1.03	A
			Co-60	pCi/L	168	160	1.04	A
			Fe-59	pCi/L	127	112	1.13	A
			Mn-54	pCi/L	134	117	1.15	A
			Zn-65	pCi/L	257	222	1.16	A
4th/2019	E12373	Milk	Sr-89	pCi/L	66.0	80.6	0.82	A
			Sr-90	pCi/L	11.1	11.0	1.00	A
	E12375	Water	Cs-134	pCi/L	106	114	0.93	A
			Cs-137	pCi/L	109	103	1.06	A
			Co-58	pCi/L	95.4	91.1	1.05	A
			Co-60	pCi/L	122	117	1.05	A
			Fe-59	pCi/L	93.2	88.2	1.06	A
			Mn-54	pCi/L	144	131	1.10	A
			Zn-65	pCi/L	191	161	1.19	A

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

(b) Analytics evaluation based on laboratory's internal acceptance criteria of 75% - 125%:
A = Acceptable - Reported value falls within the Acceptance Limits
N = Not Acceptable - Reported value falls outside of the Acceptance Limits

APPENDIX E

ERRATA DATA

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Errata Data for 2019

1. Pages 6 and 7 of the 2016 ARERR, Table 1 - *Summary of Gaseous and Liquid Effluent Doses to Members of the Public at the Highest Dose Receptors* and Table 2 - *Summary of Gaseous and Liquid Effluent Doses to Members of the Public for 40CFR190 Compliance.*

   During a review of the 2016 calculated doses, it was determined that there were nine release permits associated with the North Stack that did not calculate dose for C-14. The curies were correct, but the dose was not calculated. These permits were then recalculated and the correct dose was applied. This impacted the dose reported in Table 1 - *Summary of Gaseous and Liquid Effluent Doses to Members of the Public at the Highest Dose Receptors* for Iodine, Particulate, C-14 & Tritium and in Table 2 - *Summary of Gaseous and Liquid Effluent Doses to Members of the Public for 40CFR190 Compliance* for Organ Dose. None of the changes resulted in an applicable limit being exceeded.

   See attached original and corrected pages for actual values updated highlighted in yellow.

2. Pages 14 and 15 of the 2018 ARERR, Table 1 - *Summary of Gaseous and Liquid Effluent Doses to Members of the Public at the Highest Dose Receptors* and Table 2 - *Summary of Gaseous and Liquid Effluent Doses to Members of the Public for 40CFR190 Compliance.*

   The percent of applicable limit was transposed instead of the estimated dose from Table 1 to Table 2 for both Total Body Dose and Thyroid Dose for Gaseous Effluent Noble Gas. The percent of applicable limit value was 3.25E-03, while the estimated dose value was 3.25E-02. This resulted in a conservative value being listed in Table 2 - *Summary of Gaseous and Liquid Effluent Doses to Members of the Public for 40CFR190 Compliance*.

   See attached original and corrected pages for actual values updated highlighted in yellow.

Original Page 6 of the 2016 ARERR

J. Independent Spent Fuel Storage Installation (ISFSI)

An Independent Spent Fuel Storage Installation (ISFSI) was placed in service starting July 21, 2008. Direct radiation exposure was determined using dosimetry measurements (minus background levels) obtained from the Radiological Environmental Monitoring Program for the nearest residence to the Independent Spent Fuel Storage Installation (ISFSI). In 2016 the dose to the nearest resident from the ISFSI was 0.00 mrem.

K. Annual Land Use Census Changes

The 2016 Land Use Survey identified differences in locations for gardens only. The gardens identified in sectors NNE, NE, SSW, SW, W, and NNW are farther away than in 2015. A new garden was identified in the WNW sector.

3. Radiological Impact to Man and Compliance to 40 CFR 190 Limits

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

Per 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 (minus background levels) obtained from the Radiological Environmental Monitoring Program 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 40CFR190 compliance.

Gaseous Releases (Table 1):

The critical age-organ group was the child-bone. Calculated dose was 1.05E+00 mrem, which represents 3.50E+00 percent of the allowable limits. Carbon-14 represented 99.9% or 1.05E+00 mrem of the total dose.

Liquid Releases (Table 1):

The critical age-organ was the adult-liver. Calculated total body dose was 3.80E-04 mrem and organ dose was 4.59E-04 mrem.

40 CFR 190 Compliance (Table 2):

The maximum calculated dose to a real individual would not exceed 2.22E-01 mrem (total body), 1.07E+00 mrem (organ), or 2.22E-01 mrem (thyroid).

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

Corrected Page 6 of the 2016 ARERR

J. Independent Spent Fuel Storage Installation (ISFSI)

An Independent Spent Fuel Storage Installation (ISFSI) was placed in service starting July 21, 2008. Direct radiation exposure was determined using dosimetry measurements (minus background levels) obtained from the Radiological Environmental Monitoring Program for the nearest residence to the Independent Spent Fuel Storage Installation (ISFSI). In 2016 the dose to the nearest resident from the ISFSI was 0.00 mrem.

K. Annual Land Use Census Changes

The 2016 Land Use Survey identified differences in locations for gardens only. The gardens identified in sectors NNE, NE, SSW, SW, W, and NNW are farther away than in 2015. A new garden was identified in the WNW sector.

3. Radiological Impact to Man and Compliance to 40 CFR 190 Limits

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

Per 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 (minus background levels) obtained from the Radiological Environmental Monitoring Program 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 40CFR190 compliance.

Gaseous Releases (Table 1):

The critical age-organ group was the child-bone. Calculated dose was 1.31E+00 mrem, which represents 4.35E+00 percent of the allowable limits. Carbon-14 represented 99.9% or 1.31E+00 mrem of the total dose.

Liquid Releases (Table 1):

The critical age-organ was the adult-liver. Calculated total body dose was 3.80E-04 mrem and organ dose was 4.59E-04 mrem.

40 CFR 190 Compliance (Table 2):

The maximum calculated dose to a real individual would not exceed 2.22E-01 mrem (total body), 1.33E+00 mrem (organ), or 2.22E-01 mrem (thyroid).

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

Original Page 7 of the 2016 ARERR

SITE: LIMERICK GENERATING STATION – UNITS 1 & 2
LICENSEE: EXELON GENERATION COMPANY, LLC

Table 1 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	9.71E-03	All	4.86E-02	20	mRad
Nearest Residence	Beta Air Dose	8.58E-03	All	2.15E-02	40	mRad
Nearest Residence	Total Body	9.21E-03	All	9.21E-02	10	mrem
Nearest Residence	Skin	1.79E-02	All	5.97E-02	30	mrem
Iodine, Particulate, C-14 & Tritium						
Vegetation Pathway	Bone	1.05E+00	Child	3.50E+00	30	mrem
Liquid						
LGS Outfall	Total Body	3.80E-04	Adult	6.33E-03	6	mrem
LGS Outfall	Liver	4.59E-04	Adult	2.30E-03	20	mrem

Table 2 Summary of Gaseous and Liquid Effluent Doses to Members of the Public for 40CFR190 Compliance

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	9.21E-03	2.11E-01	3.80E-04	0.00E+00	2.21E-01	8.82E-01	25	mrem
Organ Dose	1.79E-02	1.05E+00	4.59E-04	0.00E+00	1.07E+00	4.27E+00	25	mrem
Thyroid Dose	9.21E-03	2.11E-01	3.00E-04	0.00E+00	2.21E-01	2.94E-01	75	mrem

A. Dose to Members of the Public Inside the Site Boundary

ODCM Control 6.2 also requires that the Annual Effluent Release Report shall include an assessment of the radiation doses from radioactive liquid and gaseous effluents to members of the public due to activities inside the Site Boundary during the report period. MEMBER OF THE PUBLIC shall include all persons not occupationally associated with the plant. This category does not include employees of the utility or contractors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational education, or other purposes not associated with the plant. A MEMBER OF THE PUBLIC may receive up to 100 mrem in a year (10CFR20.1301). Areas within the site boundary, where radiation dose of this type could occur include the Limerick Information Center on Longview Road, Frick's Lock on the south shore of the Schuylkill River, and the railroad track that runs along the north shore of the Schuylkill River. The radiation doses to Members of the Public have been estimated using methodology stated in the ODCM. The maximum gaseous dose to members of the public at these locations is based on the following assumptions:

- Long term annual average meteorology and actual effluent releases for the sectors encompassing the Railroad Tracks (W), Information Center, and Frick's Lock.
- Dose is from ground plane and inhalation only. No ingestion dose is included.
- The maximum expected occupancy factor is 25% of a working year at all locations.

The maximum calculated dose for activities on site was 3.59E-02 mrem at the Rail Road Tracks in the West sector (Table 3). All Doses calculated were a small fraction of the 10 CFR 20.1301 limits.

SITE: LIMERICK GENERATING STATION – UNITS 1 & 2
LICENSEE: EXELON GENERATION COMPANY, LLC

Corrected Page 7 of the 2016 ARERR

SITE: LIMERICK GENERATING STATION – UNITS 1 & 2
LICENSEE: EXELON GENERATION COMPANY, LLC

Table 1 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	9.71E-03	All	4.86E-02	20	mRad
Nearest Residence	Beta Air Dose	8.58E-03	All	2.15E-02	40	mRad
Nearest Residence	Total Body	9.21E-03	All	9.21E-02	10	mrem
Nearest Residence	Skin	1.79E-02	All	5.97E-02	30	mrem
Iodine, Particulate, C-14 & Tritium						
Vegetation Pathway	Bone	1.31E+00	Child	4.35E+00	30	mrem
Liquid						
LGS Outfall	Total Body	3.80E-04	Adult	6.33E-03	6	mrem
LGS Outfall	Liver	4.59E-04	Adult	2.30E-03	20	mrem

Table 2 Summary of Gaseous and Liquid Effluent Doses to Members of the Public for 40CFR190 Compliance

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	9.21E-03	2.11E-01	3.80E-04	0.00E+00	2.21E-01	8.82E-01	25	mrem
Organ Dose	1.79E-02	1.31E+00	4.59E-04	0.00E+00	1.33E+00	5.31E+00	25	mrem
Thyroid Dose	9.21E-03	2.11E-01	3.00E-04	0.00E+00	2.21E-01	2.94E-01	75	mrem

A. Dose to Members of the Public Inside the Site Boundary

ODCM Control 6.2 also requires that the Annual Effluent Release Report shall include an assessment of the radiation doses from radioactive liquid and gaseous effluents to members of the public due to activities inside the Site Boundary during the report period. MEMBER OF THE PUBLIC shall include all persons not occupationally associated with the plant. This category does not include employees of the utility or contractors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational education, or other purposes not associated with the plant. A MEMBER OF THE PUBLIC may receive up to 100 mrem in a year (10CFR20.1301). Areas within the site boundary, where radiation dose of this type could occur include the Limerick Information Center on Longview Road, Frick's Lock on the south shore of the Schuylkill River, and the railroad track that runs along the north shore of the Schuylkill River. The radiation doses to Members of the Public have been estimated using methodology stated in the ODCM. The maximum gaseous dose to members of the public at these locations is based on the following assumptions:

- Long term annual average meteorology and actual effluent releases for the sectors encompassing the Railroad Tracks (W), Information Center, and Frick's Lock.
- Dose is from ground plane and inhalation only. No ingestion dose is included.
- The maximum expected occupancy factor is 25% of a working year at all locations.

The maximum calculated dose for activities on site was 3.59E-02 mrem at the Rail Road Tracks in the West sector (Table 3). All Doses calculated were a small fraction of the 10 CFR 20.1301 limits.

meat animals identified in sectors N, S, SSW and WSW and are closer than in 2017. There were no changes in the nearest residences and dairy farms from 2017.

4. Radiological Impact to Man and Compliance to 40 CFR 190 Limits

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

Per 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 (minus background levels) obtained from the Radiological Environmental Monitoring Program 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 40CFR190 compliance.

Gaseous Releases (Table 1):

The critical age-organ group was the child-bone. Calculated dose was 1.28E+00 mrem, which represents 4.26E+00 percent of the allowable limits. Carbon-14 represented 100.0% or 1.28E+00 mrem of the total dose.

Liquid Releases (Table 1):

The critical age-organ was the adult-liver. Calculated total body dose was 4.90E-04 mrem and organ dose was 6.59E-04 mrem.

40 CFR 190 Compliance (Table 2):

The maximum calculated dose to a real individual would not exceed 2.90E-01 mrem (total body), 1.29E+00 mrem (organ), or 2.90E-01 mrem (thyroid).

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

Corrected Page 14 of the 2018 ARERR

meat animals identified in sectors N, S, SSW and WSW and are closer than in 2017. There were no changes in the nearest residences and dairy farms from 2017.

4. Radiological Impact to Man and Compliance to 40 CFR 190 Limits

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

Per 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 (minus background levels) obtained from the Radiological Environmental Monitoring Program 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 40CFR190 compliance.

Gaseous Releases (Table 1):

The critical age-organ group was the child-bone. Calculated dose was 1.28E+00 mrem, which represents 4.26E+00 percent of the allowable limits. Carbon-14 represented 100.0% or 1.28E+00 mrem of the total dose.

Liquid Releases (Table 1):

The critical age-organ was the adult-liver. Calculated total body dose was 4.90E-04 mrem and organ dose was 6.59E-04 mrem.

40 CFR 190 Compliance (Table 2):

The maximum calculated dose to a real individual would not exceed 2.61E-01 mrem (total body), 1.29E+00 mrem (organ), or 2.61E-01 mrem (thyroid).

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

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Table 1 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	3.45E-03	All	1.73E-02	20	mRad
Nearest Residence	Beta Air Dose	2.13E-03	All	5.33E-03	40	mRad
Nearest Residence	Total Body	3.25E-03	All	3.25E-02	10	mrem
Nearest Residence	Skin	5.35E-03	All	1.78E-02	30	mrem
Iodine, Particulate, C-14 & Tritium						
Vegetation Pathway	Bone	1.28E+00	Child	4.26E+00	30	mrem
Liquid						
LGS Outfall	Total Body	4.90E-04	Teen	8.16E-03	6	mrem
LGS Outfall	Liver	6.59E-04	Adult	3.29E-03	20	mrem

Table 2 Summary of Gaseous and Liquid Effluent Doses to Members of the Public for 40CFR190 Compliance

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	3.25E-02	2.57E-01	4.90E-04	0.00E+00	2.90E-01	1.16E+00	25	mrem
Organ Dose	5.35E-03	1.28E+00	6.59E-04	0.00E+00	1.29E+00	5.14E+00	25	mrem
Thyroid Dose	3.25E-02	2.57E-01	2.92E-04	0.00E+00	2.90E-01	3.86E-01	75	mrem

A. Dose to Members of the Public Inside the Site Boundary

ODCM Control 6.2 also requires that the Annual Effluent Release Report shall include an assessment of the radiation doses from radioactive liquid and gaseous effluents to members of the public due to activities inside the Site Boundary during the report period. MEMBER OF THE PUBLIC shall include all persons not occupationally associated with the plant. This category does not include employees of the utility or contractors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational education, or other purposes not associated with the plant. A MEMBER OF THE PUBLIC may receive up to 100 mrem in a year (10CFR20.1301). Areas within the site boundary, where radiation dose of this type could occur include the Limerick Information Center on Longview Road, Frick's Lock on the south shore of the Schuylkill River, and the railroad track that runs along the north shore of the Schuylkill River. The radiation doses to Members of the Public have been estimated using methodology stated in the ODCM. The maximum gaseous dose to members of the public at these locations is based on the following assumptions:

- Long term annual average meteorology and actual effluent releases for the sectors encompassing the Railroad Tracks (W), Information Center, and Frick's Lock.
- Dose is from ground plane and inhalation only. No ingestion dose is included.
- The maximum expected occupancy factor is 25% of a working year at all locations.

The maximum calculated dose for activities on site was 3.53E-02 mrem at the Rail Road Tracks in the West sector (Table 3). All Doses calculated were a small fraction of the 10 CFR 20.1301 limits.

Corrected Page 15 of the 2018 ARERR

Table 1 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	3.45E-03	All	1.73E-02	20	mRad
Nearest Residence	Beta Air Dose	2.13E-03	All	5.33E-03	40	mRad
Nearest Residence	Total Body	3.25E-03	All	3.25E-02	10	mrem
Nearest Residence	Skin	5.35E-03	All	1.78E-02	30	mrem
Iodine, Particulate, C-14 & Tritium						
Vegetation Pathway	Bone	1.28E+00	Child	4.26E+00	30	mrem
Liquid						
LGS Outfall	Total Body	4.90E-04	Teen	8.16E-03	6	mrem
LGS Outfall	Liver	6.59E-04	Adult	3.29E-03	20	mrem

Table 2 Summary of Gaseous and Liquid Effluent Doses to Members of the Public for 40CFR190 Compliance

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	3.25E-03	2.57E-01	4.90E-04	0.00E+00	2.61E-01	1.04E+00	25	mrem
Organ Dose	5.35E-03	1.28E+00	6.59E-04	0.00E+00	1.29E+00	5.14E+00	25	mrem
Thyroid Dose	3.25E-03	2.57E-01	2.92E-04	0.00E+00	2.61E-01	3.47E-01	75	mrem

A. Dose to Members of the Public Inside the Site Boundary

ODCM Control 6.2 also requires that the Annual Effluent Release Report shall include an assessment of the radiation doses from radioactive liquid and gaseous effluents to members of the public due to activities inside the Site Boundary during the report period. MEMBER OF THE PUBLIC shall include all persons not occupationally associated with the plant. This category does not include employees of the utility or contractors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational education, or other purposes not associated with the plant. A MEMBER OF THE PUBLIC may receive up to 100 mrem in a year (10CFR20.1301). Areas within the site boundary, where radiation dose of this type could occur include the Limerick Information Center on Longview Road, Frick's Lock on the south shore of the Schuylkill River, and the railroad track that runs along the north shore of the Schuylkill River. The radiation doses to Members of the Public have been estimated using methodology stated in the ODCM. The maximum gaseous dose to members of the public at these locations is based on the following assumptions:

- Long term annual average meteorology and actual effluent releases for the sectors encompassing the Railroad Tracks (W), Information Center, and Frick's Lock.
- Dose is from ground plane and inhalation only. No ingestion dose is included.
- The maximum expected occupancy factor is 25% of a working year at all locations.

The maximum calculated dose for activities on site was 3.53E-02 mrem at the Rail Road Tracks in the West sector (Table 3). All Doses calculated were a small fraction of the 10 CFR 20.1301 limits.

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APPENDIX G

ANNUAL RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM REPORT (ARGPPR)

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Docket No: 50-352
50-353

LIMERICK GENERATING STATION
UNITS 1 AND 2

Annual Radiological Groundwater Protection Program Report

1 January through 31 December 2019

Prepared By
Teledyne Brown Engineering
Environmental Services

Exelon Generation®

Limerick Power Station
Pottstown, PA 19464

April 2020

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Table of Contents

Appendices

I. Summary and Conclusions

This report on the Radiological Groundwater Protection Program (RGPP) conducted for the Limerick Generating Station (LGS) by Exelon Nuclear covers the period 01 January 2019 through 31 December 2019. During that time period, 302 analyses were performed on 147 samples from 13 groundwater, 7 surface water and 4 precipitation water locations collected from the environment, both on and off station property in 2019.

Groundwater and surface water was analyzed for tritium. Low levels of tritium were detected at 4 of the 13 groundwater monitoring locations and at 1 of the 7 surface water monitoring locations. All other results were less than the required Exelon-specified LLD of 200 pCi/L.

Groundwater and surface water was analyzed for Strontium-89 (Sr-89) and Strontium-90 (Sr-90). All Sr-89 and Sr-90 results were less than the MDC.

Groundwater was analyzed for gross alpha and gross beta in dissolved and suspended fractions. Gross alpha (dissolved) was detected at 4 of the 13 groundwater locations sampled. Gross alpha (suspended) was detected at 1 of the 13 groundwater locations sampled. Gross beta (dissolved) was detected at 11 of 13 groundwater locations sampled. Gross beta (suspended) was detected at 2 of the 13 groundwater locations sampled.

Groundwater and surface water was analyzed for gamma-emitting radionuclides associated with the renewed licensed plant operation. Naturally-occurring Potassium-40 (K-40) was detected in 1 of 13 groundwater locations. All other gamma isotopic 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. No HTD analyses were performed in 2019.

Precipitation water samples were analyzed for tritium. Tritium was detected at 1 of 4 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 MWt 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 river bank elevation rises from approximately 110 to 300 feet mean sea level (MSL). On the western river bank elevation rises to approximately 50 feet MSL.

This report covers those analyses performed by Teledyne Brown Engineering (TBE) on samples collected in 2019.

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 2019. Sample locations can be found in Table A–1, Appendix A.

1. Sample Collection

Groundwater and Surface Water

Samples of both groundwater and surface water 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 (^{3}He). 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 2019. The analytical procedures used by the laboratories are listed in the AREOR Appendix B Table B-3.

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

1. Concentrations of tritium in groundwater, surface water and precipitation water

2. Concentrations of gross alpha (dissolved and suspended) and gross beta, (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 and surface water

4. Concentrations of Strontium (Sr-89 and Sr-90) in groundwater and surface water

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. 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 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. Laboratory Measurements Uncertainty

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.

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 B, Table B–I.1) Tritium values ranged from non-detectable to 2,120 pCi/L. Although no drinking water pathway is available from groundwater, the theoretical dose via the drinking water pathway was calculated at 0.125 mrem to a child (total body), which represents 2.09% 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 B, Table B–I.1)

Gross Alpha and Gross Beta (dissolved and suspended)

All samples were analyzed for gross alpha and gross beta in the dissolved and suspended fractions once in May, 2019. Gross alpha (dissolved) was detected in 4 of the 13 groundwater locations. The concentrations ranged from 1.3 to 5.2 pCi/L. Gross alpha (suspended) was detected in 1 of 13 groundwater locations sampled with concentrations ranging from 1.3 to 5.2 pCi/L. Gross beta (dissolved) was detected in 11 of 13 groundwater locations sampled. The concentrations ranged from 1.8 to 15.3 pCi/L. Gross beta (suspended) was detected in 2 of the 13 groundwater locations sampled with concentrations ranging from 2.0 to 23.2 pCi/L. (Appendix B, Table B-I.1)

Gamma Emitters

Samples were analyzed for gamma-emitting nuclides. Naturally-occurring Potassium-40 (K-40) was detected in 1 of the 13 locations sampled at a concentration of 83 pCi/L, All other gamma results were below the required LLDs. (Appendix B, Table B-I.2)

Hard-To-Detect

No HTD analyses were performed in 2019. (Appendix B, Table B-I.3)

B. Surface Water Results

In accordance with the Station's Radiological Groundwater Protection

Program surface water samples were collected from streams that transverses the site, as well as, from other water bodies that could influence the tritium concentration at Limerick. Analytical results and anomalies are discussed below.

Tritium

Samples from 7 locations were analyzed for tritium activity (Appendix B, Table B-II.1). Tritium was detected in 1 of the 7 locations, sampled at a concentration of 366 pCi/L. The theoretical dose via the drinking water pathway was calculated at 0.022 mrem to a child (total body), which represents 0.36% 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 B, Table B-II.1)

Gamma Emitters

Samples were analyzed for gamma-emitting nuclides. All gamma results were below the required LLDs. (Appendix B, Table B–II.2)

C. Precipitation Sample Results

Tritium

Tritium activity was detected in 1 of 4 precipitation water locations analyzed. The concentrations ranged from 249 to 275 pCi/L. These concentrations are consistent with historical values observed. (Appendix B, Table B-III.1)

D. 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 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.

E. Summary of Results – Inter-Laboratory Comparison Program

Inter-Laboratory Comparison Program results for TBE are presented in the Annual Radiological Environmental Operating Report.

F. Leaks, Spills, and Releases

There were no spills to ground containing radioactive material in 2019. However, the Power Block Foundation Sump, which collects groundwater around the reactor buildings, turbine building and rad waste building, identified tritium in one sample of potentially contaminated systems (IR 0423206). The activity of 1.33E-06 µCi/mL was recorded. The source of the tritium is groundwater movement from the previously identified and reported leaks/spills.

G. Trends

Low level tritium detections in monitoring well MW-LR-5 are being trended.

H. Investigations

Intermittent, low-level tritium detections in monitoring well MW-LR-5 are currently being investigated.

I. 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

APPENDIX A

LOCATION DESIGNATION

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TABLE A-1: Radiological Groundwater Protection Program – Sampling Locations for the Limerick Generating Station, 2019

Location	Type	Distance
MW-LR-1	Monitoring Well	Onsite
MW-LR-2	Monitoring Well	Onsite
MW-LR-3	Monitoring Well	Onsite
MW-LR-4	Monitoring Well	Onsite
MW-LR-5	Monitoring Well	Onsite
MW-LR-6	Monitoring Well	Onsite
MW-LR-7	Monitoring Well	Onsite
MW-LR-8	Monitoring Well	Onsite
MW-LR-9	Monitoring Well	Onsite
MW-LR-10	Monitoring Well	Onsite
P11	Monitoring Well	Onsite
P14	Monitoring Well	Onsite
P17	Monitoring Well	Onsite
P3	Monitoring Well	Onsite
SP22	Monitoring Well	Onsite
DW-LR-1	Monitoring Well	Onsite
SW-LR-2	Surface Water	Offsite
SW-LR-4	Surface Water	Offsite
SW-LR-6	Surface Water	Offsite
SW-LR-7	Surface Water	Onsite
SW-LR-8 (Hold Pond)	Surface Water	Onsite
SW-LR-9 (Spray Pond)	Surface Water	Onsite
SW-LR-10	Surface Water	Onsite
36S3	Precipitation Water	Onsite
E-5	Precipitation Water	Onsite
ESE-6	Precipitation Water	Onsite
SE-7	Precipitation Water	Onsite

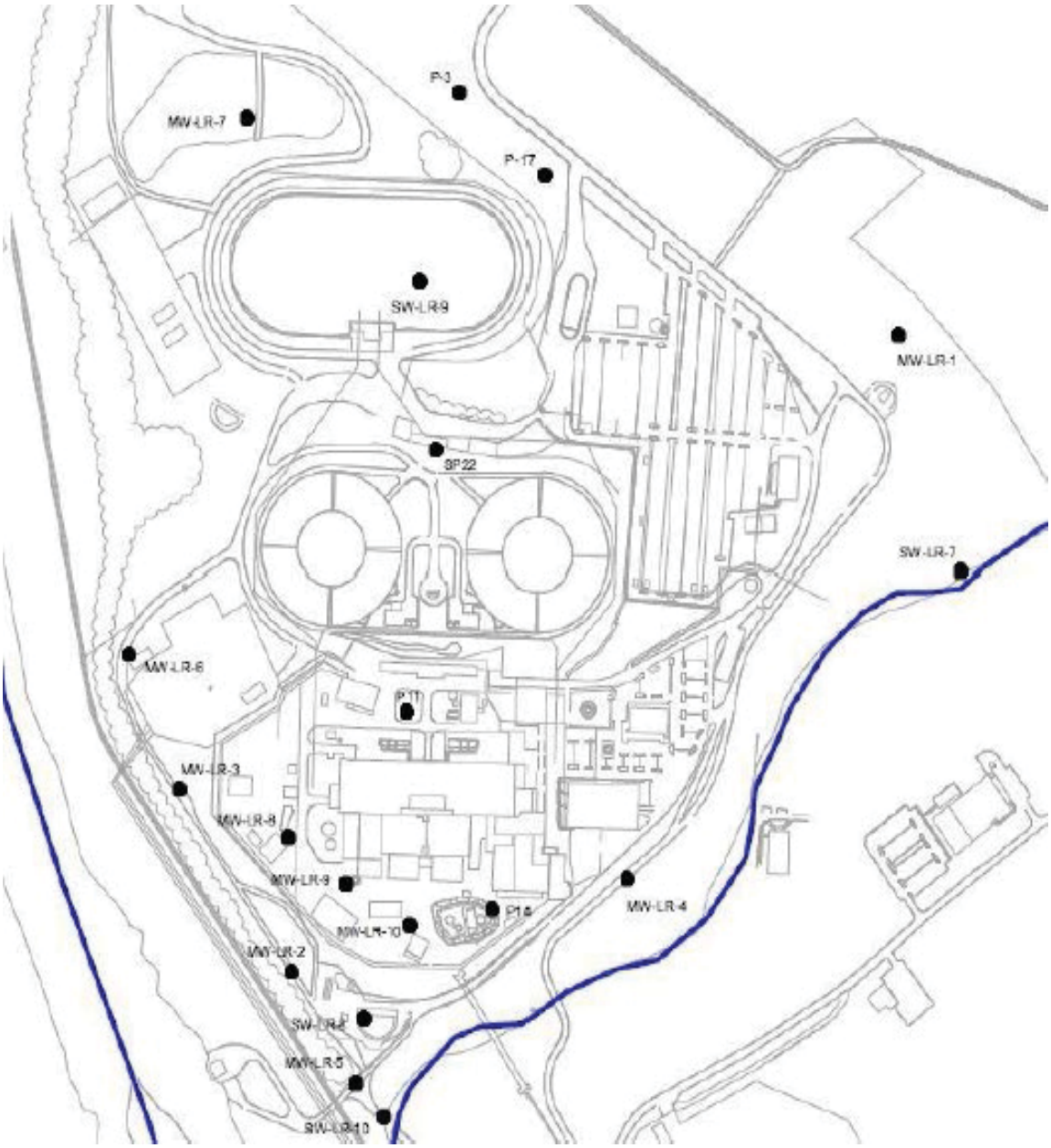

Figure 1 Routine Well Water and Surface Water Sample Locations for the Radiological Groundwater Protection Program, Limerick Generating Station, 2019

Figure 2 Routine Surface Water Sample Locations for the Radiological Groundwater Protection Program, Limerick Generating Station, 2019

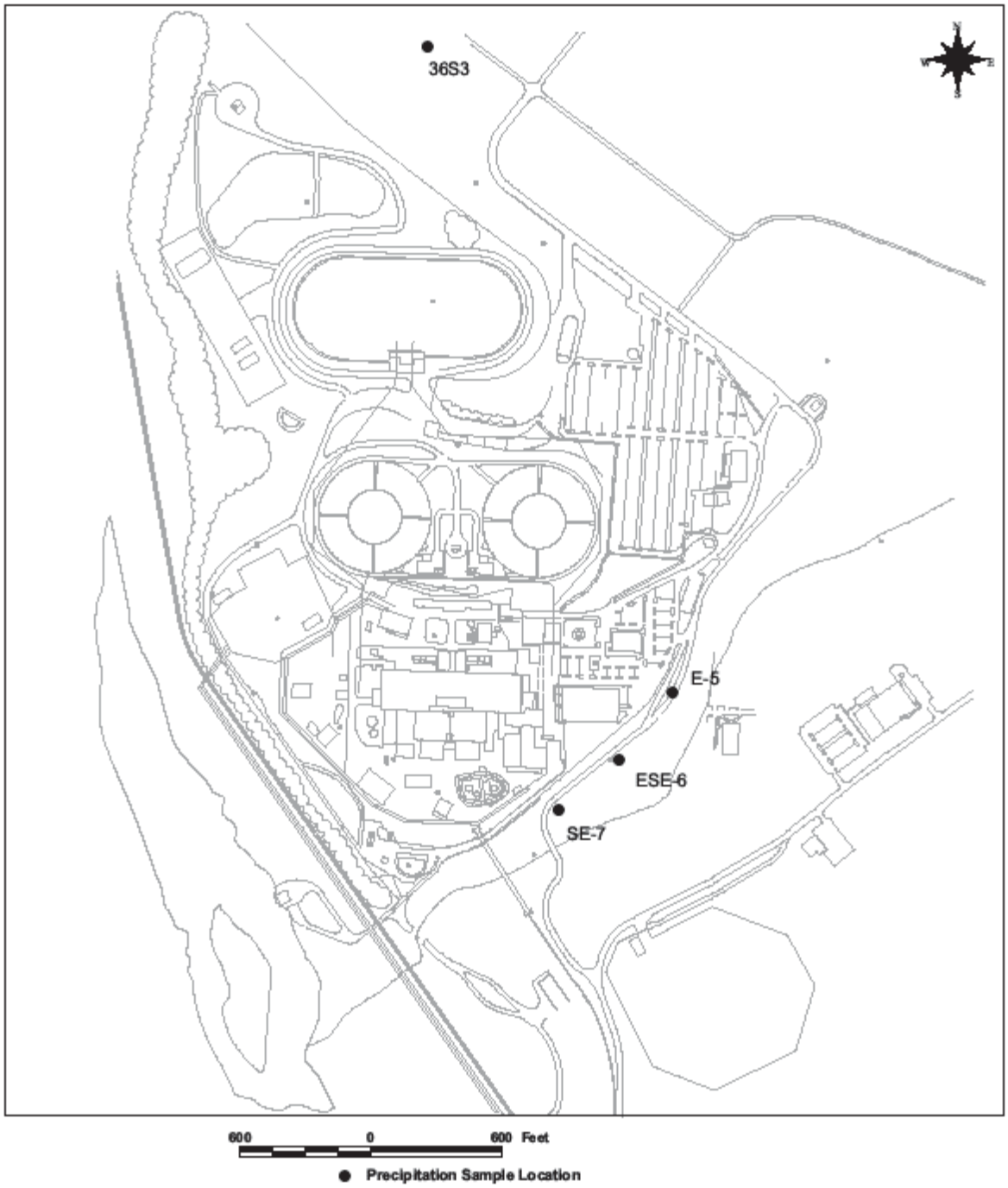

Figure 3 Routine Precipitation Sample Locations for the Radiological Groundwater Protection Program, Limerick Generating Station, 2019

APPENDIX B

DATA TABLES

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TABLE B-I.1 CONCENTRATIONS OF TRITIUM, STRONTIUM, GROSS ALPHA AND GROSS BETA IN WELL WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2019

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE		H-3	Sr-89	Sr-90	Gr-A (Dis)	Gr-A (Sus)	Gr-B (Dis)	Gr-B (Sus)
DW-LR-1	02/06/19		< 183						
DW-LR-1	05/06/19		< 193			1.5 ± 0.8	< 0.8	< 1.3	< 1.4
DW-LR-1	08/14/19		< 195	< 3.9	< 0.9				
DW-LR-1	11/04/19		< 184						
MW-LR-1	05/08/19		< 197	< 3.2	< 0.7	< 0.6	< 0.4	5.4 ± 1.1	< 1.7
MW-LR-2	02/06/19		< 188						
MW-LR-2	05/08/19		< 191	< 5.7	< 0.6	< 0.6	< 0.8	3.4 ± 0.9	< 1.4
MW-LR-2	08/14/19		< 191						
MW-LR-2	11/04/19		194 ± 124						
MW-LR-3	02/06/19		< 183						
MW-LR-3	05/08/19		< 193	< 4.2	< 0.6	< 0.9	< 0.8	3.0 ± 1.1	< 1.4
MW-LR-3	08/14/19		< 197						
MW-LR-3	11/04/19		< 194						
MW-LR-4	02/06/19		< 192						
MW-LR-4	05/08/19		< 190	< 3.4	< 0.8	< 1.6	< 0.4	3.8 ± 1.1	< 1.7
MW-LR-4	08/14/19		< 195						
MW-LR-4	11/04/19		< 191						
MW-LR-5	02/06/19		311 ± 141						
MW-LR-5	02/06/19	*DUP*	< 192						
MW-LR-5	02/06/19	*GEL*	< 114						
MW-LR-5	04/22/19		226 ± 127						
MW-LR-5	05/08/19		2120 ± 281	< 3.7	< 0.6	< 1.0	< 0.4	5.0 ± 1.0	< 1.7
MW-LR-5	05/08/19	*R1*	1750 ± 244						
MW-LR-5	05/08/19	*DUP*	1940 ± 263	< 4.1	< 0.5	1.3 ± 0.8	< 0.4	5.6 ± 1.0	< 1.7
MW-LR-5	05/08/19	*DUP R1*	1830 ± 250						
MW-LR-5	05/08/19	*GEL*	1860 ± 481	< 0.6	< 0.7	< 3.2	*(1)*	< 2.2 *(1)*	
MW-LR-5	08/14/19		214 ± 127						
MW-LR-5	08/14/19	*DUP*	< 194						
MW-LR-5	08/14/19	*GEL*	203 ± 89						
MW-LR-5	11/04/19		273 ± 127						
MW-LR-5	11/04/19	*DUP*	328 ± 129						
MW-LR-5	11/04/19	*GEL*	< 175						
MW-LR-7	02/06/19		< 188						
MW-LR-7	05/08/19		< 188	< 2.7	< 0.8	< 0.6	< 0.8	1.8 ± 0.7	< 1.4
MW-LR-7	08/13/19		< 184						
MW-LR-7	11/04/19		< 174						
MW-LR-8	02/05/19		364 ± 127						
MW-LR-8	02/05/19	*DUP*	516 ± 135						
MW-LR-8	02/06/19	*GEL*	545 ± 104						
MW-LR-8	05/10/19		509 ± 141	< 6.1	< 0.8	< 2.8	< 0.8	3.7 ± 1.3	2.0 ± 1.1
MW-LR-8	05/10/19	*DUP*	699 ± 150	< 4.9	< 0.7	2.5 ± 1.3	< 1.8	3.8 ± 1.4	< 1.9
MW-LR-8	05/10/19	*GEL*	681 ± 112	< 0.8	< 0.7	6.6 ± 2.4	*(1)*	5.5 ± 1.9	*(1)*
MW-LR-8	08/16/19		460 ± 136						
MW-LR-8	08/16/19	*DUP*	494 ± 141						
MW-LR-8	08/16/19	*GEL*	590 ± 116						
MW-LR-8	11/06/19		584 ± 141						
MW-LR-8	11/06/19	*DUP*	519 ± 138						
MW-LR-8	11/06/19	*GEL*	549 ± 126						

(1) Total gross alpha/beta results reported (not dissolved/suspended)

TABLE B-I.1 CONCENTRATIONS OF TRITIUM, STRONTIUM, GROSS ALPHA AND GROSS BETA IN WELL WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2019

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE		H-3	Sr-89	Sr-90	Gr-A (Dis)	Gr-A (Sus)	Gr-B (Dis)	Gr-B (Sus)
MW-LR-9	02/05/19		679 ± 145						
MW-LR-9	02/05/19	*DUP*	900 ± 165						
MW-LR-9	02/05/19	*GEL*	904 ± 123						
MW-LR-9	05/10/19		855 ± 163	< 8.9	< 0.8	4.2 ± 1.7	8.6 ± 3.8	15.3 ± 2.4	23.2 ± 4.9
MW-LR-9	05/10/19	*DUP*	1000 ± 176	< 8.4	< 0.9	5.2 ± 2.1	8.2 ± 3.6	11.0 ± 2.3	19.1 ± 4.6
MW-LR-9	05/10/19	*GEL*	722 ± 111	< 0.8	< 0.7	30.4 ± 8.9	*(1)*	22.2 ± 4.8	*(1)*
MW-LR-9	08/16/19		886 ± 170						
MW-LR-9	08/16/19	*DUP*	954 ± 176						
MW-LR-9	08/16/19	*GEL*	862 ± 129						
MW-LR-9	11/06/19		800 ± 157						
MW-LR-9	11/06/19	*DUP*	930 ± 171						
MW-LR-9	11/06/19	*GEL*	772 ± 145						
MW-LR-10	02/05/19		< 196						
MW-LR-10	05/10/19		< 192	< 4.5	< 0.4	< 0.8	< 0.4	2.9 ± 1.1	< 1.7
MW-LR-10	08/16/19		< 195						
MW-LR-10	11/06/19		< 185						
P11	02/05/19		< 183						
P11	05/10/19		< 193			< 1.5	< 0.8	10.5 ± 1.4	< 1.4
P11	08/16/19		< 196	< 6.3	< 0.9				
P11	11/06/19		< 193						
P14	02/05/19		< 191						
P14	05/10/19		< 196			< 2.6	< 0.4	< 2.2	< 1.7
P14	08/16/19		< 193	< 4.5	< 0.7				
P14	11/06/19		< 186						
P17	05/08/19		< 196			< 1.2	< 0.4	2.1 ± 1.2	< 1.7

(1) Total gross alpha/beta results reported (not dissolved/suspended)

TABLE B-I.2 **CONCENTRATIONS OF GAMMA EMITTERS IN WELL WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE		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	La-140
DW-LR-1	05/08/18		< 74	< 117	< 7	< 8	< 18	< 8	< 15	< 11	< 13	< 15	< 7	< 7	< 35	< 11
MW-LR-1	05/08/18		< 60	< 63	< 7	< 6	< 12	< 7	< 15	< 8	< 14	< 12	< 6	< 6	< 34	< 15
MW-LR-10	05/09/18		< 60	< 69	< 7	< 6	< 14	< 7	< 13	< 7	< 10	< 12	< 6	< 7	< 35	< 11
MW-LR-2	05/08/18		< 53	< 54	< 7	< 6	< 14	< 7	< 14	< 7	< 12	< 10	< 6	< 8	< 34	< 8
MW-LR-3	05/08/18		< 46	< 41	< 5	< 5	< 13	< 7	< 11	< 7	< 10	< 10	< 5	< 6	< 26	< 8
MW-LR-4	05/08/18		< 55	< 137	< 7	< 6	< 14	< 8	< 14	< 7	< 12	< 14	< 8	< 8	< 34	< 11
MW-LR-5	05/08/18		< 67	< 139	< 8	< 5	< 16	< 6	< 21	< 9	< 17	< 11	< 7	< 10	< 34	< 14
MW-LR-5	05/08/18	*DUP*	< 56	< 104	< 6	< 6	< 13	< 7	< 13	< 9	< 11	< 10	< 6	< 6	< 29	< 10
MW-LR-5	05/08/18	*GEL*	(1)	(1)	< 1	< 1	< 4	< 1	< 3	< 2	< 3	< 13	< 1	< 1	< 18	< 7
DW-LR-1	05/06/19		< 29	< 52	< 4	< 3	< 6	< 3	< 7	< 4	< 6	< 8	< 3	< 3	< 20	< 6
MW-LR-1	05/08/19		< 59	< 94	< 7	< 6	< 12	< 6	< 11	< 8	< 11	< 13	< 6	< 5	< 33	< 12
MW-LR-2	05/08/19		< 35	< 43	< 4	< 4	< 9	< 4	< 8	< 5	< 7	< 7	< 4	< 4	< 21	< 7
MW-LR-3	05/08/19		< 37	83 ± 52	< 4	< 4	< 8	< 4	< 9	< 5	< 7	< 7	< 4	< 4	< 22	< 7
MW-LR-4	05/08/19		< 39	< 37	< 4	< 4	< 8	< 4	< 9	< 5	< 9	< 8	< 5	< 5	< 22	< 8
MW-LR-5	05/08/19	*DUP*	< 47	< 52	< 6	< 5	< 12	< 5	< 13	< 6	< 10	< 10	< 6	< 5	< 29	< 9
MW-LR-5	05/08/19	*GEL*	*(1)*	*(1)*	< 1	< 2	< 3	< 2	< 3	< 2	< 3	< 5	< 2	< 2	< 10	< 3
MW-LR-5	05/08/19		< 45	< 78	< 5	< 5	< 10	< 6	< 10	< 6	< 9	< 10	< 5	< 5	< 25	< 10
MW-LR-7	05/08/19		< 43	< 59	< 5	< 6	< 12	< 6	< 11	< 6	< 10	< 11	< 7	< 6	< 26	< 8
MW-LR-8	05/10/19		< 40	< 92	< 5	< 5	< 10	< 4	< 10	< 5	< 7	< 7	< 5	< 4	< 19	< 7
MW-LR-8	05/10/19	*DUP*	< 46	< 98	< 5	< 5	< 12	< 5	< 9	< 7	< 10	< 10	< 6	< 5	< 25	< 9
MW-LR-8	05/10/19	*GEL*	*(1)*	*(1)*	< 1	< 2	< 3	< 1	< 3	< 1	< 3	< 4	< 1	< 2	< 8	< 3
MW-LR-9	05/10/19		< 58	< 65	< 8	< 6	< 14	< 6	< 16	< 9	< 10	< 11	< 7	< 6	< 34	< 10
MW-LR-9	05/10/19	*DUP*	< 48	< 82	< 5	< 6	< 12	< 6	< 11	< 7	< 9	< 9	< 6	< 6	< 25	< 10
MW-LR-9	05/10/19	*GEL*	*(1)*	*(1)*	< 1	< 1	< 3	< 2	< 3	< 2	< 3	< 4	< 1	< 2	< 9	< 3
MW-LR-10	05/10/19		< 51	< 110	< 6	< 6	< 10	< 6	< 11	< 6	< 9	< 9	< 6	< 6	< 25	< 9
P11	05/10/19		< 61	< 70	< 6	< 7	< 13	< 7	< 14	< 8	< 12	< 12	< 8	< 7	< 34	< 9
P14	05/10/19		< 55	< 111	< 4	< 5	< 12	< 7	< 16	< 6	< 10	< 9	< 6	< 6	< 31	< 13
P17	05/08/19		< 55	< 71	< 8	< 7	< 15	< 7	< 13	< 7	< 14	< 12	< 9	< 6	< 38	< 9

(1) No result

TABLE B-I.3 **CONCENTRATIONS OF HARD TO DETECTS IN GROUNDWATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	AM-241	CM-242	CM-243/244	PU-238	PU-239	U-233/234	U-235	U-238	FE-55	NI-63

There were no HTD's Analyzed in 2019

TABLE B-II.1 **CONCENTRATIONS OF TRITIUM AND STRONTIUM IN SURFACE WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE	H-3	Sr-89	Sr-90
SW-LR-2	02/06/19	< 183		
SW-LR-2	05/06/19	< 190	< 6.2	< 0.8
SW-LR-2	08/13/19	< 193		
SW-LR-2	11/06/19	< 180		
SW-LR-4	02/06/19	< 182		
SW-LR-4	05/06/19	< 189	< 6.4	< 0.6
SW-LR-4	08/13/19	< 182		
SW-LR-4	11/06/19	< 186		
SW-LR-6	02/06/19	< 189		
SW-LR-6	05/06/19	< 187	< 3.9	< 0.8
SW-LR-6	08/13/19	< 182		
SW-LR-6	11/06/19	< 180		
SW-LR-7	02/06/19	< 188		
SW-LR-7	05/06/19	< 192	< 4.3	< 0.8
SW-LR-7	08/13/19	< 181		
SW-LR-7	11/06/19	< 192		
SW-LR-8	02/05/19	< 192		
SW-LR-8	05/06/19	366 ± 136	< 4.9	< 0.6
SW-LR-8	08/14/19	< 181		
SW-LR-8	11/05/19	< 183		
SW-LR-9	02/05/19	< 184		
SW-LR-9	05/06/19	< 185	< 4.3	< 0.7
SW-LR-9	08/14/19	< 198		
SW-LR-9	11/04/19	< 184		
SW-LR-10	02/06/19	< 190		
SW-LR-10	05/08/19	< 186	< 6.1	< 0.6
SW-LR-10	08/13/19	< 184		
SW-LR-10	11/06/19	< 183		

TABLE B-II.2 **CONCENTRATIONS OF GAMMA EMITTERS IN SURFACE WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2019**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE	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	La-140
SW-LR-2	05/06/19	< 58	< 137	< 7	< 6	< 13	< 7	< 12	< 7	< 11	< 14	< 5	< 6	< 28	< 15
SW-LR-4	05/06/19	< 52	< 120	< 4	< 6	< 13	< 7	< 12	< 6	< 10	< 12	< 6	< 5	< 25	< 13
SW-LR-6	05/06/19	< 54	< 59	< 6	< 6	< 15	< 6	< 12	< 6	< 10	< 13	< 7	< 6	< 39	< 8
SW-LR-7	05/06/19	< 37	< 41	< 4	< 4	< 9	< 5	< 8	< 5	< 7	< 9	< 4	< 5	< 24	< 9
SW-LR-8	05/06/19	< 68	< 130	< 7	< 6	< 15	< 8	< 14	< 7	< 10	< 14	< 8	< 4	< 34	< 6
SW-LR-9	05/06/19	< 53	< 117	< 6	< 6	< 10	< 7	< 13	< 7	< 12	< 13	< 7	< 5	< 33	< 9
SW-LR-10	05/08/19	< 35	< 39	< 4	< 4	< 7	< 4	< 7	< 4	< 6	< 7	< 4	< 4	< 20	< 5

TABLE B-III.1 CONCENTRATIONS OF TRITIUM IN PRECIPITATION WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2019

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE	H-3
36S3	01/02/19 - 01/28/19	< 188
36S3	01/28/19 - 02/26/19	< 194
36S3	02/26/19 - 04/02/19	< 198
36S3	04/02/19 - 04/30/19	< 190
36S3	04/30/19 - 06/03/19	< 191
36S3	06/03/19 - 07/01/19	< 199
36S3	07/01/19 - 07/29/19	< 182
36S3	07/29/19 - 09/04/19	< 192
36S3	09/04/19 - 09/30/19	< 186
36S3	09/30/19 - 10/28/19	< 186
36S3	10/28/19 - 12/03/19	< 189
36S3	12/03/19 - 12/30/19	< 190
E-5	01/02/19 - 01/28/19	< 189
E-5	01/28/19 - 02/26/19	< 188
E-5	02/26/19 - 04/02/19	< 196
E-5	04/02/19 - 04/30/19	< 189
E-5	04/30/19 - 06/03/19	< 188
E-5	06/03/19 - 07/01/19	< 193
E-5	07/01/19 - 07/29/19	< 184
E-5	07/29/19 - 09/04/19	< 189
E-5	09/04/19 - 09/30/19	< 189
E-5	09/30/19 - 10/28/19	< 183
E-5	10/28/19 - 12/03/19	< 188
E-5	12/03/19 - 12/30/19	< 189
ESE-6	01/02/19 - 01/28/19	< 192
ESE-6	01/28/19 - 02/26/19	< 190
ESE-6	02/26/19 - 04/02/19	< 194
ESE-6	04/02/19 - 04/30/19	< 194
ESE-6	04/30/19 - 06/03/19	< 189
ESE-6	06/03/19 - 07/01/19	< 197
ESE-6	07/01/19 - 07/29/19	< 186
ESE-6	07/29/19 - 09/04/19	< 186
ESE-6	09/04/19 - 09/30/19	< 185
ESE-6	09/30/19 - 10/28/19	< 186
ESE-6	10/28/19 - 12/03/19	< 191
ESE-6	12/03/19 - 12/30/19	< 189
SE-7	01/02/19 - 01/28/19	< 194
SE-7	01/28/19 - 02/26/19	< 190
SE-7	02/26/19 - 04/02/19	249 ± 132
SE-7	04/02/19 - 04/30/19	< 186
SE-7	04/30/19 - 06/03/19	< 198
SE-7	06/03/19 - 07/01/19	< 196
SE-7	07/01/19 - 07/29/19	275 ± 124
SE-7	07/29/19 - 09/04/19	< 190
SE-7	09/04/19 - 09/30/19	< 189
SE-7	09/30/19 - 10/28/19	257 ± 125
SE-7	10/28/19 - 12/03/19	< 191
SE-7	12/03/19 - 12/30/19	< 197

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