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LIMERICK GENERATING STATION
UNITS 1 AND 2

Annual Radiological
Environmental Operating Report

1 January through 31 December 2016

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Exelon Generation®

Limerick Power Station
Pottstown, PA 19464

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I. Summary and Conclusions

In 2016, the Limerick Generating Station released to the environment through the radioactive effluent liquid and gaseous pathways approximately 180 curies of noble gas, fission and activation products and approximately 31 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							
Effluent	Applicable Organ	Estimated Dose	Age Group	Location	% of Applicable Limit	Limit	Unit
Noble Gas	Gamma - Air Dose	9.71E-03	All	Nearest Residence	4.86E-02	20	mRad
Noble Gas	Beta – Air Dose	8.58E-03	All	Nearest Residence	2.15E-02	40	mRad
Noble Gas	Total Body (Gamma)	9.21E-03	All	Nearest Residence	9.21E-02	10	mrem
Noble Gas	Skin (Beta)	1.79E-02	All	Nearest Residence	5.97E-02	30	mrem
Iodine, Particulate, Tritium & C-14	Bone	1.05E-00	Child	Vegetation	3.50E-00	30	mrem
Liquid	Total Body	3.80E-04	Adult	LGS Outfall	6.33E-03	6	mrem
Liquid	Liver	4.59E-04	Adult	LGS Outfall	2.30E-03	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 2016 through 31 December 2016. During that time period, 1517 analyses were performed on 1277 samples.

Surface and drinking water samples were analyzed for concentrations of tritium and gamma-emitting nuclides. Drinking water samples were also analyzed for concentrations of Iodine-131 (I-131) and total gross beta. Iodine-131 was not detected in primary laboratory samples, however, 3 samples from the secondary laboratory indicated I-131 in drinking water. For results, discussion, and dose to member of the public calculation see Section IV.A.2. 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. No fission or activation products were detected in fish.

Sediment samples were analyzed for concentrations of gamma-emitting nuclides. Samples collected upstream and downstream of the discharge had Cesium-137 (Cs-137) concentrations that were consistent with those detected in previous years. 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 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.

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.

Broad leaf vegetation samples were analyzed for gamma-emitting nuclides. Concentrations of naturally-occurring Be-7 and K-40 were detected. Radium-226 (Ra-226) was found in 14 of 39 samples. Thorium-228 (Th-228) was found in 3 of 39 samples. Naturally-occurring Ra-226 and Th-228 were detected in low concentrations, which are consistent with historical values.

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.

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 2016, well water samples were analyzed for tritium, 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.

II. 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 Environmental Inc., Midwest Laboratory (EIML) on samples collected during the period 1 January 2016 through 31 December 2016.

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. Evaluate 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

III. Program Description

A. Sample Collection

Samples for the LGS REMP were collected for Exelon Nuclear by Normandeau Associates, Inc. (NAI). This section describes the general collection methods used by NAI to obtain environmental samples for the LGS REMP in 2016. 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 NAI are listed in Table B-3.

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 (white sucker/carp/catfish) and predator (sunfish/bass/rock bass/catfish), 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.

Broad leaf vegetation was collected monthly, during the growing season, at three locations (11S3, 13S3, and 31G1). The control location was 31G1. Nine 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 PVC conduit 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 2016, no material 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 (TBE) and the secondary laboratory (EIML) on environmental samples for the LGS REMP in 2016. 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 Environmental Inc., Midwest Laboratory 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 results for each type of sample were grouped 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 broad leaf 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 2016 the LGS REMP had a sample recovery rate of greater than 99%. Exceptions are listed below:

1. Air sample from location 11S1 for the week of 11/28/16 – 12/05/16 was not available due to pump failure (IR 3957053).

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

There were no program changes in 2016.

F. Compliance to 40 CFR 190 Limits

1. 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 40 CFR 190 compliance.

40 CFR 190 Compliance:
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 below all ODCM and 40 CFR Part 190 limits to a real individual.

Table 1: 40 CFR 190 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	2.22E-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-02	2.11E-01	3.00E-04	0.00E+00	2.21E-01	2.94E-01	75	mRem

IV. 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.

Gamma Spectrometry

Samples from all locations were analyzed for gamma-emitting nuclides (Appendix C, Table C–I.2). 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 2.3 to 6.1 pCi/L. 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 from TBE; however, EIML indicated I-131 was present in October, November, and December of 2016, with concentrations ranging from 0.4 to 1.1 pCi/L. (Results can be found in Appendix D, Table D-1.2)

Coinciding with the positive I-131 identified at drinking water location 16C2 during the 3rd quarter of 2016, samples taken from the onsite settling basin showed low levels of I-131. However, concentrations in the settling basin do not align with the concentration at the drinking water location, given the dilution factor of the Schuylkill River. After thorough evaluation, the I-131 found in drinking water is determined not to be from LGS effluent releases. However, the dose to an infant's thyroid was conservatively calculated at 1.26E+00 mRem. This dose represents 6.31E+00% of the Appendix 1 to 10 CFR Part 50 dose limits.

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 (white sucker/carp/catfish) and predator (sunfish/bass/rock bass/catfish), 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 2,706 to 4,889 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 a two locations and ranged from 1,188 to 2,453 pCi/kg dry. K-40 was found at all locations and ranged from 9,798 to 16,560 pCi/kg dry. The fission product Cs-137 was found at locations 16C4 and 33A2. The concentration ranged from 147 to 184 pCi/kg dry.

The activity detected was consistent with those detected in the pre–operational years. The control location, 33A2, and a downstream location, 16C4, both showed positive activity. Additionally, there was no release of Cs-137 from LGS. Therefore, the Cs-137 activity found at 16C4 is not attributed to LGS

radioactive effluent releases. The dose to a teenager's skin and whole body was conservatively calculated at 3.86E-04 mRem and 3.31E-04 mRem, respectively. This dose represents 1.93E-03% and 5.52E-03%, 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. The results from the on-site locations (Group I) ranged from 7E–3 to 36E–3 pCi/m^3 with a mean of 15E–3 pCi/m^3. The results from the intermediate distance location (Group II) ranged from 7E–3 to 38E–3 pCi/m^3 with a mean of 15E–3 pCi/m^3. The results from the remote distance locations (Group III) ranged from 6E–3 to 30E–3 pCi/m^3 with a mean of 16E–3 pCi/m^3. Comparison of the 2016 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 2016 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 (Appendix C, Table C–V.3). Naturally-occurring Be-7 was detected in all 28 samples and is contributed to cosmic ray activity. These values ranged from 41E–3 to 125E–3 pCi/m^3. All other nuclides were below the required LLDs.

b. Airborne Iodine

Continuous air samples were collected from six locations (6C1, 10S3, 11S1, 13S4, 14S1, 15D1, and 22G1) and analyzed weekly for I-131 (Appendix C, Table C–VI.1). All results were below the required LLD.

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 (Appendix C, Table C–VII.1). All results met the required LLD.

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 972 to 1,546 pCi/L. All other nuclides were below the required LLDs.

b. Broad Leaf Vegetation

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

Gamma Spectrometry

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

Cosmogenic Be-7 was found in 9 of 39 samples and ranged from 200 to 1,913 pCi/kg wet. Naturally-occurring K-40 was found in all samples and ranged from 2,237 to 11,000 pCi/kg wet. Naturally-occurring Ra-226 was found in 14 of 39

samples and ranged from 418 to 2,194 pCi/kg wet. Naturally-occurring Th-228 was found in 3 of 39 samples and ranged from 44 to 82 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, Tables C–IX.1 and C–IX.2, Figure C–4. Dosimeter measurements were reported in mR/standard month. All dosimeter measurements were below 10 mR/standard month, with a range of 3.6 to 9.8 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.

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, after subtracting background, shows the net direct radiation exposure to the nearest residence was 0.0 mRem for the year.

F. Land Use Survey

A Land Use Survey conducted in September 2016 around Limerick Generating Station (LGS) was performed by Normandeau Associates, Inc. for Exelon Nuclear to comply with Bases 3.3.2 of the Limerick's Offsite Dose Calculation Manual. The purpose of the survey was to document 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 2016 Land Use Survey identified differences in locations for gardens only between 2015 and 2016. The gardens identified in NNE, NE, SSW, SW, W and NNW sectors are farther away than in 2015. A new garden was identified in the WNW sector. There were no changes required to the LGS REMP, as a result of this survey. The results of this survey are summarized below:

Distance in feet from the LGS Reactor Buildings (Out to 26,400 feet)					
Sector		Residence	Garden	Milk Farm	Meat Animal
		Feet	Feet	Feet	Feet
1	N	3,109	3,333	24,775	24,775
2	NNE	2,706	12,399	-	26,297
3	NE	3,469	16,718	-	14,064
4	ENE	3,231	14,208	-	7,451
5	E	2,864	11,723	-	-
6	ESE	3,434	4,498	-	12,385
7	SE	3,945	23,335	-	25,246
8	SSE	5,403	6,912	-	-
9	S	4,347	6,103	22,114	12,210
10	SSW	5,063	5,732	10,390	7,620
11	SW	3,251	6,544	-	23,145
12	WSW	3,799	4,507	14,177	14,177
13	W	3,627	8,886	-	17,137
14	WNW	3,685	21.421	-	-
15	NW	3,619	8,200	-	-
16	NNW	5,050	6,473	-	20,930

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:

1. Analytics Evaluation Criteria

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

2. ERA Evaluation Criteria

   ERA's evaluation report provides an acceptance range for control

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

3. DOE Evaluation Criteria

   MAPEP's evaluation report provides an acceptance range with associated flag values.

   The MAPEP defines three levels of performance: Acceptable (flag = "A"), Acceptable with Warning (flag = "W"), and Not Acceptable (flag = "N"). Performance is considered acceptable when a mean result for the specified analyte is ± 20% of the reference value. Performance is acceptable with warning when a mean result falls in the range from ± 20% to ± 30% of the reference value. If the bias is greater than 30%, the results are deemed not acceptable.

For the TBE laboratory, 156 out of 160 analyses performed met the specified acceptance criteria. Four analyses did not meet the specified acceptance criteria for the following reasons and were addressed through the TBE Corrective Action Program.

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. The MAPEP March 2016 Sr-90 in vegetation was evaluated as failing a false positive test. In reviewing the data that was reported vs the data in LIMS, it was found that the error was incorrectly reported as 0.023 rather than the correct value of 0.230. If the value had been reported with the activity and correct uncertainty of 0.301 ± 0.230, MAPEP would have evaluated the result as acceptable. NCR 16-14
2. Teledyne Brown Engineering's Analytics' March 2016 milk Sr-90 result of 15 ± 0.125 pCi/L was higher than the known value of 11.4 pCi/L with a ratio of 1.32. The upper ratio of 1.30 (acceptable with warning) was exceeded. After an extensive review of the data it is believed the technician did not rinse the filtering apparatus properly and some cross contamination from one of the internal laboratory spike samples may have been transferred to the Analytics sample.

This issue is specific to the March 2016 Analytics sample. NCR 16-26

3. Teledyne Brown Engineering's ERA November 2016 sample for H-3 in water was evaluated as failing. A result of 918 pCi/L was reported incorrectly due to a data entry issue. If the correct value of 9180 had been reported, ERA would have evaluated the result as acceptable. NCR 16-34

4. Teledyne Brown Engineering's Analytics' December 2016 milk Sr-90 sample result of 14.7 ± 0.26 pCi/L was higher than the known value of 10 pCi/L with a ratio of 1.47. The upper ratio of 1.30 (acceptable with warning) was exceeded. The technician entered the wrong aliquot into the LIMS system. To achieve a lower error term TBE uses a larger aliquot of 1.2L (Normally we use .6L for client samples). If the technician had entered an aliquot of 1.2L into the LIMS system, the result would have been 12.2 pCi/L, which would have been considered acceptable. NCR 16-35

For the EIML laboratory, 198 of 203 analyses met the specified acceptance criteria. Five analyses did not meet the specified acceptance criteria for the following reasons:

1. The Environmental Inc., Midwest Laboratory's ERA April 2016 water Ba-133 result of 65.2 pCI/L was higher than the known value of 58.8 pCi/L, exceeding the upper control limit of 64.9 pCi/L. The reanalysis result of 57.8 pCI/L fell within acceptance criteria.

2. The Environmental Inc., Midwest Laboratory's MAPEP February 2016 water Co-57 result of 1.38 Bq/L sample was higher than the known value of 0.00 Bq/L sample. This sample is considered a false positive.

3. The Environmental Inc., Midwest Laboratory's MAPEP August 2016 soil Ni-60 result of 648 Bq/kg was lower than the known value of 990 Bq/kg, exceeding the lower control limit of 693 Bq/kg. Reanalysis with a smaller aliquot resulted in acceptable results. An investigation is in process to identify better techniques for analyzing samples with complex matrices.

4. The Environmental Inc., Midwest Laboratory's MAPEP August 2016 soil U-233/234 result of 46.8 Bq/kg was lower than the known value of 122 Bq/kg, exceeding the lower control limit of 85 Bq/kg. MAPEP states that samples contain two fractions of Uranium; one that is soluble in concentrated HNO3 and HCL acid and one that is "fundamentally insoluble in these acids". They also state that HF

treatment cannot assure complete dissolution. Results are consistent with measuring the soluble form.

5. The Environmental Inc., Midwest Laboratory's MAPEP August 2016 soil U-238 result of 46.6 Bq/kg was lower than the known value of 121 Bq/kg, exceeding the lower control limit of 85 Bq/kg. MAPEP states that samples contain two fractions of Uranium; one that is soluble in concentrated HNO3 and HCL acid and one that is "fundamentally insoluble in these acids". They also state that HF treatment cannot assure complete dissolution. Results are consistent with measuring the soluble form.

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

V. 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

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, 2016

NAME OF FACILITY:	**LIMERICK GENERATING STATION**			**DOCKET NUMBER:**		**50-352 & 50-353**		
LOCATION OF FACILITY:	**MONTGOMERY, PA**			**REPORTING PERIOD:**		**2016**		
				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	24						
	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
DRINKING WATER *(PCI/LITER)*	**GR-B**	48	**4**	3.7 (33/36) *2.3 - 6.1*	3.4 (9/12) *2.6 - 4.6*	4.3 (11/12) *2.6 - 6.1*	15F4 INDICATOR AQUA AMERICA	0
	H-3	16	**200**	<LLD	<LLD	-		0
	I-131 (LOW LVL)	48	**1**	<LLD	<LLD	-		0

(M) The Mean Values are calculated using the positive values. **(F)** Fraction of dectectable measurements at specified locations are indicated in parentheses.

TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR THE LIMERICK GENERATING STATION, 2016

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

LOCATION OF FACILITY: MONTGOMERY, PA | **REPORTING PERIOD:** 2016

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*	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*	4199.5 (2/2) *3510 - 4889*	3019 (2/2) *2706 - 3332*	4199.5 (2/2) *3510 - 4889*	16C5 INDICATOR VINCENT POOL DOWNSTREAM OF DISCHARGE	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

(M) The Mean Values are calculated using the positive values. **(F)** Fraction of dectectable measurements at specified locations are indicated in parentheses.

TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR THE LIMERICK GENERATING STATION, 2016

NAME OF FACILITY:	LIMERICK GENERATING STATION			DOCKET NUMBER:		50-352 & 50-353		
LOCATION OF FACILITY:	MONTGOMERY, PA			REPORTING PERIOD:		2016		
				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*	3761.5	3094.5	3761.5	16C5 INDICATOR	0
				(2/2)	(2/2)	(2/2)	VINCENT POOL	
				3586 - 3937	*2762 - 3427*	*3586 - 3937*	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**	6						
(PCI/KG DRY)	*BE-7*		*NA*	2453	1188	2453	16B2 INDICATOR	0
				(1/4)	(1/2)	(1/2)	LINFIELD BRIDGE	
							1.35 MILES SSE OF SITE	
	K-40		*NA*	13880	11799	13940	16C4 INDICATOR	0
				(4/4)	(2/2)	(2/2)	VINCENT DAM	
				11320 - 16560	*9798 - 13800*	*11320 - 16560*	2.18 MILES SSE OF SITE	
	MN-54		*NA*	<LLD	<LLD	-		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**	147	184	184	33A2 CONTROL	0
				(1/4)	(1/2)	(1/2)	UPSTREAM OF INTAKE	
							0.84 MILES NNW OF SITE	

(M) The Mean Values are calculated using the positive values. **(F)** Fraction of dectectable measurements at specified locations are indicated in parentheses.

TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR THE LIMERICK GENERATING STATION, 2016

NAME OF FACILITY:	**LIMERICK GENERATING STATION**			**DOCKET NUMBER:**		**50-352 & 50-353**		
LOCATION OF FACILITY:	**MONTGOMERY, PA**			**REPORTING PERIOD:**		**2016**		
				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**	370	**10**	15	16	16	14S1 INDICATOR	0
(E-3 PCI/CU.METER)				(311/323)	(52/54)	(52/54)	LONGVIEW ROAD	
				7 - 38	*6 - 30*	*8 - 36*	0.63 MILES SSE OF SITE	
	GAMMA	28						
	BE-7		*NA*	66.9	86.3	86.3	22G1 CONTROL	0
				(24/24)	(4/4)	(4/4)	MANOR SUBSTATION	
				40.4 - 101.4	*60.1 - 125.4*	*60.1 - 125.4*	17.73 MILES SW 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**	370						
(E-3 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*	1263	1276	1356	25C1 INDICATOR	0
				(66/66)	(26/26)	(22/22)		
				972 - 1546	*1031 - 1522*	*1069 - 1546*	2.69 MILES WSW 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

(M) The Mean Values are calculated using the positive values. **(F)** Fraction of dectectable measurements at specified locations are indicated in parentheses.

TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR THE LIMERICK GENERATING STATION, 2016

NAME OF FACILITY:	LIMERICK GENERATING STATION			DOCKET NUMBER:		50-352 & 50-353		
LOCATION OF FACILITY:	MONTGOMERY, PA			REPORTING PERIOD:		2016		
				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
VEGETATION	**GAMMA**	39						
(PCI/KG WET)	*BE-7*		*NA*	756.4	783	905.7	13S3 INDICATOR	0
				(5/28)	(5/11)	(3/14)	VINCENT DAM	
				200.3 - 1913	*239.1 - 1730*	*200.3 - 1913*	0.24 MILES SE OF SITE	
	K-40		*NA*	5191.5	6408.1	6408.1	31G1 CONTROL	0
				(28/28)	(11/11)	(11/11)		
				2237 - 9033	*4751 - 11000*	*4751 - 11000*		
	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*	1385.9	<LLD	1385.9	13S3 INDICATOR	0
				(14/28)		(14/14)	VINCENT DAM	
				418.4 - 2194		*418.4 - 2194*	0.24 MILES SE OF SITE	
	TH-228		*NA*	63.1	52.5	81.9	11S3 INDICATOR	0
				(2/28)	(1/11)	(1/14)	LGS INFORMATION CENTER	
				44.3 - 81.9			0.35 MILES ESE OF SITE	
	TH-232		*NA*	<LLD	<LLD	-		0
DIRECT RADIATION	**OSLD-QUARTERLY**	320	*NA*	5.6	6.8	7.7	13S2 INDICATOR	0
(MILLI-ROENTGEN/STD.MO.)				(156/156)	(4/4)	(4/4)	500 KV SUBSTATION	
				3.6 - 9.8	*6.2 - 7.3*	*7.5 - 8*	0.41 MILES SE	

(M) The Mean Values are calculated using the positive values. **(F)** Fraction of dectectable measurements at specified locations are indicated in parentheses.

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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, 2016

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, 2016

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, 2016

Sample Medium	Analysis	Sampling Method	Collection Procedure Number	Sample Size	Analytical Procedure Number
Surface Water	Gamma Spectroscopy	Monthly composite from a continuous water compositor	RMC-ER5 Collection of water samples for radiological analysis (Limerick Generating Station)	2 gallon	TBE, TBE-2007 Gamma emitting radioisotope analysis Env. Inc., GS-01 Determination of gamma emitters by gamma spectroscopy
Surface Water	Tritium	Quarterly composite from a continuous water compositor	RMC-ER5 Collection of water samples for radiological analysis (Limerick Generating Station)	500 ml	TBE, TBE-2011 Tritium analysis in drinking water by liquid scintillation Env. Inc., T-02 Determination of tritium in water (direct method)
Drinking Water	Gross Beta	Monthly composite from a continuous water compositor	RMC-ER5 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 Env. Inc., W(DS)-01 Determination of gross alpha and/or gross beta in water (dissolved solids or total residue) Env. Inc., W(SS)-02 Determination of gross alpha and/or gross beta in water (suspended solids)
Drinking Water	I-131	Monthly composite from a continuous water compositor	RMC-ER10 Collection of water samples for radiological analysis (Limerick Generating Station)	2 gallon	TBE, TBE-2012 Radioiodine in various matrices Env. Inc., I-131-01 Determination of I-131 in water by an ion exchange
Drinking Water	Gamma Spectroscopy	Monthly composite from a continuous water compositor	RMC-ER5 Collection of water samples for radiological analysis (Limerick Generating Station)	2 gallon	TBE, TBE-2007 Gamma emitting radioisotope analysis Env. Inc., GS-01 Determination of gamma emitters by gamma spectroscopy
Drinking Water	Tritium	Quarterly composite from a continuous water compositor	RMC-ER5 Collection of water samples for radiological analysis (Limerick Generating Station)	500 ml	TBE, TBE-2011 Tritium analysis in drinking water by liquid scintillation Env. Inc., T-02 Determination of tritium in water (direct method)
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 Env. Inc., GS-01 Determination of gamma emitters by gamma spectroscopy
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 Env. Inc., GS-01 Determination of gamma emitters by gamma spectroscopy

TABLE B-3: Radiological Environmental Monitoring Program – Summary of Sample Collection and Analytical Methods, Limerick Generating Station, 2016

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	RMC-ER8 Collection of air particulate and air iodine samples 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 Env. Inc., AP-02 Determination of gross alpha and/or gross beta in air particulate filters
Air Particulates	Gamma Spectroscopy	Quarterly composite of each station	TBE, TBE-2023 Compositing of samples Env. Inc., AP-03 Procedure for compositing air particulate filters for gamma spectroscopic analysis	13 filters (approximately 3600 cubic meters)	TBE, TBE-2007 Gamma emitting radioisotope analysis Env. Inc., GS-01 Determination of gamma emitters by gamma spectroscopy
Air Iodine	Gamma Spectroscopy	One-week composite of continuous air sampling through charcoal filter	RMC-ER8 Collection of air particulate and air iodine samples for radiological analysis (Limerick Generating Station)	1 filter (approximately 280 cubic meters weekly)	TBE, TBE-2007 Gamma emitting radioisotope analysis Env. Inc., I-131-02 Determination of I-131 in charcoal canisters by gamma spectroscopy (batch method)
Milk	I-131	Bi-weekly grab sample when cows are on pasture; Monthly all other times	RMC-ER10 Collection of milk samples for radiological analysis (Limerick Generating Station)	2 gallon	TBE, TBE-2012 Radioiodine in various matrices Env. Inc., I-131-01 Determination of I-131 in milk by anion exchange
Milk	Gamma Spectroscopy	Bi-weekly grab sample when cows are on pasture; Monthly all other times	RMC-ER10 Collection of milk samples for radiological analysis (Limerick Generating Station)	2 gallon	TBE, TBE-2007 Gamma emitting radioisotope analysis Env. Inc., GS-01 Determination of gamma emitters by gamma spectroscopy
DLR	Thermoluminescent Dosimetry	Quarterly DLRs comprised of two dosimeter elements	RMC-ER9 Collection of dosimetry samples for radiological analysis (Limerick Generating Station)	2 dosimeters	Mirion Technologies

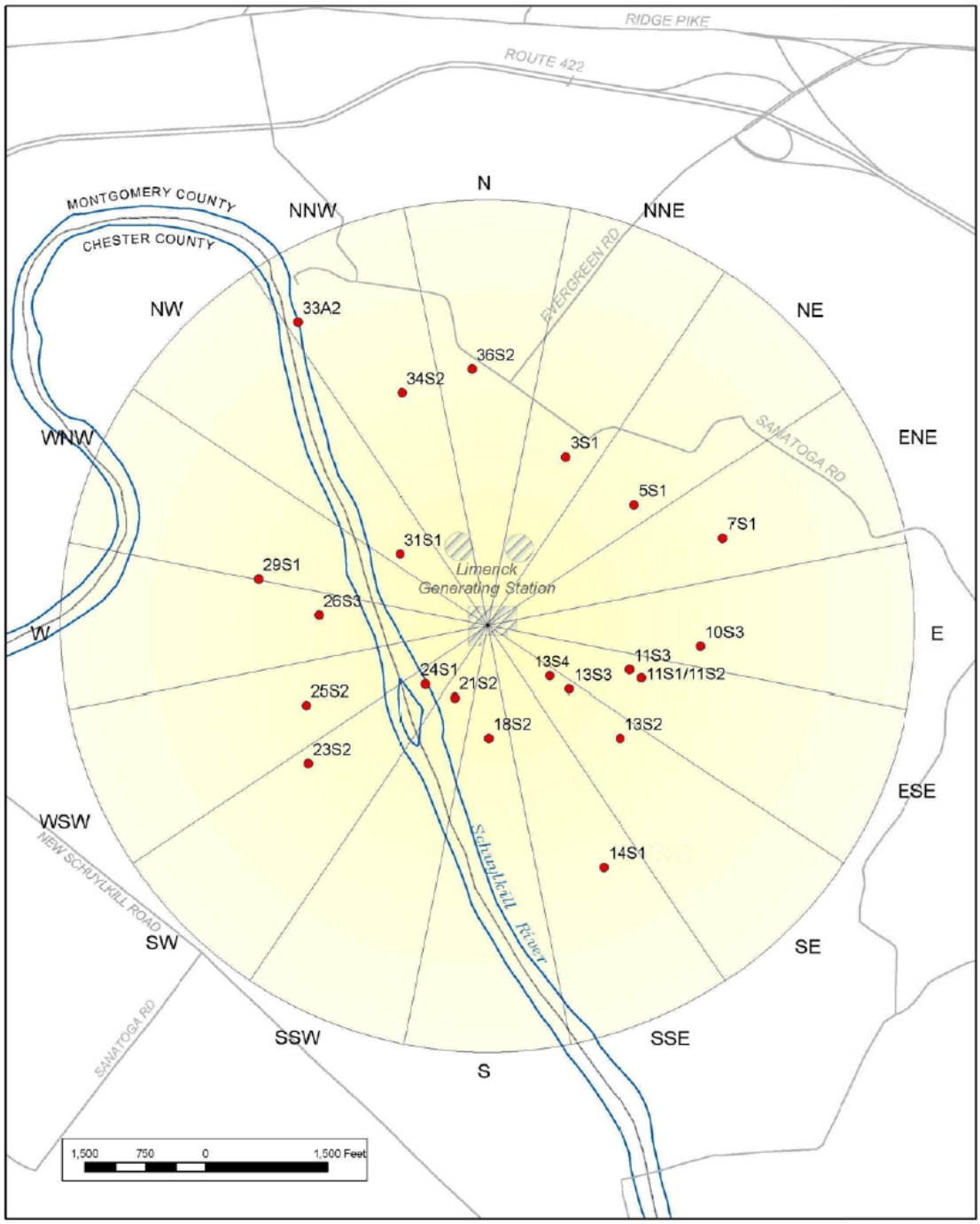

Figure B-1
Environmental Sampling Locations Within 5,280 Feet
of the Limerick Generating Station, 2016

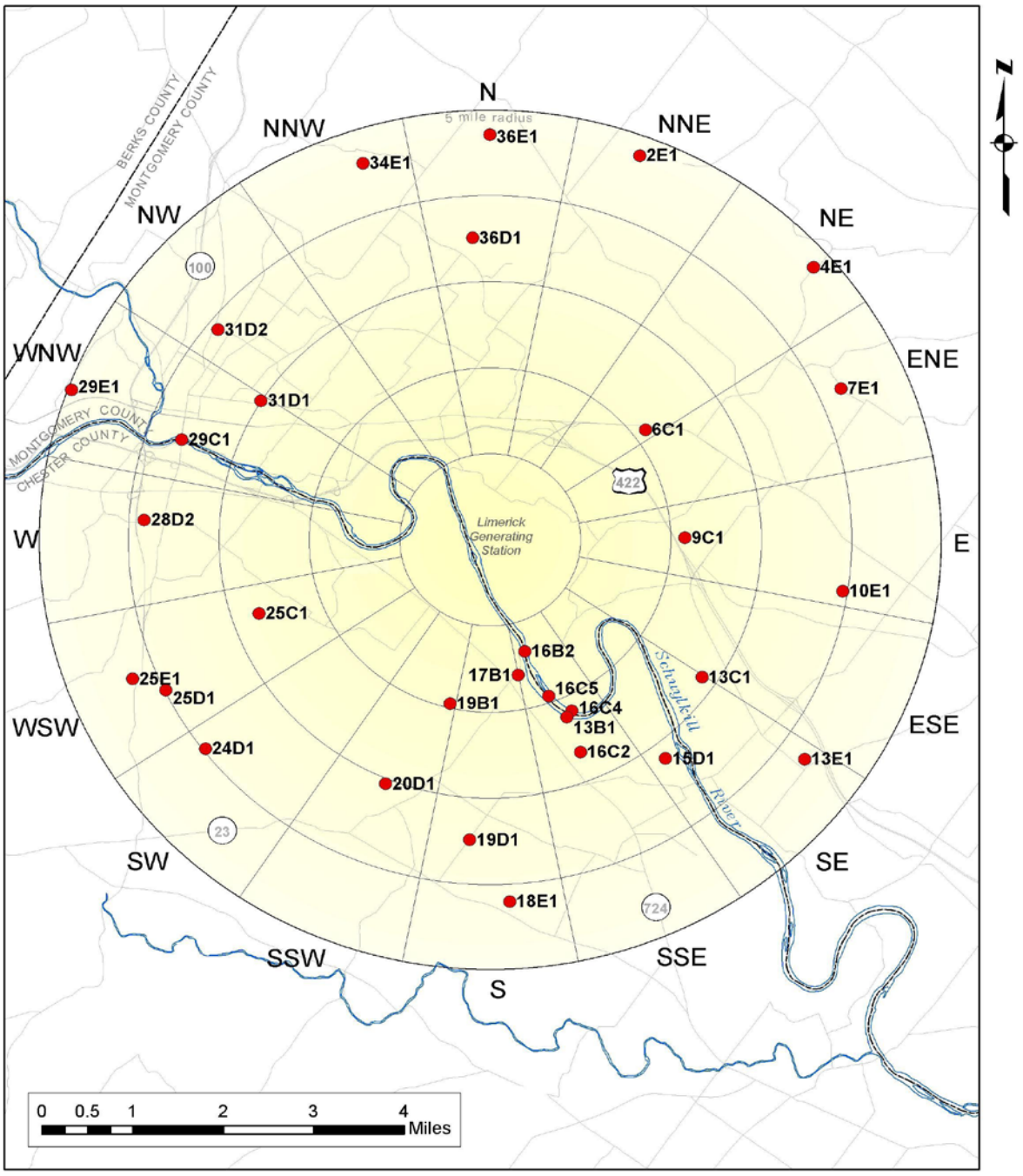

Figure B-2
Environmental Sampling Locations Between 5,280 and 26,400 Feet
from the Limerick Generating Station, 2016

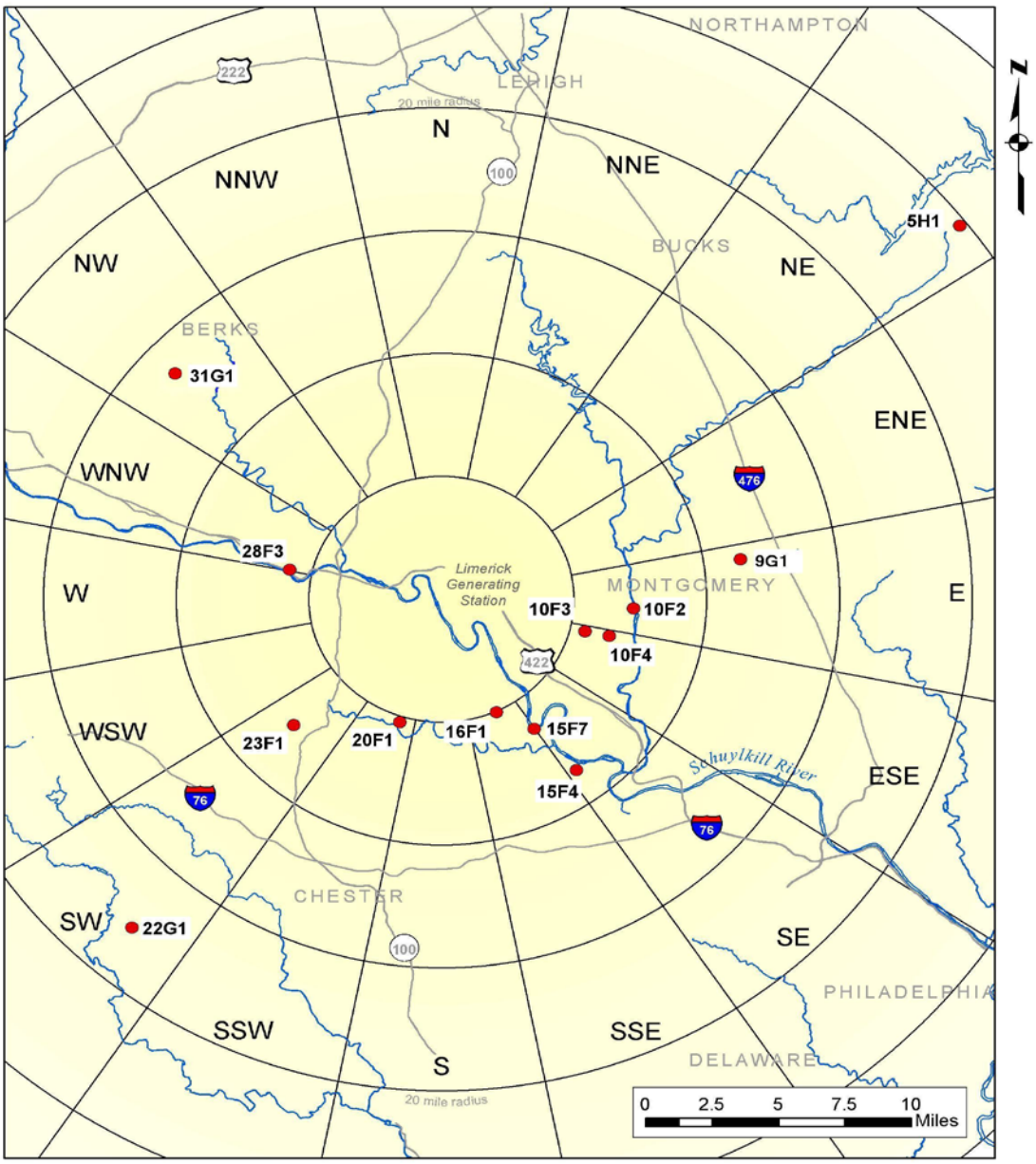

Figure B-3
Environmental Sampling Locations Greater than 26,400 Feet
from the Limerick Generating Station, 2016

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, 2016**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	13B1	24S1
12/28/15 - 03/29/16	< 185	< 189
03/29/16 - 06/27/16	< 191	< 189
06/27/16 - 10/03/16	< 175	< 174
10/03/16 - 12/27/16	< 195	< 191
MEAN	-	-

Table C-I.2 **CONCENTRATIONS OF GAMMA EMITTERS IN SURFACE WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2016**

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	12/28/15 - 02/02/16	< 6	< 6	< 14	< 6	< 14	< 6	< 10	< 9	< 5	< 6	< 26	< 7
	02/02/16 - 03/01/16	< 4	< 4	< 10	< 4	< 8	< 5	< 7	< 5	< 4	< 5	< 15	< 5
	03/01/16 - 03/29/16	< 4	< 5	< 9	< 4	< 9	< 6	< 8	< 6	< 4	< 5	< 17	< 6
	03/29/16 - 05/02/16	< 9	< 7	< 24	< 10	< 20	< 8	< 15	< 12	< 9	< 9	< 44	< 11
	05/02/16 - 05/31/16	< 2	< 2	< 4	< 2	< 3	< 2	< 3	< 8	< 2	< 2	< 16	< 5
	05/31/16 - 06/27/16	< 6	< 5	< 13	< 6	< 14	< 8	< 10	< 8	< 7	< 7	< 24	< 8
	06/27/16 - 08/02/16	< 5	< 6	< 13	< 5	< 9	< 6	< 11	< 13	< 5	< 5	< 31	< 6
	08/02/16 - 08/30/16	< 7	< 6	< 16	< 6	< 12	< 8	< 14	< 13	< 7	< 7	< 31	< 14
	08/30/16 - 10/03/16	< 5	< 6	< 14	< 5	< 13	< 7	< 9	< 7	< 7	< 7	< 25	< 7
	10/03/16 - 11/01/16	< 6	< 6	< 13	< 5	< 13	< 6	< 9	< 14	< 7	< 7	< 39	< 10
	11/01/16 - 11/28/16	< 6	< 5	< 12	< 5	< 15	< 7	< 12	< 9	< 6	< 8	< 29	< 10
	11/28/16 - 12/27/16	< 8	< 9	< 16	< 7	< 16	< 8	< 13	< 8	< 8	< 6	< 25	< 13
	MEAN	-	-	-	-	-	-	-	-	-	-	-	-
24S1	12/28/15 - 02/02/16	< 4	< 4	< 9	< 5	< 7	< 5	< 7	< 6	< 4	< 3	< 18	< 4
	02/02/16 - 03/01/16	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 0	< 1	< 2	< 1
	03/01/16 - 03/29/16	< 4	< 4	< 9	< 6	< 8	< 4	< 6	< 6	< 4	< 5	< 17	< 6
	03/29/16 - 05/02/16	< 6	< 4	< 7	< 8	< 14	< 6	< 11	< 10	< 8	< 7	< 30	< 8
	05/02/16 - 05/31/16	< 2	< 2	< 5	< 2	< 4	< 2	< 3	< 10	< 2	< 2	< 18	< 5
	05/31/16 - 06/27/16	< 6	< 7	< 14	< 8	< 18	< 9	< 12	< 7	< 7	< 10	< 32	< 14
	06/27/16 - 08/02/16	< 7	< 9	< 21	< 12	< 19	< 8	< 13	< 14	< 7	< 8	< 50	< 14
	08/02/16 - 08/30/16	< 5	< 6	< 9	< 5	< 11	< 6	< 9	< 6	< 5	< 7	< 21	< 6
	08/30/16 - 10/03/16	< 7	< 4	< 15	< 6	< 21	< 6	< 9	< 9	< 8	< 7	< 22	< 9
	10/03/16 - 11/01/16	< 6	< 6	< 14	< 7	< 15	< 6	< 12	< 12	< 6	< 6	< 29	< 11
	11/01/16 - 11/29/16	< 6	< 8	< 11	< 7	< 12	< 7	< 11	< 10	< 7	< 7	< 19	< 10
	11/29/16 - 12/27/16	< 5	< 7	< 12	< 7	< 14	< 9	< 11	< 8	< 6	< 7	< 25	< 6
	MEAN	-	-	-	-	-	-	-	-	-	-	-	-

Table C-II.1 CONCENTRATIONS OF GROSS BETA IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2016

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	15F4	15F7	16C2	28F3
12/28/15 - 02/02/16	3.8 ± 1.6	2.9 ± 1.5	2.7 ± 1.6	3.7 ± 1.6
02/02/16 - 03/01/16	3.6 ± 1.6	< 2.0	2.3 ± 1.6	3.0 ± 1.5
03/01/16 - 03/29/16	4.3 ± 1.6	3.3 ± 1.5	2.9 ± 1.6	2.9 ± 1.5
03/29/16 - 05/02/16	2.6 ± 1.7	3.6 ± 1.7	3.1 ± 1.8	3.3 ± 1.7
05/02/16 - 05/31/16	< 2.4	< 2.5	2.8 ± 1.9	< 2.5
05/31/16 - 06/27/16	3.2 ± 1.7	2.4 ± 1.6	2.4 ± 1.7	< 2.3
06/27/16 - 08/02/16	4.5 ± 1.8	4.5 ± 1.8	2.4 ± 1.7	< 2.3
08/02/16 - 08/30/16	5.7 ± 1.9	4.7 ± 1.8	3.7 ± 1.7	3.3 ± 1.7
08/30/16 - 10/03/16	4.3 ± 1.8	4.6 ± 1.8	4.0 ± 1.7	3.6 ± 1.7
10/03/16 - 11/01/16	6.1 ± 1.9	5.0 ± 1.8	3.1 ± 1.7	4.6 ± 1.8
11/01/16 - 11/28/16	5.2 ± 1.8	4.9 ± 1.8	3.8 ± 1.7	4.0 ± 1.7
11/29/16 - 12/27/16	4.1 ± 1.7	3.9 ± 1.6	2.6 ± 1.6	2.6 ± 1.5
MEAN ± 2 STD DEV	4.3 ± 2.1	4.0 ± 1.8	3.0 ± 1.2	3.4 ± 1.2

Table C-II.2 CONCENTRATIONS OF TRITIUM IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2016

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	15F4	15F7	16C2	28F3
12/28/15 - 03/29/16	< 187	< 187	< 187	< 185
03/29/16 - 06/27/16	< 192	< 189	< 191	< 191
06/27/16 - 10/03/16	< 182	< 177	< 176	< 177
10/03/16 - 12/27/16	< 189	< 193	< 192	< 191
MEAN	-	-	-	-

Table C-II.3 CONCENTRATIONS OF I-131 IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2016

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	15F4	15F7	16C2	28F3
12/28/15 - 02/02/16	< 0.7	< 0.7	< 0.5	< 0.8
02/02/16 - 03/01/16	< 0.7	< 0.5	< 0.7	< 0.7
03/01/16 - 03/29/16	< 0.3	< 0.6	< 0.4	< 0.6
03/29/16 - 05/02/16	< 0.5	< 0.5	< 0.5	< 0.4
05/02/16 - 05/31/16	< 0.9	< 0.7	< 0.9	< 0.8
05/31/16 - 06/27/16	< 0.6	< 0.6	< 0.6	< 0.6
06/27/16 - 08/02/16	< 0.6	< 0.7	< 0.5	< 0.7
08/02/16 - 08/30/16	< 0.6	< 0.6	< 0.4	< 0.6
08/30/16 - 10/03/16	< 0.6	< 0.6	< 0.7	< 0.6
10/03/16 - 11/01/16	< 0.5	< 0.7	< 0.6	< 0.5
11/01/16 - 11/28/16	< 0.7	< 0.7	< 0.6	< 0.8
11/29/16 - 12/27/16	< 0.4	< 0.3	< 0.5	< 0.5
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, 2016

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	12/28/15 - 02/02/16	< 5	< 5	< 9	< 4	< 10	< 5	< 8	< 4	< 5	< 18	< 5
	02/02/16 - 03/01/16	< 7	< 7	< 13	< 6	< 14	< 7	< 12	< 7	< 7	< 28	< 7
	03/01/16 - 03/29/16	< 4	< 4	< 8	< 5	< 10	< 4	< 7	< 4	< 5	< 19	< 6
	03/29/16 - 05/02/16	< 9	< 8	< 15	< 10	< 17	< 7	< 14	< 8	< 10	< 30	< 13
	05/02/16 - 05/31/16	< 2	< 2	< 5	< 2	< 4	< 2	< 4	< 2	< 2	< 18	< 6
	05/31/16 - 06/27/16	< 6	< 6	< 9	< 7	< 11	< 7	< 11	< 7	< 7	< 27	< 9
	06/27/16 - 08/02/16	< 7	< 7	< 15	< 7	< 15	< 8	< 13	< 8	< 7	< 33	< 12
	08/02/16 - 08/30/16	< 7	< 8	< 14	< 5	< 14	< 9	< 12	< 8	< 9	< 35	< 11
	08/30/16 - 10/03/16	< 8	< 9	< 17	< 8	< 22	< 10	< 16	< 13	< 10	< 36	< 10
	10/03/16 - 11/01/16	< 5	< 6	< 12	< 5	< 13	< 7	< 12	< 7	< 6	< 35	< 13
	11/01/16 - 11/29/16	< 5	< 6	< 13	< 5	< 14	< 7	< 10	< 6	< 6	< 26	< 8
	11/29/16 - 12/27/16	< 7	< 7	< 13	< 7	< 13	< 7	< 10	< 6	< 7	< 24	< 8
	MEAN	-	-	-	-	-	-	-	-	-	-	-
15F7	12/28/15 - 02/02/16	< 6	< 5	< 10	< 6	< 14	< 6	< 10	< 5	< 8	< 25	< 7
	02/02/16 - 03/01/16	< 6	< 6	< 10	< 6	< 15	< 7	< 10	< 6	< 8	< 24	< 7
	03/01/16 - 03/29/16	< 4	< 5	< 8	< 5	< 9	< 4	< 8	< 4	< 5	< 17	< 7
	03/29/16 - 05/02/16	< 8	< 9	< 13	< 7	< 17	< 10	< 14	< 7	< 8	< 29	< 10
	05/02/16 - 05/31/16	< 2	< 2	< 4	< 2	< 4	< 2	< 3	< 2	< 2	< 15	< 4
	05/31/16 - 06/27/16	< 6	< 6	< 8	< 7	< 13	< 8	< 13	< 6	< 9	< 29	< 11
	06/27/16 - 08/02/16	< 6	< 7	< 11	< 8	< 14	< 7	< 12	< 7	< 7	< 39	< 9
	08/02/16 - 08/30/16	< 6	< 6	< 17	< 9	< 16	< 7	< 11	< 8	< 7	< 38	< 14
	08/30/16 - 10/03/16	< 8	< 7	< 14	< 7	< 17	< 6	< 13	< 7	< 7	< 28	< 7
	10/03/16 - 11/01/16	< 7	< 8	< 15	< 7	< 17	< 8	< 14	< 6	< 8	< 41	< 14
	11/01/16 - 11/29/16	< 10	< 10	< 21	< 8	< 18	< 9	< 18	< 10	< 9	< 34	< 10
	11/29/16 - 12/27/16	< 4	< 4	< 6	< 5	< 10	< 5	< 9	< 6	< 6	< 25	< 6
	MEAN	-	-	-	-	-	-	-	-	-	-	-

Table C-II.4 CONCENTRATIONS OF GAMMA EMITTERS IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2016

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	12/28/15 - 02/02/16	< 5	< 6	< 11	< 5	< 8	< 5	< 7	< 6	< 6	< 22	< 6
	02/02/16 - 03/01/16	< 9	< 7	< 15	< 8	< 20	< 10	< 14	< 8	< 8	< 26	< 10
	03/01/16 - 03/29/16	< 4	< 4	< 9	< 4	< 9	< 4	< 8	< 4	< 4	< 16	< 5
	03/29/16 - 05/02/16	< 6	< 7	< 12	< 6	< 11	< 6	< 13	< 7	< 8	< 24	< 12
	05/02/16 - 05/31/16	< 2	< 2	< 5	< 2	< 5	< 3	< 4	< 2	< 2	< 21	< 7
	05/31/16 - 06/27/16	< 8	< 6	< 18	< 8	< 18	< 9	< 14	< 8	< 9	< 35	< 11
	06/27/16 - 08/02/16	< 6	< 7	< 16	< 7	< 13	< 6	< 11	< 7	< 7	< 35	< 15
	08/02/16 - 08/30/16	< 9	< 11	< 18	< 8	< 18	< 8	< 14	< 8	< 9	< 38	< 13
	08/30/16 - 10/03/16	< 7	< 7	< 14	< 8	< 19	< 7	< 13	< 7	< 6	< 28	< 9
	10/03/16 - 11/01/16	< 6	< 7	< 13	< 7	< 13	< 7	< 12	< 5	< 7	< 27	< 9
	11/01/16 - 11/28/16	< 5	< 4	< 9	< 3	< 9	< 5	< 9	< 5	< 5	< 21	< 7
	11/28/16 - 12/27/16	< 6	< 6	< 15	< 6	< 10	< 7	< 12	< 7	< 7	< 25	< 7
	MEAN	-	-	-	-	-	-	-	-	-	-	-
28F3	12/28/15 - 02/02/16	< 7	< 7	< 16	< 8	< 16	< 8	< 14	< 6	< 7	< 29	< 8
	02/02/16 - 03/01/16	< 7	< 6	< 14	< 8	< 16	< 9	< 14	< 8	< 8	< 27	< 7
	03/01/16 - 03/29/16	< 5	< 4	< 9	< 5	< 11	< 5	< 8	< 4	< 4	< 21	< 7
	03/29/16 - 05/02/16	< 8	< 7	< 13	< 10	< 14	< 8	< 9	< 7	< 8	< 31	< 8
	05/02/16 - 05/31/16	< 2	< 3	< 7	< 3	< 5	< 3	< 5	< 2	< 3	< 22	< 7
	05/31/16 - 06/27/16	< 8	< 7	< 16	< 11	< 20	< 8	< 13	< 8	< 9	< 29	< 9
	06/27/16 - 08/02/16	< 5	< 4	< 12	< 7	< 12	< 6	< 10	< 5	< 6	< 34	< 10
	08/02/16 - 08/30/16	< 6	< 6	< 10	< 7	< 12	< 7	< 11	< 6	< 7	< 32	< 10
	08/30/16 - 10/03/16	< 6	< 6	< 15	< 8	< 10	< 6	< 12	< 6	< 7	< 27	< 8
	10/03/16 - 11/01/16	< 7	< 6	< 14	< 8	< 11	< 8	< 11	< 7	< 6	< 35	< 11
	11/01/16 - 11/28/16	< 4	< 3	< 9	< 4	< 7	< 4	< 7	< 3	< 4	< 16	< 8
	11/28/16 - 12/27/16	< 6	< 5	< 13	< 7	< 15	< 7	< 10	< 6	< 7	< 26	< 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, 2016**

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									
	05/20/16	3586 ± 1150	< 53	< 60	< 96	< 55	< 109	< 76	< 46	< 57
	12/01/16	3937 ± 842	< 52	< 49	< 63	< 60	< 86	< 75	< 46	< 47
	MEAN ± 2 STD DEV	3762 ± 496	-	-	-	-	-	-	-	-
16C5	BOTTOM FEEDER									
	05/20/16	3510 ± 969	< 77	< 68	< 149	< 80	< 127	< 106	< 69	< 55
	12/01/16	4889 ± 1416	< 95	< 101	< 169	< 119	< 175	< 135	< 85	< 94
	MEAN ± 2 STD DEV	4200 ± 1950	-	-	-	-	-	-	-	-
29C1	PREDATOR									
	05/19/16	3427 ± 776	< 47	< 46	< 162	< 47	< 98	< 1249	< 36	< 45
	12/01/16	2762 ± 719	< 49	< 42	< 85	< 45	< 84	< 64	< 42	< 44
	MEAN ± 2 STD DEV	3095 ± 940	-	-	-	-	-	-	-	-
29C1	BOTTOM FEEDER									
	05/19/16	2706 ± 700	< 43	< 38	< 91	< 48	< 103	< 69	< 45	< 45
	12/01/16	3332 ± 841	< 56	< 45	< 90	< 59	< 117	< 70	< 39	< 53
	MEAN ± 2 STD DEV	3019 ± 885	-	-	-	-	-	-	-	-

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, 2016**

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	06/21/16	2453 ± 1135	11960 ± 2331	< 115	< 100	< 139	< 224	< 132	< 137
	12/08/16	< 706	15680 ± 1553	< 75	< 64	< 74	< 91	< 71	< 87
	MEAN ± 2 STD DEV	2453 ± 0	13820 ± 5261	-	-	-	-	-	-
16C4	06/21/16	< 920	11320 ± 2281	< 124	< 119	< 148	< 197	< 91	< 145
	12/08/16	< 796	16560 ± 2139	< 95	< 83	< 116	< 140	< 85	147 ± 78
	MEAN ± 2 STD DEV	-	13940 ± 7410	-	-	-	-	-	147 ± 0
33A2	06/21/16	1188 ± 653	9798 ± 1461	< 78	< 80	< 98	< 136	< 59	184 ± 92
	12/08/16	< 712	13800 ± 1579	< 89	< 67	< 77	< 122	< 86	< 86
	MEAN ± 2 STD DEV	1188 ± 0	11799 ± 5660	-	-	-	-	-	184 ± 0

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, 2016**

RESULTS IN UNITS OF E-3 PCI/CU METER ± 2 SIGMA

COLLECTION PERIOD	GROUP I				GROUP II		GROUP III
	10S3	11S1	13S4	14S1	6C1	15D1	22G1
12/28/15 - 01/04/16	16 ± 5	16 ± 5	15 ± 3	13 ± 5	18 ± 5	13 ± 4	14 ± 5
01/04/16 - 01/11/16	8 ± 4	9 ± 4	11 ± 3	16 ± 5	13 ± 5	10 ± 4.2	15 ± 5
01/11/16 - 01/19/16	16 ± 4	17 ± 4	15 ± 3	20 ± 5	19 ± 5	23 ± 4	18 ± 4
01/19/16 - 01/26/16	14 ± 5	10 ± 5	11 ± 3	16 ± 5	9 ± 5	16 ± 5	18 ± 5
01/26/16 - 02/01/16	17 ± 6	21 ± 6	16 ± 4	18 ± 6	16 ± 6	13 ± 5	17 ± 6
02/01/16 - 02/08/16	14 ± 5	15 ± 5	11 ± 3	12 ± 5	12 ± 5	14 ± 4	12 ± 5
02/08/16 - 02/14/16	11 ± 5	8 ± 5	7 ± 3	12 ± 5	13 ± 5	13 ± 5	12 ± 5
02/14/16 - 02/22/16	16 ± 4	9 ± 4	12 ± 3	18 ± 4	12 ± 4	15 ± 4	12 ± 4
02/22/16 - 02/29/16	12 ± 4	10 ± 4	9 ± 6	11 ± 5	12 ± 5	15 ± 4	13 ± 5
02/29/16 - 03/07/16	11 ± 5	12 ± 5	13 ± 4	11 ± 5	12 ± 5	10 ± 4	11 ± 5
03/07/16 - 03/14/16	18 ± 5	15 ± 5	14 ± 3	18 ± 5	15 ± 5	17 ± 4	18 ± 5
03/14/16 - 03/21/16	7 ± 4	9 ± 4	9 ± 3	8 ± 4	8 ± 4	8 ± 4	9 ± 4
03/21/16 - 03/28/16	9 ± 4	13 ± 5	9 ± 3	15 ± 5	11 ± 5	11 ± 4	12 ± 5
03/28/16 - 04/04/16	13 ± 4	15 ± 5	16 ± 3	14 ± 5	14 ± 5	13 ± 4	16 ± 5
04/04/16 - 04/11/16	12 ± 5	11 ± 5	10 ± 3	11 ± 5	14 ± 5	10 ± 4	12 ± 5
04/11/16 - 04/18/16	12 ± 5	17 ± 5	12 ± 3	15 ± 5	17 ± 6	12 ± 5	11 ± 5
04/18/16 - 04/25/16	16 ± 5	17 ± 5	14 ± 3	14 ± 5	20 ± 5	15 ± 4	20 ± 5
04/25/16 - 05/03/16	11 ± 4	9 ± 4	14 ± 7	9 ± 4	10 ± 4	11 ± 4	6 ± 4
05/03/16 - 05/09/16	< 8	< 8	< 5	< 8	< 8	< 7	< 8
05/09/16 - 05/16/16	21 ± 5	13 ± 5	9 ± 3	12 ± 5	19 ± 5	10 ± 4	12 ± 5
05/16/16 - 05/23/16	13 ± 5	13 ± 5	12 ± 3	13 ± 5	16 ± 5	9 ± 4	16 ± 5
05/23/16 - 05/31/16	18 ± 5	26 ± 5	18 ± 3	21 ± 5	21 ± 5	12 ± 4	24 ± 5
05/31/16 - 06/06/16	14 ± 5	13 ± 5	12 ± 3	12 ± 5	12 ± 5	7 ± 4	12 ± 5
06/06/16 - 06/13/16	13 ± 4	10 ± 4	14 ± 3	13 ± 5	13 ± 5	9 ± 4	17 ± 5
06/13/16 - 06/20/16	10 ± 4	14 ± 5	13 ± 3	14 ± 4	12 ± 4	15 ± 5	14 ± 4
06/20/16 - 06/28/16	14 ± 4	18 ± 4	16 ± 3	18 ± 4	20 ± 5	16 ± 4	19 ± 4
06/28/16 - 07/05/16	14 ± 5	12 ± 5	14 ± 3	17 ± 5	20 ± 5	13 ± 5	14 ± 5
07/05/16 - 07/11/16	17 ± 6	11 ± 5	10 ± 4	17 ± 6	18 ± 6	17 ± 6	14 ± 6
07/11/16 - 07/19/16	10 ± 4	13 ± 5	12 ± 3	13 ± 5	15 ± 5	15 ± 5	15 ± 5
07/19/16 - 07/25/16	11 ± 5	16 ± 6	16 ± 4	13 ± 6	21 ± 6	19 ± 6	16 ± 6
07/25/16 - 08/01/16	10 ± 4	20 ± 5	13 ± 3	15 ± 5	15 ± 5	16 ± 5	18 ± 5
08/01/16 - 08/08/16	14 ± 5	15 ± 5	10 ± 3	12 ± 4	12 ± 4	14 ± 5	14 ± 5
08/08/16 - 08/15/16	19 ± 5	13 ± 5	15 ± 3	14 ± 5	17 ± 5	17 ± 5	17 ± 5
08/15/16 - 08/22/16	10 ± 4	12 ± 5	13 ± 3	13 ± 5	13 ± 5	13 ± 5	18 ± 5
08/22/16 - 08/29/16	15 ± 5	24 ± 6	19 ± 4	18 ± 5	22 ± 5	20 ± 5	17 ± 5
08/29/16 - 09/06/16	12 ± 4	13 ± 4	14 ± 3	20 ± 5	16 ± 4	16 ± 4	18 ± 4
09/06/16 - 09/13/16	13 ± 5	16 ± 5	13 ± 3	17 ± 5	18 ± 5	13 ± 5	16 ± 5
09/13/16 - 09/19/16	21 ± 6	25 ± 7	15 ± 5	19 ± 6	20 ± 6	20 ± 6	23 ± 6
09/19/16 - 09/26/16	16 ± 5	19 ± 5	16 ± 3	20 ± 5	19 ± 5	19 ± 5	16 ± 5
09/26/16 - 10/03/16	13 ± 5	10 ± 4	11 ± 3	10 ± 4	11 ± 4	10 ± 4	11 ± 4
10/03/16 - 10/11/16	16 ± 4	12 ± 4	13 ± 3	16 ± 4	15 ± 4	15 ± 4	13 ± 4
10/11/16 - 10/17/16	12 ± 6	10 ± 5	15 ± 4	15 ± 6	13 ± 6	12 ± 6	11 ± 6
10/17/16 - 10/24/16	18 ± 5	17 ± 5	19 ± 4	22 ± 5	19 ± 5	15 ± 5	18 ± 5
10/24/16 - 10/31/16	13 ± 5	11 ± 4	15 ± 3	15 ± 5	13 ± 5	17 ± 5	14 ± 5
10/31/16 - 11/07/16	19 ± 5	20 ± 5	17 ± 4	19 ± 5	20 ± 5	21 ± 5	22 ± 5
11/07/16 - 11/14/16	15 ± 5	12 ± 5	13 ± 4	17 ± 5	15 ± 5	10 ± 5	9 ± 5
11/14/16 - 11/21/16	33 ± 6	35 ± 6	28 ± 4	36 ± 6	30 ± 6	38 ± 6	30 ± 6
11/21/16 - 11/28/16	15 ± 5	14 ± 5	17 ± 4	14 ± 5	13 ± 4	15 ± 5	18 ± 5
11/28/16 - 12/05/16	15 ± 5	*(1)*	10 ± 3	16 ± 5	12 ± 4	13 ± 5	15 ± 5
12/05/16 - 12/12/16	12 ± 4	15 ± 5	14 0 3	15 ± 5	15 ± 5	15 ± 5	13 ± 4
12/12/16 - 12/19/16	22 ± 5	20 ± 5	20 ± 4	24 ± 5	21 ± 5	22 ± 5	24 ± 6
12/19/16 - 12/27/16	24 ± 5	23 ± 5	19 ± 3	27 ± 5	25 ± 5	24 ± 5	23 ± 5
12/27/16 - 01/03/17	11 ± 4	14 ± 5	10 ± 3	10 ± 4	9 ± 4	13 ± 5	14 ± 5
MEAN ± 2 STD DEV	14 ± 9	15 ± 10	14 ± 7	16 ± 10	16 ± 9	15 ± 10	16 ± 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, 2016

RESULTS IN UNITS OF E-3 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
12/28/15 - 02/01/16	8	21	15 ± 7	12/28/15 - 02/01/16	9	23	15 ± 8	12/28/15 - 02/01/16	14	18	16 ± 4
02/01/16 - 02/29/16	7	18	12 ± 6	02/01/16 - 02/29/16	12	15	13 ± 2	02/01/16 - 02/29/16	12	13	12 ± 2
02/29/16 - 04/04/16	7	18	12 ± 7	02/29/16 - 04/04/16	8	17	12 ± 6	02/29/16 - 04/04/16	9	18	13 ± 8
04/04/16 - 05/03/16	9	17	13 ± 5	04/04/16 - 05/03/16	10	20	13 ± 7	04/04/16 - 05/03/16	6	20	12 ± 11
05/03/16 - 05/31/16	9	26	16 ± 10	05/03/16 - 05/31/16	9	21	14 ± 10	05/03/16 - 05/31/16	12	24	17 ± 12
05/31/16 - 06/28/16	10	18	14 ± 5	05/31/16 - 06/28/16	7	20	13 ± 8	05/31/16 - 06/28/16	12	19	16 ± 6
06/28/16 - 08/01/16	10	20	14 ± 6	06/28/16 - 08/01/16	13	21	17 ± 5	06/28/16 - 08/01/16	14	18	15 ± 3
08/01/16 - 08/29/16	10	24	15 ± 7	08/01/16 - 08/29/16	12	22	16 ± 7	08/01/16 - 08/29/16	14	18	16 ± 3
08/29/16 - 10/03/16	10	25	16 ± 8	08/29/16 - 10/03/16	10	20	16 ± 7	08/29/16 - 10/03/16	11	23	17 ± 8
10/03/16 - 10/31/16	10	22	15 ± 6	10/03/16 - 10/31/16	12	19	15 ± 4	10/03/16 - 10/31/16	11	18	14 ± 6
10/31/16 - 11/28/16	12	36	20 ± 16	10/31/16 - 11/28/16	10	38	20 ± 19	10/31/16 - 11/28/16	9	30	19 ± 17
11/28/16 - 01/03/17	10	27	17 ± 11	11/28/16 - 01/03/17	9	25	17 ± 11	11/28/16 - 01/03/17	13	24	18 ± 11
12/28/15 - 01/03/17	7	36	15 ± 9	12/28/15 - 01/03/17	7	38	15 ± 9	12/28/15 - 01/03/17	6	30	16 ± 9

Table C-V.3 **CONCENTRATIONS OF GAMMA EMITTERS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2016**

RESULTS IN UNITS OF E-3 PCI/CU METER ± 2 SIGMA

SITE	COLLECTION PERIOD	Be-7	Mn-54	Co-58	Co-60	Cs-134	Cs-137
10S3	12/28/15 - 03/28/16	83 ± 31	< 4	< 3	< 4	< 3	< 3
	03/28/16 - 06/28/16	85 ± 30	< 3	< 3	< 3	< 3	< 2
	06/28/16 - 10/03/16	52 ± 21	< 2	< 2	< 3	< 2	< 2
	10/03/16 - 01/03/17	41 ± 24	< 5	< 5	< 7	< 4	< 5
	MEAN ± 2 STD DEV	65 ± 45	-	-	-	-	-
11S1	12/28/15 - 03/28/16	47 ± 27	< 2	< 4	< 2	< 2	< 2
	03/28/16 - 06/28/16	101 ± 28	< 3	< 3	< 2	< 3	< 3
	06/28/16 - 10/03/16	69 ± 15	< 2	< 2	< 2	< 2	< 2
	10/03/16 - 01/03/17	63 ± 17	< 3	< 3	< 3	< 2	< 2
	MEAN ± 2 STD DEV	70 ± 46	-	-	-	-	-
13S4	12/28/15 - 03/28/16	50 ± 26	< 2	< 3	< 2	< 2	< 2
	03/28/16 - 06/28/16	88 ± 19	< 1	< 2	< 2	< 1	< 1
	06/28/16 - 10/03/16	77 ± 17	< 1	< 2	< 1	< 2	< 2
	10/03/16 - 01/03/17	40 ± 12	< 2	< 2	< 2	< 2	< 1
	MEAN ± 2 STD DEV	64 ± 45	-	-	-	-	-
14S1	12/28/15 - 03/28/16	66 ± 26	< 3	< 5	< 3	< 4	< 3
	03/28/16 - 06/28/16	64 ± 25	< 3	< 4	< 3	< 4	< 3
	06/28/16 - 10/03/16	74 ± 17	< 2	< 3	< 3	< 2	< 2
	10/03/16 - 01/03/17	48 ± 17	< 2	< 2	< 3	< 2	< 2
	MEAN ± 2 STD DEV	63 ± 22	-	-	-	-	-
15D1	12/28/15 - 03/28/16	65 ± 19	< 2	< 3	< 2	< 2	< 2
	03/28/16 - 06/28/16	72 ± 25	< 2	< 3	< 3	< 3	< 2
	06/28/16 - 10/03/16	63 ± 30	< 4	< 3	< 4	< 3	< 4
	10/03/16 - 01/03/17	57 ± 21	< 4	< 2	< 3	< 4	< 4
	MEAN ± 2 STD DEV	64 ± 12	-	-	-	-	-
22G1	12/28/15 - 03/28/16	90 ± 34	< 3	< 5	< 3	< 2	< 3
	03/28/16 - 06/28/16	125 ± 25	< 3	< 3	< 3	< 3	< 3
	06/28/16 - 10/03/16	70 ± 18	< 2	< 2	< 2	< 2	< 2
	10/03/16 - 01/03/17	60 ± 17	< 2	< 2	< 3	< 2	< 3
	MEAN ± 2 STD DEV	86 ± 58	-	-	-	-	-
6C1	12/28/15 - 03/28/16	64 ± 33	< 4	< 5	< 4	< 4	< 3
	03/28/16 - 06/28/16	89 ± 24	< 2	< 2	< 2	< 2	< 2
	06/28/16 - 10/03/16	75 ± 28	< 4	< 5	< 5	< 4	< 4
	10/03/16 - 01/03/17	75 ± 20	< 3	< 1	< 3	< 2	< 2
	MEAN ± 2 STD DEV	75 ± 20	-	-	-	-	-

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, 2016**

RESULTS IN UNITS OF E-3 PCI/CU METER + 2 SIGMA

COLLECTION	GROUP I				GROUP II		GROUP III
PERIOD	10S3	11S1	13S4	14S1	6C1	15D1	22G1
12/28/15 - 01/04/16	< 58	< 59	< 10	< 47	< 60	< 42	< 47
01/04/16 - 01/11/16	< 52	< 52	< 43	< 69	< 53	< 32	< 70
01/11/16 - 01/19/16	< 34	< 34	< 10	< 35	< 35	< 32	< 35
01/19/16 - 01/26/16	< 56	< 57	< 41	< 58	< 58	< 57	< 64
01/26/16 - 02/01/16	< 55	< 56	< 44	< 57	< 57	< 62	< 70
02/01/16 - 02/08/16	< 41	< 25	< 27	< 43	< 26	< 16	< 44
02/08/16 - 02/14/16	< 54	< 46	< 12	< 47	< 56	< 42	< 47
02/14/16 - 02/22/16	< 34	< 34	< 24	< 35	< 35	< 38	< 43
02/22/16 - 02/29/16	< 59	< 59	< 62	< 60	< 60	< 38	< 42
02/29/16 - 03/07/16	< 36	< 36	< 18	< 52	< 37	< 47	< 53
03/07/16 - 03/14/16	< 42	< 42	< 27	< 43	< 43	< 34	< 39
03/14/16 - 03/21/16	< 26	< 26	< 15	< 27	< 27	< 19	< 21
03/21/16 - 03/28/16	< 60	< 60	< 42	< 62	< 61	< 57	< 65
03/28/16 - 04/04/16	< 44	< 44	< 24	< 45	< 45	< 34	< 38
04/04/16 - 04/11/16	< 60	< 60	< 40	< 62	< 62	< 56	< 63
04/11/16 - 04/18/16	< 31	< 31	< 23	< 32	< 37	< 33	< 37
04/18/16 - 04/25/16	< 52	< 52	< 34	< 53	< 53	< 48	< 54
04/25/16 - 05/03/16	< 38	< 38	< 59	< 39	< 39	< 35	< 37
05/03/16 - 05/09/16	< 42	< 43	< 16	< 44	< 44	< 49	< 56
05/09/16 - 05/16/16	< 34	< 34	< 38	< 35	< 35	< 53	< 60
05/16/16 - 05/23/16	< 41	< 41	< 43	< 42	< 42	< 62	< 70
05/23/16 - 05/31/16	< 49	< 50	< 40	< 51	< 50	< 57	< 62
05/31/16 - 06/06/16	< 48	< 49	< 41	< 50	< 49	< 59	< 68
06/06/16 - 06/13/16	< 67	< 67	< 41	< 69	< 69	< 68	< 68
06/13/16 - 06/20/16	< 67	< 68	< 41	< 66	< 66	< 67	< 66
06/20/16 - 06/28/16	< 69	< 70	< 16	< 66	< 68	< 67	< 65
06/28/16 - 07/05/16	< 40	< 40	< 24	< 40	< 39	< 39	< 39
07/05/16 - 07/11/16	< 47	< 48	< 42	< 47	< 47	< 67	< 67
07/11/16 - 07/19/16	< 51	< 52	< 10	< 51	< 39	< 40	< 39
07/19/16 - 07/25/16	< 65	< 65	< 41	< 65	< 65	< 66	< 68
07/25/16 - 08/01/16	< 62	< 62	< 41	< 62	< 61	< 64	< 63
08/01/16 - 08/08/16	< 42	< 42	< 29	< 41	< 41	< 47	< 46
08/08/16 - 08/15/16	< 56	< 56	< 37	< 56	< 55	< 58	< 58
08/15/16 - 08/22/16	< 35	< 35	< 14	< 35	< 35	< 23	< 23
08/22/16 - 08/29/16	< 67	< 67	< 40	< 67	< 66	< 65	< 64
08/29/16 - 09/06/16	< 30	< 31	< 25	< 30	< 30	< 41	< 41
09/06/16 - 09/13/16	< 53	< 53	< 21	< 53	< 52	< 34	< 34
09/13/16 - 09/19/16	< 43	< 43	< 25	< 32	< 42	< 33	< 32
09/19/16 - 09/26/16	< 36	< 37	< 21	< 31	< 36	< 32	< 32
09/26/16 - 10/03/16	< 40	< 41	< 29	< 40	< 40	< 45	< 44
10/03/16 - 10/11/16	< 32	< 32	< 14	< 32	< 32	< 23	< 22
10/11/16 - 10/17/16	< 34	< 34	< 26	< 34	< 34	< 42	< 42
10/17/16 - 10/24/16	< 22	< 22	< 17	< 22	< 22	< 26	< 26
10/24/16 - 10/31/16	< 59	< 59	< 22	< 65	< 58	< 66	< 66
10/31/16 - 11/07/16	< 40	< 40	< 23	< 40	< 40	< 36	< 36
11/07/16 - 11/14/16	< 34	< 34	< 27	< 34	< 34	< 40	< 40
11/14/16 - 11/21/16	< 45	< 46	< 21	< 45	< 45	< 32	< 32
11/21/16 - 11/28/16	< 38	< 38	< 22	< 38	< 38	< 33	< 32
11/28/16 - 12/05/16	< 15	*(1)*	< 26	< 38	< 38	< 39	< 38
12/05/16 - 12/12/16	< 38	< 39	< 8	< 38	< 38	< 33	< 31
12/12/16 - 12/19/16	< 27	< 28	< 13	< 27	< 27	< 22	< 22
12/19/16 - 12/27/16	< 28	< 28	< 14	< 28	< 28	< 25	< 24
12/27/16 - 01/03/17	< 22	< 22	< 15	< 22	< 22	< 26	< 26
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, 2016**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION	CONTROL FARM		INDICATOR FARM		
PERIOD	23F1	36E1	18E1	19B1	25C1
01/12/16	< 0.6	< 0.8	< 0.6	< 0.8	< 0.7
02/09/16	< 0.5		< 0.5	< 0.3	< 0.3
03/08/16	< 0.3		< 0.4	< 0.4	< 0.3
04/05/16	< 0.7	< 0.7	< 0.7	< 0.9	< 0.6
04/19/16	< 0.5		< 0.6	< 0.6	< 0.4
05/03/16	< 0.8		< 0.6	< 0.9	< 0.8
05/18/16	< 0.4		< 0.5	< 0.7	< 0.6
06/03/16	< 0.5		< 0.4	< 0.8	< 0.8
06/14/16	< 0.8		< 1.0	< 0.5	< 0.9
06/28/16	< 0.6		< 0.4	< 0.7	< 0.8
07/12/16	< 0.7	< 0.4	< 0.6	< 0.7	< 0.4
07/26/16	< 0.7		< 0.6	< 0.7	< 0.6
08/09/16	< 0.6		< 0.9	< 0.8	< 0.6
08/23/16	< 0.6		< 0.9	< 0.6	< 0.7
09/06/16	< 0.3		< 0.5	< 0.8	< 0.5
09/20/16	< 0.5		< 0.6	< 0.6	< 0.7
10/04/16	< 0.5	< 0.6	< 0.5	< 0.6	< 0.5
10/18/16	< 0.5		< 0.6	< 0.5	< 0.6
11/01/16	< 0.5		< 0.5	< 0.6	< 0.5
11/15/16	< 0.5		< 0.9	< 0.6	< 0.6
11/29/16	< 0.5		< 0.9	< 0.6	< 0.7
12/13/16	< 0.5		< 0.9	< 0.8	< 0.7
MEAN	-	-	-	-	-

Table C-VII.2 **CONCENTRATIONS OF GAMMA EMITTERS IN MILK SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2016**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	K-40	Cs-134	Cs-137	Ba-140	La-140
18E1	01/11/16	1199 ± 124	< 5	< 5	< 23	< 6
	02/09/16	1361 ± 143	< 5	< 5	< 28	< 8
	03/07/16	1063 ± 147	< 5	< 6	< 28	< 7
	04/06/16	1093 ± 212	< 9	< 13	< 42	< 13
	04/18/16	1164 ± 136	< 5	< 5	< 30	< 8
	05/02/16	1051 ± 168	< 8	< 8	< 36	< 8
	05/18/16	1227 ± 162	< 5	< 6	< 27	< 10
	06/03/16	1132 ± 194	< 9	< 10	< 37	< 12
	06/13/16	1346 ± 165	< 6	< 7	< 36	< 10
	06/27/16	1164 ± 221	< 4	< 5	< 32	< 7
	07/11/16	1038 ± 178	< 7	< 8	< 31	< 9
	07/25/16	1079 ± 210	< 8	< 10	< 36	< 14
	08/09/16	1398 ± 183	< 8	< 7	< 34	< 9
	08/23/16	1296 ± 210	< 6	< 8	< 42	< 15
	09/06/16	972 ± 214	< 9	< 10	< 35	< 13
	09/20/16	1223 ± 169	< 6	< 8	< 31	< 10
	10/04/16	1277 ± 134	< 5	< 7	< 24	< 8
	10/17/16	1126 ± 109	< 4	< 5	< 18	< 5
	11/01/16	1284 ± 191	< 8	< 10	< 46	< 9
	11/15/16	1262 ± 206	< 10	< 8	< 38	< 11
	11/29/16	1234 ± 182	< 9	< 11	< 39	< 9
	12/13/16	1186 ± 123	< 5	< 5	< 19	< 5
	MEAN ± 2 STD DEV	1190 ± 227	-	-	-	-
19B1	01/12/16	1283 ± 179	< 8	< 9	< 34	< 8
	02/09/16	1285 ± 154	< 5	< 7	< 34	< 10
	03/08/16	1125 ± 160	< 7	< 8	< 37	< 8
	04/05/16	1502 ± 207	< 7	< 6	< 27	< 8
	04/19/16	1046 ± 209	< 10	< 10	< 58	< 13
	05/03/16	1323 ± 124	< 4	< 5	< 18	< 5
	05/17/16	1223 ± 128	< 5	< 6	< 25	< 8
	05/31/16	1046 ± 184	< 6	< 7	< 41	< 11
	06/14/16	1329 ± 206	< 7	< 8	< 35	< 10
	06/28/16	1180 ± 178	< 9	< 10	< 54	< 13
	07/12/16	1365 ± 183	< 7	< 7	< 22	< 8
	07/26/16	1415 ± 230	< 8	< 12	< 31	< 14
	08/09/16	1240 ± 241	< 12	< 10	< 43	< 10
	08/23/16	1329 ± 183	< 8	< 10	< 38	< 11
	09/06/16	1057 ± 219	< 9	< 10	< 33	< 12
	09/20/16	1231 ± 166	< 7	< 8	< 30	< 7
	10/04/16	1238 ± 160	< 6	< 7	< 30	< 7
	10/18/16	1074 ± 94.6	< 4	< 4	< 15	< 5
	11/01/16	1272 ± 189	< 8	< 8	< 46	< 14
	11/15/16	1210 ± 214	< 8	< 9	< 36	< 7
	11/29/16	1189 ± 172	< 10	< 10	< 35	< 11
	12/13/16	1414 ± 117	< 7	< 6	< 21	< 7
	MEAN ± 2 STD DEV	1244 ± 250	-	-	-	-

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, 2016**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	K-40	Cs-134	Cs-137	Ba-140	La-140
23F1	01/12/16	1307 ± 137	< 5	< 6	< 22	< 8
	02/09/16	1216 ± 159	< 7	< 7	< 27	< 5
	03/08/16	1153 ± 147	< 5	< 6	< 28	< 6
	04/05/16	1397 ± 219	< 9	< 11	< 41	< 10
	04/19/16	1202 ± 223	< 9	< 9	< 53	< 9
	05/03/16	1250 ± 142	< 10	< 9	< 39	< 11
	05/17/16	1287 ± 136	< 5	< 5	< 26	< 9
	05/31/16	1291 ± 179	< 6	< 9	< 36	< 11
	06/14/16	1083 ± 208	< 9	< 11	< 41	< 15
	06/28/16	1472 ± 320	< 12	< 10	< 52	< 8
	07/12/16	1342 ± 212	< 7	< 8	< 30	< 13
	07/26/16	1308 ± 176	< 7	< 7	< 22	< 8
	08/09/16	1286 ± 213	< 9	< 10	< 38	< 13
	08/23/16	1414 ± 182	< 7	< 7	< 38	< 11
	09/06/16	1368 ± 177	< 12	< 11	< 43	< 9
	09/20/16	1273 ± 191	< 7	< 8	< 34	< 7
	10/04/16	1422 ± 180	< 7	< 7	< 34	< 8
	10/18/16	1304 ± 106	< 4	< 5	< 17	< 5
	11/01/16	1382 ± 166	< 6	< 7	< 41	< 11
	11/15/16	1522 ± 194	< 9	< 10	< 30	< 13
	11/29/16	1278 ± 196	< 8	< 7	< 25	< 10
	12/13/16	1088 ± 179	< 5	< 6	< 21	< 7
	MEAN ± 2 STD DEV	1302 ± 224	-	-	-	-
25C1	01/12/16	1317 ± 140	< 5	< 6	< 24	< 5
	02/09/16	1229 ± 130	< 6	< 8	< 33	< 9
	03/08/16	1248 ± 132	< 6	< 7	< 33	< 10
	04/05/16	1387 ± 210	< 8	< 9	< 31	< 12
	04/19/16	1356 ± 191	< 8	< 8	< 38	< 14
	05/03/16	1375 ± 200	< 8	< 7	< 36	< 13
	05/17/16	1469 ± 132	< 5	< 6	< 25	< 6
	05/31/16	1172 ± 174	< 8	< 8	< 47	< 12
	06/14/16	1384 ± 200	< 10	< 9	< 47	< 15
	06/28/16	1244 ± 196	< 8	< 10	< 52	< 12
	07/12/16	1257 ± 194	< 8	< 10	< 35	< 9
	07/26/16	1187 ± 224	< 8	< 9	< 36	< 4
	08/09/16	1069 ± 217	< 11	< 12	< 43	< 13
	08/23/16	1427 ± 194	< 6	< 9	< 37	< 15
	09/06/16	1421 ± 172	< 7	< 7	< 27	< 9
	09/20/16	1379 ± 158	< 6	< 8	< 27	< 8
	10/04/16	1519 ± 151	< 10	< 9	< 38	< 8
	10/18/16	1385 ± 100	< 4	< 5	< 16	< 5
	11/01/16	1453 ± 198	< 7	< 7	< 35	< 13
	11/15/16	1540 ± 182	< 12	< 10	< 39	< 10
	11/29/16	1546 ± 218	< 7	< 9	< 34	< 9
	12/13/16	1474 ± 148	< 8	< 8	< 28	< 6
	MEAN ± 2 STD DEV	1356 ± 255	-	-	-	-

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, 2016**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	K-40	Cs-134	Cs-137	Ba-140	La-140
36E1	01/12/16	1102 ± 241	< 8	< 16	< 49	< 10
	04/05/16	1111 ± 151	< 6	< 7	< 23	< 8
	07/12/16	1031 ± 217	< 8	< 10	< 43	< 8
	10/04/16	1291 ± 150	< 9	< 8	< 39	< 10
	MEAN ± 2 STD DEV	1134 ± 222	-	-	-	-

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, 2016

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	06/22/16	Cabbage	< 244	3946 ± 575	< 25	< 23	< 32	< 40	< 28	< 28	< 522	< 54	< 109
	06/22/16	Collards	< 167	4729 ± 500	< 20	< 19	< 30	< 25	< 18	< 20	< 518	< 34	< 88
	06/22/16	Swiss Chard	< 210	6290 ± 636	< 25	< 23	< 32	< 39	< 23	< 25	< 520	< 42	< 115
	07/25/16	Cabbage	< 255	2416 ± 619	< 29	< 24	< 20	< 30	< 26	< 26	< 642	< 47	< 115
	07/25/16	Collards	< 247	4855 ± 975	< 42	< 43	< 49	< 46	< 40	< 38	< 882	< 61	< 172
	07/25/16	Swiss Chard	< 386	9033 ± 1070	< 36	< 34	< 60	< 46	< 41	< 48	< 900	< 73	< 184
	08/23/16	Cabbage	< 131	2405 ± 338	< 15	< 14	< 15	< 24	< 14	< 14	< 308	< 22	< 65
	08/23/16	Collards	< 294	5998 ± 753	< 22	< 27	< 35	< 51	< 24	< 22	< 694	< 54	< 119
	08/23/16	Swiss Chard	< 270	7346 ± 711	< 20	< 22	< 30	< 37	< 20	< 24	< 528	< 41	< 91
	09/14/16	Cabbage	< 262	3112 ± 572	< 32	< 33	< 32	< 51	< 29	< 30	< 705	< 62	< 131
	09/14/16	Collards	< 305	5644 ± 689	< 33	< 26	< 35	< 49	< 24	< 28	< 716	< 56	< 116
	09/14/16	Swiss Chard	< 270	8207 ± 752	< 25	< 29	< 31	< 48	< 26	< 26	< 665	82 ± 44	< 114
	10/24/16	Collards	362 ± 192	4015 ± 633	< 30	< 31	< 32	< 60	< 30	< 29	< 510	< 39	< 114
	10/24/16	Swiss Chard	703 ± 251	8641 ± 780	< 26	< 29	< 35	< 57	< 21	< 25	< 604	< 43	< 119
		MEAN ± 2 STD DEV	532 ± 483	5474 ± 4451	-	-	-	-	-	-	-	82 ± 0	-
13S3	06/22/16	Cabbage	< 331	2703 ± 671	< 23	< 24	< 31	< 44	< 28	< 34	2080 ± 696	< 66	< 136
	06/22/16	Collards	< 208	3311 ± 529	< 19	< 26	< 25	< 33	< 23	< 23	1564 ± 581	< 38	< 98
	06/22/16	Swiss Chard	1913 ± 298	8367 ± 739	< 26	< 27	< 36	< 50	< 24	< 28	1611 ± 588	< 50	< 108
	07/25/16	Cabbage	< 344	2498 ± 613	< 33	< 33	< 44	< 39	< 29	< 37	1357 ± 701	< 72	< 152
	07/25/16	Collards	< 358	5389 ± 934	< 43	< 40	< 61	< 40	< 36	< 41	1103 ± 739	< 53	< 139
	07/25/16	Swiss Chard	< 202	7556 ± 707	< 17	< 18	< 20	< 24	< 21	< 21	2194 ± 909	< 45	< 84
	08/23/16	Cabbage	< 126	2237 ± 321	< 14	< 15	< 16	< 27	< 16	< 15	418 ± 346	< 27	< 62
	08/23/16	Collards	< 205	4021 ± 562	< 26	< 28	< 31	< 44	< 21	< 27	587 ± 561	< 46	< 104
	08/23/16	Swiss Chard	< 258	5608 ± 645	< 28	< 23	< 31	< 44	< 23	< 26	1538 ± 645	< 46	< 124
	09/14/16	Cabbage	< 278	3441 ± 523	< 28	< 28	< 30	< 53	< 26	< 28	1641 ± 849	< 51	< 119
	09/14/16	Collards	< 345	5991 ± 750	< 29	< 29	< 37	< 54	< 28	< 34	1212 ± 824	< 62	< 141
	09/14/16	Swiss Chard	< 252	5726 ± 744	< 34	< 28	< 39	< 45	< 28	< 38	900 ± 619	< 49	< 128
	10/24/16	Collards	200 ± 155	4763 ± 521	< 23	< 21	< 27	< 48	< 20	< 20	1543 ± 517	44 ± 31	< 101
	10/24/16	Swiss Chard	604 ± 276	7113 ± 664	< 25	< 31	< 30	< 55	< 26	< 26	1654 ± 519	< 56	< 94
		MEAN ± 2 STD DEV	906 ± 1791	4909 ± 3911	-	-	-	-	-	-	1386 ± 1011	44 ± 0	-
31G1	06/22/16	Broccoli Leaves	239 ± 179	5232 ± 572	< 24	< 25	< 34	< 38	< 22	< 25	< 548	< 44	< 108
	06/22/16	Cabbage	< 291	5064 ± 702	< 28	< 23	< 37	< 47	< 26	< 22	< 700	53 ± 41	< 120
	06/22/16	Swiss Chard	< 328	8766 ± 909	< 33	< 33	< 36	< 49	< 29	< 36	< 689	< 59	< 137
	07/25/16	Cabbage	< 310	6855 ± 584	< 28	< 32	< 37	< 40	< 32	< 34	< 790	< 65	< 139
	07/25/16	Kale	< 330	5683 ± 1072	< 35	< 54	< 53	< 52	< 44	< 39	< 878	< 67	< 170
	07/25/16	Zucchini Leaves	< 260	5356 ± 1033	< 32	< 33	< 41	< 45	< 38	< 38	< 914	< 73	< 169
	08/23/16	Eggplant Leaves	1043 ± 284	6528 ± 801	< 35	< 30	< 46	< 51	< 28	< 34	< 820	< 59	< 118
	08/23/16	Green Bean Leaves	1730 ± 392	5841 ± 727	< 27	< 29	< 37	< 54	< 25	< 27	< 720	< 59	< 124
	08/23/16	Kale	254 ± 220	4751 ± 678	< 30	< 35	< 44	< 50	< 27	< 31	< 575	< 49	< 103
	09/14/16	Kale	< 243	5413 ± 565	< 23	< 24	< 32	< 43	< 22	< 23	< 591	< 45	< 110
	09/14/16	Pepper Leaves	648 ± 267	11000 ± 828	< 29	< 29	< 38	< 47	< 25	< 28	< 551	< 44	< 116
		MEAN ± 2 STD DEV	783 ± 1248	6408 ± 3781	-	-	-	-	-	-	-	53 ± 0	-

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

Table C-IX.1 **QUARTERLY DLR RESULTS FOR LIMERICK GENERATING STATION, 2016**

RESULTS IN UNITS OF MILLIROENTGEN/STANDARD MONTH ± 2 STANDARD DEVIATIONS

STATION CODE	MEAN ± 2 S.D.	JAN - MAR	APR - JUN	JUL - SEP	OCT - DEC
2E1	5.8 ± 0.8	5.2 ± 1.7	5.8 ± 0.7	6.2 ± 0.1	5.9 ± 0.5
3S1	5.6 ± 0.6	5.3 ± 1.2	5.4 ± 1.5	6.0 ± 0.0	5.6 ± 0.8
4E1	4.0 ± 0.5	3.7 ± 0.5	3.9 ± 0.6	4.3 ± 0.4	4.1 ± 0.0
5H1	6.8 ± 0.9	6.2 ± 1.1	6.7 ± 0.7	7.3 ± 0.9	7.0 ± 0.1
5S1	6.3 ± 0.7	5.8 ± 1.2	6.2 ± 1.8	6.7 ± 1.0	6.3 ± 0.2
6C1	5.6 ± 0.9	5.0 ± 1.5	5.4 ± 1.4	6.1 ± 0.8	5.7 ± 0.5
7E1	5.8 ± 1.0	5.2 ± 1.0	5.5 ± 0.6	6.3 ± 0.1	6.0 ± 0.5
7S1	5.8 ± 0.7	5.3 ± 0.8	5.7 ± 2.0	6.1 ± 0.5	5.9 ± 0.3
9C1	5.4 ± 1.0	4.8 ± 1.5	5.3 ± 1.5	6.0 ± 0.4	5.6 ± 0.1
10E1	5.5 ± 0.5	5.2 ± 0.9	5.5 ± 1.7	5.6 ± 0.5	5.8 ± 0.1
10F3	5.6 ± 0.4	5.3 ± 1.1	5.6 ± 1.5	5.7 ± 0.9	5.7 ± 0.5
10S3	5.5 ± 0.7	5.1 ± 1.0	5.5 ± 0.6	5.5 ± 0.0	6.0 ± 0.5
11S1	6.5 ± 0.9	5.9 ± 1.8	6.4 ± 2.2	6.9 ± 0.4	6.7 ± 0.6
13C1	3.9 ± 0.5	3.6 ± 1.5	4.1 ± 0.6	3.7 ± 0.9	4.0 ± 0.2
13E1	5.5 ± 0.6	5.2 ± 1.8	5.6 ± 1.6	5.3 ± 1.0	5.8 ± 0.6
13S2	7.7 ± 0.4	7.6 ± 0.4	7.8 ± 0.9	7.5 ± 1.6	8.0 ± 0.1
14S1	5.0 ± 0.4	4.7 ± 0.9	5.2 ± 1.9	4.9 ± 0.2	5.0 ± 0.5
15D1	5.7 ± 0.4	5.4 ± 0.4	5.8 ± 1.5	5.8 ± 0.3	5.6 ± 2.1
16F1	6.0 ± 1.0	5.4 ± 2.0	5.9 ± 1.0	6.2 ± 1.0	6.6 ± 0.1
17B1	5.2 ± 0.3	5.1 ± 2.1	5.3 ± 0.9	5.0 ± 0.3	5.2 ± 3.1
18S2	6.4 ± 0.7	5.9 ± 1.1	6.7 ± 4.4	6.3 ± 0.2	6.5 ± 0.8
19D1	5.5 ± 0.8	4.9 ± 1.4	5.9 ± 3.3	5.4 ± 0.0	5.6 ± 0.2
20D1	5.0 ± 0.2	4.8 ± 0.8	5.0 ± 1.0	5.0 ± 0.3	5.0 ± 0.1
20F1	5.1 ± 0.5	5.0 ± 0.9	4.8 ± 2.8	5.3 ± 0.5	5.3 ± 1.9
21S2	5.1 ± 0.5	4.7 ± 0.6	5.2 ± 1.6	5.2 ± 0.7	5.2 ± 1.1
23S2	5.2 ± 0.7	4.7 ± 1.2	5.1 ± 1.1	5.4 ± 2.1	5.4 ± 0.1
24D1	5.3 ± 2.8	4.6 ± 1.7	4.5 ± 1.3	4.8 ± 0.1	7.4 ± 0.4
25D1	5.1 ± 2.9	4.2 ± 0.9	4.5 ± 1.2	4.3 ± 0.8	7.2 ± 0.1
25S2	4.8 ± 0.5	4.4 ± 0.8	4.9 ± 0.9	5.0 ± 0.1	4.7 ± 0.8
26S3	4.9 ± 0.5	4.5 ± 0.9	4.8 ± 1.1	5.1 ± 0.8	5.0 ± 0.0
28D2	5.7 ± 3.2	4.6 ± 1.1	4.7 ± 1.3	5.5 ± 0.0	8.0 ± 1.3
29E1	5.9 ± 3.3	4.5 ± 0.4	5.0 ± 1.4	5.7 ± 0.5	8.2 ± 0.2
29S1	4.9 ± 0.2	4.8 ± 1.6	4.9 ± 1.8	4.9 ± 0.6	5.0 ± 0.2
31D1	7.4 ± 3.2	6.4 ± 1.2	6.4 ± 1.3	7.0 ± 0.1	9.8 ± 0.0
31D2	6.3 ± 3.2	5.1 ± 1.9	5.6 ± 3.4	5.8 ± 0.8	8.6 ± 0.9
31S1	5.8 ± 0.4	5.5 ± 1.6	5.8 ± 2.3	5.9 ± 1.5	6.0 ± 0.9
34E1	6.2 ± 2.9	5.3 ± 2.8	5.3 ± 2.0	5.8 ± 0.4	8.3 ± 0.1
34S2	5.4 ± 0.2	5.3 ± 4.4	5.4 ± 2.0	5.5 ± 0.2	5.5 ± 0.1
36D1	5.3 ± 3.2	4.3 ± 0.9	4.4 ± 1.0	4.8 ± 0.2	7.7 ± 0.2
36S2	5.7 ± 0.8	5.1 ± 0.8	5.6 ± 1.1	6.0 ± 0.6	5.9 ± 0.6

Table C-IX.2 MEAN QUARTERLY DLR RESULTS FOR THE SITE BOUNDARY, MIDDLE AND CONTROL LOCATIONS FOR LIMERICK GENERATING STATION, 2016

RESULTS IN UNITS OF MILLIROENTGEN/STANDARD MONTH ± 2 STANDARD DEVIATIONS OF THE STATION DATA

COLLECTION PERIOD	SITE BOUNDARY ± 2 S.D.	MIDDLE ± 2 S.D.	CONTROL ± 2 S.D.
JAN-MAR	5.3 ± 1.6	4.9 ± 1.2	6.2 ± 0
APR-JUN	5.7 ± 1.6	5.2 ± 1.3	6.7 ± 0
JUL-SEP	5.8 ± 1.5	5.5 ± 1.5	7.3 ± 0
OCT-DEC	5.8 ± 1.7	6.4 ± 3.0	7.0 ± 0

Table C-IX.3 SUMMARY OF THE AMBIENT DOSIMETRY PROGRAM FOR LIMERICK GENERATING STATION, 2016

RESULTS IN UNITS OF MILLIROENTGEN/STANDARD MONTH ± 2 STANDARD DEVIATIONS OF THE STATION DATA

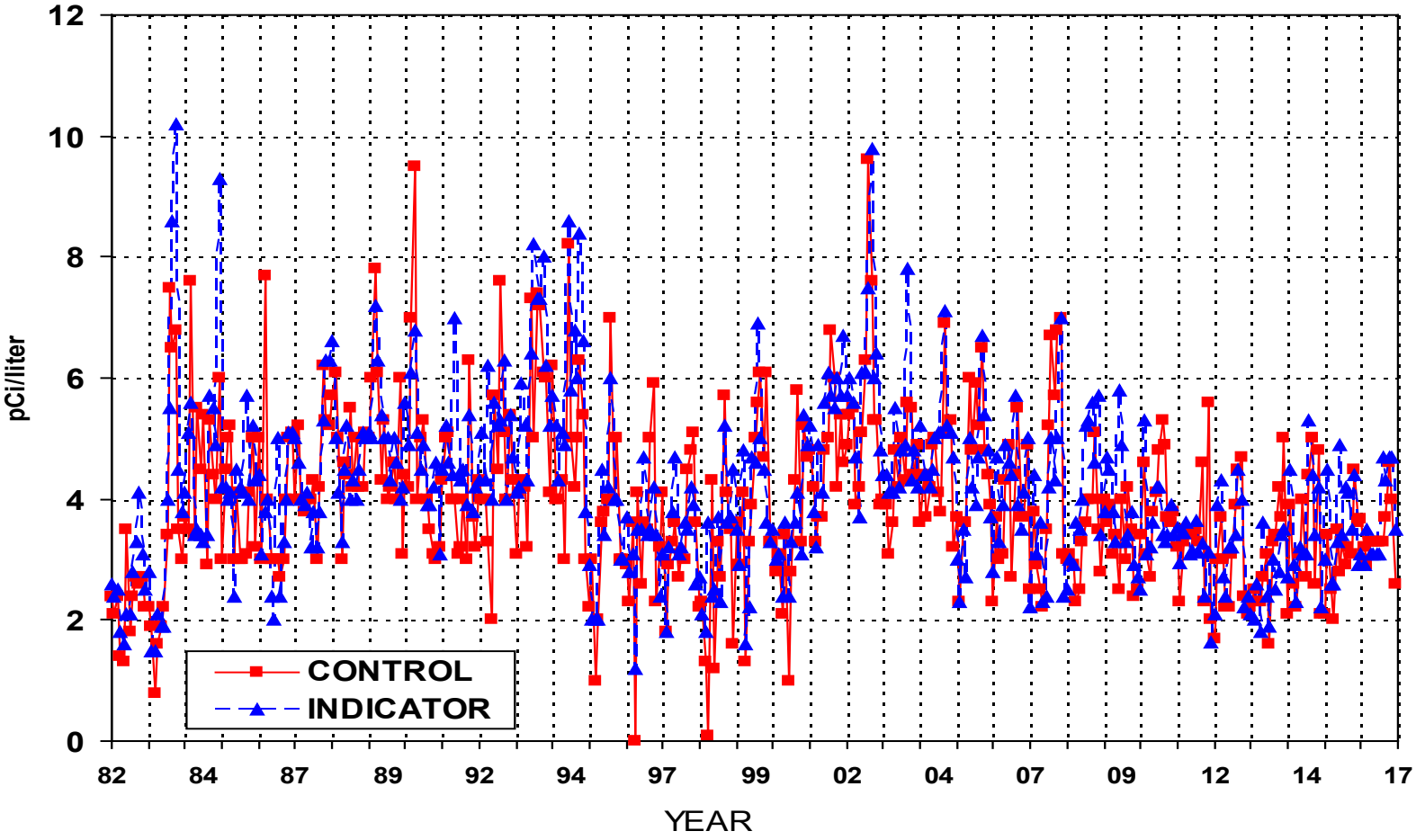
LOCATION	SAMPLES ANALYZED	PERIOD MINIMUM	PERIOD MAXIMUM	PERIOD MEAN ± 2 S.D.
SITE BOUNDARY	128	4.4	8.0	6.2 ± 5.1
MIDDLE	184	3.6	9.8	6.7 ± 8.8
CONTROL	8	6.0	7.2	6.8 ± 1.1

SITE BOUNDARY STATIONS - 10S3, 11S1, 13S2, 14S1, 18S2, 21S2, 23S2, 25S2, 26S3, 29S1, 31S1, 34S2, 36S2, 3S1, 5S1, 7S1

MIDDLE STATIONS - 10E1, 10F3, 13C1, 13E1, 15D1, 16F1, 17B1, 19D1, 20D1, 20F1, 24D1, 25D1, 28D2, 29E1, 2E1, 31D1, 31D2, 34E1, 36D1, 4E1, 6C1, 7E1, 9C1

CONTROL STATIONS - 5H1

FIGURE C-1
MEAN MONTHLY TOTAL GROSS BETA CONCENTRATIONS IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LGS, 1982 - 2016



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 – 2016

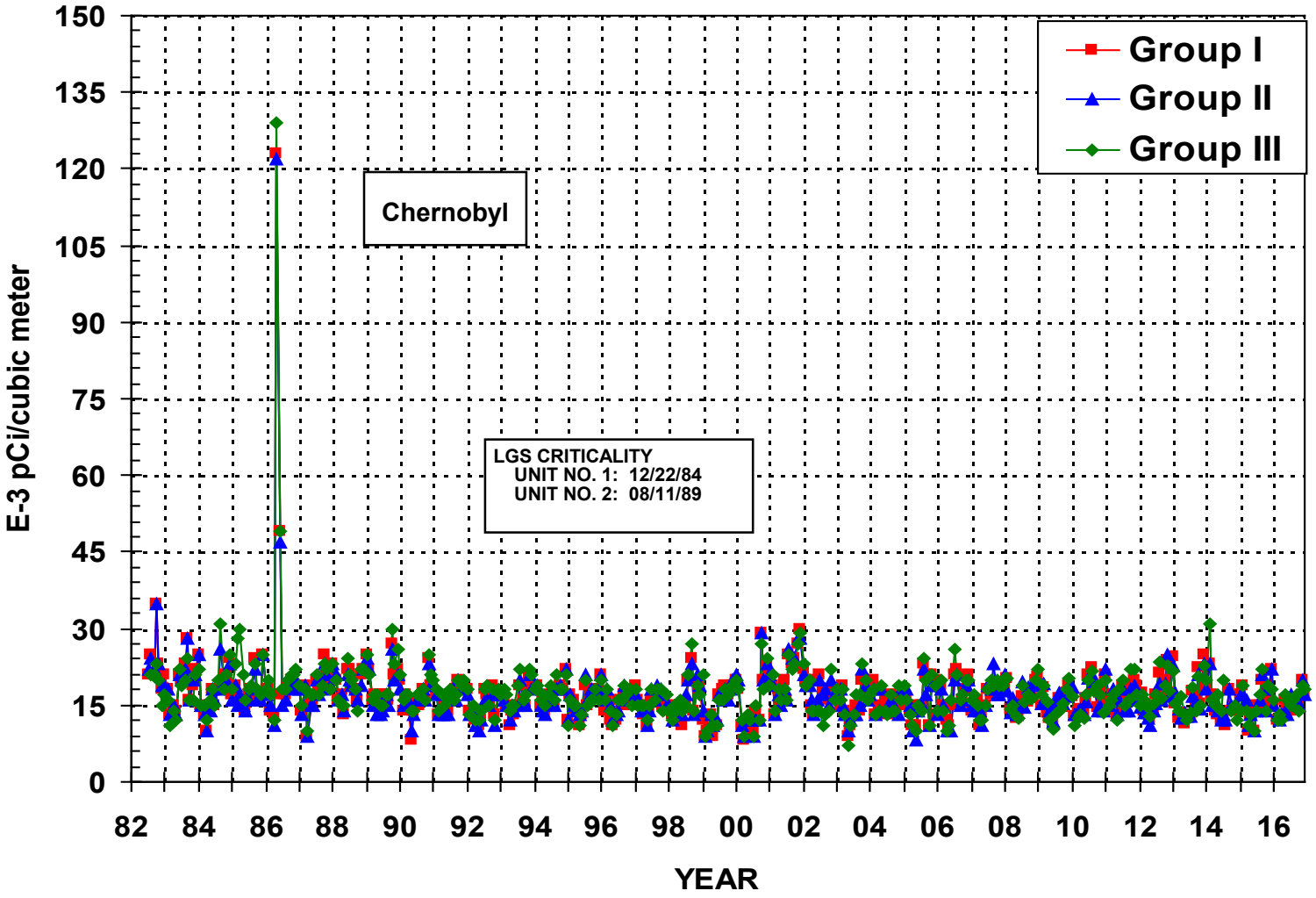


FIGURE C-3
MEAN WEEKLY GROSS BETA CONCENTRATIONS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LGS, 2016

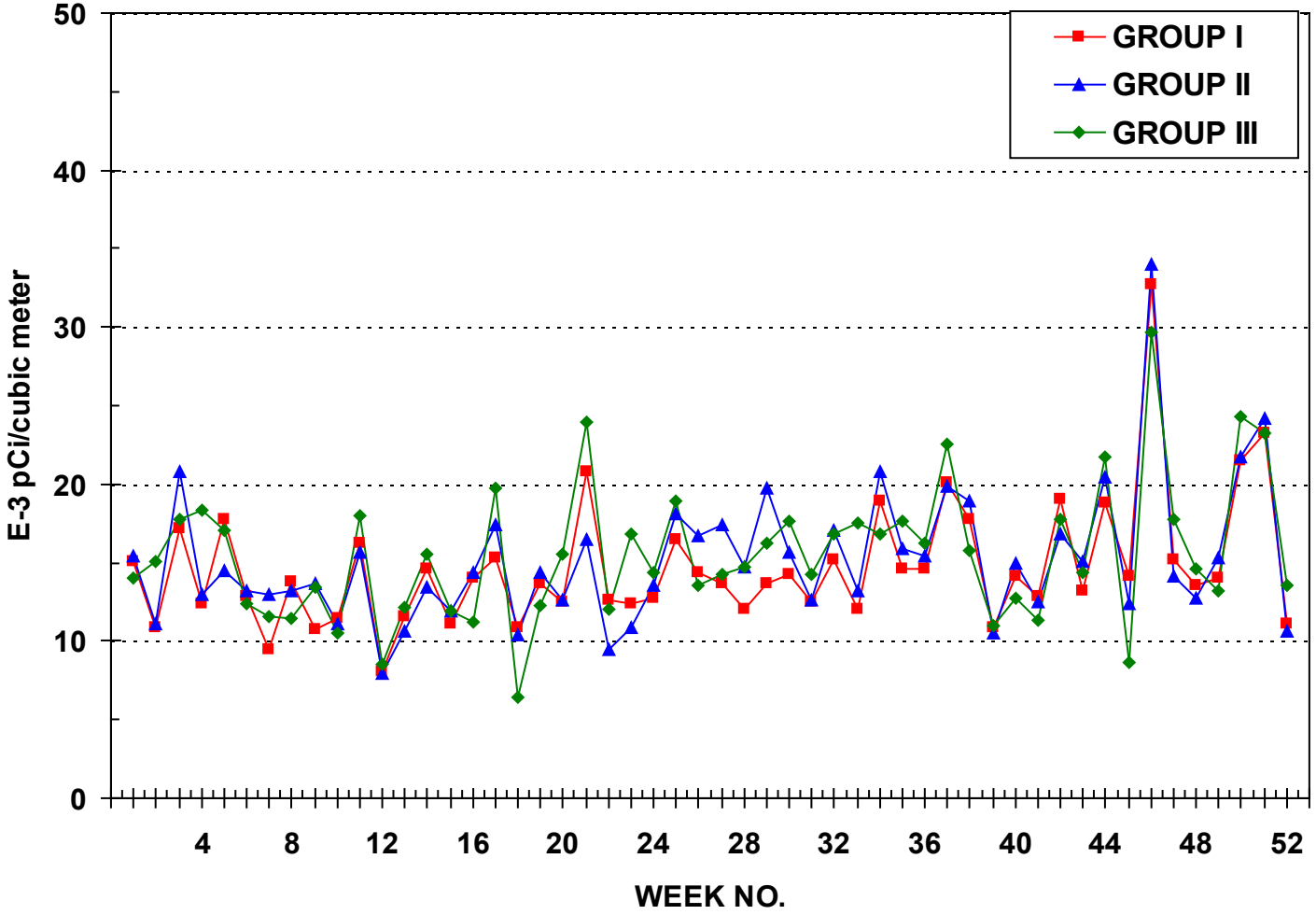
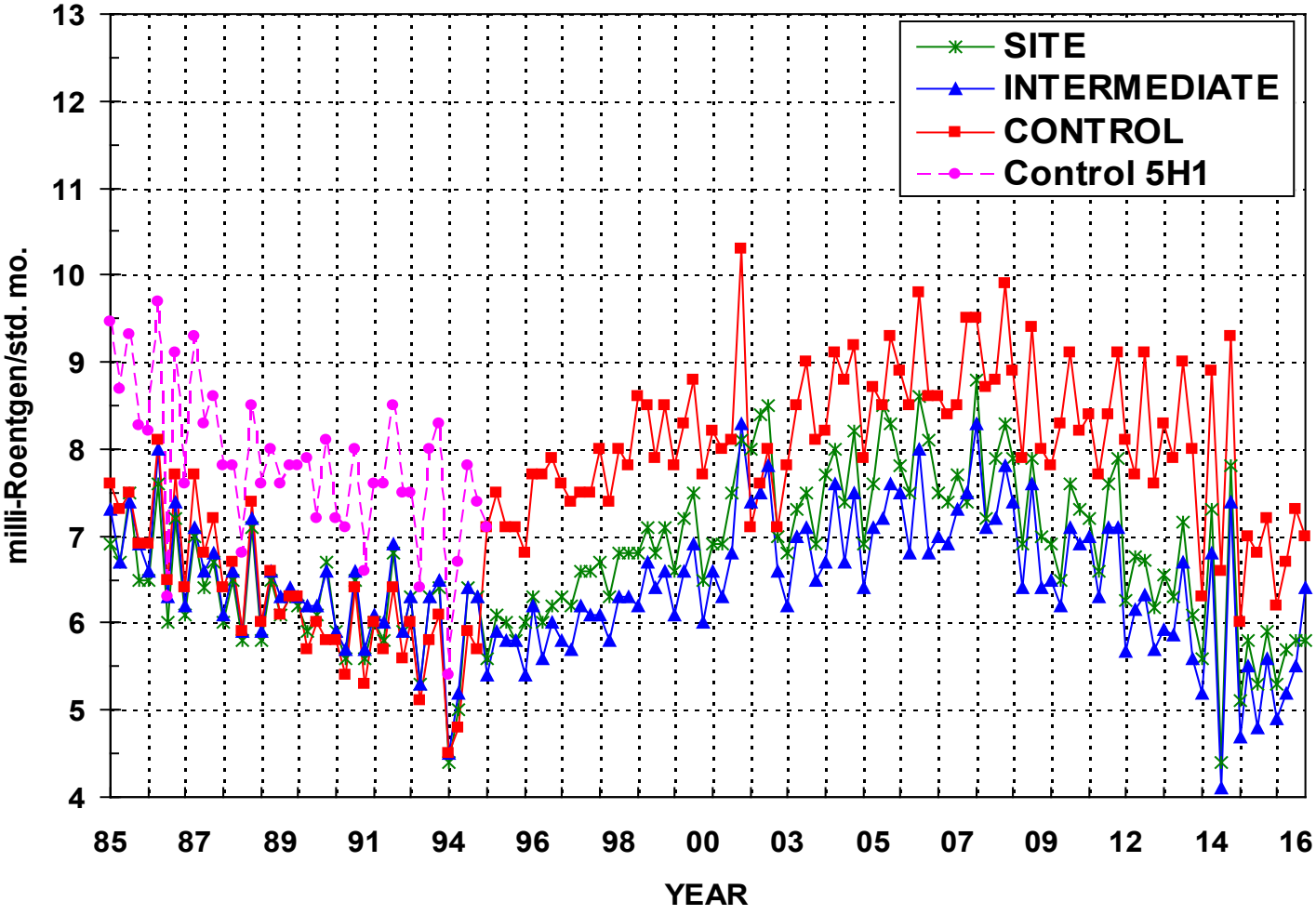


FIGURE C-4
MEAN QUARTERLY AMBIENT GAMMA RADIATION LEVELS (DLR) IN THE VICINITY OF LGS, 1985 – 2016

NOTE: Control Station 5H1 became the only distant location beginning in 1995



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, 2016

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	16C2
12/28/15 - 02/02/16	2.3 ± 1.0
02/02/16 - 03/01/16	< 0.9
03/01/16 - 03/29/16	2.1 ± 0.9
03/29/16 - 05/02/16	0.8 ± 0.5
05/02/16 - 05/31/16	< 1.8
05/31/16 - 06/27/16	1.7 ± 0.7
06/27/16 - 08/02/16	2.3 ± 1.0
08/02/16 - 08/30/16	3.9 ± 1.1
08/30/16 - 10/03/16	2.6 ± 1.0
10/03/16 - 11/01/16	< 0.7
11/01/16 - 11/28/16	2.7 ± 1.0
11/29/16 - 12/27/16	2.9 ± 0.8
MEAN ± 2 STD DEV	2.4 ± 1.7

TABLE D-I.2 CONCENTRATIONS OF I-131 IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2016

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	16C2	
12/28/15 - 02/02/16	< 0.2	
02/02/16 - 03/01/16	< 0.4	
03/01/16 - 03/29/16	< 0.2	
03/29/16 - 05/02/16	< 0.2	
05/02/16 - 05/31/16	< 0.4	
05/31/16 - 06/27/16	< 0.4	
06/27/16 - 08/02/16	< 0.2	
08/02/16 - 08/30/16	< 0.3	
08/30/16 - 10/03/16	< 0.5	
10/03/16 - 11/01/16	1.1 ± 0.1	*Original*
10/03/16 - 11/01/16	0.6 ± 0.2	*Reanalysis*
11/01/16 - 11/28/16	0.4 ± 0.1	
11/29/16 - 12/27/16	0.4 ± 0.1	
MEAN ± 2 STD DEV	0.6 ± 0.8	

TABLE D-I.3 CONCENTRATIONS OF TRITIUM IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2016

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	16C2
12/28/15 - 03/29/16	< 146
03/29/16 - 06/27/16	< 147
06/27/16 - 10/03/16	< 142
10/03/16 - 12/28/16	< 154
MEAN	-

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

TABLE D-I.4 **CONCENTRATIONS OF GAMMA EMITTERS IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2016**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Zr-95	Nb-95	I-131	Cs-134	Cs-137	Ba-140	La-140
16C2	12/28/15 - 02/02/16	< 2	< 2	< 4	< 2	< 4	< 5	< 3	< 8	< 2	< 2	< 13	< 4
	02/02/16 - 03/01/16	< 2	< 3	< 5	< 3	< 6	< 3	< 3	< 4	< 3	< 3	< 10	< 1
	03/01/16 - 03/29/16	< 3	< 2	< 4	< 2	< 4	< 6	< 3	< 7	< 3	< 3	< 17	< 5
	03/29/16 - 05/02/16	< 2	< 3	< 4	< 2	< 5	< 5	< 4	< 6	< 3	< 3	< 10	< 2
	05/02/16 - 05/31/16	< 2	< 3	< 6	< 2	< 5	< 4	< 3	< 4	< 3	< 2	< 10	< 2
	05/31/16 - 06/27/16	< 1	< 1	< 4	< 2	< 3	< 3	< 3	< 5	< 2	< 2	< 13	< 4
	06/27/16 - 08/02/16	< 1	< 1	< 2	< 1	< 2	< 2	< 2	< 7	< 1	< 1	< 10	< 4
	08/02/16 - 08/30/16	< 2	< 2	< 5	< 2	< 4	< 4	< 4	< 11	< 2	< 2	< 20	< 4
	08/30/16 - 10/03/16	< 2	< 3	< 5	< 1	< 3	< 4	< 3	< 11	< 2	< 3	< 21	< 6
	10/03/16 - 11/01/16	< 2	< 4	< 6	< 3	< 5	< 7	< 3	< 8	< 4	< 4	< 20	< 3
	11/01/16 - 11/28/16	< 2	< 2	< 4	< 2	< 4	< 4	< 3	< 15	< 2	< 2	< 22	< 6
	11/28/16 - 12/27/16	< 3	< 1	< 4	< 2	< 5	< 4	< 3	< 3	< 2	< 3	< 8	< 4
	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, 2016

RESULTS IN UNITS OF E-3 PCI/CU METER ± 2 SIGMA

COLLECTION PERIOD	11S2 GROSS BETA	11S2 I-131
12/28/15 - 01/04/16	22 ± 5	< 13
01/04/16 - 01/11/16	25 ± 5	< 21
01/11/16 - 01/19/16	31 ± 5	< 15
01/19/16 - 01/26/16	17 ± 5	< 19
01/26/16 - 02/01/16	26 ± 6	< 15
02/01/16 - 02/08/16	24 ± 5	< 19
02/08/16 - 02/14/16	11 ± 5	< 20
02/14/16 - 02/22/16	20 ± 4	< 12
02/22/16 - 02/29/16	20 ± 5	< 17
02/29/16 - 03/07/16	20 ± 5	< 15
03/07/16 - 03/14/16	27 ± 5	< 14
03/14/16 - 03/21/16	12 ± 4	< 10
03/21/16 - 03/28/16	20 ± 5	< 12
03/28/16 - 04/04/16	27 ± 5	< 15
04/04/16 - 04/11/16	21 ± 5	< 10
04/11/16 - 04/18/16	22 ± 5	< 19
04/18/16 - 04/25/16	27 ± 5	< 12
04/25/16 - 05/03/16	18 ± 4	< 17
05/03/16 - 05/09/16	6 ± 4	< 13
05/09/16 - 05/16/16	15 ± 4	< 16
05/16/16 - 05/23/16	15 ± 4	< 14
05/23/16 - 05/31/16	33 ± 5	< 13
05/31/16 - 06/06/16	22 ± 5	< 15
06/06/16 - 06/13/16	21 ± 4	< 17
06/13/16 - 06/20/16	20 ± 4	< 17
06/20/16 - 06/28/16	30 ± 4	< 13
06/28/16 - 07/05/16	25 ± 5	< 17
07/05/16 - 07/11/16	27 ± 5	< 22
07/11/16 - 07/19/16	28 ± 4	< 10
07/19/16 - 07/25/16	27 ± 5	< 17
07/25/16 - 08/01/16	30 ± 5	< 9
08/01/16 - 08/08/16	19 ± 4	< 9
08/08/16 - 08/15/16	16 ± 4	< 17
08/15/16 - 08/22/16	23 ± 5	< 15
08/22/16 - 08/29/16	28 ± 5	< 13
08/29/16 - 09/06/16	26 ± 4	< 14
09/06/16 - 09/13/16	29 ± 5	< 18
09/13/16 - 09/19/16	27 ± 5	< 24
09/19/16 - 09/26/16	31 ± 5	< 15
09/26/16 - 10/03/16	14 ± 4	< 15
10/03/16 - 10/11/16	21 ± 4	< 22
10/11/16 - 10/17/16	27 ± 5	< 14
10/17/16 - 10/24/16	30 ± 5	< 23
10/24/16 - 10/31/16	21 ± 5	< 15
10/31/16 - 11/07/16	25 ± 5	< 19
11/07/16 - 11/14/16	20 ± 5	< 18
11/14/16 - 11/21/16	51 ± 6	< 17
11/21/16 - 11/28/16	28 ± 5	< 20
11/28/16 - 12/05/16	26 ± 5	< 13
12/05/16 - 12/12/16	17 ± 4	< 10
12/12/16 - 12/19/16	32 ± 5	< 12
12/19/16 - 12/27/16	34 ± 5	< 16
12/27/16 - 01/03/17	26 ± 5	< 18
MEAN ± 2 STD DEV	24 ± 14	-

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

TABLE D-II.2 CONCENTRATIONS OF GAMMA EMITTERS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF LIMERICK GENERATING STATION, 2016

RESULTS IN UNITS OF E-3 PCI/CU METER ± 2 SIGMA

SITE	COLLECTION PERIOD	Be-7	Mn-54	Co-58	Co-60	Cs-134	Cs-137
11S2	12/28/15 - 03/28/16	75 ± 16	< 0.9	< 1.2	< 0.7	< 0.8	< 0.5
	03/28/16 - 06/28/16	106 ± 15	< 0.6	< 0.7	< 0.4	< 0.6	< 0.5
	06/28/16 - 10/03/16	83 ± 16	< 0.8	< 0.9	< 0.6	< 0.8	< 0.5
	10/03/16 - 01/03/17	66 ± 16	< 0.8	< 0.7	< 0.9	< 0.8	< 0.7
	MEAN ± 2 STD DEV	83 ± 34	-	-	-	-	-

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, 2016

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	I-131	K-40	Cs-134	Cs-137	Ba-140	La-140
19B1	01/12/16	< 0.3	1298 ± 114	< 3	< 5	< 17	< 6
	04/05/16	< 0.4	1304 ± 93	< 3	< 3	< 25	< 4
	07/12/16	< 0.2	1337 ± 96	< 3	< 2	< 33	< 6
	10/04/16	< 0.2	1284 ± 51	< 1	< 1	< 23	< 3
MEAN ± 2 STD DEV		-	1306 ± 45	-	-	-	-
25C1	01/12/16	< 0.2	1373 ± 160	< 5	< 5	< 23	< 5
	04/05/16	< 0.3	1337 ± 102	< 3	< 4	< 20	< 20
	07/12/16	< 0.2	1361 ± 87	< 2	< 2	< 25	< 9
	10/04/16	< 0.4	1379 ± 109	< 3	< 3	< 37	< 5
MEAN ± 2 STD DEV		-	1363 ± 38	-	-	-	-

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, 2016

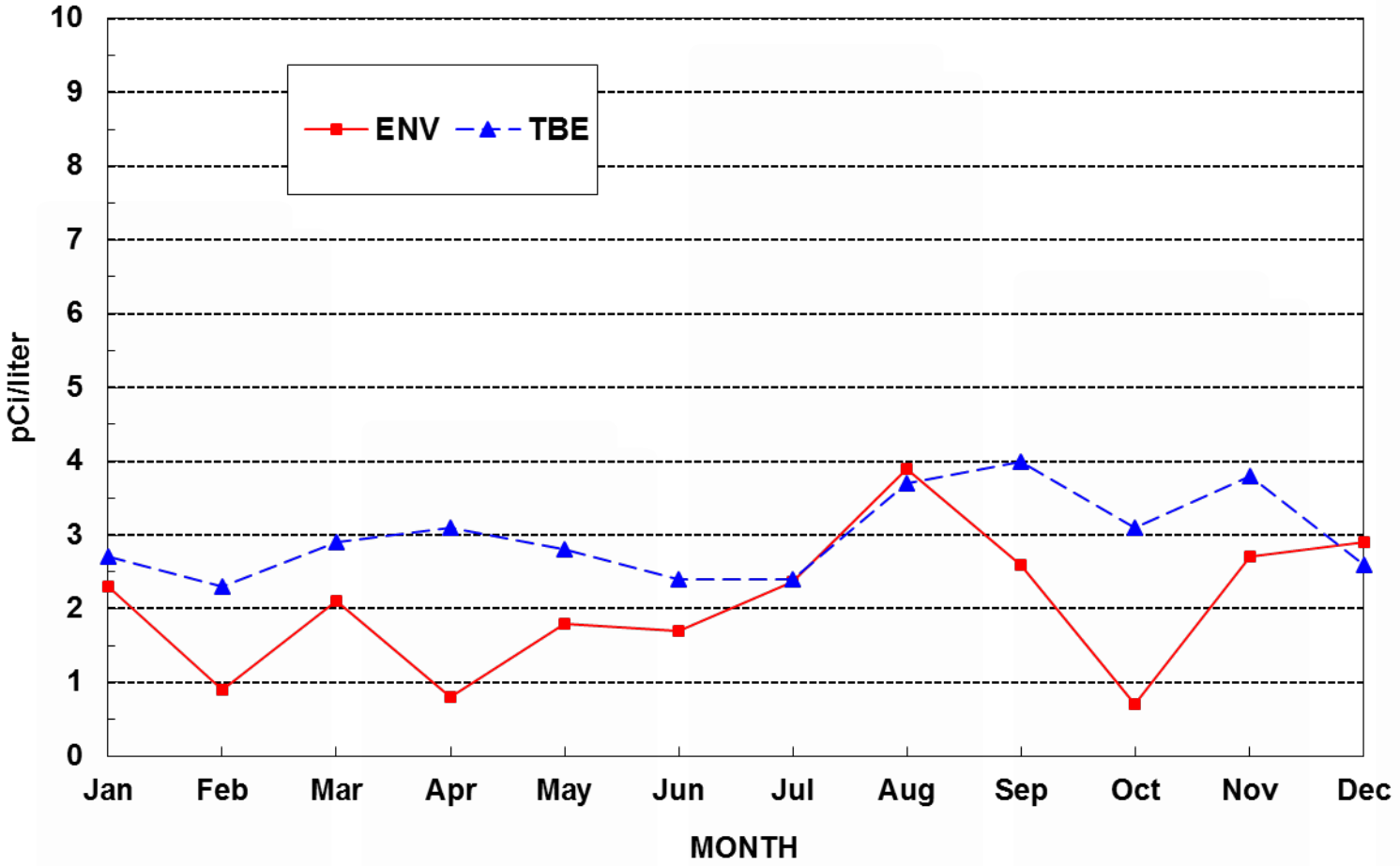
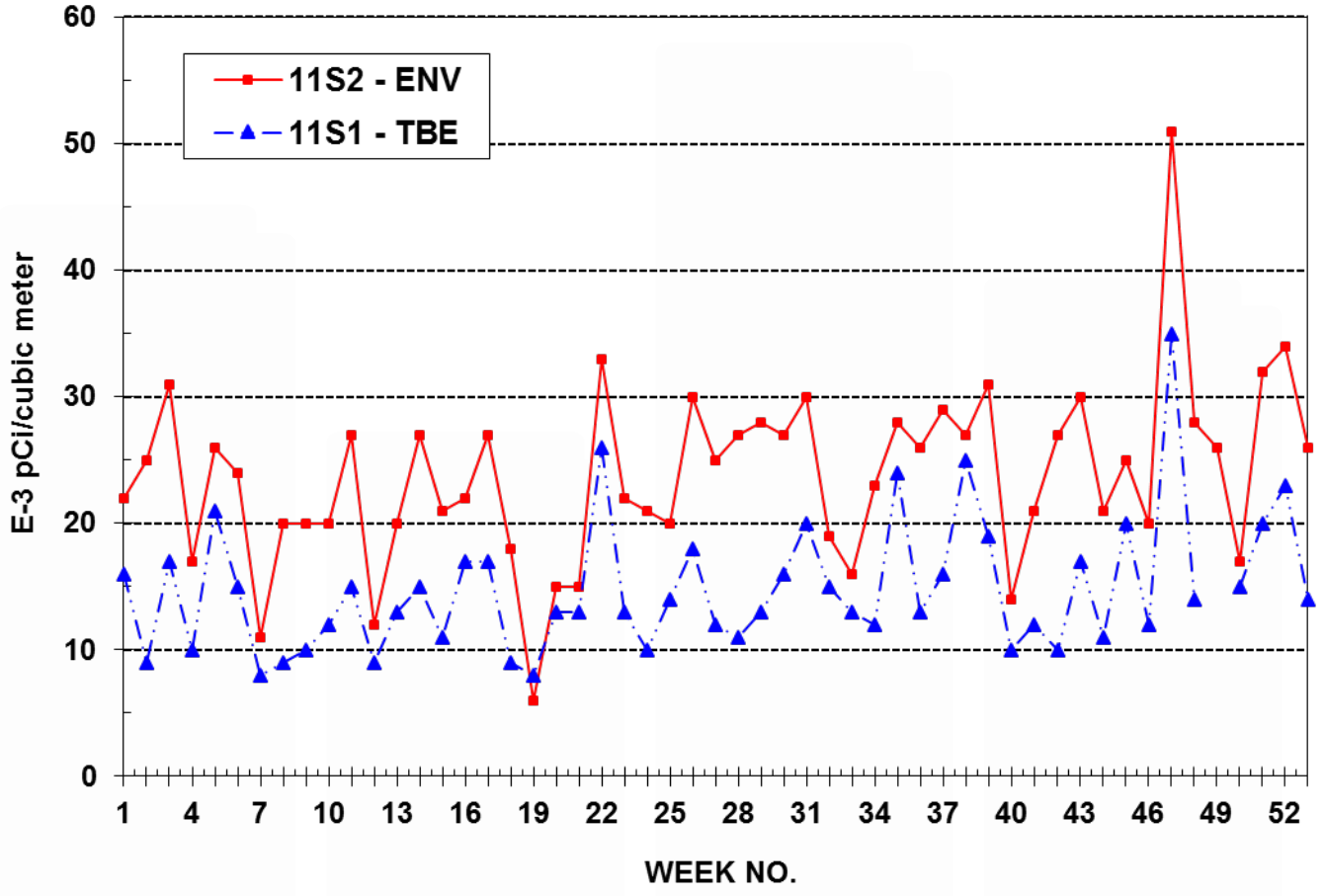


FIGURE D-2
COMPARISON OF WEEKLY GROSS BETA CONCENTRATIONS IN AIR PARTICULATE SAMPLES COLLECTED FROM LGS COLLOCATED LOCATIONS 11S1 AND 11S2, 2016



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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	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
March 2016	E11476	Milk	Sr-89	pCi/L	97	86.7	1.12	A
			Sr-90	pCi/L	15	11.4	1.32	N(2)
	E11477	Milk	I-131	pCi/L	85.9	82.2	1.05	A
			Ce-141	pCi/L	106	98.4	1.08	A
			Cr-51	pCi/L	255	243	1.05	A
			Cs-134	pCi/L	134	130	1.03	A
			Cs-137	pCi/L	174	161	1.08	A
			Co-58	pCi/L	123	117	1.05	A
			Mn-54	pCi/L	141	117	1.21	W
			Fe-59	pCi/L	152	131	1.16	A
			Zn-65	pCi/L	193	179	1.08	A
			Co-60	pCi/L	259	244	1.06	A
	E11479	AP	Ce-141	pCi	69	81.1	0.85	A
			Cr-51	pCi	242	201	1.20	W
			Cs-134	pCi	98.1	107.0	0.92	A
			Cs-137	pCi	136	133	1.02	A
			Co-58	pCi	91.9	97	0.95	A
			Mn-54	pCi	98.6	96.2	1.02	A
			Fe-59	pCi	98.8	108	0.91	A
			Zn-65	pCi	131	147	0.89	A
			Co-60	pCi	209	201	1.04	A
	E11478	Charcoal	I-131	pCi	85.3	88.3	0.97	A
	E11480	Water	Fe-55	pCi/L	1800	1666	1.08	A
June 2016	E11537	Milk	Sr-89	pCi/L	94.4	94.4	1.00	A
			Sr-90	pCi/L	13.4	15.4	0.87	A
	E11538	Milk	I-131	pCi/L	96.8	94.5	1.02	A
			Ce-141	pCi/L	129	139	0.93	A
			Cr-51	pCi/L	240	276	0.87	A
			Cs-134	pCi/L	157	174	0.90	A
			Cs-137	pCi/L	117	120	0.98	A
			Co-58	pCi/L	131	142	0.92	A
			Mn-54	pCi/L	128	125	1.02	A
			Fe-59	pCi/L	132	122	1.08	A
			Zn-65	pCi/L	235	235	1.00	A
			Co-60	pCi/L	169	173	0.98	A
June 2016	E11539	Charcoal	I-131	pCi	86.1	89.4	0.96	A
	E11540	AP	Ce-141	pCi	105	99.8	1.05	A
			Cr-51	pCi	216	198.0	1.09	A
			Cs-134	pCi	113	125	0.90	A
			Cs-137	pCi	94.5	86.6	1.09	A
			Co-58	pCi	101	102	0.99	A
			Mn-54	pCi	88.8	90.2	0.98	A
			Fe-59	pCi	82	87.5	0.94	A
			Zn-65	pCi	174	169	1.03	A
			Co-60	pCi	143	124	1.15	A
	E11541	Water	Fe-55	pCi/L	164	186	0.88	A

TABLE E-1 **ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM**
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES
(PAGE 2 OF 3)

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
September 2016	E11609	Milk	Sr-89	pCi/L	90	90.9	0.99	A
			Sr-90	pCi/L	13.3	13.7	0.97	A
	E11610	Milk	I-131	pCi/L	80.4	71.9	1.12	A
			Ce-141	pCi/L	81.3	93	0.87	A
			Cr-51	pCi/L	198	236	0.84	A
			Cs-134	pCi/L	122	136	0.90	A
			Cs-137	pCi/L	119	119	1.00	A
			Co-58	pCi/L	92.2	97.4	0.95	A
			Mn-54	pCi/L	156	152	1.03	A
			Fe-59	pCi/L	97.5	90.6	1.08	A
			Zn-65	pCi/L	189	179	1.06	A
			Co-60	pCi/L	131	135	0.97	A
	E11611	Charcoal	I-131	pCi	52.4	59.9	0.87	A
	E11612	AP	Ce-141	pCi	67.5	63.6	1.06	A
			Cr-51	pCi	192	161.0	1.19	A
			Cs-134	pCi	91.4	92.6	0.99	A
			Cs-137	pCi	93.9	80.8	1.16	A
			Co-58	pCi	66	66.4	0.99	A
			Mn-54	pCi	104	104	1.00	A
			Fe-59	pCi	60.5	61.8	0.98	A
			Zn-65	pCi	140	122	1.15	A
			Co-60	pCi	119	91.9	1.29	W
	E11613	Water	Fe-55	pCi/L	1990	1670	1.19	A
	E11614	Soil	Ce-141	pCi/g	0.153	0.175	0.87	A
			Cr-51	pCi/g	0.482	0.441	1.09	A
			Cs-134	pCi/g	0.270	0.254	1.06	A
			Cs-137	pCi/g	0.313	0.299	1.05	A
			Co-58	pCi/g	0.177	0.182	0.97	A
			Mn-54	pCi/g	0.340	0.285	1.19	A
			Fe-59	pCi/g	0.206	0.17	1.21	W
			Zn-65	pCi/g	0.388	0.335	1.16	A
			Co-60	pCi/g	0.284	0.252	1.13	A
December 2016	E11699	Milk	Sr-89	pCi/L	95	74.2	1.28	W
			Sr-90	pCi/L	14.7	10	1.47	N(3)
	E11700	Milk	I-131	pCi/L	97.5	97.4	1.00	A
			Ce-141	pCi/L	136	143	0.95	A
			Cr-51	pCi/L	247	280	0.88	A
			Cs-134	pCi/L	164	178	0.92	A
			Cs-137	pCi/L	120	126	0.95	A
			Co-58	pCi/L	139	146	0.95	A
			Mn-54	pCi/L	126	129	0.98	A
			Fe-59	pCi/L	114	125	0.91	A
			Zn-65	pCi/L	237	244	0.97	A
			Co-60	pCi/L	168	178	0.94	A
	E11701	Charcoal	I-131	pCi	95.6	98	0.98	A

TABLE E-1 **ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM**
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
December 2016	E11702	AP	Ce-141	pCi	91.7	97.7	0.94	A
			Cr-51	pCi	210	192.0	1.09	A
			Cs-134	pCi	122	122	1.00	A
			Cs-137	pCi	93.9	86.4	1.09	A
			Co-58	pCi	92	100	0.92	A
			Mn-54	pCi	93.7	88.5	1.06	A
			Fe-59	pCi	84.9	84.5	1.00	A
			Zn-65	pCi	176	167	1.05	A
			Co-60	pCi	151	122	1.24	W
	E11702	AP	Sr-89	pCi	79.1	92	0.86	A
			Sr-90	pCi	10	12.5	0.80	A
	E11703	Water	Fe-55	pCi/L	2180	1800	1.21	W

(a) Teledyne Brown Engineering reported result.

(b) 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.

(c) Ratio of Teledyne Brown Engineering to Analytics results.

(d) 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.

(2) NCR 16-26 was initiated

(3) NCR 16-35 was initiated

TABLE E-2 **DOE's MIXED ANALYTE PERFORMANCE EVALUATION PROGRAM (MAPEP)**
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Month/Year	Identification Number	Media	Nuclide	Units	Reported Value (a)	Known Value (b)	Acceptance Range	Evaluation (c)
March 2016	16-MaW34	Water	Am-241	Bq/L	0.008		(1)	A
			Ni-63	Bq/L	12.4	12.3	8.6-16.0	A
			Pu-238	Bq/L	1.4900	1.2440	0.871-1.617	A
			Pu-239/240	Bq/L	0.729	0.641	0.449-0.833	A
	16-MaS34	Soil	Ni-63	Bq/kg	1140	1250.0	875-1625	A
			Sr-90	Bq/kg	8.15		(1)	A
	16-RdF34	AP	U-234/233	Bq/sample	0.1620	0.1650	0.116-0.215	A
			U-238	Bq/sample	0.163	0.172	0.120-0.224	A
	16-GrF34	AP	Gr-A	Bq/sample	0.608	1.20	0.36-2.04	A
			Gr-B	Bq/sample	0.8060	0.79	0.40-1.19	A
	16-RdV34	Vegetation	Cs-134	Bq/sample	10.10	10.62	7.43-13.81	A
			Cs-137	Bq/sample	6.0	5.62	3.93-7.31	A
			Co-57	Bq/sample	13.3000	11.8	8.3-15.3	A
			Co-60	Bq/sample	0.013		(1)	A
			Mn-54	Bq/sample	0.0150		(1)	A
			Sr-90	Bq/sample	0.301		(1)	N(4)
			Zn-65	Bq/sample	10.500	9.6	6.7-12.5	A
September 2016	16-MaW35	Water	Am-241	Bq/L	0.626	0.814	.570-1058	W
			Ni-63	Bq/L	12.4	17.2	12.0-22.4	A
			Pu-238	Bq/L	1.23	1.13	0.79-1.47	W
			Pu-239/240	Bq/L	0.0318	0.013	(1)	A
	16-MaS35	Soil	Ni-63	Bq/kg	724	990	693-1287	A
			Sr-90	Bq/kg	747	894	626-1162	A
	16-RdF35	AP	U-234/233	Bq/sample	0.160	0.15	0.105-0.195	A
			U-238	Bq/sample	0.157	0.156	0.109-0.203	A
	16-RdV35	Vegetation	Cs-134	Bq/sample	-0.103		(1)	A
			Cs-137	Bq/sample	5.64	5.54	3.88-7.20	A
			Co-57	Bq/sample	7.38	6.81	4.77-8.85	A
			Co-60	Bq/sample	4.81	4.86	3.40-6.32	A
			Mn-54	Bq/sample	7.4	7.27	5.09-9.45	A
			Sr-90	Bq/sample	0.774	0.80	0.56-1.04	A
			Zn-65	Bq/sample	5.46	5.4	3.78-7.02	A

(1) False positive test.

(a) Teledyne Brown Engineering reported result.

(b) 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.

(c) DOE/MAPEP evaluation: A=acceptable, W=acceptable with warning, N=not acceptable.

(4)NCR 16-14 was initiated

TABLE E-3

ERA ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Month/Year	Identification Number	Media	Nuclide	Units	Reported Value (a)	Known Value (b)	Acceptance Limits	Evaluation (c)
May 2016	RAD-105	Water	Sr-89	pCi/L	48.9	48.2	37.8 - 55.6	A
			Sr-90	pCi/L	25.0	28.5	20.7 - 33.1	A
			Ba-133	pCi/L	53.1	58.8	48.7 - 64.9	A
			Cs-134	pCi/L	40.9	43.3	34.6 - 47.6	A
			Cs-137	pCi/L	84.8	78.4	70.6 - 88.9	A
			Co-60	pCi/L	108	102	91.8 - 114	A
			Zn-65	pCi/L	226	214	193 - 251	A
			Gr-A	pCi/L	38.9	62.7	32.9 - 77.8	A
			Gr-B	pCi/L	41.9	39.2	26.0 - 46.7	A
			I-131	pCi/L	24.1	26.6	22.1 - 31.3	A
			U-Nat	pCi/L	4.68	4.64	3.39 - 5.68	A
			H-3	pCi/L	7720	7840	6790 - 8620	A
November 2016	RAD-107	Water	Sr-89	pCi/L	43.0	43.3	33.4-50.5	A
			Sr-90	pCi/L	30.0	33.6	24.6-38.8	A
			Ba-133	pCi/L	47.8	54.9	45.4-60.7	A
			Cs-134	pCi/L	72.9	81.8	67.0-90.0	A
			Cs-137	pCi/L	189	210	189-233	A
			Co-60	pCi/L	58.4	64.5	58.0-73.4	A
			Zn-65	pCi/L	243	245	220-287	A
			Gr-A	pCi/L	37.2	68.4	35.9-84.5	A
			Gr-B	pCi/L	35.1	33.9	22.1-41.6	A
			I-131	pCi/L	23.5	26.3	21.9-31.0	A
			U-Nat	pCi/L	49.2	51.2	41.6-56.9	A
			H-3	pCi/L	918	9820	8540-10800	N(5)
	MRAD-25	AP	Gr-A	pCi/Filter	56.8	71.2	23.9-111	A

(a) Teledyne Brown Engineering reported result.

(b) 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.

(c) ERA evaluation: A=acceptable. Reported result falls within the Warning Limits. NA=not acceptable. Reported result falls outside of the Control Limits. CE=check for Error. Reported result falls within the Control Limits and outside of the Warning Limit.

(5) NCR 16-34 was initiated

TABLE E-4 **ERA STATISTICAL SUMMARY PROFICIENCY TESTING PROGRAM[a]**

MRAD Study, ENVIRONMENTAL, INC., 2016

			Concentration [a]			
Lab Code [b]	Date	Analysis	Laboratory Result	ERA Result	Control Limits	Acceptance
ERAP-1101	3/14/2016	Am-241	37.3	45.9	28.3 - 62.1	Pass
ERAP-1101	3/14/2016	Co-60	637	623	482 - 778	Pass
ERAP-1101	3/14/2016	Cs-134	251	304	193 - 377	Pass
ERAP-1101	3/14/2016	Cs-137	1,273	1,150	864 - 1,510	Pass
ERAP-1101	3/14/2016	Fe-55	< 162	126	39.1 - 246	Pass
ERAP-1101	3/14/2016	Mn-54	< 2.64	< 50.0	0.00 - 50.0	Pass
ERAP-1101	3/14/2016	Pu-238	68.0	70.5	48.3 - 92.7	Pass
ERAP-1101	3/14/2016	Pu-239/240	54.1	54.8	39.70 - 71.60	Pass
ERAP-1101	3/14/2016	Sr-90	139	150	73.3 - 225.0	Pass
ERAP-1101	3/14/2016	U-233/234	59.3	64.8	40.2 - 97.7	Pass
ERAP-1101	3/14/2016	U-238	55.5	64.2	41.5 - 88.8	Pass
ERAP-1101	3/14/2016	Zn-65	428	356	255 - 492	Pass
ERAP-1101	3/14/2016	Gr. Alpha	98.0	70.1	23.5 - 109	Pass
ERAP-1101	3/14/2016	Gr. Beta	78.6	54.4	34.4 - 79.3	Pass
ERSO-1105	3/14/2016	Am-241	1,030	1,360	796 - 1,770	Pass
ERSO-1105	3/14/2016	Ac-228	1,540	1,240	795 - 1,720	Pass
ERSO-1105	3/14/2016	Bi-212	1,550	1,240	330 - 1,820	Pass
ERSO-1105	3/14/2016	Bi-214	3,100	3,530	2,130 - 5,080	Pass
ERSO-1105	3/14/2016	Co-60	5,600	5,490	3,710 - 7,560	Pass
ERSO-1105	3/14/2016	Cs-134	3,030	3,450	2,260 - 4,140	Pass
ERSO-1105	3/14/2016	Cs-137	4,440	4,310	3,300 - 5,550	Pass
ERSO-1105	3/14/2016	K-40	10,300	10,600	7,740 - 14,200	Pass
ERSO-1105	3/14/2016	Mn-54	< 50.8	< 1000	0.0 - 1,000	Pass
ERSO-1105	3/14/2016	Pb-212	1,140	1,240	812 - 1,730	Pass
ERSO-1105	3/14/2016	Pb-214	3,190	3,710	2,170 - 5,530	Pass
ERSO-1105	3/14/2016	Pu-238	680	658	396 - 908	Pass
ERSO-1105	3/14/2016	Pu-239/240	460	496	324 - 0,685	Pass
ERSO-1105	3/14/2016	Sr-90	7,740	8,560	3,260 - 13,500	Pass
ERSO-1105	3/14/2016	Th-234	3,630	3,430	1,080 - 6,450	Pass
ERSO-1105	3/14/2016	U-233/234	3,090	3,460	2,110 - 4,430	Pass
ERSO-1105	3/14/2016	U-238	3,280	3,430	2,120 - 4,350	Pass
ERSO-1105	3/14/2016	Zn-65	2,940	2,450	1,950 - 3,260	Pass
ERW-1115	3/14/2016	Gr. Alpha	105.0	117.0	41.5 - 181.0	Pass
ERW-1115	3/14/2016	Gr. Beta	76.2	75.5	43.2 - 112.0	Pass
ERW-1117	3/14/2016	H-3	8,870	8,650	5,800 - 12,300	Pass
ERVE-1108	3/14/2016	Am-241	1,930	2,120	1,300 - 2,820	Pass
ERVE-1108	3/14/2016	Cm-244	1,294	1,560	764 - 2,430	Pass
ERVE-1108	3/14/2016	Co-60	1,164	1,100	759 - 1,540	Pass
ERVE-1108	3/14/2016	Cs-134	1,056	1,070	687 - 1,390	Pass
ERVE-1108	3/14/2016	Cs-137	930	838	608 - 1,170	Pass
ERVE-1108	3/14/2016	K-40	32,200	31,000	22,400 - 43,500	Pass
ERVE-1108	3/14/2016	Mn-54	< 24.5	< 300	0.00 - 300	Pass
ERVE-1108	3/14/2016	Zn-65	3,320	2,820	2,030 - 3,960	Pass

TABLE E-4 **ERA STATISTICAL SUMMARY PROFICIENCY TESTING PROGRAM[a]**

MRAD Study, ENVIRONMENTAL, INC., 2016

			Concentration [a]			
Lab Code [b]	Date	Analysis	Laboratory Result	ERA Result	Control Limits	Acceptance
ERVE-1108	3/14/2016	Pu-238	3,410	2,810	1,680 - 3,850	Pass
ERVE-1108	3/14/2016	Pu-239/240	4,120	3,640	2,230 - 5,010	Pass
ERVE-1108	3/14/2016	Sr-90	8,120	8,710	4,960 - 11,500	Pass
ERVE-1108	3/14/2016	U-233/234	4,350	4,160	2,740 - 5,340	Pass
ERVE-1108	3/14/2016	U-238	4,220	4,120	2,750 - 5,230	Pass
ERW-1111	3/14/2016	Am-241	113	121	81.5 - 162	Pass
ERW-1111	3/14/2016	Co-60	1,120	1,050	912 - 1,230	Pass
ERW-1111	3/14/2016	Cs-134	806	842	618 - 968	Pass
ERW-1111	3/14/2016	Cs-137	1,190	1,100	934 - 1,320	Pass
ERW-1111	3/14/2016	Mn-54	< 5.89	< 100	0.00 - 100	Pass
ERW-1111	3/14/2016	Pu-238	159	138	102 - 172	Pass
ERW-1111	3/14/2016	Pu-239/240	113	98.7	76.6 - 124	Pass
ERW-1111	3/14/2016	U-233/234	46.9	52.7	39.6 - 68.0	Pass
ERW-1111	3/14/2016	U-238	50.4	52.3	39.9 - 64.2	Pass
ERW-1111	3/14/2016	Zn-65	1,160	1,010	842 - 1,270	Pass
ERW-1111	3/14/2016	Fe-55	1,600	1,650	984 - 2,240	Pass
ERW-1111	3/14/2016	Sr-90	430	434	283 - 574	Pass

[a] Results obtained by Environmental, Inc., Midwest Laboratory as a participant in the crosscheck program for proficiency testing administered by Environmental Resources Associates, serving as a replacement for studies conducted previously by the Environmental Measurements Laboratory Quality Assessment Program (EML).

[b] Laboratory codes as follows: ERW (water), ERAP (air filter), ERSO (soil), ERVE (vegetation). Results are reported in units of pCi/L, except for air filters (pCi/Filter), vegetation and soil (pCi/kg).

[c] Results are presented as the known values, expected laboratory precision (1 sigma, 1 determination) and control limits as provided by ERA.

TABLE E-5 **DOE's Mixed Analyte Performance Evaluation Program (MAPEP)**
ENVIRONMENTAL, INC., 2016

			Concentration [a]			
Lab Code [b]	Reference Date	Analysis	Laboratory result	Known Activity	Control Limits [c]	Acceptance
MASO-1053	2/1/2016	Ni-63	1,206 ± 20	1250	875 - 1625	Pass
MASO-1053	2/1/2016	Sr-90	0.65 ± 1.27	0.00	NA [c]	Pass
MASO-1053	2/1/2016	Tc-99	0.1 ± 5.5	0.0	NA [c]	Pass
MASO-1053	2/1/2016	Cs-134	908 ± 26	1030	721 - 1339	Pass
MASO-1053	2/1/2016	Cs-137	0.10 ± 6.20	0.00	NA [c]	Pass
MASO-1053	2/1/2016	Co-57	1058 ± 26	992	694 - 1290	Pass
MASO-1053	2/1/2016	Co-60	1229 ± 28	1190	833 - 1547	Pass
MASO-1053	2/1/2016	Mn-54	1235 ± 43	1160	812 - 1508	Pass
MASO-1053	2/1/2016	Zn-65	753 ± 64	692	484 - 900	Pass
MASO-1053	2/1/2016	K-40	753 ± 140	607	425 - 789	Pass
MASO-1053	2/1/2016	Am-241	79 ± 6	103	72 - 134	Pass
MASO-1053	2/1/2016	Pu-238	73.9 ± 9.2	63.6	44.5 - 82.7	Pass
MASO-1053	2/1/2016	Pu-239/240	0.76 ± 1.34	0.21	NA [d]	Pass
MASO-1053	2/1/2016	U-234/233	45.0 ± 5.1	45.9	32.1 - 59.7	Pass
MASO-1053	2/1/2016	U-238	129 ± 9	146	102 - 190	Pass
MAW-989	2/1/2016	Am-241	0.018 ± 0.015	0.00	NA [c]	Pass
MAW-989	2/1/2016	H-3	0.2 ± 2.8	0.0	NA [c]	Pass
MAW-989	2/1/2016	Ni-63	12.8 ± 2.7	12.3	8.6 - 16.0	Pass
MAW-989	2/1/2016	Sr-90	8.70 ± 1.20	8.74	6.12 - 11.36	Pass
MAW-989	2/1/2016	Tc-99	-1.1 ± 0.6	0.0	NA [c]	Pass
MAW-989	2/1/2016	Cs-134	15.5 ± 0.3	16.1	11.3 ± 20.9	Pass
MAW-989	2/1/2016	Cs-137	23.7 ± 0.5	21.2	14.8 - 27.6	Pass
MAW-989[e]	2/1/2016	Co-57	1.38 ± 0.12	0.00	NA [c]	Fail
MAW-989	2/1/2016	Co-60	12.5 ± 0.3	11.8	8.3 - 15.3	Pass
MAW-989	2/1/2016	Mn-54	12.2 ± 0.4	11.1	7.8 - 14.4	Pass
MAW-989	2/1/2016	Zn-65	15.7 ± 0.7	13.6	9.5 - 17.7	Pass
MAW-989	2/1/2016	K-40	288 ± 5	251	176 - 326	Pass
MAW-989	2/1/2016	Fe-55	17.3 ± 7.0	16.2	11.3 - 21.1	Pass
MAW-989	2/1/2016	Ra-226	0.710 ± 0.070	0.718	0.503 - 0.933	Pass
MAW-989	2/1/2016	Pu-238	1.280 ± 0.110	1.244	0.871 ± 1.617	Pass
MAW-989	2/1/2016	Pu-239/240	0.640 ± 0.080	0.641	0.449 - 0.833	Pass
MAW-989	2/1/2016	U-234/233	1.39 ± 0.12	1.48	1.04 - 1.92	Pass
MAW-989	2/1/2016	U-238	1.43 ± 0.12	1.53	1.07 - 1.99	Pass
MAW-893	2/1/2016	Gross Alpha	0.600 ± 0.050	0.673	0.202 - 1.144	Pass
MAW-893	2/1/2016	Gross Beta	2.10 ± 0.06	2.15	1.08 - 3.23	Pass
MAW-896	2/1/2016	I-129	3.67 ± 0.20	3.85	2.70 - 5.01	Pass
MAAP-1056	2/1/2016	Gross Alpha	0.39 ± 0.05	1.20	0.36 - 2.04	Pass
MAAP-1056	2/1/2016	Gross Beta	1.03 ± 0.07	0.79	0.40 - 1.19	Pass
MAAP-1057	2/1/2016	Sr-90	1.34 ± 0.15	1.38	0.97 ± 1.79	Pass
MAAP-1057	2/1/2016	Cs-134	-0.01 ± 0.03	0.00	NA [c]	Pass
MAAP-1057	2/1/2016	Cs-137	2.57 ± 0.10	2.30	1.61 - 2.99	Pass

TABLE E-5 **DOE's Mixed Analyte Performance Evaluation Program (MAPEP)**
ENVIRONMENTAL, INC., 2016

			Concentration [a]			
Lab Code [b]	Reference Date	Analysis	Laboratory result	Known Activity	Control Limits [c]	Acceptance
MAAP-1057	2/1/2016	Co-57	3.01 ± 0.06	2.94	2.06 - 3.82	Pass
MAAP-1057	2/1/2016	Co-60	4.28 ± 0.10	4.02	2.81 - 5.23	Pass
MAAP-1057	2/1/2016	Mn-54	4.90 ± 0.13	4.53	3.17 - 5.89	Pass
MAAP-1057	2/1/2016	Zn-65	4.09 ± 0.18	3.57	2.50 - 4.64	Pass
MAAP-1057	2/1/2016	Am-241	0.059 ± 0.015	0.0805	0.0564 - 0.1047	Pass
MAAP-1057	2/1/2016	Pu-238	0.066 ± 0.020	0.0637	0.0446 - 0.0828	Pass
MAAP-1057	2/1/2016	Pu-239/240	0.074 ± 0.020	0.099	NA [d]	Pass
MAAP-1057	2/1/2016	U-234/233	0.151 ± 0.026	0.165	0.116 - 0.215	Pass
MAAP-1057	2/1/2016	U-238	0.160 ± 0.026	0.172	0.120 - 0.224	Pass
MAVE-1050	2/1/2016	Cs-134	9.83 ± 0.19	10.62	7.43 - 13.81	Pass
MAVE-1050	2/1/2016	Cs-137	6.06 ± 0.19	5.62	3.93 - 7.31	Pass
MAVE-1050	2/1/2016	Co-57	13.8 ± 0.2	11.8	8.3 - 15.3	Pass
MAVE-1050	2/1/2016	Co-60	0.022 ± 0.040	0.00	NA [c]	Pass
MAVE-1050	2/1/2016	Mn-54	0.009 ± 0.044	0.000	NA [c]	Pass
MAVE-1050	2/1/2016	Zn-65	10.67 ± 0.39	9.60	6.70 - 12.50	Pass
MASO-4780[f]	8/1/2016	Ni-63	648 ± 14	990	693 - 1287	Fail
MASO-4780[g]	8/1/2016	Ni-63	902 ± 46	990	693 - 1287	Pass
MASO-4780	8/1/2016	Sr-90	757 ± 16	894	626 - 1162	Pass
MASO-4780	8/1/2016	Tc-99	559 ± 12	556	389 - 723	Pass
MASO-4780	8/1/2016	Cs-134	0.93 ± 2.92	0.00	NA [c]	Pass
MASO-4780	8/1/2016	Cs-137	1061 ± 12	1067	747 - 1387	Pass
MASO-4780	8/1/2016	Co-57	1178 ± 8	1190	833 - 1547	Pass
MASO-4780	8/1/2016	Co-60	841 ± 9	851	596 - 1106	Pass
MASO-4780	8/1/2016	Mn-54	0.69 ± 2.53	0.00	NA [c]	Pass
MASO-4780	8/1/2016	Zn-65	724 ± 19	695	487 - 904	Pass
MASO-4780	8/1/2016	K-40	566 ± 52	588	412 - 764	Pass
MASO-4780	8/1/2016	Am-241	0.494 ± 0.698	0.000	NA [c]	Pass
MASO-4780	8/1/2016	Pu-238	69.7 ± 7.4	70.4	49.3 - 91.5	Pass
MASO-4780	8/1/2016	Pu-239/240	53.9 ± 6.3	53.8	37.7 - 69.9	Pass
MASO-4780[h]	8/1/2016	U-233/234	46.8 ± 3.9	122	85 - 159	Fail
MASO-4780[h]	8/1/2016	U-238	46.6 ± 3.9	121	85 - 157	Fail
MAW-4776	8/1/2016	I-129	4.40 ± 0.20	4.54	3.18 - 5.90	Pass
MAVE-4782	8/1/2016	Cs-134	-0.01 ± 0.05	0.00	NA [c]	Pass
MAVE-4782	8/1/2016	Cs-137	6.18 ± 0.20	5.54	3.88 - 7.20	Pass
MAVE-4782	8/1/2016	Co-57	8.13 ± 0.16	6.81	4.77 - 8.85	Pass
MAVE-4782	8/1/2016	Co-60	5.30 ± 0.15	4.86	3.40 - 6.32	Pass
MAVE-4782	8/1/2016	Mn-54	8.08 ± 0.24	7.27	5.09 - 9.45	Pass
MAVE-4782	8/1/2016	Zn-65	6.24 ± 0.36	5.40	3.78 - 7.02	Pass
MAAP-4784	8/1/2016	Sr-90	1.18 ± 0.10	1.03	0.72 - 1.34	Pass
MAAP-4784	8/1/2016	Cs-134	1.58 ± 0.08	2.04	1.43 - 2.65	Pass

TABLE E-5 **DOE's Mixed Analyte Performance Evaluation Program (MAPEP)**
ENVIRONMENTAL, INC., 2016

			Concentration [a]			
Lab Code [b]	Reference Date	Analysis	Laboratory result	Known Activity	Control Limits [c]	Acceptance
MAAP-4784	8/1/2016	Cs-137	1.85 ± 0.09	1.78	1.25 - 2.31	Pass
MAAP-4784	8/1/2016	Co-57	2.39 ± 0.52	2.48	1.74 - 3.22	Pass
MAAP-4784	8/1/2016	Co-60	3.22 ± 0.08	3.26	2.28 - 4.24	Pass
MAAP-4784	8/1/2016	Mn-54	2.82 ± 0.12	2.75	1.93 - 3.58	Pass
MAAP-4784	8/1/2016	Zn-65	-0.015 ± 0.062	0.00	NA [c]	Pass
MAAP-4784	8/1/2016	Am-241	-0.001 ± 0.006	0.00	NA [c]	Pass
MAAP-4784	8/1/2016	Pu-238	0.075 ± 0.022	0.069	0.049 - 0.090	Pass
MAAP-4784	8/1/2016	Pu-239/240	0.048 ± 0.015	0.054	0.038 - 0.070	Pass
MAAP-4784	8/1/2016	U-234/233	0.151 ± 0.036	0.150	0.105 - 0.195	Pass
MAAP-4784	8/1/2016	U-238	0.147 ± 0.034	0.156	0.109 - 0.203	Pass
MAW-4778	8/1/2016	H-3	365 ± 11	334	234 - 434	Pass
MAW-4778	8/1/2016	Fe-55	23.6 ± 16.3	21.5	15.1 ± 28.0	Pass
MAW-4778	8/1/2016	Ni-63	17.0 ± 2.8	17.2	12.0 ± 22.4	Pass
MAW-4778	8/1/2016	Sr-90	0.17 ± 0.28	0.00	NA [c]	Pass
MAW-4778	8/1/2016	Tc-99	9.50 ± 0.41	11.60	8.10 - 15.10	Pass
MAW-4778	8/1/2016	Cs-134	22.6 ± 0.4	23.9	16.7 - 31.1	Pass
MAW-4778	8/1/2016	Cs-137	0.018 ± 0.117	0.00	NA [c]	Pass
MAW-4778	8/1/2016	Co-57	27.6 ± 0.2	27.3	19.1 ± 35.5	Pass
MAW-4778	8/1/2016	Co-60	0.018 ± 0.090	0.00	NA [c]	Pass
MAW-4778	8/1/2016	Mn-54	16.2 ± 0.4	14.8	10.4 - 19.2	Pass
MAW-4778	8/1/2016	Zn-65	19.3 ± 0.7	17.4	12.2 - 22.6	Pass
MAW-4778	8/1/2016	K-40	286 ± 6	252	176 - 328	Pass
MAW-4778	8/1/2016	Ra-226	1.48 ± 0.09	1.33	0.93 - 1.73	Pass
MAW-4778	8/1/2016	Pu-238	1.09 ± 0.13	1.13	0.79 - 1.47	Pass
MAW-4778	8/1/2016	Pu-239/240	0.003 ± 0.011	0.016	NA [d]	Pass
MAW-4778	8/1/2016	U-234/233	1.80 ± 0.13	1.86	1.30 - 2.42	Pass
MAW-4778	8/1/2016	U-238	1.77 ± 0.13	1.92	1.34 - 2.50	Pass
MAW-4778	8/1/2016	Am-241	0.678 ± 0.086	0.814	0.570 ± 1.058	Pass

[a] Results are reported in units of Bq/kg (soil), Bq/L (water) or Bq/total sample (filters, vegetation).

[b] Laboratory codes as follows: MAW (water), MAAP (air filter), MASO (soil), MAVE (vegetation).

[c] MAPEP results are presented as the known values and expected laboratory precision (1 sigma, 1 determination) and control limits as defined by the MAPEP. A known value of "zero" indicates an analysis was included in the testing series as a "false positive". MAPEP does not provide control limits.

[d] Provided in the series for "sensitivity evaluation". MAPEP does not provide control limits.

[e] The laboratory properly identified the Sn-75 interfering peak in the vicinity of Co-57 and stated so in the comment field. MAPEP requires results to be reported as an activity with an uncertainty. Since the calculated uncertainty was less than the activity MAPEP interpreted the submitted result as a "false positive" resulting in a failure.

[f] Original analysis for Ni-63 failed.

[g] Reanalysis with a smaller aliquot resulted in acceptable results. An investigation is in process to identify better techniques for analyzing samples with complex matrices.

[h] MAPEP states that samples contain two fractions of Uranium; one that is soluble in concentrated HNO^3 and HCl acid and one that is "fundamentally insoluble in these acids". They also state that HF treatment can not assure complete dissolution. Results are consistent with measuring the soluble form.

TABLE E-6 Interlaboratory Comparison Crosscheck Program, Environmental Resource Associates (ERA)[a]

RAD Study, ENVIRONMENTAL, INC., 2016

Lab Code	Date	Analysis	Concentration (pCi/L) Laboratory Result	ERA Result	Control Limits	Acceptance
ERW-1392	4/4/2016	Sr-89	43.5 ± 4.3	48.2	37.8 - 55.6	Pass
ERW-1392	4/4/2016	Sr-90	27.5 ± 1.9	28.5	20.7 - 33.1	Pass
ERW-1394 [b]	4/4/2016	Ba-133	65.2 ± 3.8	58.8	48.7 - 64.9	Fail
ERW-1394 [c]	4/4/2016	Ba-133	57.8 ± 5.3	58.8	48.7 - 64.9	Pass
ERW-1394	4/4/2016	Cs-134	43.7 ± 3.0	43.3	34.6 - 47.6	Pass
ERW-1394	4/4/2016	Cs-137	86.1 ± 5.3	78.4	70.6 - 88.9	Pass
ERW-1394	4/4/2016	Co-60	108 ± 44	102	91.8 - 114	Pass
ERW-1394	4/4/2016	Zn-65	240 ± 13	214	193 - 251	Pass
ERW-1397	4/4/2016	Gr. Alpha	52.0 ± 2.2	62.7	32.9 - 77.8	Pass
ERW-1397	4/4/2016	Gr. Beta	33.9 ± 1.2	39.2	26.0 - 46.7	Pass
ERW-1400	4/4/2016	I-131	24.7 ± 0.6	26.6	22.1 - 31.3	Pass
ERW-1402	4/4/2016	Ra-226	15.6 ± 0.5	15.2	11.3 - 17.4	Pass
ERW-1402	4/4/2016	Ra-228	5.28 ± 0.76	5.19	3.12 - 6.93	Pass
ERW-1403	4/4/2016	Uranium	4.02 ± 0.42	4.64	3.39 - 5.68	Pass
ERW-1405	4/4/2016	H-3	8,150 ± 270	7,840	6,790 - 8,620	Pass
SPW-2845	7/7/2015	Ba-133	60.3 ± 5.7	64.7	53.9 - 71.2	Pass
SPW-2845	7/7/2015	Cs-134	48.8 ± 9.3	50.1	40.3 - 55.1	Pass
SPW-2845	7/7/2015	Cs-137	101 ± 8	89.8	80.8 - 101	Pass
SPW-2845	7/7/2015	Co-60	65.1 ± 5.8	59.9	53.9 - 68.4	Pass
SPW-2845	7/7/2015	Zn-65	288 ± 29	265	238 - 310	Pass
ERW-3485	7/11/2016	Sr-89	43.3 ± 6.5	53.3	42.3 - 60.9	Pass
ERW-3485	7/11/2016	Sr-90	39.0 ± 2.8	39.2	28.8 - 45.1	Pass
ERW-3487	7/11/2016	Ba-133	83.3 ± 4.9	82.9	69.7 - 91.2	Pass
ERW-3487	7/11/2016	Cs-134	62.5 ± 4.4	65.3	53.1 - 71.8	Pass
ERW-3487	7/11/2016	Cs-137	98.1 ± 5.6	95.2	85.7 - 107	Pass
ERW-3487	7/11/2016	Co-60	122 ± 5	117	105 - 131	Pass
ERW-3487	7/11/2016	Zn-65	124 ± 9	113	102 - 134	Pass
ERW-3490	7/11/2016	Gr. Alpha	46.6 ± 2.2	48.1	25.0 - 60.5	Pass
ERW-3490	7/11/2016	Gr. Beta	26.8 ± 1.1	28.6	18.2 - 36.4	Pass
ERW-3492	7/11/2016	I-131	23.7 ± 1.0	24.9	20.7 - 29.5	Pass
ERW-3493	7/11/2016	Ra-226	12.9 ± 0.4	12.3	9.2 - 14.2	Pass
ERW-3493	7/11/2016	Ra-228	5.8 ± 0.8	5.8	3.5 - 7.6	Pass
ERW-3493	7/11/2016	Uranium	32.8 ± 0.8	25.2	28.4 - 39.3	Pass
ERW-3495	7/11/2016	H-3	12,400 ± 334	12,400	10,800 - 13,600	Pass

[a] Results obtained by Environmental, Inc., Midwest Laboratory as a participant in the crosscheck program for proficiency testing in drinking water conducted by Environmental Resources Associates (ERA).

[b] No reason determined for failure of Ba-133 result.

[c] The result of reanalysis (Compare to original result, footnoted "b" above).

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APPENDIX F

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 2016

Prepared By
Teledyne Brown Engineering
Environmental Services

Exelon Generation®

Limerick Power Station
Pottstown, PA 19464

April 2017

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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 2016 through 31 December 2016. During that time period, 309 analyses were performed on 173 samples from 13 groundwater, 7 surface water and 4 precipitation water locations collected from the environment, both on and off station property in 2016.

Groundwater and surface water was analyzed for tritium. All sample results were at concentrations less than the United States Environmental Protection Agency (USEPA) drinking water standard (and the Nuclear Regulatory Commission Reporting Limit) of 20,000 pCi/L. Low levels of tritium were detected at 5 of the 13 groundwater monitoring locations. Tritium was not detected at any of the seven 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 2 of 13 groundwater locations sampled. Gross alpha (suspended) was less than the MDC. Gross beta (dissolved) was detected at 13 of 13 groundwater locations sampled. Gross beta (suspended) was less than the MDC.

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 sampled and 1 of 7 surface water 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. These analyses were performed on one groundwater location in 2016. All HTD results were less than the MDC.

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 2016.

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 for Exelon Nuclear by Normandeau Associates, Inc. (NAI). This section describes the general collection methods used to obtain environmental samples for the LGS RGPP in 2016. Sample locations can be found in Table A–1, Appendix A.

1. Sample Collection

<u>Groundwater and Surface Water</u>

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 EIML on environmental samples for the LGS RGPP in 2016. 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. <u>Lower Limit of Detection and Minimum Detectable Concentration</u>

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

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

2. 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 5200 pCi/L.

Although no drinking water pathway is available from groundwater, the theoretical dose via the drinking water pathway was calculated at 3.08E-01 mrem to a child (total body), which represents 5.13E-00% 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 April, 2016, with one additional sample taken in June for MW-LR-5. Gross alpha (dissolved) was detected in 2 of 13 groundwater locations sampled. The concentrations ranged from 2.0 to 3.9 pCi/L. Gross alpha (suspended) results were below the required LLDs. Gross beta (dissolved) was detected in 13 of 13 groundwater locations sampled. The concentrations ranged from 1.9 to 22.9 pCi/L. Gross beta (suspended) results were below the required LLDs (Appendix B, Table B-I.1).

Gamma Emitters

Samples were analyzed for gamma-emitting nuclides. Naturally-occurring K-40 was detected in 1 of 13 locations. All other gamma results were below the required LLDs (Appendix B, Table B-I.2).

Hard-To-Detect

One sample was analyzed for HTD nuclides. All results were below the required LLDs (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 not detected in any of the 7 locations sampled.

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. Naturally-occurring K-40 was detected in 1 of 7 locations at a concentration of 111 pCi/L. All other gamma results were below the required LLDs (Appendix B, Table B–II.2).

C. Precipitation Sample Results

Tritium

Tritium activity was detected in one of four precipitation water locations analyzed. The concentrations ranged was 184 pCi/L. This concentration is consistent with historical values observed. (Appendix B, Table B-III.1).

D. Drinking Water Well Survey

A drinking water well survey was conducted during the summer 2006 by CRA (CRA 2006) around the Limerick Generating Station. CRA reviewed the Pennsylvania Groundwater Information System database to identify wells within a 1-mile radius from the center of the Station. Forty-six domestic withdrawal wells, two industrial wells, two commercial wells, and one institutional well were identified within the specified radius. The well depths range from 78 to 345 feet below ground surface (bgs), and they yield between 8 and 100 gallons per minute (gpm). All wells are completed in the Brunswick Formation.

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 below ground surface (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. 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 2016, approximately 1.3 million 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

In accordance with NEI 07-07 "Industry Ground Water Protection Initiative Final Guidance Document", on July 14, 2016, voluntary notification was made to the PA Department of Environmental Protection Bureau of Radiation Protection and the Nuclear Regulatory Commission due to leakage of tritiated water from a storm drain. A bounding dose calculation was performed using the maximum concentration at undiluted tritium source of 9,480 pCi/L. The calculated dose to the public was determined to be 1.90E-05 mrem to organ and total body, which is a fraction of a percent of the liquid effluent limits. (IR 2692113).

G. Trends

No trends were identified.

H. Investigations

Currently no investigations are ongoing.

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 well

3. Actions to Recover/Reverse Plumes

   No actions were required to recover or reverse groundwater plumes.

V. References

1. Conestoga Rovers and Associates, Fleetwide Assessment, Limerick Generating Station, Sanatoga, Pennsylvania, Ref. No. 045136(17), September 2006

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, 2016

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

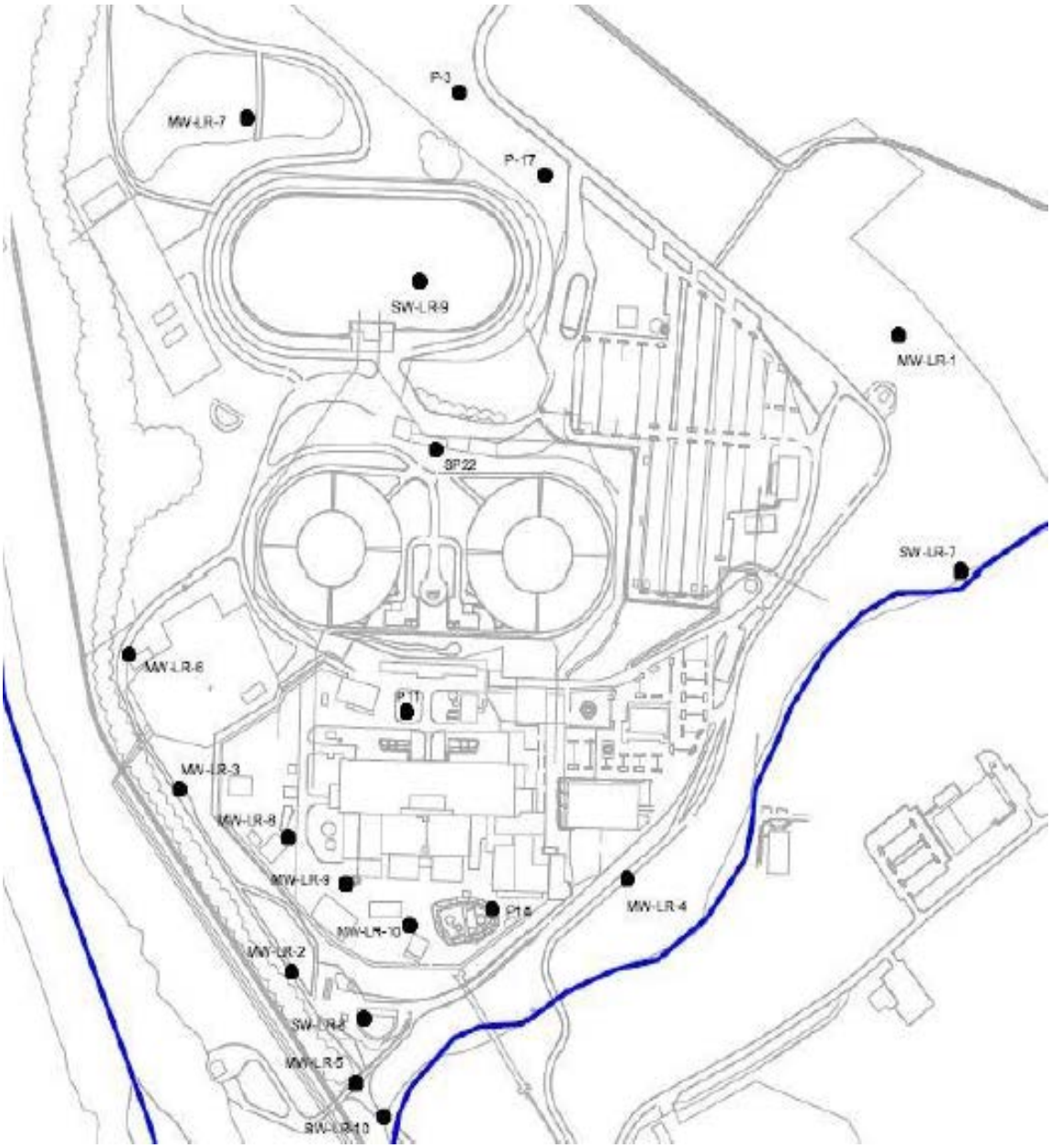

Figure 1 Routine Well Water and Surface Water Sample Locations for the Radiological Groundwater Protection Program, Limerick Generating Station, 2016

Figure 2 Routine Surface Water Sample Locations for the Radiological Groundwater Protection Program, Limerick Generating Station, 2016

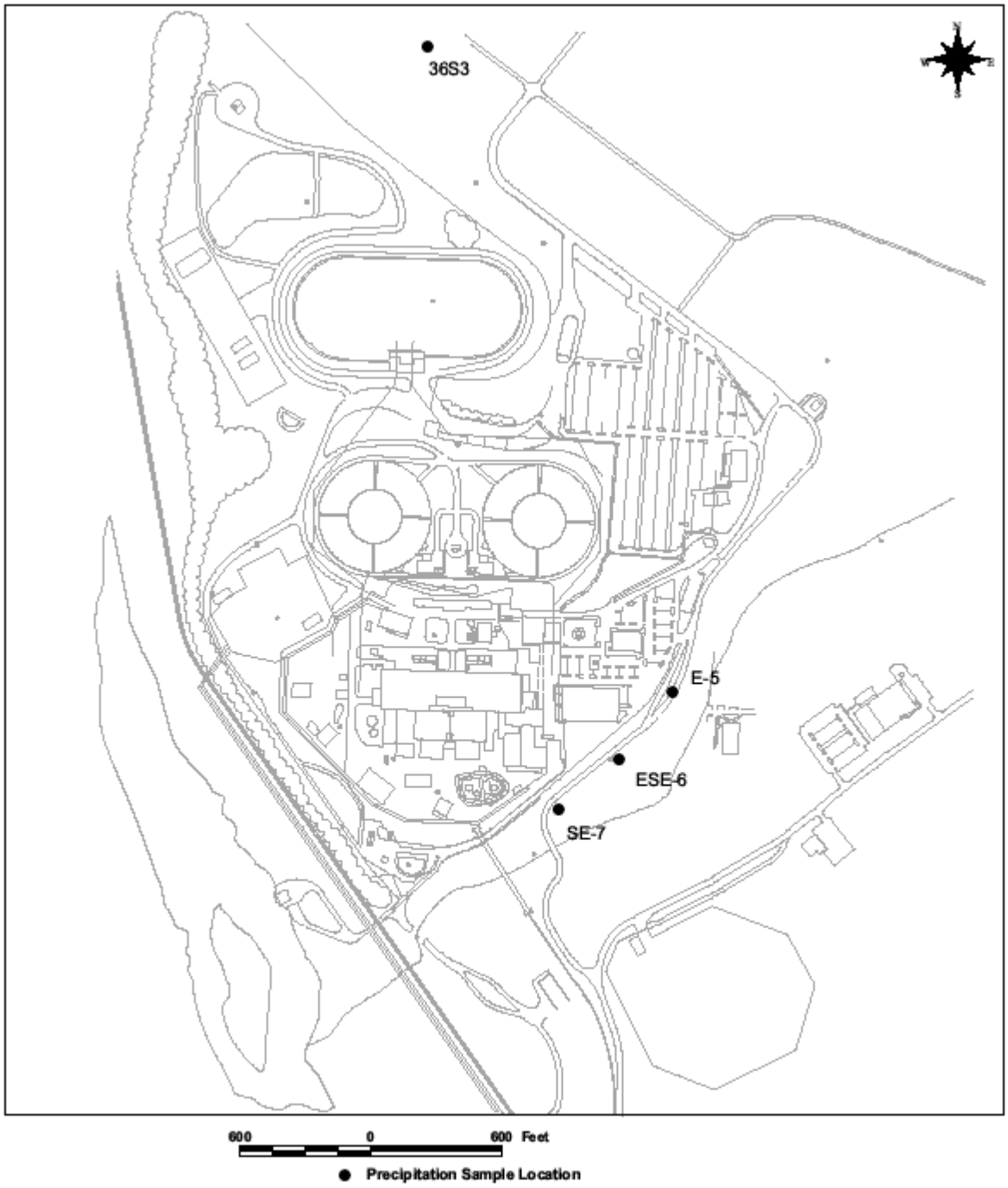

Figure 3 Routine Precipitation Sample Locations for the Radiological Groundwater Protection Program, Limerick Generating Station, 2016

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, 2016

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	01/13/16		< 197						
DW-LR-1	04/21/16		< 193	< 3.6	< 0.5	2.0 ± 0.9	< 0.8	1.9 ± 0.9	< 1.6
DW-LR-1	07/06/16		< 183						
DW-LR-1	10/05/16		< 181						
MW-LR-1	04/20/16		< 192			< 4.5	< 1.7	12.5 ± 4.6	< 3.9
MW-LR-2	01/06/16		< 193						
MW-LR-2	04/21/16		< 190	< 4.8	< 0.6	< 1.6	< 0.8	2.6 ± 1.0	< 1.6
MW-LR-2	06/22/16		< 186						
MW-LR-2	06/27/16		< 173						
MW-LR-2	07/05/16	*Original*	218 ± 118						
MW-LR-2	07/05/16	*Recount*	< 188						
MW-LR-2	07/05/16	*Rerun*	< 183						
MW-LR-2	07/11/16		< 177						
MW-LR-2	07/18/16	TBE	< 176						
MW-LR-2	07/18/16	EIML	< 148						
MW-LR-2	07/25/16	TBE	< 177						
MW-LR-2	07/25/16	EIML	< 151						
MW-LR-2	08/08/16	TBE	< 194						
MW-LR-2	08/08/16	EIML	< 145						
MW-LR-2	09/06/16	TBE	< 176						
MW-LR-2	09/06/16	EIML	< 155						
MW-LR-2	10/05/16		< 187						
MW-LR-3	01/06/16		< 197						
MW-LR-3	04/21/16		< 193	< 4.1	< 0.5	< 1.7	< 0.9	3.3 ± 1.1	< 1.6
MW-LR-3	06/22/16		< 185						
MW-LR-3	07/06/16		< 161						
MW-LR-3	10/05/16		< 184						
MW-LR-4	01/06/16		< 196						
MW-LR-4	04/20/16		< 195	< 5.4	< 0.7	< 5.1	< 0.8	7.1 ± 1.5	< 1.6
MW-LR-4	06/22/16		< 185						
MW-LR-4	07/06/16		< 179						
MW-LR-4	10/05/16		< 186						
MW-LR-5	01/06/16		< 195						
MW-LR-5	04/20/16	*Original*	5160 ± 581	< 3.7	< 0.5	< 1.6	< 0.8	9.9 ± 1.3	< 1.6
MW-LR-5	04/20/16	*Rerun*	5200 ± 576	< 3.7	< 0.5	< 1.6	< 0.8	9.9 ± 1.3	< 1.6
MW-LR-5	06/06/16		366 ± 121	< 4.3	< 0.9	< 1.2	< 0.7	7.4 ± 1.2	< 1.9
MW-LR-5	06/13/16		342 ± 124						
MW-LR-5	06/20/16		391 ± 124						
MW-LR-5	06/27/16		383 ± 124						
MW-LR-5	07/05/16		476 ± 131						
MW-LR-5	07/05/16		406 ± 125						
MW-LR-5	07/11/16		292 ± 120						
MW-LR-5	07/18/16	TBE	284 ± 122						
MW-LR-5	07/18/16	EIML	309 ± 93						
MW-LR-5	07/25/16	TBE	288 ± 124						
MW-LR-5	07/25/16	EIML	332 ± 90						
MW-LR-5	08/08/16	TBE	225 ± 128						
MW-LR-5	08/08/16	EIML	423 ± 106						
MW-LR-5	09/06/16	TBE	< 175						
MW-LR-5	09/06/16	EIML	282 ± 89						
MW-LR-5	10/05/16	TBE	< 192						
MW-LR-5	10/05/16	TBE	< 189						
MW-LR-5	10/05/16	EIML	309 ± 87						
MW-LR-7	01/06/16		< 194						
MW-LR-7	04/20/16		< 194	< 5.0	< 0.6	< 0.9	< 0.8	2.5 ± 0.7	< 1.6

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, 2016

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-7	07/07/16		< 186						
MW-LR-7	10/05/16		< 189						
MW-LR-8	01/05/16		374 ± 136						
MW-LR-8	04/21/16	*Original*	517 ± 137	< 4.2	< 0.7	< 3.2	< 0.8	3.5 ± 1.5	< 1.6
MW-LR-8	04/21/16	*Recount*	511 ± 125						
MW-LR-8	04/21/16	TBE	375 ± 136	< 5.5	< 0.7	< 4.8	< 0.8	5.5 ± 1.4	< 1.6
MW-LR-8	04/21/16	EIML	523 ± 99	< 0.7	< 0.5	1.2 ± 0.7 (1)		1.6 ± 1.2 (1)	
MW-LR-8	06/22/16		593 ± 143						
MW-LR-8	06/27/16		484 ± 128						
MW-LR-8	07/05/16		600 ± 140						
MW-LR-8	07/05/16		610 ± 140						
MW-LR-8	07/11/16		399 ± 126						
MW-LR-8	07/18/16	TBE	448 ± 128						
MW-LR-8	07/18/16	EIML	512 ± 102						
MW-LR-8	07/25/16	TBE	378 ± 127						
MW-LR-8	07/25/16	EIML	< 151						
MW-LR-8	08/08/16	TBE	277 ± 129						
MW-LR-8	08/08/16	EIML	500 ± 109						
MW-LR-8	09/06/16	TBE	318 ± 121						
MW-LR-8	09/06/16	EIML	505 ± 99						
MW-LR-8	10/04/16	TBE	327 ± 131						
MW-LR-8	10/04/16	TBE	279 ± 128						
MW-LR-8	10/04/16	EIML	514 ± 97						
MW-LR-9	01/05/16	TBE	455 ± 134						
MW-LR-9	01/05/16	TBE	409 ± 139						
MW-LR-9	01/05/16	EIML	508 ± 96						
MW-LR-9	04/20/16	TBE	331 ± 131	< 2.7	< 0.6	< 1.5	< 0.8	7.9 ± 1.4	< 1.6
MW-LR-9	04/20/16	TBE	< 193	< 4.5	< 0.5	< 1.9	< 0.9	8.0 ± 1.3	< 1.6
MW-LR-9	04/20/16	EIML	323 ± 90	< 0.8	< 0.7	2.8 ± 0.7 (1)		< 1.3 (1)	< 1.6
MW-LR-9	06/22/16		276 ± 123						
MW-LR-9	06/27/16		178 ± 115						
MW-LR-9	07/05/16		272 ± 121						
MW-LR-9	07/05/16		179 ± 116						
MW-LR-9	07/11/16		< 178						
MW-LR-9	07/18/16	TBE	< 175						
MW-LR-9	07/18/16	EIML	< 148						
MW-LR-9	07/25/16	TBE	< 180						
MW-LR-9	07/25/16	EIML	< 151						
MW-LR-9	08/08/16	TBE	412 ± 134						
MW-LR-9	08/08/16	EIML	407 ± 105						
MW-LR-9	09/06/16	TBE	266 ± 120						
MW-LR-9	09/06/16	EIML	359 ± 93						
MW-LR-9	10/04/16	TBE	369 ± 131						
MW-LR-9	10/04/16	TBE	367 ± 130						
MW-LR-9	10/04/16	EIML	409 ± 92						
MW-LR-10	01/05/16	TBE	< 192						
MW-LR-10	01/05/16	TBE	< 194						
MW-LR-10	01/05/16	EIML	< 145						
MW-LR-10	04/20/16	TBE	< 194	< 3.3	< 0.7	3.9 ± 1.4	< 0.8	3.6 ± 1.0	< 1.6
MW-LR-10	04/20/16	TBE	< 191	< 3.2	< 0.7	< 1.1	< 0.8	< 1.5	< 1.6
MW-LR-10	04/20/16	EIML	< 149	< 0.7	< 0.5	3.0 ± 0.9 (1)		2.9 ± 0.7 (1)	
MW-LR-10	06/22/16		< 187						
MW-LR-10	07/06/16		< 185						
MW-LR-10	10/04/16		< 189						

(1) Total Gross Alpha & Gross Beta results reported (not Dissolved)

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, 2016

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)
P11	01/05/16	< 193						
P11	04/21/16	< 193	< 5.6	< 0.7	< 8.5	< 0.8	22.9 ± 2.3	< 1.6
P11	06/22/16	< 185						
P11	07/06/16	< 184						
P11	10/04/16	< 189						
P14	01/05/16	< 194						
P14	04/21/16	< 193	< 4.8	< 0.8	< 4.1	< 0.9	5.3 ± 1.5	< 1.6
P14	06/22/16	190 ± 121						
P14	07/06/16	< 184						
P14	10/04/16	< 192						
P17	04/20/16	< 189			< 2.7	< 0.9	2.7 ± 1.4	< 1.7

TABLE B-I.2 **CONCENTRATIONS OF GAMMA EMITTERS IN WELL WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2016**

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	04/21/16		< 74	< 118	< 6	< 7	< 14	< 6	< 14	< 9	< 11	< 13	< 7	< 7	< 33	< 12
MW-LR-1	04/20/16		< 65	< 73	< 7	< 7	< 15	< 9	< 15	< 9	< 9	< 12	< 5	< 8	< 35	< 12
MW-LR-2	04/21/16		< 42	< 90	< 5	< 6	< 10	< 5	< 10	< 6	< 9	< 9	< 5	< 5	< 21	< 8
MW-LR-3	04/21/16		< 57	136 ± 84	< 6	< 6	< 12	< 7	< 13	< 8	< 12	< 11	< 6	< 7	< 33	< 9
MW-LR-4	04/20/16		< 48	< 100	< 5	< 5	< 12	< 5	< 11	< 6	< 10	< 9	< 6	< 5	< 25	< 8
MW-LR-5	04/20/16		< 67	< 74	< 7	< 9	< 16	< 7	< 16	< 7	< 13	< 12	< 7	< 9	< 34	< 11
MW-LR-5	06/06/16		< 75	< 123	< 9	< 7	< 15	< 10	< 17	< 11	< 16	< 12	< 8	< 9	< 38	< 11
MW-LR-7	04/20/16		< 40	< 74	< 5	< 6	< 8	< 4	< 12	< 6	< 9	< 10	< 5	< 6	< 28	< 7
MW-LR-8	04/21/16	TBE	< 49	< 120	< 6	< 6	< 10	< 8	< 13	< 6	< 9	< 11	< 4	< 6	< 26	< 13
MW-LR-8	04/21/16	TBE	< 41	< 47	< 5	< 5	< 10	< 5	< 8	< 6	< 9	< 8	< 5	< 5	< 27	< 7
MW-LR-8	04/21/16	EIML	< 28	< 66	< 3	< 3	< 4	< 2	< 4	< 3	< 7	< 9	< 2	< 3	< 13	< 3
MW-LR-9	04/20/16	TBE	< 62	< 144	< 7	< 9	< 15	< 9	< 17	< 8	< 11	< 14	< 8	< 9	< 44	< 8
MW-LR-9	04/20/16	TBE	< 55	< 57	< 6	< 5	< 12	< 7	< 14	< 6	< 11	< 9	< 5	< 7	< 31	< 10
MW-LR-9	04/20/16	EIML	< 23	< 64	< 2	< 2	< 4	< 2	< 5	< 4	< 5	< 7	< 2	< 2	< 15	< 3
MW-LR-10	04/20/16	TBE	< 60	< 130	< 6	< 7	< 14	< 8	< 12	< 9	< 12	< 15	< 6	< 7	< 38	< 11
MW-LR-10	04/20/16	TBE	< 41	< 93	< 4	< 5	< 9	< 5	< 9	< 5	< 8	< 9	< 4	< 5	< 23	< 8
MW-LR-10	04/20/16	EIML	< 29	< 54	< 3	< 3	< 5	< 2	< 5	< 4	< 3	< 8	< 2	< 3	< 26	< 4
P11	04/21/16		< 45	< 47	< 5	< 5	< 10	< 6	< 11	< 6	< 8	< 9	< 5	< 5	< 27	< 9
P14	04/21/16		< 53	< 118	< 5	< 5	< 15	< 7	< 11	< 7	< 11	< 12	< 6	< 7	< 29	< 6
P17	04/20/16		< 53	< 56	< 7	< 6	< 17	< 7	< 16	< 8	< 12	< 10	< 6	< 7	< 36	< 14

TABLE B-I.3 **CONCENTRATIONS OF HARD TO DETECTS IN GROUNDWATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2016**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

	STC	COLLECTION PERIOD	AM-241	CM-242	CM-243/244	PU-238	PU-239	U-233/234	U-235	U-238	FE-55	NI-63
EIML	MW-LR-10	04/20/16	< 0.1	< 0.11	< 0.2	< 0.1	< 0.2	3.3 ± 0.4	< 0.08	< 0.05	< 785	< 122

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, 2016

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE	H-3	Sr-89	Sr-90
SW-LR-2	01/04/16	< 196		
SW-LR-2	04/19/16	< 194	< 4.6	< 0.6
SW-LR-2	07/07/16	< 182		
SW-LR-2	10/03/16	< 192		
SW-LR-4	01/04/16	< 193		
SW-LR-4	04/19/16	< 195	< 4.4	< 0.6
SW-LR-4	07/07/16	< 188		
SW-LR-4	10/03/16	< 191		
SW-LR-6	01/04/16	< 194		
SW-LR-6	04/19/16	< 193	< 3.6	< 0.9
SW-LR-6	07/07/16	< 184		
SW-LR-6	10/03/16	< 191		
SW-LR-7	01/04/16	< 195		
SW-LR-7	04/19/16	< 192	< 4.4	< 0.6
SW-LR-7	07/07/16	< 184		
SW-LR-7	10/03/16	< 189		
SW-LR-8	01/13/16	< 196		
SW-LR-8	04/21/16	< 194	< 3.6	< 0.6
SW-LR-8	07/06/16	< 186		
SW-LR-8	10/05/16	< 192		
SW-LR-9	01/13/16	< 196		
SW-LR-9	04/21/16	< 190	< 5.4	< 0.9
SW-LR-9	07/05/16	< 187		
SW-LR-9	10/03/16	< 191		
SW-LR-10	01/04/16	< 195		
SW-LR-10	04/19/16	< 194	< 4.5	< 0.6
SW-LR-10	06/06/16	< 168		
SW-LR-10	07/07/16	< 188		
SW-LR-10	10/03/16	< 189		

TABLE B-II.2 **CONCENTRATIONS OF GAMMA EMITTERS IN SURFACE WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2016**

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	04/19/16	< 68	111 ± 67	< 8	< 5	< 17	< 7	< 15	< 6	< 15	< 14	< 7	< 8	< 38	< 13
SW-LR-4	04/19/16	< 56	< 61	< 6	< 6	< 12	< 4	< 12	< 7	< 10	< 15	< 5	< 7	< 29	< 8
SW-LR-6	04/19/16	< 67	< 129	< 7	< 8	< 16	< 7	< 14	< 7	< 13	< 14	< 8	< 8	< 42	< 12
SW-LR-7	04/19/16	< 55	< 128	< 5	< 8	< 16	< 8	< 10	< 8	< 12	< 14	< 7	< 7	< 37	< 9
SW-LR-8	04/21/16	< 43	< 88	< 5	< 6	< 11	< 4	< 9	< 6	< 8	< 9	< 5	< 6	< 23	< 7
SW-LR-9	04/21/16	< 69	< 126	< 9	< 5	< 17	< 7	< 12	< 7	< 13	< 13	< 8	< 6	< 35	< 9
SW-LR-10	04/19/16	< 61	< 135	< 5	< 7	< 17	< 6	< 14	< 7	< 11	< 13	< 6	< 6	< 33	< 9

TABLE B-III.1 CONCENTRATIONS OF TRITIUM IN PRECIPITATION WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, LIMERICK GENERATING STATION, 2016

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE		H-3
36S3	02/01/16 - 02/25/16		< 172
36S3	02/25/16 - 03/28/16		< 190
36S3	03/28/16 - 04/25/16		< 182
36S3	04/25/16 - 05/25/16		< 180
36S3	05/25/16 - 06/27/16		< 180
36S3	06/27/16 - 07/25/16		< 168
36S3	07/25/16 - 09/21/16		< 181
36S3	09/21/16 - 10/24/16		< 197
36S3	10/24/16 - 12/01/16		< 195
E-5	02/01/16 - 02/25/16		< 175
E-5	02/25/16 - 03/28/16		< 187
E-5	03/28/16 - 04/25/16		< 182
E-5	04/25/16 - 05/25/16		< 179
E-5	05/25/16 - 06/27/16		< 179
E-5	06/27/16 - 07/25/16		< 167
E-5	07/25/16 - 09/21/16		< 189
E-5	09/21/16 - 10/24/16		< 192
E-5	10/24/16 - 12/01/16		< 182
ESE-6	02/01/16 - 02/25/16		< 171
ESE-6	02/25/16 - 03/28/16		< 186
ESE-6	03/28/16 - 04/25/16		< 180
ESE-6	04/25/16 - 05/25/16		< 178
ESE-6	05/25/16 - 06/27/16		< 179
ESE-6	06/27/16 - 07/25/16	*Original*	< 182
ESE-6	06/27/16 - 07/25/16	*Rerun*	< 182
ESE-6	07/25/16 - 09/21/16		< 188
ESE-6	09/21/16 - 10/24/16		< 196
ESE-6	10/24/16 - 12/01/16		< 199
SE-7	02/01/16 - 02/25/16		< 173
SE-7	02/25/16 - 03/28/16		< 182
SE-7	03/28/16 - 04/25/16		184 ± 121
SE-7	04/25/16 - 05/25/16		< 181
SE-7	05/25/16 - 06/27/16		< 180
SE-7	06/27/16 - 07/25/16		< 166
SE-7	07/25/16 - 09/21/16		< 186
SE-7	09/21/16 - 10/24/16		< 189
SE-7	10/24/16 - 12/01/16		< 186