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Technical Specification 6.9.1.b
10 CFR 50 Appendix I

April 30, 2021

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

Oyster Creek Nuclear Generating Station
Renewed Facility Operating License No. DPR-16
Docket No. 50-219

Subject: Annual Radioactive Environmental Operating Report for 2020

Enclosed with this cover letter is the Annual Radioactive Environmental Operating Report for the calendar year 2020 for the Oyster Creek Nuclear Generating Station. This submittal is made in accordance with Oyster Creek Nuclear Generating Station Technical Specification 6.9.1.b, "Annual Radiological Environmental Operating Report."

There are no regulatory commitments in this letter.

Should you have any questions or require further information, please contact Kevin Wolf, Radiation Protection and Chemistry Manager, at (609) 971-4051.

Respectfully,

Andrea Sterdis

Digitally signed by Andrea Sterdis
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Docket No: 50-219

OYSTER CREEK GENERATING STATION
UNIT 1

Annual Radiological
Environmental Operating Report

1 January through 31 December 2020

Prepared By
Teledyne Brown Engineering
Environmental Services

HOLTEC DECOMMISSIONING INTERNATIONAL

Oyster Creek Generating Station
Forked River, NJ 08731

April 2021

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Preface

The nuclear power industry uses terms and concepts that may be unfamiliar to all readers of this report. This section of the report is intended to help the reader better understand some of these terms and concepts. In this section, we will discuss radiation and exposure pathways. This section is intended only to give a basic understanding of these subjects to hopefully allow the reader to better understand the data provided within the report.

Every nuclear power station is required to submit two reports annually, the Annual Radioactive Effluents Release Report (ARERR) and the Annual Radiological Environmental Operating Report (AREOR). The following information is provided in both reports for Oyster Creek Generating Station.

Understanding Radiation

Radiation is simply defined as the process of emitting radiant energy in the form of waves or particles. Radiation can be categorized as ionizing or non-ionizing radiation. If the radiation has enough energy to displace electrons from an atom it is termed ionizing radiation. Typically you will see a warning sign where there is a potential to be exposed to man-made ionizing radiation. These signs normally have the trefoil symbol on a yellow background.

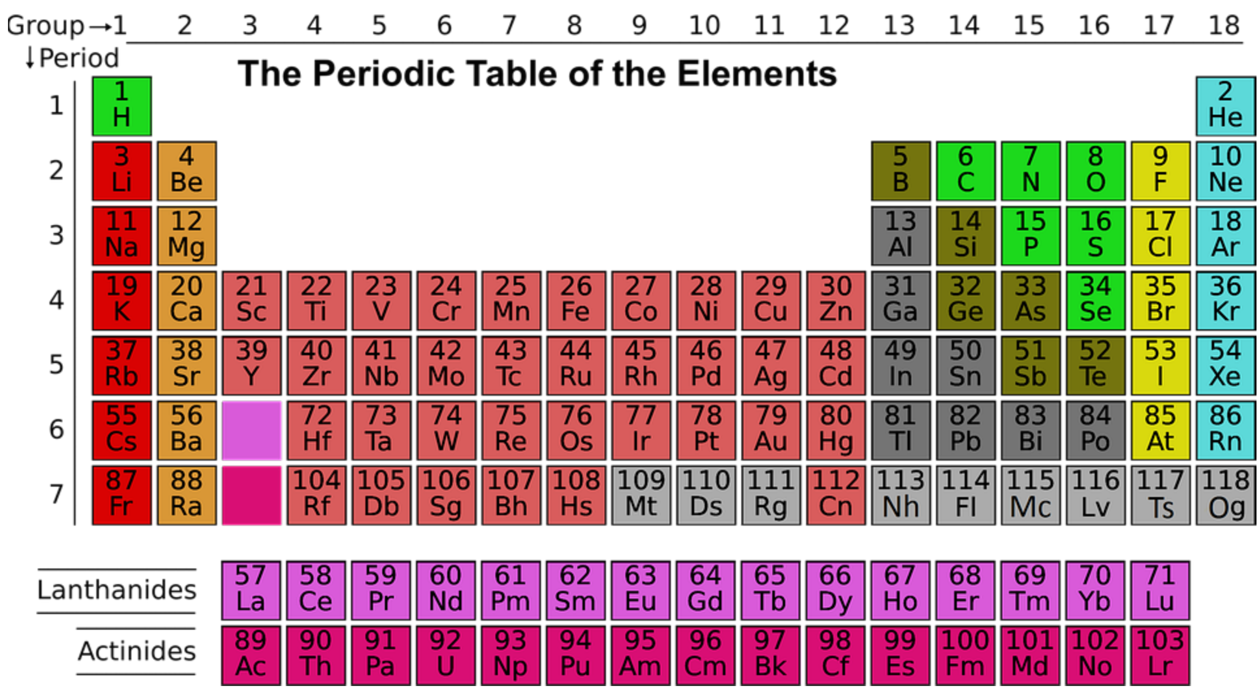
Example Radiological warning signs

People do not always recognize non-ionizing radiation as a form of radiation, such as light, heat given off from a stove, radiowaves and microwaves. In our report we focus on the ionizing radiation that is produced at a nuclear power plant though it is important to note that ionizing radiation comes from many sources. In fact, the amount of ionizing radiation an average person is exposed to due to operation of a nuclear power plant is a very small fraction of the total ionizing radiation they will be exposed to in their lifetime and will be discussed later.

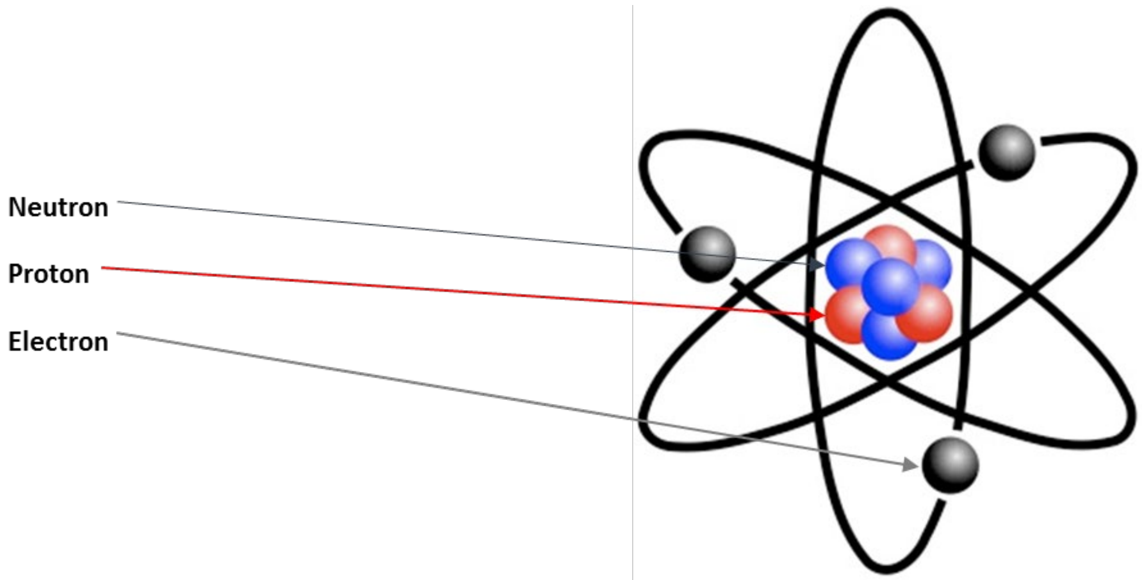
From this point forward we will only be discussing ionizing radiation but we will just use the term radiation.

Since this report discusses radiation in different forms and different pathways we first need to understand where the radiation comes from that we report. Radiation comes from atoms. So, what are atoms and how does radiation come from atoms?

You may have seen a Periodic Table of the Elements



This table lists all the elements found on earth. An atom is the smallest part of an element that maintains the characteristics of that element. An atom is made up of three parts, protons, neutrons and electrons.



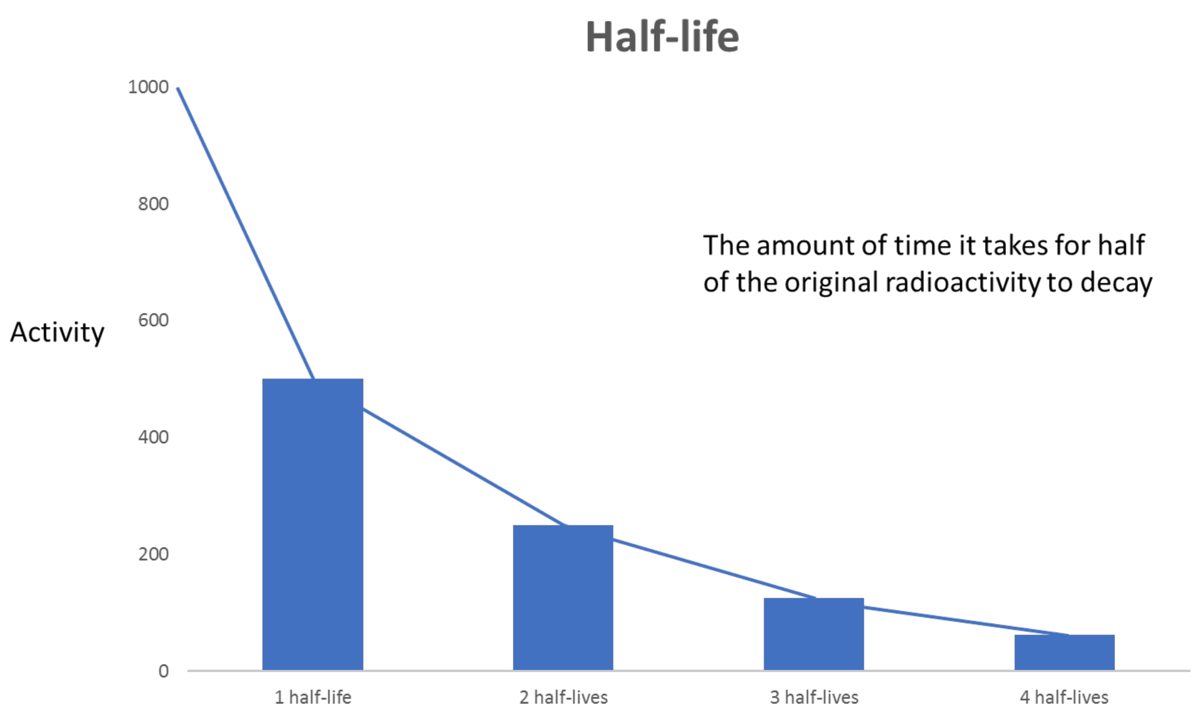
The number of protons in an atom determines the element. A hydrogen atom will always have one proton while an oxygen atom will always have eight protons. The protons are clustered with the neutrons at the center of the atom and this is called the nucleus. Orbiting around the nucleus are the relatively small electrons. Neutrons do not have an electrical charge, protons have a positive charge while electrons have a negative charge. In an electrically neutral atom, the negative and positive charges are balanced. Atoms of the same element that have a different number of neutrons in their nucleus are called isotopes.

Isotopes are atoms that have the same number of protons but different number of neutrons. They all have the same chemical properties and many isotopes are nonradioactive or stable while other isotopes may be unstable and are radioactive. Radioactive isotopes can be called a radionuclide, a radioisotope or simply called a radioactive atom. A radionuclide usually contains an excess amount of energy in the nucleus usually due to a deficit or excess of neutrons in the nucleus.

There are two basic ways radionuclides are produced at a nuclear power plant. The first way is a direct result of the fission process and the radionuclides created through this process are termed fission products. Fission occurs when a very large atom, such as U-235 (Uranium-235) and Pu-239 (Plutonium-239), absorbs a neutron into its nucleus making the atom unstable. In this instance the atom can actually split into smaller atoms, this splitting of the atom is called fission. When fission occurs there is also a large amount of energy released from the atom in the form of heat which is what is used to produce the steam that will spin the turbines to produce electricity at a nuclear power plant.

The second way a radionuclide is produced at a nuclear power plant is through a process called activation and the radionuclides produced in this method are termed activation products. Water passes through the core where the fission process is occurring. This water is used to both produce the steam to turn the turbines and to cool the reactor. Though the water passing through the core is considered to be very pure water, there is always some other material within the water. This material typically comes from the material used in the plant's construction. As the water passes through the core, the material is exposed to the fission process and the radiation within the core can react with the material causing it to become unstable, creating a radionuclide. The atoms in the water itself can become activated and create radionuclides.

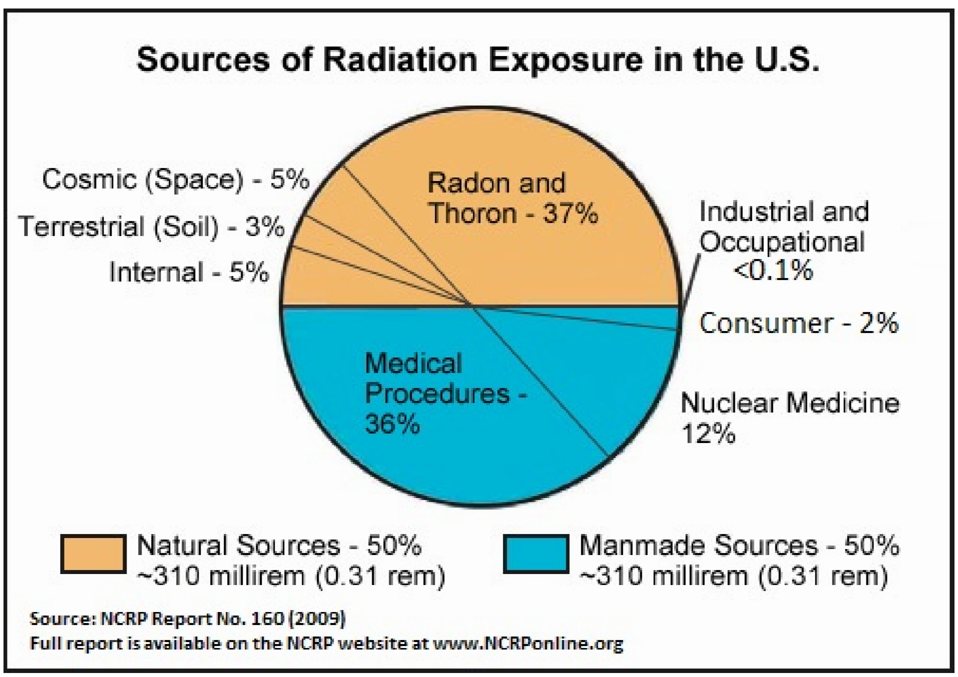
Over time, radioactive atoms will reach a stable state and no longer be radioactive. To do this they must release the excess energy. The release of excess energy can be in different forms and is called radioactive decay and the energy released is called radiation. The time it takes for a radionuclide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



In this report, you will see radionuclides listed such as K-40 (potassium-40) and Co-60 (cobalt-60). The letter(s) represents the element and the number represents the specific isotope of that element and is the number of protons and neutrons in the nucleus of that radionuclide. You may hear the term naturally occurring radionuclide which refers to radionuclides that naturally occur in nature such as K-40. There are man-made radionuclides such as Co-60 that we are concerned with since these man-made radionuclides result as a by-product when generating electricity at a nuclear power plant. There are other ways man-made radionuclides are produced, such as detonating nuclear weapons, and this is important to note since nuclear weapons testing deposited these man-made radionuclides into the environment and some are still present today. There is a discussion in the AREOR for the radionculides Cs-137, Sr-89 and Sr-90. The reason we only see some of the radionuclides today is due to the fact that some of the radionuclides released into the environment had relatively short half-lives and all the atoms have decayed to a stable state while other radionuclides have relatively long half-lives and will be measurable in the environment for years to come.

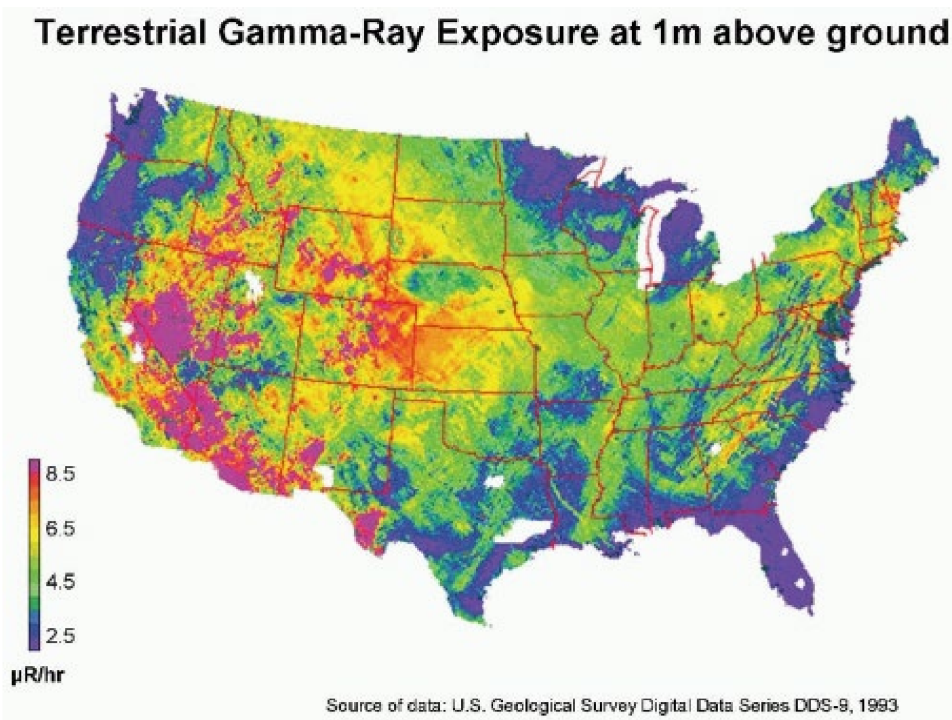
Sources of Radiation

People are exposed to radiation every day of their lives and have been since the dawn of mankind. Some of this radiation is naturally occurring while some is man-made. There are many factors that will determine the amount of radiation an individual will be exposed to such as where you live, medical treatments, etc. Below are examples of some of the typical sources of radiation an individual is exposed to in a year.



Adapted with permission of the National Council on Radiation Protection and Measurements, http://NCRPonline.org

As you can see from the graph, the largest natural source of radiation is due to Radon. That is because essentially all air contains Radon. Cosmic and Internal make up the next largest natural sources of radiation. Cosmic radiation comes from the sun and stars and there are multiple factors which can impact the amount of cosmic radiation you are exposed to such as the elevation at which you live and the amount of air travel you take a year. The internal natural source of radiation mainly comes from two sources. Technically, all organic material is slightly radioactive due to C-14 (carbon-14), including humans and the food we eat. C-14 makes up a percentage of the carbon in all organic material. Another contributor to the internal natural source is K-40 (potassium-40). Potassium is present in many of the foods we eat, such as brazil nuts, bananas, carrots and red meat. The smallest natural source listed is terrestrial. Soil and rocks contain radioactive materials such as Radium and Uranium. The amount of terrestrial radiation you are exposed to depends on where you live. The map below shows terrestrial exposure levels across the United States. The radiation released from nuclear power plants is included in the Industrial and Occupational slice and is listed as <0.1%.

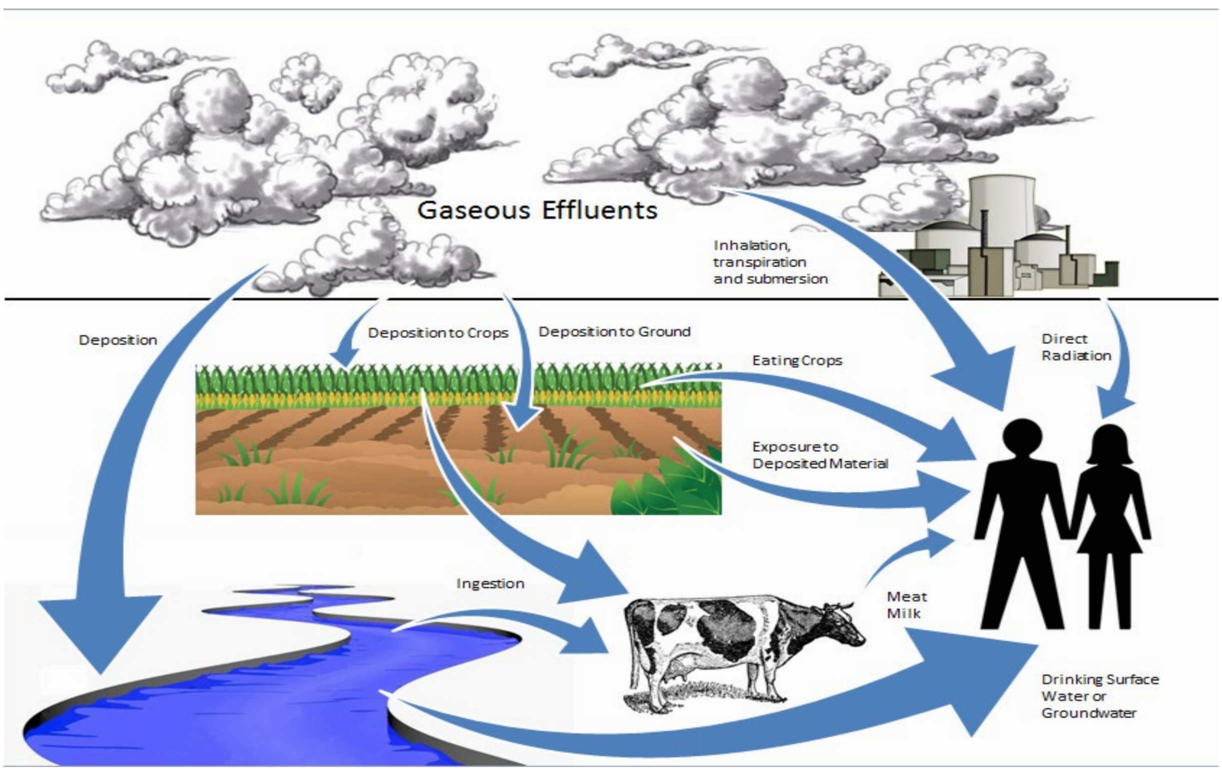


Exposure Pathways

Radiological exposure pathways define the methods by which people may become exposed to radioactive material. The major pathways of concern are those which could cause the highest calculated radiation dose. These projected pathways are determined from the type and amount of radioactive material released into the environment and how the environment is used. The way radioactive material is transported in the environment includes consideration of physical factors, such as the hydrological (water) and meteorological (weather) characteristics of the area. An annual average of the water flow, wind speed, and wind direction are used to evaluate how the radionuclides will be distributed in an area for gaseous or liquid releases. An important factor in evaluating the exposure pathways is the use of the environment. Many factors are considered such as dietary intake of residents, recreational use of the area, and the locations of homes and farms in the area.

The external and internal exposure pathways considered are shown in Figure 2.1. The release of radioactive gaseous effluents involves pathways such as external whole-body exposure, deposition of radioactive material on plants, deposition on soil, inhalation by animals destined for human consumption, and inhalation by humans. The release of radioactive material in liquid effluents involves pathways such as drinking water, fish, and direct exposure from the water at the shoreline while swimming. Although radionuclides can reach humans by many different pathways, some result in more dose than others. The critical pathway is the exposure route that will provide, for a specific radionuclide, the greatest dose to a population, or to a specific group of the population called the critical group. The critical group may vary depending on the radionuclides involved, the age and diet of the group, or other cultural factors. The dose may be delivered to the whole body or to a specific organ. The organ receiving the greatest fraction of the dose is called the critical organ.

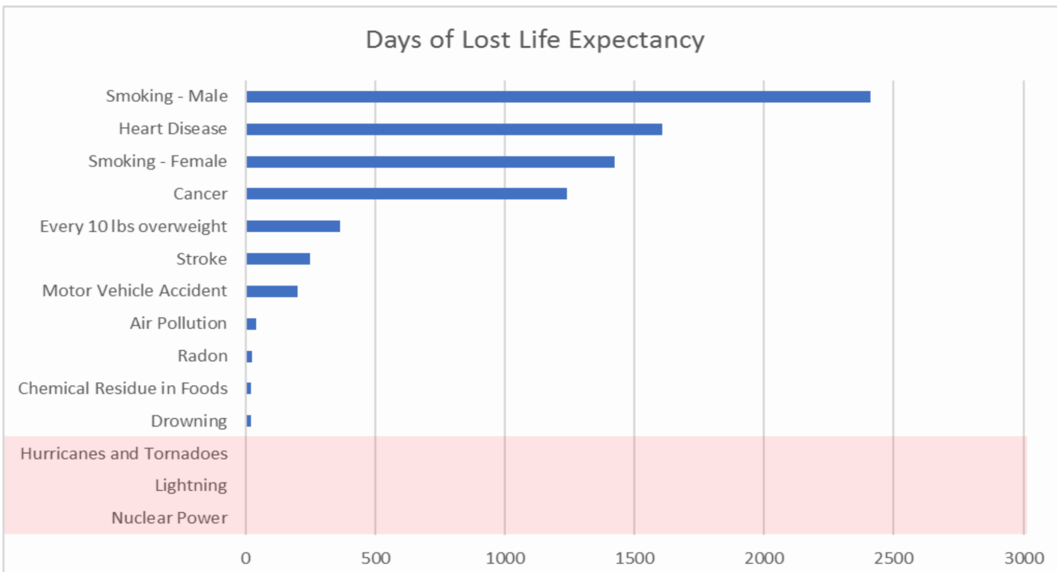
Figure 2.1 External and Internal Exposure Pathways

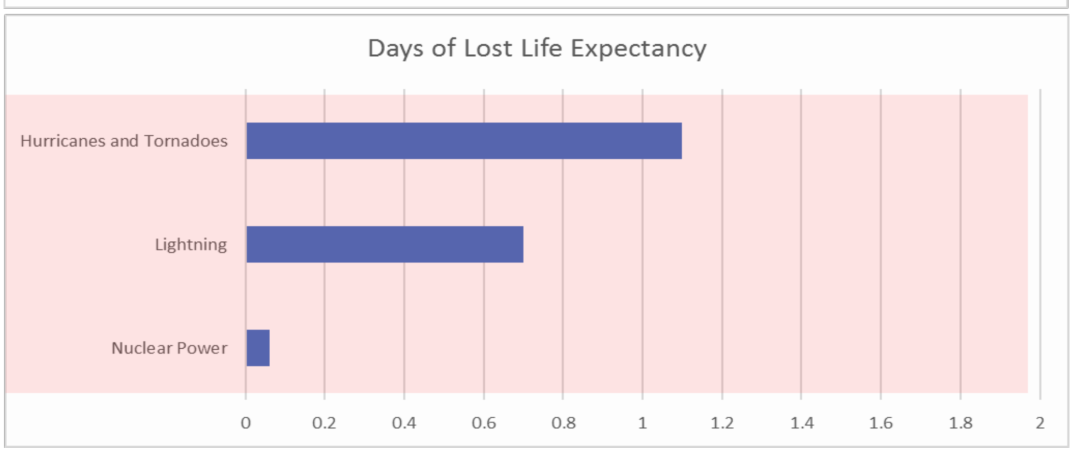


This simple diagram demonstrates some potential exposure pathways from Oyster Creek Generating Station.

Radiation Risk

U.S. radiation protection standards are based on the premise that any radiation exposure carries some risk. There is a risk whether the radiation exposure is due to man-made sources or natural sources. There have been many studies performed trying to determine the level of risk. The following graph is an example of one study that tries to relate risk from many different factors. This graph represents risk as "Days of Lost Life Expectancy." All the categories are averaged over the entire population except Male Smokers, Female Smokers and individuals that are overweight. Those risks are only for people that fall into those categories. The category for Nuclear Power is a government estimate based on all radioactivity releases from nuclear power, including accidents and wastes.





Adapted from the article by Bernard L. Cohen, Ph.D. in the Journal of American Physicians and Surgeons Volume 8 Number 2 Summer 2003. The full article can be found at *http://www.jpands.org/vol8no2/cohen.pdf*

Annual Reports

All nuclear power plants are required to perform sampling of both the potential release paths from the plant and the potential exposure pathways in the environment. The results of this sampling are required to be reported annually to the Nuclear Regulatory Commission (NRC) and made available to the public. There are two reports generated annually, the Annual Radioactive Effluents Release Report (ARERR) and the Annual Radiological Environmental Operating Report (AREOR). The ARERR summarizes all of the effluents released from the plant and quantifies the doses to the public from these effluents. The AREOR summarizes the results of the samples obtained in the environment looking at all the potential exposure pathways by sampling different media such as air, vegetation, direct radiation, etc. These two reports are related in that the results should be aligned. The AREOR should validate that the effluent program is accurate. The ARERR and AREOR together ensure Nuclear Power Plants are operating in a manner that adequately protects the public and the environment.

In the reports, there are four different but interrelated units for measuring radioactivity, exposure, absorbed dose, and dose equivalent. Together, they are used to properly capture both the amount of radiation and its effects on humans.

- Radioactivity refers to the amount of ionizing radiation released by a material. The units of measure for radioactivity used within the AREOR and ARERR are the curie (Ci). Small fractions of the Ci often have a prefix, such as microCurie (µCi) that means 1/1,000,000. That means there are 1,000,000 µCi in one Ci. Due to the extremely low levels of radioactivity in the environment, the unit commonly used for these samples is the picocurie (pCi). A pCi is 1/1,000,000 of a µCi; there are 1,000,000 pCi in a µCi. There are 1,000,000,000,000 pCi in a Ci.

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

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

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

Typically releases from nuclear power plants are so low that the samples taken in the environment are below the detection levels required to be met by all nuclear power plants. There are some radionuclides identified in the environment during the routine sampling, but this is typically background radiation from nuclear weapons testing and events such as Chernobyl and these radionuclides are discussed in the AREOR.

Each report lists the types of samples that are collected and the analyses performed. Different types of media may be used at one sample location looking for specific radionuclides. For example, at our gaseous effluent release points we use different media to collect samples for particulates, iodines, noble gases and tritium. There are also examples where a sample collected on one media is analyzed differently depending on the radionuclide for which the sample is being analyzed.

These annual reports, and much more information related to nuclear power, are available on the NRC website at www.nrc.gov.

I. Summary and Conclusions

On July 1st 2019, ownership of the Oyster Creek Nuclear Power Station and transfer of the station and decommissioning license from Exelon Generation Company, LLC to Oyster Creek Environmental Protection, LLC (OCEP) as the licensed owner and Holtec Decommissioning International, LLC (HDI) as the licensed operator, was completed. Exelon had determined that transitioning operational nuclear plants to decommissioning nuclear plants targeted for permanent shutdown was not aligned with its core objectives and actively sought buyers who would assume ownership and complete decommissioning and license termination.

This report on the Radiological Environmental Monitoring Program (REMP) conducted for the Oyster Creek Generating Station (OCGS) by Holtec Decommissioning International, LLC (HDI) covers the period 01 January 2020 through 31 December 2020. During that time period, a total of 1,134 analyses were performed on 837 samples. In assessing all the data gathered for this report and comparing these results with historical data, it was concluded that the decommissioning of OCGS had no adverse radiological impact on the environment.

REMP-designated surface water samples were analyzed for concentrations of tritium and gamma emitting nuclides. No tritium, fission or activation products were detected in any of the surface water samples collected as part of the Radiological Environmental Monitoring Program during 2020.

REMP-designated drinking water samples were analyzed for concentrations of gross beta, tritium, and gamma emitting nuclides. The preoperational environmental monitoring program did not include analysis of drinking water for gross beta. No tritium or fission or activation products were detected in any of the drinking water samples collected.

REMP-designated groundwater samples were analyzed for concentrations of tritium and gamma emitting nuclides. No tritium and no fission or activation products were detected in REMP groundwater samples.

Fish (predator and bottom feeder), clams, crabs, and sediment samples were analyzed for concentrations of gamma emitting nuclides. No OCGS-produced fission or activation products were detected in fish, clams, crabs or sediment samples.

Air particulate samples were analyzed for concentrations of gross beta, gamma emitting nuclides, strontium-89 (Sr-89), and strontium-90 (Sr-90). 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. Sr-89 and Sr-90 analyses were performed on quarterly composites of air particulate samples. All Sr-89 and Sr-90 results were below the MDC.

Iodine-131 (I-131) analyses were performed weekly on air samples during the 1st quarter of 2020. All results were less than the minimum detectable concentration.

Vegetation samples were analyzed for gamma emitting nuclides, Sr-89, and Sr-90. Concentrations of naturally occurring potassium-40 (K-40) were consistent with those detected in previous years. No fission or activation products were detected. All Sr-89 results were below the minimum detectable activity. Sr-90 activity was at levels consistent with those detected in previous years at both control and indicator stations and can be attributed to historical nuclear weapons testing and the Chernobyl accident.

Environmental gamma radiation measurements were performed quarterly using Optically Stimulated Luminescence Dosimeters (OSLD). Beginning in calendar year 2012, Exelon (the previous plant owner) began using OSLDs and discontinued the use of Thermoluminescent Dosimetry (TLD). There were two main reasons for this change. First, OSLDs have minimal “fade” over a quarterly time period. Fade is where the dose on the dosimeter drifts lower over time. Second, OSLDs may be re-read if necessary. TLDs are reset to zero after they are read. Levels detected were consistent with those observed in previous years. The maximum dose to any member of the public attributable to radioactive effluents and direct radiation from the OCGS was less than the 25 mRem/year limit established by the United States Environmental Protection Agency (EPA).

II. Introduction

The Oyster Creek Generating Station (OCGS) is a non-operational single unit nuclear power plant owned and operated by HDI. OCGS is located on the Atlantic Coastal Plain Physiographic Province in Ocean County, New Jersey, about 60 miles south of Newark, 9 miles south of Toms River, and 35 miles north of Atlantic City. It lies approximately 2 miles inland from the Barnegat Bay. The Oyster Creek Site is approximately 152 acres located west of U.S. Highway Route 9 between the south branch of the Forked River and the Oyster Creek. Most of the Site is identified as Block 100, Lot 4.02 in Lacey Township according to a 2018 American Land Title Association (ALTA)/National Society of Professional Surveyors (NSPS) land title survey. The site includes a small land area south of the Discharge Canal identified as Block 4, Lot 43 in Ocean Township. A perimeter security fence surrounds the restricted /protected area of the site. The site description is changed to reflect the current decommissioning site boundaries. The site location is part of the New Jersey shore area with its relatively flat topography and extensive freshwater and saltwater marshlands. The South Branch of Forked River runs across the northern side of the site and Oyster Creek partly borders the southern side.

A preoperational Radiological Environmental Monitoring Program (REMP) for OCGS was established in 1966 and continued prior to the plant becoming operational in 1969. This report covers those analyses performed by Teledyne Brown Engineering (TBE), Landauer and Environmental Inc. (Midwest Labs) on samples collected during the period 01 January 2020 through 31 December 2020.

A. Objectives of the REMP

The objectives of the REMP are to:

1. Provide data on measurable levels of radiation and radioactive materials in and beyond 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
3. Validate the effluent computer model that predicts radioactive material concentrations at populated off-site locations
4. Fulfill the obligations of the radiological surveillance sections of Oyster Creek's Offsite Dose Calculation Manual (ODCM)

B. Implementation of the Objectives

The implementation of the objectives is accomplished by:

1. Identifying significant exposure pathways
2. Establishing baseline radiological data for media within those pathways
3. Continuously monitoring those media before, during and after terminating Station operation to assess Station radiological effects (if any) on the public, plant workers and the environment

C. Discussion

1. General Program

The Radiological Environmental Monitoring Program (REMP) was established in 1966, before the plant became operational. This preoperational surveillance program was established to describe and quantify the radioactivity, and its variability, in the area prior to the operation of OCGS. After OCGS became operational in 1969, the operational surveillance program continued to measure radiation and radioactivity in the surrounding areas.

A variety of environmental samples are collected as part of the REMP at OCGS. The selection of sample types is based on the established pathways for the transfer of radionuclides through the environment to humans. The selection of sampling locations is based on sample availability, local meteorological and hydrological characteristics, local population characteristics, and land usage in the area of interest. The selection of sampling frequencies for the various environmental media is based on the radionuclides of interest, their respective half-lives, and their behavior in both the biological and physical environment.

2. Preoperational Surveillance Program

The federal government requires nuclear facilities to conduct radiological environmental monitoring prior to constructing the facility. This preoperational surveillance program is aimed at collecting the data needed to identify pathways, including selection of the radioisotope and sample media combinations to be included in the environmental surveillance program conducted after facility operation begins. Radiochemical analyses performed on the environmental samples should include not only those nuclides expected to be released during facility operation but should also include typical radionuclides from nuclear weapons testing and natural background radioactivity. All environmental media with a potential to be affected by facility operation as well as those media directly in the major pathways, should be sampled on at least an annual basis during the preoperational phase of the environmental surveillance program.

The preoperational surveillance design, including nuclide/media combinations, sampling frequencies and locations, collection techniques, and radioanalyses performed, should be carefully considered and incorporated in the design of the operational surveillance program. In this manner, data can be compared in a variety of ways (for example, from year to year, location to location, etc.) in order to detect any radiological impact the facility has on the surrounding environment. Data collection during the preoperational phase should be planned to provide a comprehensive database for evaluating any future changes in the environment surrounding the nuclear facility.

OCGS began its preoperational environmental surveillance program three years before the plant began operating in 1969. Data accumulated during those early years provide an extensive database from which environmental monitoring personnel are able to identify trends in the radiological characteristics of the local environment. The environmental surveillance program at OCGS will continue after the plant has reached the end of its economically useful life and decommissioning has begun.

3. Consideration of Plant Effluents

Effluents are strictly monitored to ensure that radioactivity released to the environment is as low as reasonably achievable (ALARA) and does not exceed regulatory limits. Effluent control includes the operation of monitoring systems, in-plant and environmental sampling and analyses programs, quality assurance programs for effluent and environmental programs, and procedures covering all aspects of effluent and environmental monitoring.

Both radiological environmental and effluent monitoring indicate that the operation of OCGS does not result in significant radiation exposure of the people or the environment surrounding OCGS and is well below the applicable levels set by the Nuclear Regulatory Commission (NRC) and the EPA.

Environmental sampling of airborne iodine and particulates showed no radioactivity attributable to the operation of OCGS.

III. Program Description

A. Sample Collection

Samples for the OCGS REMP were collected for HDI by on-site personnel and Normandeau Associates, Incorporated. This section describes the general collection methods used to obtain environmental samples for the OCGS REMP in 2020. Sample locations and descriptions can be found in Tables B-1 and B-2, and Figures B-1, B-2, and B-3, Appendix B. The collection procedures are listed in Table B-3.

Aquatic Environment

The aquatic environment was evaluated by performing radiological analyses on samples of surface water, drinking water, groundwater, fish, clams, crabs, and sediment. One gallon water samples were collected monthly from two surface water locations (33 and 94), semiannually at two surface water locations (23 and 24), monthly from four drinking water wells (1N, 1S, 37, and 38) and quarterly from 2 groundwater stations (MW-24-3A and W-3C). Control locations were 94 and 37. All samples were collected in plastic bottles, which were rinsed at least twice with source water prior to collection. Fish samples comprising the flesh of two groups, bottom feeder and predator, were collected semiannually at three locations (33, 93 and 94 [control]). Clams were collected semiannually from three locations (23, 24, and 94 [control]). Two annual crab samples were collected from two locations (33 and 93). Sediment samples were collected at four locations semiannually (23, 24, 33, and 94 [control]).

Atmospheric Environment

The atmospheric environment was evaluated by performing radiological analyses on samples of air particulate and airborne iodine. Airborne iodine and particulate samples were collected and analyzed weekly at eight locations (C, 3, 20, 66, 71, 72, 73, and 111). The control location was C. 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. After the first quarter of 2020, the sample interval was changed to bi-weekly from weekly. See Program Changes for more detail.

Terrestrial Environment

The terrestrial environment was evaluated by performing radiological analyses on samples of garden vegetation. No commercial dairy operations and no dairy animals producing milk for human consumption are located within a 5-mile radius of the plant. Therefore, vegetation samples were collected in lieu of milk. Vegetation samples were collected, when available, at four locations (35, 36, 66 and 115). Station 36 is the control location as it is 24 miles northwest of the plant in the lowest X/Q sector, beyond any influence of the plant when the plant was operating, and while it is permanently shut down for decommissioning. All samples were collected in 18" x 24" new unused plastic bags and shipped promptly to the laboratory.

Ambient Gamma Radiation

Direct radiation measurements were made using Al_2O_3:C Optically Stimulated Luminescence Dosimetry (OSLD). Exelon Nuclear (the previous plant owner) changed the dosimetry used for environmental monitoring. Beginning in calendar year 2012, Exelon began using OSLDs and discontinued the use of Thermoluminescent Dosimetry (TLD). There were two main reasons for this change. First, OSLDs are subject to minimal fade. Fade is where the dose on the dosimeter drifts lower over time. Second, OSLDs may be re-read if necessary. TLDs are reset to zero after they are read. The OSLDs were placed on and around the OCGS site and were categorized as follows:

An inner ring consisting of 19 locations (1, T1, 51, 52, 53, 54, 55, 56, 57, 58, 59, 61, 62, 63, 64, 65, 66, 112 and 113) near the site boundary.

An outer ring consisting of 21 locations (6, 8, 9, 22, 68, 73, 74, 75, 78, 79, 98, 99, 100, 101, 102, 103, 104, 106, 107, 109 and 110) extending to approximately 5 miles from the site designed to measure possible exposures to close-in population.

Special interest stations consisting of 3 locations (71, 72 and 81) representing special interest areas such as population centers, state parks, etc.

Background (Control) stations consisting of one location (C) greater than 20 miles distant from the site.

Indicator OSLDs were placed systematically, with at least one station in each of 16 meteorological compass sectors in the general area of the site boundary. OSLDs were also placed in each meteorological sector in the 1 to 5 mile range, where reasonable highway access would permit, in areas of public interest and population centers. Background locations were located greater than twenty miles distant from the OCGS and generally in an upwind direction from the OCGS.

Two OSLDs were placed at each location approximately three to eight feet above ground level. The OSLDs were exchanged quarterly and sent to a vendor for analysis.

B. Sample Analysis

This section describes the general analytical methodologies used by TBE and Environmental Inc. (Midwest Labs) to analyze the environmental samples for radioactivity for the OCGS REMP in 2020. The analytical procedures used by the laboratories are listed in Table B–3.

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

1. Concentrations of beta emitters in air particulates and drinking water

2. Concentrations of gamma emitters in surface water, drinking water, groundwater, fish, clams, crabs, sediment, air particulates and vegetation

3. Concentrations of tritium in REMP-designated surface water, drinking water and groundwater

4. Concentrations of I-131 in air iodine cartridges

5. Concentrations of strontium in air particulates and vegetation

6. Ambient gamma radiation levels at various locations around the OCGS

C. Data Interpretation

For trending purposes, the radiological and direct radiation data collected during 2020 were compared with data from past years. The results of environmental sampling show that radioactivity levels have not increased from the background radioactivity detected prior to the operation of OCGS. The operation of OCGS continues to have no measurable radiological impact upon the environment.

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 OCGS 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. <u>Net Activity Calculation and Reporting of Results</u>

   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, which results in a negative number. A less than 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, drinking water, and groundwater - 8 nuclides: Mn-54, Co-58, Fe-59, Co-60, Zn-65, Zr-95, Cs-134 and Cs-137 were reported

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

For clams - eight nuclides: K-40, Mn-54, Co-58, Fe-59, Co-60, Zn-65, Cs-134, and Cs-137 were reported

For crabs - eight nuclides: K-40, Mn-54, Co-58, Fe-59, Co-60, Zn-65, Cs-134, and Cs-137 were reported

For sediment - nine nuclides: Be-7, K-40, Mn-54, Co-58, Co-60, Cs-134, Cs-137, Ra-226, and Th-228 were reported

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

For air iodine cartridges - one nuclide: I-131 was reported

For vegetation - four nuclides: Be-7, K-40, Cs-134 and Cs-137 were reported

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

D. Program Exceptions

For 2020, the OCGS REMP had a sample recovery rate in excess of 97%. Exceptions are listed below:

Environmental Dosimetry

1. June, 2020: Station 6 (Lane Place, Lacey) - No 2nd quarter results due to loss of both dosimeters from Station 6. The dosimeters for the 3rd Quarter were deployed and recovered. Recovery of three of four quarters of OSLD data will not adversely affect the program.

Air

1. 01/15/20 & 02/12/20: Station C - Timer not running properly. Monitored for several weeks. Sample run times calculated from collection dates/times. Timer replaced 02/12/20.

2. 03/04/20: Station 111 - No valid sample due to pump not running. Vanes replaced the same day and a new start time for the week.

3. <u>04/22/20:</u> Station C - No valid sample for Week 16 due to the station being turned off on 04/09/20. The air station was restarted that day.

4. <u>05/09/20:</u> Station C - Timer not running properly. Sample run times calculated from collection dates/times. Timer replaced 05/20/20.

5. <u>05/20/20:</u> Station 71 - No valid sample for Week 20 due to pump not running long enough to constitute a valid sample. Vanes replaced the same day.

6. <u>06/02/20:</u> Stations 73 & C - No power due to storms the previous day. All air samples valid. Breaker tripped at Station 73 and reset on 06/08/20.

7. <u>06/18/20:</u> Station 111 - Pump not running; samples are valid. Pump replaced the same day.

8. <u>07/01/20:</u> Station 72 - timer not running properly. Sample run times calculated from collection dates/times. Timer placed the same day.

9. <u>09/09/20:</u> Station 66 - No valid sample for Week 36 due to safety concerns in sample collection. The main power line was disconnected from the utility pole. The sampler did not run long enough to constitute a valid sample. Power line reconnected 09/15/20.

10. <u>11/18/20:</u> Station 73 - Pump not running due to tripped breaker. Breaker was reset the same day.

<u>Drinking Water</u>

Note: Stations 1S and 1N are on-site drinking water wells. Typically, only one well is in service at a time. They are only listed as deviations when there is not a sample for the monitoring period.

1. <u>2020:</u> Station 1S was not operational for the entire year.

<u>Fish/Crabs</u>

1. <u>June & October, 2020:</u> Control Station 94 - no fish samples collected for spring & fall sampling. Per procedure ER-OCGS-14, fish are to be collected if available.

2. <u>June, 2020:</u> Station 93 collected only 1 species of fish.

3. <u>October, 2020:</u> Station 93 - no crabs available. As per procedure ER-OCGS-16, crabs are to be collected if available.

Vegetation

1. 09/23/20: Stations 66 & 35 - Only 1 of 3 species collected at Station 66 and only 2 of 3 species collected at Station 35 due to the lateness of the growing season.

2. 10/2620: Stations 66 & 35 - No vegetation samples available at Station 66. Only 2 of 3 species collected at Station 35 due to the lateness of growing season.

Program exceptions are tracked by Oyster Creek staff and Normandeau and investigated to understand the causes of the program exception. Sampling and maintenance errors are reviewed with the personnel involved to prevent recurrence.

The overall sample recovery rate indicates that the appropriate procedures and equipment are in place to assure reliable program implementation.

E. Program Changes

In April, monthly water station samples changed from composite to grab samples. The number of active monthly water sample stations was reduced to 5. Air Station 3 was removed from the active sampling program for air particulates because it is further from the plant than plant effluents would be detected in a decommissioning facility. Active air station monitoring changed from weekly to bi-weekly beginning with the air samples deployed on April 9, 2020.

Sampling and analysis for I-131 was stopped in the first quarter of 2020. I-131 has a short half-life (8.0 days) and production of this isotope ceased when the plant permanently shut down in September 2018. In this interval, all the inventory of I-131 has undergone radioactive decay and is no longer present in OCGS effluents. Coincidentally with this change, the sample interval was changed from weekly to bi-weekly. I-131 has an 8 day half-life and sampling at a 14-day interval posed the risk of low levels of I-131 being missed in analysis. All of the particulate isotopes being analyzed for now have a half-life of greater than eight days and the same risk of missing low level contamination no longer exists.

Similarly, analysis of the short half-life Sr-89 isotope (50.5 days) is no longer performed for the same reason. Production of this fission product ceased in September 2018. Analysis for Sr-90 (29 year half-life) continues to be a part of the program at OCGS.

IV. Results and Discussion

A. Aquatic Environment

1. Surface Water

Samples were taken via grab sample methodology at two locations (33 and 94) on a monthly schedule. In addition, grab samples were collected semi-annually at two locations (23 and 24). Of these locations 23, 24, and 33, located downstream, could be affected by Oyster Creek's effluent releases. The following analyses were performed:

Tritium

Surface water sampling began in 1966, and the samples were analyzed for tritium as well as other radioactivity. During this preoperational program, tritium was detected at an average concentration of 1,050 pCi/L. At that time, counting instrumentation was not as sensitive as it now, and the minimum detectable concentration (MDC) was 1,000 pCi/L versus 200 pCi/L used through October, 2020. (The MDC was changed to 2,000 pCi/L in November, 2020). By comparing the 2020 sampling results to the decay- corrected average preoperational concentration reported in the 2007 Annual Radiological Environmental Operating Report (111 pCi/L), it can be seen that the inventory of tritium in the environment is due to fallout from past atmospheric nuclear weapons testing and is decreasing with time.

Samples from all locations were analyzed for tritium activity. No tritium activity was detected. (Table C–I.1, Appendix C)

Gamma Spectrometry

Samples from all locations were analyzed for gamma emitting nuclides. All nuclides were less than the MDC. (Table C–I.2, Appendix C)

2. Drinking water

Monthly samples were composited from monthly grab samples from six drinking water wells (1N, 1S, 37 and 38) through the 1st quarter of 2020. A monthly grab sample was taken from May through December. Station 1, because it is located on the OCGS site, could potentially be affected by radioactive releases from the plant. Station 1 was split into two separate locations, 1N and 1S. Station 38, the Ocean Township Municipal Utility Authority Well, could potentially be affected by effluent releases from the OCGS. Given its distance from the facility (1.6 miles) and depth (approximately 360 feet), however, the probability of any OCGS-related impact is very small. Stations 37 and 39, Lacey Township Municipal Utility Authority wells, are not likely to be impacted by effluents from the OCGS. These wells are located generally up-gradient of the regional groundwater flow direction (southeast). In addition, because of their depth (> 200 feet) and distance from the site (2.2 and 3.5 miles respectively), they are unlikely to be affected by OCGS operations. The following analyses were performed:

Tritium

Monthly samples from all locations were analyzed for tritium activity. No tritium activity was detected. Drinking water was sampled during the preoperational program and throughout the almost 50 years of the plant's operational program. Tritium sampling results during the preoperational years, yielded results all less than the minimum detectable concentration of 1000 pCi/L. The 2020 results are all less than the MDC. (Table C–II.1, Appendix C)

Gross Beta

Monthly samples from all locations were analyzed for concentrations of total gross beta activity. Gross beta was detected in 21 of 36 samples and is attributed to natural sources and fallout residual from previous bomb testing. The values ranged from 1.6 to 4.5 pCi/L. (Table C-II.2, Appendix C)

Gamma Spectrometry

Samples from all locations were analyzed for gamma emitting nuclides. All nuclides were less than the MDC. (Table C–II.3, Appendix C)

3. Groundwater

The following analyses were performed:

Tritium

Samples from all locations were analyzed for tritium activity. No tritium activity was detected. (Table C–III.1, Appendix C)

Gamma Spectrometry

Samples from all locations were analyzed for gamma emitting nuclides (Table C–III.2, Appendix C). All nuclides were less than the MDC.

4. Fish

Fish samples comprised of bottom feeder (summer flounder) and predator (American eel, white perch, silver perch, smooth dogfish, striped bass, and tautog) were collected at three locations (33, 93, and 94) semiannually when available. Locations 93 and 33 could be affected by Oyster Creek's effluent releases. The following analysis was performed:

Gamma Spectrometry

The edible portions of fish samples from three locations were analyzed for gamma emitting nuclides. Naturally occurring K-40 was found at all stations and ranged from 2,531 to 5,972 pCi/kg wet and was consistent with levels detected in previous years. No fission or activation products were found. (Table C–IV.1, Appendix C)

No fish were sampled during the preoperational sampling program for OCGS.

5. Clams and Crabs

Clams were collected at three locations (23, 24, and 94) semiannually when available. Crabs were collected at two locations (33 and 93) annually when available. Locations 23, 24, 33, and 93 could be affected by Oyster Creek's effluent releases. The following analysis was performed:

<u>Gamma Spectrometry</u>

The edible portions of clam samples from all three locations were analyzed for gamma emitting nuclides. Naturally occurring K-40 was found at all stations and ranged from 1,198 to 2,657 pCi/kg wet and was consistent with levels detected in previous years. No fission or activation products were found. (Table C–IV.2, Appendix C) Historical levels of Co-60 in clams are shown in Figure C–1, Appendix C. After 1986, all results were less than the Lower Limit of Detection (LLD).

Preoperational clam sample results for naturally occurring K-40 ranged from 600 to 9,800 pCi/kg wet, which are consistent with current sample results.

The edible portions of an annual crab sample were analyzed for gamma emitting nuclides. Naturally occurring K-40 was found at one location at a concentration of 2,063 pCi/kg wet, consistent with levels detected in previous years. No fission or activation products were found. (Table C–IV.2, Appendix C)

Crabs were not sampled during the preoperational years of the OCGS environmental monitoring program.

6. Sediment

Aquatic sediment samples were collected at four locations (23, 24, 33, and 94) semiannually. Of these locations, stations 23, 24, and 33 located downstream, could be affected by Oyster Creek's effluent releases. The following analysis was performed:

<u>Gamma Spectrometry</u>

Sediment samples from all four locations were analyzed for gamma emitting nuclides. Naturally occurring K-40 was found at all stations and ranged from 615 to 19,230 pCi/kg dry. Naturally occurring Ra-226 was found at one location at a concentration of 4,319 pCi/kg dry. Naturally occurring Th-228 was found at all 4 stations and ranged from 108 to 875 pCi/kg wet. Cs-137 was not detected in any of the samples. No fission or activation products were found. (Table C–V.1, Appendix C)

The Figure C-3, Appendix C graph shows Cs-137 concentrations in sediment from 1984 through 2020 and Figure C–2, Appendix C graph shows Co-60 concentrations in sediment from 1984 through 2020.

The requirement for sampling sediment is a requirement of ODCM 3.12.1, Table 3.12.1-1.d. ODCM Table 3.12.1-2, "Reporting Levels for Radioactive Concentrations in Environmental Samples Reporting Levels" does not include requirements for sediment. CY-AA-170-1000, Radiological Environmental Monitoring Program and Meteorological Program Implementation, Attachment 1, Analytical Results Investigation Levels, includes sediment investigation level for Cs-137 of 1000E+00 pCi/kg dry.

While aquatic sediment sampling was part of the preoperational program, samples were not analyzed for gamma emitting nuclides until 1981.

In conclusion, the 2020 aquatic monitoring results for surface water, drinking water, groundwater, fish, clams, crabs, and sediment showed only naturally occurring radioactivity and were consistent with levels measured prior to the operation of OCGS, and with levels measured in past years. No radioactivity attributable to activities at OCGS was detected in any aquatic samples during 2020 and no adverse long-term trends are shown in the aquatic monitoring data.

B. Atmospheric Environment

1. Airborne

a. Air Particulates

Continuous air particulate samples were collected from eight locations on a weekly basis until April 9, 2020. Bi-weekly sampling began with the period April9 - April 22, 2020. See Program Changes for more detail. The eight locations were separated into three groups: Group I represents locations near the OCGS site boundary (20, 66 and 111), Group II represents the locations at an intermediate distance from the OCGS site (71, 72, and 73), and Group III represents the control and locations at a remote distance from OCGS (C and 3). The following analyses were performed:

Gross Beta

Samples were analyzed for concentrations of beta emitters. Detectable gross beta activity was observed at all locations. Comparison of results among the three groups aids in determining the effects, if any, resulting from the operation of OCGS. The results from the Site Boundary locations (Group I) ranged from 5E-03 to 21E–03 pCi/m^3 with a mean of 12E–03 pCi/m^3. The results from the

Intermediate Distance locations (Group II) ranged from 5E-03 to 19E–03 pCi/m^3 with a mean of 11E–03 pCi/m^3. The results from the Distant locations (Group III) ranged from 7E-03 to 24E–03 pCi/m^3 with a mean of 13E–03 pCi/m^3. (Table C–VI.1 and C–VI.2, Appendix C)

The similarity of the results from the three groups indicates that there is no relationship between gross beta activity and distance from OCGS. These results are consistent with data from previous years and indicate no effects from the operation of OCGS (Figures C-4 and C–5, Appendix C).

Air sample filters have been analyzed for gross beta activity since the inception of the preoperational environmental monitoring program in 1966. The preoperational data values ranged from 1.90E-02 to 2.77E-01 pCi/m3. The 2020 gross beta activity values ranged from <5E-03 to 24E-03 pCi/m3. The 2020 results are consistent with historical operational data (Figure C-5, Appendix C) and fall within the range of results observed during the preoperational period.

Strontium-89 and Strontium-90

Samples were composited quarterly and analyzed for Sr-89 and Sr-90. No strontium was detected in any of the samples. (Table C–VI.3, Appendix C) These results are consistent with historical operational data. The preoperational environmental monitoring program did not include analysis of air samples for Sr-89 and Sr-90.

Gamma Spectrometry

Samples were composited quarterly and analyzed for gamma emitting nuclides. Naturally occurring Be-7 due to cosmic ray activity was detected in 29 of 29 samples. The values ranged from 39E-03 to 83E–03 pCi/m^3. All other nuclides were less than the MDC. (Table C–VI.4, Appendix C) These results are consistent with historical operational data. The preoperational environmental monitoring program did not include analysis of air samples for gamma emitting nuclides.

b. Airborne Iodine

Continuous air samples were collected from eight (C, 3, 20, 66, 71, 72, 73, 111) locations and analyzed weekly for I-131 in the 1st quarter of 2020. After the first quarter, analysis for I-131 was eliminated. See Program Changes section for more detail Consistent with historical operational data, all results were less than the MDC for I-131. (Table C–VII.1, Appendix C)

The preoperational environmental monitoring program for OCGS did not include analysis of air media for I-131.

In conclusion, the atmospheric monitoring data are consistent with preoperational and prior operational data and show no long-term trends in the environment attributable to the operation of OCGS.

2. Terrestrial

a. Vegetation

Samples were collected from four locations (35, 36, 66 and 115) when available. The following analyses were performed:

Strontium-89 and Strontium-90

Vegetation samples from all locations were analyzed for concentrations of Sr-89 and Sr-90. All Sr-89 results were less than the MDC. Sr-90 was detected in 34 of 55 samples. The values ranged from 4.4 to 14.4 pCi/kg wet, which is consistent with historical data. (Table C–VIII.1, Appendix C)

The following information on Sr-90 is available on the NRC web page under "Backgrounder Radiation Protection and the "Tooth Fairy" Issue" published in December of 2004:

> *The largest source of Sr-90 in the environment (~99%) is from weapons testing fallout. Approximately 16.8 million curies of Sr-90 were produced and globally dispersed in atmospheric nuclear weapons testing until 1980. As a result of the Chernobyl accident, approximately 216,000 curies of Sr-90 were released into the atmosphere. With a 28-year half-life, Sr-90 still remains in the environment at nominal levels.*
>
> *The total annual release of Sr-90 into the atmosphere from all 103 commercial nuclear power plants operating in the United States is typically 1/1000th of a curie. (NUREG/CR-2907 Vol.12). At an individual nuclear power plant, the amount of Sr-90 is so low that it is usually at or below the minimum detectable activity of sensitive detection equipment.*

Oyster Creek did not report any Sr-90 released in the Annual Radioactive Effluent Release Report as all analyses for Sr-90 performed were less than the minimum detectable concentration.

Gamma Spectrometry

Vegetation samples from locations 35, 36, and 115 were analyzed for concentrations of gamma-emitting nuclides. Naturally occurring K-40 activity was found in all samples and ranged from 1,379 to 5,287 pCi/kg wet. Naturally occurring Be-7 was detected in 9 of 55 samples and ranged from 185 to 830 pCi/kg wet. All other nuclides were less than the MDC. (Table C–VIII.1, Appendix C)

Preoperational vegetation sample analyses did not include strontium analyses or gamma spectroscopy.

Oyster Creek conducted a Cs-137 study in 2006/2007. A report was generated titled "Evaluation of Cesium-137 in Environmental Samples from the Amergen Property East of the Oyster Creek Generating Station". Below is an excerpt from that report:

> “The levels of Cs-137 observed in the soil and vegetation samples are consistent with environmental concentrations known to be attributable to fallout from historic nuclear weapons testing and the Chernobyl accident. In addition, the variability of Cs-137 concentrations in soil and vegetation on the farm property appears to be driven by a number of environmental factors. Cs-137 concentrations in soil were non-detectable. Vegetation samples exhibited Cs-137 concentrations from non-detectable to 0.130 pCi/g, with a mean concentration of 0.078 pCi/g. For comparison, in the year 2000, as part of the confirmatory release survey for the adjacent Forked River site to the west of OCGS, the NRC reported that the maximum observed soil concentration of 0.53 pCi/g was not distinguishable from the variation in Cs-137 in the environment due to these fallout sources. The NRC also reported background Cs-137 concentrations in New Jersey coastal plain soils as high as 1.5 and 2.8 pCi/g. In addition, decay-corrected historic REMP data from a predominantly upwind location, nearly four miles from the OCGS, yields present-day Cs-137 concentrations ranging from 0.862 to 1.68 pCi/g.”

In 2020, there was no Cs-137 identified in any vegetation samples, but it is not unusual for Cs-137 to be identified given the known environmental levels of this radionuclide attributable to atmospheric nuclear weapons testing and the Chernobyl accident.

In conclusion, terrestrial monitoring results for vegetation samples during 2020 showed only naturally-occurring radioactivity and radioactivity associated with fallout from past atmospheric nuclear weapons testing and Chernobyl. The radioactivity levels detected were consistent with levels measured in past years, and no radioactivity attributable to activities at OCGS was detected in any terrestrial samples. The terrestrial monitoring data show no adverse long-term trends in the terrestrial environment.

C. Ambient Gamma Radiation

Ambient gamma radiation levels were measured using Optically Stimulated Luminenscence Dosimeters (OSLD). Forty-four OSLD locations were monitored around the site with all measurements below 25 mRem/yr. Results of background corrected OSLD measurements are summarized in Tables C-IX.1 to C-IX.3 and Figure C-6.

The non-background corrected OSLD measurements ranged from 17.8 to 31.7 mR/standard quarter. In order to correct these results for background radiation, the mean of the dose rates measured at the background OSLD station (C) was subtracted from the dose measured at each indicator station.

The preoperational environmental monitoring program utilized film badges, the results of which are not comparable with the doses measured using thermoluminescent dosimeters or optically stimulated dosimeters during the operational REMP. In conclusion, the 2020 OSLD results are consistent with past operational measurements of direct radiation and demonstrate that the OCGS continues to be in compliance with the 40 CFR 190 limit on maximum dose to the public.

D. Land Use Survey

A Land Use Survey, conducted in September 2020 around the Oyster Creek Generating Station (OCGS), was performed by Normandeau Associates, Inc. for HDI. The survey is conducted annually to identify any changes from the previous year. The purpose of the survey is to identify the nearest residence and garden larger than 500 square feet within each meteorological sector, at a distance of 5 miles from the plant. Additionally, as part of the survey, Normandeau also looked for evidence of milk-producing animals for human consumption in each of the 16 meteorological sectors out to a distance of 5 miles from the OCGS. None were observed. The distance and direction of all locations from the OCGS Reactor Building were determined using Global Positioning System (GPS) technology. Thirty-three gardens identified in the 2019 report were not viable or determined to be too small to be considered this year. However, thirty-four new gardens, previously not identified, were noted within 3 miles of the facility during this year's survey. The results of this survey are summarized below:

Distance in Feet from the OCGS Reactor Building			
Sector		Residence (ft.)	Garden* (ft.)
1	N	5,655	6,077
2	NNE	3,240	4,557
3	NE	3,245	3,932
4	ENE	5,704	6,486
5	E	6,549	1,758
6	ESE	3,189	2,081
7	SE	3,073	2,321
8	SSE	4,666	8,141
9	S	7,971	9,034
10	SSW	8,260	8,290
11	SW	9,285	9,776
12	WSW	10,713	12,354
13	W	22,191	None
14	WNW	None	None
15	NW	27,985	None
16	NNW	7,506	8,918

**Greater than 500 ft^2 in size producing broad leaf vegetation*

E. Summary of Results – Inter-laboratory Comparison Program

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

A. Analytics Evaluation Criteria

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

B. 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 United States Environmental Protection Agency (USEPA), National Environmental Laboratory Accreditation Conference (NELAC), state-specific Performance Testing (PT) program requirements or ERA's standard operating procedure (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.

C. DOE Evaluation Criteria

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

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

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

For the TBE laboratory, 126 out of 133 analyses performed met the specified acceptance criteria. Seven analyses did not meet the specified acceptance criteria for the following reasons and were addressed through the TBE Corrective Action Program. A summary is found below:

1. The MAPEP February 2020 AP U-233/234 and U-238 results were evaluated as *Not Acceptable*. The reported value for U-233/234 was 0.0416 ± 0.0102 Bq/sample and the known result was 0.075 Bq/sample (acceptance range 0.053 - 0.098). The reported value for U-238 was 0.0388 ± 0.00991 Bq/sample and the known result was 0.078 Bq/sample (acceptance range 0.055 - 0.101). This sample was run as the workgroup duplicate and had relative percentage differences (RPD's) of 10.4% (U-234) and 11.7% (U-238). After the known results were obtained, the sample was relogged. The filter was completely digested with tracer added originally; the R1 results were almost identical. It was concluded that the recorded tracer amount was actually double, causing the results to be skewed. Lab worksheets have been modified to verify actual tracer amount vs. LIMS data. TBE changed vendors for this cross-check to ERA MRaD™ during the 2nd half of 2020. Results were acceptable at 97.8% for U-234 and 106% for U-238. (NCR 20-13)

2. The Analytics September 2020 milk Sr-89 result was evaluated as *Not Acceptable*. The reported value was 62.8 pCi/L and the known result was 95.4 (66%). All QC data was reviewed and there were no anomalies. This was the first failure for milk Sr-89 since 2013 and there have only been 3 upper/lower boundary warnings since that time. It is believed that there may have been some Sr-89 loss during sample prep. The December 2020 result was at 92% of the known. (NCR 20-19)

3. The ERA October 2020 water I-131 result was evaluated as *Not Acceptable*. The reported value was 22.9 pCi/L and the known result was 28.2 (acceptance range 23.5 - 33.1). The reported result was 81% of the known, which passes TBE QC criteria. This was the first failure for water I-131. (NCR 20-17)

4. The ERA October 2020 water Gross Alpha and Gross Beta results were evaluated as *Not Acceptable*. The reported/acceptable values and ranges are as follows:

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

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

5. The MAPEP August 2020 soil Ni-63 result was evaluated as *Not Acceptable*. The reported value was 438 ± 21.1 Bq/kg and the known result was 980 Bq/kg (acceptance range 686 - 1274). It is believed that some Ni-63 loss occurred during the sample prep step. (NCR 20- 20)

For the secondary QC samples, Environmental Inc., Midwest Laboratories (EIML) analyzed samples for H-3, Gross Alpha, Sr-89/90 and gamma nuclides. For these analyses, 46 of 46 analyses met the specified acceptance criteria.

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

1. HDI Offsite Dose Calculation Manual for Oyster Creek Generating Station, Procedure CY-OC-170-301.

2. United States Nuclear Regulatory Commission Branch Technical Position, An Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

3 Pre-Operational Environmental Radiation Survey, Oyster Creek Nuclear Electric Generating Station, Jersey Central Power and Light Company, March 1968.

VI. Errata

In the 2019 AREOR, Table C-VI.3 results for AP Sr-89 & Sr-90 were not updated from the previous year. All results were < MDC for both years. The correction is found in Appendix F.

APPENDIX A

RADIOLOGICAL ENVIRONMENTAL MONITORING REPORT SUMMARY

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TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR THE OYSTER CREEK GENERATING STATION, 2020

NAME OF FACILITY: OYSTER CREEK GENERATING STATION **DOCKET NUMBER: 50-219**
LOCATION OF FACILITY: OCEAN COUNTY, NJ **REPORTING PERIOD: 2020**

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
SURFACE WATER *(PCI/LITER)*	**H-3**	30	**2000**	<LLD	<LLD	-		0
	GAMMA	30						
	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
	ZR-95		**30**	<LLD	<LLD	-		0
	CS-134		**15**	<LLD	<LLD	-		0
	CS-137		**18**	<LLD	<LLD	-		0
DRINKING WATER *(PCI/LITER)*	**H-3**	36	**2000**	<LLD	<LLD	-		0
	GR-B	36	**4**	2.5 (12/24) *1.6 - 4.5*	2.3 (9/12) *1.8 - 3.5*	3.1 (2/12) *1.8 - 4.5*	1N INDICATOR ON-SITE DOMESTIC WELL AT OCGS 0.2 MILES N OF SITE	0
	GAMMA	36						
	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
	ZR-95		**30**	<LLD	<LLD	-		0
	CS-134		**15**	<LLD	<LLD	-		0
	CS-137		**18**	<LLD	<LLD	-		0
GROUNDWATER *(PCI/LITER)*	**H-3**	8	**2000**	<LLD	*NA*	-		0
	GAMMA	8						
	MN-54		**15**	<LLD	*NA*	-		0
	CO-58		**15**	<LLD	*NA*	-		0
	FE-59		**30**	<LLD	*NA*	-		0
	CO-60		**15**	<LLD	*NA*	-		0
	ZN-65		**30**	<LLD	*NA*	-		0
	ZR-95		**30**	<LLD	*NA*	-		0
	CS-134		**15**	<LLD	*NA*	-		0
	CS-137		**18**	<LLD	*NA*	-		0

***(M)** The Mean Values are calculated using the positive values. **(F)** Fraction of detectable measurement are indicated in parentheses.*

TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR THE OYSTER CREEK GENERATING STATION, 2020

NAME OF FACILITY: OYSTER CREEK GENERATING STATION **DOCKET NUMBER: 50-219**
LOCATION OF FACILITY: OCEAN COUNTY, NJ **REPORTING PERIOD: 2020**

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED		NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	INDICATOR LOCATIONS MEAN (M) (F) RANGE	CONTROL LOCATION MEAN (M) (F) RANGE	LOCATION WITH HIGHEST ANNUAL MEAN (M): MEAN (M) (F) RANGE	LOCATION WITH HIGHEST ANNUAL MEAN (M): STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
BOTTOM FEEDER	**GAMMA**		2						
(PCI/KG WET)		*K-40*		*NA*	3813.5 (2/2) *3515 - 4112*	*NA*	3813.5 (2/2) *3515 - 4112*	33 INDICATOR EAST OF RT 9 BRIDGE IN OCGS DISCHARGE 0.4 MILES ESE OF SITE	0
		MN-54		**130**	<LLD	*NA*	-		0
		CO-58		**130**	<LLD	*NA*	-		0
		FE-59		**260**	<LLD	*NA*	-		0
		CO-60		**130**	<LLD	*NA*	-		0
		ZN-65		**260**	<LLD	*NA*	-		0
		CS-134		**130**	<LLD	*NA*	-		0
		CS-137		**150**	<LLD	*NA*	-		0
PREDATOR	**GAMMA**		11						
(PCI/KG WET)		*K-40*		*NA*	4004.9 (11/11) *2531 - 5972*	*NA*	4288.7 (3/3) *3258 - 5466*	93 INDICATOR OCGS DISCHARGE CANAL 0.1 MILES WSW OF SITE	0
		MN-54		**130**	<LLD	*NA*	-		0
		CO-58		**130**	<LLD	*NA*	-		0
		FE-59		**260**	<LLD	*NA*	-		0
		CO-60		**130**	<LLD	*NA*	-		0
		ZN-65		**260**	<LLD	*NA*	-		0
		CS-134		**130**	<LLD	*NA*	-		0
		CS-137		**150**	<LLD	*NA*	-		0
CLAMS	**GAMMA**		7						
(PCI/KG WET)		*K-40*		*NA*	1792.6 (5/5) *1198 - 2657*	1829 (2/2) *1773 - 1885*	2241 (2/2) *1198 - 2657*	23 INDICATOR BARNEGAT BAY OFF STOUTS CREEK 3.6 MILES ENE OF SITE	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
		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 detectable measurement are indicated in parentheses.*

TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR THE OYSTER CREEK GENERATING STATION, 2020

NAME OF FACILITY: OYSTER CREEK GENERATING STATION **DOCKET NUMBER: 50-219**

LOCATION OF FACILITY: OCEAN COUNTY, NJ **REPORTING PERIOD: 2020**

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
CRABS	**GAMMA**	1						
(PCI/KG WET)	*K-40*		*NA*	2063 (1/1)	*NA*	2063 (1/1)	33 INDICATOR EAST OF RT 9 BRIDGE IN OCGS DISCHARGE 0.4 MILES ESE OF SITE	0
	MN-54		**130**	<LLD	*NA*	-		0
	CO-58		**130**	<LLD	*NA*	-		0
	FE-59		**260**	<LLD	*NA*	-		0
	CO-60		**130**	<LLD	*NA*	-		0
	ZN-65		**260**	<LLD	*NA*	-		0
	CS-134		**130**	<LLD	*NA*	-		0
	CS-137		**150**	<LLD	*NA*	-		0
SEDIMENT	**GAMMA**	10						
(PCI/KG DRY)	*BE-7*		*NA*	<LLD	<LLD	-		0
	K-40		*NA*	6858 (8/8) *615 - 12190*	16380 (2/2) *13530 - 19230*	16380 (2/2) *13530 - 19230*	94 CONTROL GREAT BAY/LITTLE EGG HARBOR 20.0 MILES SSW OF SITE	0
	MN-54		*NA*	<LLD	<LLD	-		0
	CO-58		*NA*	<LLD	<LLD	-		0
	CO-60		*NA*	<LLD	<LLD	-		0
	CS-134		**150**	<LLD	<LLD	-		0
	CS-137		**180**	<LLD	<LLD	-		0
	Ra-226		*NA*	4319 (1/8)	*<LLD*	4319 (1/2)	24 INDICATOR BARNEGAT BAY 2.1 MILES E OF SITE	0
	Th-226		*NA*	445 *(8/8)* *108 - 875*	581 *(2/2)* 468 - 693	650 *(2/2)* *426 - 875*	24 INDICATOR BARNEGAT BAY 2.1 MILES E OF SITE	0
AIR PARTICULATE	**GR-B**	240	**10**	12 (184/195) *5 - 21*	13 (43/45) *7 - 24*	13 (31/32) *7 - 24*	C CONTROL JCP&L OFFICE - COOKSTOWN NJ 24.7 MILES NW OF SITE	0
(E-3 PCI/CU.METER)	**SR-89**	22	**10**	<LLD	<LLD	-		0
	SR-90	29	**10**	<LLD	<LLD	-		0

(M) *The Mean Values are calculated using the positive values.* ***(F)*** *Fraction of detectable measurement are indicated in parentheses.*

TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR THE OYSTER CREEK GENERATING STATION, 2020

NAME OF FACILITY: OYSTER CREEK GENERATING STATION — **DOCKET NUMBER: 50-219**
LOCATION OF FACILITY: OCEAN COUNTY, NJ — **REPORTING PERIOD: 2020**

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
AIR PARTICULATE *(E-3 PCI/CU.METER)*	**GAMMA**	29						
	BE-7		*NA*	55.1 (24/24) *39 - 83*	62.9 (5/5) *52 - 77*	64.6 (4/4) *52 - 77*	C CONTROL JCP&L OFFICE - COOKSTOWN NJ 24.7 MILES NW OF SITE	0
	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 *(E-3 PCI/CU.METER)*	**GAMMA**	56						
	I-131		**70**	<LLD	<LLD	-		0
VEGETATION *(PCI/KGWET)*	**SR-89**	55	**25**	<LLD	<LLD	-		0
	SR-90	55	**5**	7.4 (25/40) *4.4 - 14.4*	7.6 (9/15) *4.5 - 14.2*	8.5 (13/15) *4.6 - 14.4*	115 INDICATOR EAST OF SITE 0.3 MILES E OF SITE	0
	GAMMA	33						
	BE-7		*NA*	572.8 (6/40) *185 - 782*	513.5 (3/15) *343 - 830*	776.3 (2/15) *771 - 782*	115 INDICATOR EAST OF SITE 0.4 MILES SE OF SITE	0
	K-40		*NA*	3202.3 (40/40) *1379 - 5189*	3766.8 (15/15) *1583 - 5287*	3874.3 (3/3) *3026 - 4647*	QCA INDICATOR QC DUPLICATE SAMPLE	0
	CS-134		**60**	<LLD	<LLD	-		0
	CS-137		**80**	<LLD	<LLD	-		0
DIRECT RADIATION *(MILLIREM/STD.MO.)*	**OSLD-QUARTERLY**	381	*NA*	22.2 (377/377) *18.7 - 31.7*	22.2 (4/4) *18.7 - 25.4*	28.9 (4/4) *25.7 - 31.7*	55 INDICATOR SOUTHERN AREA STORES SECURITY FENCE 0.3 MILES W	0

***(M)** The Mean Values are calculated using the positive values.* ***(F)** Fraction of detectable measurement are indicated in parentheses.*

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 Oyster Creek Generating Station

Sample Medium	-	APT = Air Particulate AIO = Air Iodine DW = Drinking Water VEG = Vegetation SWA = Surface Water AQS = Aquatic Sediment Clam = Clam OSLD = Optically Stimulated Luminescence Dosimetry Fish = Fish Crab = Crab GW = Ground Water
Station Code	-	Station's Designation
Distance	-	Distance from the OCGS in miles
Azimuth	-	Azimuth with respect to the OCGS in degrees
Description	-	Meteorological sector in which the station is located and a narrative description

TABLE B-2: Radiological Environmental Monitoring Program – Sampling Locations, Distance and Direction, Oyster Creek Generating Station, 2020

Sample Medium	Station Code	Distance (miles)	Azimuth (degrees)	Description
OSLD	1	0.4	219	SW of site at OCGS Fire Pond, Forked River, NJ
DW	1N	0.2	349	On-site northern domestic well at OCGS, Forked River, NJ
DW	1S	0.1	209	On-site southern domestic well at OCGS, Forked River, NJ
APT, AIO	3	6.0	97	East of site, near old Coast Guard Station, Island Beach State Park
OSLD	6	2.1	13	NNE of site, Lane Place, behind St. Pius Church, Forked River, NJ
OSLD	8	2.3	177	South of site, Route 9 at the Waretown Substation, Waretown, NJ
OSLD	9	2.0	230	WSW of site, west of where Route 532 and the Garden State Parkway meet, Waretown, NJ
APT, AIO, OSLD	C	24.7	313	NW of site, JCP&L office in rear parking lot, Cookstown, NJ
APT, AIO	20	0.7	95	East of site, on Finninger Farm on south side of access road, Forked River, NJ
OSLD	22	1.6	145	SE of site, on Long John Silver Way, Skippers Cove, Waretown, NJ
SWA, CLAM, AQS	23	3.6	64	ENE of site, Barnegat Bay off Stouts Creek, approximately 400 yards SE of “Flashing Light 1”
SWA, CLAM, AQS	24	2.1	101	East of site, Barnegat Bay, approximately 250 yards SE of “Flashing Light 3”
SWA, AQS, FISH, CRAB	33	0.4	123	ESE of site, east of Route 9 Bridge in OCGS Discharge Canal
VEG	35	0.4	111	ESE of site, east of Route 9 and north of the OCGS Discharge Canal, Forked River, NJ
VEG	36	23.1	319	NW of site, at "U-Pick" Farm, New Egypt, NJ
DW	37	2.2	18	NNE of Site, off Boox Road at Lacey MUA Pumping Station, Forked River, NJ
DW	38	1.6	197	SSW of Site, on Route 532, at Ocean Township MUA Pumping Station, Waretown, NJ
OSLD	51	0.4	358	North of site, on the access road to Forked River site, Forked River, NJ
OSLD	52	0.3	333	NNW of site, on the access road to Forked River site, Forked River, NJ
OSLD	53	0.3	309	NW of site, at sewage lift station on the access road to the Forked River site, Forked River, NJ

TABLE B-2: Radiological Environmental Monitoring Program – Sampling Locations, Distance and Direction, Oyster Creek Generating Station, 2020

Sample Medium	Station Code	Distance (miles)	Azimuth (degrees)	Description
OSLD	54	0.3	288	WNW of site, on the access road to Forked River site, Forked River, NJ
OSLD	55	0.3	263	West of site, on Southern Area Stores security fence, west of OCGS Switchyard, Forked River, NJ
OSLD	56	0.3	249	WSW of site, on utility pole east of Southern Area Stores, west of the OCGS Switchyard, Forked River, NJ
OSLD	57	0.3	206	SSW of site, on Southern Area Stores access road, Forked River, NJ
OSLD	58	0.3	188	South of site, on Southern Area Stores access road, Forked River, NJ
OSLD	59	0.3	166	SSE of site, on Southern Area Stores access road, Waretown, NJ
OSLD	61	0.3	104	ESE of site, on Route 9 south of OCGS Main Entrance, Forked River, NJ
OSLD	62	0.2	83	East of site, on Route 9 at access road to OCGS Main Gate, Forked River, NJ
OSLD	63	0.2	70	ENE of site, on Route 9, between main gate and OCGS North Gate access road, Forked River, NJ
OSLD	64	0.3	42	NE of site, on Route 9 North at entrance to Finninger Farm, Forked River, NJ
OSLD	65	0.4	19	NNE of site, on Route 9 at Intake Canal Bridge, Forked River, NJ
APT, AIO, OSLD, VEG	66	0.4	133	SE of site, east of Route 9 and south of the OCGS Discharge Canal, inside fence, Waretown, NJ
OSLD	68	1.3	266	West of site, on Garden State Parkway North at mile marker 71.7, Lacey Township, NJ
APT, AIO, OSLD	71	1.6	164	SSE of site, on Route 532 at the Waretown Municipal Building, Waretown, NJ
APT, AIO, OSLD	72	1.9	25	NNE of site, on Lacey Road at Knights of Columbus Hall, Forked River, NJ
APT, AIO, OSLD	73	1.8	108	ESE of site, on Bay Parkway, Sands Point Harbor, Waretown, NJ
OSLD	74	1.8	88	East of site, Orlando Drive and Penguin Court, Forked River, NJ
OSLD	75	2.0	71	ENE of site, Beach Blvd. and Maui Drive, Forked River, NJ
OSLD	78	1.8	2	North of site, 1514 Arient Road, Forked River, NJ
OSLD	79	2.9	160	SSE of site, Hightide Drive and Bonita Drive, Waretown, NJ

TABLE B-2: Radiological Environmental Monitoring Program – Sampling Locations, Distance and Direction, Oyster Creek Generating Station, 2020

Sample Medium	Station Code	Distance (miles)	Azimuth (degrees)	Description
OSLD	81	3.5	201	SSW of site, on Rose Hill Road at intersection with Barnegat Boulevard, Barnegat, NJ
FISH, CRAB	93	0.1	242	WSE of site, OCGS Discharge Canal between Pump Discharges and Route 9, Forked River, NJ
SWA, AQS, CLAM, FISH	94	20.0	198	SSW of site, in Great Bay/Little Egg Harbor
OSLD	98	1.6	318	NW of site, on Garden State Parkway North at mile marker 73, Lacey Township, NJ
OSLD	99	1.5	310	NW of site, on Garden State Parkway at mile marker 72.8, Lacey Township, NJ
OSLD	100	1.4	43	NE of site, Yacht Basin Plaza South off Lakeside Dr., Lacey Township, NJ
OSLD	101	1.6	49	NE of site, end of Lacey Rd. East, Lacey Township, NJ
OSLD	102	2.4	344	NNW of site, end of Sheffield Dr., Barnegat Pines, Lacey Township, NJ
OSLD	103	1.8	337	NNW of site, Llewellyn Pkwy., Barnegat Pines, Lacey Township, NJ
OSLD	104	1.2	221	W of site, Rt. 532 West, before Garden State Parkway, Ocean Township, NJ
OSLD	106	1.2	288	WNW of site, Garden State Parkway North beside mile marker 72.2, Lacey Township, NJ
OSLD	107	1.3	301	WNW of site, Garden State Parkway North beside mile marker 72.5, Lacey Township, NJ
OSLD	109	1.2	141	SE of site, Lighthouse Dr., Waretown, Ocean Township, NJ
OSLD	110	1.5	127	SE of site, Tiller Dr. and Admiral Way, Waretown, Ocean Township, NJ
OSLD	112	0.2	176	S of site, along southern access road
OSLD	113	0.3	90	E of site, along Rt.9, North
OSLD	T1	0.4	219	SW of site, at OCGS Fire Pond, Forked River, NJ
GW	MW-24-3A	0.8	97	ESE of site, Finninger Farm on South side of access road, Lacey Township, NJ
GW	W-3C	0.4	112	ESE of site, Finninger Farm adjacent to Station 35, Lacey Township, NJ

TABLE B-3: Radiological Environmental Monitoring Program – Summary of Sample Collection and Analytical Methods, Oyster Creek Generating Station, 2020

Sample Medium	Analysis	Sampling Method	Collection Procedure Number	Sample Size	Analytical Procedure Number
Drinking Water	Gamma Spectroscopy	Monthly samples	ER-OCGS-06, Collection of water samples for radiological analysis CY-OC-120-1200, REMP sample collection procedure – well water	1 gallon	TBE, TBE-2007 Gamma-Emitting Radioisotopes Analysis Env. Inc., GS-01 Determination of gamma emitters by gamma spectroscopy
Drinking Water	Tritium	Monthly samples	ER-OCGS-06, Collection of water samples for radiological analysis CY-OC-120-1200, REMP sample collection procedure – well water	1 gallon	TBE, TBE-2011 Tritium in Drinking Water by Liquid Scintillation Env. Inc., T-02 Determination of tritium in water (direct method)
Drinking water	Iodine	Monthly Samples	ER-OCGS-06, Collection of water samples for radiological analysis CY-OC-120-1200, REMP sample collection procedure – well water	1 gallon	TBE, TBE-2012 Radioiodine in Various Matrices Env. Inc., I-131-01 Determination of I-131 in water by anion exchange
Drinking Water	Gross Beta	Monthly Samples	ER-OCGS-06, Collection of water samples for radiological analysis CY-OC-120-1200, REMP sample collection procedure – well water	1 gallon	TBE, TBE-2008 Gross Alpha and/or Gross Beta Activity in Various Matrices
Surface Water	Gamma Spectroscopy	Grab Sample	ER-OCGS-06, Collection of water samples for radiological analysis	1 gallon	TBE, TBE-2007 Gamma-Emitting Radioisotopes Analysis Env. Inc., GS-01 Determination of gamma emitters by gamma spectroscopy
Surface Water	Tritium	Grab Sample	ER-OCGS-06, Collection of water samples for radiological analysis	1 gallon	TBE, TBE-2011 Tritium in Drinking Water by Liquid Scintillation Env. Inc., T-02 Determination of tritium in water (direct method)
Groundwater	Tritium	Grab Sample	ER-OCGS-06, Collection of water samples for radiological analysis	1 gallon	TBE, TBE-2011 Tritium in Drinking Water by Liquid Scintillation
Groundwater	Gamma	Grab Sample	ER-OCGS-06, Collection of water samples for radiological analysis	1 gallon	TBE, TBE-2007 Gamma-Emitting Radioisotopes Analysis Env. Inc., GS-01 Determination of gamma emitters by gamma spectroscopy
Fish	Gamma Spectroscopy	Semi-annual samples collected via hook and line technique and traps	ER-OCGS-14, Collection of fish samples for radiological analysis	250 grams (wet)	TBE, TBE-2007 Gamma-Emitting Radioisotopes Analysis

TABLE B-3: Radiological Environmental Monitoring Program – Summary of Sample Collection and Analytical Methods, Oyster Creek Generating Station, 2020

Sample Medium	Analysis	Sampling Method	Collection Procedure Number	Sample Size	Analytical Procedure Number
Clams and Crabs	Gamma Spectroscopy	Semi-annual and annual samples collected using clam tongs and traps.	ER-OCGS-16, Collection of clam and crab samples for radiological analysis	300 grams (wet)	TBE, TBE-2007 Gamma-Emitting Radioisotopes Analysis
Sediment	Gamma Spectroscopy	Semi-annual grab samples	ER-OCGS-03, Collection of aquatic sediment samples for radiological analysis	1000 grams (dry)	TBE, TBE-2007 Gamma-Emitting Radioisotopes Analysis Env. Inc., GS-01 Determination of gamma emitters by gamma spectroscopy
Air Particulates	Gross Beta	One-week composite of continuous air sampling through glass fiber filter paper	ER-OCGS-05, Collection of air iodine and air particulate samples for radiological analysis	1 filter (approximately 300 cubic meters weekly)	TBE, TBE-2008 Gross alpha and/or beta activity in various matrices
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 4000 cubic meters)	TBE, TBE-2007 Gamma-Emitting Radioisotopes Analysis
Air Particulates	Strontium-89/90	Quarterly composite of each station	ER-OCGS-05, Collection of air iodine and air particulate samples for radiological analysis	13 filters (approximately 4000 cubic meters)	TBE, TBE-2018 Radiostrontium Analysis by Chemical Separation
Air Iodine	Gamma Spectroscopy	One-week composite of continuous air sampling through charcoal filter	ER-OCGS-05, Collection of air iodine and air particulate samples for radiological analysis	1 filter (approximately 300 cubic meters weekly)	TBE, TBE-2007 Gamma-Emitting Radioisotopes Analysis
Vegetation	Gamma Spectroscopy	Grab sample during growing season	ER-OCGS-04, Collection of food products and broadleaf vegetation samples for radiological analysis	1000 grams	TBE, TBE-2007 Gamma-Emitting Radioisotopes Analysis Env. Inc., GS-01 Determination of gamma emitters by gamma spectroscopy
Vegetation	Strontium-89/90	Grab sample during growing season	ER-OCGS-04, Collection of food products and broadleaf vegetation samples for radiological analysis	1000 grams	TBE, TBE-2018 Radiostrontium Analysis by Chemical Separation Env. Inc., SR-05 Determination of Sr-89 and Sr-90 in Ashed Samples
OSLD	Optically Stimulated Luminescence Dosimetry	Quarterly OSLDs comprised of two Al_2O_3:C Landauer Incorporated elements.	ER OCGS-02, Collection/Exchange of Field Dosimeters for Radiological Analysis	2 dosimeters	Landauer Incorporated

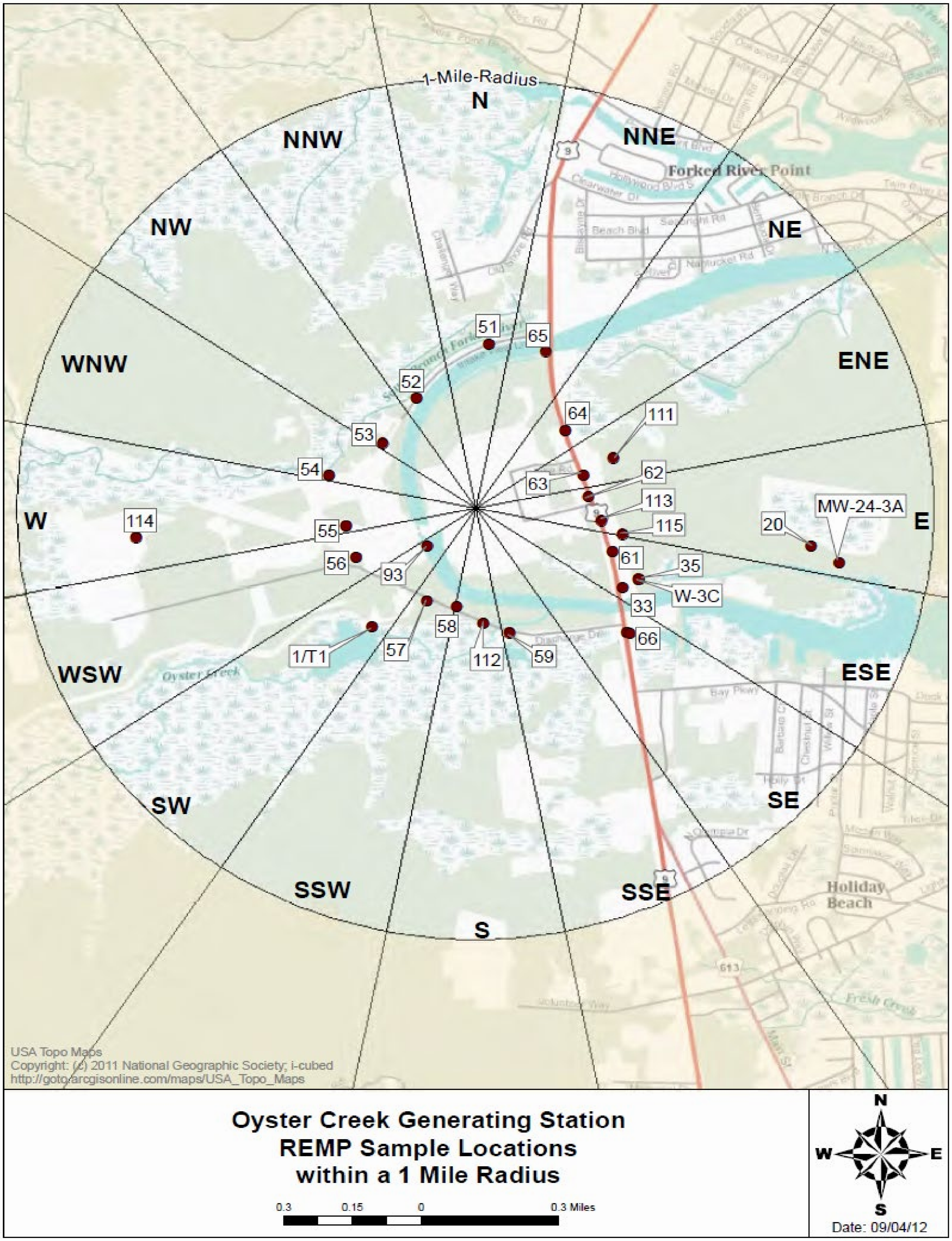

Figure B-1
Locations of REMP Stations within a 1-mile radius
of the Oyster Creek Generating Station, 2020

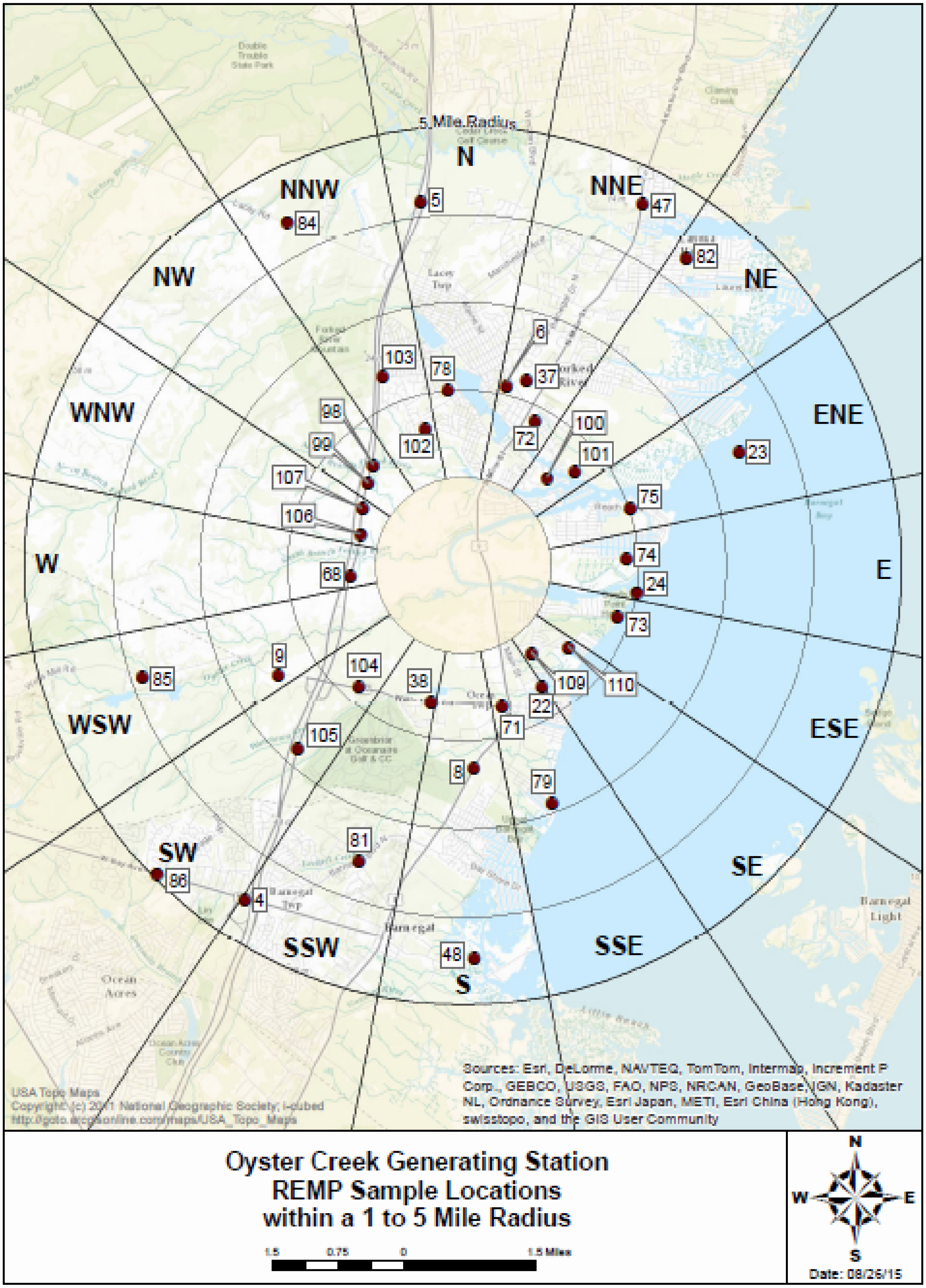

Figure B-2
Locations of REMP Stations within a 1 to 5-mile radius
of the Oyster Creek Generating Station, 2020

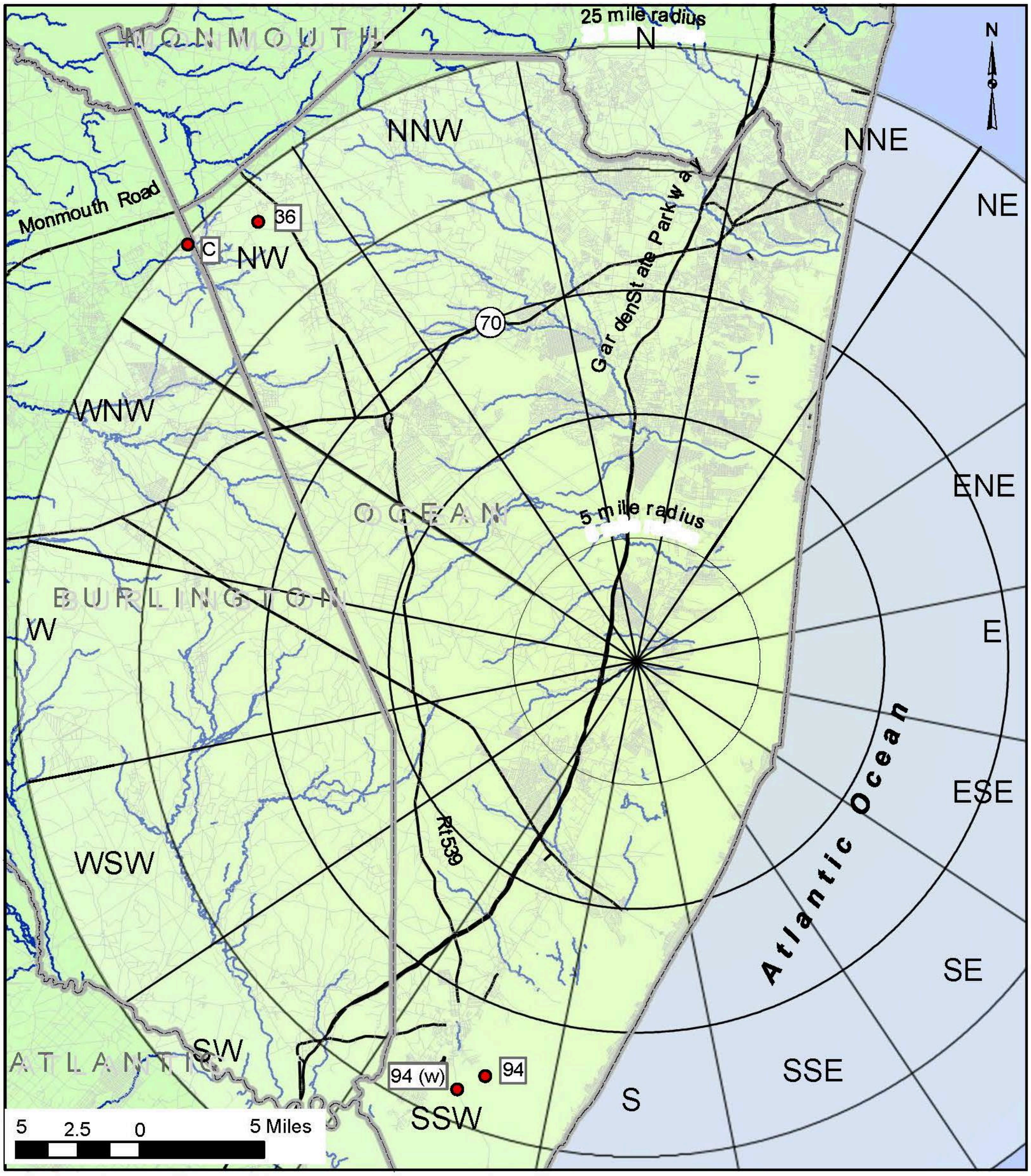

Figure B-3
Locations of REMP Stations greater than 5 miles
from the Oyster Creek Generating Station, 2020

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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 OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	23	24	33	94
01/08/20 - 01/29/20			< 184	< 181
02/04/20 - 02/25/20			< 180	< 184
03/03/20 - 03/30/20			< 188	< 187
04/27/20 - 04/27/20			< 164	< 163
05/27/20 - 05/27/20			< 178	< 182
06/01/20 - 07/01/20	< 171	< 174	< 181	< 184
07/30/20 - 07/30/20			< 184	< 185
08/27/20 - 08/27/20			< 180	< 180
09/25/20 - 09/25/20			< 187	< 180
10/19/20 - 10/30/20	< 188	< 184	< 189	< 188
11/30/20 - 11/30/20			< 315	< 304
12/29/20 - 12/29/20			< 297	< 293
MEAN	-	-	-	-

Table C-I.2 CONCENTRATIONS OF GAMMA EMITTERS IN SURFACE WATER SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Zr-95	Cs-134	Cs-137
23	06/01/20 - 06/01/20	< 7	< 6	< 11	< 8	< 17	< 10	< 8	< 9
	10/19/20 - 10/19/20	< 4	< 6	< 13	< 8	< 12	< 9	< 7	< 6
	MEAN	-	-	-	-	-	-	-	-
24	06/01/20 - 06/01/20	< 8	< 6	< 12	< 9	< 15	< 11	< 10	< 8
	10/20/20 - 10/20/20	< 7	< 6	< 13	< 6	< 12	< 12	< 7	< 7
	MEAN	-	-	-	-	-	-	-	-
33	01/08/20 - 01/29/20	< 7	< 7	< 20	< 7	< 15	< 13	< 7	< 6
	02/04/20 - 02/25/20	< 9	< 9	< 17	< 6	< 12	< 16	< 10	< 10
	03/03/20 - 03/30/20	< 7	< 6	< 18	< 8	< 14	< 12	< 7	< 7
	04/27/20 - 04/27/20	< 8	< 7	< 16	< 9	< 14	< 14	< 9	< 7
	05/27/20 - 05/27/20	< 6	< 5	< 11	< 6	< 10	< 10	< 8	< 6
	07/01/20 - 07/01/20	< 7	< 6	< 14	< 7	< 16	< 14	< 8	< 8
	07/30/20 - 07/30/20	< 6	< 5	< 9	< 5	< 10	< 9	< 6	< 6
	08/27/20 - 08/27/20	< 7	< 7	< 14	< 7	< 15	< 11	< 7	< 6
	09/25/20 - 09/25/20	< 8	< 6	< 14	< 8	< 16	< 15	< 8	< 8
	10/30/20 - 10/30/20	< 4	< 6	< 12	< 5	< 14	< 11	< 8	< 5
	11/30/20 - 11/30/20	< 8	< 7	< 15	< 7	< 11	< 12	< 6	< 8
	12/29/20 - 12/29/20	< 5	< 6	< 12	< 6	< 13	< 12	< 7	< 8
	MEAN	-	-	-	-	-	-	-	-
94	01/08/20 - 01/29/20	< 7	< 8	< 19	< 9	< 15	< 14	< 8	< 7
	02/04/20 - 02/25/20	< 7	< 7	< 13	< 8	< 11	< 11	< 8	< 6
	03/03/20 - 03/30/20	< 8	< 6	< 15	< 8	< 14	< 12	< 9	< 8
	04/27/20 - 04/27/20	< 5	< 5	< 9	< 6	< 12	< 9	< 7	< 5
	05/27/20 - 05/27/20	< 5	< 6	< 14	< 8	< 11	< 12	< 7	< 7
	07/01/20 - 07/01/20	< 8	< 8	< 17	< 11	< 17	< 11	< 9	< 9
	07/30/20 - 07/30/20	< 5	< 6	< 15	< 11	< 14	< 11	< 7	< 7
	08/27/20 - 08/27/20	< 6	< 6	< 11	< 7	< 11	< 10	< 6	< 6
	09/25/20 - 09/25/20	< 8	< 8	< 21	< 6	< 18	< 13	< 10	< 10
	10/30/20 - 10/30/20	< 7	< 7	< 12	< 6	< 14	< 14	< 8	< 7
	11/30/20 - 11/30/20	< 6	< 7	< 16	< 6	< 12	< 12	< 9	< 8
	12/29/20 - 12/29/20	< 6	< 5	< 9	< 7	< 11	< 11	< 6	< 7
	MEAN	-	-	-	-	-	-	-	-

Table C-II.1 CONCENTRATIONS OF TRITIUM IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	1N	1S	37	38
01/08/20 - 01/29/20	< 180	*(1)*	< 181	< 184
02/04/20 - 02/26/20	< 178	*(1)*	< 187	< 183
03/03/20 - 04/01/20	< 199	*(1)*	< 185	< 187
04/01/20 - 04/30/20	< 162	*(1)*	< 163	< 168
05/13/20 - 05/27/20	< 180	*(1)*	< 180	< 183
06/03/20 - 07/01/20	< 185	*(1)*	< 182	< 186
07/01/20 - 07/31/20	< 186	*(1)*	< 182	< 185
08/05/20 - 08/31/20	< 180	*(1)*	< 184	< 177
09/01/20 - 09/30/20	< 179	*(1)*	< 183	< 180
10/01/20 - 10/30/20	< 176	*(1)*	< 189	< 190
11/04/20 - 11/30/20	< 198	*(1)*	< 320	< 320
12/01/20 - 12/29/20	< 312	*(1)*	< 296	< 296
MEAN	-		-	-

Table C-II.2 CONCENTRATIONS OF GROSS BETA IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	1N	1S	37	38
01/08/20 - 01/29/20	< 1.6	*(1)*	2.4 ± 1.1	2.0 ± 1.1
02/04/20 - 02/26/20	< 2.8	*(1)*	1.9 ± 1.2	2.1 ± 1.3
03/03/20 - 04/01/20	< 1.9	*(1)*	< 1.4	1.6 ± 1.0
04/01/20 - 04/30/20	4.5 ± 1.2	*(1)*	3.5 ± 1.1	2.2 ± 1.1
05/13/20 - 05/27/20	< 1.6	*(1)*	1.8 ± 1.1	2.0 ± 1.1
06/03/20 - 07/01/20	< 1.8	*(1)*	< 1.6	< 1.6
07/01/20 - 07/31/20	< 1.9	*(1)*	2.4 ± 1.1	2.5 ± 1.3
08/05/20 - 08/31/20	1.8 ± 1.1	*(1)*	1.8 ± 1.1	2.8 ± 1.2
09/01/20 - 09/30/20	< 1.8	*(1)*	2.2 ± 1.1	< 1.6
10/01/20 - 10/30/20	< 1.6	*(1)*	2.1 ± 1.2	3.1 ± 1.9
11/04/20 - 11/30/20	< 1.5	*(1)*	2.6 ± 1.1	2.0 ± 1.1
12/01/20 - 12/29/20	< 1.6	*(1)*	< 1.7	2.9 ± 1.3
MEAN ± 2 STD DEV	3.1 ± 3.8		2.3 ± 1.1	2.3 ± 0.9

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

(1) SEE PROGRAM EXCEPTIONS SECTION FOR EXPLANATION

Table C-II.3 CONCENTRATIONS OF GAMMA EMITTERS IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Zr-95	Cs-134	Cs-137
1N	01/09/20 - 01/29/20	< 6	< 6	< 12	< 7	< 14	< 10	< 7	< 6
	02/05/20 - 02/26/20	< 9	< 8	< 15	< 9	< 17	< 14	< 9	< 8
	03/03/20 - 04/01/20	< 5	< 5	< 8	< 5	< 9	< 7	< 5	< 5
	04/01/20 - 04/14/20	< 3	< 3	< 7	< 3	< 7	< 6	< 3	< 3
	05/13/20 - 05/13/20	< 2	< 2	< 5	< 2	< 4	< 4	< 2	< 2
	06/03/20 - 06/03/20	< 2	< 2	< 5	< 1	< 3	< 4	< 2	< 2
	07/01/20 - 07/01/20	< 2	< 3	< 7	< 2	< 5	< 5	< 2	< 2
	08/05/20 - 08/05/20	< 3	< 2	< 6	< 3	< 5	< 5	< 3	< 3
	09/01/20 - 09/01/20	< 3	< 3	< 7	< 3	< 5	< 6	< 2	< 3
	10/01/20 - 10/01/20	< 5	< 6	< 12	< 6	< 12	< 9	< 6	< 6
	11/04/20 - 11/04/20	< 6	< 6	< 13	< 6	< 15	< 10	< 7	< 6
	12/01/20 - 12/01/20	< 6	< 8	< 14	< 7	< 7	< 12	< 8	< 6
	MEAN	-	-	-	-	-	-	-	-
1S (1)									
37	01/08/20 - 01/27/20	< 8	< 7	< 14	< 7	< 15	< 13	< 9	< 8
	02/04/20 - 02/25/20	< 6	< 5	< 13	< 9	< 13	< 12	< 8	< 8
	03/03/20 - 03/30/20	< 7	< 8	< 15	< 9	< 15	< 10	< 5	< 8
	04/27/20 - 04/27/20	< 6	< 6	< 12	< 8	< 12	< 9	< 7	< 5
	05/27/20 - 05/27/20	< 5	< 5	< 10	< 5	< 11	< 10	< 6	< 5
	07/01/20 - 07/01/20	< 7	< 7	< 14	< 7	< 14	< 11	< 8	< 8
	07/31/20 - 07/31/20	< 2	< 2	< 4	< 2	< 4	< 3	< 2	< 2
	08/27/20 - 08/27/20	< 4	< 5	< 10	< 5	< 9	< 8	< 6	< 5
	09/25/20 - 09/25/20	< 7	< 7	< 17	< 7	< 15	< 13	< 10	< 8
	10/30/20 - 10/30/20	< 7	< 7	< 15	< 7	< 15	< 12	< 7	< 7
	11/30/20 - 11/30/20	< 7	< 7	< 15	< 7	< 18	< 11	< 8	< 6
	12/29/20 - 12/29/20	< 7	< 8	< 13	< 9	< 17	< 13	< 5	< 7
	MEAN	-	-	-	-	-	-	-	-
38	01/15/20 - 01/29/20	< 5	< 4	< 11	< 5	< 14	< 10	< 6	< 5
	02/05/20 - 02/25/20	< 4	< 4	< 8	< 4	< 9	< 8	< 4	< 4
	03/03/20 - 03/30/20	< 5	< 4	< 13	< 7	< 11	< 13	< 6	< 6
	04/30/20 - 04/30/20	< 5	< 6	< 11	< 6	< 10	< 10	< 5	< 6
	05/27/20 - 05/27/20	< 4	< 5	< 13	< 7	< 11	< 11	< 6	< 7
	07/01/20 - 07/01/20	< 6	< 6	< 11	< 6	< 14	< 10	< 7	< 5
	07/30/20 - 07/30/20	< 7	< 7	< 16	< 7	< 14	< 12	< 8	< 8
	08/31/20 - 08/31/20	< 6	< 7	< 14	< 7	< 12	< 11	< 9	< 7
	09/30/20 - 09/30/20	< 5	< 5	< 8	< 4	< 11	< 11	< 5	< 5
	10/30/20 - 10/30/20	< 7	< 7	< 12	< 8	< 14	< 12	< 6	< 5
	11/30/20 - 11/30/20	< 8	< 6	< 13	< 7	< 15	< 9	< 7	< 6
	12/29/20 - 12/29/20	< 7	< 6	< 11	< 9	< 15	< 14	< 5	< 6
	MEAN	-	-	-	-	-	-	-	-

(1) SEE PROGRAM EXCEPTIONS SECTION FOR EXPLANATION

Table C-III.1 CONCENTRATIONS OF TRITIUM IN GROUNDWATER SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	MW-24-3A	W-3C
01/29/20 - 01/29/20	< 185	< 194
05/21/20 - 05/21/20	< 173	< 174
08/19/20 - 08/19/20	< 152	< 154
10/14/20 - 10/14/20	< 184	< 187
MEAN	-	-

Table C-III.2 CONCENTRATIONS OF GAMMA EMITTERS IN GROUNDWATER SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Zr-95	Cs-134	Cs-137
MW-24-3A	01/29/20 - 01/29/20	< 5	< 6	< 14	< 4	< 15	< 10	< 6	< 5
	05/21/20 - 05/21/20	< 7	< 8	< 15	< 7	< 17	< 13	< 7	< 8
	08/19/20 - 08/19/20	< 8	< 7	< 7	< 7	< 18	< 11	< 9	< 8
	10/14/20 - 10/14/20	< 8	< 6	< 14	< 8	< 15	< 12	< 7	< 7
	MEAN	-	-	-	-	-	-	-	-
W-3C	01/29/20 - 01/29/20	< 7	< 6	< 11	< 7	< 17	< 13	< 7	< 7
	05/21/20 - 05/21/20	< 7	< 7	< 13	< 8	< 16	< 12	< 9	< 10
	08/19/20 - 08/19/20	< 7	< 8	< 15	< 9	< 18	< 12	< 8	< 8
	10/14/20 - 10/14/20	< 4	< 6	< 15	< 7	< 14	< 11	< 8	< 6
	MEAN	-	-	-	-	-	-	-	-

Table C-IV.1 CONCENTRATIONS OF GAMMA EMITTERS IN PREDATOR AND BOTTOM FEEDER (FISH) SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/KG WET ± 2 SIGMA

SITE	COLLECTION PERIOD	K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Cs-134	Cs-137
33 *PREDATOR*	06/01/20	2531 ± 912	< 48	< 59	< 118	< 72	< 108	< 58	< 62
	06/01/20	3740 ± 867	< 60	< 44	< 93	< 51	< 107	< 40	< 57
	06/01/20	4203 ± 1108	< 72	< 74	< 137	< 70	< 147	< 70	< 63
	10/19/20	3546 ± 1000	< 33	< 45	< 106	< 72	< 109	< 63	< 55
	10/19/20	4533 ± 1156	< 74	< 66	< 154	< 70	< 114	< 73	< 76
	10/19/20	5972 ± 1313	< 68	< 82	< 164	< 100	< 162	< 89	< 68
	10/19/20	3520 ± 1202	< 66	< 65	< 108	< 93	< 130	< 64	< 84
	10/19/20	3143 ± 1061	< 68	< 70	< 102	< 62	< 131	< 75	< 81
	MEAN ± 2 STD DEV	3899 ± 2074	-	-	-	-	-	-	-
33 *BOTTOM FEEDER*	06/01/20	3515 ± 985	< 49	< 50	< 137	< 63	< 126	< 49	< 60
	10/19/20	4112 ± 1006	< 49	< 56	< 134	< 53	< 114	< 59	< 58
	MEAN ± 2 STD DEV	3814 ± 844	-	-	-	-	-	-	-
93 *PREDATOR*	06/03/20	4142 ± 1073	< 74	< 66	< 124	< 75	< 141	< 82	< 81
	10/19/20	5466 ± 1356	< 80	< 77	< 169	< 88	< 217	< 86	< 95
	10/19/20	3258 ± 1031	< 33	< 52	< 114	< 30	< 113	< 49	< 59
	MEAN ± 2 STD DEV	4289 ± 2223	-	-	-	-	-	-	-
93 *BOTTOMFEEDER*	*(1)*								
94 *PREDATOR*	*(1)*								
94 *BOTTOMFEEDER*	*(1)*								

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

Table C-IV.2 CONCENTRATIONS OF GAMMA EMITTERS IN CLAM AND CRAB SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/KG WET ± 2 SIGMA

SITE	COLLECTION PERIOD	K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Cs-134	Cs-137
23									
Clams	06/01/20	1825 ± 1005	< 84	< 70	< 131	< 64	< 144	< 83	< 88
	10/19/20	2657 ± 872	< 66	< 58	< 121	< 56	< 105	< 54	< 42
	MEAN ± 2 STD DEV	2241 ± 1177	-	-	-	-	-	-	-
24									
Clams	06/01/20	1540 ± 987	< 81	< 84	< 157	< 88	< 169	< 99	< 81
	10/20/20	1743 ± 755	< 53	< 37	< 130	< 30	< 109	< 54	< 44
	MEAN ± 2 STD DEV	1642 ± 287	-	-	-	-	-	-	-
94									
Clams	06/03/20	1885 ± 854	< 69	< 61	< 136	< 51	< 148	< 73	< 65
	10/21/20	1773 ± 816	< 48	< 53	< 108	< 50	< 117	< 60	< 52
	MEAN ± 2 STD DEV	1829 ± 158	-	-	-	-	-	-	-
33									
Crabs	10/19/20	2063 ± 796	< 59	< 25	< 103	< 28	< 98	< 63	< 54
	MEAN ± 2 STD DEV	2063 ± 0	-	-	-	-	-	-	-
93									
Crabs	*(1)*								

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

Table C-V.1 **CONCENTRATIONS OF GAMMA EMITTERS IN SEDIMENT SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020**

RESULTS IN UNITS OF PCI/KG DRY ± 2 SIGMA

SITE	COLLECTION PERIOD	Be-7	K-40	Mn-54	Co-58	Co-60	Cs-134	Cs-137	Ra-226	Th-228
23	06/01/20	< 780	2051 ± 865	< 76	< 88	< 79	< 90	< 93	< 1872	167 ± 110
	10/19/20	< 465	5679 ± 1068	< 54	< 49	< 57	< 63	< 53	< 980	282 ± 80
MEAN ± 2 STD DEV		-	3865 ± 5131	-	-	-	-	-	-	225 ± 162
24	06/01/20	< 1012	8501 ± 1707	< 121	< 112	< 127	< 145	< 121	4319 ± 1838	875 ± 197
	10/20/20	< 382	9138 ± 989	< 51	< 45	< 52	< 55	< 45	< 1054	426 ± 87
MEAN ± 2 STD DEV		-	8820 ± 901	-	-	-	-	-	4319 ± 0	650 ± 635
33	06/02/20	< 799	7560 ± 1356	< 104	< 112	< 139	< 116	< 130	< 2492	507 ± 171
	10/20/20	< 207	615 ± 339	< 29	< 28	< 24	< 33	< 29	< 577	108 ± 38
MEAN ± 2 STD DEV		-	4088 ± 9821	-	-	-	-	-		307 ± 565
94	06/02/20	< 1300	19230 ± 3085	< 145	< 121	< 165	< 130	< 145	< 2807	693 ± 195
	10/20/20	< 345	13530 ± 1065	< 44	< 41	< 42	< 54	< 46	< 902	468 ± 69
MEAN ± 2 STD DEV		-	16380 ± 8061	-	-	-	-	-	-	581 ± 319

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

Table C-VI.1 **CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020**

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

COLLECTION	GROUP I			GROUP II			GROUP III	
PERIOD	20	66	111	71	72	73	3	C
01/02/20 - 01/09/20	12 ± 4	11 ± 4	9 ± 4	8 ± 4	10 ± 5	12 ± 5	13 ± 5	11 ± 4
01/09/20 - 01/15/20	10 ± 5	8 ± 5	< 7	7 ± 5	9 ± 5	< 7	10 ± 5	< 8
01/15/20 - 01/22/20	12 ± 5	15 ± 5	15 ± 5	17 ± 5	17 ± 5	14 ± 5	13 ± 5	16 ± 5
01/22/20 - 01/29/20	10 ± 4	14 ± 5	11 ± 4	10 ± 4	9 ± 4	11 ± 4	10 ± 4	15 ± 5
01/29/20 - 02/05/20	7 ± 4	12 ± 5	11 ± 4	11 ± 4	9 ± 5	10 ± 4	10 ± 4	10 ± 5
02/05/20 - 02/12/20	9 ± 4	7 ± 4	< 5	7 ± 4	< 6	6 ± 4	< 6	10 ± 4
02/12/20 - 02/19/20	14 ± 5	10 ± 4	11 ± 4	11 ± 5	< 7	10 ± 4	7 ± 4	14 ± 5
02/19/20 - 02/26/20	16 ± 5	17 ± 5	11 ± 5	9 ± 5	15 ± 5	8 ± 5	11 ± 5	14 ± 5
02/26/20 - 03/04/20	< 7	9 ± 5	*(1)*	12 ± 5	8 ± 5	9 ± 5	9 ± 5	13 ± 5
03/04/20 - 03/11/20	12 ± 5	13 ± 5	11 ± 5	11 ± 5	9 ± 4	< 6	11 ± 5	10 ± 4
03/11/20 - 03/18/20	7 ± 4	8 ± 5	10 ± 5	8 ± 4	10 ± 5	10 ± 5	11 ± 5	10 ± 5
03/18/20 - 03/26/20	12 ± 4	14 ± 4	14 ± 4	13 ± 4	15 ± 4	6 ± 4	10 ± 4	15 ± 4
03/26/20 - 04/01/20	9 ± 5	11 ± 6	9 ± 5	< 8	< 8	< 8	13 ± 6	10 ± 5
04/01/20 - 04/09/20	11 ± 4	13 ± 4	12 ± 4	13 ± 4	10 ± 4	9 ± 4	*(1)*	14 ± 4
04/09/20 - 04/22/20	14 ± 3	13 ± 3	11 ± 3	15 ± 3	14 ± 3	11 ± 3	*(1)*	*(1)*
04/22/20 - 05/06/20	7 ± 2	5 ± 2	7 ± 2	8 ± 2	8 ± 2	8 ± 2	*(1)*	7 ± 2
05/06/20 - 05/20/20	10 ± 3	9 ± 3	11 ± 3	*(1)*	11 ± 3	9 ± 3	*(1)*	12 ± 3
05/20/20 - 06/04/20	5 ± 2	6 ± 2	6 ± 2	7 ± 2	7 ± 2	5 ± 2	*(1)*	10 ± 2
06/04/20 - 06/18/20	11 ± 3	< 3	9 ± 3	11 ± 3	9 ± 3	8 ± 3	*(1)*	12 ± 3
06/18/20 - 07/01/20	13 ± 3	17 ± 3	12 ± 3	14 ± 3	11 ± 3	11 ± 3	*(1)*	11 ± 3
07/01/20 - 07/15/20	11 ± 3	12 ± 3	10 ± 3	10 ± 3	11 ± 3	9 ± 3	*(1)*	12 ± 3
07/15/20 - 07/30/20	18 ± 3	19 ± 3	19 ± 3	18 ± 3	19 ± 3	15 ± 3	*(1)*	18 ± 3
07/30/20 - 08/12/20	13 ± 3	14 ± 3	15 ± 3	12 ± 3	13 ± 3	12 ± 3	*(1)*	14 ± 3
08/12/20 - 08/27/20	18 ± 3	21 ± 3	17 ± 3	19 ± 3	19 ± 3	16 ± 3	*(1)*	20 ± 3
08/27/20 - 09/09/20	12 ± 3	*(1)*	13 ± 3	11 ± 3	17 ± 3	11 ± 3	*(1)*	13 ± 3
09/09/20 - 09/22/20	11 ± 3	12 ± 4	9 ± 3	12 ± 3	11 ± 3	9 ± 3	*(1)*	13 ± 3
09/22/20 - 10/06/20	17 ± 3	18 ± 3	20 ± 3	14 ± 3	19 ± 3	13 ± 3	*(1)*	21 ± 3
10/06/20 - 10/21/20	15 ± 3	13 ± 3	19 ± 3	15 ± 3	18 ± 3	14 ± 3	*(1)*	18 ± 3
10/21/20 - 11/05/20	10 ± 2	10 ± 2	9 ± 2	9 ± 2	8 ± 2	11 ± 2	*(1)*	9 ± 2
11/05/20 - 11/18/20	17 ± 3	17 ± 3	19 ± 3	19 ± 3	18 ± 3	15 ± 4	*(1)*	24 ± 4
11/18/20 - 12/03/20	13 ± 3	12 ± 3	16 ± 3	13 ± 3	15 ± 3	12 ± 3	*(1)*	15 ± 3
12/03/20 - 12/15/20	12 ± 3	11 ± 3	12 ± 3	9 ± 3	12 ± 3	9 ± 3	*(1)*	12 ± 3
12/15/20 - 12/29/20	11 ± 3	8 ± 2	10 ± 3	10 ± 3	12 ± 3	11 ± 3	*(1)*	12 ± 3
MEAN ± 2 STD DEV	12 ± 6	12 ± 8	12 ± 7	12 ± 7	12 ± 8	10 ± 5	11 ± 4	13 ± 7

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

Table C-VI.2

MONTHLY AND YEARLY MEAN VALUES OF GROSS BETA CONCENTRATIONS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

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
01/02/20 - 01/29/20	8	15	11 ± 5	01/02/20 - 01/29/20	7	17	11 ± 7	01/02/20 - 01/29/20	10	16	13 ± 5
01/29/20 - 02/26/20	7	17	11 ± 6	01/29/20 - 02/26/20	6	15	10 ± 5	01/29/20 - 02/26/20	7	14	11 ± 5
02/26/20 - 04/01/20	7	14	11 ± 4	02/26/20 - 03/26/20	6	15	10 ± 5	02/26/20 - 04/01/20	9	15	11 ± 4
04/01/20 - 05/06/20	5	14	10 ± 6	04/01/20 - 05/06/20	8	15	11 ± 5	04/01/20 - 05/06/20	7	14	10 ± 10
05/06/20 - 06/04/20	5	11	8 ± 5	05/06/20 - 06/04/20	5	11	8 ± 4	05/06/20 - 06/04/20	10	12	11 ± 2
06/04/20 - 07/01/20	9	17	12 ± 5	06/04/20 - 07/01/20	8	14	11 ± 4	06/04/20 - 07/01/20	11	12	11 ± 1
07/01/20 - 07/30/20	10	19	15 ± 8	07/01/20 - 07/30/20	9	19	14 ± 8	07/01/20 - 07/30/20	12	18	15 ± 9
07/30/20 - 08/27/20	13	21	16 ± 6	07/30/20 - 08/27/20	12	19	15 ± 7	07/30/20 - 08/27/20	14	20	17 ± 8
08/27/20 - 09/22/20	9	13	11 ± 3	08/27/20 - 09/22/20	9	17	12 ± 5	08/27/20 - 09/22/20	13	13	13 ± 0
09/22/20 - 11/05/20	9	20	14 ± 9	09/22/20 - 11/05/20	8	19	13 ± 7	09/22/20 - 11/05/20	9	21	16 ± 12
11/05/20 - 12/03/20	12	19	16 ± 5	11/05/20 - 12/03/20	12	19	15 ± 5	11/05/20 - 12/03/20	15	24	20 ± 13
12/03/20 - 12/29/20	8	12	11 ± 3	12/03/20 - 12/29/20	9	12	10 ± 2	12/03/20 - 12/29/20	12	12	12 ± 1
01/02/20 - 12/29/20	5	21	12 ± 7	01/02/20 - 12/29/20	5	19	11 ± 7	01/02/20 - 12/29/20	7	24	13 ± 7

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

Table C-VI.3 CONCENTRATIONS OF STRONTIUM IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

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

SITE	COLLECTION PERIOD	SR-89	SR-90
3 (1)	01/02/20 - 04/01/20	< 7	< 5
	MEAN	-	-
20	01/02/20 - 04/01/20	< 7	< 6
	04/01/20 - 07/01/20	< 7	< 6
	07/01/20 - 09/22/20	< 8	< 7
	09/22/20 - 12/29/20		< 6
	MEAN	-	-
66	01/02/20 - 04/01/20	< 9	< 5
	04/01/20 - 07/01/20	< 8	< 9
	07/01/20 - 09/22/20	< 9	< 8
	09/22/20 - 12/29/20		< 5
	MEAN	-	-
71	01/02/20 - 04/01/20	< 8	< 6
	04/01/20 - 07/01/20	< 7	< 10
	07/01/20 - 09/22/20	< 8	< 8
	09/22/20 - 12/29/20		< 6
	MEAN	-	-
72	01/02/20 - 04/01/20	< 7	< 6
	04/01/20 - 07/01/20	< 7	< 5
	07/01/20 - 09/22/20	< 8	< 8
	09/22/20 - 12/29/20		< 5
	MEAN	-	-
73	01/02/20 - 04/01/20	< 8	< 7
	04/01/20 - 07/01/20	< 8	< 8
	07/01/20 - 09/22/20	< 7	< 8
	09/22/20 - 12/29/20		< 5
	MEAN	-	-
111	01/02/20 - 04/01/20	< 7	< 7
	04/01/20 - 07/01/20	< 8	< 10
	07/01/20 - 09/22/20	< 8	< 8
	09/22/20 - 12/29/20		< 6
	MEAN	-	-
C	01/02/20 - 04/01/20	< 6	< 5
	04/01/20 - 07/01/20	< 8	< 7
	07/01/20 - 09/22/20	< 5	< 8
	09/22/20 - 12/29/20		< 5
	MEAN	-	-

Table C-VI.4 **CONCENTRATIONS OF GAMMA EMITTERS IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020**

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
3 (1)	01/02/20 - 04/01/20	56 ± 15	< 2	< 1	< 2	< 2	< 2
	MEAN ± 2 STD DEV	56 ± 0	-	-	-	-	-
20	01/02/20 - 04/01/20	58 ± 14	< 2	< 2	< 2	< 2	< 1
	04/01/20 - 07/01/20	61 ± 17	< 2	< 2	< 2	< 2	< 2
	07/01/20 - 09/22/20	53 ± 20	< 2	< 2	< 2	< 2	< 2
	09/22/20 - 12/29/20	48 ± 16	< 1	< 1	< 2	< 1	< 2
	MEAN ± 2 STD DEV	55 ± 12	-	-	-	-	-
66	01/02/20 - 04/01/20	46 ± 15	< 2	< 2	< 2	< 2	< 2
	04/01/20 - 07/01/20	50 ± 24	< 3	< 3	< 2	< 3	< 3
	07/01/20 - 09/22/20	55 ± 36	< 6	< 7	< 6	< 6	< 5
	09/22/20 - 12/29/20	39 ± 18	< 2	< 2	< 2	< 2	< 2
	MEAN ± 2 STD DEV	48 ± 13	-	-	-	-	-
71	01/02/20 - 04/01/20	48 ± 16	< 2	< 2	< 1	< 2	< 1
	04/01/20 - 07/01/20	64 ± 15	< 2	< 3	< 2	< 2	< 2
	07/01/20 - 09/22/20	65 ± 19	< 3	< 3	< 4	< 3	< 3
	09/22/20 - 12/29/20	45 ± 14	< 2	< 2	< 2	< 3	< 2
	MEAN ± 2 STD DEV	56 ± 21	-	-	-	-	-
72	01/02/20 - 04/01/20	55 ± 18	< 2	< 2	< 3	< 2	< 2
	04/01/20 - 07/01/20	59 ± 15	< 1	< 2	< 3	< 1	< 2
	07/01/20 - 09/22/20	61 ± 26	< 2	< 3	< 2	< 3	< 2
	09/22/20 - 12/29/20	58 ± 15	< 3	< 2	< 3	< 2	< 2
	MEAN ± 2 STD DEV	58 ± 5	-	-	-	-	-
73	01/02/20 - 04/01/20	47 ± 15	< 2	< 2	< 3	< 2	< 2
	04/01/20 - 07/01/20	59 ± 17	< 1	< 2	< 2	< 3	< 2
	07/01/20 - 09/22/20	48 ± 29	< 3	< 4	< 4	< 3	< 3
	09/22/20 - 12/29/20	48 ± 15	< 2	< 2	< 2	< 1	< 2
	MEAN ± 2 STD DEV	50 ± 12	-	-	-	-	-
111	01/02/20 - 04/01/20	47 ± 19	< 3	< 2	< 3	< 2	< 2
	04/01/20 - 07/01/20	66 ± 18	< 2	< 2	< 2	< 1	< 2
	07/01/20 - 09/22/20	83 ± 22	< 1	< 2	< 2	< 3	< 2
	09/22/20 - 12/29/20	58 ± 16	< 2	< 2	< 2	< 1	< 2
	MEAN ± 2 STD DEV	63 ± 31	-	-	-	-	-
C	01/02/20 - 04/01/20	59 ± 13	< 2	< 2	< 3	< 2	< 2
	04/01/20 - 07/01/20	72 ± 32	< 3	< 4	< 3	< 3	< 4
	07/01/20 - 09/22/20	76 ± 25	< 3	< 3	< 2	< 3	< 3
	09/22/20 - 12/29/20	52 ± 13	< 2	< 2	< 3	< 2	< 2
	MEAN ± 2 STD DEV	65 ± 23	-	-	-	-	-

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

Table C-VII.1 CONCENTRATIONS OF I-131 IN AIR IODINE SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

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

COLLECTION	GROUP I			GROUP II			GROUP III	
PERIOD	20	66	111	71	72	73	3	C
12/26/19 - 01/09/20	< 23	< 23	< 22	< 23	< 19	< 10	< 21	< 22
01/09/20 - 01/15/20	< 58	< 59	< 56	< 58	< 23	< 25	< 22	< 20
01/15/20 - 01/22/20	< 30	< 31	< 29	< 30	< 45	< 17	< 42	< 45
01/22/20 - 01/29/20	< 43	< 43	< 41	< 42	< 17	< 18	< 31	< 33
01/29/20 - 02/05/20	< 36	< 36	< 34	< 36	< 31	< 30	< 30	< 22
02/05/20 - 02/12/20	< 9	< 18	< 17	< 17	< 20	< 18	< 19	< 17
02/12/20 - 02/19/20	< 27	< 27	< 26	< 27	< 24	< 14	< 34	< 36
MEAN	-	-	-	-	-	-	-	-

Table C-VIII.1 CONCENTRATIONS OF STRONTIUM AND GAMMA EMITTERS IN VEGETATION SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/KG WET ± 2 SIGMA

SITE	COLLECTION PERIOD	Sr-89	Sr-90	Be-7	K-40	Cs-134	Cs-137
35	*(1)*						
Cabbage	06/16/20	< 19	10.0 ± 2.7	< 357	2427 ± 628	< 47	< 46
Collards	06/16/20	< 21	< 5.0	< 419	4844 ± 891	< 48	< 44
Kale	06/16/20	< 20	< 4.8	< 335	2632 ± 688	< 43	< 40
Cabbage	07/22/20	< 18	< 3.5	< 153	1563 ± 517	< 21	< 20
Collards	07/22/20	< 16	6.2 ± 2.5	< 157	2179 ± 341	< 19	< 18
Kale	07/22/20	< 20	< 3.4	< 163	3865 ± 409	< 20	< 18
Cabbage	08/31/20	< 22	< 3.1	< 247	1379 ± 455	< 25	< 25
Collards	08/31/20	< 19	< 4.2	732 ± 340	4234 ± 685	< 28	< 39
Cabbage	09/23/20	< 19	5.6 ± 2.7	< 346	2712 ± 680	< 36	< 36
Collards	09/23/20	< 20	5.4 ± 2.5	< 410	3412 ± 806	< 42	< 46
Cabbage	10/26/20	< 19	7.4 ± 2.3	< 299	2113 ± 527	< 38	< 36
Collards	10/26/20	< 21	< 3.2	452 ± 172	2781 ± 418	< 24	< 24
	MEAN ± 2 STD DEV	-	6.9 ± 3.8	592 ± 396	2845 ± 2115	-	-
36 (Control)							
Collards	06/16/20	< 20	5.4 ± 2.4	< 194	4447 ± 579	< 32	< 25
Kale	06/16/20	< 18	< 4.4	< 368	3520 ± 871	< 47	< 41
Rape	06/16/20	< 22	4.5 ± 2.2	< 223	4862 ± 497	< 29	< 24
Cabbage	07/22/20	< 21	< 4.4	< 137	1583 ± 356	< 21	< 24
Collards	07/22/20	< 20	5.6 ± 2.2	< 228	4643 ± 585	< 25	< 27
Kale	07/22/20	< 22	11.5 ± 2.6	< 244	4263 ± 657	< 32	< 26
Mustard Greens	08/31/20	< 20	< 4.4	367 ± 277	3799 ± 784	< 39	< 28
Collards	08/31/20	< 19	< 3.8	< 262	5287 ± 651	< 29	< 28
Kale	08/31/20	< 25	< 4.6	< 265	2944 ± 640	< 32	< 37
Cabbage	09/23/20	< 20	11.2 ± 2.6	< 227	1899 ± 425	< 22	< 23
Collards	09/23/20	< 21	14.2 ± 3.6	< 238	4036 ± 595	< 32	< 28
Kale	09/23/20	< 16	5.4 ± 2.4	< 249	4448 ± 589	< 28	< 29
Cabbage	10/26/20	< 22	< 4.0	< 199	2251 ± 427	< 27	< 24
Collards	10/26/20	< 19	6.0 ± 2.2	344 ± 179	3792 ± 481	< 24	< 23
Swiss Chard	10/26/20	< 24	4.8 ± 2.6	830 ± 280	4728 ± 547	< 26	< 23
	MEAN ± 2 STD DEV	-	7.6 ± 7.3	514 ± 549	3767 ± 2252	-	-

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

(1) SEE PROGRAM EXCEPTIONS SECTION FOR EXPLANATION

Table C-VIII.1 CONCENTRATIONS OF STRONTIUM AND GAMMA EMITTERS IN VEGETATION SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/KG WET ± 2 SIGMA

SITE	COLLECTION PERIOD	Sr-89	Sr-90	Be-7	K-40	Cs-134	Cs-137
66	*(1)*						
Cabbage	06/16/20	< 13	< 3.9	< 404	4444 ± 909	< 48	< 53
Collards	06/16/20	< 21	< 3.8	< 239	4375 ± 668	< 35	< 28
Kale	06/16/20	< 24	4.4 ± 2.8	< 327	5112 ± 846	< 54	< 39
Cabbage	07/22/20	< 18	< 3.1	< 306	2381 ± 585	< 36	< 41
Collards	07/22/20	< 20	5.7 ± 2.4	< 384	3737 ± 697	< 36	< 29
Kale	07/22/20	< 19	5.6 ± 2.7	< 426	5189 ± 813	< 38	< 34
Cabbage	08/31/20	< 21	< 4.1	< 477	2875 ± 655	< 38	< 40
Collards	08/31/20	< 23	< 4.4	516 ± 312	2926 ± 675	< 38	< 41
Kale	08/31/20	< 21	5.5 ± 2.1	< 448	3745 ± 754	< 42	< 51
Collards	09/23/20	< 19	< 4.3	< 326	3464 ± 611	< 31	< 30
	MEAN ± 2 STD DEV	-	5.3 ± 1.2	516 ± 0	3825 ± 1902	-	-
115							
Cabbage	06/16/20	< 16	7.2 ± 2.4	< 232	2938 ± 562	< 33	< 40
Collards	06/16/20	< 18	9.2 ± 2.8	< 328	4285 ± 836	< 33	< 44
Kale	06/16/20	< 24	10.7 ± 2.9	< 328	2939 ± 608	< 39	< 38
Cabbage	07/22/20	< 19	8.0 ± 2.6	< 301	2727 ± 541	< 28	< 29
Collards	07/22/20	< 17	14.4 ± 2.9	< 374	1806 ± 590	< 34	< 42
Kale	07/22/20	< 13	11.4 ± 3.2	< 356	4313 ± 767	< 35	< 47
Cabbage	08/31/20	< 23	11.6 ± 3.2	< 427	2062 ± 578	< 48	< 44
Collards	08/31/20	< 19	< 4.0	< 425	3248 ± 676	< 39	< 41
Kale	08/31/20	< 22	5.6 ± 2.7	< 494	4017 ± 848	< 60	< 46
Cabbage	09/23/20	< 19	4.6 ± 2.5	< 252	1745 ± 658	< 39	< 38
Collards	09/23/20	< 17	5.6 ± 2.7	< 403	2773 ± 709	< 42	< 43
Kale	09/23/20	< 20	< 3.5	< 322	3404 ± 738	< 47	< 41
Cabbage	10/26/20	< 16	7.3 ± 2.8	< 257	1711 ± 468	< 34	< 34
Collards	10/26/20	< 22	8.2 ± 2.5	782 ± 243	2730 ± 463	< 27	< 31
Kale	10/26/20	< 21	6.9 ± 2.5	771 ± 330	3383 ± 778	< 46	< 49
	MEAN ± 2 STD DEV	-	8.5 ± 5.7	776 ± 15	2939 ± 1730	-	-

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

(1) SEE PROGRAM EXCEPTIONS SECTION FOR EXPLANATION

Table C-IX.1 QUARTERLY OSLD RESULTS FOR OYSTER CREEK GENERATING STATION, 2020[(1)]

RESULTS IN UNITS OF MILLIREM/STD. QUARTER ± 2 STANDARD DEVIATION

STATION CODE	MEAN ± 2 S.D.	JAN - MAR	APR - JUN	JUL - SEP	OCT - DEC
1	22.9 ± 3.6	22.5	25.2	20.8	23.2
6	21.6 ± 3.6	22.3	*(1)*	19.5	22.9
8	21.1 ± 4.5	21.1	24.1	18.7	20.5
9	20.7 ± 2.3	20.6	22.1	*19.3*	20.7
C	22.2 ± 3.6	22.5	*24.25*	19.9	22.3
22	24.7 ± 4.3	24.4	27.0	21.9	25.6
51	24.3 ± 5.6	23.0	28.2	21.8	24.1
52	25.3 ± 4.7	25.3	27.8	22.2	26.1
53	23.5 ± 4.8	23.4	26.6	20.7	23.3
54	20.5 ± 4.4	19.2	23.6	18.7	20.4
55	28.9 ± 4.9	28.6	31.7	25.7	29.5
56	26.1 ± 4.8	25.3	29.3	23.5	26.3
57	21.5 ± 3.2	21.7	22.4	19.3	22.8
58	20.4 ± 3.7	21.6	21.8	17.8	20.6
59	22.8 ± 4.2	21.7	26.0	21.6	22.0
61	21.6 ± 2.6	20.5	23.4	20.8	21.7
62	22.4 ± 4.2	22.5	24.7	19.6	22.8
63	21.9 ± 2.7	21.6	23.3	20.1	22.6
64	22.4 ± 3.7	21.9	24.6	20.2	23.0
65	22.8 ± 3.6	21.4	24.8	21.2	23.9
66	21.0 ± 2.8	21.3	22.4	19.1	21.0
68	20.1 ± 2.0	19.9	21.2	18.8	20.5
71	21.6 ± 2.7	21.2	23.5	20.4	21.3
72	22.2 ± 4.1	21.4	25.1	20.2	22.1
73	21.3 ± 4.4	21.1	22.8	18.4	23.1
74	21.9 ± 2.7	21.6	23.9	20.8	21.4
75	23.3 ± 4.1	23.1	25.9	20.8	23.5
78	22.4 ± 3.5	22.6	24.6	20.3	22.2
79	22.9 ± 3.8	22.9	25.0	20.4	23.2
81	22.5 ± 3.7	22.6	24.3	19.9	23.2
98	20.7 ± 4.1	19.6	23.5	18.8	21.1
99	20.3 ± 3.9	20.0	22.6	17.9	20.8
T1	22.3 ± 3.7	23.1	24.2	19.9	22.0
100	21.6 ± 4.1	20.8	24.5	19.7	21.6
101	21.3 ± 3.8	21.2	23.2	18.8	22.1
102	22.6 ± 3.7	22.6	23.8	20.0	23.9
103	21.9 ± 3.7	21.6	24.1	19.6	22.5
104	21.6 ± 1.3	21.7	22.3	20.8	21.8
106	20.2 ± 2.9	20.9	22.0	18.6	19.6
107	21.1 ± 2.2	20.7	22.4	19.8	21.4
109	22.5 ± 4.2	21.5	25.1	20.2	23.1
110	20.9 ± 3.5	20.5	22.6	18.6	21.9
112	24.3 ± 3.3	24.1	26.5	22.5	24.2
113	21.4 ± 2.7	21.6	23.0	19.6	21.4

(1) SEE PROGRAM EXCEPTIONS SECTION FOR EXPLANATION

[(1)] Note: There are two (2) OSLD's posted at each indicator station for redundancy and data recovery. In reporting results, the average of the gross mean for the two readings is reported. There are four (4) single OSLD's posted at Control Station C and the average of the gross mean for the four readings is reported.

TABLE C-IX.2 MEAN QUARTERLY OSLD RESULTS FOR THE SITE BOUNDARY, INTERMEDIATE, SPECIAL INTEREST, AND CONTROL LOCATIONS FOR OYSTER CREEK GENERATING STATION, 2020[1]

RESULTS IN UNITS OF MILLIREM PER STANDARD QUARTER ± 2 STANDARD DEVIATION

STANDARD DEVIATIONS OF THE STATION DATA

COLLECTION PERIOD	SITE BOUNDARY ± 2 S.D.	INTERMEDIATE ± 2 S.D.	SPECIAL INTEREST ± 2 S.D.	CONTROL ± 2 S.D.
JAN-MAR	22.6 ± 4.1	21.5 ± 2.4	21.7 ± 1.5	22.5 ± 0.0
APR-JUN	25.1 ± 5.2	23.7 ± 2.8	24.3 ± 1.6	24.3 ± 0.0
JUL-SEP	20.7 ± 3.7	19.6 ± 1.8	20.2 ± 0.5	19.9 ± 0.0
OCT-DEC	23.1 ± 4.4	22.0 ± 2.8	22.2 ± 2.0	22.3 ± 0.0

TABLE C-IX.3 SUMMARY OF THE AMBIENT DOSIMETRY PROGRAM FOR OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF MILLIREM PER STANDARD QUARTER ± 2 STANDARD DEVIATION

LOCATION	SAMPLES ANALYZED	PERIOD MINIMUM	PERIOD MAXIMUM	PERIOD MEAN ± 2 S.D.
SITE BOUNDARY	159	17.8	31.7	22.8 ± 5.3
INTERMEDIATE	182	17.9	27.0	21.7 ± 3.8
SPECIAL INTEREST	24	19.9	25.1	22.1 ± 3.3
CONTROL	16	18.7	25.4	22.2 ± 3.6

SITE BOUNDARY STATIONS - 1, 51, 52, 53, 54, 55, 56, 57, 58, 59, 61, 62, 63, 64, 65, 66, 112, 113, T1

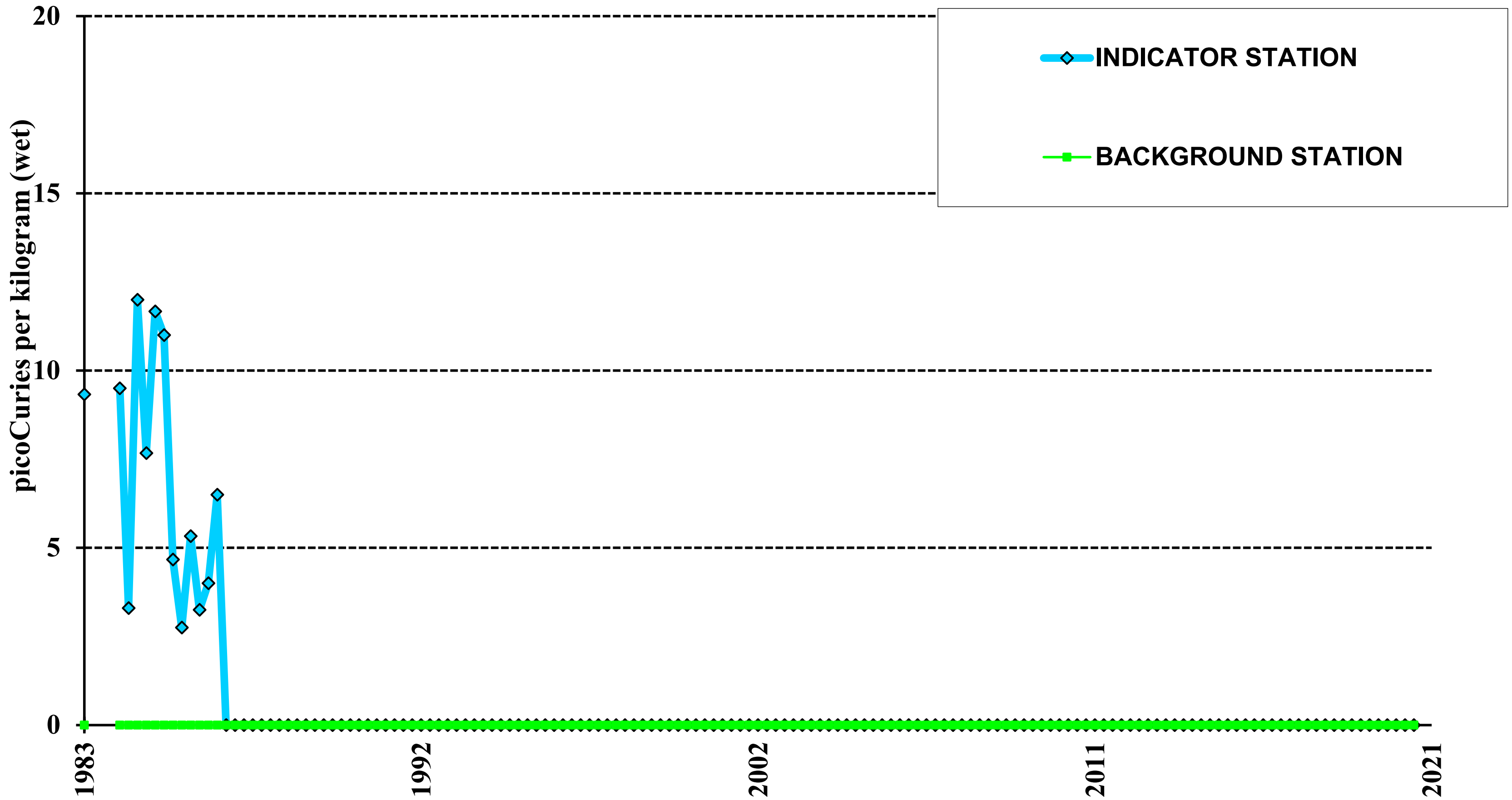
INTERMEDIATE STATIONS - 6, 8, 9, 22, 68, 73, 74, 75, 78, 79, 98, 99, 100, 101, 102, 103, 104, 106, 107, 109, 110

SPECIAL INTEREST STATIONS - 71, 72, 81

CONTROL STATIONS - C

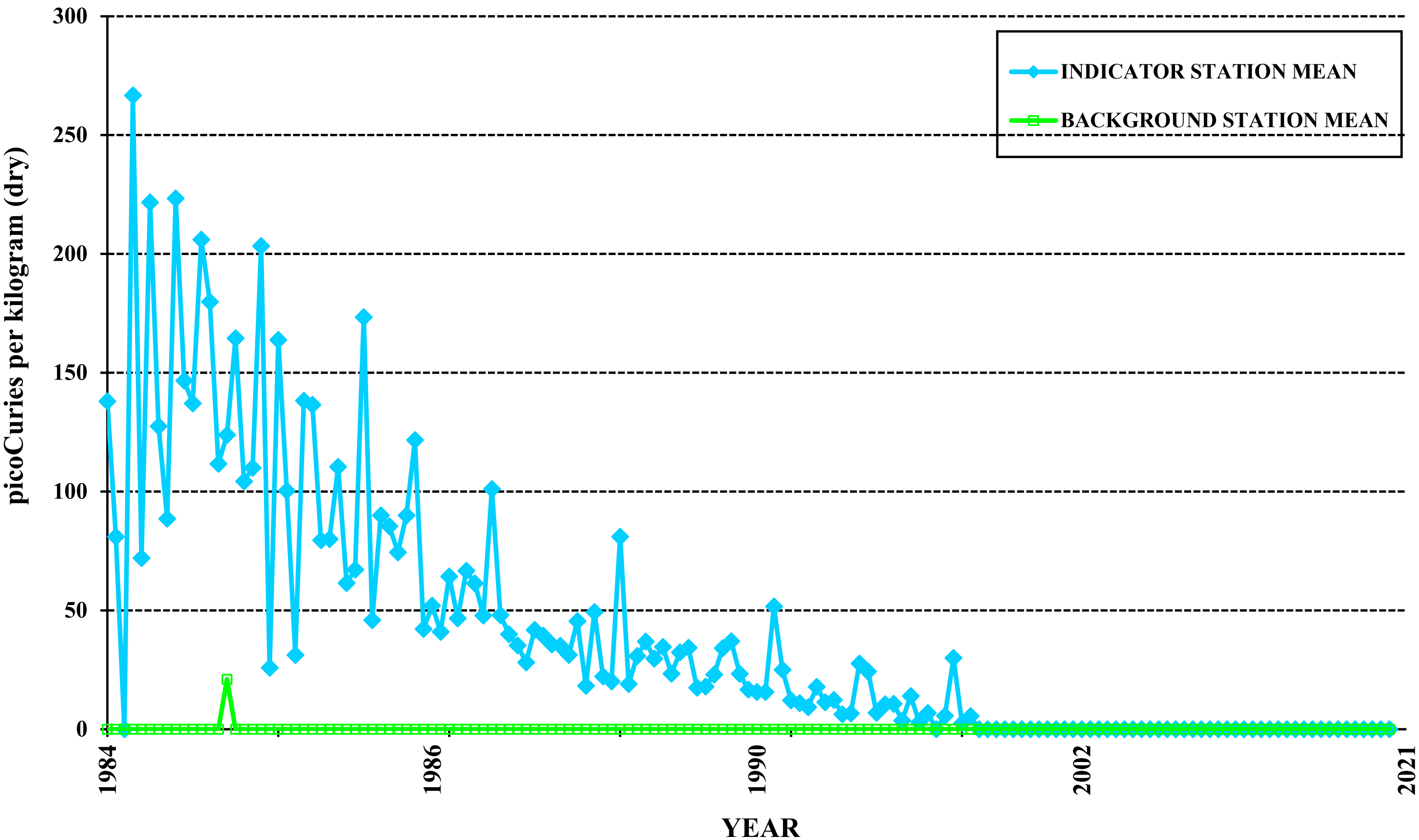
(1) Note: There are two (2) OSLD's posted at each indicator station for redundancy and data recovery. In reporting results, the average of the gross mean for the two readings is reported. There are four (4) single OSLD's posted at Control Station C and the average of the gross mean for the four readings is reported.

FIGURE C-1
MEAN COBALT-60 CONCENTRATION IN CLAMS
OYSTER CREEK GENERATING STATION, 1983 - 2020



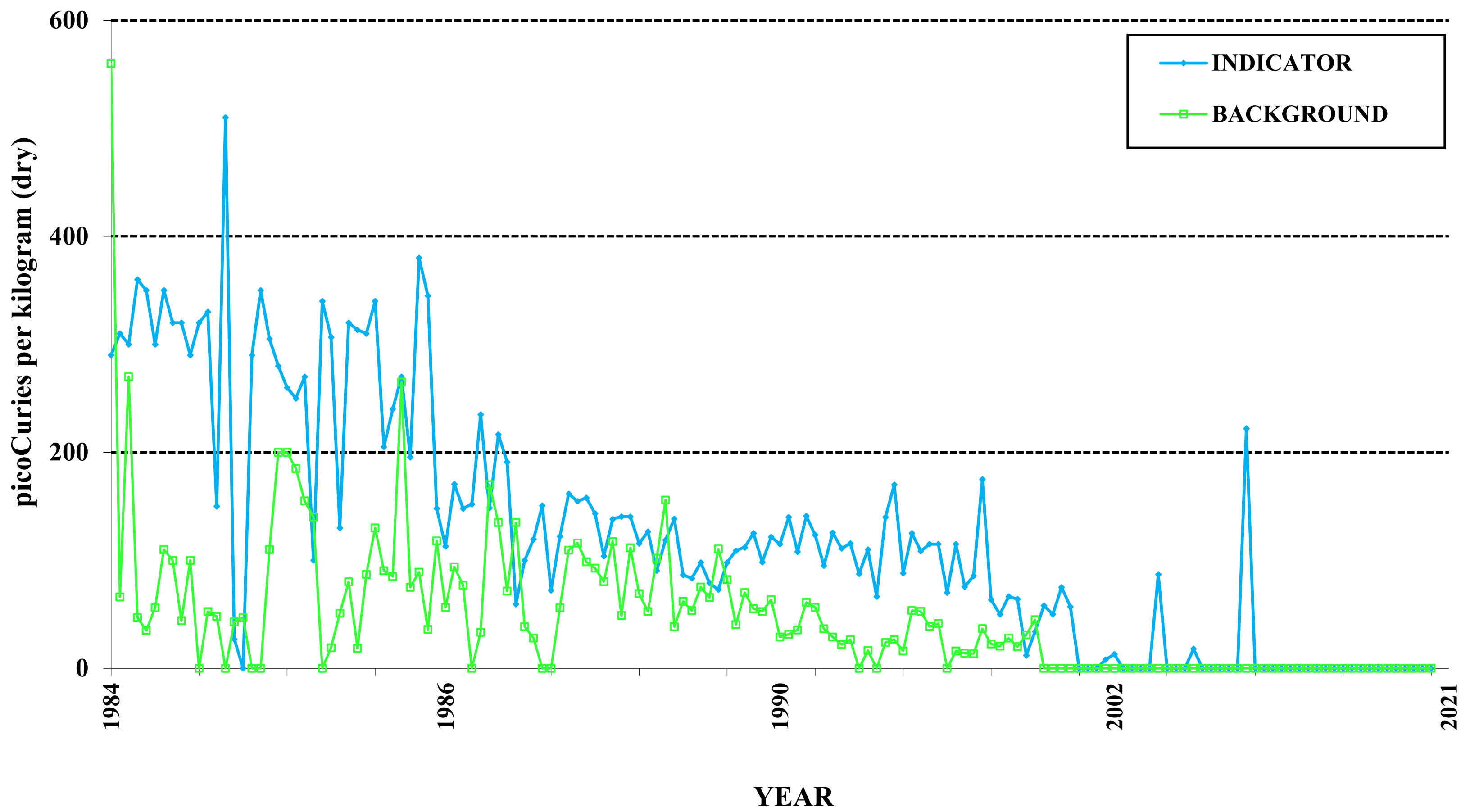
* The year designations on the x-axis reflect multiple sampling periods in a given year, as well as historical changes in the number of sampling periods per year.

FIGURE C-2
MEAN COBALT-60 CONCENTRATION IN AQUATIC SEDIMENT
OYSTER CREEK GENERATING STATION, 1984 - 2020



* The year designations on the x-axis reflect multiple sampling periods in a given year, as well as historical changes in the number of sampling periods per year.

FIGURE C-3
MEAN CESIUM-137 CONCENTRATION IN AQUATIC SEDIMENT
OYSTER CREEK GENERATING STATION, 1984 - 2020



* The year designations on the x-axis reflect multiple sampling periods in a given year, as well as historical changes in the number of sampling periods per year.

FIGURE C-4
MEAN WEEKLY GROSS BETA CONCENTRATIONS
IN AIR PARTICULATES
OYSTER CREEK GENERATING STATION, 2008 - 2020

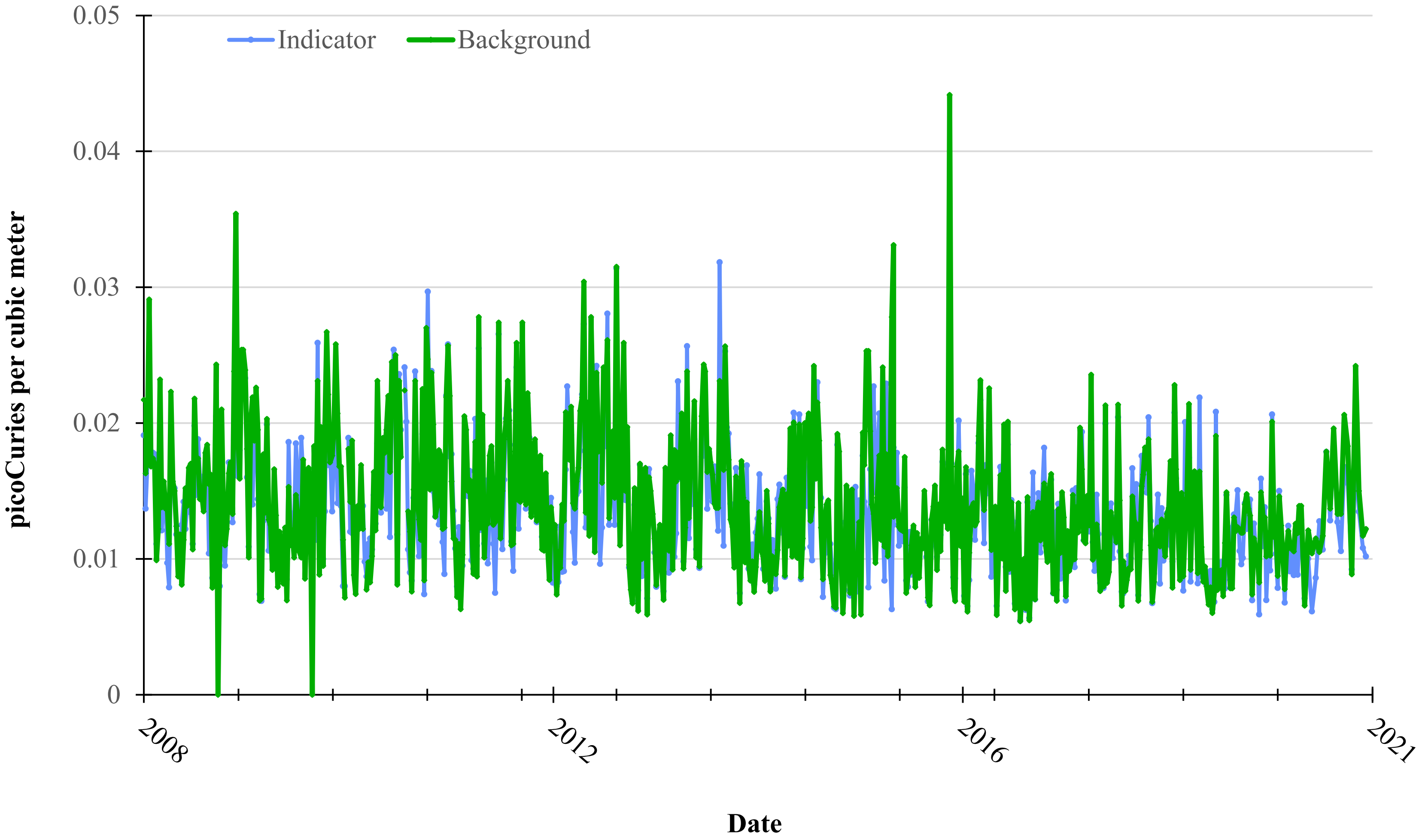
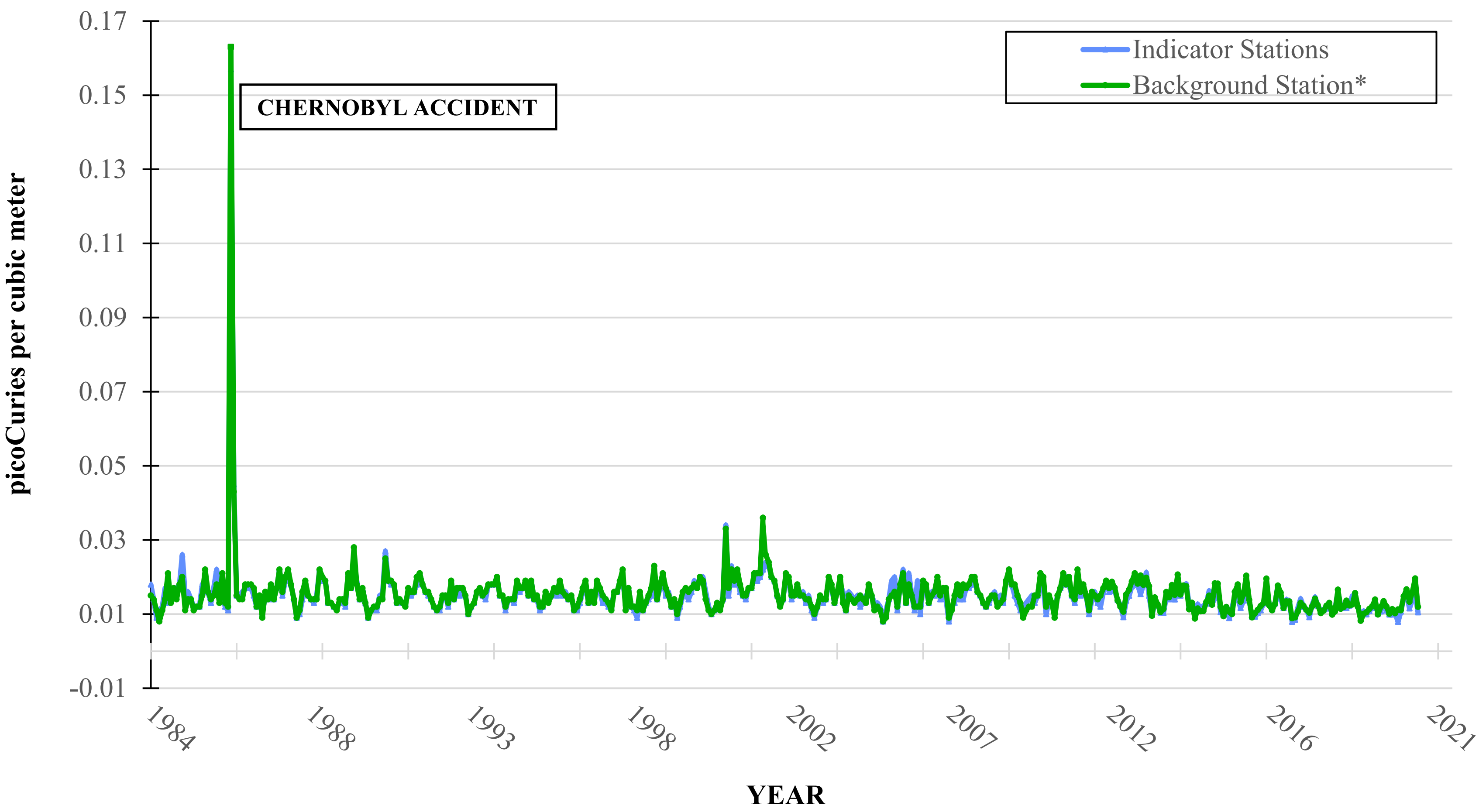
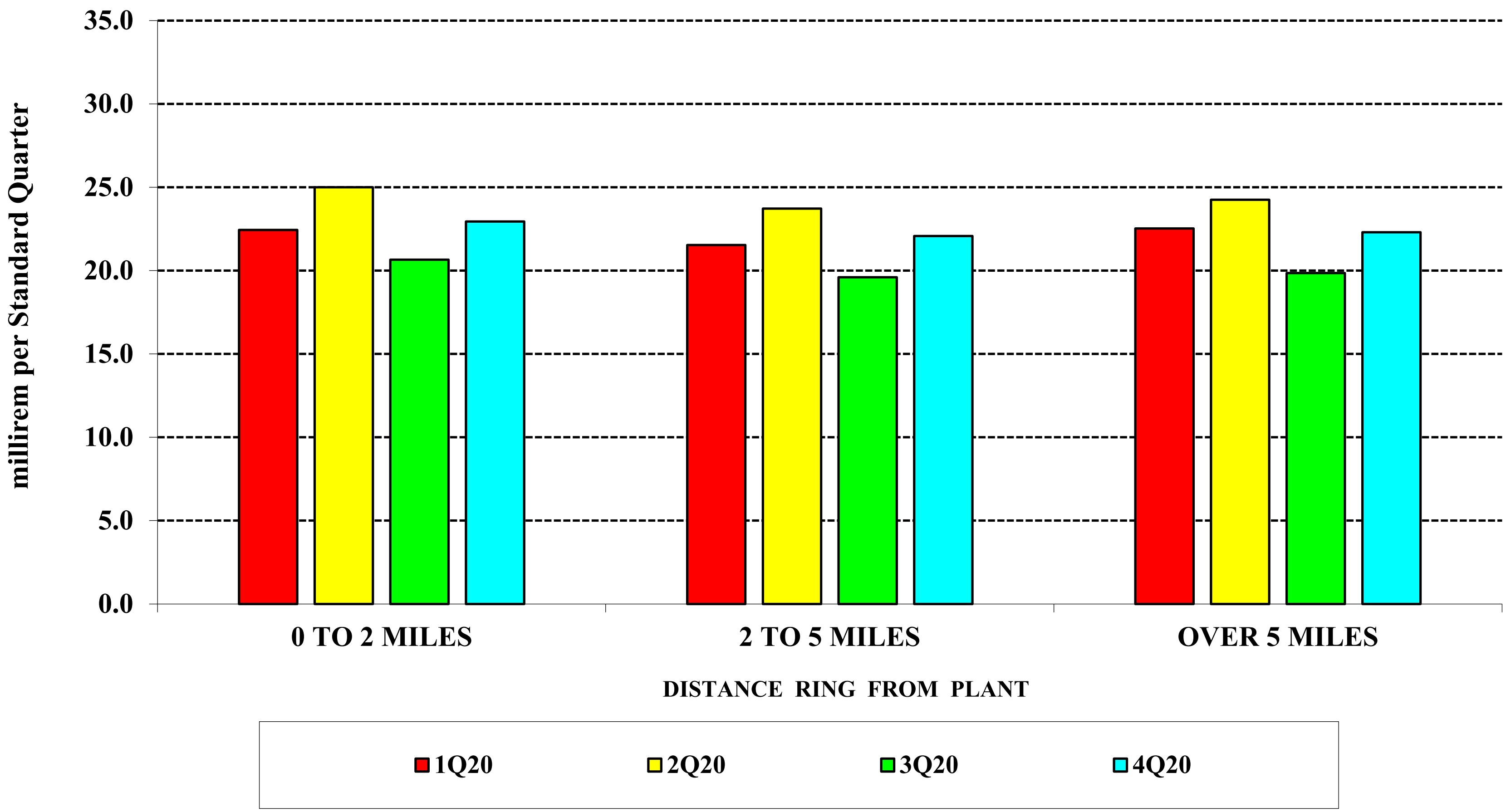


FIGURE C-5
MEAN MONTHLY GROSS BETA CONCENTRATIONS IN AIR PARTICULATES OYSTER CREEK GENERATING STATION, 1984 - 2020



** Data from Cookstown station ONLY after December 1996*

FIGURE C-6
MEAN QUARTERLY OSLD GAMMA DOSE
OYSTER CREEK GENERATING STATION, 2020



Oyster Creek's dosimetry changed from TLD to OSLD in 2012.

APPENDIX D

DATA TABLES
QC COMPARISON SAMPLES

The following section presents the results of data analysis performed by the QC laboratory, Environmental Inc. Duplicate samples were obtained from several locations and media and were split with the primary laboratory, Teledyne Brown Engineering (TBE) and the QC Laboratory. Comparison of the results for all media were within expected ranges.

Table D-I.1 CONCENTRATIONS OF TRITIUM IN SURFACE WATER SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	24 (TBE)	QCA (TBE)	OC-24 (EIML)
06/01/20	< 174	< 173	< 150
10/30/20	< 184	< 182	< 155

Table D-I.2 CONCENTRATIONS OF GAMMA EMITTERS IN SURFACE WATER SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Zr-95	Cs-134	Cs-137
24	06/01/20	< 8	< 6	< 12	< 9	< 15	< 11	< 10	< 8
(TBE)	10/20/20	< 7	< 6	< 13	< 6	< 12	< 12	< 7	< 7
QCA	06/01/20	< 9	< 10	< 18	< 9	< 20	< 14	< 9	< 9
(TBE)	10/20/20	< 6	< 6	< 12	< 6	< 12	< 9	< 6	< 6
OC-24	06/01/20	< 4	< 3	< 5	< 4	< 8	< 8	< 3	< 4
(EIML)	10/20/20	< 5	< 3	< 4	< 3	< 12	< 7	< 4	< 4

Table D-II.1 CONCENTRATIONS OF TRITIUM IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	1N (TBE)	OC-QC1N (EIML)
01/09/20 - 01/29/20	< 180	< 153
02/05/20 - 02/26/20	< 178	< 157
03/03/20 - 04/01/20	< 199	< 158
04/01/20 - 04/14/20	< 162	< 153
05/13/20 - 05/13/20	< 180	< 160
06/03/20 - 06/03/20	< 185	< 159
07/01/20 - 07/01/20	< 186	< 158
08/05/20 - 08/05/20	< 180	< 159
09/01/20 - 09/01/20	< 179	< 159
10/01/20 - 10/01/20	< 176	< 158
11/04/20 - 11/04/20	< 198	< 155
12/01/20 - 12/01/20	< 312	< 155

Table D-II.2 **CONCENTRATIONS OF GAMMA EMITTERS IN DRINKING WATER SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020**

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Zr-95	Cs-134	Cs-137
1N	01/09/20 - 01/29/20	< 6	< 6	< 12	< 7	< 14	< 10	< 7	< 6
(TBE)	02/05/20 - 02/26/20	< 9	< 8	< 15	< 9	< 17	< 14	< 9	< 8
	03/03/20 - 04/01/20	< 5	< 5	< 8	< 5	< 9	< 7	< 5	< 5
	04/01/20 - 04/14/20	< 3	< 3	< 7	< 3	< 7	< 6	< 3	< 3
	05/13/20 - 05/13/20	< 2	< 2	< 5	< 2	< 4	< 4	< 2	< 2
	06/03/20 - 06/03/20	< 2	< 2	< 5	< 1	< 3	< 4	< 2	< 2
	07/01/20 - 07/01/20	< 2	< 3	< 7	< 2	< 5	< 5	< 2	< 2
	08/05/20 - 08/05/20	< 3	< 2	< 6	< 3	< 5	< 5	< 3	< 3
	09/01/20 - 09/01/20	< 3	< 3	< 7	< 3	< 5	< 6	< 2	< 3
	10/01/20 - 10/01/20	< 5	< 6	< 12	< 6	< 12	< 9	< 6	< 6
	11/04/20 - 11/04/20	< 6	< 6	< 13	< 6	< 15	< 10	< 7	< 6
	12/01/20 - 12/01/20	< 6	< 8	< 14	< 7	< 7	< 12	< 8	< 6
OC-QC1N	01/09/20 - 01/29/20	< 2	< 3	< 5	< 2	< 5	< 4	< 3	< 2
(EIML)	02/05/20 - 02/26/20	< 2	< 2	< 5	< 2	< 6	< 6	< 3	< 3
	03/03/20 - 04/01/20	< 3	< 2	< 7	< 3	< 6	< 7	< 4	< 3
	04/01/20 - 04/14/20	< 2	< 2	< 5	< 1	< 3	< 3	< 3	< 3
	05/13/20 - 05/13/20	< 2	< 3	< 5	< 2	< 3	< 5	< 2	< 2
	06/03/20 - 06/03/20	< 3	< 2	< 8	< 1	< 6	< 6	< 2	< 3
	07/01/20 - 07/01/20	< 4	< 4	< 8	< 4	< 6	< 7	< 3	< 2
	08/05/20 - 08/05/20	< 3	< 3	< 6	< 1	< 3	< 7	< 4	< 3
	09/01/20 - 09/01/20	< 2	< 2	< 3	< 2	< 2	< 5	< 2	< 3
	10/01/20 - 10/01/20	< 2	< 5	< 7	< 3	< 6	< 7	< 4	< 3
	11/04/20 - 11/04/20	< 3	< 3	< 5	< 2	< 4	< 5	< 3	< 3
	12/01/20 - 12/01/20	< 3	< 3	< 5	< 2	< 6	< 5	< 4	< 3

Table D-III.1 CONCENTRATIONS OF TRITIUM IN GROUNDWATER SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

COLLECTION PERIOD	W-3C	OC-W-3C (EIML)
01/29/20 - 01/29/20	< 194	< 153
05/21/20 - 05/21/20	< 174	< 160

Table D-III.2 CONCENTRATIONS OF GAMMA EMITTERS IN GROUNDWATER SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Zr-95	Cs-134	Cs-137
W-3C	01/29/20 - 01/29/20	< 7	< 6	< 11	< 7	< 17	< 13	< 7	< 7
(TBE)	05/21/20 - 05/21/20	< 7	< 7	< 13	< 8	< 16	< 12	< 9	< 10
OC -W-3C									
(EIML)	01/29/20 - 01/29/20	< 4	< 3	< 4	< 3	< 6	< 5	< 3	< 2
	05/21/20 - 05/21/20	< 1	< 2	< 2	< 2	< 2	< 3	< 1	< 2

Table D-IV.1

CONCENTRATIONS OF GAMMA EMITTERS IN CLAM SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/KG WET ± 2 SIGMA

SITE	COLLECTION PERIOD	K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Cs-134	Cs-137
24 (TBE)	06/01/20	1540 ± 987	< 81	< 84	< 157	< 88	< 169	< 99	< 81
QCA (TBE)	06/01/20	1198 ± 700	< 52	< 59	< 111	< 66	< 109	< 41	< 54
OC-24 (EIML)	06/01/20	1286 ± 102	< 4	< 4	< 15	< 4	< 8	< 4	< 4

(1) No sample collected or analyzed

Table D-V.1

CONCENTRATIONS OF GAMMA EMITTERS IN SEDIMENT SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/KG DRY ± 2 SIGMA

SITE	COLLECTION PERIOD	Be-7	K-40	Mn-54	Co-58	Co-60	Cs-134	Cs-137	Ra-226	Th-228
24	06/01/20	< 1012	8501 ± 1707	< 121	< 112	< 127	< 145	< 121	4319 ± 1838	875 ± 197
(TBE)	10/20/20	< 382	9138 ± 989	< 51	< 45	< 52	< 55	< 45	< 1054	426 ± 87
QCA	06/01/20	< 948	9132 ± 2159	< 137	< 113	< 125	< 142	< 122	< 1647	572 ± 185
(TBE)	10/20/20	< 505	12190 ± 1225	< 60	< 52	< 62	< 77	< 61	< 1186	625 ± 99
OC-24	06/01/20	< 296	6752 ± 633	< 28	< 19	< 22	< 22	< 23	1945 ± 782	< 2116
(EIML)	10/20/20	< 295	13165 ± 639	< 20	< 25	< 18	< 13	< 18	1523 ± 639	< 1661

(1) No sample collected or analyzed

TABLE D-VI.1 CONCENTRATIONS OF STRONTIUM AND GAMMA EMITTERS IN VEGETATION SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/KG WET ± 2 SIGMA

SITE	COLLECTION PERIOD	Sr-89	Sr-90	Be-7	K-40	Cs-134	Cs-137
36 (TBE)							
Collards	08/31/20	< 19	< 3.8	< 262	5287 ± 651	< 29	< 28
Kale	08/31/20	< 25	< 4.6	< 265	2944 ± 640	< 32	< 37
Mustard Greens	08/31/20	< 20	< 4.4	367 ± 277	3799 ± 784	< 39	< 28
QCA (TBE)							
Collards	08/31/20	< 18	4.8 ± 2.4	< 189	4647 ± 565	< 25	< 25
Kale	08/31/20	< 19	6.8 ± 2.3	< 239	3950 ± 707	< 35	< 36
Mustard Greens	08/31/20	< 23	6.0 ± 2.5	185 ± 175	3026 ± 473	< 20	< 25
OC-36 (EIML)							
Collards	08/31/20	< 4	< 3.0	< 109	4354 ± 354	< 5	< 6
Kale	08/31/20	< 4	< 3.0	< 148	3799 ± 352	< 10	< 10
Mustard Greens	08/31/20	< 4	< 4.0	248 ± 131	4372 ± 366	< 10	< 12

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APPENDIX E

INTER-LABORATORY COMPARISON PROGRAM

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Table E-1

Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Value	Known Value (a)	Ratio of TBE to Known Result	Evaluation (b)
September 2020	E13247	Milk	Sr-89	pCi/L	62.8	95.4	0.66	N(1)
			Sr-90	pCi/L	12.0	12.8	0.94	A
	E13248	Milk	Ce-141	pCi/L	156	150	1.04	A
			Co-58	pCi/L	172	180	0.96	A
			Co-60	pCi/L	369	379	0.97	A
			Cr-51	pCi/L	372	372	1.00	A
			Cs-134	pCi/L	171	200	0.85	A
			Cs-137	pCi/L	241	250	0.96	A
			Fe-59	pCi/L	217	200	1.08	A
			I-131	pCi/L	84.6	95.0	0.89	A
			Mn-54	pCi/L	175	180	0.97	A
			Zn-65	pCi/L	252	270	0.93	A
	E13249	Charcoal	I-131	pCi	70.2	75.8	0.93	A
	E13250	AP	Ce-141	pCi	101	101	1.00	A
			Co-58	pCi	111	120	0.92	A
			Co-60	pCi	249	254	0.98	A
			Cr-51	pCi	287	249	1.15	A
			Cs-134	pCi	114	134	0.85	A
			Cs-137	pCi	159	168	0.95	A
			Fe-59	pCi	127	134	0.95	A
			Mn-54	pCi	114	121	0.94	A
			Zn-65	pCi	168	181	0.93	A
	E13251	Soil	Ce-141	pCi/g	0.241	0.191	1.26	W
			Co-58	pCi/g	0.211	0.228	0.93	A
			Co-60	pCi/g	0.466	0.481	0.97	A
			Cr-51	pCi/g	0.450	0.472	0.95	A
			Cs-134	pCi/g	0.273	0.254	1.07	A
			Cs-137	pCi/g	0.370	0.390	0.95	A
			Fe-59	pCi/g	0.233	0.254	0.92	A
			Mn-54	pCi/g	0.217	0.229	0.95	A
			Zn-65	pCi/g	0.368	0.343	1.07	A
	E13252	AP	Sr-89	pCi	79.9	100.0	0.80	A
			Sr-90	pCi	12.1	13.4	0.90	A

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

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

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

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

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

(1) See ***NCR 20-19***

Table E-1

Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Value	Known Value [(a)]	Ratio of TBE to Known Result	Evaluation [(b)]
December 2020	E13254	Milk	Sr-89	pCi/L	82.2	89.7	0.92	A
			Sr-90	pCi/L	12.4	13.0	0.96	A
	E13255	Milk	Ce-141	pCi/L	91.1	100	0.91	A
			Co-58	pCi/L	77.5	84.3	0.92	A
			Co-60	pCi/L	147	152	0.97	A
			Cr-51	pCi/L	259	253	1.02	A
			Cs-134	pCi/L	97.1	108	0.90	A
			Cs-137	pCi/L	117	127	0.92	A
			Fe-59	pCi/L	114	112	1.02	A
			I-131	pCi/L	84.3	91.9	0.92	A
			Mn-54	pCi/L	137	143	0.96	A
			Zn-65	pCi/L	175	190	0.92	A
	E13256	Charcoal	I-131	pCi	70.2	78.2	0.90	A
	E13257A	AP	Ce-141	pCi	67.4	74.6	0.90	A
			Co-58	pCi	57.9	62.9	0.92	A
			Co-60	pCi	108	113	0.95	A
			Cr-51	pCi	162	189	0.86	A
			Cs-134	pCi	68.1	80.4	0.85	A
			Cs-137	pCi	82.4	95.0	0.87	A
			Fe-59	pCi	80.5	83.7	0.96	A
			Mn-54	pCi	102	107	0.95	A
			Zn-65	pCi	115	142	0.81	A
	E13258	Soil	Ce-141	pCi/g	0.167	0.170	0.98	A
			Co-58	pCi/g	0.125	0.143	0.87	A
			Co-60	pCi/g	0.245	0.257	0.95	A
			Cr-51	pCi/g	0.393	0.429	0.92	A
			Cs-134	pCi/g	0.147	0.183	0.80	A
			Cs-137	pCi/g	0.260	0.288	0.90	A
			Fe-59	pCi/g	0.199	0.190	1.05	A
			Mn-54	pCi/g	0.229	0.243	0.94	A
			Zn-65	pCi/g	0.320	0.322	0.99	A
	E13259	AP	Sr-89	pCi	85.0	78.6	1.08	A
			Sr-90	pCi	13.1	11.4	1.15	A

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

(b) Analytics evaluation based on TBE internal QC limits:
A = Acceptable - reported result falls within ratio limits of 0.80-1.20
W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30
N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

Table E-2

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

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Value	Known Value [(a)]	Acceptance Range	Evaluation [(b)]
February 2020	20-GrF42	AP	Gross Alpha	Bq/sample	0.676	1.24	0.37 - 2.11	A
			Gross Beta	Bq/sample	2.03	2.00	1.00 - 3.00	A
	20-MaS42	Soil	Ni-63	Bq/kg	0.01		*(1)*	A
			Sr-90	Bq/kg	348	340	238 - 442	A
	20-MaW42	Water	Ni-63	Bq/L	11.6	11.1	7.8 - 14.4	A
			Pu-238	Bq/L	0.926	0.94	0.66 - 1.22	A
			Pu-239/240	Bq/L	0.712	0.737	0.516 - 0.958	A
	20-RdF42	AP	U-234/233	Bq/sample	0.0416	0.075	0.053 - 0.098	N(3)
			U-238	Bq/sample	0.0388	0.078	0.055 - 0.101	N(3)
	20-RdV42	Vegetation	Cs-134	Bq/sample	3.23	3.82	2.67 - 4.97	A
			Cs-137	Bq/sample	2.64	2.77	1.94 - 3.60	A
			Co-57	Bq/sample	0.0281		*(1)*	A
			Co-60	Bq/sample	2.62	2.79	1.95 - 3.63	A
			Mn-54	Bq/sample	4.3	4.58	3.21 - 5.95	A
			Sr-90	Bq/sample	0.396	0.492	0.344 - 0.640	A
			Zn-65	Bq/sample	3.93	3.79	2.65 - 4.93	A
August 2020	20-GrF43	AP	Gross Alpha	Bq/sample	0.267	0.528	0.158 - 0.898	A
			Gross Beta	Bq/sample	0.939	0.915	0.458 - 1.373	A
	20-MaS43	Soil	Ni-63	Bq/kg	438	980	686 - 1274	N(4)
			Tc-99	Bq/kg	1.11		*(1)*	A
	20-MaW43	Water	Ni-63	Bq/L	0.175		*(1)*	A
			Tc-99	Bq/L	8.8	9.4	6.6 - 12.2	A
	20-RdV43	Vegetation	Cs-134	Bq/sample	3.635	4.94	3.46 - 6.42	W
			Cs-137	Bq/sample	0.0341		*(1)*	A
			Co-57	Bq/sample	5.855	6.67	4.67 - 8.67	W
			Co-60	Bq/sample	3.122	4.13	2.89 - 5.37	W
			Mn-54	Bq/sample	4.524	5.84	4.09 - 7.59	A
			Sr-90	Bq/sample	1.01	1.39	0.97 - 1.81	W
			Zn-65	Bq/sample	4.706	6.38	4.47 - 8.29	W

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

(b) DOE/MAPEP evaluation:

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

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

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

(1) False positive test

(2) Sensitivity evaluation

(3) See ***NCR 20-13***

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

(Page 1 of 1)

Table E-3

ERA Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

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

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

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

(1) See ***NCR 20-18***

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

TABLE E-4

Interlaboratory Comparison Crosscheck Program
New York Department of Health (ELAP)[a]
Environmental, Inc., Midwest Laboratory
(Relevant Nuclides Only)

Lab Code	Date	Analysis	Laboratory Result	Known Activity	Acceptance Limits	Acceptance
NYW-3307	09/15/20	H-3	11,500 ± 465	11,208	9,760 - 12,300	Pass
NYW-3337	09/15/20	GR-A	43.7 ± 2.5	64.9	34.0 - 80.4	Pass
NYW-3337	09/15/20	Co-60	46.4 ± 3.8	42.3	38.1 - 49.2	Pass
NYW-3337	09/15/20	Zn-65	133 ± 9.0	116	104 - 138	Pass
NYW-3337	09/15/20	Cs-134	32.5 ± 3.1	33.0	26.0 - 36.3	Pass
NYW-3337	09/15/20	Cs-137	147 ± 7.0	134	121 - 150	Pass

[a] *Results obtained by Environmental, Inc., Midwest Laboratory as a participant in the crosscheck program for proficiency testing in drinking water conducted by the New York Department of Health Laboratory Approval Program (NY ELAP)*

TABLE E-5

DOE's Mixed Analyte Performance Evaluation Program (MAPEP)
Environmental, Inc., Midwest Laboratory
(Relevant Nuclides Only)

			Concentration [a]			
Lab Code [b]	Reference Date	Analysis	Laboratory Result	Known Activity	Control Limits [c]	Acceptance
MAW-536	02/01/20	GR-A	0.86 ± 0.06	1	0.31 - 1.75	Pass
MASO-662	02/01/20	Cs-134	955 ± 9.0	1,114	780 -1,448	Pass
MASO-662	02/01/20	Cs-137	1089 ± 12	1,020	714 - 1,326	Pass
MASO-662	02/01/20	Co-60	0.33 ± 1.26	0	NA [c]	Pass
MASO-662	02/01/20	Mn-54	1,022 ± 27	945	662 - 1,229	Pass
MASO-662	02/01/20	K-40	710 ± 42	625	438 - 813	Pass
MAW-599	02/01/20	H-3	202 ± 9.0	196	137 - 255	Pass
MAW-599	02/01/20	Cs-134	16.1 ± 0.3	18.5	13.0 - 24.1	Pass
MAW-599	02/01/20	Cs-137	11.5 ± 0.4	11.3	13.8 - 25.6	Pass
MAW-599	02/01/20	Co-60	10.6 ± 0.2	10.6	7.4 - 13.8	Pass
MAW-599	02/01/20	Mn-54	20.5 ± 0.4	19.6	13.7 - 25.5	Pass
MAW-599	02/01/20	Zn-65	24.1 ± 0.70	22.2	15.5 - 28.9	Pass
MAW-599	02/01/20	Sr-90	0.07 ± 0.18	0	NA [c]	Pass
MAVE-668	02/01/20	Cs-134	3.51 ± 0.22	3.82	2.67 - 4.97	Pass
MAVE-668	02/01/20	Cs-137	3.04 ± 0.18	2.77	1.94 - 3.60	Pass
MADW-3101	08/01/20	GR-A	0.57 ± 0.4	0.62	0.19 - 1.05	Pass
MASO-3179	08/01/20	Cs-134	599 ± 7.0	710	497 - 923	Pass
MASO-3179	08/01/20	Cs-137	3.33 ± 4.81	0	NA [c]	Pass
MASO-3179	08/01/20	Co-60	965 ± 9.0	1000	700 - 1,300	Pass
MASO-3179	08/01/20	Mn-54	651 ± 11	610	427 - 793	Pass
MASO-3179	08/01/20	K-40	684 ± 58	622	435 - 809	Pass
MAW-3175	08/01/20	Cs-134	13.9 ± 0.3	15.2	10.6 - 19.8	Pass
MAW-3175	08/01/20	Cs-137	15.4 ± 0.4	14.3	10.0 - 18.6	Pass
MAW-3175	08/01/20	Co-60	12.5 ± 0.3	12.2	8.5 - 15.9	Pass
MAW-3175	08/01/20	Mn-54	0.07 ± 0.17	0	NA [c]	Pass
MAW-3175	08/01/20	Zn-65	18.3 ± 0.6	16.9	11.8 - 22.0	Pass
MAVE-3185	08/01/20	Cs-134	4.73 ± 0.10	4.94	3.46 - 6.42	Pass
MAVE-3185	08/01/20	Cs-137	0.03 ± 0.06	0	NA [c]	Pass

[a] *Results are reported in units of Bq/kg (soil), Bq/L (water) or Bq/total sample (vegetation)*
[b] *Laboratory codes as follows: MAW (water), 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.*

TABLE E-6

Interlaboratory Comparison Crosscheck Program
Environmental Resource Associates (ERA)[a] RAD Study
Environmental, Inc., Midwest Laboratory
(Relevant Nuclides Only)

Lab Code	Date	Analysis	Laboratory Result	ERA Result	Control Limits	Acceptance
RAD-120						
ERW-49	01/06/20	Cs-134	22.7 ± 2.8	22.9	17.5 - 25.6	Pass
ERW-49	01/06/20	Cs-137	225 ± 8.0	220	198 - 244	Pass
ERW-49	01/06/20	Co-60	94.6 ± 4.6	91.2	82.1 - 103	Pass
ERW-49	01/06/20	Zn-65	331 ± 13	298	268 - 348	Pass
ERW-49	01/06/20	GR-A	52.3 ± 2.4	58.9	30.8 - 73.3	Pass
ERW-49	01/06/20	H-3	18,200 ± 408	17,800	15,600 - 19,600	Pass
RAD-122						
ERW-2297	07/06/20	Cs-134	19.8 ± 2.4	22.3	17.0 - 25.0	Pass
ERW-2297	07/06/20	Cs-137	73.2 ± 5.4	73.0	65.7 - 83.0	Pass
ERW-2297	07/06/20	Co-60	90.0 ± 4.0	86.1	77.5 - 97.0	Pass
ERW-2297	07/06/20	Zn-65	84.9 ± 7.5	82.9	74.6 - 99.6	Pass
ERW-2297	07/06/20	GR-A	40.3 ± 2.2	52.4	27.3 - 65.6	Pass
ERW-2297	07/06/20	H-3	21,100 ± 400	20,300	17.800 - 22,300	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).*

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APPENDIX F

ERRATA DATA

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For the 2019 AREOR, Sr-89 and Sr-90 results reported on Table C-VI.3 were not updated from the previous year. All results for both years were < MDC. The updated table is presented below:

Table C-VI.3 CONCENTRATIONS OF STRONTIUM IN AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK GENERATING STATION, 2019

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

SITE	COLLECTION PERIOD	SR-89	SR-90
3	01/02/19 - 04/03/19	< 7	< 5
	04/03/19 - 07/02/19	< 8	< 7
	07/02/19 - 10/02/19	< 6	< 5
	10/02/19 - 01/02/20	< 7	< 5
	MEAN	-	-
20	01/16/19 - 04/03/19	< 6	< 9
	04/03/19 - 07/02/19	< 7	< 5
	07/02/19 - 10/02/19	< 7	< 7
	10/02/19 - 01/02/20	< 8	< 6
	MEAN	-	-
66	01/02/19 - 04/03/19	< 7	< 7
	04/03/19 - 07/02/19	< 8	< 9
	07/02/19 - 10/02/19	< 7	< 6
	10/02/19 - 01/02/20	< 7	< 8
	MEAN	-	-
71	01/02/19 - 04/03/19	< 5	< 5
	04/03/19 - 07/02/19	< 8	< 7
	07/02/19 - 10/02/19	< 5	< 6
	10/02/19 - 01/02/20	< 6	< 7
	MEAN	-	-
72	01/02/19 - 04/03/19	< 6	< 4
	04/03/19 - 07/02/19	< 9	< 6
	07/02/19 - 10/02/19	< 6	< 6
	10/02/19 - 01/02/20	< 6	< 5
	MEAN	-	-
73	01/02/19 - 04/03/19	< 7	< 7
	04/03/19 - 07/02/19	< 7	< 6
	07/02/19 - 10/02/19	< 6	< 6
	10/02/19 - 01/02/20	< 8	< 7
	MEAN	-	-
111	01/02/19 - 04/03/19	< 7	< 6
	04/03/19 - 07/02/19	< 7	< 5
	07/02/19 - 10/02/19	< 7	< 5
	10/02/19 - 01/02/20	< 8	< 5
	MEAN	-	-
C	01/02/19 - 04/03/19	< 6	< 5
	04/03/19 - 07/02/19	< 9	< 7
	07/02/19 - 10/02/19	< 7	< 5
	10/02/19 - 01/02/20	< 7	< 5
	MEAN	-	-

C-13 2019 OCGS AREOR REVISION 12/01/20

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APPENDIX G

ANNUAL RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM REPORT (ARGPPR)

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Docket No: 50-219

OYSTER CREEK GENERATING STATION
UNIT 1

Annual Radiological
Groundwater Protection Program Report

1 January through 31 December 2020

Prepared By
Teledyne Brown Engineering
Environmental Services

HOLTEC
DECOMMISSIONING
INTERNATIONAL

Oyster Creek Generating Station
Forked River, NJ 08731

April 26, 2020

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Appendices

Appendix A Location Designation

Security-Related Information: Detailed maps of the Oyster Creek Generating Station have been withheld from public disclosure under 10 CFR 2.390 and N.J.S.A. 47:1A-1.1

Appendix B Data Tables

I. Summary and Conclusions

This report on the Radiological Groundwater Protection Program (RGPP) conducted for the Oyster Creek Generating Station (OCGS) by Holtec Decommissioning International (HDI) covers the period 01 January 2020 through 31 December 2020.

This report covers groundwater and surface water samples collected from the environment, both on and off station property in 2020. In 2020, 480 analyses were performed on 142 samples from 42 locations.

There were three inadvertent releases of contaminated water into the groundwater during 2009 resulting in a plume located west of the turbine building, which is monitored via a series of monitoring wells.

No gamma emitting radionuclides were detected at any of the 35 groundwater well sample locations. Gamma-emitting nuclide K-40 was detected at a concentration of 186 pCi/L at 1 of the 3 surface water locations analyzed during 2020.

In the case of tritium, HDI specified that the laboratory achieve a lower limit of detection 10 times lower than the drinking water limit specified by the United States Environmental Protection Agency (USEPA) (2,000 pCi/l versus 20,000 pCi/l). As expected, tritium was detected in groundwater samples, although tritium concentrations have decreased substantially since 2009. The 2020 tritium concentrations varied from <147 to 2,240 pCi/l. The well with the highest concentration was MW-57I.

Surface water samples were collected from onsite and offsite monitoring locations during 2020. Tritium was not detected in any of the 23 samples.

Strontium-89 (Sr-89) and Strontium-90 (Sr-90) were not detected in any groundwater samples during 2020.

Gross Alpha and Gross Beta analyses in the dissolved and suspended fractions were performed on groundwater samples in 2020. There were 42 samples taken from 20 groundwater well locations. Gross Alpha (dissolved) was detected in 12 samples. The concentrations ranged from 0.7 to 1.3 pCi/L. Gross Alpha (suspended) was detected in 14 samples and ranged from 1.8 to 18.4 pCi/L. Gross Beta (dissolved) was detected in 31 samples and ranged from 1.0 to 19.5 pCi/L. Gross Beta (suspended) was detected in 21 samples and ranged from 2.0 to 23.4 pCi/L.

“Hard-To-Detect” (HTD) analyses were performed on one groundwater sample in 2020. These analyses included americium-241 (Am-241), cerium-242 (Ce-242), cerium-243/244 (Ce-243/244), plutonium-238 (Pu-238), plutonium-239/240 (Pu-239/240), uranium-234 (U-234), uranium-235 (U-235), and uranium-238 (U-238). U-234 was detected at a concentration of 2.5 pCi/L and U-238 was detected at a concentration of 2.3 pCi/L All other HTD analyses were less than the MDC.

II. Introduction

On July 1st, 2019, ownership of the Oyster Creek Nuclear Generating Station and transfer of the license from Exelon Generation Company, LLC to Oyster Creek Environmental Protection, LLC (OCEP) as the licensed owner and Holtec Decommissioning International, LLC (HDI) as the licensed operator, was completed. OCEP and HDI are wholly-owned subsidiaries of Holtec International.

The Oyster Creek Nuclear Generating Station consisted of a single boiling water reactor (BWR) and turbine generator was capable of producing 650 megawatts of electricity. The Station operated under Nuclear Regulatory Commission (NRC) renewed facility operating license number DPR-16. Brackish water from Barnegat Bay is supplied to the circulating water system. The circulating water system is designed to supply a continuous flow of water from Barnegat Bay through the plant to remove the waste heat released by the power cycle in the Main Condenser. The circulating water system is comprised of the intake canal from Barnegat Bay to the plant, the Main Condenser Circulating Water System, the dilution plant, and the discharge canal to Barnegat Bay. The dilution plant portion of the system minimized the adverse effects of the thermal discharge on aquatic life in the discharge canal and Barnegat Bay.

The Station is located in the Atlantic Coastal Plain physiographic province. Topography in the region of the Station is a slightly undulating coastal plain having low relief. The land surface gradually rises from sea level at Barnegat Bay, which is located east of the Station, to approximately 50 feet above mean sea level (AMSL) 2 miles inland. This region of the coastal plain has numerous tidal marshes and is incised by easterly flowing streams and creeks. Elevations at the Station property west of Route 9 range from approximately 0 to 15 feet AMSL immediately adjacent to the intake and discharge canals to slightly more than 30 feet AMSL in the northwest portion of the Station property. The 150-acre developed portion of the Site located within the "horseshoe" formed by the intake and discharge canals west of Route 9 has an approximate average elevation of 20 feet AMSL. In the immediate vicinity of the intake and discharge canals, the Station property slopes steeply down to the canal. The average elevation of the surface water level in the intake and discharge canals is approximately 1-foot AMSL. The ground surface is relatively level except for the steep slopes at areas adjacent to the intake and discharge canals.

The three shallowest stratigraphic units in the vicinity of the Oyster Creek area in descending order are the Cape May Formation, the Cohansey Formation, and the Kirkwood Formation. Some of the Station structures are constructed to depths of approximately 50 feet below ground surface (bgs). Excavations were completed from grade, through the fill, Cape May Formation, Upper Clay, and into the Cohansey Formation during construction. Consequently, the bottoms of some Station structures are completed within the Cohansey Formation and some structures breach the Upper Clay.

The Cape May Formation regionally has an average thickness of 40 feet and at OCGS, the Cape May is described as a light gray to tan, medium- to fine-grained sand, with trace to some silt and occasional coarse sand. It is generally poorly compacted. The Cape May Formation varies from 0 to 21 feet in thickness based on historical boring logs. The variation principally is due to the varying amount of material excavated and replaced by fill during Station construction. When present, the thickness of the Cape May generally ranges from 15 to 20 feet thick. The base of the Cape May generally is defined by the presence of a dark clay unit referred to as the Upper Clay unit. The Upper Clay is a stiff to hard, gray, plastic organic clay containing inclusions (also described as lenses or partings) of dense fine sand with trace to some organic silt. The deposits of fine sand within the Upper Clay layer have high relative densities and occur as lenses or inclusions.

The Cohansey Formation is primarily composed of a light-colored, fine- to very coarse-grained quartzose sand with lenses of silt and clay. Although most borings at the Station do not penetrate the entire Cohansey Formation, this formation appears to be approximately 60 to 80 feet thick at OCGS. A clay sequence, referred to at the Station as the "Lower Clay", marks the base of the Cohansey, which generally is present to approximately 90 to 100 feet bgs. The lower clay is a dense gray medium- to fine-grained sand containing trace to some organic silt and layers or inclusions of very stiff to hard gray organic clay. The thickness of the lower clay is estimated to be approximately 10 to 20 feet in the vicinity of OCGS.

The Cohansey Formation is underlain by the Kirkwood Formation which consists of several stratigraphic units. The Kirkwood Formation is described as a medium- to fine-grained sand with trace silt. The thickness of this formation beneath the Station is unknown. The south domestic supply well terminates in the Kirkwood at a depth of 310 feet bgs. The Kirkwood thickness in Ocean County ranges from approximately 300 to 400 feet.

This report covers those analyses performed by Teledyne Brown Engineering (TBE) and Environmental Inc. (Midwest Labs) on samples collected in 2020.

A. Objectives of the RGPP

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

- Ensure that the site characterization of geology and hydrology provides an understanding of predominant ground water gradients based upon current site conditions
- Identify site risk based on plant design and work practices
- Evaluate all structures, systems and components (SSC) that contain or could contain licensed material and for which there is a credible mechanism for the licensed material to reach groundwater
- Evaluate work practices that involve licensed material and for which there is a credible mechanism for the licensed material to reach groundwater
- Perform on-site monitoring to ensure timely detection of inadvertent radiological releases to ground water
- Understand background concentrations of radioactive analytes outside of

the REMP, as required

- Evaluate return/re-use of previously discharged radioactive effluents in gaseous or liquid effluents that are returned from the environment to the operating nuclear power facility
- Ensure controls are established for the selection, installation and retirement of monitoring wells
- Perform remediation protocols to prevent migration of licensed material off-site and to minimize decommissioning impacts
- Ensure that records of leaks, spills, remediation efforts are retained and retrievable to meet the requirements of 10 CFR 50.75(g)
- Ensure periodic communications are held on the RGPP with the designated State/Local officials
- Ensure timely verbal and written reporting occurs if there is an inadvertent release of licensed materials to the soil, groundwater or surface water
- Document and report all applicable RGPP data
- Identify and resolve deficiencies via the Decommissioning Corrective Action Program
- Perform program oversight to ensure effective implementation of the voluntary RGPP

B. Implementation of the Objectives

The objectives identified have been implemented at the Oyster Creek Generating Station through compliance with approved procedures EN-AA-408-4000, Radiological Groundwater Protection Program Implementation, and site specific procedure EN-OC-408-4160, RGPP Reference Material, for Oyster Creek Generating Station.

C. Program Description

Samples for the OCGS site were collected for HDI by on-site personnel and Normandeau Associates, Inc. This section describes the general collection methods used to obtain environmental samples for the OCGS RGPP in 2020. Sample locations can be found in Table A–1, Appendix A.

1. Sample Collection

Samples of water are collected, managed, transported and analyzed in accordance with approved procedures. Both groundwater and surface water are collected. Sample locations, sample collection frequencies and analytical frequencies are controlled in accordance with approved station procedures. Contractor and/or station personnel are trained in the collection, preservation management, and shipment of samples, as well as in documentation of sampling events.

2. Sample Analysis

   Samples are analyzed in accordance with approved procedures that are based on industry standards.

3. Quality Control

   Analytical laboratories are subject to internal quality assurance programs, industry cross-check programs, nuclear industry audits, as well as being certified by the State of New Jersey.

4. Data Interpretation

   Station personnel review and evaluate all analytical data deliverables as data is received. Analytical data results are reviewed by both station personnel and independent consultants, including a hydrogeologist, for adverse trends or changes to hydrogeologic conditions.

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 the 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 10 days.

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. Also, tritium was released into the atmosphere from Chernobyl in 1986. 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 (He-3). This radioactive decay releases a beta particle (18.6 keV 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 describes the general analytical methodologies used by TBE to analyze the environmental samples for radioactivity for the Oyster Creek Generating Station RGPP in 2020. The sampling frequencies are increased if activity is detected.

In order to achieve the stated objectives, the current program includes the following analyses for groundwater, surface water, and precipitation water:

1. Gamma emitters
2. Strontium-89 and Strontium-90
3. Tritium
4. Gross Alpha (Dissolved and Suspended) and Gross Beta (Dissolved and Suspended)
5. Selected transuranics
6. Fe-55
7. Ni-63

B. Data Interpretation

The radiological data collected prior to Oyster Creek Generating Station becoming operational, as well as background data from publicly available databases, were used as a baseline with which these operational data were compared. For the purpose of this report, Oyster Creek 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 OCGS detection capabilities for environmental sample analysis.

   The minimum detectable concentration (MDC) 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 as 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. Uncertainty comes from factors such as calibration standards, sample volume/weight measurements, or sampling uncertainty. The uncertainty of a measurement created by statistical process (counting error) is reported as well as all sources of error (Total Propagated Uncertainty or TPU). Each result has two values calculated. Each counting result is reported and then followed with a plus or minus (±) result of 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.

C. Background Analysis

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 peaked in 1963 with the signing of the limited test ban treaty. The Canadian heavy water nuclear power reactors, other commercial power reactors, nuclear research and weapons production continue to influence tritium concentrations in the environment. Also, tritium was released into the atmosphere from Chernobyl in 1986.

b. Precipitation Data

Precipitation samples are routinely collected at stations around the world for the analysis of tritium and other radionuclides. One publicly available database that provides tritium concentrations in precipitation is the USEPA's RadNet database. RadNet provides tritium precipitation concentration data for samples collected at stations throughout the U.S. from 1978 up to and including 1996. Tritium concentrations in precipitation in New Jersey from 1978 through 1996 have ranged from 600 pCi/L in 1979 to 0 pCi/L in 1996, with an average of 185 pCi/L. Tritium concentrations in wells may still be above the 2000 pCi/l detection limit from the external causes described above. Water from previous years and decades is naturally captured in groundwater, so some well water sources today are affected by the surface water from the 1960s that was elevated in tritium.

c. Surface Water Data

Tritium concentrations are routinely measured in surface water bodies, including Oyster Creek and the Delaware River. New Jersey surface water data between 1978 and 1998 averaged 185 pCi/L.

The USEPA RadNet surface water data typically has a reported 'Combined Standard Uncertainty' of 2 standard deviations. This corresponds to a ± 36 to ±100 pCi/L confidence bound on each given reported measurement so that the typical surface water background data provided by RadNet may be subject to measurement uncertainty of up to 100 pCi/L.

The radio-analytical laboratory counts tritium results to an HDI-specified LLD of 200 pCi/L with a typical uncertainty of ±100 pCi/L. Therefore, sample results reported by TBE near this LLD cannot be distinguished from natural background concentrations in surface water.

IV. Results and Discussion

A. Program Exceptions

There were no program exceptions in 2020. All samples required by station procedures were collected as required.

B. Groundwater Results

Samples were collected from on-site locations in accordance with the station radiological groundwater protection program. As reported in the latest Hydrogeologic Investigation Report, groundwater flow is towards the intake and discharge canals.

Tritium

Samples from 35 locations were analyzed for tritium activity. Tritium was detected in 10 of 119 samples. The values ranged from <147 to 2,240 pCi/L. The well with the highest concentration was MW-57I.
(Table B–I.1, Appendix B)

Strontium

Samples collected from onsite wells are analyzed for hard-to-detect (HTD) isotopes, including strontium to characterize the source of any contaminant. Per station procedures, ongoing surveillance for HTD isotopes is required after initial negative findings to ensure a new source of contamination is not present.

Strontium-89 and Strontium-90 were not detected in any location sampled in 2020. (Table B-I.1, Appendix B)

Gross Alpha and Gross Beta (dissolved and suspended)

Gross Alpha and Gross Beta analyses in the dissolved and suspended fractions were performed on groundwater samples in 2020. There were 42 samples taken from 20 groundwater well locations. Gross Alpha (dissolved) was detected in 12 samples. The concentrations ranged from 0.7 to 1.3 pCi/L. Gross Alpha (suspended) was detected in 14 samples and ranged from 1.8 to 18.4 pCi/L. Gross Beta (dissolved) was detected in 31 samples and ranged from 1.0 to 19.5 pCi/L. Gross Beta (suspended) was detected in 21 samples and ranged from 2.0 to 23.4 pCi/L. (Table B-I.1, Appendix B)

Gamma Emitters

No gamma-emitting nuclides were detected in any groundwater sample in 2020. (Table B–I.2, Appendix B).

“Hard-To-Detect”

“Hard-To-Detect” (HTD) analyses were performed on one groundwater sample in 2020. U-234 was detected at a concentration of 2.5 pCi/L and

U-238 was detected at a concentration of 2.3 pCi/L All other HTD analyses were less than the MDC. (Table B-I.3, Appendix B)

C. Surface Water Results

Samples were collected from on-site locations in accordance with the station radiological groundwater protection program. Analytical results and anomalies are discussed below:

Tritium

Samples from 7 locations were analyzed for tritium activity. Tritium was found in 1 of 23 samples at a concentration of 211 pCi/L.
(Table B–II.1, Appendix B)

Gross Alpha and Gross Beta (dissolved and suspended)

Gross Alpha and Gross Beta analyses in the dissolved and suspended fractions are not required on a routine basis and were not analyzed in 2020.

Gamma Emitters

Gamma-emitting nuclide K-40 was detected at a concentration of 186 pCi/L in 1 of 3 samples analyzed during 2020. (Table B–II.2, Appendix B)

“Hard-To-Detect”

“Hard-To-Detect” analyses are not required on a routine basis and were not analyzed in 2020.

D. Precipitation Water Results
No precipitation samples were collected in 2020. (Table B–III.1, Appendix B)

E. Summary of Results – Inter-Laboratory Comparison Program

Inter-Laboratory Comparison Program results for TBE and Environmental Inc. (Midwest Labs) are presented in the 2020 Oyster Creek AREOR. This report is part of the AREOR.

F. Leaks, Spills, and Releases

There were no abnormal liquid releases during 2020.

G. Trends

Active remediation of tritium in groundwater due to the spills that occurred in 2009 was initiated in October 2010. Trending of the data due to active remediation is on-going. Continuous remediation was terminated in October 2019 with State of New Jersey concurrence. Overall, the station has seen a decreasing trend in tritium values to the point where ground water tritium is below the ODCM LLD (2,000 pCi/L) and the TBE lab MDL of 200 pCi/L in 33 monitoring wells.

H. Investigations

GHD Services Inc. performed an independent assessment of the tritium plume. The results of their assessment can be found in References 1, 2 and 3.

I. Actions Taken

1. Compensatory Actions

Active remediation of tritium in groundwater due to the spills that occurred in 2009 was initiated in October 2010. Due to the decrease in groundwater tritium as a result of the remediation project, continuous remediation was ceased in 2019. The Oyster Creek ODCM has provision to re-start remediation from this well, if necessary, via either continuous or batch discharge methods.

2. Installation of Monitoring Wells

The following wells were installed in 2010 to better characterize and monitor the tritium plume and site hydrology:

Well Number	Formation	Well Installation Date
W-58 I	Cohansey	July
W-59 I	Cohansey	March
W-60 I	Cohansey	July
W-61 I	Cohansey	July
W-62	Cape May	March
W-63 I	Cohansey	July
W-64	Cape May	March
W-65	Cape May	March
W-66 I	Cohansey	July
W-67	Cape May	March
W-68 I	Cohansey	July
W-69 I	Cohansey	July
W-70 I	Cohansey	July
W-71	Cape May	August
W-72	Cape May	August
W-73 Pumping well	Cohansey	October

3. Actions to Recover/Reverse Plumes

Oyster Creek Generating Station addressed the tritium in groundwater through continuous pumping of groundwater from of W-73 to the intake structure. Remediation of groundwater progressed to the stage where this program was terminated in the 4th quarter of 2019 with State of New Jersey concurrence. Should groundwater tritium levels regress initiating an adverse trend, the ODCM has provisions to restore ground water remediation using well 73 in batch or continuous mode.

V. References

1. Conestoga Rovers and Associates, Hydrogeologic Investigation Report, Fleetwide Assessment, Oyster Creek Generating Station, Forked River, New Jersey, Ref. No. 055875 (6), April 2011
2. Conestoga Rovers and Associates, Site Investigation Report, Oyster Creek Generating Station, Forked River, New Jersey, Ref. No. 055875 (4), August 2009
3. Conestoga Rovers and Associates, Remedial Investigation Workplan, Oyster Creek Generating Station, Forked River, New Jersey, Ref. No. 055875 (5), October 2009

APPENDIX A

LOCATION DESIGNATION

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TABLE A-1: Radiological Groundwater Protection Program - Sampling Locations, Oyster Creek Generating Station, 2020

Oyster Creek Generating Station RGPP Sample Point List

Sample Identification Number	Location	Well GPS Coordinates (Northing/Easting)	Depth (ft)	RGPP Sample Point Designation	Tritium Alert Value	Aquifer or Water Body Monitored
MW-1A-2A	SW of MFOT Moat	357380.76 575043.44	24.0	D	2,000 pCi/L	Cape May
MW-1I-1A	Roadway – NW of TWST	357598.17 574412.70	19.0	D	2,000 pCi/L	Cape May
MW-1I-2A	Roadway – SE of TWST	357574.80 574493.50	17.5	D	2,000 pCi/L	Cape May
MW-15K-1A	Roadway - Intake	357297.90 574469.50	19.0	D	2,000 pCi/L	Cape May
MW-16D	Yard – W of MAC Building	357573.30 574746.50	25.0	D	2,000 pCi/L	Cape May
SW-1	Intake Canal	N/A	N/A	SW	2,000 pCi/L	Surface Water
SW-2	RT 9 South Bridge	N/A	N/A	SW	2,000 pCi/L	Surface Water
SW-3	Fire Pond	N/A	N/A	SW	2,000 pCi/L	Surface Water
W-1A	North Yard Area	358311.70 574679.00	50.0	B	2,000 pCi/L	Cohansey
W-3	Intake – Access Road	357173.00 574499.10	24.0	D	2,000 pCi/L	Cape May
W-4	Intake – Access Road	357176.40 574497.70	55.0	D	2,000 pCi/L	Cohansey
W-4A	SE of OCAB Building	356913.30 575387.10	50.0	B	2,000 pCi/L	Cohansey
W-5	NW Yard area, near Fire Water Tank	357510.95 574374.05	20.5	D	2,000 pCi/L	Cape May
W-6	NW Yard – near Fire Water Tank	357514.02 574373.77	52.0	D	2,000 pCi/L	Cohansey
W-9	Roadway – NE of SAS Building	357289.29 574892.74	20.0	D	2,000 pCi/L	Cape May
W-9	Roadway – NE of SAS Building	357289.29 574892.74	20.0	D	2,000 pCi/L	Cape May
W-10	NW of SAS Building	357286.29 574890.61	60.0	D	2,000 pCi/L	Cape May
W-12	Yard – NW of DWPC Building	357669.10 574755.60	20.0	D	2,000 pCi/L	Cape May
W-13	Yard – NW of DWPC Building	357666.00 574755.90	50.0	D	2,000 pCi/L	Cape May
W-14	Yard – SW of Warehouse	357702.41 575018.75	53.0	D	2,000 pCi/L	Cape May
W-15	Yard – SW of Warehouse	357705.83 575017.70	20.0	D	2,000 pCi/L	Cape May

TABLE A-1: Radiological Groundwater Protection Program - Sampling Locations, Oyster Creek Generating Station, 2020

Oyster Creek Generating Station RGPP Sample Point List

Sample Identification Number	Location	Well GPS Coordinates (Northing/Easting)	Depth (ft)	RGPP Sample Point Designation	Tritium Alert Value	Aquifer or Water Body Monitored
W-16	Yard – E of LLRW	357967.26 574933.03	20.0	D	2,000 pCi/L	Cape May
W-24	South of TB W of old Machine Shop	357128.94 574650.77	19.0	D	2,000 pCi/L	Cape May
W-34	South of TB W of old Machine Shop	357196.14 574649.43	40.0	D	2,000 pCi/L	Cohansey
MW-52	Near Intake Structure	357400.90 574353.00	20.0	D	2,000 pCi/L	Cape May
MW-53	Near end of CW discharge piping	357272.80 574447.60	20.0	D	2,000 pCi/L	Cape May
MW-54	Near Intake Structure	357276.20 574311.70	20.0	E	2,000 pCi/L	Cape May
MW-55	Between CST and Intake Structure	357354.88 574440.07	30.0	E	2,000 pCi/L	Cape May
MW-56I	By NaOCl tanks	357305.30 574465.50	52.0	E	2,000 pCi/L	Cohansey
MW-57I	Near Intake Structure	357343.71 574373.89	50.0	E	2,000 pCi/L	Cohansey
MW-59I	Intake Roadway – NW of CST	357422.14 574406.38	44.0	D	2,000 pCi/L	Cohansey
MW-61I	Between CST and Intake Structure	357328.64 574444.45	72.0	E	2,000 pCi/L	Cohansey
MW-62	NW Corner of Turbine Bldg	357467.93 574524.10	25.0	D	2,000 pCi/L	Cape May
MW-64	Near Intake Structure	357343.96 574377.88	25.0	E	2,000 pCi/L	Cape May
MW-65	Intake Roadway – NW of CST	357421.00 574402.55	25.0	D	2,000 pCi/L	Cape May
MW-67	West side of Turbine Bldg	357401.99 574540.38	25.0	E	2,000 pCi/L	Cape May
MW-68I	SE of Reactor Bldg	357323.83 574897.64	100.0	D	2,000 pCi/L	Cohansey
MW-71	S of Reactor Bldg	357365.52 574841.89	25.0	D	2,000 pCi/L	Cape May
MW-72	N of Reactor Bldg	357549.87 574788.52	25.0	D	2,000 pCi/L	Cape May

KEY: B = Background D = Detection E = Elevated I = Idle/Standby
P = Plume L = Long-Term Shutdown SW = Surface Water

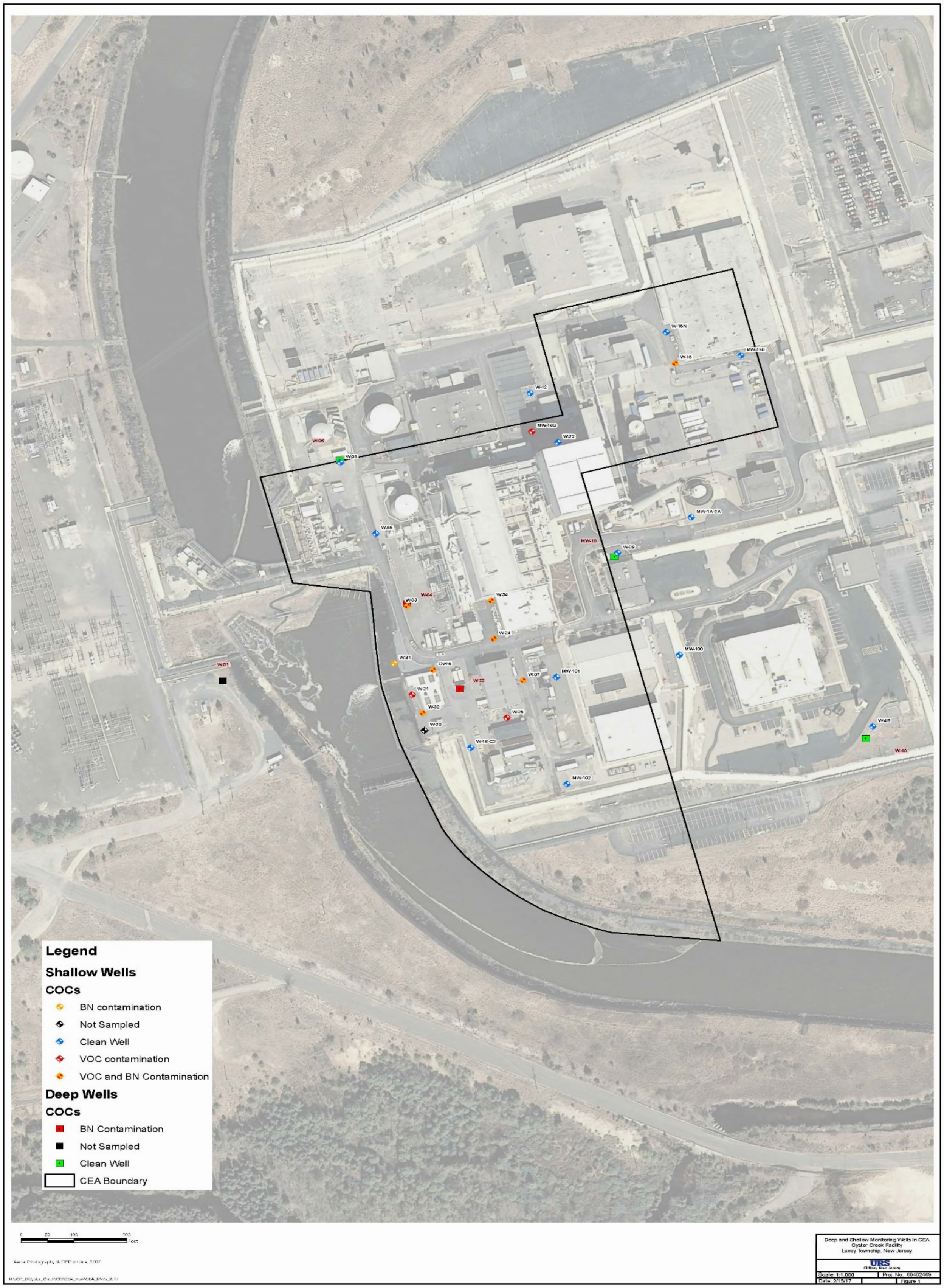

Figure A-1
Sampling Locations – Selected Cohansey
and Cape May Formation Wells,
Oyster Creek Generating Station, 2020

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APPENDIX B

DATA TABLES

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TABLE B-I.1 CONCENTRATIONS OF TRITIUM, STRONTIUM, GROSS ALPHA, AND GROSS BETA IN GROUNDWATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, OYSTER CREEK GENERATING STATION, 2020

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-1A-2A	05/21/20		< 176						
MW-1I-1A	01/28/20		< 172						
MW-1I-1A	05/20/20		< 171	< 7.7	< 0.8	< 0.4	1.8 ± 1.0	2.4 ± 0.6	< 1.6
MW-1I-1A	08/18/20		< 148						
MW-1I-1A	10/14/20		< 176						
MW-1I-2A	01/28/20		< 169						
MW-1I-2A	05/20/20		< 179	< 3.2	< 0.8	< 0.3	< 0.6	1.0 ± 0.5	< 1.7
MW-1I-2A	08/18/20		< 152						
MW-1I-2A	10/14/20		< 177						
MW-15K-1A	01/28/20		< 179	< 7.8	< 0.8	< 1.4	< 3.7	< 2.7	7.9 ± 3.3
MW-15K-1A	05/19/20		< 171	< 4.0	< 0.6	< 0.8	4.2 ± 1.2	2.7 ± 1.2	2.9 ± 1.3
MW-15K-1A	08/18/20		< 181	< 6.5	< 0.8	0.7 ± 0.4	5.9 ± 2.5	< 1.2	6.1 ± 2.3
MW-15K-1A	10/13/20		< 171	< 7.5	< 0.8	< 0.6	< 3.6	3.1 ± 0.9	10.7 ± 2.8
MW-16D	01/29/20		< 171						
MW-16D	05/20/20		< 174	< 4.3	< 0.7	< 0.7	< 0.6	2.5 ± 0.8	< 1.7
MW-16D	05/20/20	*Duplicate*	< 180	< 3.9	< 0.7	< 0.7	< 0.6	2.5 ± 0.8	< 1.7
MW-16D	05/20/20	*EIML*	< 157	< 0.5	< 0.5	< 0.8	*(1)*		
MW-16D	08/19/20		< 151						
MW-16D	10/13/20		< 177						
MW-52	05/19/20		< 176						
MW-53	05/19/20	*Duplicate*	< 179						
MW-54	05/19/20		283 ± 120						
MW-55	01/28/20		< 175	< 5.7	< 0.9	< 0.7	< 1.3	1.8 ± 0.6	2.0 ± 1.2
MW-55	05/19/20		< 179	< 3.2	< 0.8	< 0.4	< 1.8	1.3 ± 0.7	3.4 ± 1.8
MW-55	08/18/20		< 185	< 6.0	< 0.7	< 0.4	< 0.7	1.4 ± 0.6	< 1.5
MW-55	10/13/20		< 184	< 6.6	< 0.8	< 0.6	< 1.1	1.3 ± 0.6	< 1.5
MW-56I	01/28/20		< 178	< 6.9	< 0.8	< 0.6	1.9 ± 1.1	4.5 ± 0.8	< 1.6
MW-56I	05/19/20		< 177	< 6.0	< 0.9	< 0.3	< 1.4	4.1 ± 0.7	< 2.2
MW-56I	08/18/20		458 ± 130	< 2.8	< 0.7	< 0.4	< 0.7	3.0 ± 0.7	< 3.2
MW-56I	10/13/20		939 ± 166	< 6.8	< 0.8	< 0.9	< 1.2	4.5 ± 0.9	2.3 ± 1.1
MW-57I	01/28/20		668 ± 141	< 7.1	< 0.9	< 1.4	< 1.6	19.5 ± 1.6	4.0 ± 1.4
MW-57I	05/19/20		555 ± 133	< 5.8	< 0.8	< 0.7	5.7 ± 1.8	4.9 ± 1.2	6.9 ± 1.6
MW-57I	08/18/20		738 ± 148	< 5.1	< 0.7	< 0.6	2.4 ± 1.2	8.5 ± 1.1	4.0 ± 1.4
MW-57I	10/13/20		2240 ± 277	< 6.8	< 0.8	< 1.0	< 3.5	9.1 ± 1.4	11.6 ± 2.9
MW-59I	01/28/20		< 182						
MW-59I	05/19/20		< 181	< 8.5	< 0.7	< 0.3	< 1.6	1.6 ± 0.6	< 2.3
MW-59I	08/18/20		220 ± 122						
MW-59I	10/13/20		787 ± 144						
MW-61I	01/28/20		< 182						
MW-61I	05/19/20		< 179	< 5.3	< 0.7	< 0.4	< 1.9	2.0 ± 0.6	2.7 ± 1.8
MW-61I	05/19/20	*Duplicate*	< 178	< 6.0	< 0.8	< 0.3	< 1.8	2.0 ± 0.6	3.8 ± 1.8
MW-61I	05/19/20	*EIML*	< 157	< 0.6	< 0.6	< 0.5	*(1)*		
MW-61I	08/18/20		< 178						
MW-61I	10/14/20		< 176						
MW-62	01/28/20		< 180						
MW-62	05/20/20		< 180	< 6.5	< 0.8	< 0.8	< 1.5	11.4 ± 1.1	< 2.2
MW-62	08/18/20		< 181						
MW-62	10/14/20		< 171						
MW-64	01/28/20		< 178						
MW-64	01/28/20	*Duplicate*	< 179						
MW-64	01/28/20	*EIML*	< 153						
MW-64	05/19/20		< 180	< 5.7	< 0.5	< 1.7	17.5 ± 3.5	< 3.7	23.4 ± 3.6
MW-64	05/19/20	*Duplicate*	< 188	< 6.0	< 1.0	< 1.0	12.0 ± 3.3	< 4.0	15.7 ± 3.4
MW-64	05/19/20	*EIML*	< 157	< 0.5	< 0.5	< 1.3	*(1)*		

(1) Total Gross Alpha result reported (not dissolved/suspended)

TABLE B-I.1 CONCENTRATIONS OF TRITIUM, STRONTIUM, GROSS ALPHA, AND GROSS BETA IN GROUNDWATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, OYSTER CREEK GENERATING STATION, 2020

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-64	08/18/20		< 182						
MW-64	08/18/20	*Duplicate*	< 184						
MW-64	08/18/20	*EIML*	< 156						
MW-64	10/13/20		< 172						
MW-64	10/13/20	*Duplicate*	< 180						
MW-65	01/28/20		< 182	< 7.7	< 0.9	< 1.2	< 5.4	< 2.3	16.5 ± 4.3
MW-65	05/19/20		< 175	< 4.7	< 0.7	< 3.5	18.4 ± 5.2	< 8.3	22.4 ± 6.6
MW-65	08/18/20		< 182	< 7.6	< 0.7	< 2.0	16.6 ± 4.0	< 9.1	23.0 ± 6.5
MW-65	10/13/20		< 189	< 7.3	< 0.8	< 1.6	7.1 ± 2.0	< 2.3	11.4 ± 2.0
MW-67	01/28/20		< 179	< 8.3	< 0.9	< 1.0	< 2.0	< 0.9	5.4 ± 1.6
MW-67	05/20/20		< 180	< 6.3	< 0.8	< 0.5	< 1.8	4.0 ± 0.7	< 2.4
MW-67	08/18/20		< 182	< 7.4	< 0.6	< 0.3	< 0.2	4.1 ± 0.8	< 1.6
MW-67	10/14/20		197 ± 118	< 8.3	< 0.9	< 0.5	< 0.5	4.7 ± 0.7	< 1.7
MW-68I	08/19/20		< 178						
MW-71	01/29/20		< 182						
MW-71	01/29/20	*Duplicate*	< 178						
MW-71	01/28/20	*EIML*	< 153						
MW-71	05/21/20		< 180	< 7.6	< 0.8	< 0.7	< 2.3	< 1.3	< 3.0
MW-71	08/19/20		< 183						
MW-71	08/19/20	*Duplicate*	< 179						
MW-71	08/19/20	*EIML*	< 156						
MW-71	10/13/20		< 194						
MW-71	10/13/20	*Duplicate*	< 190						
MW-72	01/29/20		< 179						
MW-72	05/20/20		< 180	< 7.9	< 0.8	< 0.5	< 1.3	2.3 ± 0.7	< 2.2
MW-72	08/19/20		< 182						
MW-72	10/13/20		< 190						
W-1A	05/21/20		< 180						
W-3	01/28/20		< 176						
W-3	05/19/20		< 178	< 4.0	< 0.8	1.3 ± 0.8	< 1.0	7.6 ± 1.3	< 2.9
W-3	08/18/20		< 151						
W-3	10/13/20		< 176						
W-4	05/19/20		< 176						
W-4A	05/21/20		< 178						
W-5	01/28/20		< 171						
W-5	01/28/20	*Duplicate*	< 173						
W-5	01/28/20	*EIML*	< 153						
W-5	05/20/20		< 177	< 8.0	< 0.9	< 0.4	< 0.6	2.3 ± 0.7	< 1.7
W-5	05/20/20	*Duplicate*	< 173	< 3.8	< 0.7	< 0.4	< 0.6	2.6 ± 0.7	< 1.7
W-5	05/20/20	*EIML*	< 157	< 0.6	< 0.6	< 0.5	*(1)*		
W-5	08/18/20		< 152						
W-5	08/18/20	*Duplicate*	< 147						
W-5	08/18/20	*EIML*	< 156						
W-5	10/14/20		< 181						
W-5	10/14/20	*Duplicate*	< 189						
W-6	05/20/20		< 174						
W-9	01/29/20		< 171						
W-9	05/19/20		< 174	< 3.7	< 0.9	< 0.9	< 0.8	5.1 ± 1.1	< 1.9
W-9	08/19/20		< 150						
W-9	10/13/20		< 188						
W-10	05/19/20		< 174						
W-10	08/19/20		< 149						
W-12	01/29/20		< 174						
W-12	05/20/20		< 170	< 3.5	< 0.7	< 1.6	8.8 ± 4.2	4.1 ± 2.1	7.7 ± 1.5

(1) Total Gross Alpha result reported (not dissolved/suspended)

TABLE B-I.1 CONCENTRATIONS OF TRITIUM, STRONTIUM, GROSS ALPHA, AND GROSS BETA IN GROUNDWATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, OYSTER CREEK GENERATING STATION, 2020

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)
W-12	08/19/20	< 186						
W-12	10/13/20	< 194						
W-13	05/20/20	< 174						
W-14	05/20/20	< 180						
W-15	05/20/20	< 169						
W-16	05/20/20	< 178						
W-24	05/21/20	< 175						
W-34	01/28/20	< 178						
W-34	05/19/20	< 175	< 4.0	< 0.6	< 0.3	< 0.6	< 0.9	< 1.7
W-34	08/18/20	< 186						
W-34	10/13/20	< 198						

TABLE B-I.2 **CONCENTRATIONS OF GAMMA EMITTERS IN GROUNDWATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, OYSTER CREEK GENERATING STATION, 2020**

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	Zr-95	Cs-134	Cs-137
MW-1A-2A	05/21/20		< 70	< 130	< 7	< 9	< 16	< 7	< 13	< 13	< 9	< 7
MW-1I-1A	05/20/20		< 68	< 118	< 7	< 8	< 16	< 8	< 13	< 12	< 8	< 8
MW-1I-2A	05/20/20		< 60	< 126	< 6	< 7	< 11	< 5	< 12	< 11	< 7	< 7
MW-15K-1A	01/28/20		< 15	< 16	< 2	< 2	< 4	< 2	< 4	< 3	< 2	< 2
MW-15K-1A	05/19/20		< 48	< 74	< 5	< 5	< 11	< 5	< 10	< 10	< 6	< 5
MW-15K-1A	08/18/20		< 56	< 120	< 7	< 6	< 11	< 8	< 13	< 16	< 8	< 7
MW-15K-1A	10/13/20		< 26	< 32	< 3	< 3	< 7	< 4	< 7	< 6	< 3	< 3
MW-16D	05/20/20		< 51	< 85	< 6	< 5	< 11	< 7	< 14	< 10	< 6	< 7
MW-16D	05/20/20	*Duplicate*	< 59	< 96	< 5	< 5	< 11	< 6	< 10	< 10	< 5	< 5
MW-16D	05/20/20	*EIML*	< 22	< 87	< 4	< 2	< 4	< 2	< 7	< 4	< 3	< 3
MW-52	05/19/20		< 43	< 109	< 5	< 5	< 12	< 5	< 9	< 10	< 5	< 6
MW-53	05/19/20	*Duplicate*	< 49	< 100	< 5	< 7	< 9	< 7	< 12	< 10	< 5	< 5
MW-54	05/19/20		< 60	< 141	< 6	< 6	< 10	< 7	< 13	< 13	< 6	< 7
MW-55	01/28/20		< 17	< 20	< 2	< 2	< 4	< 2	< 4	< 3	< 2	< 2
MW-55	05/19/20		< 48	< 84	< 5	< 5	< 12	< 7	< 12	< 11	< 6	< 6
MW-55	08/18/20		< 69	< 129	< 6	< 7	< 17	< 8	< 14	< 12	< 8	< 7
MW-55	10/13/20		< 30	< 28	< 3	< 3	< 6	< 4	< 7	< 6	< 4	< 4
MW-56I	01/28/20		< 16	< 16	< 2	< 2	< 4	< 2	< 4	< 3	< 2	< 2
MW-56I	05/19/20		< 56	< 38	< 6	< 7	< 16	< 6	< 15	< 12	< 8	< 7
MW-56I	08/18/20		< 53	< 131	< 6	< 5	< 12	< 8	< 11	< 11	< 6	< 7
MW-56I	10/13/20		< 26	< 32	< 3	< 3	< 6	< 3	< 7	< 5	< 3	< 3
MW-57I	01/28/20		< 16	< 18	< 2	< 2	< 3	< 2	< 3	< 3	< 2	< 2
MW-57I	05/19/20		< 49	< 106	< 5	< 6	< 11	< 4	< 9	< 10	< 6	< 6
MW-57I	08/18/20		< 55	< 65	< 6	< 5	< 13	< 7	< 11	< 12	< 8	< 6
MW-57I	10/13/20		< 23	< 44	< 3	< 3	< 5	< 2	< 5	< 4	< 3	< 3
MW-59I	05/19/20		< 61	< 120	< 5	< 5	< 15	< 6	< 12	< 11	< 6	< 7
MW-61I	05/19/20		< 40	< 101	< 5	< 6	< 12	< 5	< 8	< 9	< 5	< 4
MW-61I	05/19/20	*Duplicate*	< 56	< 144	< 7	< 7	< 14	< 8	< 12	< 14	< 7	< 7
MW-61I	05/19/20	*EIML*	< 25	< 76	< 3	< 3	< 3	< 2	< 3	< 3	< 2	< 3
MW-62	05/20/20		< 54	< 122	< 6	< 7	< 15	< 6	< 14	< 9	< 6	< 6
MW-64	05/19/20		< 17	< 19	< 2	< 2	< 4	< 2	< 4	< 3	< 2	< 2
MW-64	05/19/20	*Duplicate*	< 40	< 99	< 5	< 4	< 10	< 5	< 10	< 8	< 5	< 5
MW-64	05/19/20	*EIML*	< 18	< 41	< 2	< 2	< 4	< 1	< 4	< 4	< 2	< 2
MW-65	01/28/20		< 15	< 15	< 2	< 2	< 4	< 2	< 3	< 3	< 2	< 2
MW-65	05/19/20		< 52	< 101	< 6	< 6	< 12	< 6	< 10	< 9	< 6	< 6
MW-65	08/18/20		< 58	< 85	< 6	< 7	< 10	< 7	< 10	< 11	< 8	< 6

TABLE B-I.2 **CONCENTRATIONS OF GAMMA EMITTERS IN GROUNDWATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, OYSTER CREEK GENERATING STATION, 2020**

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	Zr-95	Cs-134	Cs-137
MW-65	10/13/20		< 25	< 29	< 3	< 3	< 6	< 3	< 6	< 5	< 3	< 3
MW-67	01/28/20		< 15	< 30	< 2	< 2	< 4	< 2	< 4	< 3	< 2	< 2
MW-67	05/20/20		< 48	< 50	< 5	< 6	< 10	< 7	< 13	< 9	< 6	< 5
MW-67	08/18/20		< 59	< 65	< 6	< 7	< 16	< 8	< 13	< 10	< 6	< 8
MW-67	10/14/20		< 25	< 57	< 3	< 3	< 7	< 3	< 7	< 5	< 4	< 3
MW-71	05/21/20		< 54	< 130	< 6	< 6	< 10	< 9	< 15	< 11	< 6	< 6
MW-72	05/20/20		< 48	< 95	< 4	< 4	< 11	< 6	< 10	< 11	< 5	< 5
W-1A	05/21/20		< 60	< 107	< 8	< 6	< 15	< 7	< 14	< 13	< 7	< 7
W-3	05/19/20		< 57	< 106	< 5	< 7	< 13	< 6	< 14	< 10	< 7	< 6
W-4	05/19/20		< 60	< 81	< 6	< 7	< 16	< 7	< 12	< 10	< 7	< 5
W-4A	05/21/20		< 53	< 101	< 8	< 6	< 11	< 9	< 12	< 14	< 6	< 5
W-5	05/20/20		< 56	< 135	< 6	< 6	< 13	< 6	< 15	< 12	< 6	< 7
W-5	05/20/20	*Duplicate*	< 52	< 111	< 6	< 3	< 4	< 5	< 14	< 11	< 8	< 6
W-5	05/20/20	*EIML*	< 32	< 66	< 2	< 3	< 4	< 1	< 4	< 4	< 3	< 2
W-6	05/20/20		< 61	< 45	< 5	< 7	< 13	< 4	< 9	< 10	< 7	< 7
W-9	05/19/20		< 56	< 102	< 7	< 7	< 17	< 5	< 15	< 14	< 7	< 6
W-10	05/19/20		< 60	< 103	< 6	< 8	< 12	< 6	< 12	< 12	< 8	< 7
W-12	05/20/20		< 65	< 141	< 7	< 5	< 8	< 9	< 13	< 12	< 10	< 7
W-13	05/20/20		< 48	< 82	< 4	< 4	< 13	< 5	< 8	< 8	< 6	< 4
W-14	05/20/20		< 45	< 97	< 6	< 5	< 12	< 6	< 9	< 8	< 6	< 6
W-15	05/20/20		< 48	< 120	< 7	< 6	< 10	< 5	< 13	< 11	< 7	< 7
W-16	05/20/20		< 52	< 49	< 5	< 8	< 13	< 5	< 9	< 11	< 5	< 6
W-24	05/21/20		< 66	< 105	< 7	< 7	< 14	< 7	< 15	< 12	< 7	< 6
W-34	05/19/20		< 63	< 116	< 7	< 8	< 18	< 6	< 15	< 12	< 8	< 7

TABLE B-I.3 CONCENTRATIONS OF HARD-TO-DETECTS IN GROUNDWATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE		Am-241	Cm-242	Cm-243/244	Pu-238	Pu-239/240	U-234	U-235	U-238	Fe-55	Ni-63
MW-65	08/18/20		< 0.19	< 0.07	< 0.19	< 0.13	< 0.09	2.5 ± 0.7	< 0.19	2.3 ± 0.7	< 101	< 4.9
MW-65	08/18/20	*Reanalysis*						1.5 ± 0.4	< 0.08	2.1 ± 0.5		

TABLE B-II.1 CONCENTRATIONS OF TRITIUM IN SURFACE WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER + 2 SIGMA

SITE	COLLECTION DATE	H-3
SECURITY STORM DRAIN	03/09/20	< 192
SEWER PIT	01/27/20	< 200
SEWER PIT	04/14/20	< 173
SEWER PIT	07/17/20	< 189
SEWER PIT	10/02/20	< 195
STORM DRAIN EAST	01/27/20	< 190
STORM DRAIN EAST	08/17/20	< 179
STORM DRAIN EAST	10/13/20	< 188
STORM DRAIN OUTFALL #2	01/15/20	< 193
STORM DRAIN OUTFALL #2	03/09/20	< 191
STORM DRAIN OUTFALL #2	08/17/20	< 186
STORM DRAIN OUTFALL #2	10/12/20	< 197
SW-1	01/27/20	< 184
SW-1	05/18/20	< 179
SW-1	08/17/20	< 180
SW-1	10/12/20	< 191
SW-2	01/27/20	< 176
SW-2	05/18/20	< 192
SW-2	08/17/20	< 182
SW-2	10/12/20	< 185
SW-3	01/27/20	< 194
SW-3	05/18/20	< 188
SW-3	08/17/20	< 183
SW-3	10/12/20	< 189

TABLE B-II.2

CONCENTRATIONS OF GAMMA EMITTERS IN SURFACE WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, OYSTER CREEK GENERATING STATION, 2020

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	Zr-95	Cs-134	Cs-137
SW-1	05/18/20	< 25	186 ± 48	< 3	< 3	< 7	< 3	< 6	< 5	< 4	< 3
SW-2	05/18/20	< 27	< 50	< 2	< 3	< 6	< 3	< 6	< 6	< 3	< 3
SW-3	05/18/20	< 27	< 54	< 3	< 3	< 7	< 3	< 6	< 6	< 3	< 3

TABLE B-II.3 CONCENTRATIONS OF HARD TO DETECTS IN SURFACE WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE	Am-241	Cm-242	Cm-243/244	Pu-238	Pu-239/240	U-234	U-235	U-238	Fe-55	Ni-63

NONE FOR 2020

TABLE B-III.1 CONCENTRATIONS OF TRITIUM IN PRECIPITATION WATER SAMPLES COLLECTED AS PART OF THE RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM, OYSTER CREEK GENERATING STATION, 2020

RESULTS IN UNITS OF PCI/LITER + 2 SIGMA

SITE	COLLECTION DATE	H-3

NONE FOR 2020