NEXTera® ENERGY
POINT BEACH

April 27, 2020

NRC 2020-0009
10 CFR 72.44
TS 5.6.2

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Point Beach Nuclear Plant, Units 1 and 2
Dockets 50-266, 50-301 and 72-005
Renewed License Nos. DPR-24 and DPR-27

2019 Annual Monitoring Report

Enclosed is the Annual Monitoring Report for PBNP Units 1 and 2, for the period January 1 through December 31, 2019.

This letter contains no new regulatory commitments and no revisions to existing regulatory commitments.

Sincerely,
NextEra Energy Point Beach, LLC

Eric Schultz
Licensing Manager

Enclosure

cc: Administrator, Region III, USNRC
Project Manager, Point Beach Nuclear Plant, USNRC
Resident Inspector, Point Beach Nuclear Plant, USNRC
PSCW
American Nuclear Insurers
WI Division of Public Health, Radiation Protection Section
Office of Nuclear Material Safety and Safeguards, USNRC

ENCLOSURE

ANNUAL MONITORING REPORT 2019

NEXTERA ENERGY POINT BEACH, LLC
POINT BEACH NUCLEAR PLANT

DOCKETS 50-266 (UNIT 1), 50-301 (UNIT 2), 72-005 (ISFSI)
RENEWED LICENSES DPR-24 and DPR-27

January 1, 2019 through December 31, 2019

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY

The Annual Monitoring Report for the period from January 1, 2019, through December 31, 2019, is submitted in accordance with Point Beach Nuclear Plant (PBNP) Units 1 and 2, Technical Specification 5.6.2 and filed under Dockets 50-266 and 50-301 for Renewed Facility Operating Licenses DPR-24 and DPR-27, respectively. It also contains results of monitoring in support of the Independent Spent Fuel Storage Installation (ISFSI) Docket 72-005. The report presents the results of effluent and environmental monitoring programs, solid waste shipments, non-radioactive chemical releases, and circulating water system operation.

During 2019, the following Curies (Ci) of radioactive material were released via the liquid and atmospheric pathways:

	Liquid	Atmospheric
Tritium (Ci)	630	70.1
[1]Particulate (Ci)	0.0621	0.00004
Noble Gas (Ci)	0.0153	0.541
C-14[2]	0.034	11.73

[1]Atmospheric particulate includes radioiodine (I-131 - I-133).
[2]Liquid is measured, atmospheric is calculated.

For the purpose of compliance with the effluent design objectives of Appendix I to 10 CFR 50, doses from effluents are calculated for the hypothetical maximally exposed individual (MEI) for each age group and compared to the Appendix I objectives. Doses less than or equal to the Appendix I values are considered to be evidence that PBNP releases are as low as reasonably achievable (ALARA) and comply with the EPA's limits in 40CFR190. The maximum annual calculated doses in millirem (mrem) or millirad (mrad) are shown below and compared to the corresponding design objectives of 10 CFR 50, Appendix I.

LIQUID RELEASES

Dose Category	Calculated Dose	Appendix I Dose	% Appendix I
Whole body dose	0.00173 mrem	6 mrem	0.029
Organ dose	0.00290 mrem	20 mrem	0.015

ATMOSPHERIC RELEASES

Dose Category	Calculated Dose	Appendix I Dose	% Appendix I
Particulate organ dose	0.00874 mrem	30 mrem	0.029
Noble gas beta air dose	0.0000347 mrad	40 mrad	0.000087
Noble gas gamma ray air dose	0.0000986 mrad	20 mrad	0.00049
Noble gas dose to the skin	0.000137 mrem	30 mrem	0.00046
Noble gas dose to the whole body	0.0000934 mrem	10 mrem	0.00093

The results show that during 2019, the doses from PBNP effluents were ≤0.029% of the Appendix I design objectives. This is slightly lower than the 2018 results of 0.039%. Therefore, operation of the PBNP radwaste treatment system continues to be ALARA.

A survey of land use with respect to the location of dairy cattle was made pursuant to Section 12.2.5 of the PBNP ODCM. As in previous years, no dairy cattle were found to be grazing at the site boundary. Therefore, the assumption that cattle graze at the site boundary used in the evaluation of doses from PBNP effluents remains conservative. Of the sixteen compass sectors around PBNP, six are over Lake Michigan. A land use census (LUC) of the remaining ten sectors over land identifies any changes in the closest garden, occupied dwelling, and dairy in each sector. The 2017 LUC results confirm the assumption that, for the purpose of calculating effluent doses, the maximally exposed person lives at the south boundary remains conservative.

The 2019 Radiological Environmental Monitoring Program (REMP) collected 755 individual samples for radiological analyses. Quarterly composites of weekly air particulate filters generated an additional 24 samples and quarterly composites of monthly lake water samples resulted in a further 16 samples. This yielded a total of 795 samples. The ambient radiation measurements in the vicinity of PBNP and the ISFSI were conducted using 147 sets of thermoluminescent dosimeters (TLDs).

Air monitoring from six different sites did not reveal any effect from Point Beach effluents.

Terrestrial monitoring consisting of soil, vegetation, crops, and milk found no influence from PBNP. Similarly, samples from the aquatic environment, consisting of lake and well water, and fish revealed no buildup of PBNP radionuclides released in liquid effluents. (No algae were available in 2019). Therefore, the data shows no environmental effect from plant operation.

No new dry storage units were added to the ISFSI in 2019. The total number is 50 dry storage casks: 16 ventilated, vertical storage casks (VSC-24) and 34 NUHOMS®, horizontally stacked storage modules. The subset of the PBNP REMP samples used to evaluate the environmental impact of the PBNP ISFSI showed no environmental impact from its operation.

The environmental monitoring conducted during 2019 confirmed that the effluent control program at PBNP ensured a minimal impact on the environment.

One-hundred-sixty-seven (167) samples were analyzed for tritium as part of the groundwater protection program (GWPP). These samples came from drinking water wells, monitoring wells, yard drain outfalls, yard manholes, surface water on site, the sump for the subsurface drainage system (SSD - located under the plant foundation), and four groundwater foundation integrity monitoring wells located in the facades. The results show no substantial change in tritium from previous years. No drinking water wells (depth >100 feet) have any detectable tritium. Tritium continues to be confined to the upper soil layer where the flow is toward the lake. Groundwater samples from wells in the vicinity of the remediated, former earthen retention pond continue to show low levels of tritium. Gamma scans of groundwater samples originating within the power block found no plant related gamma emitters. Façade well samples had tritium results within the expected ranges (~200 pCi/L).

The results of GWPP monitoring indicate no significant change from previous years.

Part A
EFFLUENT MONITORING

1.0 INTRODUCTION

The PBNP effluent monitoring program is designed to comply with federal regulations for ensuring the safe operation of PBNP with respect to releases of radioactive material to the environment and its subsequent impact on the public. Pursuant to 10 CFR 50.34a, operations should be conducted to keep the levels of radioactive material in effluents to unrestricted areas as low as reasonably achievable (ALARA). In 10 CFR 50, Appendix I, the Nuclear Regulatory Commission (NRC) provides the numerical values for what it considers to be the appropriate ALARA design objectives to which the licensee's calculated effluent doses may be compared. These doses are a small fraction of the dose limits specified by 10 CFR 20.1301 and lower than the Environmental Protection Agency (EPA) limits specified in 40 CFR 190.

10 CFR 20.1302 directs PBNP to make the appropriate surveys of radioactive materials in effluents released to unrestricted and controlled areas. Liquid wastes are monitored by inline radiation monitors as well as by isotopic analyses of samples of the waste stream prior to discharge from PBNP. Airborne releases of radioactive wastes are monitored in a similar manner. The appropriate portions of the radwaste treatment systems are used as required to keep both liquid and atmospheric releases ALARA. Prior to release, results of isotopic analyses are used to adjust the release rate of discrete volumes of liquid and atmospheric wastes (from liquid waste holdup tanks and from gas decay tanks) such that the concentrations of radioactive material in the air and water beyond PBNP are below the PBNP Technical Specification concentration limits for liquid effluents and release rate limits for gaseous effluents.

Solid wastes are shipped offsite for disposal at NRC licensed facilities. The amount of radioactivity in the solid waste is determined prior to shipment in order to determine the proper shipping configuration as regulated by the Department of Transportation and the NRC.

10 CFR 72.210 grants a general license for an Independent Spent Fuel Storage Installation (ISFSI) to all nuclear power reactor sites operating under 10 CFR 50. The ISFSI annual reporting requirement pursuant to 10 CFR 72.44(d)(3) is no longer applicable (Reference: 64 FR 33178). Any release of radioactive materials from the operation of the ISFSI must comply with the limits of Part 20 and Part 50 Appendix I design objectives. The dose criteria for effluents and direct radiation specified by 10 CFR 72.104 states that during normal operations and anticipated occurrences, the annual dose equivalent to any real individual beyond the controlled area must not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ. The dose from naturally occurring radon and its decay products are exempt. Because the loading of the storage casks occurs within the primary auxiliary building of PBNP, the doses from effluents due to the loading process will be assessed and quantified as part of the PBNP Radiological Effluent Control Program.

2.0 RADIOACTIVE LIQUID RELEASES

The radioactive liquid release path to the environment is via the circulating water discharge. A liquid waste treatment system in conjunction with administrative controls is used to minimize the impact on the environment and maintain doses to the public ALARA from the liquid releases.

2.1 Doses From Liquid Effluent

Doses from liquid effluent are calculated using the methodology of the Offsite Dose Calculation Manual (ODCM). These calculated doses use parameters such as the amount of radioactive material released, the total volume of liquid, the total volume of dilution water, and usage factors (e.g., water and fish consumption, shoreline and swimming factors). These calculations produce a conservative estimation of the dose. For compliance with 10 CFR 50, Appendix I design objectives, the annual dose is calculated to the hypothetical maximally exposed individual (MEI). The MEI is assumed to reside at the site boundary in the highest χ/Q sector and is maximized with respect to occupancy, food consumption, and other uses of this area. As such, the MEI represents an individual with reasonable deviations from the average for the general population in the vicinity of PBNP. A comparison of the calculated doses to the 10 CFR 50, Appendix I design objectives is presented in Table 2-1. The conservatively calculated dose to the MEI is a very small fraction of the Appendix I design objective.

Table 2-1
Comparison of 2019 Liquid Effluent Calculated Doses to 10 CFR 50 Appendix I Design Objectives

Annual Limit [mrem]	Highest Total Calculated Dose [mrem]	% of Design Objective
6 (whole body)	0.00173	0.029
20 (any organ)	0.00290	0.015

2.2 2019 Circulating Water Radionuclide Release Summary

Radioactive liquid releases via the circulating water discharge are summarized by individual source and total curies released on a monthly basis, semi-annual and annual totals (Table 2-2). These releases are composed of processed waste, wastewater effluent, and blowdown from Units 1 and 2. The wastewater effluent consists of liquid from turbine hall sumps, plant well house backwashes, sewage treatment plant effluent, water treatment plant backwashes, the Unit 1 and 2 facade sumps and the subsurface drainage system sump.

2.3 2019 Isotopic Composition of Circulating Water Discharges

The isotopic composition of circulating water discharges during the current reporting period is presented in Table 2-3. The noble gases released in liquids are reported with the airborne releases in Section 3.

The 2019 processed waste volume (Table 2-2) decreased from 2018 (9.21E+05 gallons to 5.93E+05 gallons). The total isotopic curie distribution of gamma emitters plus hard-to-detects from was 9.61E-02 Ci which is similar to what was observed in 2018 (9.56E-02 Ci). The total antimony in 2019 decreased from 8.21E-04Ci in comparison to 2018 (3.49E-02 Ci). By contrast, Zr-Nb increased to 1.04E-03 Ci in 2019 when compared to the 7.30E-04 Ci observed in 2018. The tin isotopes Sn-113/117m decreased from 1.93E-03 Ci in 2018 to 9.28E-04 Ci in 2019. The 2019 C-14 increased to 3.40E-02 Ci from 3.11E-02 Ci in 2018. No strontium isotopes (Sr-89, Sr-90, Sr-92) were discharged in 2019. Tritium decreased from 981 Ci in 2018 to 630 Ci in 2019.

2.4 Beach Drain System Releases Tritium Summary

Beach drain is the term used to describe the point at which the site yard drainage system empties onto the beach of Lake Michigan. These outfalls carry yard and roof drain runoff to the beach.

The plant foundation has a subsurface drainage system (SSD) around the external base of the foundation. This SSD relieves hydrostatic pressure on the foundation by draining water away from the foundation. The drainage pipes empty out onto the beach. In 2014, the SSD outfalls, designated as S-12 and S-13, were added to the beach drain sampling program. Their quarterly results are presented with the other beach drains.

The quarterly results from the monthly beach drain and SSD samples are presented in Table 2-4. The total monthly flow is calculated assuming that the flow rate at the time of sampling persists for the whole month. In 2019, no tritium was observed at the effluent LLDs. Tritium found in the beach drains is not included in the effluent totals unless it can be shown to be the result of a spill or similar event. Because the source of beach drain tritium has been determined to be recapture, including beach drain tritium in the effluent totals would be double counting (NRC RIS 2008-03, Return/re-use of previously discharged radioactive effluents).

The principle source of water for the beach drains is the yard drain system. Yard drain water sources are rain and snow melt containing recaptured tritium. During the winter natural melting is the principle source. (Additionally, various roof drains connect to the yard drain system. In addition to precipitation, the roof drains also carry condensate from various building AC units. A secondary source may be groundwater in leakage. This is evidenced by flow during periods of no precipitation.

Because there are no external storage tanks or piping that carries radioactive liquids, the main source of radioactivity for this system is recapture/washout of airborne tritium discharges via the yard drain system. Because of these various recapture sources, the beach drains also are sampled as part of the groundwater monitoring program. These results and other groundwater monitoring results are presented in Part D of this Annual Monitoring Report.

Table 2-2
Summary of Circulating Water Discharge
January 1, 2019 through December 31, 2019

							Total							Total	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jan-Jun	Jul	Aug	Sep	Oct	Nov	Dec	July-Dec	Total
Total Activity Released (Ci)															
Gamma Scan(+HTDs)[1]	8.53E-03	4.75E-02	2.58E-03	1.44E-02	4.97E-03	3.55E-03	8.15E-02	1.51E-03	4.70E-03	4.20E-04	1.35E-03	1.03E-03	5.62E-03	1.46E-02	9.61E-02
Gross Alpha	2.23E-06	ND	ND	ND	3.43E-07	ND	2.57E-06	ND	ND	ND	ND	ND	ND	ND	2.57E-06
Tritium	4.52E+01	6.99E+01	1.39E+01	3.54E+01	4.45E+00	1.13E+02	2.82E+02	9.68E+00	1.28E+02	8.73E+00	8.36E+01	7.01E-02	1.18E+02	3.48E+02	6.30E+02
Strontium (89/90/92)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Noble Gases	1.46E-03	9.06E-03	5.36E-04	2.34E-03	ND	4.59E-04	1.39E-02	ND	4.03E-04	ND	3.51E-04	ND	7.33E-04	1.49E-03	1.53E-02
Total Vol Released (gal)															
Processed Waste	8.67E+04	1.29E+05	3.67E+04	1.55E+05	8.23E+03	3.75E+04	4.53E+05	2.20E+04	3.62E+04	1.31E+04	2.29E+04	0.00E+00	4.66E+04	1.41E+05	5.93E+05
Waste Water Effluent	3.65E+06	3.09E+06	3.39E+06	3.91E+06	3.35E+06	2.87E+06	2.03E+07	3.14E+06	3.31E+06	3.16E+06	3.75E+06	3.77E+06	4.04E+06	2.12E+07	4.14E+07
U1 SG Blowdown	2.67E+06	2.40E+06	2.00E+06	2.18E+06	4.43E+06	2.64E+06	1.63E+07	2.66E+06	2.57E+06	2.56E+06	2.82E+06	3.12E+06	2.75E+06	1.65E+07	3.28E+07
U2 SG Blowdown	2.65E+06	2.38E+06	2.66E+06	2.58E+06	2.89E+06	2.60E+06	1.58E+07	2.66E+06	3.01E+06	2.57E+06	2.55E+06	2.86E+06	2.67E+06	1.63E+07	3.21E+07
Total Gallons	9.05E+06	8.00E+06	8.09E+06	8.82E+06	1.07E+07	8.15E+06	5.28E+07	8.48E+06	8.93E+06	8.30E+06	9.14E+06	9.75E+06	9.50E+06	5.41E+07	1.07E+08
Total cc	3.43E+10	3.03E+10	3.06E+10	3.34E+10	4.04E+10	3.08E+10	2.00E+11	3.21E+10	3.38E+10	3.14E+10	3.46E+10	3.69E+10	3.59E+10	2.05E+11	4.05E+11
Dilution vol(cc)[2]	7.10E+13	6.41E+13	6.32E+13	5.84E+13	1.24E+14	1.23E+14	5.04E+14	1.27E+14	1.27E+14	1.23E+14	1.27E+14	1.23E+14	8.60E+13	7.12E+14	1.22E+15
Avg diluted discharge conc (µCi/cc)															
Gamma Scan (+HTDs)[1]	1.20E-10	7.41E-10	4.08E-11	2.47E-10	4.00E-11	2.89E-11		1.19E-11	3.71E-11	3.42E-12	1.06E-11	8.35E-12	6.54E-11		
Gross Alpha	3.14E-14	ND	ND	ND	2.77E-15	ND		ND	ND	ND	ND	ND	ND		
Tritium	6.37E-07	1.09E-06	2.20E-07	6.05E-07	3.59E-08	9.19E-07		7.63E-08	1.01E-06	7.11E-08	6.59E-07	5.71E-10	1.37E-06		
Strontium (89/90/92)	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND		
Noble Gases	2.06E-11	1.41E-10	8.48E-12	4.00E-11	ND	3.74E-12		ND	3.18E-12	ND	2.76E-12	ND	8.52E-12		
Max Batch Discharge Conc (µCi/cc)															
Tritium	3.26E-05	3.27E-05	1.31E-05	1.33E-05	3.12E-06	3.43E-05		5.53E-06	4.39E-05	8.44E-06	3.03E-05	NR	3.68E-05		
Gamma Scan	6.34E-10	1.51E-08	1.36E-09	9.54E-09	1.99E-09	3.84E-10		1.03E-10	8.66E-11	8.50E-11	1.03E-10	NR	1.71E-10		

1 HTDs include Fe-55, C-14, Ni-63, and Tc-99. Does not include strontium which is totaled separately.
2 Circulating water discharge from both units.
ND: means that the radionuclide was not identified in any samples and all analyses were performed with instrumentation meeting the lower limit of detection as required by the PBNP Offsite Dose Calculation Manual.
NR: means No Release during that month

Table 2-3
Isotopic Composition of Circulating Water Discharges (Ci)
January, 2019 through December 31, 2019

Nuclide	Jan	Feb	Mar	Apr	May	Jun	Total Jan-Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total July-Dec	Annual Total
H-3	4.52E+01	6.99E+01	1.39E+01	3.54E+01	4.45E+00	1.13E+02	2.82E+02	9.68E+00	1.28E+02	8.73E+00	8.36E+01	7.01E-02	1.18E+02	3.48E+02	6.30E+02
C-14	6.56E-03	1.61E-02	9.18E-04	2.22E-03	ND	1.99E-03	2.78E-02	ND	3.15E-03	ND	2.60E-04	ND	2.82E-03	6.23E-03	3.40E-02
F-18	8.99E-05	3.18E-04	2.80E-04	2.94E-04	1.63E-03	1.00E-03	3.61E-03	1.24E-03	1.10E-03	2.81E-04	8.07E-04	1.03E-03	1.32E-03	5.77E-03	9.38E-03
Cr-51	ND	ND	ND	2.44E-03	ND	ND	2.44E-03	ND	ND	ND	ND	ND	ND	ND	2.44E-03
Mn-54	6.89E-06	1.04E-03	8.76E-06	3.81E-05	ND	ND	1.09E-03	ND	ND	ND	ND	ND	ND	ND	1.09E-03
Fe-55	7.22E-04	4.73E-03	4.87E-04	7.02E-04	3.08E-04	ND	6.95E-03	ND	ND	ND	ND	ND	ND	ND	6.95E-03
Fe-59	ND	ND	ND	1.63E-04	ND	ND	1.63E-04	ND	ND	ND	ND	ND	ND	ND	1.63E-04
Co-57	ND	1.25E-04	9.42E-06	1.28E-05	1.04E-05	ND	1.58E-04	ND	ND	ND	1.79E-06	ND	7.09E-07	2.50E-06	1.60E-04
Co-58	2.28E-04	2.02E-03	1.79E-04	4.96E-03	1.87E-03	2.55E-04	9.51E-03	7.08E-05	1.65E-04	2.74E-05	4.62E-05	ND	2.41E-05	3.34E-04	9.84E-03
Co-60	4.81E-04	1.73E-02	2.34E-04	1.86E-03	9.31E-04	1.84E-04	2.10E-02	9.09E-05	1.05E-04	6.70E-05	8.25E-05	ND	1.13E-04	4.58E-04	2.15E-02
Ni-63	2.26E-04	9.26E-04	3.75E-04	3.28E-04	1.68E-04	3.83E-05	2.06E-03	1.08E-04	1.78E-04	4.47E-05	5.29E-05	ND	1.24E-03	1.62E-03	3.68E-03
Zn-65	ND	1.72E-04	ND	ND	ND	ND	1.72E-04	ND	ND	ND	ND	ND	ND	ND	1.72E-04
Se-75	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
As-76	ND	ND	ND	2.93E-05	ND	ND	2.93E-05	ND	ND	ND	ND	ND	ND	ND	2.93E-05
Sr-90	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr-92	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nb-95	ND	2.91E-04	ND	3.22E-04	ND	ND	6.13E-04	ND	ND	ND	ND	ND	ND	ND	6.13E-04
Nb-97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.35E-06	1.35E-06	1.35E-06
Zr-95	ND	1.53E-04	ND	2.14E-04	ND	ND	3.67E-04	ND	ND	ND	ND	ND	ND	ND	3.67E-04
Zr-97	ND	6.06E-05	ND	ND	ND	ND	6.06E-05	ND	ND	ND	ND	ND	ND	ND	6.06E-05
Tc-99	3.28E-05	1.17E-04	1.25E-05	3.16E-05	1.15E-05	7.94E-06	2.13E-04	ND	1.12E-05	ND	8.67E-05	ND	1.01E-04	1.99E-04	4.12E-04
Ag-110m	8.48E-05	3.02E-03	5.90E-05	8.80E-05	3.71E-05	ND	3.29E-03	ND	ND	ND	2.19E-06	ND	ND	2.19E-06	3.29E-03
Sn-113	ND	1.66E-04	ND	6.92E-05	ND	ND	2.35E-04	ND	ND	ND	ND	ND	ND	ND	2.35E-04
Sn-117m	2.70E-06	1.42E-05	5.90E-06	5.81E-04	ND	8.20E-05	6.86E-04	ND	ND	ND	6.62E-06	ND	ND	6.62E-06	6.92E-04
Sb-122	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sb-124	4.77E-05	4.08E-06	ND	2.89E-06	ND	ND	5.47E-05	ND	ND	ND	ND	ND	ND	ND	5.47E-05
Sb-125	5.08E-05	7.11E-04	4.69E-06	ND	ND	ND	7.66E-04	ND	ND	ND	ND	ND	ND	ND	7.66E-04
I-131	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
I-132	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Te-132	ND	ND	ND	3.05E-05	ND	ND	3.05E-05	ND	ND	ND	ND	ND	ND	ND	3.05E-05
Cs-136	ND	1.76E-04	5.21E-06	ND	ND	ND	1.81E-04	ND	ND	ND	ND	ND	ND	ND	1.81E-04
Cs-137	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.09E-06	2.09E-06	2.09E-06
Cs-138	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
La-140	ND	1.37E-05	ND	ND	ND	ND	1.37E-05	ND	ND	ND	ND	ND	ND	ND	1.37E-05
Xe-131m	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xe-133	1.45E-03	8.84E-03	5.34E-04	2.27E-03	ND	4.59E-04	1.36E-02	ND	4.01E-04	ND	3.50E-04	ND	7.33E-04	1.48E-03	1.50E-02
Xe-133m	1.22E-05	1.02E-04	ND	ND	ND	ND	1.14E-04	ND	ND	ND	ND	ND	ND	ND	1.14E-04
Xe-135	2.57E-06	1.19E-04	1.72E-06	6.39E-05	ND	ND	1.87E-04	ND	2.63E-06	ND	1.08E-06	ND	ND	3.71E-06	1.91E-04

ND: means that the radionuclide was not identified in any samples and all analyses were performed with instrumentation meeting the lower limit of detection as required by the PBNP Offsite Dose Calculation Manual.

Table 2-4
Beach and Subsoil System Drains - Tritium Summary
January 1, 2019 through December 31, 2019

	S-1	S-3	S-7	S-8	S-9	S-10	S-12	S-13
1st Qtr								
H-3 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Flow (gal)	2.58E+06	8.64E+05	0.00E+00	0.00E+00	3.89E+05	0.00E+00	0.00E+00	0.00E+00
2nd Qtr								
H-3 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Flow (gal)	3.29E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3rd Qtr								
H-3 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Flow (gal)	1.77E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.70E+04
4th Qtr								
H-3 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Flow (gal)	2.10E+06	2.01E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.46E+04	0.00E+00

2.6 Land Application of Sewage Sludge and Wastewater

In 1988, pursuant to 10 CFR 20.302(a), Point Beach received NRC approval for the disposal of sewage sludge, which may contain trace amounts of radionuclides, by land application on acreage within the site. Land application of sewage sludge is regulated by the Wisconsin Department of Natural Resources. Point Beach has not land applied sewage sludge for over a decade. Therefore, Point Beach has not renewed its WI DNR permit to dispose of sewage sludge in this manner.

There were no sludge or equalization basin disposals by land application during 2019. All disposals from the PBNP sewage treatment plant (STP) were done at the Manitowoc Sewage Treatment Plant. A total of 152,300 gallons in 27 shipments were sent to Manitowoc. All sludge and equalization basin discharges were analyzed to environmental LLDs. Naturally occurring radionuclides such as Ra-226 and K-40 were present in all samples. For the 27 shipments in 2019 the total Ra-226 and K-40 were 91.7 µCi and 116 µCi, respectively. Small concentrations of H-3 (not detectable – 317 pCi/L) were found in twenty-one (21) of the shipments for a total of 91.0 µCi. Based on the daily flow at the Manitowoc plant, the H-3 discharge concentration would be on the order of 0.112 pCi/L or 175,000 times lower than the EPA drinking water limit of 20,000 pCi/L.

The STP H-3 is attributable to groundwater in-leakage at the STP lift station whose volume is known to increase after a heavy rain or snow melt event. The STP is in the groundwater flow path from the retention pond area and the lake. The STP H-3 concentrations are comparable to those found in the retention pond area monitoring wells.

2.7 Carbon-14

Carbon-14 (C-14) is a naturally occurring radionuclide. Nuclear weapons testing in the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. Small amounts of C-14 also are produced by nuclear reactors, but the amounts produced are less than C-14 produced by weapons testing or that occurs naturally. Based on information from the NRC obtained at industry sponsored workshops, Point Beach began evaluating C-14 liquid discharges in 2009, prior to the issuance of Regulatory Guide 1.21 [RG 1.21], Rev 2 in June of 2009. Point Beach continues to analyze batch liquid waste discharges for C-14 and reporting the results in the Annual Monitoring Report.

The NRC requested that all nuclear plants report C-14 emissions beginning with the 2010 monitoring reports. Pursuant to NRC guidance in RG 1.21(Rev 2), evaluation of C-14 in liquid wastes is not required because the quantity released via this pathway is much less than that contributed by gaseous emissions. However, as stated above, Point Beach began C-14 analyses and reporting prior to the issuance of RG 1.21 (Rev 2). RG 1.21 states that a radionuclide is a principal effluent component if it contributes greater than 1% of the Appendix I design objective dose compared to the other radionuclides in the effluent type, or, if it is greater than 1% of the activity of all radionuclides in the effluent type. In this case, C-14 is compared to other (non-tritium or noble gases) radionuclides discharged in liquids.

For 2019, the monthly and total C-14 (3.40E-02 Ci) in liquid discharges is documented in Table 2-3. The 2019 amount of C-14 released makes up about 35% of the non-tritium radionuclides released in liquids (3.40E-02/9.61E-02).

The liquid C-14 dose contribution is included in the doses calculated for the hypothetically, maximally exposed individual (Table 2-1). Under the parameters and pathways used for the dose calculations, the C-14 dose contribution to the infant age group ranges from 0.194 to 0.196% of the dose to the whole body and the applicable organs except for bone, for which C-14 contributes 25.0% of the total dose. For the remaining age groups, the C-14 contributes roughly 88.3% of the bone dose and 8 – 27% of the dose to the whole body and to other organs specified in RG 1.109.

3.0 RADIOACTIVE AIRBORNE RELEASES

The release paths to the environment contributing to radioactive airborne release totals during this reporting period were the auxiliary building vent stack, the drumming area vent stack, the letdown gas stripper, the Unit 1 containment purge stack, and the Unit 2 containment purge stack. A gaseous radioactive effluent treatment system in conjunction with administrative controls is used to minimize the impact on the environment from the airborne releases and maintain doses to the public ALARA.

3.1 Doses from Airborne Effluent

Doses from airborne effluent are calculated for the maximum exposed individual (MEI) following the methodology contained in the PBNP ODCM. These calculated doses use parameters such as the amount of radioactive material released, the concentration at and beyond the site boundary, the average site weather conditions, and usage factors (e.g., breathing rates, food consumption). In addition to the MEI doses, the energy deposited in the air by noble gas beta particles and gamma rays is calculated and compared to the corresponding Appendix I design objectives. A comparison of the annual Appendix I design objectives for atmospheric effluents to the highest organ dose and the noble gas doses calculated using ODCM methodology is listed in Table 3-1. C-14 is not included in the Appendix I calculations because it is not an Appendix I radionuclide. The C-14 dose calculation has been required since 2010 (see Sections 3.4 through 3.6, below, for a more detailed description) and is treated separately. The comparison between airborne effluent doses with and without C-14 is shown in Table 3-4. The highest Appendix I dose is 8.74E-03 mrem for the child age group thyroid. Had C-14 been included, the child-bone dose would have been the highest at 2.43E-01 mrem. Even with the inclusion of C-14 the doses demonstrate that releases from PBNP to the atmosphere continue to be ALARA at 0.8% of the dose objective.

3.2 Radioactive Airborne Release Summary

Radioactivity released in airborne effluents for 2019 is summarized in Table 3-2. The particulate total increased from 3.27E-05 Ci in 2018 to 3.90E-05 Ci in 2019. Tritium decreased from 94.1 Ci in 2018 to 70.1 Ci in 2019. Noble gases decreased from 6.07E-01 Ci in 2018 to 5.41E-01 Ci in 2019.

3.3 Isotopic Airborne Releases

The monthly isotopic airborne releases for 2019, from which the airborne doses were calculated, are presented in Table 3-3. Carbon-14 is not included in Table 3-3 because it was calculated and not measured. C-14 is discussed in the following sections.

As in previous years the outage impact of the isotopic mixture is demonstrated in the comparison of the non-outage particulate releases. During March and April, eight different particulates were identified in the airborne effluent whereas in the non-outage months, at most one was found. Most were released via the open hatch on the 66-foot elevation of containment. The convective flow through the open hatch during purge is unfiltered. Although the flow is into the façade, there are two circumferential gaps around the façade. It is assumed that the release

into façade is transferred to the outside and therefore is treated as a release to the environment.

3.4 Carbon-14

C-14 is a naturally occurring radionuclide. Nuclear weapons testing of the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. Small amounts of C-14 also are produced by nuclear reactors as neutrons interact with the dissolved oxygen and nitrogen in the primary coolant. However, the amount produced by nuclear reactors is much less than that produced by weapons testing or that occur naturally.

The NRC has requested that nuclear plants report C-14 emissions. C-14 is a hard-to-detect radionuclide. It is not a gamma emitter and must be chemically separated from the effluent stream before it can be measured. Because nuclear plants currently are not equipped to perform this type of sampling, RG 1.21 allows for calculating C-14 discharges based on fission rates.

The Electric Power Research Institute (EPRI) developed the methodology for calculating C-14 generation and releases for the nuclear industry. The results were published as Technical Report 1021106 (December 2010), "Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents." In addition to neutron flux, the percent oxygen and nitrogen in the VCTs is used in the C-14 calculation as both gases contribute to the generation of C-14. Pursuant to NRC guidance (Regulatory Guide 1.21, Rev 2, p. 16, June 2009), most of the C-14 emissions from nuclear plant occur in the gaseous phase.

The Point Beach C-14 generation for 2019 was calculated using the EPRI guidance and the current core parameters resulting from the power uprate. The calculated amounts were 5.87 Ci for Unit 1 and 5.87 Ci for Unit 2 yielding a total of 11.73 Ci which is statistically the same as 2016 through 2018. The 2019 calculated total 11.73 Ci is roughly 345 times higher than the 3.40E-02 Ci of C-14 determined by analyses of composites from liquid waste batch discharges, steam generator blowdown, and other waste streams.

3.5 C-14 Airborne Effluent Dose Calculation

The dose from the airborne C-14 is dependent on its chemical form. The C-14 released to the atmosphere consists of both organic and inorganic species. Both the inorganic and organic C-14 contribute to the inhalation dose. Only the inorganic $^{14}CO_2$ species contributes to the dose from the ingestion of photosynthetically incorporated C-14. The organic forms such as methane, CH_4, are not photosynthetically active. For PWRs such as PBNP most of the gaseous C-14 occurs as methane, $^{14}CH_4$, not as carbon dioxide, $^{14}CO_2$.

The amount of $^{14}CO_2$ present in the PBNP airborne effluent has not been measured. However, such measurements have been made at a comparable PWR site similar to the PBNP design. The Ginna nuclear generating station is of similar design to PBNP. It is a Westinghouse 2-loop PWR of the same vintage as PBNP and approximately the same power (prior to the PBNP power uprate). Measurements at Ginna for 18 months in 1980 - 1981 (Kunz, "Measurement of

^{14}C Production and Discharge From the Ginna Nuclear Power Reactor," 1982) found that ten percent of the C-14 was discharged as $^{14}CO_2$. Therefore, 10% of the 11.73 Ci of the calculated C-14 for PBNP will be used in the ingestion dose calculations.

C-14 dose calculations were made using the dose factors and the methodology of Regulatory Guide 1.109. The inhalation dose factors were updated for the 2018 calculation due to a change in the χ/Q that is stated in the Point Beach ODCM Rev. 20. The inhalation dose was calculated using all of the C-14 calculated to be released. All the C-14 is used because whether the C-14 is in the form of $^{14}CO_2$ or one of the organic forms, such as CH_4, both would be inhaled and contribute to a lung dose.

For the other existing pathways, milk, meat, and produce, the dose depends upon the amount incorporated into biomass consumed by cattle and people: forage for cattle and produce for humans. Incorporation only occurs via photosynthesis. Photosynthesis only incorporates $^{14}CO_2$ and hence the use only of the 10% fraction of the total C-14 release for these pathways.

The airborne effluent C-14 dose calculations were made as described above. They were made for the MEI as explained in Section 2.1. This approach utilizes all the pathways that are applicable to a hypothetical person residing at the site boundary. Because C-14 is present as a gas, the pathways are milk, meat, and produce (vegetables, fruit, and grain) and the Regulatory Guide 1.109, Table E-5 usage factors applied to the calculation. As such, the resulting dose will be conservative in that the produce usage factor includes grain and fruit and these pathways do not exist in the vicinity of the point for which the C-14 doses are calculated. Furthermore, because leafy vegetables are included in the produce pathway, they are not used as a separate pathway because that would result in double accounting for leafy vegetable dose contribution.

Carbon-14 is not an Appendix I radionuclide. Therefore, airborne C-14 is not summed with the other airborne radioactive effluents for comparison of airborne effluent dose to the Appendix I dose objectives. However, the C-14 doses are presented and compared to the other radionuclide doses in Table 3-4.

3.6 C-14 Measurements

No C-14 measurements were made of PBNP airborne effluents. In 2010, C-14 was measured in crops grown on fields in the owner controlled area located in the highest χ/Q sector at the site's south boundary. One field is leased for feed corn by a dairy south of the plant. That dairy is part of the REMP. In an adjacent field soybeans are grown by another farmer. These two crops were sampled in this sector and as well as in a background location about 17 miles SW of the plant. Based on the measurement error, there was no statistical difference between the results obtained on site in the highest χ/Q sector as compared to the background site some 17 miles away (2013 AMR, Table 10-3). These results demonstrated that the dose from C-14 in Point Beach airborne effluents should not measurably increase the C-14 dose compared to that received from naturally occurring C-14 in plants (1 mrem: NCRP Report 93, Ionizing Radiation Exposure of the Population of the United States, 1987, p.12).

Table 3-1
Comparison of 2019 Airborne Effluent Calculated Doses to 10 CFR 50 Appendix I Design Objectives

Category	Annual Appendix I Design Objective	January-December Calculated Dose	Percent of Appendix I Design Objective
Particulate	30 mrem/organ	0.00874 mrem	0.029
Noble gas	40 mrad (beta air)	0.0000347 mrad	0.000087
Noble gas	20 mrad (gamma air)	0.0000986 mrad	0.00049
Noble gas	30 mrem (skin)	0.000137 mrem	0.00046
Noble gas	10 mrem (whole body)	0.0000934 mrem	0.00093

Table 3-2
Radioactive Airborne Effluent Release Summary
January 1, 2019, through December 31, 2019

							Total							Total	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jan-Jun	Jul	Aug	Sep	Oct	Nov	Dec	July-Dec	Total
Total Noble Gas (Ci)[1]	4.67E-02	3.73E-02	4.45E-02	2.82E-02	6.06E-02	5.84E-02	2.76E-01	4.68E-02	3.31E-02	4.19E-02	4.79E-02	4.13E-02	5.48E-02	2.66E-01	5.41E-01
Total Radioiodines (Ci)[2]	ND	ND	2.57E-05	2.68E-06	ND	ND	2.84E-05	ND	ND	ND	ND	ND	ND	ND	2.84E-05
Total Particulate (Ci)[3]	ND	ND	2.40E-06	6.94E-06	ND	1.28E-06	1.06E-05	ND	ND	ND	ND	ND	ND	ND	1.06E-05
Alpha (Ci)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Strontium(Ci)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
All other beta + gamma (Ci)	ND	ND	2.40E-06	6.94E-06	ND	1.28E-06	1.06E-05	ND	ND	ND	ND	ND	ND	ND	1.06E-05
Total Tritium (Ci)	7.17E+00	7.32E+00	8.30E+00	7.78E+00	7.40E+00	1.59E+00	3.96E+01	3.58E+00	4.54E+00	2.63E+00	3.11E+00	7.57E+00	9.12E+00	3.06E+01	7.01E+01
Max NG H'rly Rel.(Ci/sec)	4.38E-08	4.57E-08	4.41E-08	3.93E-08	7.01E-08	7.73E-08		4.18E-08	3.64E-08	4.28E-08	4.27E-08	5.09E-08	5.14E-08		

[1] Total noble gas (airborne releases) and activation gas Ar-41. It does not include the activation gas F-18 because of its short $T_{1/2}$ and because it is not an Appendix I radionuclide.
[2] Airborne radioiodines only include I-131 and I-133. Although for dose calculations iodines are grouped with particulates, for this reporting table they are separated from the particulate group.
[3] Total Particulate is the sum of alpha, strontium, and others. It does not include radioiodines or C-14. C-14 was calculated for the year and no monthly values are available.

ND: means that the radionuclide was not identified in any samples and all analyses were performed with instrumentation meeting the lower limit of detection as required by the PBNP Offsite Dose Calculation Manual.

TABLE 3-3
Isotopic Composition of Airborne Releases
January 1, 2019 through December 31, 2019

	Jan	Feb	Mar	Apr	May	Jun	Total	Jul	Aug	Sep	Oct	Nov	Dec	Total	Annual
Nuclide	(Ci)	(Ci)	(Ci)	(Ci)	(Ci)	(Ci)	Jan-Jun	(Ci)	(Ci)	(Ci)	(Ci)	(Ci)	(Ci)	July-Dec	Total
H-3	7.17E+00	7.32E+00	8.30E+00	7.78E+00	7.40E+00	1.59E+00	3.96E+01	3.58E+00	4.54E+00	2.63E+00	3.11E+00	7.57E+00	9.12E+00	3.06E+01	7.01E+01
F-18	ND	ND	ND	ND	ND	ND	ND	1.22E-06	ND	ND	6.17E-09	ND	ND	1.23E-06	1.23E-06
Ar-41	4.12E-02	3.27E-02	3.60E-02	2.29E-02	4.51E-02	3.99E-02	2.18E-01	4.20E-02	3.14E-02	3.99E-02	4.54E-02	3.86E-02	5.19E-02	2.49E-01	4.67E-01
Kr-85	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Kr-85m	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Kr-87	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Kr-88	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xe-131m	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xe-133	5.49E-03	4.60E-03	8.48E-03	5.30E-03	1.55E-02	1.85E-02	5.79E-02	4.78E-03	1.71E-03	2.00E-03	2.49E-03	2.71E-03	2.92E-03	1.66E-02	7.45E-02
Xe-133m	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xe-135	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xe-135m	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xe-138	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cr-51	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mn-54	ND	ND	3.79E-08	1.89E-08	ND	ND	5.68E-08	ND	ND	ND	ND	ND	ND	ND	5.68E-08
Fe-59	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Co-57	ND	ND	ND	1.70E-08	ND	ND	1.70E-08	ND	ND	ND	ND	ND	ND	ND	1.70E-08
Co-58	ND	ND	1.30E-06	4.35E-06	ND	ND	5.65E-06	ND	ND	ND	ND	ND	ND	ND	5.65E-06
Co-60	ND	ND	9.42E-07	2.54E-06	ND	ND	3.48E-06	ND	ND	ND	ND	ND	ND	ND	3.48E-06
Zn-65	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nb-95	ND	ND	3.60E-08	1.79E-08	ND	ND	5.39E-08	ND	ND	ND	ND	ND	ND	ND	5.39E-08
Zr-95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
I-131	ND	ND	3.73E-06	2.68E-06	ND	ND	6.41E-06	ND	ND	ND	ND	ND	ND	ND	6.41E-06
I-132	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
I-133	ND	ND	2.20E-05	ND	ND	ND	2.20E-05	ND	ND	ND	ND	ND	ND	ND	2.20E-05
Sb-124	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sb-125	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cs-137	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fe-55	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ni-63	ND	ND	8.21E-08	ND	ND	ND	8.21E-08	ND	ND	ND	ND	ND	ND	ND	8.21E-08
Tc-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr-90	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sn-113	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sn-117m	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Br-82	ND	ND	ND	ND	ND	1.28E-06	1.28E-06	ND	ND	ND	ND	ND	ND	ND	1.28E-06

ND: means that the radionuclide was not identified in any samples and all analyses were performed with instrumentation meeting the lower limit of detection as required by the PBNP Offsite Dose Calculation Manual.

Table 3-4
Comparison of Airborne Effluent Doses (Appendix I and C-14)

2019 Appendix I (Airborne Particulate + Tritium) Dose (mrem)

	Bone	Liver	T-WB	Thyroid	Kidney	Lung	GI-LLI	Skin
Adult	1.52E-05	5.55E-03	5.55E-03	5.59E-03	5.55E-03	5.55E-03	5.55E-03	1.01E-08
Teen	1.53E-05	6.11E-03	6.11E-03	6.16E-03	6.11E-03	6.11E-03	6.11E-03	1.01E-08
Child	1.64E-05	8.64E-03	8.64E-03	8.74E-03	8.64E-03	8.64E-03	8.64E-03	1.01E-08
Infant	1.55E-05	3.75E-03	3.74E-03	3.91E-03	3.75E-03	3.74E-03	3.75E-03	1.01E-08

Ann.Limit	3.00E+01
% Ann Lim	2.91E-02

2019 Carbon-14 Dose (mrem)

	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	6.75E-02	1.34E-02	1.34E-02	1.34E-02	1.34E-02	1.34E-02	1.34E-02	0.00E+00
Teen	1.06E-01	2.10E-02	2.10E-02	2.10E-02	2.10E-02	2.10E-02	2.10E-02	0.00E+00
Child	2.43E-01	4.84E-02	4.84E-02	4.84E-02	4.84E-02	4.84E-02	4.84E-02	0.00E+00
Infant	1.24E-01	2.64E-02	2.64E-02	2.64E-02	2.64E-02	2.64E-02	2.64E-02	0.00E+00

2019 Total Airborne Non-Noble Gas Dose [Particulate + H-3 + C-14 (mrem)]

	Bone	Liver	T-WB	Thyroid	Kidney	Lung	GI-LLI	Skin
Adult	6.75E-02	1.90E-02	1.90E-02	1.90E-02	1.90E-02	1.90E-02	1.90E-02	1.01E-08
Teen	1.06E-01	2.71E-02	2.71E-02	2.72E-02	2.71E-02	2.71E-02	2.71E-02	1.01E-08
Child	2.43E-01	5.71E-02	5.71E-02	5.72E-02	5.71E-02	5.71E-02	5.71E-02	1.01E-08
Infant	1.24E-01	3.01E-02	3.01E-02	3.03E-02	3.01E-02	3.01E-02	3.01E-02	1.01E-08

Ann.Limit	3.00E+01
% Limit	8.10E-01

The percent of limit is calculated using the highest total dose, the Child Age Group.

4.0 RADIOACTIVE SOLID WASTE SHIPMENTS

4.1 Types, Volumes, and Activity of Shipped Solid Waste

The following types, volumes, and activity of solid waste were shipped from PBNP for offsite disposal or burial during 2019. No Types C or D wastes were shipped. No irradiated fuel was shipped offsite. The volume, activity and type of waste are listed in Table 4-1.

Table 4-1
Quantities and Types of Waste Shipped from PBNP in 2019

Type of Waste	Quantity	Activity
A. Spent resins, filter sludge, evaporator bottoms, etc.	8.7 m^3	137.700 Ci
	307.4 ft^3	
B. Dry compressible waste, contaminated equipment, etc	151.8 m^3	0.377 Ci
	5360.0 ft^3	
C. Irradiated components, control rods, etc.	0.00 m^3	N/A Ci
	ft^3	
D. Other	0.0 m^3	N/A Ci

4.2 Solid Waste Disposition

There were five solid waste shipments from PBNP during 2019. The dates and destinations are shown in Table 4-2.

Table 4-2

2019 PBNP Radioactive Waste Shipments	
Date	**Destination**
03/06/19	Clive, UT
03/20/19	Oak Ridge, TN
04/04/19	Oak Ridge, TN
05/30/19	Oak Ridge, TN
12/12/19	Oak Ridge, TN

4.3 Major Nuclide Composition (by Type of Waste)

The major radionuclide content of the 2019 solid waste was determined by gamma isotopic analysis and the application of scaling factors for certain indicator radionuclides based on the measured isotopic content of representative waste stream samples. The estimated isotopic content is presented in Table 4-3. Only those radionuclides with detectable activity are listed.

Table 4-3
2019 Estimated Solid Waste Major Radionuclide Composition

Type A			Type B		
Nuclide	Activity (mCi)	Percent Abundance	Nuclide	Activity (mCi)	Percent Abundance
Total	1.37E+05	100.00%	Total	3.75E+02	100.00%
Ni-63	8.44E+04	61.45%	Co-60	8.93E+01	23.79%
Co-60	2.22E+04	16.12%	Zr-95	7.33E+01	19.52%
Co-58	1.14E+04	8.33%	Fe-55	5.71E+01	15.22%
Fe-55	5.82E+03	4.23%	Cr-51	3.90E+01	10.40%
Sb-125	4.15E+03	3.02%	Nb-95	3.89E+01	10.37%
Cs-137	3.85E+03	2.80%	Co-58	3.20E+01	8.52%
Mn-54	1.41E+03	1.03%	Ni-63	1.78E+01	4.75%
Ni-59	1.03E+03	0.75%	Sb-125	6.04E+00	1.61%
H-3	8.39E+02	0.61%	Mn-54	4.36E+00	1.16%
C-14	7.84E+02	0.57%	Sn-113	3.86E+00	1.03%
Co-57	7.09E+02	0.52%	Sb-124	2.85E+00	0.76%
Sb-124	2.79E+02	0.20%	Ni-59	2.05E+00	0.55%
Ag-110m	1.91E+02	0.14%	Fe-59	1.73E+00	0.46%
Pu-241	1.02E+02	0.07%	Zn-65	1.72E+00	0.46%
Zn-65	8.84E+01	0.06%	Ce-144	1.37E+00	0.37%
Ce-144	5.43E+01	0.04%	Ag-110m	1.37E+00	0.36%
Sn-113	4.53E+01	0.03%	Sn-117m	7.72E-01	0.21%
Sr-89	1.23E+01	0.01%	Tc-99	3.37E-01	0.09%
Tc-99	1.16E+01	0.01%	Te-123m	2.76E-01	0.07%
Sr-90	7.22E+00	0.01%	Cs-137	1.37E-01	0.04%
Am-241	1.80E+00	0.00%	Pu-241	1.25E-01	0.03%
Pu-239	4.75E-01	0.00%	Co-57	7.87E-01	0.21%
Pu-238	7.14E-01	0.00%	H-3	5.26E-02	0.01%
Cm-243	4.59E-01	0.00%	Sr-90	3.02E-02	0.01%
Cm-242	7.80E-02	0.00%	C-14	1.18E-02	0.00%
Nb-95	2.83E-02	0.00%	Am-241	6.44E-03	0.00%
Zr-95	1.26E-02	0.00%	Pu-238	3.46E-03	0.00%
			Pu-239	3.09E-03	0.00%
			Cm-242	2.22E-03	0.00%
			Cm-243	1.49E-03	0.00%

5.0 NONRADIOACTIVE CHEMICAL RELEASES

5.1 Scheduled Chemical Waste Releases

Scheduled chemical waste releases to the circulating water system from January 1, 2019, to June 30, 2019, included 7.78E+03 gallons of neutralized wastewater. The wastewater contained 0.77 lbs. of suspended solids and 41.0 lbs. of dissolved solids.

There were no scheduled chemical releases of neutralized wastewater to the circulating water system from July 1, 2019, to December 31, 2019.

Scheduled chemical waste releases are based on the average analytical results obtained from sampling a representative number of neutralizing tanks.

5.2 Miscellaneous Chemical Waste Releases

Miscellaneous chemical waste releases from the wastewater effluent (based on effluent analyses) to the circulating water for January 1, 2019, to June 30, 2019, included 2.09E+07 gallons of clarified effluent. The wastewater contained 2.69E+03 lbs. of suspended solids.

Miscellaneous chemical waste releases from the wastewater effluent (based on effluent analyses) to the circulating water for July 1, 2019, to December 31, 2019, included 2.21E+07 gallons of clarified effluent. The wastewater contained 3.82E+03 lbs. of suspended solids.

Miscellaneous chemical waste released directly to the circulating water, based on amount of chemicals used from January 1, 2019, to June 30, 2019, included 4.86E+05 lbs. of sodium bisulfite solution (1.85E+05 lbs. sodium bisulfite), 5.61E+05 lbs. of Sodium Hypochlorite Solution (7.01E+04 lbs. sodium hypochlorite), 2.03E+04 lbs. Acti-Brom 1338 (9.11E+03 lbs. sodium bromide). 2.51E+03 lbs. of biodetergent, and 5.19E+04 lbs. of silt dispersant.

Miscellaneous chemical waste released directly to the circulating water, based on amount of chemicals used from July 1, 2019, to December 31, 2019, included 5.39E+05 lbs. of sodium bisulfite solution (2.05E+05 lbs. sodium bisulfite), 5.76E+05 lbs. Sodium Hypochlorite Solution (7.19E+04 lbs. sodium hypochlorite), 1.78E+04 lbs. Acti-Brom 1338 (8.02E+03 lbs. sodium bromide), 4.50E+03 lbs. of biodetergent, and 4.07E+04 lbs. of silt dispersant.

6.0 CIRCULATING WATER SYSTEM OPERATION

The circulating water system operation during this reporting period for periods of plant operation is described in Table 6-1.

Table 6-1
Circulating Water System Operation for 2019

	UNIT	JAN	FEB	MAR**	APR**	MAY	JUN
Average Volume Cooling Water Discharge [million gal/day]*	1	346.7	346.7	256.8	170.9	533.6	549.7
	2	346.7	346.7	352.5	363.1	542.7	551.1
Average Cooling Water Intake Temperature [°F]	1	43	43	43	44	47	53
	2	44	45	44	42	47	53
Average Cooling Water Discharge Temperature [°F]	1	77	77	75	64	68	72
	2	75	76	73	70	64	70
Average Ambient Lake Temperature [°F]		44	44	43	41	47	53

* For days with cooling water discharge flow.
** U1 outage 3/23/19 – 4/16/19

Table 6-1(continued)
Circulating Water System Operation for 2019

	UNIT	JUL	AUG	SEP	OCT	NOV	DEC
Average Volume Cooling* Water Discharge [million gal/day]	1	549.7	549.7	549.7	549.7	549.7	376.2
	2	551.1	551.1	551.1	551.1	551.1	376.1
Average Cooling Water Intake Temperature [°F]	1	52	61	54	49	41	39
	2	53	62	54	50	42	40
Average Cooling Water Discharge Temperature [°F]	1	71	80	73	68	60	69
	2	69	77	71	67	59	68
Average Ambient Lake Temperature [°F]		53	61	54	50	41	40

* For days with cooling water discharge flow.

Part B
Miscellaneous Reporting Requirements

7.0 ADDITIONAL REPORTING REQUIREMENTS

7.1 Revisions to the PBNP Effluent and Environmental Programs

The ODCM (attached) was revised in 2019. ODCM changes included updates to remove reference to a checklist and air samples that were obtained as a courtesy for the State of Wisconsin and correcting a typo that had the LLDs switched for Cs-134 and Cs-137 Shoreline Sediment.

7.2 Interlaboratory Comparison Program

ATI Environmental, Inc, Midwest Laboratory, the analytical laboratory contracted to perform the radioanalyses of the PBNP environmental samples, participated in the interlaboratory comparison studies administered by Environmental Resources Associates (ERA) during 2019. The results of these comparisons can be found in Appendix A of the attached final report for 2019, January – December 2019 from ATI Environmental Inc.

7.3 Special Circumstances

No special circumstances to report regarding operation of the explosive gas monitor for the waste gas holdup system was needed during 2019.

Part C
RADIOLOGICAL ENVIRONMENTAL MONITORING

8.0 INTRODUCTION

The objective of the PBNP Radiological Environmental Monitoring Program (REMP) is to determine whether the operation of PBNP or the ISFSI has radiologically impacted the environment. To accomplish this, the REMP collects and analyzes air, water, milk, soil, vegetation (grasses, weeds, and crops), and fish samples for radionuclides and uses thermoluminescent dosimeters (TLDs) to determine the ambient radiation background. The analyses of the various environmental media provide data on measurable levels of radiation and radioactive materials in the principal pathways of environmental exposure. These measurements also serve as a check of the efficacy of PBNP effluent controls.

The REMP fulfills the requirements of 10 CFR 20.1302, PBNP General Design Criterion (GDC) 17, GDC 64 of Appendix A to 10 CFR 50, and Sections IV.B.2 and IV.B.3 of Appendix I to 10 CFR 50 for the operation of the plant. A subset of the PBNP REMP samples, consisting of air, soil and vegetation also fulfills 10 CFR 72.44(d)(2) for operation of the ISFSI. Additionally, TLDs provide the means to measure changes in the ambient environmental radiation levels at sites near the ISFSI and at the PBNP site boundary to ensure that radiation levels from the ISFSI are maintained within the dose limits of 10 CFR 72.104. Because the ISFSI is within the PBNP site boundary, radiation doses from PBNP and the ISFSI, combined, must be used to assess compliance with 10 CFR 72.122 and 40 CFR 190. Therefore, radiological environmental monitoring for the ISFSI is provided by selected sampling sites, which are part of the PBNP REMP.

For the aquatic environment, the samples include water as well as the biological integrators, such as fish and filamentous algae. Because of their migratory behavior, fish are wide area integrators. In contrast, the filamentous algae periphyton is attached to shoreline rocks and concentrate nuclides from the water flowing by their point of attachment. Grab samples of lake water provide a snapshot of radionuclide concentrations at the time the sample is taken; whereas analysis of fish and filamentous algae yield concentrations integrated over time.

The air-grass-cow-milk exposure pathway unites the terrestrial and atmospheric environments. This pathway is important because of the many dairy farms around PBNP. Therefore, the REMP includes samples of air, general grasses, and milk from the PBNP environs. An annual land use survey is made to determine whether the assumptions on the location of dairy cattle remain conservative with respect to dose calculations for PBNP effluents. The dose calculations assume that the dairy cattle are located at the south site boundary, the highest depositional sector. In addition, soil samples are collected and analyzed in order to monitor the potential for long-term buildup of radionuclides in the vicinity of PBNP.

For the measurement of ambient environmental radiation levels that may be affected by direct radiation from PBNP or by noble gas effluents, the REMP employs a series of TLDs situated around PBNP and the ISFSI.

9.0 PROGRAM DESCRIPTION

9.1 Results Reporting Convention

The vendor used by PBNP to analyze the environmental samples is directed to report analysis results as measured by a detector, which can meet the required lower limit of detection (LLD) as specified in Table 12-1 of the ODCM for each sample. The report provided by the vendor (see Appendix 1) contains values, which can be either negative, positive or zero plus/minus the two sigma counting uncertainty, which provides the 95% confidence level for the measured value.

The LLD is an *a priori* concentration value that specifies the performance capability of the counting system used in the analyses of the REMP samples. The parameters for the *a priori* LLD are chosen such that only a five percent chance exists of falsely concluding a specific radionuclide is present when it is not present at the specified LLD. Based on detector efficiency and average background activity, the time needed to count the sample in order to achieve the desired LLD depends upon the sample size. Hence, the desired LLD may be achieved by adjusting various parameters. When a suite of radionuclides are required to be quantified in an environmental sample such as lake water, the count time used is that required to achieve the LLD for the radionuclide with the longest counting time. Therefore, in fulfilling the requirement for the most difficult to achieve radionuclide LLD, the probability of detecting the other radionuclides is increased because the counting time used is longer than that required to achieve the remaining radionuclide LLDs.

The REMP results in this report are reported as averages of the measurements made throughout the calendar year plus/minus the associated standard deviation. If all net sample concentrations are equal to or less than zero, the result is reported as "Not Detectable" (ND), indicating no detectable level of activity present in the sample. If any of the net sample concentrations indicate a positive result statistically greater than zero, all of the data reported are used to generate the reported statistics. Because of the statistical nature of radioactive decay, when the radionuclide of interest is not present in the sample, negative and positive results centered about zero will be seen. Excluding validly measured concentrations, whether negative or as small positive values below the LLD, artificially inflates the calculated average value. Therefore, all generated data are used to calculate the statistical values (i.e., average, standard deviation) presented in this report. The calculated average may be a negative number.

As mentioned above, radioactive decay is a statistical process which has an inherent uncertainty in the analytical result. No two measurements will yield exactly the same result. However, the results are considered equal if the results fall within a certain range based upon the statistical parameters involved in the process. The REMP analytical results are reported at the 95% confidence limit in which the true result may be two standard deviations above or below the reported result. This means that there is only a 5% chance of concluding that the identified radioactive atom is not there when it really is present in the sample. A false positive is an analytical result which statistically shows that the radionuclide is present in the sample when it really is not there. Typically, if the 95% confidence interval for a positive does not include zero, the radionuclide is

considered to be present. For example, the result is reported as 100 ± 90. One hundred minus 90 yields a positive result and therefore may be considered to be present. However, this may be a false positive. If the radionuclide was not in the plant effluent, this result would fall into that category which 5% of the time it is falsely concluded that the radionuclide is present when in actuality it is not. This usually happens at low concentrations at or near the LLD where fluctuations in the background during the counting process skew the results to produce a positive result.

In interpreting the data, effects due to the plant must be distinguished from those due to other sources. A key interpretive aid in assessment of these effects is the design of the PBNP REMP, which is based upon the indicator-control concept. Most types of samples are collected at both indicator locations and at control locations. A plant effect would be indicated if the radiation level at an indicator location was significantly larger than that at the control location. The difference would have to be greater than could be accounted for by typical fluctuation in radiation levels arising from other sources.

9.2 Sampling Parameters

Samples are collected and analyzed at the frequency indicated in Table 9-1 from the locations described in Table 9-2 and shown in Figures 9-1, 9-2 and 9-3. (The latter two figures show sampling locations not shown in preceding figures due to space limitations. The location of the former retention pond, retired and remediated to NRC unrestricted access criteria, is indicated in Figure 9-3). The list of PBNP REMP sampling sites used to determine environmental impact around the ISFSI is found in Table 9-3. The minimum acceptable sample size is found in Table 9-4. In addition, Table 9-1 indicates the collection and analysis frequency of the ISFSI fence TLDs.

9.3 Deviations from Required Collection Frequency

Deviations from the collection frequency given in Table 9-1 are allowed because of hazardous conditions, automatic sampler malfunction, seasonal unavailability, and other legitimate reasons (Section 12.2.2.e of the ODCM). Table 9-5 lists the deviations from the scheduled sampling frequency that occurred during the reporting period.

9.4 Assistance to the State of Wisconsin

The Radiation Protection Unit of the Wisconsin Department of Health and Family Services maintains a radiological environmental monitoring program to confirm the results from the PBNP REMP. As a courtesy to the State of Wisconsin, PBNP personnel collect certain environmental samples (Table 9-6) for the State from sites that are near PBNP sampling sites, or are co-located.

9.5 Program Modifications

Modifications to the Radiological Environmental Monitoring Program (REMP) included the removal of two air samples that were obtained as a courtesy for the State of Wisconsin (Table 9-6) and an adjustment to the lake water and shoreline sediment sample location at E-06, Point Beach State Park. The E-06 location was adjusted north approximately 600 feet within the State Park (closer to Point Beach) due to high lake levels during the summer of 2019 that caused beach erosion and created unsafe access to this sample location. Additionally, the control location E-20 had a name change from Silver Lake College to Holy Family College.

Table 9-1
PBNP REMP Sample Analysis and Frequency

Sample Type	Sample Codes	Analyses	Frequency
Environmental Radiation Exposure	E-01, -02, -03, -04, -05 -06, -07, -08, -09, -12 -14, -15, -16B, -17, -18, 20, -22, -23, -24, -25, -26B, -27, -28 -29, -30, 31, -32, -38, -39,-41, -42,-43, -44 -TC	TLD	Quarterly
Vegetation	E-01, -02, -03, -04, -06, -08, -09, -20,	Gross Beta Gamma Isotopic Analysis	3x/yr as available
Algae	E-05, -12	Gross Beta Gamma Isotopic Analysis	1x/yr as available
Fish	E-13	Gross Beta Gamma Isotopic Analysis (Analysis of edible portions only)	Quarterly as available
Well Water	E-10	Gross Beta, H-3 Sr-89, 90, I-131 Gamma Isotopic Analysis	Quarterly
Lake Water	E-01, -05, -06, -33	Gross Beta, Sr-89/90, H-3 I-131 Gamma Isotopic Analysis	Monthly / Quarterly composite of monthly collections Monthly Monthly
Milk	E-11, -40, -21	Sr-89, 90 I-131 Gamma Isotopic Analysis	Monthly
Air Filters	E-01, -02, -03, -04, -08, -20	Gross Beta I-131 Gamma Isotopic Analysis	Weekly (particulate) Weekly (charcoal) Quarterly (on composite particulate filters)
Soil	E-01, -02, -03, -04, -06, -08, -09, -20,	Gross Beta Gamma Isotopic Analysis	1x/yr
Shoreline Sediment	E-01, -05, -06, -12, -33,	Gross Beta Gamma Isotopic Analysis	1x/yr
ISFSI Ambient Radiation Exposure	North, East, South, West Fence Sections	TLD	Quarterly

Table 9-2
PBNP REMP Sampling Locations

Location Code	Location Description
E-01	Primary Meteorological Tower South of the Plant
E-02	Site Boundary Control Center - East Side of Building
E-03	Tapawingo Road, about 0.4 Miles West of Lakeshore Road
E-04	North Boundary
E-05	Two Creeks Park
E-06	Point Beach State Park - Coast Guard Station; TLD located South of the Lighthouse on Telephone pole
E-07	WPSC Substation on County V, about 0.5 Miles West of Hwy 42
E-08	G.J. Francar Property at Southeast Corner of the Intersection of Cty. B and Zander Road
E-09	Nature Conservancy
E-10	PBNP Site Well
E-11	Dairy Farm about 3.75 Miles West of Site
E-12	Discharge Flume/Pier
E-13	Pumphouse
E-14	South Boundary, about 0.2 miles East of Site Boundary Control Center
E-15	Southwest Corner of Site
E-16B	WSW, Hwy 42, a residence about 0.25 miles North of Nuclear Road
E-17	North of Mishicot, Cty. B and Assman Road, Northeast Corner of Intersection
E-18	Northwest of Two Creeks at Zander and Tannery Roads
E-20	Reference Location, 17 miles Southwest, at Holy Family College
E-21	Local Dairy Farm just South of Site on Lakeshore and Irish Roads
E-22	West Side of Hwy 42, about 0.25 miles North of Johanek Road
E-23	Greenfield Lane, about 4.5 Miles South of Site, 0.5 Miles East of Hwy 42
E-24	North Side of County Rt. V, near intersection of Saxonburg Road
E-25	South Side of County Rt. BB, about 0.5 miles West of Norman Road
E-26B	804 Tapawingo Road, about 0.4 miles East of Cty. B, North Side of Road
E-27	Intersection of Saxonburg and Nuclear Roads, Southwest Corner, about 4 Miles WSW
E-28	TLD site on western most pole between the 2nd and 3rd parking lots.
E-29	Area of North Meteorological Tower.
E-30	NE corner at Intersection of Tapawingo and Lakeshore Roads.
E-31	On utility pole North side of Tapawingo Road closest to the gate at the West property line.
E-32	On a conduit/pole located near the junction of property lines, about 500 feet east of the west gate in line with first designated treeline on Tapawingo Road and about 1200 feet south of Tapawingo Road. The location is almost under the power lines between the blue and gray transmission towers. (The conduit/pole is about 6 feet high).
E-33	Lake Michigan shoreline accessed from the SE corner of KNPP parking lot. Sample South of creek.
E-38	Tree located at the West end of the area previously containing the Retention Pond.
E-39	Tree located at the East end of the area previously containing the Retention Pond.
E-40	Local Dairy Farm, W side of Hwy 42, about 1.8 miles north of the Nuclear Rd intersection
E-41	NW corner of Woodside and Nuclear Rds (Kewaunee County)
E-42	NW corner of Church and Division, East of Mishicot
E-43	West side of Tannery Rd south of Elmwood (7th utility pole south of Elmwood)
E-44	Utility Pole N Side of Tapawingo Rd near house at 5011
E-TC	Transportation Control; Reserved for TLDs

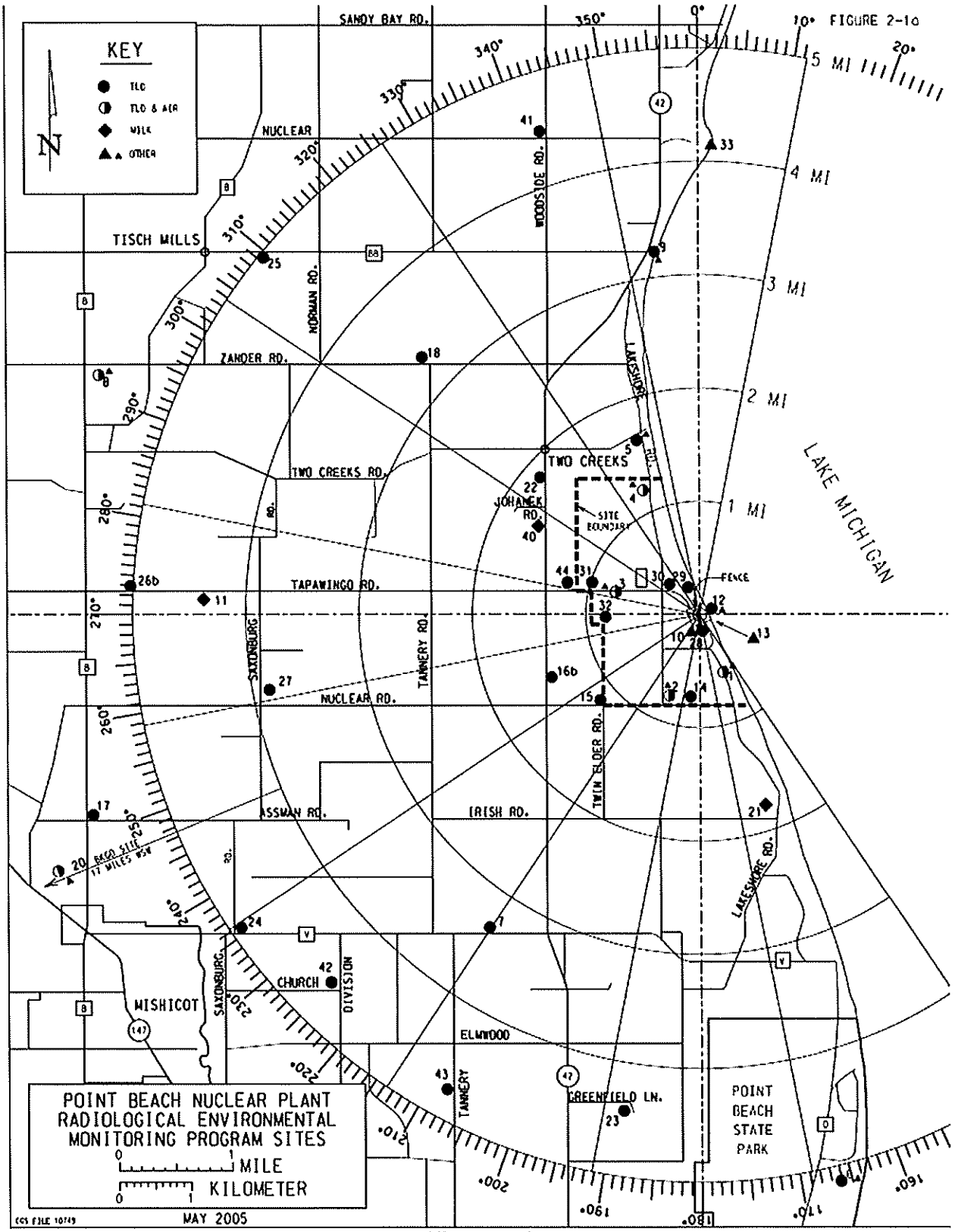


Figure 9-1
PBNP REMP Sampling Sites

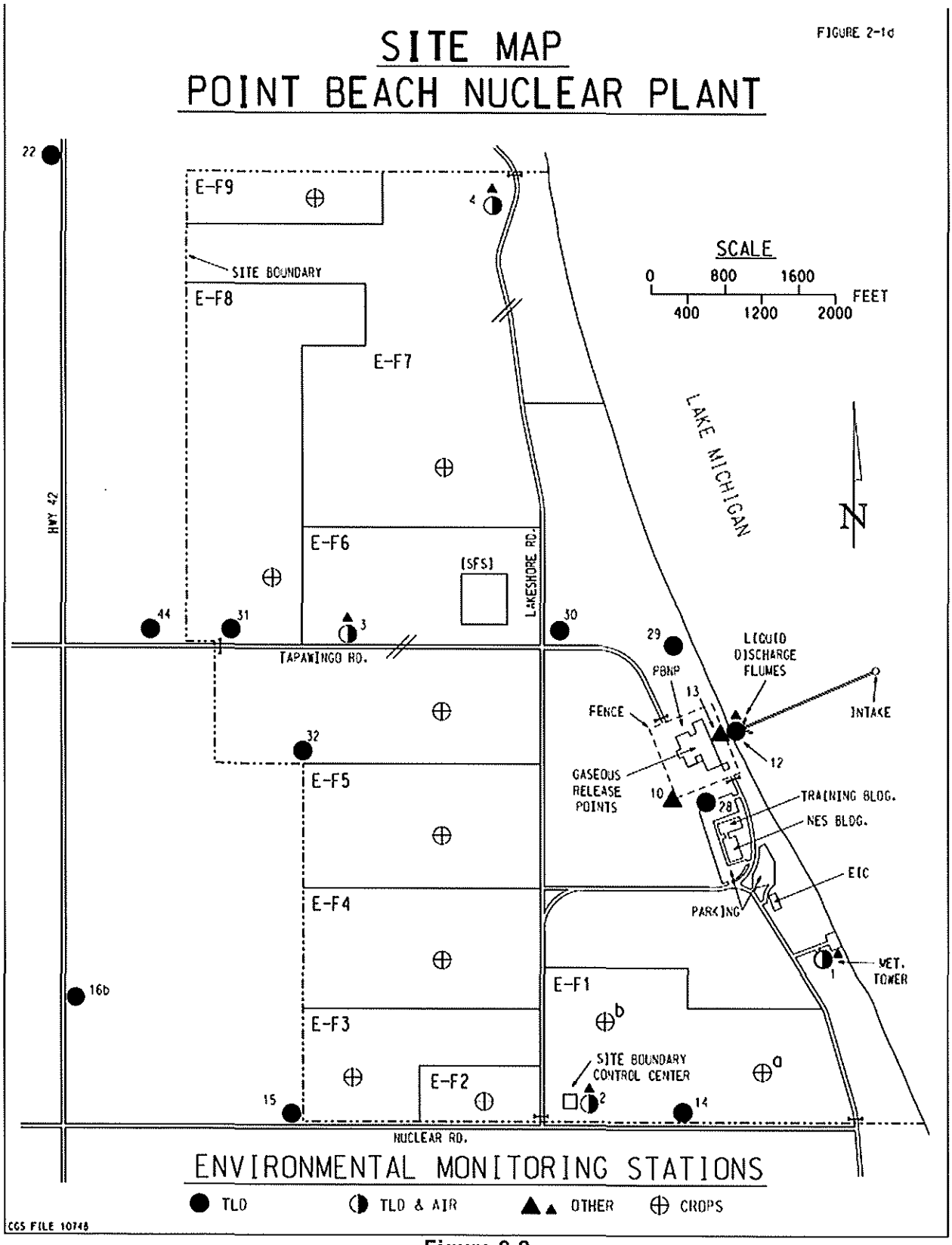


Figure 9-2
Map of REMP Sampling Sites Located Around PBNP

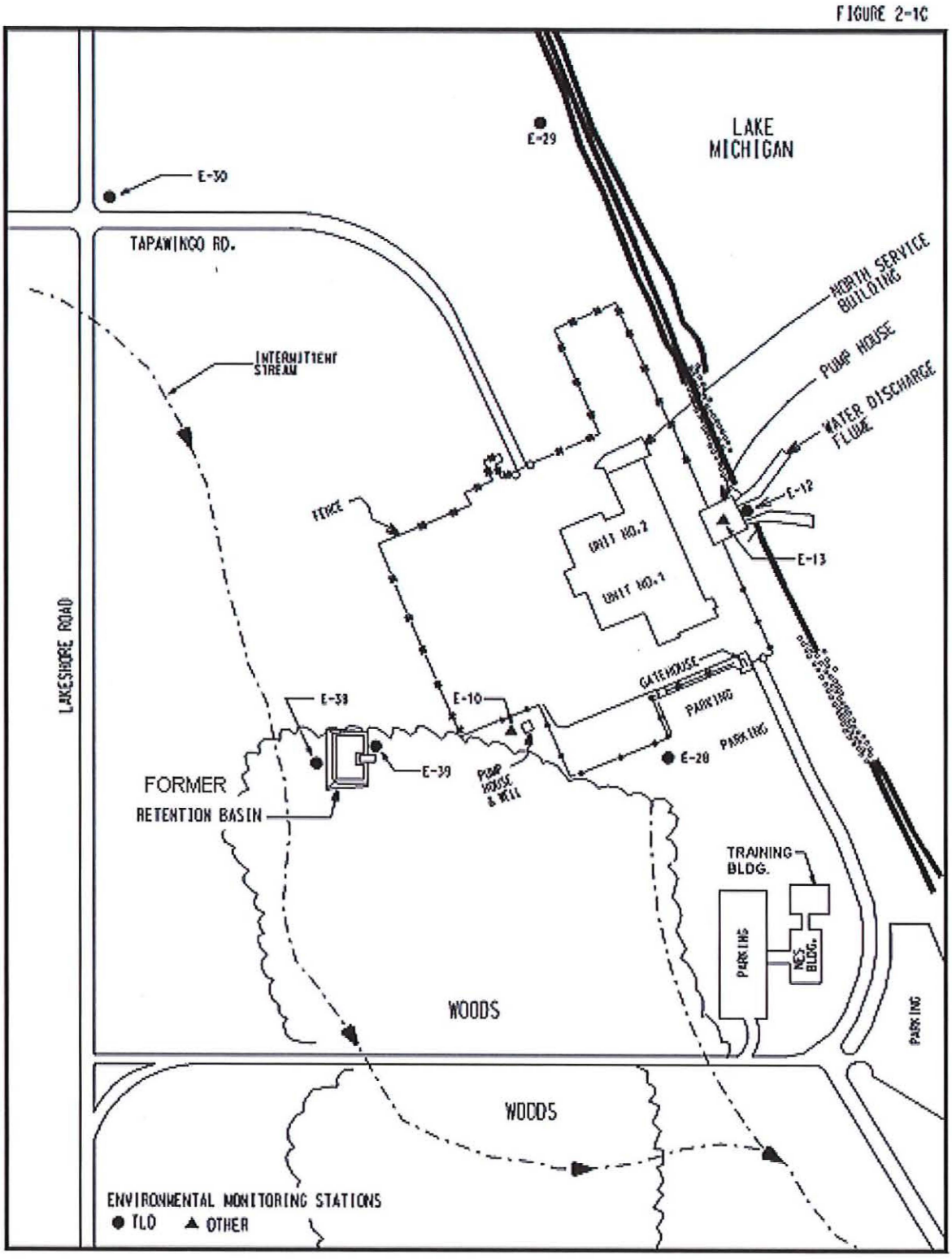


Figure 9-3
Enhanced Map Showing REMP Sampling Sites Closest to PBNP

Table 9-3
ISFSI Sampling Sites

Ambient Radiation Monitoring (TLD)	Soil, Vegetation and Airborne Monitoring
E-03	E-02
E-28	E-03
E-29	E-04
E-30	
E-31	
E-32	
E-44	

Table 9-4
Minimum Acceptable Sample Size

Sample Type	**Size**
Vegetation	100-1000 grams
Lake Water	8 liters
Air Filters	250 m3 (volume of air)
Well Water	8 liters
Milk	8 liters
Algae	100-1000 grams
Fish (edible portions)	1000 grams
Soil	500-1000 grams
Shoreline Sediment	500-1000 grams

Table 9-5
Deviations from Scheduled Sampling and Frequency During 2019

Sample Type	Location	Scheduled Collection Date	Reason for not conducting REMP as required	Plans for Preventing Recurrence
LW	E-05	2/13/2019	No sample due to icy conditions	Seasonal variability
LW	E-06	2/13/2019	No sample due to icy conditions	Seasonal variability
LW	E-33	2/13/2019	No sample due to icy conditions	Seasonal variability
LW	E-06	3/12/2019	No sample due to icy conditions	Seasonal variability
LW	E-33	3/12/2019	No sample due to icy conditions	Seasonal variability
SL	E-05	Aug-19	No algae grow th	Seasonal variability
SL	E-12	Aug-19	No algae grow th	Seasonal variability
AP/AI	All Locations	8/7/2019	Equipment malfunction	Validate factory setting prior to installation
VE	E-F6	9/4/2019	No vegetables planted	Seasonal variability
SS	E-05	10/15/2019	Unsafe/High Water conditions	Seasonal variability
TLD	E-43	4th Qtr	TLD lost in snow	Seasonal variability

Table 9-6

Sample Collections for State of Wisconsin

Sample Type	Location	Frequency
Lake Water	E-01	Monthly
Fish	E-13	Quarterly, As Available
Precipitation	E-04 E-08	Twice a month, As Available
Milk	E-11 E-21	Monthly
Well Water	E-10	Twice per year

9.6 Analytical Parameters

The types of analyses and their frequencies are given in Table 9-1. The LLDs for the various analyses are found in Section 10 (Table 10-1) with the summary of the REMP results. All environmental LLDs listed in Table 12-1 of the ODCM (also in Table 10-1) were achieved during 2019.

9.7 Description of Analytical Parameters in Table 9-1

9.7.1 Gamma isotopic analysis

Gamma isotopic analysis consists of a computerized scan of the gamma ray spectrum from 80 keV to 2048 keV. Specifically included in the scan are Mn-54, Fe-59, Co-58, Co-60, Zr-95, Nb-95, Ru-103, Ru-106, I-131, Ba-La-140, Cs-134, Cs-137, Ce-141, and Ce-144. However, other detected nuclear power plant produced radionuclides also are noted. The above radionuclides detected by gamma isotopic analysis are decay corrected to the time of collection. Frequently detected, but not normally reported in the Annual Monitoring Report, are the naturally occurring radionuclides Ra-226, Bi-214, Pb-212, Tl-208, Ac-228, Be-7, and K-40.

9.7.2 Gross Beta Analysis

Gross beta analysis is a non-specific analysis that consists of measuring the total beta activity of the sample. No individual radionuclides are identifiable by this method. Gross beta analysis is a quick method of screening samples for the presence of elevated activity that may require additional, immediate analyses.

9.7.3 Water Samples

Water samples include both Lake Michigan and well water. The Lake Michigan samples are collected along the shoreline at two locations north and two locations south of PBNP. The well water is sampled from the on-site PBNP well. Gross beta measurements are made on the solids remaining after evaporation of the unfiltered sample to dryness. Gamma isotopic analyses are performed using 1-liter liquid samples. Strontium is determined by chemical separation and beta counting.

9.7.4 Air Samples

Particulate air filters are allowed to decay at least 72 hours before gross beta measurements are made in order for naturally occurring radionuclides to become a negligible part of the total activity. Gross beta measurements serve as a quick check for any unexpected activity that may require immediate investigation. Quarterly composites of the particulate air filters are analyzed for long-lived radionuclides such as Cs-134 and Cs-137. Charcoal cartridges for radioiodine are counted as soon as possible so the I-131 will undergo only minimal decay prior to analyses. The weekly charcoal cartridges are screened for I-131 by

counting them all at the same time to achieve a lower LLD. If a positive result is obtained, each cartridge is counted individually.

In order to ensure that the air sampling pumps are operating satisfactorily, a gross leak check is performed weekly. The pumps are changed out annually for calibration and maintenance beyond what can be accomplished in the field.

9.7.5 Vegetation

Vegetation samples consist predominantly of green, growing plant material (grasses and weeds most likely to be eaten by cattle if they were present at the sampling site). Care is taken not to include dirt associated with roots by cutting the vegetation off above the soil line.

No special vegetation samples were obtained for C-14 analyses in 2019.

9.7.6 Environmental Radiation Exposure

The 2019 environmental radiation exposure measurements were made using TLD cards. The TLD card is a small passive detector, which integrates radiation exposure. Each TLD consists of a Teflon sheet coated with a crystalline, phosphorus material (calcium sulfate containing dysprosium) which absorbs the gamma ray energy deposited in them. Each TLD is read in four distinct areas to yield four exposure values which are averaged. Prior to the third quarter of 2001, exposure data was obtained using three lithium fluoride (LiF) TLD chips sealed in black plastic. The difference in material types can impact the amount of exposure measured. An evaluation of the response difference between the two types of TLD in 2001 demonstrated that the TLD cards produced a 14% higher response than the LiF chips (2011 AMR, Table 9-7, p. 36).

The reported field exposure is the arithmetic average of the measured exposure values at each location minus the exposure transportation control TLD (exposure received while the field TLD is in storage and transit). The gamma rays may originate from PBNP produced radionuclides or from naturally occurring radionuclides. The TLDs remain at the monitoring site for roughly three months prior to analyses and the results are reported as mrem per seven days. Because the TLDs are constantly bombarded by naturally occurring gamma radiation, even during shipment to and from PBNP, the amount of exposure during transportation is measured using transportation controls with each shipment of TLDs to and from the laboratory. The doses recorded on the transportation controls are subtracted from the monitoring TLDs in order to obtain the net *in situ* dose.

9.7.7 ISFSI Ambient Radiation Exposure

The ISFSI fence TLDs are part of the 10CFR72.44 monitoring and are not considered part of the REMP. However, their results can be used indirectly to determine whether the operation of the ISFSI is having an impact on the ambient environmental radiation beyond the site boundary. Impacts are determined by comparison of fence TLD results to the results of the monitoring at PBNP site boundary and other selected locations. These results are used as part of the 40CFR190 compliance demonstration.

10.0 RESULTS

10.1 Summary of 2019 REMP Results

Radiological environmental monitoring conducted at PBNP from January 1, 2019, through December 31, 2019, consisted of analysis of air filters, milk, lake water, well water, soil, fish, shoreline sediments, and vegetation as well as TLDs (No algae obtained in 2019). The results are summarized, averages and high values, in Table 10-1 which contain the following information:

Sample:	Type of the sample medium
Description:	Type of measurement
N:	Number of samples analyzed
LLD:	*a priori* lower limit of detection
Average:	Average value ± the standard deviation of N samples
High:	Highest measured value ± it's associated 2 sigma counting error
Units:	Units of measurement

For certain analyses, an LLD, which is lower than that required by REMP, is used because the lower value derives from the counting time required to obtain the LLDs for radionuclides that are more difficult to detect. For these analyses, both LLDs are listed with the technical specification required REMP LLD given in parentheses. The results are discussed in the narrative portion of this report (Section 11). Blank values have not been subtracted from the results presented in Table 10-1. A listing of all the individual results obtained from the contracted analytical laboratory and the laboratory's radioanalytical quality assurance results and Interlaboratory Crosscheck Program results are presented in the Appendix.

In Table 10-1 no results are reported as less than LLD (<LLD). All results are reported to Point Beach by the contracted radioanalytical laboratory "as measured" whether positive or negative (see Section 9-1). Based on these results, a radionuclide is considered detected if it meets the criterion that the measured value minus its 2σ counting error is greater than zero ($x-2\sigma > 0$). An "ND" entry in Table 10-1 means that for this radionuclide the criterion was not satisfied for any of the measurements. If one analysis fulfilled the criterion, then all of the reported results, both positive and negative, were used in calculating the average shown in Table 10-1.

The method of determining averages based on "as measured" results follows the recommendations made in NUREG-0475 (1978), "Radiological Environmental Monitoring by NRC Licensees for Routine Operations of Nuclear Facilities Task Force Report," and in Health Physics Society Committee Report HPSR-1 (1980) "Upgrading Environmental Radiation Data" released as document EPA 520/1-80-012 and in more recent documents such as ANSI N42.23-1996, "Instrument Quality Assurance for Radioassay Laboratories;" ANSI N13.30-1996, "Performance Criteria for Radiobioassay;" DE91-013607, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance" and NUREG-1576, "Multi-Agency Radiological Laboratory Analytical Protocols Manual."

In addition to the required radionuclides for each medium analyzed, Table 10-1 also has an additional radionuclide listed known to originate with nuclear power plants. This radionuclide is either Co-60, Ru-103, or any other radionuclide which has the lowest LLD based on the analytical parameters needed to meet the LLDs required for radionuclides specified for the medium being analyzed. The radionuclide is identified by parentheses.

During the analyses for those radionuclides specifically required to be identified, naturally occurring radionuclides such as Ra-226, Be-7 and K-40 are detected in many samples. Their concentrations are presented in Table 10-1 for a comparison to those radionuclides for which specific analyses are required by the regulations. There are no regulatory required LLDs for naturally occurring radionuclides.

Finally, Point Beach reports the results for soil analyses. There is no regulatory requirement for soil analyses in standard RETS (NUREG-0472 and NUREG-1301). Point Beach includes soil analyses in the REMP to be able to compare current results to the historical record.

The crop sampling initiated in 2015 continued in 2019. Approximately 60% of the 1260 acres comprising the NextEra Point Beach site is leased to farmers who use the land to grow various crops. These crops consist of corn, alfalfa, and soy beans and appear to be for cattle feed. Nine samples were obtained from the nine separate plots and gamma scanned for radionuclides representative of Point Beach effluents and for naturally occurring radionuclides. One location was not planted during the 2019 growing season. Results are reported in Table 10-2.

Table 10-3 contains the ISFSI fence TLD results.

Table 10-1
Summary of Radiological Environmental Monitoring Results for 2019

Sample	Description	N	LLD (a)	Average ± 1 Std. Deviation (b)	High ± 2 sigma	Units
TLD	Environmental Radiation	127	1 mrem	1.10 ± 0.20	1.54 ± 0.08	mR/7days
	Control (E-20)	4	1 mrem	1.03 ± 0.15	1.13 ± 0.07	mR/7days
Air	Gross Beta	255	0.01	0.022 ± 0.009	0.059 ± 0.005	pCi/m3
	Control (E-20) Gross beta	51	0.01	0.022 ± 0.009	0.046 ± 0.005	pCi/m3
	I-131	255	0.030 (0.07)	ND	-	pCi/m3
	Control (E-20) I-131	51	0.030 (0.07)	ND	-	pCi/m3
	Cs-134	20	0.01(0.05)	ND	-	pCi/m3
	Control (E-20) Cs-134	4	0.01(0.05)	ND	-	pCi/m3
	Cs-137	20	0.01(0.06)	-0.0001 ± 0.0004	0.0005 ± 0.0004	pCi/m3
	Control (E-20) Cs-137	4	0.01(0.06)	ND	-	pCi/m3
	Other γ emitters (Co-60)	20	0.1	ND	-	pCi/m3
	Control (E-20) Other (Co-60)	4	0.1	ND	-	pCi/m3
	Natural Be-7	20	-	0.072 ± 0.012	0.093 ± 0.018	pCi/m3
	Control (E-20) Natural Be-7	4	-	0.069 ± 0.013	0.085 ± 0.018	pCi/m3
Milk	Sr-89	36	5	ND	-	pCi/L
	Sr-90	36	1	0.5 ± 0.2	0.9 ± 0.4	pCi/L
	I-131	36	0.5	ND	-	pCi/L
	Cs-134	36	5 (15)	ND	-	pCi/L
	Cs-137	36	5 (18)	0.2 ± 1.1	2.7 ± 2.3	pCi/L
	Ba-La-140	36	5 (15)	-1.2 ± 2.1	3.1 ± 2.0	pCi/L
	Other gamma emitters(Co-60)	36	15	ND	-	pCi/L
	Natural K-40	36	-	1388 ± 79	1570 ± 120	pCi/L
Well Water	Gross beta	4	4	1.6 ± 0.2	1.9 ± 1.2	pCi/L
	H-3	4	200 (3000)	ND	-	pCi/L
	Sr-89	4	5(10)	ND	-	pCi/L
	Sr-90	4	1 (2)	ND	-	pCi/L
	I-131	4	0.5 (2)	ND	-	pCi/L
	Mn-54	4	10 (15)	ND	-	pCi/L
	Fe-59	4	30	ND	-	pCi/L
	Co-58	4	10(15)	ND	-	pCi/L
	Co-60	4	10(15)	ND	-	pCi/L
	Zn-65	4	30	ND	-	pCi/L
	Zr-Nb-95	4	15	ND	-	pCi/L
	Cs-134	4	10(15)	ND	-	pCi/L
	Cs-137	4	10(18)	ND	-	pCi/L
	Ba-La-140	4	15	ND	-	pCi/L
	Other gamma emitters(Ru-103)	4	30	ND	-	pCi/L
Algae	Co-58	0	0.25	NS	-	pCi/g
	Co-60	0	0.25	NS		pCi/g
	Cs-134	0	0.25	NS		pCi/g
	Cs-137	0	0.25	NS		pCi/g
	Natural Be-7	0	-	NS		pCi/g
	Natural K-40	0	-	NS		pCi/g

NS = No Sample obtained during the year

Table 10-1 (continued)
Summary of Radiological Environmental Monitoring Results for 2019

Sample	Description	N	LLD (a)	Average ± 1 Std. Deviation (b)	High ± 2 sigma	Units
Lake Water	Gross beta	43	4	1.4 ± 0.8	4.9 ± 0.8	pCi/L
	I-131	43	0.5 (2)	ND	-	pCi/L
	Mn-54	43	10 (15)	0.1 ± 0.9	2.1 ± 1.8	pCi/L
	Fe-59	43	30	-0.3 ± 1.8	4.6 ± 3.2	pCi/L
	Co-58	43	10(15)	0.1 ± 1.0	2.3 ± 1.6	pCi/L
	Co-60	43	10(15)	0.0 ± 1.1	4.7 ± 3.5	pCi/L
	Zn-65	43	30	-0.9 ± 4.7	3.9 ± 3.7	pCi/L
	Zr-Nb-95	43	15	ND	-	pCi/L
	Cs-134	43	10 (15)	ND	-	pCi/L
	Cs-137	43	10 (18)	0.0 ± 1.2	2.2 ± 1.7	pCi/L
	Ba-La-140	43	15	-0.7 ± 2.5	4.8 ± 2.0	pCi/L
	Other gamma (Ru-103)	43	30	-0.5 ± 1.3	1.8 ± 1.5	pCi/L
	Sr-89	16	5(10)	ND	-	pCi/L
	Sr-90	16	1 (2)	0.20 ± 0.09	0.34 ± 0.28	pCi/L
	H-3	16	200 (3000)	112 ± 197	2041 ± 165	pCi/L
Fish	Mn-54	14	0.13	ND	-	pCi/g
	Fe-59	14	0.26	-0.003 ± 0.017	0.021 ± 0.020	pCi/g
	Co-58	14	0.13	-0.001 ± 0.009	0.017 ± 0.013	pCi/g
	Co-60	14	0.13	ND	-	pCi/g
	Zn-65	14	0.26	ND	-	pCi/g
	Cs-134	14	0.13	ND	-	pCi/g
	Cs-137	14	0.15	0.018 ± 0.015	0.057 ± 0.033	pCi/g
	Other gamma (Ru-103)	14	0.5	0.001 ± 0.015	0.019 ± 0.009	pCi/g
	Natural K-40	14	-	2.47 ± 0.47	3.32 ± 0.54	pCi/g
Shoreline Sediment	Cs-134	4	0.18	ND	-	pCi/g
	Cs-137	4	0.15	0.012 ± 0.013	0.031 ± 0.012	pCi/g
	Natural Be-7	4	-	0.187 ± 0.190	0.465 ± 0.221	pCi/g
	Natural K-40	4	-	3.97 ± 1.72	5.954 ± 0.39	pCi/g
	Natural Ra-226	4	-	1.09 ± 0.92	2.199 ± 0.294	pCi/g
Soil	Cs-134	8	0.15	ND	-	pCi/g
	Cs-137	8	0.15	0.07 ± 0.06	0.163 ± 0.03	pCi/g
	Natural Be-7	8	-	0.060 ± 0.10	0.188 ± 0.10	pCi/g
	Natural K-40	8	-	15.72 ± 3.24	20.530 ± 0.88	pCi/g
	Natural Ra-226	8	-	0.80 ± 0.23	1.148 ± 0.29	pCi/g
Vegetation	I-131	24	0.06	-0.001 ± 0.010	0.018 ± 0.010	pCi/g
	Cs-134	24	0.06	ND	-	pCi/g
	Cs-137	24	0.08	0.006 ± 0.018	0.087 ± 0.027	pCi/g
	Other gamma emitters (Co-60)	24	0.25	0.002 ± 0.006	0.012 ± 0.009	pCi/g
	Natural Be-7	24	-	2.54 ± 1.94	7.75 ± 0.46	pCi/g
	Natural K-40	24	-	5.28 ± 0.90	6.93 ± 0.57	pCi/g

(a) When two LLD values are listed, the required LLD per the PBNP REMP is enclosed in the parentheses. Whenever possible, PBNP uses the lower value to obtain greater sensitivity.
(b) "ND" indicates that the sample result is Not Detectable, i.e., sample concentrations were statistically equal to zero or <MDA.

Table 10-2
Feed Crops Grown on Point Beach Land

		Average			Max		
	Number	pCi/g		1σ	pCi/g		2σ
Be-7	9	0.87	±	0.60	1.596	±	0.22
K-40	9	3.50	±	1.34	5.42	±	0.51
Co-60	9	ND				-	
I-131	9	-0.004	±	0.013	0.016	±	0.008
Cs-134	9	ND				-	
Cs-137	9	ND				-	

ND = Not detected

Table 10-3
Average ISFSI Fence TLD Results for 2019

Fence Location	Average	±	Standard Deviation	Units
North	2.20	±	0.20	mR/7 days
East	4.18	±	0.24	mR/7 days
South	1.57	±	0.20	mR/7 days
West	4.08	±	0.39	mR/7 days

11.0 DISCUSSION

11.1 TLD Cards

The ambient radiation was measured in the general area of the site boundary, at an outer ring 4 to 5 miles from the plant, at special interest areas, and at one control location, roughly 17 miles southwest of the plant. The average indicator TLD is 1.10 ± 0.20 mR/7-days compared to 1.03 ± 0.15 mR/7-days at the background location. These two values are not significantly different from each other. Neither are the indicator TLD values significantly different from those observed from 2001 through 2019 for the same type of TLD (tabulated below in Table 11-1). Prior to third quarter of 2001 TLD LiF chips were used versus the current TLD cards, see Section 9.7.6 for additional information. The response difference between the two types of TLDs is evident in Table 11-1. Prior to 2001 all of the annual averages are <1 mrem/7-days. Beginning in 2001, all are >1 mrem/7-days.

Table 11-1
Average Indicator TLD Results from 1993 – 2019

Year	Average mR/7-days	±	St. Dev*
1993	0.82	±	0.15
1994	0.90	±	0.12
1995	0.87	±	0.13
1996	0.85	±	0.12
1997	0.87	±	0.11
1998	0.79	±	0.13
1999	0.79	±	0.21
2000	0.91	±	0.15
2001	1.06	±	0.19
2002	1.17	±	0.21
2003	1.10	±	0.20
2004	1.10	±	0.22
2005	1.04	±	0.21
2006	1.14	±	0.21
2007	1.08	±	0.20
2008	1.05	±	0.17
2009	1.08	±	0.17
2010	1.11	±	0.15
2011	1.14	±	0.25
2012	1.17	±	0.17
2013	1.14	±	0.20
2014	1.07	±	0.19
2015	1.18	±	0.20
2016	1.19	±	0.21
2017	1.11	±	0.17
2018	1.11	±	0.17
2019	1.10	±	0.20

*St. Dev = Standard Deviation

In 2019, REMP TLD E-43 (Figure 9-1) was found missing in the 4th quarter of 2019. An analysis of the missing TLD was made by comparing the quarterly REMP TLD

data to TLDs that surrounded the missing TLD. As well, the TLDs used in the analysis were looked at over an eight year period to ensure the surrounding TLDs trended as expected when compared to historical data. The analysis found that there was no unmonitored impact in the area surrounding the missing TLD.

In 2019, the east fence TLDs recorded a higher exposure followed by the west, north, and south fence locations (Table 11-2). Historically, the west ISFSI fence readings were higher than the east ISFSI fence, the change could be attributed to the six new casks that were added to the East side of the ISFSI in 2018.

Table 11-2
Average ISFSI Fence TLD Results (mR/7 days)

TLD FENCE LOCATION				
	North	East	South	West
1995	1.29	1.28	1.10	1.26
1996	2.12	1.39	1.10	1.68
1997	2.05	1.28	1.00	1.66
1998	2.08	1.37	1.02	1.86
1999	2.57	1.84	1.11	3.26
2000	2.72	2.28	1.25	5.05
2001	2.78	2.54	1.36	6.08
2002	2.79	2.74	1.42	6.46
2003	2.70	2.60	1.50	6.88
2004	2.61	2.12	1.41	6.50
2005	2.54	2.05	1.44	5.63
2006	2.73	2.35	1.38	5.80
2007	2.72	2.73	1.34	5.47
2008	2.64	2.37	1.36	5.36
2009	2.36	2.35	1.20	4.63
2010	2.64	3.02	1.41	5.05
2011	2.44	2.62	1.31	4.75
2012	2.59	3.27	1.40	4.92
2013	2.62	3.66	1.15	4.28
2014	2.45	3.35	1.14	4.24
2015	2.31	3.24	1.17	4.36
2016	2.30	3.34	1.33	4.35
2017	2.21	3.84	1.30	4.25
2018	2.24	4.21	1.49	4.32
2019	2.20	4.18	1.57	4.08

There is no significant change in the exposure on the TLD monitoring locations around the ISFSI (Table 11-3). The results at E-03 and E-31 (W of the ISFSI) and

E-32 (SW of the ISFSI) are similar to previous years (1.27, 1.17, and 1.41 respectively) and continue to be higher than E-30 (1.09) on the east side and closest to the ISFSI. E-03, about equidistant between the ISFSI and the site boundary location E-31, continues to be slightly higher than the site boundary location but the difference is not statistically different. (See Figs. 9-1 and 9-2 for locations).

Although the mR/7-day results for the three TLD locations nearest the site boundary (E-03 1.27 ± 0.43; E-31, 1.17 ± 0.45; E-32, 1.41 ± 0.32) are higher than at the background site E-20 (1.03 ± 0.30), they are comparable at the 95% confidence level, indicating a small, but not significant, increase in ambient gamma radiation at the site boundary due to the operation of the ISFSI. In 2018, a TLD monitoring location was added at location E-44 TLD, directly west of E-03 and E-31, but prior to the nearest resident. The average reading at E-44 is lower (0.99 ± 0.24) than the observed readings at E-03, E-31, and background location E-20 (1.27, 1.17, and 1.03 respectively).

Further data supporting this conclusion is the comparison of the TLD results at selected locations around the ISFSI before and after the storage of spent fuel at the ISFSI (Figure 11-1). As stated in Section 9.7.6, the TLD values increased by about 14% in the second half of 2001 when the TLD monitoring devices were changed from LiF chips in the first half of the 2001 to calcium sulfate impregnated TLD cards. After that initial change, the measured radiation exposure, as measured by the TLD cards, has remained fairly constant with a slight increase with the addition of stored fuel at the ISFSI. Each year the variations in the TLD results appear to move in concert with each other and with the background site, E-20, which is 17 miles south west of the ISFSI.

Comparing the ISFSI TLD results to results from surrounding REMP indicator and background TLDs reveals minimal impact of the ISFSI on the surrounding radiation levels (Figure 11-2). As previously discussed, the small increase is more related to the switch from the LiF chips to the calcium sulfate impregnated Teflon TLD cards as evidenced by the synchronicity with E-20, the background site.

LiF TLD chips were replaced with calcium sulfate impregnated Teflon TLD cards in the third quarter of 2001 resulting in a higher measured background values.

Figure 11-1 ISFSI AREA TLD RESULTS

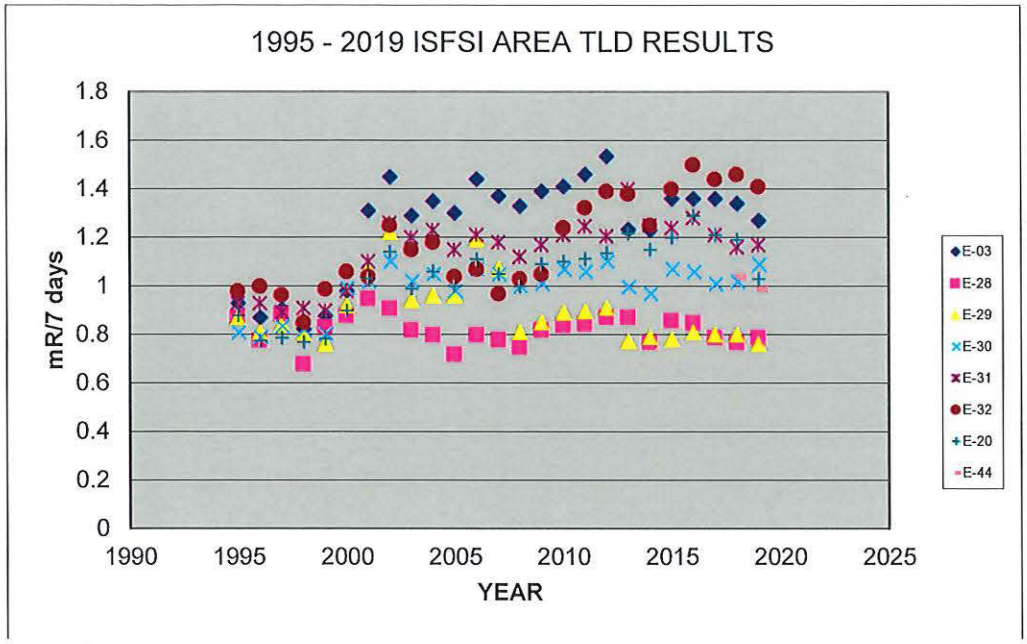
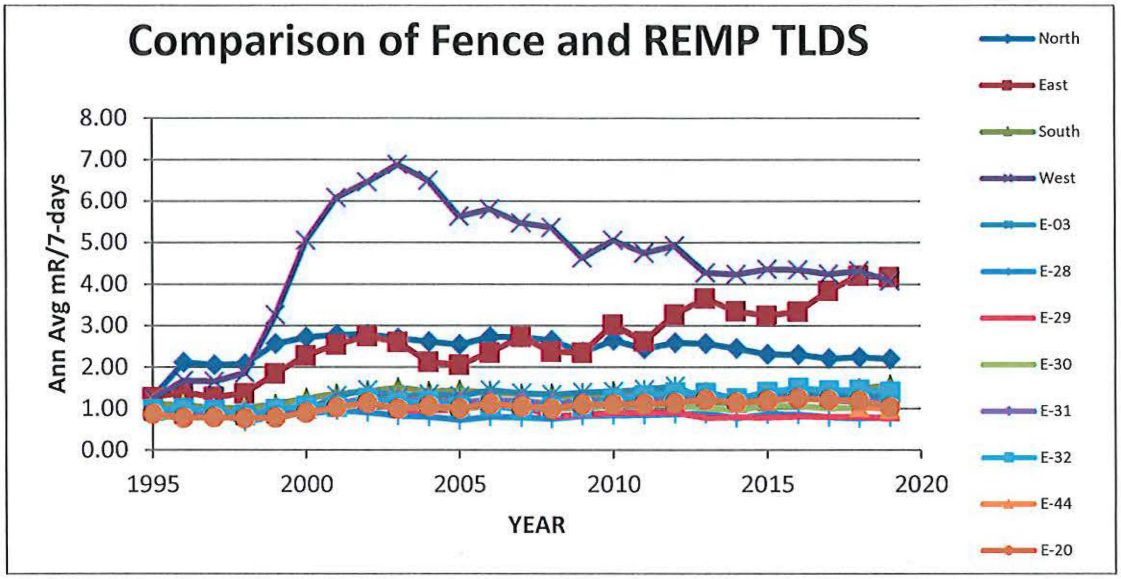


Table 11-3
Average TLD Results Surrounding the ISFSI (mR/7 days)

	E-03	E-28	E-29	E-30	E-31**	E-32**	E-44****	E-20***
Pre-Operation*	0.93	0.87	0.87	0.81	0.93	0.98		0.88
1996	0.87	0.78	0.81	0.79	0.93	1.00		0.78
1997	0.91	0.89	0.84	0.84	0.89	0.97		0.79
1998	0.82	0.68	0.80	0.82	0.91	0.85		0.77
1999	0.88	0.83	0.76	0.80	0.90	0.99		0.78
2000	0.98	0.88	0.92	0.99	0.98	1.06		0.90
2001	1.31	0.95	1.07	1.02	1.10	1.04		1.03
2002	1.45	0.91	1.22	1.10	1.26	1.25		1.14
2003	1.29	0.82	0.94	1.02	1.20	1.15		0.99
2004	1.35	0.80	0.96	1.05	1.23	1.18		1.06
2005	1.30	0.72	0.96	0.98	1.15	1.04		1.00
2006	1.44	0.80	1.19	1.07	1.21	1.07		1.11
2007	1.37	0.78	1.07	1.05	1.18	0.97		1.05
2008	1.33	0.75	0.81	1.00	1.12	1.03		1.00
2009	1.39	0.82	0.85	1.01	1.17	1.05		1.09
2010	1.41	0.84	0.89	1.07	1.21	1.24		1.10
2011	1.46	0.85	0.90	1.06	1.25	1.32		1.12
2012	1.54	0.87	0.91	1.10	1.21	1.39		1.14
2013	1.23	0.87	0.77	1.00	1.40	1.38		1.22
2014	1.23	0.77	0.79	0.97	1.25	1.25		1.15
2015	1.36	0.86	0.78	1.07	1.24	1.40		1.20
2016	1.35	0.85	0.81	1.06	1.28	1.50		1.25
2017	1.36	0.79	0.80	1.01	1.21	1.44		1.21
2018	1.34	0.77	0.80	1.02	1.16	1.46	1.04	1.19
2019	1.27	0.78	0.76	1.09	1.17	1.41	0.99	1.03

*Pre-Operational data are the averages of the years 1992 through 3rd quarter of 1995.
**Sites E-31 and E-32 are located at the Site Boundary to the West and South-West of the ISFSI.
***E-20 is located approximately 17 miles WSW of the ISFSI.
****E-44 Added in 2018

Figure 11-2 Comparison of ISFSI Fence TLDs to Selected REMP TLDs



11.2 Milk

Naturally occurring potassium-40 (1388 ± 79 pCi/L) continues to be the most prevalent radionuclide measured in milk at concentrations roughly 1300 times higher than the only potential plant related radionuclide, Sr-90 (0.9 ± 0.4 pCi/L), detected in milk. The annual average Sr-90 concentrations in milk continue to be similar to previous years. No positive results for Co-60, I-131, Cs-134, or Sr-89 were obtained in 2019.

One low positive Cs-137 result was obtained and was below the MDC limit and therefore may be false positive. In the last four years, Cs-137 was discharged from PBNP only in March 2016 and October 2017.

Three positive Ba-La-140 results were obtained at the E-21 location in 2019. Two of the results were above the MDC, with the highest value being observed in February 2019 (3.1 ± 2.0 pCi/L, MDC of 2.9 pCi/L). A review of 5 years' worth of airborne effluents show that no Ba-La-140 was discharged during that time.

The 2019 average Sr-90 concentrations have not changed much over the last few years (Figure 11-3). Over the past twenty years, the average has decreased from 1.2 ± 0.5 pCi/L in 1997 to 0.5 ± 0.2 pCi/L in 2019. The graph of the annual averages displays a logarithmic decrease over time.

The annual averages are from the monthly Sr-90 measurements from three different dairies (Figure 9-1). The only dairy that has been in the monitoring program over the entire 1997 – 2019 timespan under consideration is located at site E-21. It is located south of the plant. The other two, E-40 and E-11, are replacements for dairies which had dropped out of the program at various times during this time interval. The replacements were chosen to maintain, to the extent possible, the former sampling sites west and north of Point Beach.

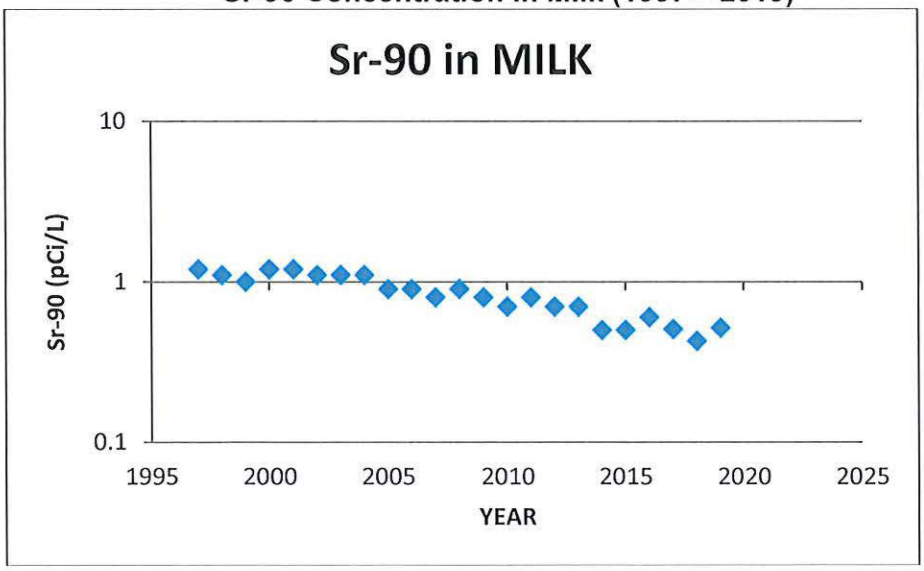
The decrease by about one-half from 1997 to 2019 indicates a Sr-90 removal half-life of about 20 years which is lower than its radiological half-life of 28.6 years. However, given the standard deviation of the annual averages, the actual decrease probably is not much different from the radiological half-life.

Point Beach discharged no airborne Sr-90 in 2019. Since 1997, PBNP has discharged airborne Sr-90 only in 3 years: 1999, 2.4E-08 Ci; 2004, 3.2E-08 Ci; and 2011, 1.6 E-08 Ci. It is interesting to note that nine of highest Sr-90 results occur at E-11 located about 4.4 miles west of PBNP (Fig. 9-1). If the observed Sr-90 activity were from Point Beach the highest Sr-90 concentrations would occur at E-21, the dairy south of the site boundary in the highest X/Q and D/Q meteorological sector. This dairy grows feed corn on site and in a field across the road from the site boundary in the highest D/Q sectors. Feed crops are the dominant source of food for dairy cattle. No cattle have been seen grazing for many years.

The major Sr-90 input to the environment is from fallout from atmospheric weapons testing during the early 1960s with minor inputs during the 50's, 70's and later contributions from the Chernobyl accident in the late 1980s and from Fukushima in 2011. The Sr-90 in milk persists due to its 28.6 year half-life and to cycling in the biosphere. With little or no atmospheric input to the environment, the mode of entry into cattle feed must be root uptake by forage crops and transfer into the milk. Over the time period of this graph (1997 – 2019), these low discharges do not appear to impact the decreasing concentrations as they continue to decrease over time.

It is concluded that the milk data for 2019 show no radiological effects of the plant operation.

Figure 11-3
Sr-90 Concentration in Milk (1997 – 2019)



11.3 Air

The average annual gross beta concentrations (plus/minus the 2σ uncertainty) in weekly airborne particulates at the indicator and control locations were 0.022 ± 0.017 pCi/m^3 and 0.022 ± 0.017 pCi/m^3, respectively, and are similar to levels observed from 1993 through 2019 (Figure 11-4).

The 2019 weekly gross beta concentrations reveal higher winter values and lower summer values (Figure 11-5). This is a repeat of the patterns seen in 2006 - 2018. The slight August – September peak is similar to what was observed in 2015 (Figure 11-6). The August-September peak is observed throughout the US and believed to result from weather patterns impacting with naturally occurring airborne radionuclides. This would explain why the control and indicators are moving in concert. Therefore, a plant effect can be ruled out.

Figure 11-4 Annual Average Air Gross β (1993 – 2019)

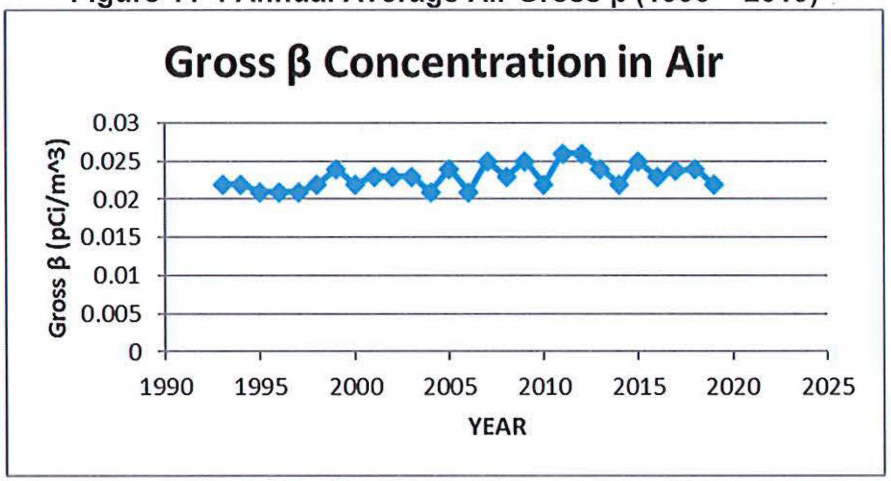


Figure 11-5 2019 Airborne Gross Beta

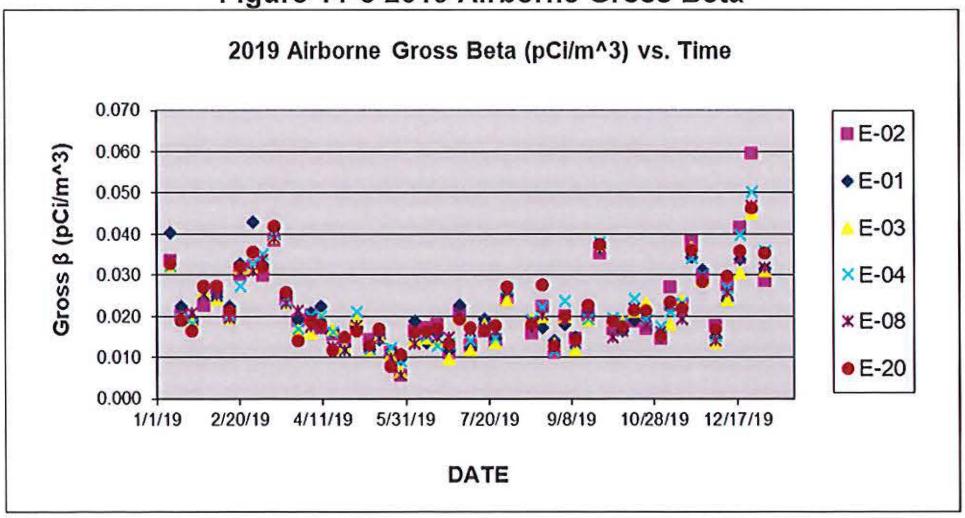
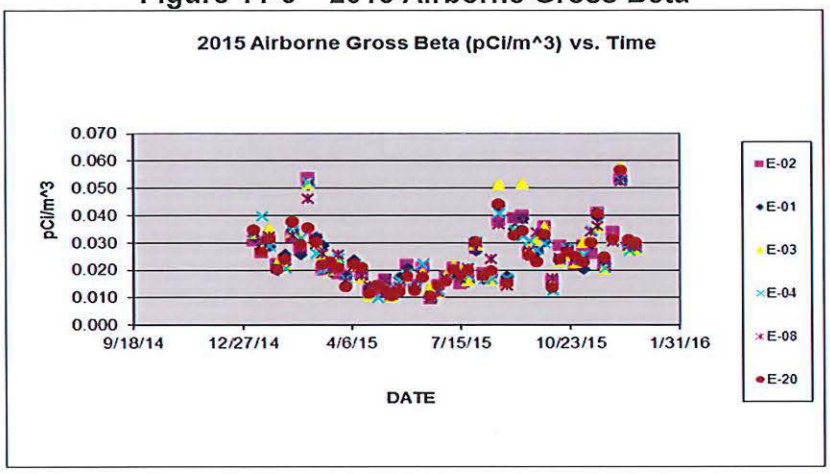


Figure 11-6 2015 Airborne Gross Beta



No I-131 was detected during 2019. In 2005, the new method of evaluating airborne I-131 was instituted. Instead of counting each charcoal cartridge separately, all six cartridges for the week are counted as one sample in a predetermined geometry to screen the samples for I-131. If any airborne radioiodine is detected, each sample cartridge is counted individually. With no detectable I-131, the reported analytical result is the minimum detectable activity (MDA) conservatively calculated using the smallest of the six sample volumes. The reported MDAs ranged from 0.005 to 0.0.024 pCi/m^3. Because the analysis LLD is based on counting only one cartridge, the use of six cartridges or roughly six times the sample volume with the same count time as would be needed to achieve the desired LLD for only one sample, the actual LLD is about six times lower than the programmatic value given in Table 10-1. Similarly, the actual MDA is about one-sixth of that reported, in the range of 0.001 to 0.004 pCi/m^3.

At each sampling location, the particulate filters are composited quarterly and analyzed for Cs-134, Cs-137 and any other (Co-60) detectable gamma emitters. As summarized in Table 10-1, the only plant effluent nuclide identified was Cs-137 in one sample and was <MDC. The sample occurred in the 3rd quarter at location E-02. No airborne Cs-137 was discharged in the first three quarters of 2019.

By contrast, naturally occurring Beryllium-7 was found in all of the quarterly composites at concentrations ranging from 0.052 to 0.093 pCi/m^3. Be-7 ($T_{1/2}$ = 53.3 days) is produced in the atmosphere by the interaction of cosmic rays with oxygen and nitrogen nuclei. Its half-life is long enough to allow for it to be detected in the quarterly composited filters.

One set of samples was missed at all locations the week of July 31st through August 7th, 2019. The air samplers had been changed out the week prior for annual calibrations and the new samplers had a factory setting that either tripped the samplers off after approximately 3 or 10 hours of operation. The setting was corrected and the air samplers have operated as expected since that week.

In summary, the 2019 air gamma data from quarterly composites do not indicate an environmental impact from the operation of PBNP.

11.4 Lake Water

For the REMP-specified gamma emitting radionuclides listed in Table 10-1, the reported concentrations continue to occur as small, negative and positive values scattered around zero, indicating no radiological impact from the operation of PBNP. Only 15 of the results were positive, of which, eight are from north of the plant, sites E-33 and E-05 (see Figure 9-1).

Only one of the 15 slightly positive results are >MDC. The one occurrence was south of the site at E-01 for Ba-La-140 in April 2019. While PBNP discharged La-140 in February 2019, this is concluded to be a false positive due to not obtaining a positive result in March 2019 and based on the half-lives of Ba-140 and La-140.

A false positive is concluding an isotope is present when it isn't. False positives occur most often at the detection limit when the random fluctuations of the background result in lower than normal background activity. The result is a higher net count and hence falsely concluding an isotope is present when it isn't because the value is statistically above zero.

Aliquots of the monthly samples are composited quarterly and analyzed for Sr-89/90 and for tritium. Small amounts of Sr-90 were detected in four of the sixteen quarterly composites, two north and two south of the plant. All the results were below their statistically calculated minimum detectable concentrations (MDCs). No Sr-90 was discharged in 2019 or in 2012 – 2015 and 2017-2018. A small amount was discharged in March of 2016. Sr-90 has a 28.6 year half-life and, like Cs-137, is a remnant of atmospheric weapons testing in the '50s and '60s. Therefore, positive Sr-90 concentrations could be indicative of fallout being recycled in Lake Michigan. However, because the concentrations are below their MDCs, they most likely are false positives and there for unlikely to be the result of past PBNP discharges.

Tritium, in addition to being produced by water-cooled reactors such as PBNP, also is a naturally occurring radionuclide. It also was produced by atmospheric weapons testing. However, due to its mobility, any tritium now found in Lake Michigan at the concentrations typically found in monitoring programs cannot be from that time period. It is the result of power plant discharges. Point Beach discharges on the order of 600 - 1000 Ci of tritium per year.

Sixteen quarterly lake water composites were generated from the monthly samples. Out of the sixteen quarterly composites, five had positive tritium indications, and of those five only two were greater than the MDC. One of these occurred on our site at the E-01 location and the other occurred in the sample obtained at the site of the shut-down Kewaunee nuclear plant. Kewaunee Nuclear Plant was contacted and confirmed that no liquid discharges had occurred at their site since August 2018. Analysis of the individual monthly samples and date of sampling when compared to date of releases indicated that PBNP sampled shortly after Point Beach discharges in both June and October.

The second quarter composite results from location E-01 contained the elevated tritium value. The composite tritium concentration was 687 ± 103 pCi/L at E-01. Additional analysis showed that the elevated result value occurred in June 2019

with a concentration of 2041 ± 165 pCi/L. The June tritium result at E-06 (Rawley Point light house six miles south of PBNP) was 202 ± 95 pCi/L.

Point Beach performed a liquid discharge approximately 11 hours prior to the obtaining the lake water samples. The concentrations of the Point Beach discharges were 3.43E+04 pCi/L. The result at E-06 was 202 ± 95 pCi/L, this location is directly south of Point Beach showed a positive tritium result that was above the MDC of 160. This sample was obtained one day after the sample was taken at E-01. Based on these results, it is likely that PBNP discharges had an impact on the observed elevated tritium concentration.

The fourth quarter composite from location E-33 at the Kewaunee site (5 miles north of PBNP) had slightly elevated composite tritium at 495 ± 101 pCi/L. The other location composites had tritium concentrations ranging from 8 ± 77 to 142 ± 85 pCi/l, all below the MDC of 160 pCi/L. Additional analysis showed that the elevated result value occurred in October 2019 with a concentration of 1282 ± 147 pCi/L. The other three sample locations south of Kewaunee were obtained on the same day and had no detectable tritium observed. During that time Point Beach had one tritium discharge approximately 2 days before this sample was obtained. The concentration of the Point Beach discharge was 3.03E+04 pCi/L. Since Kewaunee has not discharged since August 2018, there is potential that due to the lake current there is a potential that the Point Beach discharge had an impact on the observed elevated tritium concentration.

In conclusion, the observed tritium concentrations were well below the limit set forth by the EPA for drinking water standards (20,000 pCi/L). As well, based on the results of the gamma scans of Lake Michigan water, there is no measurable impact on the lake from PBNP discharges.

11.5 Algae

Filamentous algae attached to rocks along the Lake Michigan shoreline are known to concentrate radionuclides from the water. Samples are obtained at Two Creeks Park and at the PBNP discharge (locations 5 and 12 in Figure 9-1). In order to allow the algae time to grow, typically samples are collected in August.

In 2019 no algae samples were obtained. There either were no algae present or it was located in an inaccessible location.

Algae sampling is not called for in either NUREG-0472 or 1301 the standard RETS documents. However, PBNP has continued to collect algae as a good practice to provide continuity between the current REMP and the pre-operational REMP.

11.6 Fish

Fourteen fish were analyzed in 2019 with thirteen exhibiting detectable amounts of plant related activity. Of these, nine were positive for Cs-137 with 3 Cs-137 results >MDC. No other radionuclide has a positive result >MDC. The positive Cs-137 concentrations ranged from 0.020 ± 0.012 to 0.057 ± 0.033 pCi/g. In 2019 PBNP did not release any Cs-137 until December. It is likely that the Cs-137 observed is

the recycling of Cs-137 that entered Lake Michigan as fallout from atmospheric weapons testing in the '50s and '60s with lesser amounts from events at Chernobyl and Fukushima.

Positive results below their MDCs were found also for Fe-59, Co-58, and Ru-103. It is concluded that these results are false positives.

The highest radionuclide concentration in fish is naturally occurring K-40 with an average concentration of 3.32 ± 0.54 pCi/g.

Based on these results, it is concluded that there is little impact of PBNP discharges on Lake Michigan fish.

11.7 Well Water

No detectable nuclides were identified in the 2019 deep well water samples. Therefore, there is no evidence of PBNP effluents getting into the aquifer supplying drinking water to PBNP.

11.8 Soil

Cs-137 is present in the soils throughout North America and the world resulting from the atmospheric nuclear weapons testing in the 1950s, 1960s, and 1970s and from the 1986 Chernobyl accident, and more recently, from the Fukushima event. Soil is an integrating sample media, in that it is a better indicator of long term buildup of Cs-137 as opposed to current deposition for local sources. In addition to erosion and radioactive decay, human activities can modify the soil Cs-137 concentrations.

In 2019, Cs-137 was detected in seven of the eight soil samples obtained in October. The concentrations ranged from 0.021 ± 0.01 to 0.163 ± 0.03 and all were >MDC . The highest values for Cs-137 were found at E-08 and control location E-20, with concentrations of 0.157 ± 0.03 and 0.163 ± 0.03 respectively. No airborne release of Cs-137 occurred in 2019, with the most recent release of airborne Cs-137 occurring approximately two years prior in October 2017 for a total of 0.237 µCi at a concentration of 1.96E-08 pCi/cc.

Therefore, it seems unlikely that the observed soil Cs-137 is attributable to PBNP effluent, especially since the control location contained the highest observed concentration of Cs-137 observed in 2019. The most likely source is recycling of fallout from atmospheric weapons testing in the 50s and 60 as well as the Chernobyl and Fukushima events and subsequently being bound to the soil.

By comparison to naturally occurring radionuclides, Cs-137 continues to be present in soil samples at well below the levels of naturally occurring Be-7, K-40, and Ra-226 (see Table 10-1).

11.9 Shoreline Sediment

Shoreline sediment consists of sand and other sediments washed up on the Lake Michigan shore. As in soil samples, the only non-naturally occurring radionuclide found in these samples is Cs-137. Four of the five sample locations were obtained

in 2019. One of the locations north of the plant (E-05) was unobtainable due to high lake water and unsafe sampling conditions. Two of the four samples obtained had Cs-137 concentrations statistically different from zero with one result being >MDC.

Shoreline sediment Cs-137 concentrations continue to be about one-tenth of that found in soils (Table 10-1). This is expected because Cs-137 in the geological media is bound to fine particles, such as clay, as opposed to the sand found on the beach. Lake Michigan sediments are a known reservoir of fallout Cs-137. Wave action suspends lake sediments depositing them on the beach. The fine particles deposited on the beach eventually are winnowed from the beach leaving the heavier sand; hence the lower Cs-137 concentrations in beach samples. In contrast to Cs-137, K-40, which is actually part of the minerals making up the clay and sand, is at a concentration about several hundred times higher than the Cs-137 that is attached to particle surfaces. Therefore, it is not surprising that Cs-137 is present at concentrations 1% or less of the naturally occurring concentrations of K-40.

The most likely source of the observed Cs-137 is the cycling of fallout from atmospheric weapons tests and event such as Chernobyl and Fukushiima in the Lake Michigan environment and not current PBNP discharges. As with soil, the naturally occurring radionuclides such as K-40, and Ra-226 are found in the shoreline sediment samples. Therefore, the shoreline sediment data indicate no radiological effects from current plant operation.

11.10 Vegetation and Crops

The REMP collects two general types of vegetation within the site. The first consists of general vegetation, non-cultivated plants which would be consumed by grazing cattle. The second consists of crops grown on site acreage licensed to farmers, about half the site's 1400 acres, for growing feed crops for cattle. Nine samples of cultivated crops (corn, hay, alfalfa, and soybeans) grown on this acreage were obtained for analyses, one of the locations was not planted in 2019.

The naturally occurring radionuclides Be-7 and K-40 were found in all of the general vegetation and crop samples (Tables 10-1 and 10-2). The source of Be-7 is atmospheric deposition. It is continuously formed in the atmosphere by cosmic ray spallation of oxygen, carbon, and nitrogen atoms. Spallation is a process whereby a cosmic ray breaks up the target atom's nucleus producing a radionuclide of lower mass. Be-7 was lower in the crop samples with an average of 0.87 ± 0.60 pCi/g, when compared to the vegetation samples that had an average of 2.54 ± 1.94 pCi/g. In general vegetation Be-7 concentrations were higher and ranged from 0.38 ± 0.22 to 7.75 ± 0.46 pCi/g, in comparison to the concentrations in the crop samples that range from 0.063 ± 0.057 to 1.596 ± 0.22 pCi/g. The average concentrations in the vegetation increased from May (0.93 ± 0.30 pCi/g) to September (4.70 ± 1.87), and when compared to the crops that were obtained in September shows that the vegetation is about 5 times higher than the crop samples for Be-7. In contrast, K-40 is a primordial radionuclide which is incorporated into vegetation from the soil during the growing process. By not being dependent upon seasonal atmospheric variations and plant surface to capture deposition, the vegetation K-40 concentrations from root uptake are more uniform with a range of 2.85 ± 0.37 to 6.93 ± 0.57. In crops, similar to vegetation, the K-40 is higher than

Be-7. Similar to Be-7 as well, the crops K-40 average of 3.50 ± 1.34 pCi/g is lower than the average vegetation K-40 average of 5.28 ± 0.90 pCi/g.

Cs-137 can be present in vegetation via both pathways. Fresh Cs-137 fallout is associated, like Be-7, with deposition on the plant surface. Old fallout from the '50s and '60s is now being incorporated into growing plants in the same manner as potassium because it is in the same chemical family as potassium. This fallout Cs-137 has been found in firewood ash at many locations in the United States that are far from any nuclear plants (S. Farber, "Cesium-137 in Wood Ash, Results of a Nationwide Survey," 5th Ann. Nat. Biofuels Conf., 10/21/1992).

No Cs-137 was detected in the crop samples. In 2019, three of the twenty-four vegetation samples had a positive indication for Cs-137 and only two locations in September had results that were above the MDC. E-01 had a result of 0.016 ± 0.010 (MDC was 0.015) and E-06 had a result of 0.087 ± 0.027 (MDC was 0.027). The other positive result was below the MDC and was found at E-06 in May. Typically, only the vegetation collected at monitoring site E-06, in the Point Beach State Park south of PBNP, has detectable levels of Cs-137. The positive results from 2016 through 2018 were from E-06. These occurrences were attributed to the above described mechanism. The only 2016 airborne Cs-137 discharged by PBNP occurred in March when there was no fresh vegetation. In 2017 the airborne Cs-137 release occurred in October after the vegetation and crops were collected, and in 2018 and 2019 there was no airborne Cs-137 released in plant effluents. Therefore, the Cs-137 has to be the result of uptake via roots. Therefore, it is unlikely that the Cs-137 results indicate an impact from PBNP releases.

No Cs-134 or Co-60 were detected in the crop samples. In the vegetation samples no positive Cs-134 results were obtained in the 2019 samples. Two samples contained positive results for Co-60 at E-09 in July and E-04 in September, both results were below the MDC. Since no Cs-134 was released in 2019, and the Co-60 released occurred in March and April of 2019, these results are likely a false positives.

In 2019, I-131 was detected in one crop sample at E-F5, but was below the MDC. In the vegetation, the I-131 was identified in May at E-09, and at E-01 and E-02 in July. I-131 was released from the site in March and April of 2019 prior to the growing season. Therefore the I-131 results are considered to be false positives.

Based on the 2019 crop and general vegetation sampling results, it is concluded that there is little or no effect from PBNP effluents.

11.11 Land Use Census

In accordance with the requirements of Section 12.2.5 of the ODCM, a visual verification of animals grazing in the vicinity of the PBNP site boundary was completed in 2019. No significant change in the use of pasturelands or grazing herds was noted. Therefore, the existing milk-sampling program continues to be acceptable. The nearest dairy (E-21) lies in the SSE sector and it is one of the Point Beach REMP milk sampling sites. This dairy leases land in the S and SSE sectors at the PBNP site boundary for growing feed corn. Also, the highest χ/Q (1.09E-06) and D/Q (6.23E-09) values occur in these sectors. As demonstrated

from the analyses of feed crops, there is no measureable plant impact on the crops grown on site by this dairy. Therefore, dose calculations to the maximum exposed hypothetical individual, assumed to reside at the site boundary in the S sector, continues to be conservative for the purpose of calculating doses via the grass-cow-milk and the other ingestion pathways. The 2017 LUC revealed no changes that would necessitate changes to the current REMP, such as the addition of new sampling locations.

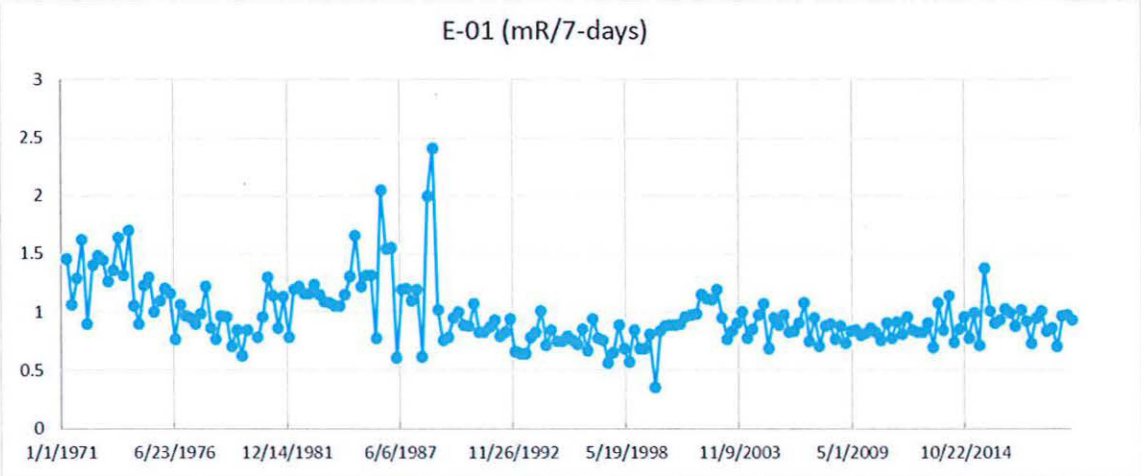
11.12 Long Term TLD Trending

To put the 2019 REMP TLD results in perspective, it is instructive to look at long term trends. The following examines the TLD results from 1971 to 2019. The ANSI standard (ANSI/HPS N13.37-2014 "Environmental Dosimetry) states that the data from early vintage dosimetry systems (c. 1970 – 1990) should not be considered comparable to current dosimetry systems in establishing a baseline for environmental TLD results. These problems are evident from the review of our early data as discussed below.

The pre-operational data, 1968 – 1970, are not included. The pre-operational ambient radiation monitoring sites were E-01 (the met tower area) through E-04 (the north boundary). They were monitored using TLDs and ionization chambers. E-04 was used as a background location until E-08 (see Figure 9-1) was added for the operational REMP in 1971. Prior to 1975, a control TLD stored in a lead pig was used for a comparison to those placed in the field. In the pre-operational data, the control TLD could be equal to or higher than the field results and both the field and control TLD results appear erratic compared to the ion-chamber results. Also, the reported TLD results do not have transportation exposures from New Mexico to Wisconsin subtracted. Therefore, only the TLD results beginning in 1971, with the transportation caveat, are used in this analysis of long-term trends.

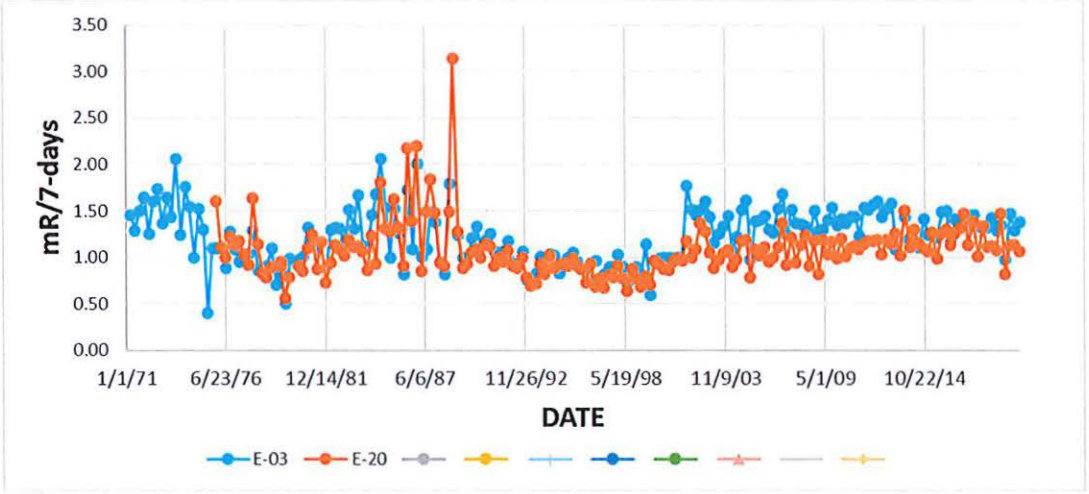
The trend at E-01(Figure 11-7) shows slowly decreasing *trend* from 1971 to 1979. This is may be an artifact. The cause is not known. As previously mentioned, no transportation controls were used until the 4th quarter of 1975 so no transport dose corrections were made prior to that quarter. There is a small increase in 1980 when the current contracted REMP lab began. A slowly decreasing exposure rate occurs from 1980 – 1992 except for the 1984 - 1988 time segments. The erratic results from 1984 – 1988 were traced to a faulty connection in the TLD reader.

Figure 11-7 E-01 Results 1971 – 2019



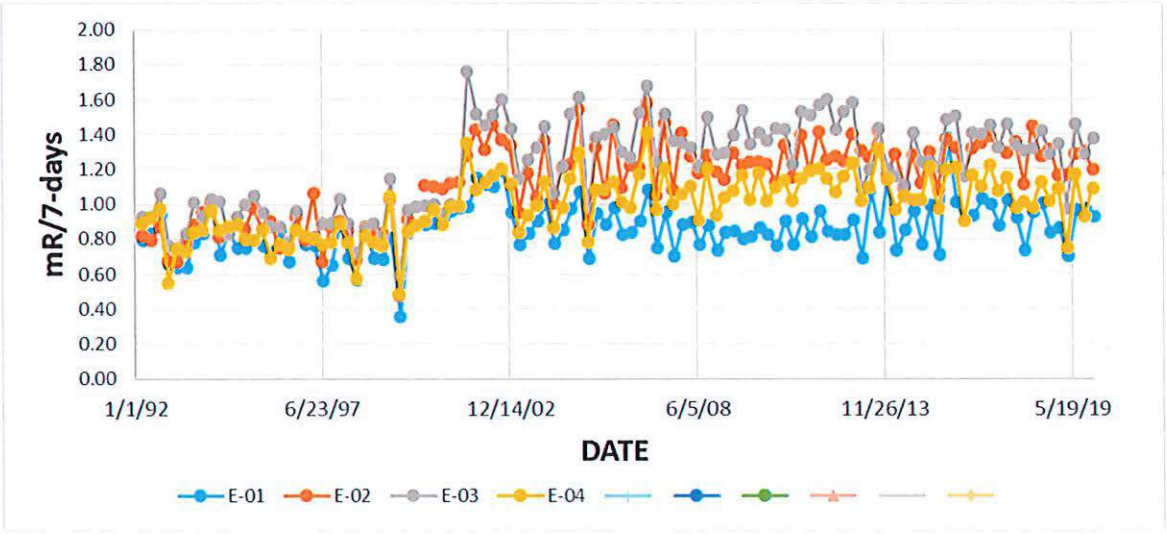
The TLD package from 1980 to 2001 consisted of three LiF chips sealed in a black plastic bag. The magnitude of the error bars indicates the degree of variability of the 1984 - 1988 results from the three chips due to a fault in the TLD reader. The results appear much the same for the E-03 and E-20 results (Figure 11-8). Note that E-20 did not begin until 1976. Again, there is an increase in both the E-20 (the background site) and E-03 (the location nearest the ISFSI) which coincides with the switch from the LiF chips to the Teflon TLD cards. Given that the first twelve casks were loaded December 1995 to September 2000 in which there were no increases in the TLD results, the increase in 2001 indicates that this change is the result of the different response of the new TLDs and not of any effluents or shine from the plant.

Figure 11-8 Comparison of E-03 and E-20 Results 1971 – 2019



Narrowing the time window for the TLD results from 1992 to the present allows for a comparison among the original four TLD locations since the introduction of the ISFSI (Figure 11-9) without the interference by the faulty TLD reader in the mid-1980s. Sites E-01 and E-02 are about 1 mile south of the ISFSI. E-03 is 1200 feet west and E-04 is 4300 feet north.

Figure 11-9 Comparison of E-01, E-02, E-03 and E-04 (1992 –2019)



The comparison shows a definite difference between E-01 and the other three locations. E-01, although approximately the same distance from the ISFSI as E-02 and further away than either E-03 or E-04, is lower than the other three sites. Therefore, distance is not the determining factor in the difference among the measured exposures. There are two factors which could cause the observed difference. The first difference is that E-02, E-03, and E-04 are surrounded by plowed fields whereas the area around E-01 is uncultivated. Second, E-01 is within 100 feet of the lake. Therefore, about 50% of the area contributing natural radiation to the location is a combination of sandy soil, beach sand, and lake water. As seen from the REMP soil and beach analyses, the soil at E-01 show a lower concentration of K-40 at E-01 verse E-02, E-03, E-04. Concentrations of K-40 are 13.35 pCi/g at E-01 vs. 16.6 pCi/g average at E-02, E-03, and E-04. As seen from the REMP soil and beach sediment analyses, the beach sands at E-01 have lower K-40 (5.95 pCi/g) concentrations than the soil at E-01. However, since E-01 has a combination of different natural radiation contributors (beach sand, lake water, and soil), that could explain the lower results that are observed at E-01.

The impact of the ISFSI on the ambient radiation levels at its nearest site boundary, the west boundary is shown in Figure 11-10. The ISFSI impact on ambient exposure levels was addressed briefly in Section 11.1 (see Figure 11-2).

Figure 11-10 E-03, E-31, E-44 and Background Site E-20 Results 1992 to 2019

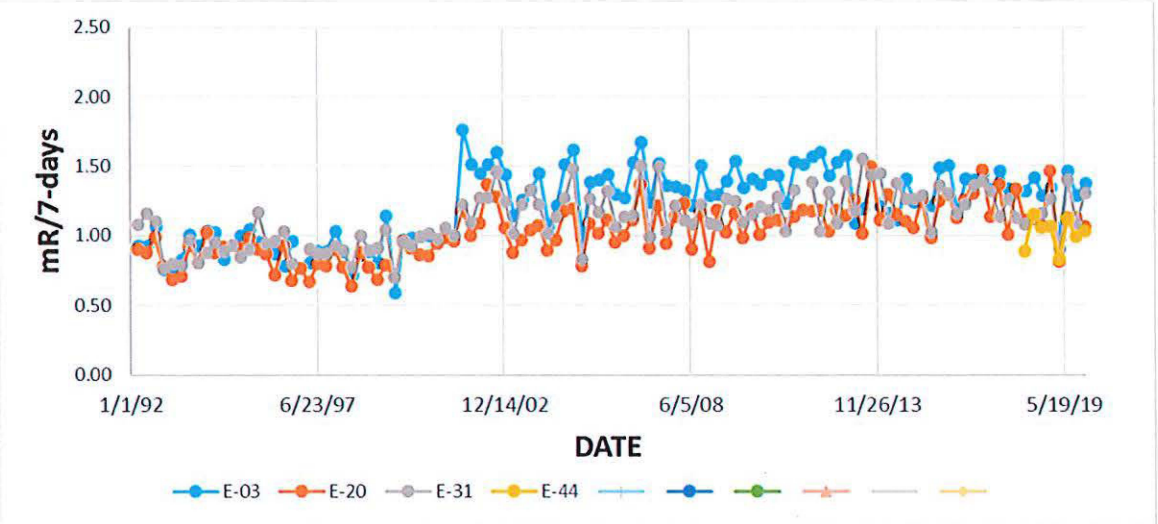


Figure 11-2 shows that beginning with the use of the Teflon TLD cards in the fourth quarter of 2000, the measured exposure levels at E-03 are 2 – 5 mR/7-days lower than the exposures at the west fence of the ISFSI. Figure 11-10 shows that although their individual 95% confidence levels overlap indicating no statistical difference, the quarterly exposures at E-03 (about 1200 feet from the ISFSI) are consistently higher than the exposure at E-31 (at the site boundary about 1400 feet west of E-03). Therefore, the lower values at E-31 compared to E-03 appear to be a real difference as the distance from the ISFSI increases at the west boundary. Because land usage and location are similar at E-03 and E-31, the cause of the previously identified response differences between E-03 and E-01 are not applicable. Therefore, the lower results at the site boundary location E-31 show that the exposures from the ISFSI are dropping off and approaching the lower readings found at the background site E-20.

12.0 REMP CONCLUSION

Based on the analytical results from the 795 environmental samples (755 individual samples with an additional 24 quarterly air particulate composites and 16 quarterly lake water composites) together with 131 REMP + 16 ISFSI sets of TLDs that comprised the PBNP REMP for 2019, PBNP effluents had no discernable effect on the surrounding environs. The calculated effluent doses are below the 10 CFR 50, Appendix I dose objectives demonstrate that PBNP continues to have good controls on effluent releases. The control of effluents from PBNP continues to be acceptable pursuant to the ALARA criteria of 10 CFR 50.34a. Additionally, when the TLD results are factored in to the overall exposure, the resulting doses are lower than the ISFSI (10 CFR 72.104) and EPA (40 CFR 190) limits of 25 mrem whole body, 75 mrem thyroid, and 25 mrem any other organ.

From the long-term analysis of TLD results, there is no evidence of elevated ambient radiation levels from the operation of Point Beach and the ISFSI except for the slightly higher exposures measured at the site boundary (E-31) compared to the background reference site (E-20) [see Figure 11-10].

Part D
GROUNDWATER MONITORING

13.0 PROGRAM DESCRIPTION

PBNP monitors groundwater for tritium as part of the Groundwater Protection Program (GWPP). The GWPP supports NEI 07-07, the nuclear industry's groundwater protection initiative. The GWPP also fulfills the requirement of 10 CFR 20.1501(a) to make surveys of areas, including to subsurface in order to comply with Part 20. During 2019 the sampling program consisted of beach drains, intermittent stream and bog locations, drinking water wells, façade wells, yard electrical manholes, ground water monitoring wells, and the subsurface drainage (SSD) system sump located in the U-2 façade.

In the late 1970s, the beach drains entering Lake Michigan were found to contain tritium. The beach drains are the discharge points for yard drainage system, which carries storm water runoff, and are known to be infiltrated by groundwater as observed by discharges even when no rain has occurred. In the 1980s, the source of tritium for this pathway was postulated to be spent fuel pool leakage into the groundwater under the plant. Based on this observation, modifications were made to the pool, and the tritium concentrations decreased below the effluent LLDs. Beach drain effluents continue to be monitored and are accounted for in the monthly effluent quantification process. Because the beach drains are susceptible to groundwater in-leakage from other sources such as the area around the former retention pond which is known to contain tritium, the beach drains are monitored as part of the groundwater monitoring program. In addition to tritium, groundwater beach drain samples also are gamma scanned for the same suite of radionuclides as lake water using the lake water LLDs.

Three intermittent stream locations and the Energy Information Center (EIC) well were added to the groundwater monitoring program in the late 1990s when it was discovered that tritium diffusion from the then operable, earthen retention pond was observable in the intermittent streams which transverse the site in a NW to SE direction. A fourth stream location closer to the plant was added in 2008. These streams pass on the east and west sides of the former retention pond and empty into Lake Michigan about half a mile south of the plant near the meteorological tower. The intermittent stream samples track tritium in the surface groundwater.

The groundwater monitoring program also includes two bogs / ponds on site. One is located about 400 feet SSE of the former retention pond; the other, about 1500 feet N between Warehouses 6 and 7.

In addition to the main plant well, four other drinking water wells are monitored. The Site Boundary Control Center well, located at the plant entrance, the Warehouse 6 well, on the north side of the plant, and the EIC well, located south of the plant. In 2012, a new building (Warehouse 7) was constructed for radwaste. The well for this building was added to the GWPP. These wells do not draw water from the top 20 - 30 feet of soil which is known to contain tritium. These wells monitor the deeper (200 - 600 feet), drinking water aquifer from

which the main plant well draws its water. The two soil layers are separated by a gray, very dense till layer of low permeability identified by hydrological studies.

Manholes in the plant yard and for the subsurface drainage (SSD) system under the plant are available for obtaining ground water samples. The plant yard manholes for accessing electrical conduits are susceptible to ground water in-leakage. Therefore, a number of these were sampled. The SSD system was designed to lessen hydrostatic pressure on the foundation by controlling the flow of water under the plant and around the perimeter of the foundation walls. The SSD system flows to a sump in the Unit 2 facade. The sump was sampled twelve times during 2019.

Due to flooding concerns, man-holes and clean-outs for the SSD were sealed in 2014. Therefore, only the SSD sump now is used for sampling.

In the 1990s, two wells were sunk in each unit's façade to monitor the groundwater levels and look for evidence of concrete integrity as part of the ISI IWE Containment Inspection Program. These wells are stand pipes which are sampled periodically for chemical analyses. Façade well sampling has been part of the GWPP since 2007. These wells are sampled quarterly.

Rising lake levels and rip-rap added for flooding protection have impacted beach drain sampling. Beach drain S-1 has been sampled most frequently, eleven out of twelve months. High lake levels had washed away the access to beach drain S-3 south of the U2 discharge, but was repaired November 2019 with sampling only occurring three times during 2019. S-7, S-8, and S-10 were available but had no flow. S-9 was available once during 2019, and at other times when accessible the locations had no flow. S-12 and S-13 are impacted by high lake levels and rip-rap. However, one sample was available from both S-12 and S-13 in 2019. Additional wave run up rip-rap was placed around the shoreline in November 2019 to prevent additional high lake level impacts and erosion.

The groundwater sampling sites (other than the beach drains, SSDs and manholes) are shown in Figure 13.1.

Figure 13-1 Groundwater Monitoring Locations

14.0 RESULTS AND DISCUSSION

14.1 Streams and Bogs

The results from the surface groundwater monitoring associated with the former retention pond are presented in Table 14-1. For the most part, the creek results are barely above the detection level and less than the MDC. The highest averages are for the East Creek and STP which are in the groundwater flow path from the retention pond area to Lake Michigan. The West Creek is west of the former retention pond, an upstream location with respect to the groundwater flow. The tritium concentration at GW-08, close to the former retention pond, is about one-tenth of the tritium concentrations it had prior to the remediation of the retention pond.

Table 14-1 Intermittent Streams and Bogs
H-3 Concentration (pCi/l)

Month	GW-01(E-01)	GW-02	GW-03	GW-17	BOGS		MDC
	Creek Confluence	E. Creek	W. Creek	STP	GW-07	GW-08	
Jan	ND ±	102 ± 86	ND ±	87 ± 86			177
Feb	NS ±	NS ±	NS ±	NS ±			
Mar	103 ± 79	171 ± 82	ND ±	154 ± 82			155
Apr	ND ±	97 ± 79	ND ±	196 ± 84			156
May	ND ±	215 ± 83	ND ±	238 ± 85	ND ±	200 ± 83	149
Jun	ND ±	160 ± 79	ND ±	421 ± 91			150
Jul	ND ±	ND ±	ND ±	ND ±			159
Aug	127 ± 79	238 ± 85	102 ± 78	96 ± 77			155
Sep	ND ±	209 ± 85	ND ±	204 ± 84			151
Oct	ND ±	158 ± 79	ND ±	108 ± 77			151
Nov	D ±	135 ± 80	ND ±	188 ± 83			156
Dec	NS ±	NS ±	NS ±	NS ±			
Average	46 ± 42	155 ± 57	40 ± 29	175 ± 105			

A blank indicates no sample was scheduled. Streams are sampled monthly; bogs, annually.

Values are presented as the measured value and the 95% confidence level counting error.

ND = not statistically different from zero at the 95% confidence level. NS= No sample available

The analyses of these surface water samples show low concentrations of tritium. Although 2 small positive tritium concentrations occur in samples from the confluence of the two creeks (GW-01), none of the concentrations are above the MDC. None of the West Creek (GW-03) samples had tritium above its MDC. In contrast, there are more positive results from GW-02 (south end of the East Creek) and GW-17 (located at the north end of the East Creek). GW-17 is east of the former retention pond area in the groundwater flow path to Lake Michigan.

The bog (GW-08) SE of the former retention pond is higher than the bog at GW-07 north of the former retention pond. The lower tritium value at GW-07 indicates that the impact of groundwater flow from the retention pond area is not to the north. These results are in conformance with the west to east groundwater flow described in the Site Conceptual Model and the FSAR. The GW-08 bog result is down from the 3200 - 3800 pCi/l seen in 1999 before the retention pond was remediated.

14.2 Beach Drains

The 2019 results for the beach drains that were sampled are presented in Table 14-2. S-1 collects yard drainage from the north part of the site yard; S-3, from the south. Drains S-8 and S-9 carry water from the lake side yard drains whereas drains S-7 and S-10 are from the turbine building roof. S-12 is a drain from the external SSD which run along the outside northern half of the foundation wall, and S-13 is the south external SSD drain. They are not connected to the internal SSD under the plant which drains to a sump in the U2 façade.

Table 14-2
2019 Beach Drain H-3 Concentration (pCi/l)

Month	S-1	S-12	S-8	S-9	S-13	S-3	MDC
Jan	186 ± 79	NF ±	NF ±	NF ±	NF ±	NF ±	147
Feb	NF ±	NF ±	NF ±	NF ±	NF ±	NF ±	
Mar	458 ± 96	NF ±	NF ±	631 ± 103	NF ±	326 ± 90	154
Apr	277 ± 88	NF ±	NF ±	NF ±	NF ±	NF ±	155
May	270 ± 86	NF ±	NF ±	NF ±	NF ±	NF ±	150
Jun	253 ± 84	NF ±	NF ±	NF ±	NF ±	NF ±	150
Jul	209 ± 83	NF ±	NF ±	NF ±	NF ±	NF ±	149
Aug	280 ± 91	NF ±	NF ±	NF ±	NF ±	NF ±	153
Sep	265 ± 87	NF ±	NF ±	NF ±	234 ± 85	NF ±	154
Oct	471 ± 96	NF ±	NF ±	NF ±	NF ±	NF ±	147
Nov	205 ± 83	NF ±	NF ±	NF ±	NF ±	216 ± 84	154
Dec	360 ± 90	305 ± 88	NF ±	NF ±	NF ±	265 ± 86	150
Avg =	294 ± 96	305 ± 88	NF ±	631 ± 103	234 ± 85	269 ± 55	

ND = not detected and ≤MDC NS = no sample
NF = no sample due to no flow

The tritium concentrations at S-1 and S-3 are consistent with results from previous years. S-9, the south lake side yard drain was sampled once in March with a detectable tritium result. There were no known sources of tritium that would have caused an elevated result, and this result may be attributable to tritium recapture in precipitation. High lake levels and the addition of rip-rap around some of the beach drains to prevent shoreline erosion and to address flooding concerns, it is not possible to sample from the other beach drains most of the year. However, the results from available samples are consistent with other groundwater results from various streams and manholes.

Gamma scans were performed on the beach drain samples at the LLD used for lake water. A few indications of small, positive concentration values below their MDCs were found for Ba-La-140, Co-58, Co-60, and Fe-59. All the positive results were below their MDCs. Therefore, it is concluded that all the gamma results are false positives. This leaves tritium as the only PBNP radionuclide positively found in the beach drains.

14.3 Electrical Vaults and Other Manholes

Manholes for access to below ground electrical facilities are susceptible to groundwater in-leakage. The manholes east side of the plant, between the Turbine building and Lake Michigan have low tritium concentrations (Table 14-3). Z-065A

and Z-065B are located on the west side of the pump house. Manholes, Z-066A and Z-067A through Z-066D and Z-067D are between the pump house and the turbine building and run in parallel in the NE section of the yard beginning just north of the Unit 2 truck bay and run from the Unit 2 truck bay north to the EDG building. Z-068 is located just west of the EDG building and north of Z-066/067D. Each of the two A, B, C, and D vaults is side by side. The similarity of the May and September Z-068 tritium values is similar to the S-1 beach tritium values.

Table 14-3
2019 East Yard Area Manhole Tritium (pCi/l)

MH	5/2/2019	9/18/2019
Z-065A(M-1)*	NS ±	225 ± 83
Z-065B(M-2)*	NS ±	218 ± 83
Z-066A	231 ± 85	174 ± 80
Z-067A	261 ± 86	231 ± 84
Z-066B	ND ±	119 ± 77
Z-067B	267 ± 87	128 ± 78
Z-066C	97 ± 78	135 ± 78
Z-067C	288 ± 88	168 ± 80
Z-066D	311 ± 89	256 ± 85
Z-067D	110 ± 79	205 ± 82
Z-068	229 ± 85	141 ± 79
MDC	154	152

*Sample Date 9/16/2019

14.4 Façade Wells and Subsurface Drainage System

There are two methods of sampling the groundwater under the plant foundation. The first is a set of four shallow wells, two in each façade. The other is a subsurface drainage system (SSD). The façade wells were installed to monitor for groundwater conditions which may affect the integrity of the concrete and rebar of each unit's foundation. The SSD was designed to relieve hydrostatic pressure on each unit's foundation as well as the Auxiliary and Turbine buildings.

The façade wells are not located symmetrically in the two units. The Unit 1 façade wells are east of the containment in the SE (1Z-361A) and NE (1Z-361B) corners of the façade. However, in Unit 2, there is one well in the NW corner (2Z-361A) and the other rotated approximately 180° in the SW corner (2Z-361B). In each the well cap is level with the floor.

The 2019 façade well tritium results are shown in Table 14-4. The Unit 1 wells continue to have higher tritium concentrations than the U2 wells with 1Z-361A, in the SE corner of the Unit 1 façade, having the highest tritium concentrations.

In addition to tritium analysis, the façade wells were gamma scanned. As in lake water samples, small positive values below their calculated, minimum detectable concentrations were found for Mn-54, Co-58, Co-60, Zn-65, and Cs-137. Elevated Co-58 and Co-60 was observed in the vendor results of the Unit 2 façade well, 2Z-361A on April 3rd 2019. No other façade well location observed elevated results, no tritium was detectable in the 2Z-361A sample, and the samples were analyzed on site prior to being shipped to the vendor and were all less than the MDA.

Reanalysis of the vendor gamma from the April 3rd 2019 samples show that the results were valid and repeatable. Hard-to-detect (HTD) radionuclides (Fe-55, Ni-63, Sr-89, Sr-90, and Tc-99) were analyzed for in all of the April 3rd 2019 façade well samples and all results were not detectable, except for Ni-63 in 2Z-361A. A follow up set of façade well samples was obtained on April 23rd 2019 at all façade well locations, and the 2Z-361A location was all less than the MDC for gamma and HTD radionuclides. A third sample was obtained in May 2019 for 2Z-361A once again confirming the samples were less than MDC at this location.

There are no known leaks in the general area of the façade wells. Therefore, based on the evidence of the April 3rd 2019 samples being less than the MDA when analyzed onsite prior to shipment to the lab, and there being no detectable tritium, it is concluded that the 2Z-361A façade well sample from that date was contaminated during transport or when it arrived to the vendor lab, and does not reflect an impact from plant operations.

Table 14-4
2019 Facade Well Water Tritium (pCi/l)

Month	UNIT 1		UNIT 2		MDC
	1Z-361A	1Z-361B	2Z-361A	2Z-361B	
January	125 ± 84	ND ±	ND ±	ND ±	156
April 3rd	199 ± 86	104 ± 81	ND ±	ND ±	153/156
April 23rd	137 ± 80	ND ±	ND ±	143 ± 80	150
May	NS ±	NS ±	ND ±	NS ±	150
July	187 ± 90	ND ±	ND ±	95 ± 86	162
October	254 ± 89	152 ± 84	ND ±	134 ± 83	157
ND = Not Detected and <MDC NS = No Sample					

To relieve hydrostatic pressure on the foundation, Point Beach has an external and an internal subsurface drainage system (SSD) to drain groundwater away from the foundation.

The internal SSD consist of perforated piping which drains groundwater by gravity to a sump located in the Unit 2 façade. A comparison of the 2016 through 2019 SSD results is presented in Table 14-5. In 2019, the tritium were similar as to what was observed in 2018. An increase was observed in the last quarter of 2019 because the subsurface drainage sump pump was out of service and the samples obtained were manual grab samples at one time during the month. There were no known system leaks and the SSD was not discharged from October 2019 until December 2019. The SSD is discharged via wastewater effluent system.

The SSD sump samples are scanned for gamma emitters. A few slightly positive values were found for Mn-54, Co-58, Fe-59, Cs-134, and Cs-137, all results were below the MDC. No HTD nuclides were observed in the October and November 2019 samples.

Table 14-5

2016 - 2019 Unit 2 Facade SSD Sump H-3 (pCi/l)

	2016		2017		2018		2019	
Date	pCi/l	2σ	pCi/l	2σ	pCi/l	2σ	pCi/l	2σ
Jan	499 ±	102	1058 ±	122	2634 ±	168	808 ±	110
Feb	510 ±	102	776 ±	107	2721 ±	169	923 ±	114
Mar	507 ±	99	765 ±	111	2217 ±	169	924 ±	116
Apr	572 ±	102	1635 ±	142	1107 ±	122	1580 ±	136
May	1018 ±	133	1503 ±	134	389 ±	98	1470 ±	131
Jun	1230 ±	125	854 ±	112	890 ±	113	1784 ±	146
Jul	1333 ±	128	907 ±	115	1225 ±	127	1681 ±	144
Aug	929 ±	116	1035 ±	115	1056 ±	119	1703 ±	143
Sep	615 ±	104	737 ±	105	803 ±	110	1412 ±	132
Oct	966 ±	119	8772 ±	284	1022 ±	116	8932 ±	291
Nov	1616 ±	140	7478 ±	265	852 ±	111	10877 ±	318
Dec	1523 ±	136	4165 ±	203	634 ±	106	5886 ±	240
Average	943 ±	410	2474 ±	2815	1296 ±	781	3165 ±	3444

The external SSD system runs along the external foundation walls for the Unit 1 and Unit 2 facades, the Auxiliary Building, the North Service Building, and the Turbine Hall. It is not connected to the internal SSD system. During 2014, work to mitigate the possibility of external flooding events uncovered the N (S-12) and S (S-13) external SSD outfalls. Both the north and south halves of the external SSD system drain toward the beach. One sample each from SSD S-12 and S-13 were obtained in 2019. The results ranged from 234 – 305 pCi/L, which is comparable to the concentrations found in various manholes (Table 14-3) on the east side of the plant during 2019.

14.5 Potable Water and Monitoring Wells

Outside of the protected area, ten wells, in addition to the main plant well (Section 11.7), are used for monitoring tritium in groundwater: the four potable water wells, GW-04 (Energy Information Center or EIC), GW-05 (Warehouse 6), GW-18 (Warehouse 7), GW-06 (Site Boundary Control Center), and six tritium groundwater monitoring wells, GW-11 through GW-16 (Figure 13-1).

The potable water wells monitor the deep, drinking water aquifer whereas the monitoring wells penetrate less than 30 feet to monitor the top soil layer. The potable water aquifer is separated from the shallow, surface water aquifer by a thick, clay layer with very low permeability. The potable water wells had no detectable tritium (Table 14-6). GW-04 had three slightly positive results for Cs-134, Ba-La-140, and Mn-54. All results were below the MDC and determined to be false positives.

Table 14-6

2019 Potable Well Water Tritium Concentration (pCi/l)

Month	EIC WELL GW-04	EIC MDC	Warehouse 6 Well GW-05	SBCC Well GW-06	WH 7 GW-18	GW-05, 06, 18 MDC
Jan	ND	177	ND	ND	ND	177
Feb	ND	157				
Mar	ND	155				
Apr	ND	156	ND	ND	ND	152
May	ND	149				
Jun	ND	150				
Jul	ND	159	ND	ND	ND	152
Aug	ND	155				
Sep	ND	153				
Oct	ND	150	ND	ND	ND	151
Nov	ND	156				
Dec	ND	160				

ND= not detected

The monitoring well results are similar to those obtained in 2018. The two monitoring wells showing higher and consistently detectable tritium (GW-15, GW-16) are in the flow path from the retention pond area to the lake (Table 14-7).

Table 14-7
2019 Quarterly Monitoring Well Tritium (pCi/l)

Q	MW-01 GW-11	MW-02 GW-12	MW-06 GW-13	MW-05 GW-14	MW-04 *GW-15	MW-03 *GW-16	MDC
1	91 ± 78	ND ±	ND ±	ND ±	91 ± 78	NS ±	156
2	94 ± 77	ND ±	ND ±	160 ± 81	124 ± 79	202 ± 83	150
3	153 ± 84	ND ±	157 ± 85	178 ± 86	200 ± 87	144 ± 84	153
4	93 ± 78	ND ±	84 ± 77	142 ± 80	175 ± 82	304 ± 89	156

ND= not statistically different from zero and <MDC. NS = no sample available
*Duplicate samples taken, highest value reported.

In summary, the results from monitoring wells GW-15 and GW-16 as well as results from the nearby surface water sample locations (GW-03, the east creek; GW-08, the bog to the SE of the former pond; and GW-17, the surface water on the SE corner of the STP) show that the area around and in the groundwater flow path from the former retention pond remain impacted by the tritium that diffused from the pond into the soil while it was in use.

14.6 AC Condensate Samples

The results from the airborne tritium recapture study presented in the 2011 AMR demonstrated that the tritium via precipitation was higher close to the plant than away from the plant. Additionally, it was shown that the condensate from AC units located on building roofs and within the plant contained high concentrations of H-3. Similar results for AC condensate were demonstrated in 2012, 2013, 2014, and 2016. Based on this information AC Condensate samples were moved to a three

year periodicity and were obtained in 2019 showing similar results as were previously observed. A comparison of the results is shown in Table 14-9.

Table 14-8
AC Condensate Tritium Results
(2012, 2013, 2014, 2016, and 2019)

Location	2012 H-3 (pCi/l) 2σ	2013 H-3 (pCi/l) 2σ	2014 H-3 (pCi/l) 2σ	2016 H-3 (pCi/l) 2σ	2019 H-3 (pCi/l) 2σ
NSB (4th floor)	557 ± 102	478 ± 102	328 ± 101	NS	NS
Turbine Bldg 66'	998 ± 118	757 ± 112	527 ± 108	6096 ± 240	NS
S Service Bldg Roof	5822 ± 231	2606 ± 166	2690 ± 166	2911 ± 174	920 ± 114
South Gate Roof	473 ± 99	217 ± 91	173 ± 95	171 ± 85	ND
Turbine Bldg 8'	602 ± 104	1055 ± 123	874 ± 119	NS	ND
Training Bldg Roof	185 ± 86	203 ± 90	ND ±	ND	ND

NS = no sample ND = not detected, measured value - 2σ ≤ 0

These results show that the H-3 concentrations continue to be higher in the immediate vicinity of Units 1 and 2 (S. Service Building and Turbine Building) than at the Training Building, which is some 800 feet south. The higher concentrations occurring within the area of the yard drains feeding beach drains support the conclusion that precipitation scavenging and roof drains continue to be a source for the H-3 found in the beach drains.

15.0 GROUNDWATER SUMMARY

Groundwater monitoring indicates that low levels of tritium continue to occur in the upper soil layer but not in the deep, drinking water aquifer. These results also indicate that the low levels of tritium are restricted to a small, well defined area close to the plant. Results from precipitation analyses (2011 AMR) show that airborne tritium concentrations are higher close to the plant as compared to results at the site boundaries. The observed tritium concentrations in the yard manholes can be explained by the higher tritium in precipitation close to the plant. In addition to tritium captured by precipitation, the beach drains also receive the tritium captured in the AC condensate because the condensate drainage is connected to the yard drain system.

Tritium continues in the soil below the plant foundation as evidenced by results from the subsurface drainage system and from the façade wells.

In conclusion, the groundwater tritium concentrations observed at Point Beach are below the EPA drinking water standards prior to emptying into Lake Michigan where they will undergo further dilution. All analyses to date indicate that the drinking water contains no tritium. None of the tritium in the upper soil layer is migrating off-site toward the surrounding population. This is based on the known west-to-east groundwater flow toward Lake Michigan and the results from the two monitoring wells west of the plant (GW-12 and GW-13, Figure 13-1). Additionally, because no tritium is detected in either of the four on-site drinking water wells close to the power block or from the drinking water well at the site boundary, none of the tritium observed in the upper soil layer has penetrated into the drinking water aquifer to impact either on-site or off-site personnel.