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May 13, 2020

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TS 5.6.2
ISFSI TS 5.2

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

Prairie Island Nuclear Generating Plant, Units 1 and 2
Docket Nos. 50-282 and 50-306
Renewed Facility Operating License Nos. DPR-42 and DPR-60

Prairie Island Independent Spent Fuel Storage Installation
Docket 72-10
Renewed Materials License No. SNM-2506

2019 Annual Radiological Environmental Monitoring Program Report

Pursuant to Prairie Island Nuclear Generating Plant Technical Specification (TS) 5.6.2, Appendix A, to Renewed Operating Licenses DPR-42 and DPR-60, and Prairie Island Independent Spent Fuel Storage Installation Technical Specification (ISFSI TS) 5.2, Appendix A, to Materials License SNM-2506, Northern States Power Company, a Minnesota corporation, doing business as Xcel Energy (hereafter "NSPM"), submits one copy of the annual Radiological Environmental Monitoring Program report for the period January 1, 2019, through December 31, 2019, as Enclosure 1.

Summary of Commitments

This letter makes no new commitments and no revisions to existing commitments.

Scott Sharp
Vice President, Prairie Island Nuclear Generating Plant
Northern States Power Company – Minnesota

Enclosure

cc: Regional Administrator, USNRC, Region III
Project Manager, Prairie Island Nuclear Generating Plant, USNRC, NRR
NRC Resident Inspector, Prairie Island Nuclear Generating Plant
Director of NMSS, USNRC
Department of Health, State of Minnesota
PI Indian Community Environmental Coordinator

ENCLOSURE 1

Annual Report to the United States Nuclear Regulatory Commission

Radiological Environmental Monitoring Program

January 1 to December 31, 2019

77 Pages Follow

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XCEL ENERGY CORPORATION

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

ANNUAL REPORT
to the
UNITED STATES NUCLEAR REGULATORY COMMISSION

Radiological Environmental Monitoring Program

January 1 to December 31, 2019

Docket No. 50-282 Renewed Operating License No. DPR-42
Docket No. 50-306 Renewed Operating License No. DPR-60

ISFSI
Docket No. 72-10 Renewed License No. SNM-2506

Prepared under Contract by

ATI ENVIRONMENTAL, Inc.
MIDWEST LABORATORY

Project No. 8010

Approved: 

Ashok Banavali, Ph.D.
Laboratory Manager

PREFACE

The staff of Environmental, Inc., Midwest Laboratory was responsible for the acquisition of data presented in this report. Samples were collected by members of the staff of the Prairie Island Nuclear Generating Plant, operated by Northern States Power Co. –Minnesota, for XCEL Energy Corporation. The report was prepared by Environmental, Inc., Midwest Laboratory.

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1.0 INTRODUCTION

This report summarizes and interprets results of the Radiological Environmental Monitoring Program (REMP) conducted by Environmental, Inc., Midwest Laboratory at the Prairie Island Nuclear Generating Plant, Red Wing, Minnesota, during the period January - December, 2019.

This program monitors the levels of radioactivity in the air, terrestrial, and aquatic environments in order to assess the impact of the plant on its surroundings.

Tabulations of the individual analyses made during the year are not included in this report. These data are included in a reference document (Environmental, Inc., Midwest Laboratory, 2019b) available at Prairie Island Nuclear Generating Plant.

Prairie Island Nuclear Generating Plant is located on the Mississippi River in Goodhue County, Minnesota, owned by Xcel Energy Corporation and operated by Northern States Power Co.-Minnesota. The plant has two 575 MWe pressurized water reactors. Unit 1 achieved initial criticality on 1 December 1973. Commercial operation at full power began on 16 December 1973. Unit 2 achieved initial criticality on 17 December 1974. Commercial operation at full power began on 21 December 1974.

2.0 SUMMARY

The Radiological Environmental Monitoring Program (REMP) required by the U.S. Nuclear Regulatory Commission (NRC) Offsite Dose Calculation Manual for the Prairie Island Nuclear Generating Plant and the Independent Spent Fuel Storage Installation (ISFSI) is described. Results for 2019 are summarized and discussed.

Program findings show background levels of radioactivity in the environmental samples collected in the vicinity of the Prairie Island Nuclear Generating Plant.

3.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)

3.1 Program Design and Data Interpretation

The purpose of the Radiological Environmental Monitoring Program (REMP) at the Prairie Island Nuclear Generating Plant is to assess the impact of the plant on its environment. For this purpose, samples are collected from the air, terrestrial, and aquatic environments and analyzed for radioactive content. In addition, ambient gamma radiation levels are monitored by thermoluminescent dosimeters (TLDs).

Sources of environmental radiation include the following:

(1) Natural background radiation arising from cosmic rays and primordial radionuclides;

(2) Fallout from atmospheric nuclear detonations;

(3) Releases from nuclear power plants;

(4) Industrial and medical radioactive waste; and

(5) Fallout from nuclear accidents.

In interpreting the data, effects due to the plant must be distinguished from those due to other sources.

A major interpretive aid in assessment of these effects is the design of the monitoring program at the Prairie Island Plant which is based on the indicator-control concept. Most types of samples are collected both at indicator locations (nearby, downwind, or downstream) and at control locations (distant, upwind, or upstream). 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 fluctuations in radiation levels arising from other sources.

An additional interpretive technique involves analyses for specific radionuclides present in the environmental samples collected from the plant site. The plant's monitoring program includes analyses for tritium and iodine-131. Most samples are analyzed for gamma-emitting isotopes with results for the following groups quantified: zirconium-95, cesium-137, cerium-144, beryllium- 7, and potassium-40. The first three gamma-emitting isotopes were selected as radiological impact indicators because of the different characteristic proportions in which they appear in the fission product mix produced by a nuclear reactor and that produced by a nuclear detonation. Each of the three isotopes is produced in roughly equivalent amounts by a reactor: each constitutes about 10% of the total activity of fission products 10 days after reactor shutdown. On the other hand, 10 days after a nuclear explosion, the contributions of zirconium-95, cerium-144, and cesium-137 to the activity of the resulting debris are in the approximate ratio 4:1:0.03 (Eisenbud, 1963). Beryllium-7 is of cosmogenic origin and potassium-40 is a naturally-occurring isotope. They were chosen as calibration monitors and should not be considered radiological impact indicators.

The other group quantified consists of niobium-95, ruthenium-103 and -106, cesium-134, barium-lanthanum-140, and cerium-141. These isotopes are released in small quantities by nuclear power plants, but to date their major source of injection into the general environment has been atmospheric nuclear testing. Nuclides of the final group, manganese-54, iron-59, cobalt-58 and -60, and zinc-65, are activation products and arise from activation of corrosion products. They are typical components of a nuclear power plant's effluents, but are not produced in significant quantities by nuclear detonations.

3.1 Program Design and Data Interpretation (continued)

Other means of distinguishing sources of environmental radiation are employed in interpreting the data. Current radiation levels are compared with previous levels, including those measured before the plant became operational. Results of the plant's monitoring program can be related to those obtained in other parts of the world. Finally, results can be related to events known to cause elevated levels of radiation in the environment, e.g., atmospheric nuclear detonations.

3.2 Program Description

The sampling and analysis schedule for the radiological environmental monitoring program at Prairie Island is summarized in Table 5.1 and briefly reviewed below. Table 5.2 defines the sampling location codes used in Table 5.1 and specifies for each location its type (indicator or control) and its distance, direction, and sector relative to the reactor site or ISFSI facility, as appropriate. To assure that sampling is carried out in a reproducible manner, detailed sampling procedures have been prescribed (Prairie Island Nuclear Generating Plant, 2018). Maps of fixed sampling locations are included in Appendix D.

To monitor the airborne environment, air is sampled by continuous pumping at six stations, four site boundary indicators (P-2, P-3, P-4 and P-7), located in the highest calculated D/Q sectors, one community indicator (P-6), and one control (P-1). The particulates are collected on membrane filters, airborne iodine is trapped by activated charcoal canisters. Particulate filters are analyzed for gross beta activity and charcoal canisters for iodine-131. Quarterly composites of particulate filters from each location are analyzed for gamma emitting isotopes.

Offsite ambient gamma radiation is monitored at thirty-four locations, using $CaSO_4$:Dy dosimeters with four sensitive areas at each location: ten in an inner ring in the general area of the site boundary, fifteen in the outer ring within a 4-5 mile radius, eight at special interest locations, and one control location, 11.1 miles distant from the plant. They are replaced and measured quarterly.

Ambient gamma radiation is monitored at the Independent Spent Fuel Storage Installation (ISFSI) Facility by twenty $CaSO_4$:Dy dosimeters. Twelve dosimeters are located inside of the earthen berm in direct line of sight from the storage casks and eight dosimeters are located outside of the earthen berm. They are replaced and measured quarterly.

To monitor the terrestrial environment, green leafy vegetables (cabbage) are collected annually from the highest D/Q garden and a control location (P-38), and analyzed for gamma-emitting isotopes, including iodine-131. Corn is collected annually only if fields are irrigated with river water and analyzed for gamma-emitting isotopes. Well water and ground water are collected quarterly from five locations near the plant and analyzed for tritium and gamma-emitting isotopes.

River water is collected weekly at two locations, one upstream of the plant (P-5) and one downstream (P-6, Lock and Dam No.3). Monthly composites are analyzed for gamma-emitting isotopes. Quarterly composites are analyzed for tritium.

Drinking water is collected weekly from the City of Red Wing well. Monthly composites are analyzed for gross beta, iodine-131, and gamma-emitting isotopes. Quarterly composites are analyzed for tritium.

3.2 Program Description (continued)

The aquatic environment is also monitored by semi-annual upstream and downstream collections of fish, periphyton or invertebrates, and bottom sediments. Shoreline sediment is collected semi-annually from one location. All samples are analyzed for gamma-emitting isotopes.

3.3 Program Execution

The Program was executed as described in the preceding section with no exceptions for 2019.

3.4 Laboratory Procedures

The iodine-131 analyses in drinking water were made using a sensitive radiochemical procedure which involves separation of the iodine using an ion-exchange method, solvent extraction and subsequent beta counting.

Gamma-spectroscopic analyses were performed using high-purity germanium (HPGe) detectors. Levels of iodine-131 in cabbage and natural vegetation and concentrations of airborne iodine-131 in charcoal samples were determined by gamma spectroscopy.

Tritium concentrations were determined by liquid scintillation.

Analytical Procedures used by Environmental, Inc. are on file and are available for inspection. Procedures are based on those prescribed by the Health and Safety Laboratory of the U.S. Dep't of Energy, Edition 28, 1997, U.S. Environmental Protection Agency for Measurement of Radioactivity in Drinking Water, 1980, and the U.S. Environmental Protection Agency, EERF, Radiochemical Procedures Manual, 1984

Environmental, Inc., Midwest Laboratory has a comprehensive quality control/quality assurance program designed to assure the reliability of data obtained. Details of the QA Program are presented elsewhere (Environmental, Inc., Midwest Laboratory, 2018). The QA Program includes participation in Interlaboratory Comparison (crosscheck) Programs. Results obtained in the crosscheck programs are presented in Appendix A.

3.5 Program Modifications

None.

3.6 Land Use Census

In accordance with the Prairie Island Nuclear Generating Plant Offsite Dose Calculation Manual, H4, (ODCM) a land use census is conducted in order to identify the location of the nearest residence, nearest milk animals, and the nearest garden of greater than 500 ft^2 producing fresh leafy vegetables in each of the 16 meteorological sectors within a distance of 5 miles. This census is conducted at least once per 12 months between the dates of May 1 and September 30. If new locations yield a calculated dose or dose equivalent (via the same exposure pathway) twenty percent greater than the required locations per the ODCM, then the new locations are added to the radiological environmental monitoring program within 30 days, and sampling locations having lower calculated doses or a lower dose commitment may be deleted from this monitoring program after September of the year in which the land use census was conducted.

This land use census insures the updating of the radiological environmental monitoring program should sampling locations change within the 5 mile radius from the plant.

The Land Use Census was conducted August through September 2019. The ranking of the highest D/Q garden changed from Mowry (NNW at 0.7 miles) to Suter (SSE at 0.6 miles) because Mowry did not have a garden in 2019. There are no dairy farms within a 5 mile radius of the plant therefore no samples were collected. The highest ranking D/Q residence remained the same for 2019 as for 2018, Sellers (WNW at 0.7 miles).

The Minnesota and Wisconsin Departments of Natural Resources were both consulted and both confirmed that no irrigation permits had been issued the past year for crop fields within the file mile Mississippi River area downstream of the Prairie Island Plant. Therefore, no crop sampling was performed.

There were no land use changes within five miles of the plant resulting in new special interest areas such as: new population centers, new residences, new schools or recreation centers.

No milk animals were identified within five miles of the plant. The last dairy within the five mile radius suspended operations in 2016.

4.0 RESULTS AND DISCUSSION

All scheduled collections and analyses were made except those listed in Table 5.3.

The results are summarized in Table 5.4 in a format recommended by the Nuclear Regulatory Commission in Regulatory Guide 4.8. For each type of analysis of each sampled medium, this table lists the mean and range for all indicator locations and for all control locations. The locations with the highest mean and range are also shown.

4.1 Atmospheric Nuclear Detonations and Nuclear Accidents

There were no reported accidents involving significant release to the environment at nuclear reactor facilities in 2019. The Fukushima Daiichi nuclear accident occurred March 11, 2011.

There were no reported atmospheric nuclear tests in 2019. The last reported test was conducted on October 16, 1980 by the People's Republic of China.

4.2 Summary of Preoperational Data

The following constitutes a summary of preoperational studies conducted at the Prairie Island Nuclear Power Plant during the years 1970 to 1973, to determine background levels expected in the environment, and provided, where applicable, as a means for comparison with present day levels. Strict comparisons, however, are difficult, since background levels of radiation were much higher in these years due to radioactive fallout from the atmosphere. Gross beta measurements in fallout declined yearly from a level of 12,167 pCi/ m^3 to 1,020 pCi/m^3, and these declining values are reflected throughout the various media tested.

In the air environment, ambient gamma radiation (TLDs) averaged 9.4 mR/4 weeks during pre-operational studies. Gross beta in air particulates declined from levels of 0.38 to 0.037 pCi/m^3. Average present day levels have stabilized at around 0.025 pCi/m^3. Airborne radioiodine remained below detection levels.

In the terrestrial environment of 1970 to 1973, milk, agricultural crops, and soil were monitored. In milk samples, low levels of Cs-137, I-131, and Sr-90 were detected. Cs-137 levels declined from 16.5 to 8.6 pCi/L. Present day measurements for both Cs-137 and I-131 are below detection levels. Agricultural crop measurements averaged 57.7 pCi/g for gross beta and 0.47 pCi/g for Cs-137. Gross beta measured in soil averaged 52 pCi/g.

The aqueous environment was monitored by testing of river, well and lake waters, bottom sediments, fish, aquatic vegetation and periphyton. Specific location comparison of drinking, river and well water concentrations for tritium and gross beta are not possible. However, tritium background levels, measured at eight separate locations, declined steadily from an average concentration of 1020 pCi/L to 490 pCi/L. Present day environmental levels of tritium measure below a detection limit of approximately 160 pCi/L. Values for gross beta, measured from 1970 to 1973, averaged 9.9 pCi/L in downstream Mississippi River water, 8.2 pCi/L for well water, and 11.0 pCi/L for lake water. Gamma emitters were below the lower limit of detection (LLD). In bottom sediments, gross beta background levels were determined at 51.0 pCi/g. Cs-137 activity during preoperational studies in 1973 measured 0.25 pCi/g upstream and 0.21 pCi/g downstream. The lower levels occasionally observed today can still be attributed to residual activity from atmospheric fallout. Gross beta in fish, measured in both flesh and skeletal samples, averaged 7.3 and 11.7 pCi/g, respectively. Gross beta background levels in aquatic vegetation, algae and periphyton samples measured 76.0 pCi/g, 46.0 pCi/g, and 13.6 pCi/g, respectively.

4.3 Program Findings

Results obtained show background levels of radioactivity in the environmental samples collected in the vicinity of the Prairie Island Nuclear Generating Plant.

Ambient Radiation (TLDs)

Ambient radiation was measured in the general area of the site boundary, at the outer ring 4 - 5 mi. distant from the Plant, at special interest areas and at one control location. The means ranged from 15.5 mR/91 days at inner ring locations to 16.0 mR/91 days at outer ring locations. The mean at special interest locations was 15.3 mR/91 days and 15.3 mR/91 days at the control location. Dose rates measured at the inner and outer ring and the control locations were comparable to 2018 dose rates and consistent with results from previous years. The results are tabulated below. No plant effect on ambient gamma radiation measurements was indicated (Figure 5-1).

Year	Average (Inner and Outer Rings)	Control		Year	Average (Inner and Outer Rings)	Control
2001	16.8	17.2		2011	15.7	15.7
2002	17.4	16.9		2012	16.5	16.5
2003	16.2	16.0		2013	15.1	16.0
2004	17.6	17.6		2014	15.3	16.2
2005	16.8	16.3		2015	16.0	17.4
2006	16.6	16.6		2016	16.7	17.4
2007	17.5	17.7		2017	16.1	16.3
2008	16.9	17.1		2018	16.6	17.4
2009	15.9	16.3		2019	15.8	15.3
2010	16.0	16.0				

Ambient gamma radiation as measured by thermoluminescent dosimetry.
Average quarterly dose rates (mR/91 days).

ISFSI Facility Operations Monitoring

Ambient radiation was measured inside the ISFSI earth berm, outside the ISFSI earth berm and at two special locations between the plant ISFSI and the Prairie Island Indian Community. The mean dose rates averaged 189.7 mR/91 days inside the ISFSI earth berm and 23.0 mR/91 days outside the ISFSI earth berm. No additional casks were placed on the ISFSI pad in 2019, a total of forty-four loaded casks remain. The higher levels inside the earth berm are expected, due to the loaded spent fuel casks being in direct line-of-sight of the TLDs.

Ambient radiation levels measured outside the earth berm show a slight increase as compared to other offsite dose rates around the plant. The cumulative average of the two special Prairie Island Indian Community TLDs (Locations P-07S and P-08S) measured 14.6 and 15.2 mR/91 days. Although the skyshine neutron dose rates are not directly measured, the neutron levels measured next to the casks are below the levels predicted in the ISFSI SAR Report, Table 7A-4, “TN-40 Dose Rates at Short Distances”. Therefore, the skyshine dose rates at farther distances from the casks should be at or below the calculated dose rates. No spent fuel storage effect on offsite ambient gamma radiation was indicated (Fig. 5-1).

Airborne Particulates

Typically, the highest averages for gross beta occur during the months of January and December, and the first and fourth quarters, as in 1999 through 2006, and also in 2008 through 2018. The elevated activity observed in 2007 was attributed to construction activity in the area, an increase in dust and consequent heavier particulate filter loading.

Average annual gross beta concentrations in airborne particulates were 0.023 pCi/m^3 for both indicator locations and the control location and similar to levels observed from 1999 through 2006 and 2008 to 2018. The results are tabulated below.

Year	Average of Indicators	Control
	Concentration (pCi/ m^3)	
2000	0.025	0.025
2001	0.023	0.023
2002	0.028	0.023
2003	0.027	0.025
2004	0.025	0.026
2005	0.027	0.025
2006	0.026	0.025
2007	0.037	0.031
2008	0.028	0.027
2009	0.029	0.029
2010	0.025	0.025
2011	0.026	0.027
2012	0.031	0.032
2013	0.027	0.028
2014	0.026	0.026
2015	0.029	0.029
2016	0.027	0.027
2017	0.026	0.025
2018	0.027	0.027
2019	0.023	0.023

Average annual gross beta concentrations in airborne particulates.

Gamma spectroscopic analysis of quarterly composites of air particulate filters yielded similar results for indicator and control locations. Beryllium-7, which is produced continuously in the upper atmosphere by cosmic radiation (Arnold and Al-Salih, 1955), was detected in all samples, with an average activity of 0.076 pCi/m^3 for indicator locations and 0.080 pCi/m^3 at the control location. All other isotopes were below the lower limit of detection.

There was no indication of a plant effect.

Airborne Iodine

Weekly levels of airborne iodine-131 were below the lower limit of detection (LLD) of 0.03 pCi/m^3 in all samples. There was no indication of a plant effect.

Drinking Water

In drinking water from the City of Red Wing well, tritium activity measured below a detection limit of 158 pCi/L for all samples.

Gross beta concentrations averaged 9.7 pCi/L throughout the year, ranging from 6.2–16.1 pCi/L. These concentrations are consistent with the 2018 average of 10.2 pCi/L and with levels observed from 1999 through 2018. The most likely contribution is the relatively high levels of naturally-occurring radium. Gamma spectroscopy indicates the presence of lead and bismuth isotopes, which are daughters of the radium decay chain. There is no indication from the 2019 data of any effect of plant operation.

Year	Gross Beta (pCi/L)
2000	10.1
2001	8.3
2002	8.7
2003	9.9
2004	9.8
2005	11.5
2006	13.4
2007	11.6
2008	11.6
2009	11.4
2010	11.7
2011	12.4
2012	11.8
2013	12.2
2014	11.5
2015	11.4
2016	12.3
2017	10.1
2018	10.2
2019	9.7

Average annual concentrations; Gross beta in drinking water.

River Water

All river water samples measured below a detection limit of 160 pCi/L for tritium. Gamma-emitting isotopes were below detection limits in all samples. In summary, the data for 2019 show no radiological effects from the plant operation.

Well Water

Water samples tested from the control well, P-43 (Peterson Farm) and from four indicator wells (P-8, Community Center, P-6, Lock and Dam No. 3, P-9, Plant Well No. 2 and P-24, Suter Farm) showed no tritium detected above a detection limit of 157 pCi/L. Gamma-emitting isotopes were below detection limits in all samples.

In summary, well water data for 2019 show no radiological effects of the plant operation.

Broadleaf Vegetation and Crops

Four samples of broadleaf vegetation, cabbage leaves, were collected in August and September 2019 and analyzed for gamma-emitting isotopes, including iodine-131. The I-131 level was below 0.027 pCi/g wet weight in all samples. With exceptions for naturally-occurring beryllium-7 and potassium-40, all other gamma-emitting isotopes were below their respective detection limits. There was no indication of a plant effect.

Field sampling personnel conducted an annual land use survey and found no river water taken for irrigation into fields within 5 miles downstream from the Prairie Island Plant. The collection and analysis of corn samples was not required since the fields have not been irrigated.

Fish

Fish were collected in June and September 2019 and analyzed for gamma emitting isotopes. Only naturally-occurring potassium-40 was detected, and there was no significant difference between upstream and downstream results. There was no indication of a plant effect.

Aquatic Insects or Periphyton

Aquatic insects (invertebrates) or periphyton were collected in July and October, 2019 and analyzed for gamma-emitting isotopes. All gamma-emitting isotopes measured below detection limits with the exception that naturally occurring potassium-40 which was detected in all four samples. There was no indication of any plant effect.

Bottom and Shoreline Sediments

Upstream and downstream bottom sediments were sampled in July and October, 2019 and downstream recreational area shoreline sediments were sampled in July and November 2019. All the samples were analyzed for gamma-emitting isotopes. One shoreline sediment sample collected in November measured positive for Cs-137 at a concentration of 0.04 pCi/g dry. It is not unusual to see low levels of Cs-137 in environmental sediment and soil samples and this can be attributed to past nuclear weapons testing.

There was no indication of a plant effect.

5.0 FIGURES AND TABLES

Figure 5-1. Offsite Ambient Radiation (TLDs); average of inner and outer ring indicator locations versus control location.

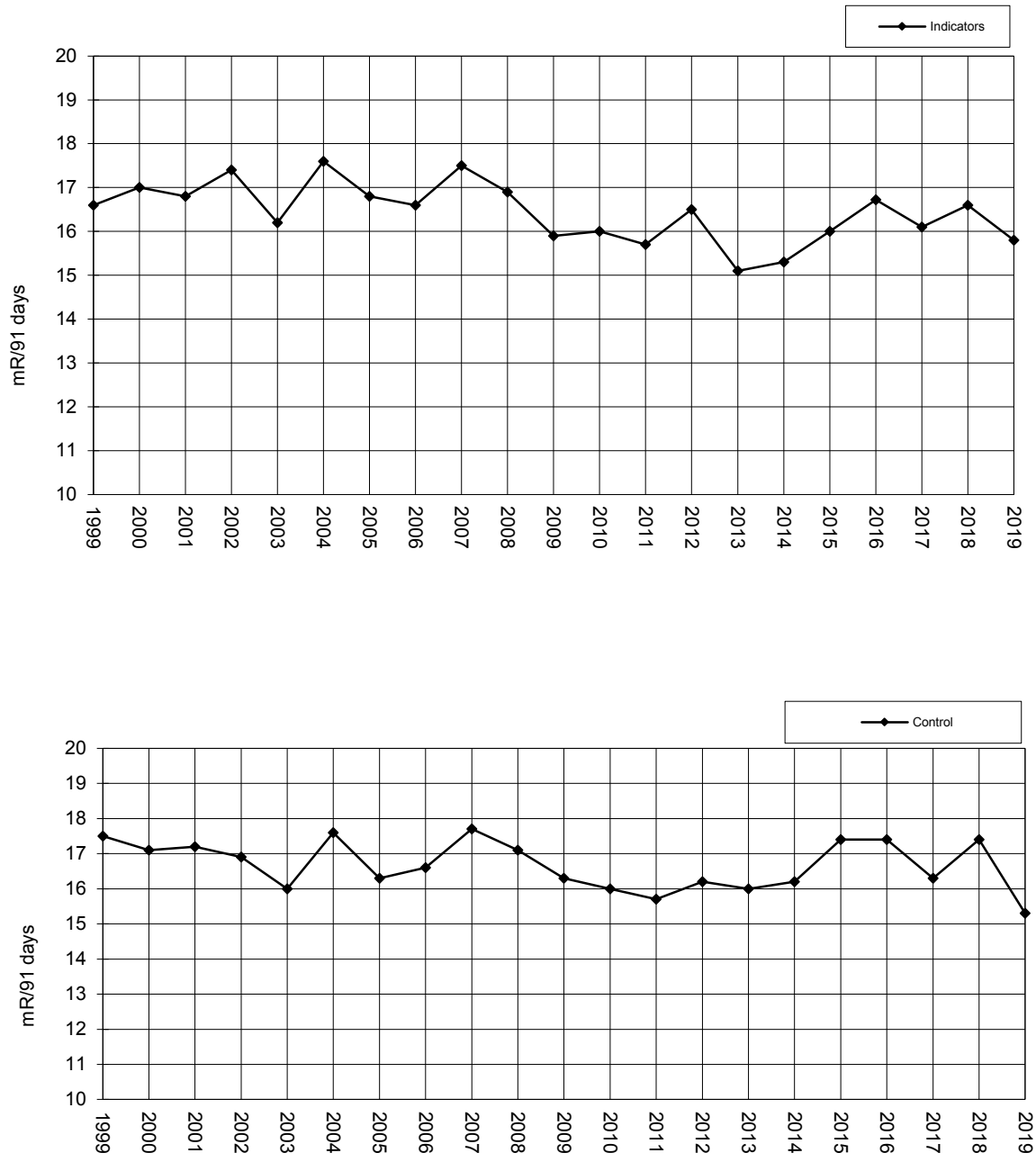

Figure 5-2. Airborne Particulates; analysis for gross beta, average mean of all indicator locations versus control location.

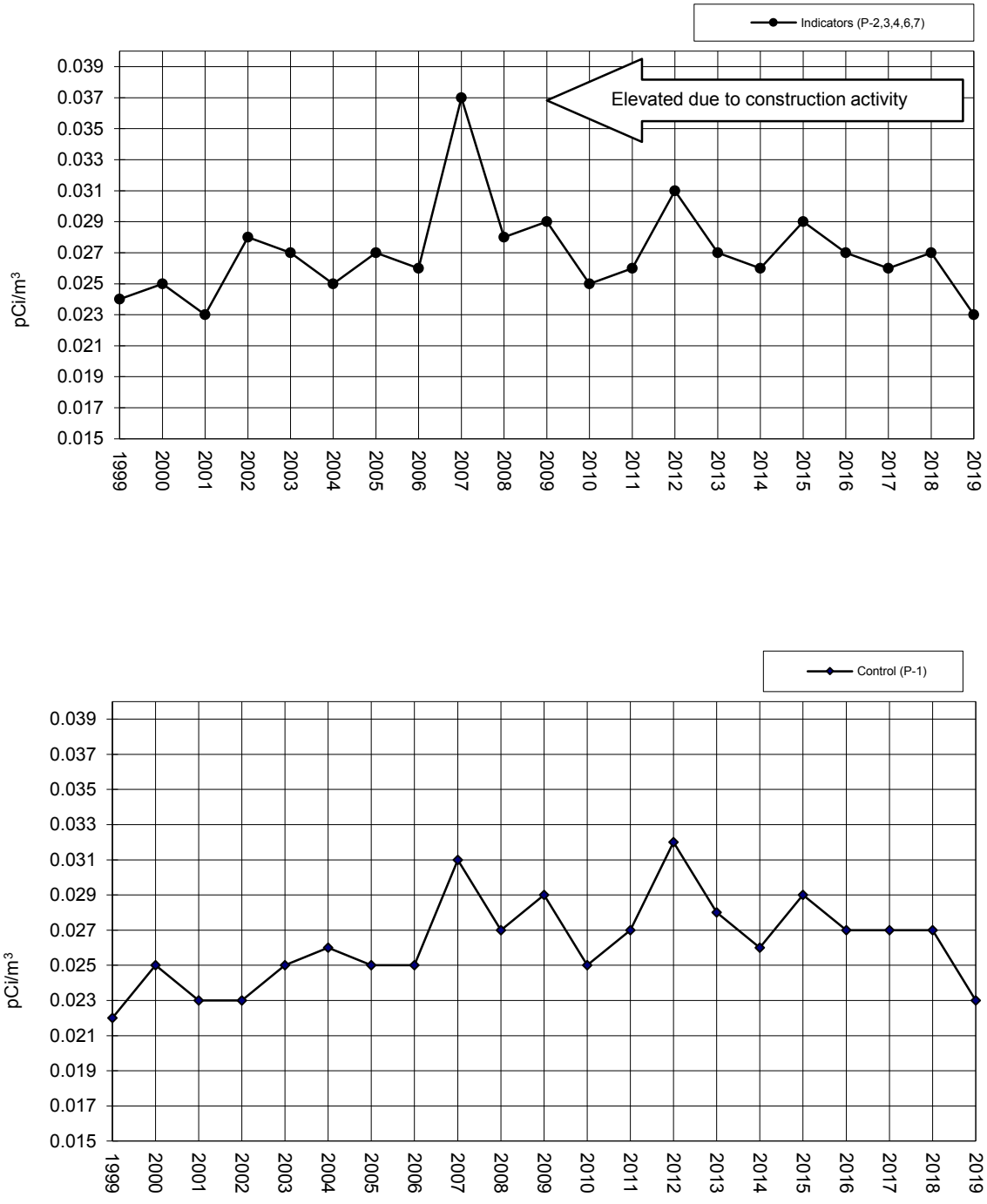

Table 5.1. Sample collection and analysis program, Prairie Island Nuclear Generating Plant.

Medium	Location No.	Location Codes (and Type)[a]	Collection Type and Frequency[b]	Analysis Type and Frequency[c]
Ambient radiation (TLD's)	54	P-01A - P-10A P-01B - P-15B P-01S - P-08S P-01IA - P-08IA P-01IB - P-08IB P-01IX- P-04IX, P-01C	C/Q	Ambient gamma
Airborne Particulates	6	P-1(C), P-2, P-3, P-4, P-6, P-7	C/W	GB, GS (QC of each location)
Airborne Iodine	6	P-1(C), P-2, P-3, P-4, P-6, P-7	C/W	I-131
River water	2	P-5(C), P-6	G/W	GS(MC), H-3(QC)
Drinking water	1	P-11	G/W	GB(MC), I-131(MC) GS (MC), H-3 (QC)
Well water	5	P-6, P-8, P-9, P-24, P-43 (C)	G/Q	H-3, GS
Edible cultivated crops -	1	P-30(C)	G/A	GS (I-131)
leafy green vegetables	4	P-8, P-24, P-28, P-38(C)	G/A	GS (I-131)
Fish (three species, edible portion)	2	P-19(C), P-13	G/SA	GS
Periphyton or invertebrates	2	P-40(C), P-6	G/SA	GS
Bottom sediment	2	P-20(C), P-6	G/SA	GS
Shoreline sediment	1	P-12	G/SA	GS

[a] Location codes are defined in Table 5.2. Control stations are indicated by (C). All other stations are indicators.

[b] Collection type is coded as follows: C/ = continuous, G/ = grab. Collection frequency is coded as follows: W= weekly, M = monthly, Q = quarterly, SA = semiannually, A = annually.

[c] Analysis type is coded as follows: GB = gross beta, GS = gamma spectroscopy, H-3 = tritium, I-131 = iodine-131. Analysis frequency is coded as follows: MC = monthly composite, QC = quarterly composite.

Table 5.2. Sampling locations, Prairie Island Nuclear Generating Plant.

Code	Type[a]	Collection Site	Sample Type[b]	Distance and Direction from Reactor
P-1	C	Air Station P-1	AP, AI	11.8 mi @ 316°/NNW
P-2		Air Station P-2	AP, AI	0.5 mi @ 294°/WNW
P-3		Air Station P-3	AP, AI	0.8 mi @ 313°/NW
P-4		Air Station P-4	AP, AI	0.4 mi @ 359°/N
P-5	C	Upstream of Plant	RW	1.8 mi @ 11°/N
P-6		Lock and Dam #3 & Air Station P-6	AP, AI, RW WW, BS, BO[c]	1.6 mi @ 129°/SE
P-7		Air Station P-7	AP, AI	0.5 mi @ 271°/W
P-8		Community Center	WW	1.0 mi @ 321°/WNW
P-9		Plant Well #2	WW	0.3 mi @ 306°/NW
P-11		Red Wing Service Center	DW	3.3 mi @ 158°/SSE
P-12		Downstream of Plant	SS	3.0 mi @ 116°/ESE
P-13		Downstream of Plant	F[c]	3.5 mi @ 113°/ESE
P-19	C	Upstream of Plant	F[c]	1.3 mi @ 0°/N
P-20	C	Upstream of Plant	BS	0.9 mi @ 45°/NE
P-24		Suter Residence	WW	0.6 mi @ 158°/SSE
P-28		Allyn Residence	VE	1.0 mi @ 152°/SSE
P-38	C	Cain Residence	VE	14.2 mi @ 359°/N
P-40	C	Upstream of Plant	BO[c]	0.4 mi @ 0°/N
P-43	C	Peterson Farm	WW	13.9 mi. @ 355°/N
General Area of the Site Boundary				
P-01A		Property Line	TLD	0.4 mi @ 359°/N
P-02A		Property Line	TLD	0.3 mi @ 10°/N
P-03A		Property Line	TLD	0.5 mi @ 183°/S
P-04A		Property Line	TLD	0.4 mi @ 204°/SSW
P-05A		Property Line	TLD	0.4 mi @ 225°/SW
P-06A		Property Line	TLD	0.4 mi @ 249°/WSW
P-07A		Property Line	TLD	0.4 mi @ 268°/W
P-08A		Property Line	TLD	0.4 mi @ 291°/WNW
P-09A		Property Line	TLD	0.7 mi @ 317°/NW
P-10A		Property Line	TLD	0.5 mi @ 333°/NNW

Table 5.2. Sampling locations, Prairie Island Nuclear Generating Plant (continued).

Code	Type[a]	Collection Site	Sample Type[b]	Distance and Direction from Reactor
Approximately 4 to 5 miles Distant from the Plant				
P-01B		Thomas Killian Residence	TLD	4.7 mi @ 355°/N
P-02B		Roy Kinneman Residence	TLD	4.8 mi @ 17°/NNE
P-03B		Wayne Anderson Farm	TLD	4.9 mi @ 46°/NE
P-04B		Nelson Drive (Road)	TLD	4.2 mi @ 61°/ENE
P-05B		County Road E and Coulee	TLD	4.2 mi @ 102°/ESE
P-06B		William Hauschildt Residence	TLD	4.4 mi @ 112°/ESE
P-07B		Red Wing Public Works	TLD	4.7 mi @ 140°/SE
P-08B		David Wnuk Residence	TLD	4.1 mi @ 165°/SSE
P-09B		Highway 19 South	TLD	4.2 mi @ 187°/S
P-10B		Cannondale Farm	TLD	4.9 mi @ 200°/SSW
P-11B		Wallace Weberg Farm	TLD	4.5 mi @ 221°/SW
P-12B		Ray Gergen Farm	TLD	4.6 mi @ 251°/WSW
P-13B		Thomas O'Rourke Farm	TLD	4.4 mi @ 270°/W
P-14B		David J. Anderson Farm	TLD	4.9 mi @ 306°/NW
P-15B		Holst Farms	TLD	3.8 mi @ 345°/NNW
Special Interest Locations				
P-01S		Federal Lock & Dam #3	TLD	1.6 mi @ 129°/SE
P-02S		Charles Suter Residence	TLD	0.5 mi @ 155°/SSE
P-03S		Carl Gustafson Farm	TLD	2.2 mi @ 173°/S
P-04S		Richard Burt Residence	TLD	2.0 mi @ 202°/SSW
P-05S		Kinney Store	TLD	2.0 mi @ 270°/W
P-06S		Earl Flynn Farm	TLD	2.5 mi @ 299°/WNW
P-07S		Indian Community	TLD	0.7 mi @ 271°/W
P-08S		Indian Community	TLD	0.7 mi @ 287°/WNW
P-01C	C	Robert Kinneman Farm	TLD	11.1 mi @ 331°/NNW

Table 5.2. Sampling locations, Prairie Island Nuclear Generating Plant (continued).

Code	Type[a]	Collection Site	Sample Type[b]	Distance and Direction from ISFSI Center.
ISFSI Area Inside Earth Berm				
P-01IA		ISFSI Nuisance Fence	TLD	190' @ 45°/NE
P-02IA		ISFSI Nuisance Fence	TLD	360' @ 82°/E
P-03IA		ISFSI Nuisance Fence	TLD	370' @ 100°/E
P-04IA		ISFSI Nuisance Fence	TLD	200' @ 134°/SE
P-05IA		ISFSI Nuisance Fence	TLD	180' @ 219°/SW
P-06IA		ISFSI Nuisance Fence	TLD	320' @ 258°/WSW
P-07IA		ISFSI Nuisance Fence	TLD	320' @ 281°/WNW
P-08IA		ISFSI Nuisance Fence	TLD	190' @ 318°/NW
P-01IX		ISFSI Nuisance Fence	TLD	140' @ 180°/S
P-02IX		ISFSI Nuisance Fence	TLD	310' @ 270°/W
P-03IX		ISFSI Nuisance Fence	TLD	140' @ 0°/N
P-04IX		ISFSI Nuisance Fence	TLD	360' @ 90°/E
ISFSI Area Outside Earth Berm				
P-01IB		ISFSI Berm Area	TLD	340' @ 3°/N
P-02IB		ISFSI Berm Area	TLD	380' @ 28°/NNE
P-03IB		ISFSI Berm Area	TLD	560' @ 85°/E
P-04IB		ISFSI Berm Area	TLD	590' @ 165°/SSE
P-05IB		ISFSI Berm Area	TLD	690' @ 186°/S
P-06IB		ISFSI Berm Area	TLD	720' @ 201°/SSW
P-07IB		ISFSI Berm Area	TLD	610' @ 271°/W
P-08IB		ISFSI Berm Area	TLD	360' @ 332°/NNW

[a] "C" denotes control location. All other locations are indicators.

[b] Sample Codes:

AP	Airborne particulates	F	Fish
AI	Airborne Iodine	SS	Shoreline Sediments
BS	Bottom (river) sediments	SW	Surface Water
BO	Bottom organisms (periphyton or macroinvertebrates)	VE	Vegetation/vegetables
DW	Drinking water	WW	Well water

[c] Distance and direction data for fish and bottom organisms are approximate since availability of sample specimen may vary at any one location.

Table 5.3. Missed collections and analyses at the Prairie Island Nuclear Generating Plant.

All required samples were collected and analyzed as scheduled with no exceptions in 2019.

Sample Type	Analysis	Location	Collection Date or Period	Reason for not Conducting REMP as Required	Plans for Preventing Recurrence

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility: Prairie Island Nuclear Power Station — Docket No.: 50-282, 50-306
Location of Facility: Goodhue, Minnesota (County, State) — Reporting Period: January-December, 2019

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F)[c] Range[c]	Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
Direct Radiation							
TLD (Inner Ring, Area at Site Boundary) mR/91 days)	Gamma 40	3.0	15.5 (40/40) (12.8-18.9)	P-06A Property Line 0.4 mi @ 249° /WSW	17.3 (4/4) (16.4-18.9)	(See Control below.)	0
TLD (Outer Ring, 4-5 mi. distant) mR/91 days)	Gamma 60	3.0	16.0 (60/60) (13.5-19.2)	P-04B, Nelson Drive 4.2 mi @ 61º/ENE	17.9 (4/4) (16.4-18.9)	(See Control below.)	0
TLD (Special Interest Areas) mR/91 days)	Gamma 32	3.0	15.3 (32/32) (11.7-18.2)	P-03S, Gustafson Farm, 2.2 mi @ 173° /S	17.2 (4/4) (15.9-18.2)	(See Control below.)	0
TLD (Control) mR/91 days)	Gamma 4	3.0	None	P-01C, Robert Kinneman 11.1 mi @ 331° /NNW	15.3 (4/4) (14.1-16.4)	15.3 (4/4) (14.1-16.4)	0
Airborne Pathway							
Airborne Particulates (pCi/m^3)	GB 312	0.005	0.023 (260/260) (0.005-0.058)	P-04, Air Station 0.4 mi @ 359° /N	0.023 (52 /52) (0.008-0.058)	0.023 (52/52) (0.007-0.052)	0
	GS 24						
	Be-7	0.015	0.076 (20/20) (0.052-0.099)	P-01, Air Station 11.8 mi @ 316° /NNW	0.080 (4/4) (0.060-0.096)	0.080 (4/4) (0.060-0.096)	0
	Mn-54	0.0010	< LLD	-	-	< LLD	0
	Co-58	0.0013	< LLD	-	-	< LLD	0
	Co-60	0.0012	< LLD	-	-	< LLD	0
	Zn-65	0.0043	< LLD	-	-	< LLD	0
	Zr-Nb-95	0.0026	< LLD	-	-	< LLD	0
	Ru-103	0.0011	< LLD	-	-	< LLD	0
	Ru-106	0.0093	< LLD	-	-	< LLD	0
	Cs-134	0.0013	< LLD	-	-	< LLD	0
	Cs-137	0.0012	< LLD	-	-	< LLD	0
	Ba-La-140	0.0047	< LLD	-	-	< LLD	0
	Ce-141	0.0021	< LLD	-	-	< LLD	0
	Ce-144	0.0053	< LLD	-	-	< LLD	0
Airborne Iodine (pCi/m^3)	I-131 312	0.030	< LLD	-	-	< LLD	0

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility: Prairie Island Nuclear Power Station
Docket No.: 50-282, 50-306
Location of Facility: Goodhue, Minnesota
(County, State)
Reporting Period: January-December, 2019

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean Location[d]	Location with Highest Annual Mean Mean (F)[c] Range[c]	Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
Terrestrial Pathway							
Crops - Cabbage (pCi/gwet)	I-131 4	0.027	< LLD	-	-	< LLD	0
Well Water (pCi/L)	H-3 20	157	< LLD	-	-	< LLD	0
	GS 20						
	Mn-54	10	< LLD	-	-	< LLD	0
	Fe-59	30	< LLD	-	-	< LLD	0
	Co-58	10	< LLD	-	-	< LLD	0
	Co-60	10	< LLD	-	-	< LLD	0
	Zn-65	30	< LLD	-	-	< LLD	0
	Zr-Nb-95	15	< LLD	-	-	< LLD	0
	Cs-134	10	< LLD	-	-	< LLD	0
	Cs-137	10	< LLD	-	-	< LLD	0
	Ba-La-140	15	< LLD	-	-	< LLD	0
	Ce-144	74	< LLD	-	-	< LLD	0

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility: Prairie Island Nuclear Power station | Docket No.: 50-282, 50-306

Location of Facility: Goodhue, Minnesota (County, state) | Reporting Period: January-December, 2019

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F)[c] Range[c]	Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
Waterborne Pathway							
Drinking Water (pCi/L)	GB 12	1.0	9.7 (12/12) (6.2-16.1)	P-11, Red Wing S.C. 3.3 mi @ 158° /SSE	9.7 (12/12) (6.2-16.1)	None	0
	I-131 12	1.0	< LLD	-	-	None	0
	H-3 4	158	< LLD	-	-	None	0
	GS 12			-	-		
	Mn-54	10	< LLD	-	-	None	0
	Fe-59	30	< LLD	-	-	None	0
	Co-58	10	< LLD	-	-	None	0
	Co-60	10	< LLD	-	-	None	0
	Zn-65	30	< LLD	-	-	None	0
	Zr-Nb-95	15	< LLD	-	-	None	0
	Cs-134	10	< LLD	-	-	None	0
	Cs-137	10	< LLD	-	-	None	0
	Ba-La-140	15	< LLD	-	-	None	0
	Ce-144	43	< LLD	-	-	None	0
River Water (pCi/L)	H-3 8	160	< LLD	-	-	< LLD	0
	GS 24						
	Mn-54	10	< LLD	-	-	< LLD	0
	Fe-59	30	< LLD	-	-	< LLD	0
	Co-58	10	< LLD	-	-	< LLD	0
	Co-60	10	< LLD	-	-	< LLD	0
	Zn-65	30	< LLD	-	-	< LLD	0
	Zr-Nb-95	15	< LLD	-	-	< LLD	0
	Cs-134	10	< LLD	-	-	< LLD	0
	Cs-137	10	< LLD	-	-	< LLD	0
	Ba-La-140	15	< LLD	-	-	< LLD	0
	Ce-144	36	< LLD	-	-	< LLD	0
Fish (pCi/g wet)	GS 12						
	K-40	0.10	2.79 (6/6) (2.50-3.09)	P-19,Upstream 1.3 mi @ 0° /N	2.93 (6/6) (2.71-3.44)	2.93 (6/6) (2.71-3.44)	0
	Mn-54	0.028	< LLD	-	-	< LLD	0
	Fe-59	0.107	< LLD	-	-	< LLD	0
	Co-58	0.048	< LLD	-	-	< LLD	0
	Co-60	0.025	< LLD	-	-	< LLD	0
	Zn-65	0.057	< LLD	-	-	< LLD	0
	Zr-Nb-95	0.076	< LLD	-	-	< LLD	0
	Cs-134	0.027	< LLD	-	-	< LLD	0
	Cs-137	0.027	< LLD	-	-	< LLD	0
	Ba-La-140	1.16	< LLD	-	-	< LLD	0

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility	Prairie Island Nuclear Power Station	Docket No.	50-282, 50-306
Location of Facility	Goodhue, Minnesota (County, State)	Reporting Period	January-December, 2019

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean Location[d]	Mean (F)[c] Range[c]	Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
Waterborne Pathway							
Invertebrates (pCi/g wet)	GS 4						
	Be-7	0.89	< LLD	-	-	< LLD	0
	K-40	0.37	3.40 (2/2) (2.04-4.77)	P-40 Upstream 0.4 mi. @ 0° /N	3.94 (2/2) (2.50-5.38)	3.94 (2/2) (2.50-3.94)	0
	Mn-54	0.060	< LLD	-	-	< LLD	0
	Co-58	0.051	< LLD	-	-	< LLD	0
	Co-60	0.072	< LLD	-	-	< LLD	0
	Zn-65	0.141	< LLD	-	-	< LLD	0
	Zr-Nb-95	0.132	< LLD	-	-	< LLD	0
	Ru-103	0.098	< LLD	-	-	< LLD	0
	Ru-106	0.402	< LLD	-	-	< LLD	0
	Cs-134	0.058	< LLD	-	-	< LLD	0
	Cs-137	0.067	< LLD	-	-	< LLD	0
	Ba-La-140	0.337	< LLD	-	-	< LLD	0
	Ce-141	0.130	< LLD	-	-	< LLD	0
	Ce-144	0.248	< LLD	-	-	< LLD	0
Bottom and Shoreline Sediments (pCi/g dry)	GS 6						
	Be-7	0.23	< LLD	P-20 Upstream 0.9 mi. @ 45° /NE	0.54(1/2)	0.54(1/2)	0
	K-40		8.42 (4/4) (6.92-9.46)	P-20 Upstream 0.9 mi. @ 45° /NE	9.62 (2/2) (7.59-11.65)	9.62 (2/2) (7.59-11.65)	0
	Mn-54	0.022	< LLD	-	-	< LLD	0
	Co-58	0.021	< LLD	-	-	< LLD	0
	Co-60	0.015	< LLD	-	-	< LLD	0
	Zn-65	0.055	< LLD	-	-	< LLD	0
	Zr-Nb-95	0.042	< LLD	-	-	< LLD	0
	Ru-103	0.027	< LLD	-	-	< LLD	0
	Ru-106	0.13	< LLD	-	-	< LLD	0
	Cs-134	0.016	< LLD	-	-	< LLD	0
	Cs-137	0.016	< LLD	P-12 Downstream	0.04 (1/2)	< LLD	0
	Ba-La-140	0.14	< LLD	3.0 mi.@ 116° /ESE	-	< LLD	0
	Ce-141	0.066	< LLD	-	-	< LLD	0
	Ce-144	0.13	< LLD	-	-	< LLD	0

[a] GB = gross beta, GS = gamma scan.

[b] LLD = nominal lower limit of detection based on a 4.66 sigma counting error for background sample.

[c] Mean and range are based on detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).

[d] Locations are specified: (1) by name, and/or station code and (2) by distance (miles) and direction relative to reactor site.

[e] Non-routine results are those which exceed ten times the control station value. If no control station value is available, the result is considered non-routine if it exceeds ten times the typical preoperational value for the medium or location.

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APPENDIX A

INTERLABORATORY AND INTRALABORATORY COMPARISON PROGRAM RESULTS

NOTE: Appendix A is updated four times a year. The complete appendix is included in March, June, September and December monthly progress reports only.

January, 2019 through December, 2019

Appendix A

Interlaboratory/ Intralaboratory Comparison Program Results

Environmental, Inc., Midwest Laboratory has participated in interlaboratory comparison (crosscheck) programs since the formulation of it's quality control program in December 1971. These programs are operated by agencies which supply environmental type samples containing concentrations of radionuclides known to the issuing agency but not to participant laboratories. The purpose of such a program is to provide an independent check on a laboratory's analytical procedures and to alert it of any possible problems.

Participant laboratories measure the concentration of specified radionuclides and report them to the issuing agency. Several months later, the agency reports the known values to the participant laboratories and specifies control limits. Results consistently higher or lower than the known values or outside the control limits indicate a need to check the instruments or procedures used.

Results in Table A-1 were obtained through participation in the RAD PT Study Proficiency Testing Program administered by Environmental Resource Associates, serving as a replacement for studies conducted previously by the U.S. EPA Environmental Monitoring Systems Laboratory, Las Vegas, Nevada.

Results in Table A-2 were obtained through participation in the New York Department of Health Environmental Laboratory Approval Program (ELAP) PT

Table A-3 lists results for thermoluminescent dosimeters (TLDs), via irradiation and evaluation by the University of Wisconsin-Madison Radiation Calibration Laboratory at the University of Wisconsin Medical Radiation Research Center.

Table A-4 lists results of the analyses on in-house "spiked" samples for the past twelve months. All samples are prepared using NIST traceable sources. Data for previous years available upon request.

Table A-5 lists results of the analyses on in-house "blank" samples for the past twelve months. Data for previous years available upon request.

Table A-6 lists analytical results from the in-house "duplicate" program for the past twelve months. Acceptance is based on the each result being with 25% of the mean of the two results or the two sigma uncertanties of each result overlap.

The results in Table A-7 were obtained through participation in the Mixed Analyte Performance Evaluation Program.

Results in Table A-8 were obtained through participation in the MRAD PT Study Proficiency Testing Program administered by Environmental Resource Associates, serving as a replacement for studies conducted previously by the Environmental Measurement Laboratory Quality Assessment Program (EML).

Attachment A lists the laboratory acceptance criteria for various analyses.

Out-of-limit results are explained directly below the result.

Attachment A

ACCEPTANCE CRITERIA FOR "SPIKED" SAMPLES

Analysis	Ratio of lab result to known value.
Gamma Emitters	0.8 to 1.2
Strontium-89, Strontium-90	0.8 to 1.2
Potassium-40	0.8 to 1.2
Gross alpha	0.5 to 1.5
Gross beta	0.8 to 1.2
Tritium	0.8 to 1.2
Radium-226, Radium-228	0.7 to 1.3
Plutonium	0.8 to 1.2
Iodine-129, Iodine-131	0.8 to 1.2
Nickel-63, Technetium-99, Uranium-238	0.7 to 1.3
Iron-55	0.8 to 1.2
Other Analyses	0.8 to 1.2

TABLE A-1. Interlaboratory Comparison Crosscheck program, Environmental Resource Associates (ERA)[a].

RAD study

Lab Code	Date	Concentration (pCi/L) Analysis	Laboratory Result	ERA Result	Control Limits	Acceptance
ERW-71	1/7/2019	Ba-133	97.9 ± 4.5	99.5	84.1 - 109	Pass
ERW-71	1/7/2019	Cs-134	45.4 ± 3.1	49.1	39.5 - 54.0	Pass
ERW-71	1/7/2019	Cs-137	129 ± 6	125	112 - 140	Pass
ERW-71	1/7/2019	Co-60	98.1 ± 4.1	96.4	86.8 - 108	Pass
ERW-71	1/7/2019	Zn-65	80.4 ± 7.8	77.4	69.5 ± 93.2	Pass
ERW-73	1/7/2019	Gr. Alpha	22.2 ± 1.6	21.8	10.9 - 29.5	Pass
ERW-73	1/7/2019	Gr. Beta	46.4 ± 1.4	55.7	38.1 - 62.6	Pass
ERW-75	1/7/2019	Ra-226	7.19 ± 0.30	7.37	5.55 ± 8.72	Pass
ERW-75	1/7/2019	Ra-228	4.02 ± 0.70	4.28	2.48 - 5.89	Pass
ERW-75	1/7/2019	Uranium	50.2 ± 2.9	68.2	55.7 - 75.0	Fail[b]
ERW-77	1/7/2019	H-3	2,129 ± 158	2,110	1,740 - 2,340	Pass
ERW-397	2/11/2019	I-131	27.2 ± 1.0	25.9	25.1 - 30.6	Pass
ERW-1141	4/8/2019	Ra-226	7.58 ± 0.53	7.15	5.39 - 8.48	Pass
ERW-1141	4/8/2019	Ra-228	2.64 ± 0.79	2.94	1.54 - 4.35	Pass
ERW-1141	4/8/2019	Uranium	67.0 ± 0.9	55.9	45.6 - 61.5	Fail[c]
ERW-2471	7/8/2019	Ba-133	66.5 ± 4.0	66.9	55.8 - 73.6	Pass
ERW-2471	7/8/2019	Cs-134	29.6 ± 2.6	32.0	25.1 - 35.2	Pass
ERW-2471	7/8/2019	Cs-137	21.3 ± 3.6	21.4	17.6 - 26.7	Pass
ERW-2471	7/8/2019	Co-60	99.9 ± 4.4	95.1	85.6 - 107.0	Pass
ERW-2471	7/8/2019	Zn-65	43.7 ± 6.2	41.2	35.3 - 51.4	Pass
ERW-2473	7/8/2019	Gr. Alpha	41.7 ± 2.1	70.6	37.1 - 87.1	Pass
ERW-2473	7/8/2019	Gr. Beta	57.0 ± 1.6	63.9	44.2 - 70.5	Pass
ERW-2477	7/8/2019	Ra-226	16.2 ± 0.5	18.5	13.8 - 21.1	Pass
ERW-2477	7/8/2019	Ra-228	6.2 ± 0.8	8.2	5.2 - 10.3	Pass
ERW-2477	7/8/2019	Uranium	63.8 ± 3.6	68.3	55.8 - 75.1	Pass
ERW-2479	7/8/2019	H-3	8,630 ± 200	16,700	14,600 - 18,400	Fail[d]
ERW-2475	7/8/2019	I-131	33.6 ± 1.3	29.6	24.6 - 34.6	Pass

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

[b] In order to get to the root cause of the above "Fail" resolution the U-232 tracer was standardized using a known concentration of NIST U-238 solution. A duplicate analysis was performed and the results obtained were well within the acceptance range (Known value for Total Uranium=68.2 pCi/L, acceptance range of (55.7-75 pCi/L). The results obtained were 63.3 pCi/L and 66.0 pCi/L respectively.

[c] The standardized U-232 value utilized on ERA sample ERW-1141 above was found to be estimated high due to interferences in the U-238 solution causing ERW-1141 to fail the study. After performing U-isotopic chemistry on the NIST-Uranium solution to remove interferences a more accurate U-232 tracer concentration was obtained. The Uranium result in the subsequent ERA PT study was acceptable. See ERW-2477 Uranium result above.

[d] EIML's routine H-3 analysis does include a blank sample. The ERA provided blank was paired with a H-3 standard vial and EIML's blank was also paired with a standard vial. Inadvertently the efficiency was overestimated by a factor of 2. This understated the calculated results by half. The result of reanalysis (17,400 pCi/L) is within the control limits for the study.

TABLE A-2. Interlaboratory Comparison Crosscheck program, New York Department of Health (ELAP)[a].

Lab Code	Date	Analysis	Concentration (pCi/L) Laboratory Result	Assigned Value	Acceptance Limits	Acceptance
			Shipment 427R			
NYW-3472	9/17/2019	H-3	5250 ± 229	4991	4280 - 5490	Pass
NYW-3476	9/17/2019	Gross Alpha	18.0 ± 1.2	20.1	9.99 - 27.5	Pass
NYW-3476	9/17/2019	Gross Beta	22.7 ± 1.0	27.2	17.1 - 35.1	Pass
NYW-3478	9/17/2019	I-131	18.7 ± 1.8	15.6	12.8 - 19.3	Pass
NYW-3480	9/17/2019	Ra-226	5.02 ± 0.37	4.41	3.37 - 5.43	Pass
NYW-3480	9/17/2019	Ra-228	16.0 ± 1.9	18.3	12.3 - 21.9	Pass
NYW-3480	9/17/2019	Uranium	13.7 ± 0.9	13.9	11.0 - 15.7	Pass
NYW-3482	9/17/2019	Co-60	63.9 ± 4.0	63.0	56.7 - 71.8	Pass
NYW-3482	9/17/2019	Zn-65	108 ± 9	113	97.2 - 129	Pass
NYW-3482	9/17/2019	Ba-133	53.3 ± 4.3	61.9	51.4 - 68.2	Pass
NYW-3482	9/17/2019	Cs-134	47.2 ± 3.4	55.8	45.1 - 61.4	Pass
NYW-3482	9/17/2019	Cs-137	52.0 ± 4.6	53.8	48.4 - 62.0	Pass

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

TABLE A-3. Thermoluminescent Dosimetry, (TLD, $CaSO_4$: Dy Cards).[a]

Lab Code	Irradiation Date	Description	Delivered Dose (mrem)	Reported[b] Dose (mrem)	Performance[c] Quotient (P)	
Environmental, Inc.		Group 1				
2019-1	11/11/2019	Spike 1	126.0	128.3	0.02	
2019-1	11/11/2019	Spike 2	126.0	122.2	-0.03	
2019-1	11/11/2019	Spike 3	126.0	122.5	-0.03	
2019-1	11/11/2019	Spike 4	126.0	119.3	-0.05	
2019-1	11/11/2019	Spike 5	126.0	116.9	-0.07	
2019-1	11/11/2019	Spike 6	126.0	109.5	-0.13	
2019-1	11/11/2019	Spike 7	126.0	114.6	-0.09	
2019-1	11/11/2019	Spike 8	126.0	121.8	-0.03	
2019-1	11/11/2019	Spike 9	126.0	120.2	-0.05	
2019-1	11/11/2019	Spike 10	126.0	126.4	0.00	
2019-1	11/11/2019	Spike 11	126.0	125.0	-0.01	
2019-1	11/11/2019	Spike 12	126.0	109.0	-0.13	
2019-1	11/11/2019	Spike 13	126.0	123.4	-0.02	
2019-1	11/11/2019	Spike 14	126.0	118.2	-0.06	
2019-1	11/11/2019	Spike 15	126.0	134.3	0.07	
2019-1	11/11/2019	Spike 16	126.0	120.1	-0.05	
2019-1	11/11/2019	Spike 17	126.0	131.3	0.04	
2019-1	11/11/2019	Spike 18	126.0	120.4	-0.04	
2019-1	11/11/2019	Spike 19	126.0	121.1	-0.04	
2019-1	11/11/2019	Spike 20	126.0	122.8	-0.03	
Mean (Spike 1-20)				121.4	-0.04	Pass[d]
Standard Deviation (Spike 1-20)				6.2	0.05	Pass[d]

a TLD's were irradiated by the University of Wisconsin-Madison Radiation Calibration Laboratory following ANSI N13.37 protocol from a known air kerma rate. TLD's were read and the results were submitted by Environmental Inc. to the University of Wisconsin-Madison Radiation Calibration Laboratory for comparison to the delivered dose.

b Reported dose was converted from exposure (R) to Air Kerma (cGy) using a conversion of 0.876. Conversion from air kerma to ambient dose equivalent for Cs-137 at the reference dose point $H^*(10)K_a = 1.20$. mrem/cGy = 1000.

c Performance Quotient (P) is calculated as ((reported dose - conventially true value) ÷ conventially true value) where the conventially true value is the delivered dose.

d Acceptance is achieved when neither the absolute value of the mean of the P values, nor the standard deviation of the P values exceed 0.15.

TABLE A-3. Thermoluminescent Dosimetry, (TLD, $CaSO_4$: Dy Cards).[a]

Lab Code	Irradiation Date	Description	Delivered Dose (mrem)	Reported[b] Dose (mrem)	Performance[c] Quotient (P)	
Environmental, Inc.		Group 2				
2019-2	11/11/2019	Spike 21	79.0	78.8	0.00	
2019-2	11/11/2019	Spike 22	79.0	71.8	-0.09	
2019-2	11/11/2019	Spike 23	79.0	75.8	-0.04	
2019-2	11/11/2019	Spike 24	79.0	71.3	-0.10	
2019-2	11/11/2019	Spike 25	79.0	74.5	-0.06	
2019-2	11/11/2019	Spike 26	79.0	71.6	-0.09	
2019-2	11/11/2019	Spike 27	79.0	73.3	-0.07	
2019-2	11/11/2019	Spike 28	79.0	74.0	-0.06	
2019-2	11/11/2019	Spike 29	79.0	73.8	-0.07	
2019-2	11/11/2019	Spike 30	79.0	76.0	-0.04	
2019-2	11/11/2019	Spike 31	79.0	76.7	-0.03	
2019-2	11/11/2019	Spike 32	79.0	77.8	-0.02	
2019-2	11/11/2019	Spike 33	79.0	75.2	-0.05	
2019-2	11/11/2019	Spike 34	79.0	69.1	-0.13	
2019-2	11/11/2019	Spike 35	79.0	68.7	-0.13	
2019-2	11/11/2019	Spike 36	79.0	68.2	-0.14	
2019-2	11/11/2019	Spike 37	79.0	67.9	-0.14	
2019-2	11/11/2019	Spike 38	79.0	68.9	-0.13	
2019-2	11/11/2019	Spike 39	79.0	78.1	-0.01	
2019-2	11/11/2019	Spike 40	79.0	68.6	-0.13	
Mean (Spike 21-40)				73.0	-0.08	Pass[d]
Standard Deviation (Spike 21-40)				3.6	0.05	Pass[d]

a TLD's were irradiated by the University of Wisconsin-Madison Radiation Calibration Laboratory following ANSI N13.37 protocol from a known air kerma rate. TLD's were read and the results were submitted by Environmental Inc. to the University of Wisconsin-Madison Radiation Calibration Laboratory for comparison to the delivered dose.

b Reported dose was converted from exposure (R) to Air Kerma (cGy) using a conversion of 0.876. Conversion from air kerma to ambient dose equivalent for Cs-137 at the reference dose point $H^*(10)K_a = 1.20$. mrem/cGy = 1000.

c Performance Quotient (P) is calculated as ((reported dose - conventially true value) ÷ conventially true value) where the conventially true value is the delivered dose.

d Acceptance is achieved when neither the absolute value of the mean of the P values, nor the standard deviation of the P values exceed 0.15.

TABLE A-4. In-House "Spiked" Samples

Lab Code[b]	Date	Concentration[a] Analysis	Laboratory results 2s, n=1[c]	Known Activity	Control Limits[d]	Acceptance	Ratio Lab/Known
SPW-61	1/5/2019	Ra-226	13.4 ± 0.4	12.3	9.8 - 14.8	Pass	1.09
SPW-118	1/14/2019	H-3	15,463 ± 369	16,507	13,206 - 19,808	Pass	0.94
SPW-178	1/16/2019	Ra-228	17.7 ± 2.1	15.1	12.10 - 18.14	Pass	1.17
SPW-199	1/18/2019	Sr-90	17.6 ± 1.2	17.9	14.3 - 21.5	Pass	0.98
SPW-250	1/24/2019	Ni-63	356.3 ± 44.5	465	326 - 605	Pass	0.77
SPW-256	1/15/2019	Ra-226	12.0 ± 0.4	12.3	9.8 - 14.8	Pass	0.98
SPW-271	3/18/2019	H-3	22,035 ± 450	21,700	17,360 - 26,040	Pass	1.02
SPW-281	1/25/2019	Ra-226	11.6 ± 0.4	12.3	9.8 - 14.8	Pass	0.94
W-012119	4/29/2016	Cs-134	37.3 ± 10.6	36.2	29.0 - 43.4	Pass	1.03
W-012119	4/29/2016	Cs-137	82.7 ± 8.0	71.9	57.5 - 86.3	Pass	1.15
W-012319	4/29/2016	Cs-134	33.4 ± 10.1	36.2	25.3 - 47.1	Pass	0.92
W-012319	4/29/2016	Cs-137	79.1 ± 9.6	71.9	57.5 - 86.3	Pass	1.10
W-012519	4/29/2016	Cs-134	35.0 ± 7.7	36.2	29.0 - 43.4	Pass	0.97
W-012519	4/29/2016	Cs-137	79.2 ± 7.9	71.9	57.5 - 86.3	Pass	1.10
W-012919	4/29/2016	Cs-134	32.3 ± 8.3	36.2	29.0 - 43.4	Pass	0.89
W-012919	4/29/2016	Cs-137	82.3 ± 8.3	71.9	57.5 - 86.3	Pass	1.14
SPW-370	3/19/2019	H-3	21,689 ± 444	21,700	17,360 - 26,040	Pass	1.00
SPW-400	1/31/2019	Ra-226	11.6 ± 0.4	12.3	8.6 - 16.0	Pass	0.95
SPW-461	2/12/2019	Ra-226	11.1 ± 0.4	12.3	8.6 - 16.0	Pass	0.90
W-020619	4/26/2016	Cs-134	35.0 ± 14.9	36.2	29.0 - 43.4	Pass	0.97
W-020619	4/29/2016	Cs-137	72.8 ± 8.9	71.9	57.5 - 86.3	Pass	1.01
W-020819	4/26/2016	Cs-134	36.7 ± 8.6	36.2	29.0 - 43.4	Pass	1.01
W-020819	4/29/2016	Cs-137	76.7 ± 8.7	71.9	57.5 - 86.3	Pass	1.07
SPW-568	2/21/2019	Ra-226	10.3 ± 0.3	12.3	8.6 - 16.0	Pass	0.84
W-021319	4/29/2016	Cs-134	37.7 ± 11.5	36.2	29.0 - 43.4	Pass	1.04
W-021319	4/26/2016	Cs-137	75.8 ± 9.6	71.9	57.5 - 86.3	Pass	1.05
SPW-469	3/19/2019	H-3	21,696 ± 447	21,700	17,360 - 26,040	Pass	1.00
SPW-600	3/6/2019	H-3	20,710 ± 425	21,700	17,360 - 26,040	Pass	0.95
SPW-837	3/21/2019	Ra-228	11.7 ± 1.5	15.1	10.58 - 19.66	Pass	0.78
SPW-709	3/19/2019	H-3	20,369 ± 421	21,700	17,360 - 26,040	Pass	0.94
SPW-818	3/19/2019	H-3	20,457 ± 424	21,700	17,360 - 26,040	Pass	0.94
SPW-845	3/22/2019	U-234	15.1 ± 0.5	13.6	9.5 - 17.7	Pass	1.11
SPW-845	3/22/2019	U-238	15.3 ± 0.5	13.1	9.2 - 17.0	Pass	1.17
SPW-934	3/19/2019	H-3	20,487 ± 421	21,700	17,360 - 26,040	Pass	0.94
SPW-1061	3/1/2019	Ra-226	10.6 ± 0.3	12.3	8.6 - 16.0	Pass	0.86
SPW-1091	4/10/2019	H-3	20,323 ± 421	21,700	17,360 - 26,040	Pass	0.94
SPW-1093	4/8/2019	Ra-228	14.9 ± 1.9	15.1	10.6 - 19.6	Pass	0.98
SPW-1267	4/16/2019	H-3	20,302 ± 421	21,700	17,360 - 26,040	Pass	0.94
SPW-1339	4/18/2019	H-3	19,924 ± 417	21,700	17,360 - 26,040	Pass	0.92
SPW-1403[e]	4/25/2019	Gr. Alpha	56.7 ± 2.6	72.4	36.2 - 108.6	Pass	0.78
SPW-1403[e]	4/25/2019	Gr. Beta	43.2 ± 1.4	54.8	43.8 - 65.8	Fail	0.79
SPW-1427	4/26/2019	H-3	20,119 ± 418	21,700	15,190 - 28,210	Pass	0.93
SPW-1537	5/6/2019	Sr-90	19.9 ± 1.2	17.9	14.3 - 21.5	Pass	1.11
W-050719	4/29/2016	Cs-134	38.5 ± 9.0	36.2	29.0 - 43.4	Pass	1.06
W-050719	4/26/2016	Cs-137	85.2 ± 8.5	71.9	57.5 - 86.3	Pass	1.18
SPW-1582	5/9/2019	H-3	20,492 ± 423	21,700	15,190 - 28,210	Pass	0.94

TABLE A-4. In-House "Spiked" Samples

Lab Code[b]	Date	Concentration[a] Analysis	Laboratory results 2s, n=1[c]	Known Activity	Control Limits[d]	Acceptance	Ratio Lab/Known
W-050919	4/29/2016	Cs-134	37.4 ± 8.9	36.2	29.0 - 43.4	Pass	1.03
W-050919	4/26/2016	Cs-137	81.5 ± 7.8	71.9	57.5 - 86.3	Pass	1.13
SPW-1596	5/8/2019	Ra-228	14.1 ± 1.7	15.1	10.6 - 19.6	Pass	0.94
W-051419	4/29/2016	Cs-134	36.2 ± 11.7	36.2	29.0 - 43.4	Pass	1.00
W-051419	4/26/2016	Cs-137	75.8 ± 10.0	71.9	57.5 - 86.3	Pass	1.05
SPW-1676	5/17/2019	H-3	20,233 ± 420	21,700	15,190 - 28,210	Pass	0.93
SPW-1799	5/20/2019	H-3	20,428 ± 422	21,700	15,190 - 28,210	Pass	0.94
SPW-1858	5/28/2019	H-3	20,367 ± 522	21,700	15,190 - 28,210	Pass	0.94
SPW-1890	5/30/2019	H-3	20,206 ± 419	21,700	15,190 - 28,210	Pass	0.93
SPW-2014	5/31/2019	Ra-226	11.9 ± 0.3	12.3	8.6 - 16.0	Pass	0.97
SPW-2030	6/12/2019	Ni-63	377 ± 45	464.8	325 - 604	Pass	0.81
SPW-2093	6/18/2019	H-3	20,158 ± 418	21,700	17,360 - 26,040	Pass	0.93
W-062419	4/29/2016	Cs-134	33.0 ± 12.4	36.2	29.0 - 43.4	Pass	0.91
W-062419	4/26/2016	Cs-137	66.0 ± 10.4	71.9	57.5 - 86.3	Pass	0.92
SPW-2338	6/26/2019	H-3	20,032 ± 417	21,700	17,360 - 26,040	Pass	0.92
SPW-2552	7/1/2019	Gr. Alpha	20.4 ± 1.5	21.8	10.9 - 32.7	Pass	0.94
SPW-2552	7/1/2019	Gr. Beta	46.1 ± 1.3	55.7	44.6 - 66.8	Pass	0.83
W-072619	4/29/2016	Cs-134	36.3 ± 9.2	36.2	29.0 - 43.4	Pass	1.00
W-072619	4/26/2016	Cs-137	79.7 ± 7.6	71.9	57.5 - 86.3	Pass	1.11
SPW-3188	7/30/2019	Ra-226	11.9 ± 0.3	12.3	8.6 - 16.0	Pass	0.97
SPW-2947	8/9/2019	H-3	20,128 ± 425	21,700	17,360 - 26,040	Pass	0.93
SPW-3003	8/14/2019	H-3	20,588 ± 435	21,700	17,360 - 26,040	Pass	0.95
W-081519	4/26/2019	Cs-134	36.2 ± 9.2	36.2	29.0 - 43.4	Pass	1.00
W-081519	4/26/2019	Cs-137	78.1 ± 8.4	71.9	57.5 - 86.3	Pass	1.09
W-082119	4/26/2019	Cs-134	32.8 ± 9.1	36.2	29.0 - 43.4	Pass	0.91
W-082119	4/26/2019	Cs-137	79.1 ± 7.9	71.9	57.5 - 86.3	Pass	1.10
SPW-3151	8/26/2019	H-3	20,329 ± 428	21,700	17,360 - 26,040	Pass	0.94
W-082619	4/26/2019	Cs-134	33.3 ± 17.8	36.2	29.0 - 43.4	Pass	0.92
W-082619	4/26/2019	Cs-137	82.6 ± 13.2	71.9	57.5 - 86.3	Pass	1.15
W-082719	4/26/2019	Cs-134	33.9 ± 7.0	36.2	29.0 - 43.4	Pass	0.94
W-082719	4/26/2019	Cs-137	81.4 ± 6.0	71.9	57.5 - 86.3	Pass	1.13
SPW-3359	8/30/2019	Gr. Alpha	54.2 ± 0.3	72.4	36.2 - 108.6	Pass	0.75
SPW-3359	8/30/2019	Gr. Beta	59.7 ± 0.2	54.8	43.8 - 65.8	Pass	1.09
SPW-3323	9/6/2019	Ra-228	12.7 ± 1.8	15.1	10.6 - 19.6	Pass	0.84
W-091019	4/26/2019	Cs-134	31.0 ± 11.3	36.2	29.0 - 43.4	Pass	0.86
W-091019	4/26/2019	Cs-137	80.5 ± 10.0	71.9	57.5 - 86.3	Pass	1.12
SPW-3349	9/10/2019	H-3	19,851 ± 422	21,700	17,360 - 26,040	Pass	0.91
SPW-3410	9/13/2019	H-3	20,267 ± 431	21,700	17,360 - 26,040	Pass	0.93
W-091719	4/26/2019	Cs-134	39.3 ± 12.6	36.2	29.0 - 43.4	Pass	1.09
W-091719	4/26/2019	Cs-137	81.1 ± 9.9	71.9	57.5 - 86.3	Pass	1.13
SPW-3450	9/17/2019	H-3	20,036 ± 427	21,700	17,360 - 26,040	Pass	0.92
W-091919	9/19/2019	Cs-134	40.0 ± 10.7	36.2	29.0 - 43.4	Pass	1.10
W-091919	9/19/2019	Cs-137	71.0 ± 8.7	71.9	57.5 - 86.3	Pass	0.99
SPW-3569	8/28/2019	Ra-226	11.9 ± 0.3	12.3	8.6 - 16.0	Pass	0.97
SPW-3571	9/27/2019	H-3	21,026 ± 440	21,700	17,360 - 26,040	Pass	0.97

TABLE A-4. In-House "Spiked" Samples

Lab Code[b]	Date	Concentration[a] Analysis	Laboratory results 2s, n=1[c]	Known Activity	Control Limits[d]	Acceptance	Ratio Lab/Known
SPW-3615	10/1/2019	Ra-228	18.9 ± 2.5	14.9	10.4 - 19.3	Pass	1.27
SPW-3706	10/8/2019	H-3	20,082 ± 427	21,700	17,360 - 26,040	Pass	0.93
SPW-4093	10/14/2019	Gr. Alpha	20.8 ± 0.1	19.7	9.9 - 29.6	Pass	1.06
SPW-4093	10/14/2019	Gr. Beta	63.2 ± 0.1	61.1	48.9 - 73.3	Pass	1.03
SPW-4095	10/24/2019	H-3	20,684 ± 432	21,700	17,360 - 26,040	Pass	0.95
SPW-4144	9/26/2019	Ra-226	12.8 ± 0.3	12.3	8.6 - 16.0	Pass	1.04
W-091719	3/19/2018	H-3	22,291 ± 470	21,700	17,360 - 26,040	Pass	1.03
SPW-4239	10/30/2019	Ra-228	12.4 ± 1.8	14.9	10.4 - 19.3	Pass	0.84
SPW-4254	11/8/2019	H-3	20,187 ± 427	21,700	17,360 - 26,040	Pass	0.93
SPW-4368	11/14/2019	H-3	20,386 ± 429	21,700	17,360 - 26,040	Pass	0.94
SPW-4370	10/30/2019	Ra-226	12.8 ± 0.4	12.3	8.6 - 16.0	Pass	1.04
SPW-4472	11/21/2019	H-3	20,479 ± 432.0	21,700	17,360 - 26,040	Pass	0.94
SPW-4474	11/22/2019	Sr-90	18.9 ± 1.2	17.9	14.3 - 21.5	Pass	1.06
SPW-4602	12/5/2019	H-3	20,187 ± 429	21,700	17,360 - 26,040	Pass	0.93
W-121119	3/19/2018	H-3	22,734 ± 477	21,700	17,360 - 26,040	Pass	1.05
SPW-4663	12/11/2019	Ra-228	11.2 ± 1.6	14.9	10.4 - 19.3	Pass	0.75
SPW-4688	12/13/2019	H-3	20,506 ± 431	21,700	17,360 - 26,040	Pass	0.94
SPW-4734	11/15/2019	Ra-226	12.6 ± 0.3	12.3	8.6 - 16.0	Pass	1.02
SPW-4743	12/5/2019	Ra-226	10.0 ± 0.3	12.3	8.6 - 16.0	Pass	0.81
SPW-4745	12/19/2019	H-3	20,067 ± 427	21,700	17,360 - 26,040	Pass	0.92
SPW-4889	12/19/2019	Ra-226	9.3 ± 0.3	12.3	8.6 - 16.0	Pass	0.76
SPW-4636	12/27/2019	Tc-99	94.3 ± 8.2	90.3	72.2 - 108.4	Pass	1.04
SPW-4899	1/3/2020	H-3	20,386 ± 432	21,700	17,360 - 26,040	Pass	0.94

[a] Liquid sample results are reported in pCi/Liter, air filters (pCi/m3), charcoal (pCi/charcoal canister), and solid samples (pCi/kg).

[b] Laboratory codes : W & SPW (Water), MI (milk), AP (air filter), SO (soil), VE (vegetation), CH (charcoal canister), F (fish), U (urine).

[c] Results are based on single determinations.

[d] Control limits are listed in Attachment A of this report.

[e] The LCS sample was prepared from an Environmental Resource Associates (ERA) sample of known activity. While the analysis did satisfy the acceptance criteria of the ERA study from which it was sourced, it did not satisfy EIML's internal LCS acceptance criteria. An investigation is in process to determine the reason for the low bias and to evaluate the acceptance criteria.

NOTE: For fish, gelatin is used for the spike matrix. For vegetation, cabbage is used for the spike matrix.

TABLE A-5. In-House "Blank" Samples

Lab Code[b]	Sample Type	Date	Analysis[c]	Concentration[a]		
				Laboratory results (4.66σ)		Acceptance
				LLD	Activity[d]	Criteria (4.66 σ)
SPW-5449	Water	1/7/2019	Gr. Alpha	0.76	-0.30 ± 0.52	2
SPW-5449	Water	1/7/2019	Gr. Beta	0.42	0.19 ± 0.31	4
SPW-34	Water	1/7/2019	I-131	0.36	0.13 ± 0.18	1
SPW-60	Water	11/5/2018	Ra-226	0.03	0.15 ± 0.03	2
SPW-119	Water	1/14/2019	H-3	148	42 ± 80	200
SPW-177	Water	1/16/2019	Ra-228	0.93	-0.10 ± 0.42	2
SPW-198	Water	1/18/2019	Sr-89	0.67	0.25 ± 0.50	5
SPW-198	Water	1/18/2019	Sr-90	0.67	-0.16 ± 0.29	1
SPW-249	Water	1/24/2019	Ni-63	67	31 ± 41	200
SPW-255	Water	1/15/2019	Ra-226	0.04	0.16 ± 0.03	2
SPW-280	Water	1/25/2019	Ra-226	0.06	-0.09 ± 0.14	2
SPW-399	Water	1/31/2019	Ra-226	0.03	0.15 ± 0.03	2
SPW-460	Water	2/12/2019	Ra-226	0.03	0.15 ± 0.02	2
SPW-567	Water	2/21/2019	Ra-226	0.03	0.13 ± 0.02	2
SPW-844	Water	3/22/2019	U-234	0.19	0.04 ± 0.14	1
SPW-844	Water	3/22/2019	U-238	0.19	0.00 ± 0.11	1
SPW-836	Water	3/21/2019	Ra-228	0.74	0.53 ± 0.41	2
SPW-1060	Water	3/31/2019	Ra-226	0.04	-0.02 ± 0.03	2
SPW-1090	Water	4/10/2019	H-3	155	-14 ± 72	200
SPW-1092	Water	4/8/2019	Ra-228	0.82	0.75 ± 0.46	2
SPW-1266	Water	4/16/2019	H-3	152	67 ± 74	200
SPW-1338	Water	4/18/2019	H-3	152	66 ± 79	200
SPW-1386	Water	4/8/2019	Ra-226	0.03	0.09 ± 0.03	2
SPW-1426	Water	4/26/2019	H-3	156	34 ± 75	200
SPW-1536	Water	5/6/2019	Sr-89	0.66	-0.07 ± 0.45	5
SPW-1536	Water	5/6/2019	Sr-90	0.59	-0.10 ± 0.26	1
SPW-1581	Water	5/9/2019	H-3	147	73 ± 77	200
SPW-1644	Water	4/22/2019	Ra-226	0.02	0.15 ± 0.02	2
SPW-1675	Water	5/17/2019	H-3	154	-30 ± 71	200
SPW-1798	Water	5/20/2019	H-3	149	24 ± 73	200
SPW-1857	Water	5/28/2019	H-3	150	54 ± 74	200
SPW-1889	Water	5/30/2019	H-3	152	45 ± 73	200
SPW-2013	Water	5/31/2019	Ra-226	0.01	0.13 ± 0.02	2
SPW-2029	Water	6/12/2019	Ni-63	66	10 ± 40	200
SPW-2092	Water	6/18/2019	H-3	154	-42 ± 70	200
SPW-2237	Water	6/26/2019	H-3	150	-9 ± 69	200
SPW-2107	Water	6/18/2019	I-131	0.16	0.04 ± 0.09	1
SPW-2152	Water	6/19/2019	I-131	0.16	0.04 ± 0.09	1

TABLE A-5. In-House "Blank" Samples

Lab Code[b]	Sample Type	Date	Analysis[c]	Concentration[a]		
				Laboratory results (4.66σ)		Acceptance
				LLD	Activity[d]	Criteria (4.66 σ)
SPW-3187	Water	7/30/2019	Ra-226	0.02	0.17 ± 0.02	2
SPW-2924	Water	8/6/2019	Sr-89	0.71	-0.06 ± 0.57	5
SPW-2924	Water	8/6/2019	Sr-90	0.59	0.08 ± 0.28	1
SPW-2946	Water	8/9/2019	H-3	152	33 ± 72	200
SPW-3002	Water	8/14/2019	H-3	152	-22 ± 74	200
SPW-3150	Water	8/26/2019	H-3	151	115 ± 77	200
SPW-3358	Water	8/30/2019	Gr. Alpha	0.44	-0.08 ± 0.30	2
SPW-3358	Water	8/30/2019	Gr. Beta	0.72	-0.31 ± 0.49	4
SPW-3568	Water	8/28/2019	Ra-226	0.03	0.16 ± 0.03	2
SPW-3322	Water	9/6/2019	Ra-228	0.82	0.46 ± 0.43	2
SPW-3348	Water	9/10/2019	H-3	150	107 ± 76	200
SPW-3409	Water	9/13/2019	H-3	154	133 ± 79	200
SPW-3449	Water	9/17/2019	H-3	147	102 ± 79	200
SPW-3570	Water	9/27/2019	H-3	151	70 ± 77	200
SPW-3614	Water	10/1/2019	Ra-228	1.29	1.03 ± 0.73	2
SPW-3705	Water	10/8/2019	H-3	147	107 ± 77	200
SPW-4238	Water	10/30/2019	Ra-228	0.99	0.58 ± 0.52	2
SPW-4253	Water	11/8/2019	H-3	151	80 ± 76	200
SPW-4367	Water	11/14/2019	H-3	154	42 ± 74	200
SPW-4369	Water	10/30/2016	Ra-226	0.03	0.14 ± 0.03	2
SPW-4471	Water	11/21/2019	H-3	155	81 ± 77	200
SPW-4474	Water	11/21/2019	C-14	12	0 ± 7	200
SPW-4476	Water	11/22/2019	Sr-89	0.62	0.23 ± 0.45	5
SPW-4476	Water	11/22/2019	Sr-90	0.57	-0.16 ± 0.24	1
SPW-4601	Water	12/5/2019	H-3	155	28 ± 74	200
SPW-4635	Water	12/9/2019	Tc-99	12	-6 ± 7	20
SPW-4662	Water	12/17/2019	Ra-228	0.77	0.55 ± 0.42	2
SPW-4687	Water	12/13/2019	H-3	150	143 ± 78	200
SPW-4733	Water	11/15/2019	Ra-226	0.03	0.13 ± 0.03	2
SPW-4742	Water	12/5/2019	Ra-226	0.04	0.10 ± 0.10	2
SPW-4744	Water	12/19/2019	H-3	151	119 ± 81	200
SPW-4888	Water	12/19/2019	Ra-226	0.03	0.15 ± 0.02	2
SPW-4898	Water	1/3/2020	H-3	159	19 ± 78	200

[a] Liquid sample results are reported in pCi/Liter, air filters (pCi/m^3), charcoal (pCi/charcoal canister), and solid samples (pCi/g).

[b] Laboratory codes : W & SPW (Water), MI (milk), AP (air filter), SO (soil), VE (vegetation), CH (charcoal canister), F (fish), U (urine).

[c] I-131(G); iodine-131 as analyzed by gamma spectroscopy.

[d] Activity reported is a net activity result.

TABLE A-6. In-House "Duplicate" Samples

			Concentration[a]			
Lab Code[b]	Date	Analysis	First Result	Second Result	Averaged Result	Acceptance
AP-5499,5500	1/2/2019	Fe-55	941 ± 220	1027 ± 226	984 ± 158	Pass
AP-5499,5500	1/2/2019	Sr-89	20.2 ± 7.3	14.9 ± 5.7	17.5 ± 4.7	Pass
AP-5499,5500	1/2/2019	Ni-63	12.1 ± 8.5	15.6 ± 8.5	13.8 ± 6.0	Pass
CF-20,21	1/2/2019	Gr. Beta	10.0 ± 0.2	10.7 ± 0.2	10.3 ± 0.2	Pass
CF-20,21	1/2/2019	Sr-90	0.005 ± 0.002	0.005 ± 0.002	0.005 ± 0.001	Pass
CF-20,21	1/2/2019	Be-7	0.27 ± 0.09	0.29 ± 0.08	0.28 ± 0.06	Pass
CF-20,21	1/2/2019	K-40	6.69 ± 0.34	6.83 ± 0.34	6.76 ± 0.24	Pass
SG-211,212	1/21/2019	Ra-226	7.94 ± 0.26	8.50 ± 0.29	8.22 ± 0.19	Pass
SG-211,212	1/21/2019	Ac-228	4.46 ± 0.37	4.63 ± 0.43	4.55 ± 0.28	Pass
WW-324,325	2/4/2019	Gr. Alpha	0.68 ± 0.44	0.49 ± 0.46	0.59 ± 0.32	Pass
WW-324,325	2/4/2019	Gr. Beta	1.80 ± 0.55	2.95 ± 0.63	2.37 ± 0.42	Pass
W-345,346	2/4/2019	H-3	245 ± 84	277 ± 85	261 ± 60	Pass
WW-797,798	3/5/2019	H-3	165 ± 80	222 ± 83	193 ± 58	Pass
WW-648,649	3/8/2019	H-3	587 ± 101	630 ± 102	608 ± 72	Pass
SW-713,714	3/14/2019	H-3	326 ± 90	254 ± 86	290 ± 62	Pass
AP-1241,1242	4/2/2019	Be-7	0.097 ± 0.018	0.108 ± 0.020	0.103 ± 0.013	Pass
AP-1285,1286	4/3/2019	Be-7	0.080 ± 0.014	0.078 ± 0.012	0.079 ± 0.009	Pass
AP-1306,1307	4/3/2019	Be-7	0.085 ± 0.009	0.096 ± 0.011	0.090 ± 0.007	Pass
AP-1327,1328	4/3/2019	Be-7	0.078 ± 0.010	0.079 ± 0.011	0.078 ± 0.007	Pass
AP-1327,1328	4/3/2019	K-40	0.012 ± 0.007	0.021 ± 0.010	0.017 ± 0.006	Pass
AP-2119,2120	4/3/2019	Be-7	0.276 ± 0.098	0.265 ± 0.116	0.270 ± 0.076	Pass
AP-2225,2226	4/3/2019	Be-7	0.231 ± 0.128	0.208 ± 0.123	0.220 ± 0.089	Pass
CF-820,821	4/3/2019	K-40	6.39 ± 0.30	6.63 ± 0.37	6.51 ± 0.24	Pass
WW-648,649	4/5/2019	H-3	587 ± 101	630 ± 102	608 ± 72	Pass
WW-1043,1044	4/5/2019	H-3	666 ± 121	662 ± 121	664 ± 86	Pass
SW-1087,1088	4/8/2019	H-3	9,997 ± 300	10,330 ± 305	10,164 ± 214	Pass
WW-1198,1199	4/9/2019	H-3	562 ± 99	640 ± 102	601 ± 71	Pass
LW-1503,1504	4/25/2019	Gr. Beta	1.09 ± 0.55	1.46 ± 0.57	1.27 ± 0.39	Pass
WW-1789,1790	5/7/2019	H-3	366 ± 90	400 ± 92	383 ± 64	Pass
SG-2269,2270	5/7/2019	Pb-214	39.1 ± 0.5	40.3 ± 0.5	39.7 ± 0.4	Pass
SG-2269,2270	5/7/2019	Ac-228	53.2 ± 1.0	57.1 ± 1.0	55.2 ± 0.7	Pass
DW-10049,10050	5/7/2019	Ra-226	1.31 ± 0.13	1.66 ± 0.15	1.49 ± 0.10	Pass
DW-10049,10050	5/7/2019	Ra-228	1.24 ± 0.52	1.33 ± 0.53	1.29 ± 0.37	Pass
WW-1690A,B	5/8/2019	H-3	325 ± 89	303 ± 93	314 ± 64	Pass
S-1812,1813	5/16/2019	K-40	22.0 ± 0.9	23.3 ± 1.0	22.6 ± 0.7	Pass
S-1812,1813	5/16/2019	Cs-137	0.05 ± 0.03	0.07 ± 0.04	0.06 ± 0.02	Pass
DW-10053,10054	5/22/2019	Gr. Alpha	0.93 ± 0.63	1.14 ± 0.72	1.04 ± 0.48	Pass
DW-10053,10054	5/22/2019	Gr. Beta	1.43 ± 0.62	1.13 ± 0.59	1.28 ± 0.43	Pass
W-2053,2054	5/29/2019	H-3	1572 ± 135	1470 ± 131	1521 ± 94	Pass

TABLE A-6. In-House "Duplicate" Samples

			Concentration[a]			
Lab Code[b]	Date	Analysis	First Result	Second Result	Averaged Result	Acceptance
G-1989,1990	6/3/2019	Be-7	0.80 ± 0.18	0.72 ± 0.15	0.76 ± 0.12	Pass
G-1989,1990	6/3/2019	K-40	6.15 ± 0.51	5.98 ± 0.46	6.07 ± 0.34	Pass
G-1989,1990	6/3/2019	Gr. Beta	7.24 ± 0.19	7.00 ± 0.19	7.12 ± 0.13	Pass
WW-2204,2205	6/6/2019	H-3	3861 ± 194	3722 ± 191	3792 ± 136	Pass
S-2031,2032	6/10/2019	Pb-214	5.16 ± 0.19	4.75 ± 0.22	4.96 ± 0.15	Pass
S-2031,2032	6/10/2019	Ac-228	3.81 ± 0.31	3.63 ± 0.33	3.72 ± 0.23	Pass
S-2010,2011	6/10/2019	Pb-214	1.48 ± 0.10	1.05 ± 0.11	1.27 ± 0.07	Pass
F-2140,2141	6/12/2019	K-40	1.01 ± 0.28	1.39 ± 0.32	1.20 ± 0.21	Pass
S-2162,2163	6/12/2019	Pb-214	0.65 ± 0.06	0.54 ± 0.05	0.60 ± 0.04	Pass
S-2162,2163	6/12/2019	Ac-228	0.46 ± 0.10	0.44 ± 0.08	0.45 ± 0.07	Pass
S-2162,2163	6/12/2019	K-40	4.22 ± 0.49	3.81 ± 0.41	4.02 ± 0.32	Pass
S-2162,2163	6/12/2019	Tl-208	0.09 ± 0.02	0.10 ± 0.02	0.09 ± 0.01	Pass
S-2162,2163	6/12/2019	Pb-212	0.34 ± 0.03	0.26 ± 0.03	0.30 ± 0.02	Pass
SWT-2355,2356	6/25/2019	Gr. Beta	1.12 ± 0.57	1.24 ± 0.56	1.18 ± 0.40	Pass
AP-2689,2690	6/28/2019	Be-7	0.089 ± 0.020	0.075 ± 0.018	0.082 ± 0.013	Pass
AP-2710,2711	7/1/2019	Be-7	0.091 ± 0.010	0.097 ± 0.010	0.094 ± 0.007	Pass
AP-2731,2732	7/2/2019	Be-7	0.073 ± 0.013	0.072 ± 0.011	0.072 ± 0.009	Pass
DW-10062,10063	7/5/2019	Ra-226	4.10 ± 0.30	4.03 ± 0.30	4.07 ± 0.21	Pass
DW-10062,10063	7/5/2019	Ra-228	1.95 ± 0.60	2.31 ± 0.62	2.13 ± 0.43	Pass
AP-70818,70819	7/8/2019	Gr. Beta	0.021 ± 0.004	0.023 ± 0.004	0.022 ± 0.003	Pass
XW-2459,2460	7/10/2019	H-3	304 ± 92	234 ± 89	269 ± 64	Pass
VE-2516,2517	7/10/2019	Be-7	0.63 ± 0.16	0.52 ± 0.19	0.58 ± 0.12	Pass
VE-2516,2517	7/10/2019	K-40	6.50 ± 0.47	6.81 ± 0.54	6.66 ± 0.36	Pass
AP-71518A,B	7/15/2019	Gr. Beta	0.022 ± 0.004	0.025 ± 0.004	0.023 ± 0.003	Pass
VE-2668,2669	7/16/2019	K-40	3.84 ± 0.27	3.74 ± 0.26	3.79 ± 0.19	Pass
DW-10076,10077	7/16/2019	Gr. Alpha	3.01 ± 0.92	4.13 ± 0.91	3.57 ± 0.65	Pass
DW-10073,10074	7/16/2019	Ra-226	1.57 ± 0.18	1.51 ± 0.21	1.54 ± 0.14	Pass
DW-10073,10074	7/16/2019	Ra-228	1.29 ± 0.56	1.48 ± 0.57	1.385 ± 0.40	Pass
AP-72218A,B	7/22/2019	Gr. Beta	0.013 ± 0.004	0.016 ± 0.004	0.015 ± 0.003	Pass
G-2752,2753	7/23/2019	K-40	4.53 ± 0.42	4.47 ± 0.46	4.50 ± 0.31	Pass
G-2752,2753	7/23/2019	Be-7	1.98 ± 0.29	1.96 ± 0.29	1.97 ± 0.20	Pass
AP-2800,2801	7/25/2019	Be-7	0.208 ± 0.090	0.321 ± 0.147	0.264 ± 0.086	Pass
AP-72918A,B	7/29/2019	Gr. Beta	0.026 ± 0.005	0.025 ± 0.005	0.025 ± 0.003	Pass
VE-2840,2841	7/31/2019	K-40	3.94 ± 0.38	3.99 ± 0.47	3.96 ± 0.30	Pass
AP-2903,2904	8/1/2019	Be-7	0.198 ± 0.102	0.228 ± 0.102	0.213 ± 0.072	Pass
P-2882,2983	8/1/2019	H-3	265 ± 85	327 ± 88	296 ± 61	Pass
SG-2926,2927	8/5/2019	Pb-214	9.07 ± 0.39	8.82 ± 0.39	8.95 ± 0.28	Pass
SG-2926,2927	8/5/2019	Ac-228	9.00 ± 0.76	8.58 ± 0.72	8.79 ± 0.52	Pass
AV-2993,2994	8/9/2019	Gr. Beta	1.22 ± 0.19	1.28 ± 0.21	1.25 ± 0.14	Pass
AV-2993,2994	8/9/2019	K-40	3.12 ± 0.36	3.14 ± 0.35	3.13 ± 0.25	Pass

TABLE A-6. In-House "Duplicate" Samples

			Concentration[a]			
Lab Code[b]	Date	Analysis	First Result	Second Result	Averaged Result	Acceptance
DW-10088,10089	8/9/2019	Ra-228	0.60 ± 0.50	1.20 ± 0.50	0.90 ± 0.35	Pass
DW-10088,10089	8/9/2019	Ra-226	1.40 ± 0.20	0.94 ± 0.20	1.17 ± 0.14	Pass
VE-3016,3017	8/12/2019	Be-7	0.39 ± 0.12	0.47 0.28	0.43 0.15	Pass
VE-3016,3017	8/12/2019	K-40	6.13 ± 0.41	6.24 0.64	6.18 0.38	Pass
G-3600,3601	8/12/2019	Be-7	4.42 ± 0.33	4.35 0.27	4.39 0.21	Pass
WW-3100,3101	8/14/2019	H-3	480 ± 96	401 ± 92	441 ± 66	Pass
MI-3211,3212	8/27/2019	K-40	1862 ± 131	1923 ± 136	1893 ± 94	Pass
MI-3211,3212	8/27/2019	Sr-90	0.90 ± 0.33	0.56 ± 0.29	0.73 ± 0.22	Pass
LW-3512,3513	8/30/2019	Gr. Beta	0.79 ± 0.50	1.39 ± 0.58	1.09 ± 0.38	Pass
DW-10100,10101	9/5/2019	Ra-226	0.50 ± 0.11	0.57 0.12	0.54 ± 0.08	Pass
DW-10100,10101	9/5/2019	Ra-228	3.38 ± 0.82	2.54 1.03	2.96 ± 0.66	Pass
DW-10111,10112	9/23/2019	Gr. Alpha	1.72 ± 0.73	1.41 0.68	1.57 ± 0.50	Pass
DW-10115,10116	9/25/2019	Ra-228	3.65 ± 0.80	2.76 0.68	3.21 ± 0.52	Pass
DW-10115,10116	9/25/2019	Ra-226	2.99 ± 0.23	2.74 0.25	2.87 ± 0.17	Pass
WW-3793,3794	10/8/2019	Gr. Beta	3.75 ± 1.18	4.34 1.20	4.05 ± 0.84	Pass
BS-3879,3880	10/9/2019	Pb-214	0.60 ± 0.03	0.65 ± 0.05	0.63 ± 0.03	Pass
BS-3879,3880	10/9/2019	Ra-226	1.27 ± 0.14	1.15 ± 0.14	1.21 ± 0.10	Pass
BS-3879,3880	10/9/2019	K-40	11.05 ± 0.29	10.69 ± 0.30	10.87 ± 0.21	Pass
BS-3879,3880	10/9/2019	Pb-212	0.58 ± 0.02	0.55 ± 0.02	0.56 ± 0.01	Pass
BS-3879,3880	10/9/2019	Tl-208	0.21 ± 0.02	0.21 ± 0.01	0.21 ± 0.01	Pass
BS-3879,3880	10/9/2019	Bi-212	0.75 ± 0.17	0.62 ± 0.17	0.68 ± 0.12	Pass
BS-3879,3880	10/9/2019	Bi-214	0.57 ± 0.02	0.52 ± 0.06	0.54 ± 0.03	Pass
BS-4161,4162	10/29/2019	K-40	15.3 ± 0.6	15.3 ± 0.7	15.3 ± 0.5	Pass
BS-4161,4162	10/29/2019	Ra-226	2.16 ± 0.35	2.27 ± 0.78	2.22 ± 0.43	Pass
DW-10126,10127	10/22/2019	Ra-228	0.85 ± 0.58	1.19 ± 0.62	1.02 ± 0.42	Pass
DW-10129,10130	10/22/2019	Gr. Alpha	1.44 ± 0.96	3.06 ± 0.95	2.25 ± 0.68	Pass
SG-4071	10/22/2019	Ac-228	2.10 ± 0.16	2.16 ± 0.20	2.13 ± 0.13	Pass
SPSG-4071,4072	10/22/2019	Pb-214	1.61 ± 0.10	1.29 ± 0.08	1.45 ± 0.06	Pass
SS-3900,3901	10/15/2019	Bi-212	0.29 ± 0.14	0.19 ± 0.12	0.24 ± 0.09	Pass
WW-4291,4292	11/5/2019	H-3	481 ± 97	528 ± 97	505 ± 68	Pass
DW-10139,10140	11/6/2019	Ra-228	2.61 ± 0.62	2.26 ± 0.63	2.44 ± 0.44	Pass
DW-10139,10140	11/6/2019	Ra-226	1.49 ± 0.17	1.32 ± 0.19	1.41 ± 0.13	Pass
WW-4270,4271	11/6/2019	H-3	112 ± 78	165 ± 81	139 ± 56	Pass
S-4312,4313	11/7/2019	K-40	20.2 ± 0.8	23.0 ± 0.9	21.6 ± 0.6	Pass
AP-4379,4380	11/12/2019	Be-7	0.133 ± 0.075	0.134 ± 0.073	0.134 ± 0.052	Pass
S-4422,4223	11/13/2019	Pb-214	1.22 ± 0.09	1.28 ± 0.10	1.25 ± 0.07	Pass
S-4422,4423	11/13/2019	Ac-228	1.14 ± 0.15	1.21 ± 0.17	1.18 ± 0.11	Pass
WW-4556,4557	11/13/2019	H-3	438 ± 96	482 ± 98	460 ± 69	Pass
SO-5024,5025	11/14/2019	K-40	6.60 ± 0.54	6.26 ± 0.58	6.43 ± 0.40	Pass
MI-4443,4444	11/18/2019	K-40	1304 ± 114	1340 ± 109	1322 ± 79	Pass

TABLE A-6. In-House "Duplicate" Samples

			Concentration[a]			
Lab Code[b]	Date	Analysis	First Result	Second Result	Averaged Result	Acceptance
SW-4492,4493	11/19/2019	H-3	188 ± 87	264 ± 97	226 ± 65	Pass
WW-4577,4578	11/21/2019	H-3	212 ± 83	232 ± 84	222 ± 59	Pass
AP-4514,4515	11/21/2019	Be-7	0.130 ± 0.055	0.193 ± 0.112	0.162 ± 0.062	Pass
SWT-4598,4599	11/26/2019	Gr. Beta	1.43 ± 0.57	1.14 ± 0.54	1.28 ± 0.39	Pass
AP-120218A,B	12/2/2019	Gr. Beta	0.009 ± 0.004	0.013 ± 0.004	0.011 ± 0.003	Pass
S-4644,4645	12/4/2019	Pb-214	1.01 ± 0.09	0.91 ± 0.09	0.96 ± 0.06	Pass
S-4644,4645	12/4/2019	Ac-228	0.85 ± 0.15	0.96 ± 0.16	0.91 ± 0.11	Pass
AP-121618A,B	12/16/2019	Gr. Beta	0.028 ± 0.005	0.030 ± 0.005	0.029 ± 0.003	Pass
S-4735,4736	12/16/2019	Pb-214	9.33 ± 0.38	9.45 ± 0.27	9.39 ± 0.23	Pass
S-4735,4736	12/16/2019	Ac-228	13.4 ± 0.7	14.9 ± 0.7	14.1 ± 0.5	Pass
AP-122318A,B	12/23/2019	Gr. Beta	0.034 ± 0.005	0.035 ± 0.005	0.035 ± 0.003	Pass
AP-123018A,B	12/30/2019	Gr. Beta	0.037 ± 0.005	0.037 ± 0.005	0.037 ± 0.004	Pass

Note: Duplicate analyses are performed on every twentieth sample received in-house. Results are not listed for those analyses with activities that measure below the LLD.

[a] Results are reported in units of pCi/L, except for air filters (pCi/Filter or pCi/m3), food products, vegetation, soil and sediment (pCi/g).

[b] CH (Charcoal Canister), DW (Drinking Water), E (Egg), F (Fish), G (Grass), LW (Lake Water), P (Precipitation), PM (Powdered Milk), S, (Solid), SG (Sludge), SO (Soil), SS (Shoreline Sediment), SW (Surface Water), SWT (Surface Water Treated), SWU (Surface Water Untreated), VE (Vegetation), W Water (Water), WW (Well Water).

TABLE A-7. Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP).

			Concentration[a]			
Lab Code [b]	Reference Date	Analysis	Laboratory result	Known Activity	Control Limits [c]	Acceptance
MAAP-609	2/1/2019	Gross Alpha	0.16 ± 0.03	0.528	0.158 - 0.898	Pass
MAAP-609	2/1/2019	Gross Beta	1.09 ± 0.07	0.948	0.474 - 1.422	Pass
MAW-550	2/1/2019	Gross Alpha	0.73 ± 0.06	0.84	0.25 - 1.43	Pass
MAW-550	2/1/2019	Gross Beta	2.26 ± 0.06	2.33	1.17 - 3.50	Pass
MASO-605	2/1/2019	Am-241	38.89 ± 5.92	49.9	34.9 ± 64.9	Pass
MASO-605	2/1/2019	Cs-134	0.45 ± 2.52	0.0	NA [c]	Pass
MASO-605	2/1/2019	Cs-137	1273.1 ± 13.0	1164	815 - 1513	Pass
MASO-605	2/1/2019	Co-57	0.46 ± 1.1	0.0	NA [c]	Pass
MASO-605	2/1/2019	Co-60	857.96 ± 8.52	855.0	599 - 1112	Pass
MASO-605	2/1/2019	Mn-54	1,138.0 ± 13.5	1027	719 - 1335	Pass
MASO-605	2/1/2019	Zn-65	730.92 ± 16.48	668	468 - 868	Pass
MASO-605	2/1/2019	K-40	676 ± 47	585	410 - 761	Pass
MASO-605	2/1/2019	Sr-90	0.0007 ± 0.0007	0.000	NA [c]	Pass
MASO-605	2/1/2019	Pu-238	78.15 ± 6.11	71.0	49.7 - 92.3	Pass
MASO-605	2/1/2019	Pu-239/240	65.00 ± 5.4	59.8	41.9 - 77.7	Pass
MASO-605	2/1/2019	U-234	65 ± 13	56	39 - 73	Pass
MASO-605	2/1/2019	U-238	237 ± 23	205	144 - 267	Pass
MAW-613	2/1/2019	Am-241	0.46 ± 0.03	0.582	0.407 - 0.757	Pass
MAW-613	2/1/2019	Cs-134	5.49 ± 0.18	5.99	4.19 - 7.79	Pass
MAW-613	2/1/2019	Cs-137	0.089 ± 0.080	0	NA [c]	Pass
MAW-613	2/1/2019	Co-57	10.87 ± 0.24	10.00	7.0 - 13.0	Pass
MAW-613	2/1/2019	Co-60	6.78 ± 0.19	6.7	4.7 - 8.7	Pass
MAW-613	2/1/2019	Mn-54	8.98 ± 0.17	8.4	5.9 - 10.9	Pass
MAW-613	2/1/2019	Zn-65	0.096 ± 0.141	0	NA [c]	Pass
MAW-613	2/1/2019	Fe-55	0.004 ± 4.00	0	NA [c]	Pass
MAW-613	2/1/2019	Ni-63	5.54 ± 1.52	5.8	4.1 - 7.5	Pass
MAW-613	2/1/2019	Sr-90	6.02 ± 0.53	6.35	4.45 - 8.26	Pass
MAW-613	2/1/2019	Pu-238	0.315 ± 0.088	0.451	0.316 - 0.586	Fail[e]
MAW-613	2/1/2019	Pu-239/240	0.07 ± 0.07	0.005	NA [d]	Pass
MAW-613	2/1/2019	U-234	0.96 ± 0.07	0.800	0.56 ± 1.04	Pass
MAW-613	2/1/2019	U-238	0.94 ± 0.07	0.810	0.57 ± 1.05	Pass
MAAP-611	2/1/2019	Cs-134	0.185 ± 0.025	0.216	0.151 - 0.281	Pass
MAAP-611	2/1/2019	Cs-137	0.288 ± 0.045	0.290	0.203 - 0.377	Pass
MAAP-611	2/1/2019	Co-57	0.369 ± 0.033	0.411	0.288 - 0.534	Pass
MAAP-611	2/1/2019	Co-60	0.333 ± 0.045	0.340	0.238 - 0.442	Pass
MAAP-611	2/1/2019	Mn-54	0.546 ± 0.058	0.547	0.383 - 0.711	Pass
MAAP-611	2/1/2019	Zn-65	0.025 ± 0.0348	0	NA [c]	Pass
MAAP-611	2/1/2019	Sr-90	1.34 ± 0.13	0.662	0.463 - 0.861	Fail[f]
MAAP-611	2/1/2019	U-234	4.14 ± 0.97	0.106	0.074 - 0.138	Fail[f]
MAAP-611	2/1/2019	U-238	3.89 ± 0.94	0.110	0.077 - 0.143	Fail[f]
MAW-601	2/1/2019	I-129	0.56 ± 0.08	0.616	0.431 - 0.801	Pass

TABLE A-7. Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP).

			Concentration[a]			
Lab Code [b]	Reference Date	Analysis	Laboratory result	Known Activity	Control Limits [c]	Acceptance
MAVE-607	2/1/2019	Cs-134	2.33 ± 0.10	2.44	1.71 - 3.17	Pass
MAVE-607	2/1/2019	Cs-137	2.62 ± 0.13	2.30	1.61 - 2.99	Pass
MAVE-607	2/1/2019	Co-57	2.39 ± 0.11	2.07	1.45 - 2.69	Pass
MAVE-607	2/1/2019	Co-60	0.046 ± 0.04	0	NA [c]	Pass
MAVE-607	2/1/2019	Mn-54	0.031 ± 0.04	0	NA [c]	Pass
MAVE-607	2/1/2019	Sr-90	0.013 ± 0.022	0	NA [c]	Pass
MAAP-3299	8/1/2019	Gross Alpha	0.13 ± 0.03	0.528	0.158 - 0.898	Fail[g]
MAAP-3299	8/1/2019	Gross Beta	1.06 ± 0.07	0.937	0.469 - 1.406	Pass
MAW-3252	8/1/2019	Gross Alpha	0.93 ± 0.06	1.06	0.32 - 1.80	Pass
MAW-3252	8/1/2019	Gross Beta	3.03 ± 0.07	3.32	1.66 - 4.98	Pass
MASO-3297	8/19/2019	Cs-134	881.98 ± 9.03	1020	714 - 1326	Pass
MASO-3297	8/19/2019	Cs-137	871.50 ± 10.83	789	552 - 1026	Pass
MASO-3297	8/19/2019	Co-57	-1.72 ± 3.01	0	NA [c]	Pass
MASO-3297	8/19/2019	Co-60	783.69 ± 8.21	760	532 - 988	Pass
MASO-3297	8/19/2019	Mn-54	834.48 ± 11.29	745	522 - 969	Pass
MASO-3297	8/19/2019	Zn-65	-3.01 ± 5.27	0	NA [c]	Pass
MASO-3297	8/19/2019	K-40	662.91 ± 42.65	555	389 - 722	Pass
MAW-3240	8/1/2019	Cs-134	-0.08 ± 0.06	0	NA [c]	Pass
MAW-3240	8/1/2019	Cs-137	18.48 ± 0.90	18.4	12.9 - 23.9	Pass
MAW-3240	8/1/2019	Co-57	14.68 ± 0.52	15.6	10.9 - 20.3	Pass
MAW-3240	8/1/2019	Co-60	8.67 ± 0.39	8.8	6.2 - 11.4	Pass
MAW-3240	8/1/2019	Mn-54	20.72 ± 0.93	20.6	14.4 - 26.8	Pass
MAW-3240	8/1/2019	Zn-65	20.52 ± 1.05	20.3	14.200 - 26.400	Pass
MAW-3240	8/1/2019	K-40	5.11 ± 0.68	0	NA [c]	Fail
MAW-3240	8/1/2019	H-3	179.52 ± 3.32	175	123 - 228	Pass
MAW-3240	8/1/2019	U-234	1.11 ± 0.04	1.07	0.75 - 1.39	Pass
MAW-3240	8/1/2019	U-238	1.08 ± 0.04	1.05	0.74 - 1.37	Pass
MAVE-3295	8/1/2019	Cs-134	0.02 ± 0.02	0	NA [c]	Pass
MAVE-3295	8/1/2019	Cs-137	3.38 ± 0.32	3.28	2.30 - 4.26	Pass
MAVE-3295	8/1/2019	Co-57	4.99 ± 0.51	4.57	3.20 - 5.94	Pass
MAVE-3295	8/1/2019	Co-60	5.29 ± 0.39	5.30	3.71 - 6.89	Pass
MAVE-3295	8/1/2019	Mn-54	4.73 ± 0.45	4.49	3.14 - 5.84	Pass
MAVE-3295	8/1/2019	Zn-65	3.10 ± 0.31	2.85	2.00 - 3.71	Pass

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

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

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

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

[e] Past results have been acceptable so will watch to see if a trend develops.

[f] An erroneous volume conversion caused some incorrect values to be submitted. If the conversion had been performed properly the results in Bq/sample would have been (Sr-90: 0.671 ± 0.066) and (U-234: 0.153 ± 0.036) and (U-238: 0.144 ± 0.035). This result had been included in the Uranium investigation. See footnote "C" on Table A-1.

[g] The lab will adopt a MAPEP specific gross alpha/beta filter calibration as discussed in the MAPEP test instructions.. Utilizing a MAPEP specific calibration, the result in Bq/sample yields a result of (0.39 ± 0.09 Bq/total).

TABLE A-8. Interlaboratory Comparison Crosscheck Program, Environmental Resource Associates (ERA)[a].

MRAD-30 Study

Lab Code [b]	Concentration [a]					
	Date	Analysis	Laboratory Result	ERA Value [c]	Control Limits [d]	Acceptance
ERAP-846	3/18/2019	Am-241	19.1	18.7	13.3 - 24.9	Pass
ERAP-846	3/18/2019	Cs-134	612	721	468 - 884	Pass
ERAP-846	3/18/2019	Cs-137	679	634	521 - 832	Pass
ERAP-846	3/18/2019	Co-60	93.7	93.8	79.7 - 119	Pass
ERAP-846	3/18/2019	Fe-55	612	718	262 - 1150	Pass
ERAP-846	3/18/2019	Mn-54	< 0.5	< 50.0	0.00 - 50.0	Pass
ERAP-846	3/18/2019	Zn-65	1500	1380	1130 - 2110	Pass
ERAP-846	3/18/2019	Pu-238	34.0	33.8	25.5 - 41.5	Pass
ERAP-846	3/18/2019	Pu-239	64.9	67.0	50.1 - 80.8	Pass
ERAP-846	3/18/2019	Sr-90	199	181	114 - 246	Pass
ERAP-846	3/18/2019	U-234[e]	29.0	18.2	13.5 - 21.3	Fail
ERAP-846	3/18/2019	U-238[e]	28.6	18.1	13.7 - 21.6	Fail
ERAP-848	3/18/2019	Gross Alpha	48.4	50.3	26.3 - 82.9	Pass
ERAP-848	3/18/2019	Gross Beta	95.5	78.6	47.7 - 119	Pass

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

[b] Laboratory code ERAP (air filter). Results are reported in units of (pCi/Filter).

[c] The ERA Assigned values for the air filter standards are equal to 100% of the parameter present in the standard as determined by the gravimetric and/or volumetric measurements made during standard preparation as applicable.

[d] The acceptance limits are established per the guidelines contained in the Department of Energy (DOE) report EML-564, Analysis of Environmental Measurements Laboratory (EML) Quality Assessment Program (QAP) Data Determination of Operational Criteria and Control Limits for Performance Evaluation Purposes or ERA's SOP for the generation of Performance Acceptance Limits.

[e] Failure traced to an over-estimated U-232 tracer value. Tracer has been re-standardized. (See footnote "c" on Table A-1).

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Appendix B

Data Reporting Conventions

APPENDIX B. DATA REPORTING CONVENTIONS

Data Reporting Conventions

1.0. All activities, except gross alpha and gross beta, are decay corrected to collection time or the end of the collection period.

2.0. Single Measurements

Each single measurement is reported as follows: $x \pm s$

where: x = value of the measurement;
s = 2σ counting uncertainty (corresponding to the 95% confidence level).

In cases where the activity is less than the lower limit of detection L, it is reported as: < L, where L = the lower limit of detection based on 4.66σ uncertainty for a background sample.

3.0. Duplicate analyses

If duplicate analyses are reported, the convention is as follows. :

3.1 Individual results: For two analysis results; $x_1 \pm s_1$ and $x_2 \pm s_2$

Reported result: $x \pm s$; where $x = (1/2)(x_1 + x_2)$ and $s = (1/2)\sqrt{s_1^2 + s_2^2}$

3.2. Individual results: $< L_1$, $< L_2$ Reported result: < L, where L = lower of L_1 and L_2

3.3. Individual results: $x \pm s$, < L Reported result: $x \pm s$ if $x \geq L$; < L otherwise.

4.0. Computation of Averages and Standard Deviations

4.1 Averages and standard deviations listed in the tables are computed from all of the individual measurements over the period averaged; for example, an annual standard deviation would not be the average of quarterly standard deviations. The average $\bar{x}$ and standard deviation "s" of a set of n numbers $x_1, x_2 \ldots x_n$ are defined as follows:

$$\bar{x} = \frac{1}{n} \sum x \qquad s = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$

4.2 Values below the highest lower limit of detection are not included in the average.

4.3 If all values in the averaging group are less than the highest LLD, the highest LLD is reported.

4.4 If all but one of the values are less than the highest LLD, the single value x and associated two sigma error is reported.

4.5 In rounding off, the following rules are followed:

4.5.1. If the number following those to be retained is less than 5, the number is dropped, and the retained numbers are kept unchanged. As an example, 11.443 is rounded off to 11.44.

4.5.2. If the number following those to be retained is equal to or greater than 5, the number is dropped and the last retained number is raised by 1. As an example, 11.445 is rounded off to 11.45.

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Appendix C

Maximum permissible concentrations of radioactivity
in air and water above natural background in unrestricted areas

APPENDIX C

Table C-1. Maximum permissible concentrations of radioactivity in air and water above natural background in unrestricted areas[a].

	Air (pCi/m^3)		Water (pCi/L)
Gross alpha	1×10^{-3}	Strontium-89	8,000
Gross beta	1	Strontium-90	500
Iodine-131[b]	2.8×10^{-1}	Cesium-137	1,000
		Barium-140	8,000
		Iodine-131	1,000
		Potassium-40 [c]	4,000
		Gross alpha	2
		Gross beta	10
		Tritium	1×10^6

[a] Taken from Table 2 of Appendix B to Code of Federal Regulations Title 10, Part 20, and appropriate footnotes. Concentrations may be averaged over a period not greater than one year.

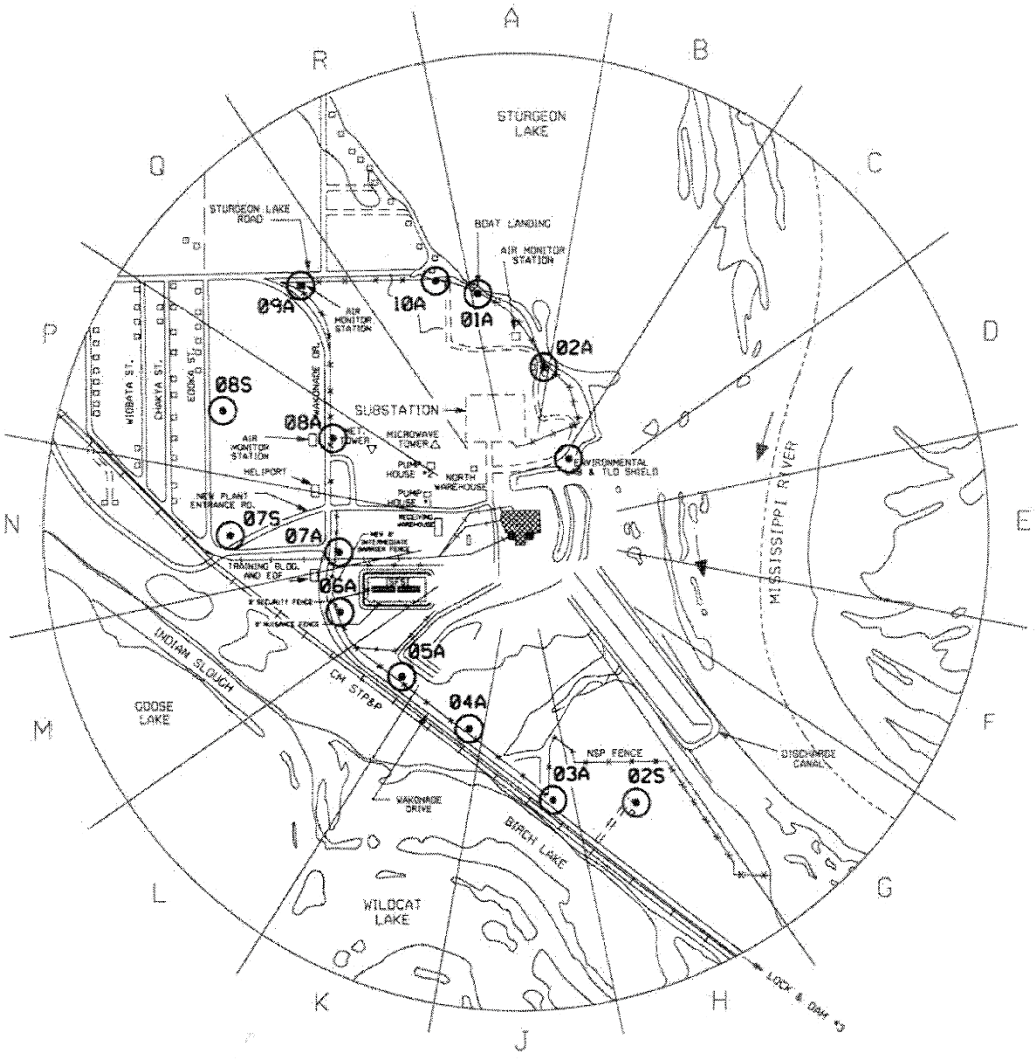
[b] Value adjusted by a factor of 700 to reduce the dose resulting from the air-grass-cow-milk-child pathway.

[c] A natural radionuclide.

APPENDIX D

Sample Collection and Analysis Program

TLD LOCATIONS
ONE MILE RADIUS

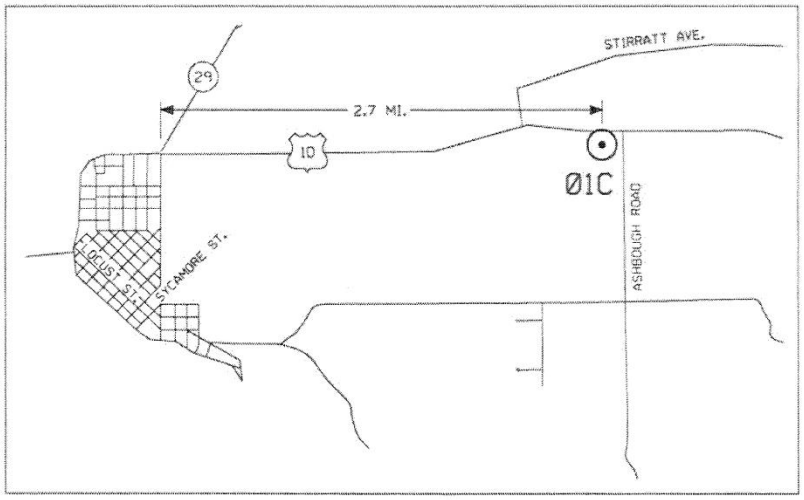


PLANT AREA ENLARGED PLAN [1.00 MILE RADIUS]
[NO SCALE]

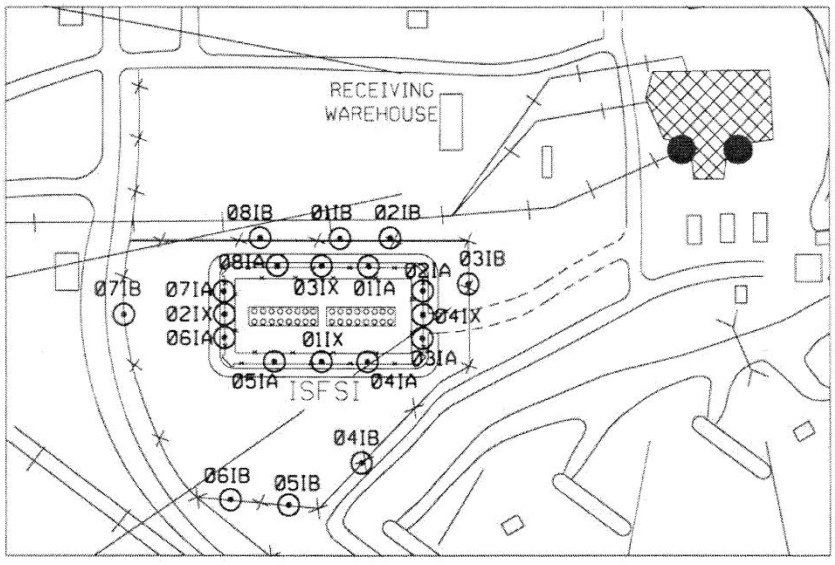
MONITORING LEGEND:

⊙ PRAIRIE ISLAND TLD POINTS

TLD LOCATIONS



CONTROL POINTS
PRESCOTT, WISCONSIN



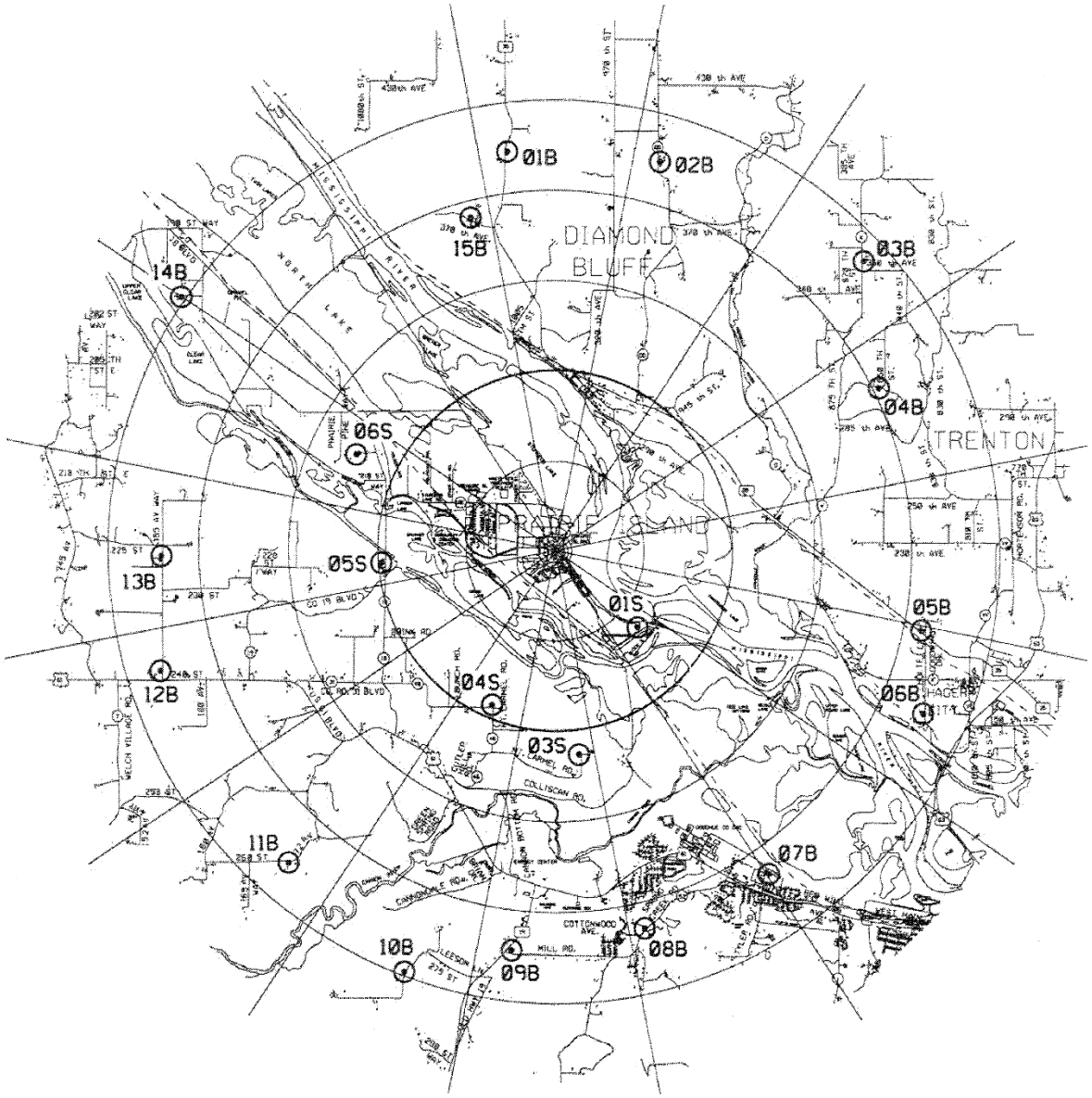
ISFSI AREA TLD LOCATIONS

MONITORING LEGEND:

⊙ PRAIRIE ISLAND TLD POINTS

TLD LOCATIONS

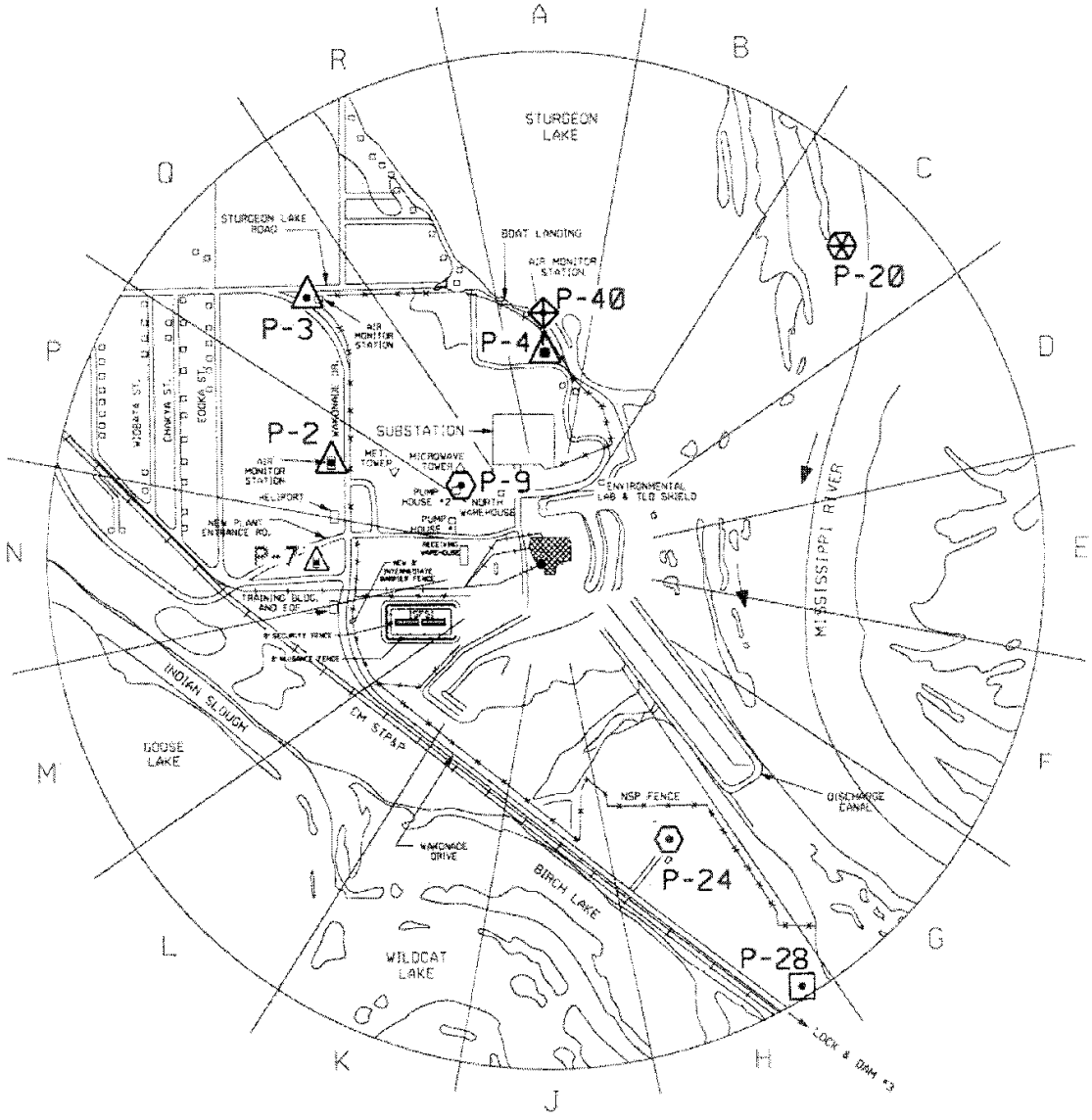
FIVE MILE RADIUS



MONITORING LEGEND:

⊙ PRAIRIE ISLAND TLD POINTS

ENVIRONMENTAL SAMPLING POINTS
ONE MILE RADIUS



PLANT AREA ENLARGED PLAN [1.00 MILE RADIUS]

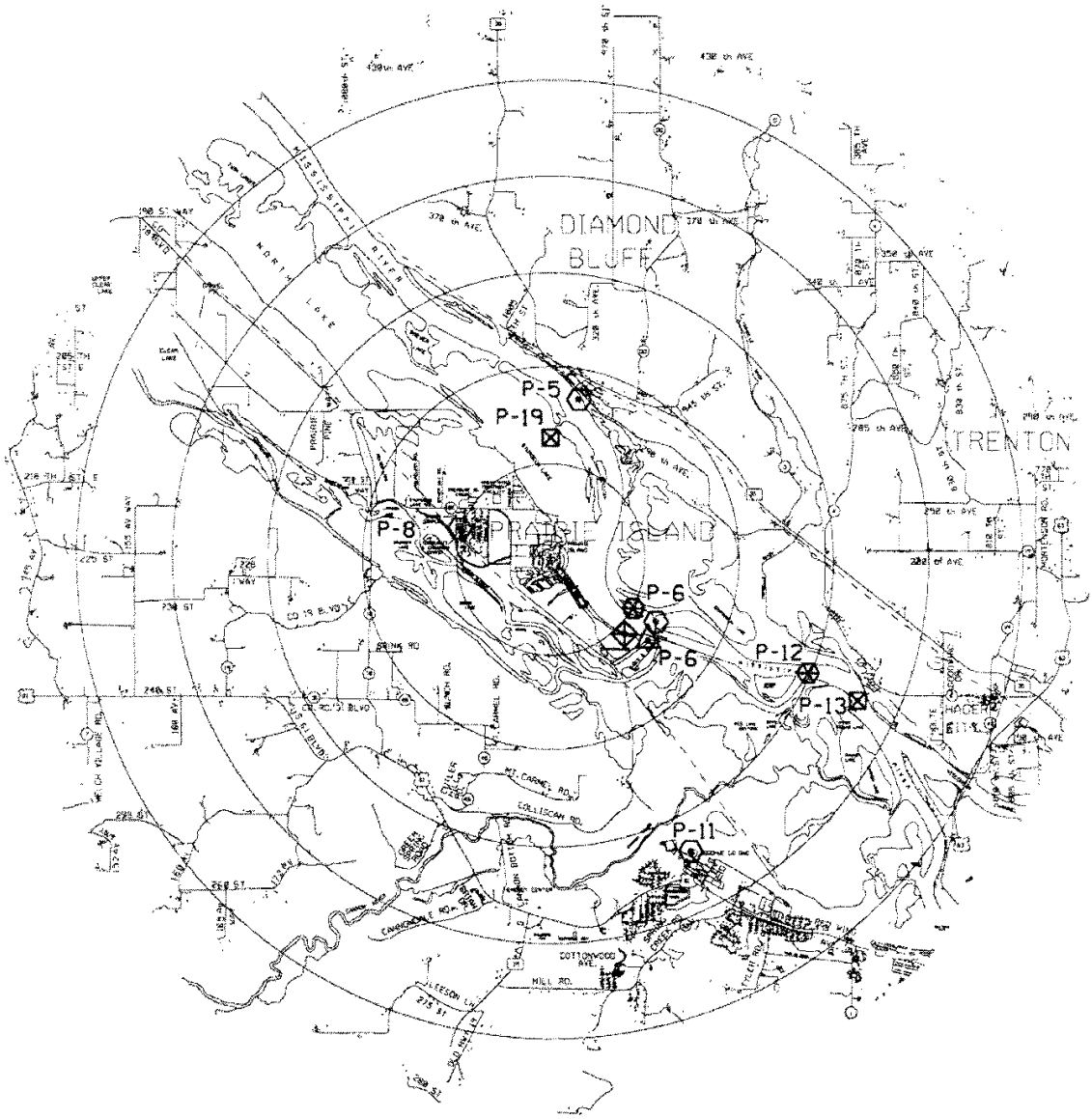
[NO SCALE]

MONITORING LEGEND

- AIR SAMPLING POINT ID NUMBERS P-1, P-2, P-3, P-4, P-6, P-7
- WATER SAMPLING POINT ID NUMBERS P-5, P-6, P-8, P-9, P-11, P-24, P-43
- VEGETATION / VEGETABLES ID NUMBERS P-28, P-38
- FISH SAMPLING POINT ID NUMBERS P-13, P-19
- INVERTEBRATES POINT ID NUMBERS P-6, P-40
- SEDIMENT SAMPLING POINT ID NUMBERS P-6, P-12, P-20

ENVIRONMENTAL SAMPLING POINTS

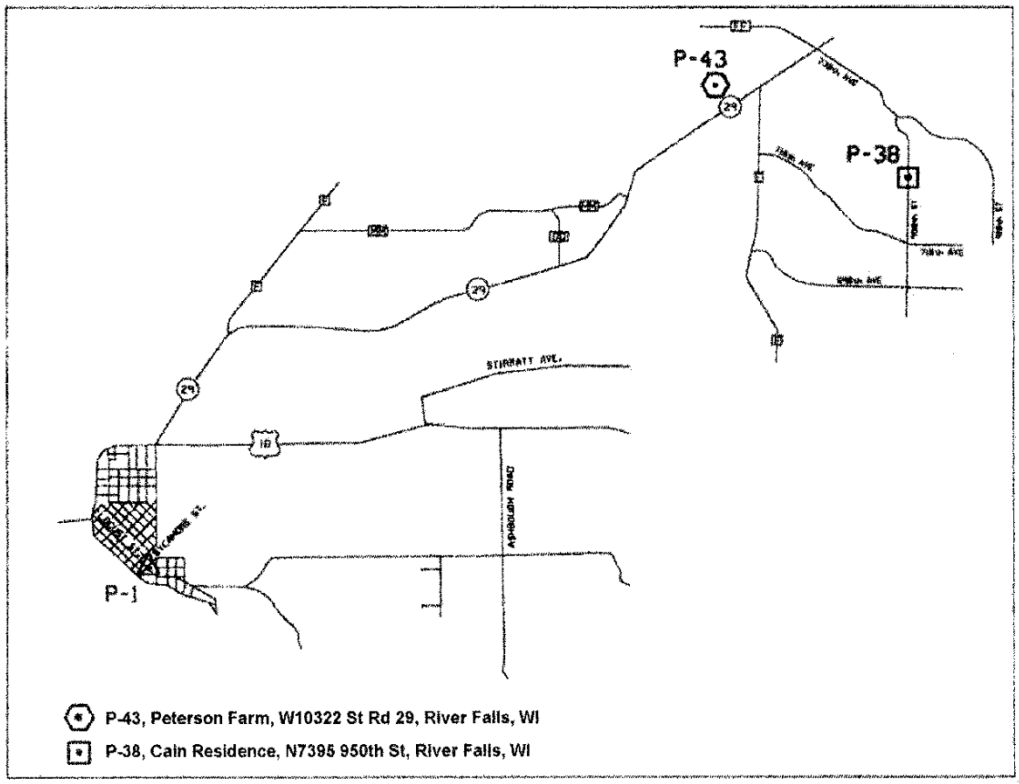
FIVE MILE RADIUS



MONITORING LEGEND

- AIR SAMPLING POINT ID NUMBERS
  P-1, P-2, P-3, P-4, P-6, P-7
- WATER SAMPLING POINT ID NUMBERS
  P-5, P-6, P-8, P-9, P-11, P-24, P-43
- VEGETATION / VEGETABLES ID NUMBERS
  P-28, P-38
- FISH SAMPLING POINT ID NUMBERS
  P-13, P-19
- INVERTEBRATES POINT ID NUMBERS
  P-6, P-40
- SEDIMENT SAMPLING POINT ID NUMBERS
  P-6, P-12, P-20

ENVIRONMENTAL SAMPLING POINTS



CONTROL POINTS
PRESCOTT, WISCONSIN

MONITORING LEGEND

- AIR SAMPLING POINT ID NUMBERS
  P-1, P-2, P-3, P-4, P-6, P-7
- WATER SAMPLING POINT ID NUMBERS
  P-5, P-6, P-8, P-9, P-11, P-43
- VEGETATION / VEGETABLES ID NUMBERS
  P-28, P-38

APPENDIX E

Special Well and

Surface Water Samples

1.0 INTRODUCTION

This appendix to the Radiological Environmental Monitoring Program Annual Report to the United States Nuclear Regulatory Commission summarizes and interprets results of the special well and surface water samples taken at the Prairie Island Nuclear Generating Plant, Red Wing, Minnesota, during the period January - December, 2019. This supplemental special sampling program was established in December of 1989 when higher than expected levels of tritium were detected in a nearby residence well sample.

Tabulations of the special sampling program individual analyses made during the year are included in this appendix. A summary table of tritium analyses is also included in this appendix.

2.0 SUMMARY

This special sampling program was established following the detection of tritium in a residence well water sample south of the PINGP during 1989. This program is described and the results for 2019 are summarized and discussed.

Program findings for 2019 detected low levels of tritium in nearby residence wells, ground water, surface samples, and storage tanks at or near the expected natural background levels with the exception of ground water sample well MW-8, D5/6 tank vaults, and the septic system. The 2019 sample results (except for MW-8, parking lot snow, D5/6 tank vaults, and the septic system) ranged from <19 pCi/L to 321 pCi/L. Sample well MW-8 ranged from 100 pCi/L to 416 pCi/L. Parking lot snow was 349 pCi/L. D5/6 tank vaults were 1170 pCi/L and 2372 pCi/L, respectively. The septic system ranged from 57 to 1181 pCi/L. All tritium results are far below the Environmental Protection Agency's drinking water standard of 20,000 pCi/L and present no harm to any members of the public.

None of the water samples monitored for gamma-emitting isotopes showed any activity greater than the LLD.

3.0 Special Tritium Sampling Program

3.1 Program Design and Data Interpretation

The purpose of this sampling program is to assess the impact of any tritium leaching into the environment (ground water system) from the PINGP. For this purpose, special water samples are collected and analyzed for tritium content.

3.2 Program Description

The sampling and analysis schedule for the special water sampling program is summarized in Table E-4.1 and briefly reviewed below. Table E-4.2 defines the additional sample locations and codes for the special water sampling program.

Special well, tank, and surface water samples were collected quarterly (spring, summer, fall) at seven locations, quarterly at one location, monthly at six locations, semi-annually at five locations, and annually at thirty-six locations. The Peterson (P-43) and Hanson (SW-1) farm wells are used as control locations for these special samples.

To detect low levels of tritium at or below natural background levels, analyses of the samples have been contracted to a laboratory (University of Waterloo Laboratories) capable of detecting tritium concentrations down to 19 pCi/L. Waterloo Laboratories report tritium analyses results in Tritium Units (1 TU = 3.2 pCi/L). The tritium results in this report are indicated in pCi/L.

3.3 Program Execution

The special water sampling was executed as described in the preceding section.

3.4 Program Modifications

Changes to the program in 2019 include:

- samples were taken from monitoring wells P-10, and MW-8 and snow from S-6, S-7, S-8, S-9, and P-43 and were sent to Environmental Incorporated for analysis for hard-to-detect nuclides in accordance with American Nuclear Insurers recommendation
- samples were taken from the D5 and D6 Fuel Oil Storage Tank vaults because these areas were accessible in 2019
- no sample was taken from groundwater well MW-4 in April due to high water levels, making the well inaccessible
- no sample was taken from PIIC-28 because the resident was not available

3.5 Results and Discussion

Results show tritium in well water and ground water samples at or near expected natural background levels except the MW-8 ground water sample well. Table E-4.4 provides the complete data table of results for each period and sampling location.

The tritium level annual averages have shown a downward trend since the special sampling began in 1989.

Except for sample well MW-8, parking lot snow, D5/6 tank vaults, and the septic system, the 2019 sample results are within the range of expected background tritium levels in shallow ground water and surface water due to tritium concentrations measured in precipitation. Sampling points in North America have shown tritium concentrations in precipitation ranging from 5 pCi/L to 157 pCi/L (Environmental Isotope Data No. 10; World Survey of Isotope Concentration in Precipitation (1988-1991)).

The higher level results at the Suter residence and Birch Lake in 1989 were possibly due to seepage from the PINGP discharge canal water into the ground water. This is thought to occur due to the elevation difference between the Vermillion River and the discharge canal. The Suter residence is located between the discharge canal and Birch Lake, which connects to the Vermillion River. The PINGP discharge canal piping was lengthened during 1991, so that liquid discharges from the plant are released near the end of the discharge canal, diffused and discharged to the Mississippi River. In 1992, the underground liquid discharge pipe from the plant to the discharge canal piping was replaced with a double walled leak detectable piping system. This year's sample results continue to indicate that these modifications have eliminated the suspected radioactive effluent flow into the local ground water.

The elevated tritium levels in sample well MW-8 in 2019 may be due to prior leakage from the PINGP liquid radwaste discharge pipe, discharge of turbine building sump water into the landlocked area, or discharge of heating steam condensate from the main warehouse in 1978/1979. The liquid radwaste discharge pipe was replaced in 1992 and the discharge to the landlocked area has been terminated, the last discharge took place on 11/14/09. The main warehouse heating system was repaired in 1979. The heating steam system has not been used in the outer plant buildings since the 2011 – 2012 heating season.

The elevated tritium levels in the parking lot snow and D5/6 tank vaults are most likely due to tritium recaptured from effluent releases by precipitation. The levels found in the septic system have returned to background levels.

None of the water samples monitored for gamma-emitting isotopes showed any activity greater than the LLD.

Table E-4.1. Sample collection and analysis program for special well, storage tank, and surface water samples, Prairie Island Nuclear Generating Plant, 2019.

Medium	No.	Location codes and type [a]	Collection type and frequency [b]	Analysis type [c]
Well water Annual	26	P-8 post-treat, P-8 pre-treat, REMP P-6, REMP P-11, PIIC-22, PIIC-26, PIIC-29, P-7, P-11, PZ-1, PZ-2, PZ-4, PZ-5, PZ-7, MW-6, P-26, P-30, SW-3, SW-4, SW-5, SW-6, SW-7, SW-8, SW-9, P-9	G/A	H-3
Well water quarterly	1	P-24D	G/Q	H-3
Well water quarterly'	7	P-2, P-3, P-5, P-6, PZ-8, MW-4, MW-5	G/Q'	H-3
Well water monthly	5	P-43(C), SW-1(C), MW-7, MW-8, P-10	G/M	H-3
Surface water	8	S-1, S-2, S-3, S-4, S-5, S-6, S-7, P-31	G/A[d]	H-3
Storage Tank	7	11 CST, 21 CST, 22 CST, U1/2 Demin Hdr, D5/6 vaults	G/S	H-3
Storage Tank	1	Septic System	G/M	H-3
Snow	5	S-6, S-7, S-8, S-9, P-43(C)	G/A	H-3

[a] Location codes are defined in table D-4.2. Control Stations are indicated by (C). All other stations are indicators.

[b] Collection type is codes as follows: G/ = grab. Collection frequency is coded as follows: M = monthly; Q = quarterly; Q' = quarterly (spring, summer, and fall), S= semiannually: A = annually.

[c] Analysis type is coded as follows: H-3 = tritium.

[d] Location S-6 and S-7 are sampled semi-annually.

Table E-4.2. Sampling locations for special well, storage tank, and surface water samples, Prairie Island Nuclear Generating Plant, 2019.

Code	Collection site	Type of sample [a]	Distance and direction from reactor
P-8	PI Community well post treat	DW	1.0 mi. @ 321°/WNW
P-8	PI Community well pre treat	DW	1.0 mi. @ 321°/WNW
REMP P-6	Lock & Dam #3 well	DW	1.6 mi. @ 129°/SE
REMP P-11	Red Wing Service Center	DW	3.3 mi @ 158°/SSE
PIIC-22	1773 Buffalo Slough Rd	DW	1 mi. @ 315°/NW
PIIC-26	1771 Buffalo Slough Rd	DW	1 mi. @ 315°/NW
PIIC-29	Buffalo Project	DW	4.3 mi @ 302°/WNW
P-24D	Suter residence	DW	0.6 mi. @ 158°/SSE
P-43	Peterson Farm (Control)	DW	13.9 mi. @ 355°/N
SW-1	Hanson Farm (Control)	DW	2.2 mi. @ 315°/NW
P-2	Sample well	WW	See map
P-3	Sample well	WW	See map
P-5	Sample well	WW	See map
P-6	Sample well	WW	See map
P-7	Sample well	WW	See map
P-10	Sample well	WW	See map
P-11	Sample well	WW	See map
PZ-1	Sample well	WW	See map
PZ-2	Sample well	WW	See map
PZ-4	Sample well	WW	See map
PZ-5	Sample well	WW	See map
PZ-7	Sample well	WW	See map
PZ-8	Sample well	WW	See map
MW-4	Sample well	WW	See map
MW-5	Sample well	WW	See map
MW-6	Sample well	WW	See map
MW-7	Sample well	WW	See map
MW-8	Sample well	WW	See map
P-26	PITC well	DW	0.4 mi. @ 258°/WSW
P-30	Environ lab well	DW	0.2 mi. @ 32°/NNE

Table E-4.2. Sampling locations for special well, storage tank, and surface water samples, Prairie Island Nuclear Generating Plant, 2019 (continued).

Code	Collection site	Type of sample [a]	Distance and direction from reactor
SW-3	Cooling Tower pump	WW	See map
SW-4	New Admin Bldg	DW	0.05 mi. @ 315˚/NW
SW-5	Plant Screenhouse well	WW	0.05 mi. @ 0˚/N
SW-6	SGR Building	DW	0.2 mi @ 310˚/NW
SW-7	Distribution Center	DW	0.35 mi @ 271˚/W
SW-8	Site Admin Building well	WW	0.2 mi @ 310˚/NW
SW-9	FLEX Building	WW	0.2 mi @ 238°/WSW
P-9	Plant well # 2	DW	0.3 mi. @ 306°/NW
S-1	Upstream Miss. River	SW	See map
S-2	Recirc/Intake canal	SW	See map
S-3	Cooling water canal	SW	See map
S-4	Discharge Canal (end)	SW	See map
S-5	Mid Discharge Canal	SW	See map
S-6	Roof Stormwater Runoff (also snow)	SW	0.05 mi. @ 0˚/N
S-7	Parking Lot Stormwater (also snow)	SW	0.3 mi @ 306˚/NW
S-8	P-10 area snow	SW	See map
S-9	MW-7/8 area snow	SW	See map
P-31	Birch Lake Seepage	SW	0.69 mi. @ 172°/S
11 CST	Storage Tank	ST	Turbine Building
21 CST	Storage Tank	ST	Turbine Building
22 CST	Storage Tank	ST	Turbine Building
Unit 1/2 demin hdr	Storage Tank	ST	Turbine Building
Septic System	Storage Tank	ST	Outside #1 Warehouse
D5/6 Vault	Concrete Vault	ST	Outside Turbine Bldg

[a] Sample codes: DW = Drinking Water: WW = Well Water; SW = Surface Water: ST = Storage Tank.

Table E-4.3 Radiation Environmental Monitoring Program Summary: Special well, storage tank, and surface water samples.

Name of Facility	Prairie Island Nuclear Power Station	Docket No.	50-282, 50-306
Location of Facility	Goodhue, Minnesota (County, State)	Reporting Period	January – December, 2019

Sample Type (Units)	Type and Number of Analyses [a]	LLD [b]	Indicator Locations	Location with Highest Annual Mean		Control Locations	Number Non-Routine Results [e]
			Mean (F) [c] Range [c]	Location [d]	Mean (F) [c] Range [c]	Mean (F) [c] Range [c]	
Offsite Well Water (pCi/L)	H-3 12	19	32 (4/12) (20-51)	P-24D	35 (3/5) (20-51)	(See Control Below)	0
Onsite Well Water (pCi/L)	H-3 74	19	118 (62/74) (20-416)	MW-8	264 (12/12) (100-416)	(See Control Below)	12
Onsite Surface Water (pCi/L)	H-3 16	19	120 (12/16) (28-349)	S-7	158 (3/3) (31-349)	(See Control Below)	1
Onsite Storage Tank (pCi/L)	H-3 24	19	315 (20/24) (24-2372)	D-6 Fuel Oil Storage Tank Vault	2372 (1/1) (2372)	(See Control Below)	5
Control (offsite well water)	H-3 24	19	none	P-43	23 (5/12) (21-31)	23 (5/24) (21-31)	0
Control (offsite snow)	H-3 1	19	none	P-43	32 (1/1) (32)	32 (1/1) (32)	0

[a] H-3 = tritium
[b] LLD = Nominal lower limit of detection based on 4.66 sigma error for background sample. Value shown is lowest for the period.
[c] Mean and range are based on detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).
[d] Locations are specified by code.
[e] Non-routine results are those which exceed ten times the control station mean value.

Table E-4.4 Radiological Environmental Monitoring Program , Complete Data Table, 2019.

	SAMPLE DATES	JAN 2019	FEB 2019	MAR 2019	APR 2019	MAY 2019	JUN 2019	JUL 2019	AUG 2019	SEP 2019	OCT 2019	NOV 2019	DEC 2019
CODE	SAMPLE LOCATIONS	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L
	OFFSITE WELLS												
P-8 Post-treat	PI Comm. Well							<19					
P-8 Pre-treat	PI Comm. Well							<19					
REMP P-6	Lock & Dam #3 well							<19					
REMP P-11	Red Wing Service Center							<19					
PIIC-22	1773 Buffalo Slough Rd							<19					
PIIC-26	1771 Buffalo Slough Rd							<19					
PIIC-29	Buffalo Project							23					
P-24D	Suter residence		<19			51		35	<19			20	
P-43	Peterson Farm(Control	23/ 32* *snow	31	<19	<19	21	<19	<19	<19	21	<19	21	<19
SW-1	Hanson Farm (Control)	<19	<19	<19	<19	<19	<19	<19	<19	<19	<19	<19	<19

Table E-4.4 Radiological Environmental Monitoring Program , Complete Data Table, 2019 (continued).

	SAMPLE DATES	JAN 2019	FEB 2019	MAR 2019	APR 2019	MAY 2019	JUN 2019	JUL 2019	AUG 2019	SEP 2019	OCT 2019	NOV 2019	DEC 2019
CODE	SAMPLE LOCATIONS	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L
	ONSITE WELLS												
P-2	Sample well				89			83				157	
P-3	Sample well				20			29				<19	
P-5	Sample well				72			67				70	
P-6	Sample well				<19			23				20	
P-7	Sample well							82					
P-10	Sample well	177	255	139	85	66	114	102	153	152	252	274	245
P-11	Sample well							32					
PZ-1	Sample well							<19					
PZ-2	Sample well							26					
PZ-4	Sample well							30					
PZ-5	Sample well							<19					
PZ-7	Sample well							27					
PZ-8	Sample well				26			34				70	
MW-4	Sample well							52				<19	
MW-5	Sample well				<19			72				21	
MW-6	Sample well							47					
MW-7	Sample well	46	57	28	47	54	70	55	76	76	84	123	156
MW-8	Sample well	372	233	127	100	131	244	246	394	339	194	372	416
P-26	PITC well							<19					
P-30	Env. lab well							<19					
SW-3	CT pump							<19					
P-9	Plant well # 2							48					
SW-4	New Admin							22					
SW-5	Plnt Scrnhs							29					
SW-6	RSG Bldg							<19					
SW-7	Dist Center							<19					

Table E-4.4 Radiological Environmental Monitoring Program , Complete Data Table, 2019 (continued).

	SAMPLE DATES	JAN 2019	FEB 2019	MAR 2019	APR 2019	MAY 2019	JUN 2019	JUL 2019	AUG 2019	SEP 2019	OCT 2019	NOV 2019	DEC 2019
CODE	SAMPLE LOCATIONS	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L
	ONSITE WELLS												
SW-8	Site Admin Bldg							<19					
SW-9	FLEX Bldg							21					

Table E-4.4 Radiological Environmental Monitoring Program , Complete Data Table, 2019 (continued).

	SAMPLE DATES	JAN 2019	FEB 2019	MAR 2019	APR 2019	MAY 2019	JUN 2019	JUL 2019	AUG 2019	SEP 2019	OCT 2019	NOV 2019	DEC 2019
CODE	SAMPLE LOCATIONS	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L
	ONSITE SURFACE WATER												
S-1	Mississippi River upstream							33					
S-2	Recirculation/Intake canal							<19					
S-3	Cooling water canal							32					
S-4	Discharge Canal (end)							40					
S-5	Discharge Canal (midway)							36					
S-6	Stormwater runoff	60*			<19						229		
S-7	Parking Lot runoff	349*			95						31		
S-8	P-10 area snow	278*											
S-9	MW-7/8 area snow	231*											
P-31	Birch Lake Seepage				<19			28				<19	

* snow samples

Table E-4.4 Radiological Environmental Monitoring Program , Complete Data Table, 2019 (continued).

	SAMPLE DATES	JAN 2019	FEB 2019	MAR 2019	APR 2019	MAY 2019	JUN 2019	JUL 2019	AUG 2019	SEP 2019	OCT 2019	NOV 2019	DEC 2019
CODE	SAMPLE LOCATIONS	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L
	ONSITE STORAGE TANKS												
11 CST	Storage tank				24						55		
21 CST	Storage tank				<19						<19		
22 CST	Storage tank				40						28		
U1/U2 Demin Header	Storage tank				<19/77						<19/27		
Septic System	Storage tank	108	59	291	88	275	73	80	65	57	1181	157	65
D5/6	D5/6 Fuel Oil Storage Tank Vaults								NA/ 2372	1170/ NA			

Table E-4.5. Results of the analyses for iron-55, nickel-63, strontium-90, isotopic plutonium, americium-241 and isotopic curium.

Location	S-8	P-43	S-9	S-6	S-7
Collection Date	01-23-19	01-22-19	01-23-19	01-23-19	01-22-19
Lab Code	PXW-293	PXW-294	PXW-295	PXW-296	PXW-297
Isotope	Concentration (µCi/mL)				
Fe-55	< 6.1 E-07	< 5.9 E-07	< 5.8 E-07	< 5.9 E-07	< 6.1 E-07
Ni-63	< 6.8 E-08	< 6.7 E-08	< 6.5 E-08	< 6.5 E-08	< 6.5 E-08
Sr-90	< 6.2 E-10	< 5.9 E-10	< 7.0 E-10	< 6.3 E-10	< 6.0 E-10
Pu-238	< 3.1 E-10	< 8.9 E-10	< 4.5 E-10	< 3.4 E-10	< 3.2 E-10
Pu-239/240	< 3.1 E-10	< 6.3 E-10	< 4.5 E-10	< 3.4 E-10	< 3.2 E-10
Am-241	< 4.1 E-10	< 3.0 E-09	< 1.3 E-09	< 7.4 E-10	< 1.1 E-09
Cm-242	< 9.3 E-10	< 1.8 E-09	< 1.9 E-09	< 4.3 E-10	< 1.1 E-09
Cm-243/244	< 8.3 E-10	< 2.8 E-09	< 1.9 E-09	< 6.0 E-10	< 1.5 E-09

Less than (<), value is based on a 4.66 sigma counting error for the background sample.

Table E-4.5. Results of the analyses for iron-55, nickel-63, strontium-90, isotopic plutonium, americium-241 and isotopic curium.

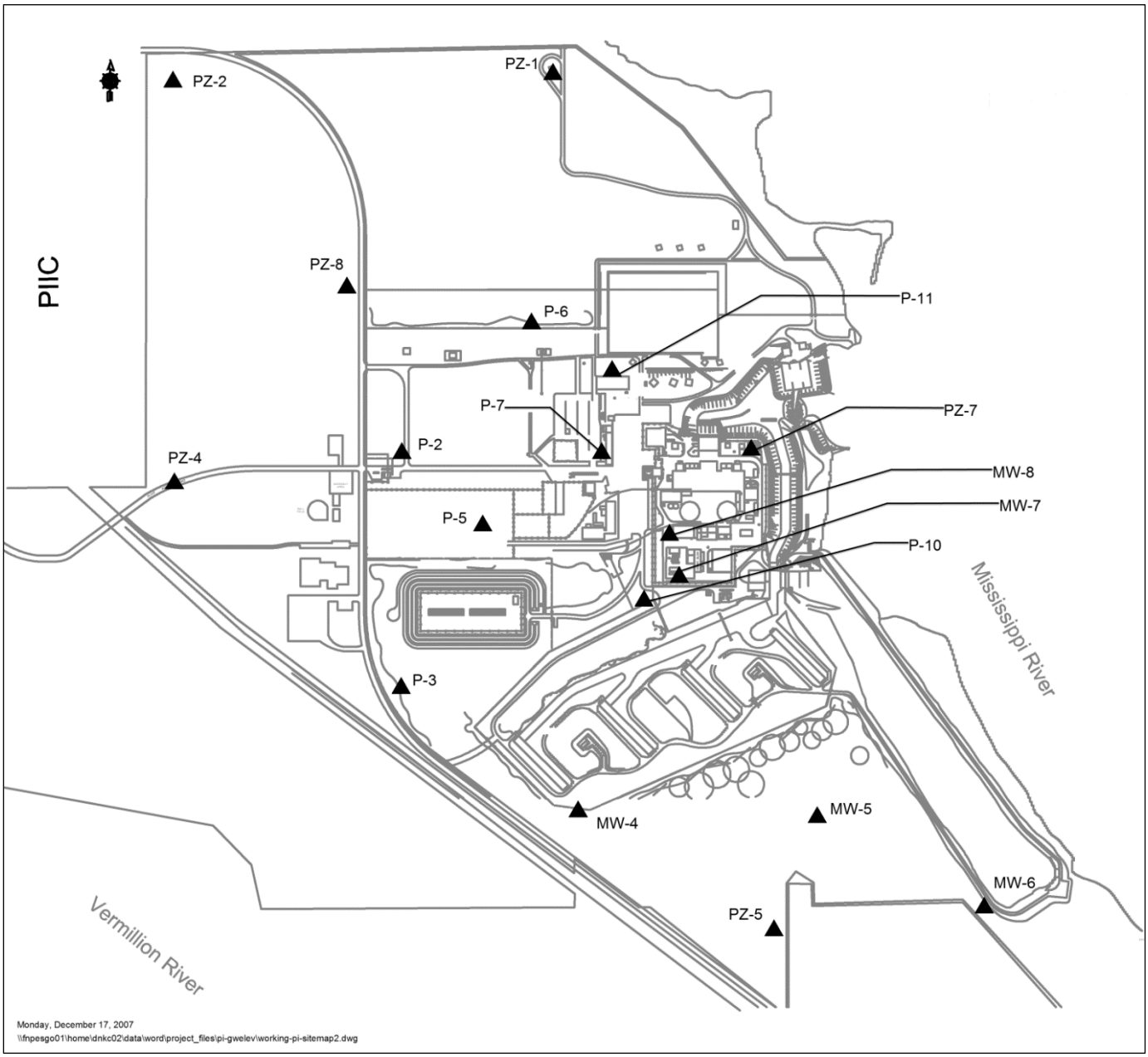
Location drains	S-6	S-7
Collection Date	04-24-19	04-24-19
Lab Code	PXW-1428	PXW-1429
Isotope	**Concentration (µCi/mL)**	
Fe-55	< 5.7 E-07	< 5.7 E-07
Ni-63	< 6.9 E-08	< 7.1 E-08
Sr-90	< 5.4 E-10	< 5.3 E-10
Pu-238	< 1.8 E-10	< 2.8 E-10
Pu-239/240	< 1.8 E-10	< 2.8 E-10
Am-241	< 8.2 E-11	< 1.6 E-10
Cm-242	< 1.4 E-10	< 9.0 E-11
Cm-243/244	< 1.2 E-10	< 5.2 E-11

Less than (<), value is based on a 4.66 sigma counting error for the background sample.

Table E-4.5. Results of the analyses for iron-55, nickel-63, strontium-90, isotopic plutonium, americium-241 and isotopic curium.

Location	P-10	MW-8
Collection Date	04-24-19	04-24-19
Lab Code	PXW-1520	PXW-1521
Isotope	Concentration (µCi/mL)	
Fe-55	< 6.0 E-07	< 5.9 E-07
Ni-63	< 6.9 E-08	<6.8 E-08
Sr-90	< 5.7 E-10	< 5.0 E-10
Pu-238	< 2.3 E-10	< 1.8 E-10
Pu-239/240	< 1.6 E-10	< 1.8 E-10
Am-241	< 1.1 E-10	< 8.7 E-11
Cm-242	< 1.5 E-10	< 5.0 E-11
Cm-243/244	< 5.1 E-11	< 1.2 E-10

Less than (<), value is based on a 4.66 sigma counting error for the background sample.



Groundwater Monitoring Well Locations