Xcel Energy®
RESPONSIBLE BY NATURE®

2807 West County Road 75
Monticello, MN 55362

May 13, 2019

L-MT-19-023
10 CFR 50, Appendix I

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

Monticello Nuclear Generating Plant
Docket No. 50-263
Renewed Facility Operating License No. DPR-22

2018 Annual Radiological Environmental Operating Report

Pursuant to 10 CFR 50, Appendix I, Section IV.B.2, IV.B.3, IV.C and, in accordance with Monticello Nuclear Generating Plant (MNGP) Technical Specifications 5.6.1, the Northern States Power Company, a Minnesota corporation (NSPM), d/b/a Xcel Energy, is submitting the Annual Radiological Environmental Operating Report, under MNGP's "Radiological Environmental Monitoring Program," for year 2018.

Summary of Commitments

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

Christopher R. Church
Site Vice President, Monticello Nuclear Generating Plant
Northern States Power Company – Minnesota

Enclosure

cc: Administrator, Region III, USNRC
Project Manager, Monticello, USNRC
Resident Inspector, Monticello, USNRC
Minnesota Department of Commerce

ENCLOSURE

RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
JANUARY 1 – DECEMBER 31, 2018

ATI Environmental, Inc.
Midwest Laboratory
700 Landwehr Road • Northbrook, IL 60062-2310
phone (847) 564-0700 • fax (847) 564-4517

XCEL ENERGY CORPORATION

MONTICELLO NUCLEAR GENERATING PLANT
DOCKET No. 50-263 LICENSE No. DPR-22

Annual Radiological Environmental Operating Report (AREOR)

Part 1: Discussion and Summarized Results.

January 1 to December 31, 2018

Prepared under Contract by

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 personnel of the Monticello Nuclear Generating Plant, operated by Northern States Power Co., Minnesota for XCEL Energy Corporation. This report was prepared by Environmental, Inc., Midwest Laboratory.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

The following figures are located in the Appendices:

Appendix D

1.0 INTRODUCTION

This report summarizes and interprets results of the Radiological Environmental Monitoring Program (REMP) conducted by Environmental, Inc., Midwest Laboratory for the Monticello Nuclear Generating Plant, Monticello, Minnesota, during the period January - December, 2018. 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 included in Part II of this report.

The Monticello Nuclear Generating Plant is a boiling water reactor with a nominal generating capacity of 681 MWe. It is located on the Mississippi River in Wright County, Minnesota, owned by Xcel Energy Corporation and operated by Northern States Power Co. Minnesota. Initial criticality was achieved on December 10, 1970. Full power was achieved March 5, 1971 and commercial operation began on June 30, 1971.

2.0 SUMMARY

The Radiological Environmental Monitoring Program (REMP) is described; this program is required by the U.S. Nuclear Regulatory Commission (NRC) as well as Technical Specifications and the Offsite Dose Calculation Manual (ODCM) for the Monticello Nuclear Generating Plant. Results for the year 2018 are summarized and discussed.

Program findings show background levels of radioactivity in the environmental samples collected in the vicinity of the Monticello 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 Monticello 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 (TLD's).

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 Monticello 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 environmental samples collected from the Plant site. The Plant's monitoring program includes analyses for tritium and iodine-131. Most samples are also 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 as 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.

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 (REMP) at the Monticello Plant 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 plant site. To assure that sampling is carried out in a reproducible manner, detailed sampling procedures have been prescribed (Monticello Generating Plant REMP Surveillances, Current Revision). Maps of sampling locations are included in Appendix D.

To monitor the air environment, airborne particulates are collected on membrane filters by continuous pumping at five locations. Also, airborne iodine is collected by continuous pumping through charcoal filters at all of these locations. Both types of filters are changed and counted weekly. Particulate filters are analyzed for gross beta activity and charcoal filters for iodine-131. Quarterly composites of particulate filters from each location are determined by gamma spectroscopy. One of the five locations is a control (M-1), and four are indicators (M-2, M-3, M-4, M-5). One of the indicators is located in the geographical sector expected to be most susceptible to any atmospheric emissions from the Plant (highest D/Q sector).

Ambient gamma radiation is monitored at forty locations, using CaSO4:Dy dosimeters (TLD's), each including four sensitive areas: fourteen in an inner ring in the general area of the site boundary, sixteen in the outer ring within 4-5 mile radius, six at special interest locations and four control locations, outside a 10 mile radius from the plant. They are replaced and measured quarterly.

As substitute for dairy sampling, vegetation is collected from locations M-41, M-42, and M-43 (C). The samples are analyzed for iodine-131 and other gamma emitting isotopes.

Corn and potatoes are collected annually if fields are irrigated by water in which liquid radioactive effluent has been discharged. Analysis is done for gamma-emitting isotopes.

Well water is monitored by quarterly collections from three off-site locations (one control and two indicators) and one on-site Plant well. To detect possible groundwater contamination due to plant operations, samples from nineteen on-site monitoring wells are collected and analyzed for tritium and gamma emitting isotopes. The Ground Water Monitoring Program is further described in the Annual Effluent Release Report.

Quarterly collections of storm water runoff were added to monitor another possible pathway to the groundwater aquifer. The samples are also analyzed for tritium and gamma emitting isotopes.

River water is collected weekly at two locations, one upstream of the plant and one downstream. Monthly composites are analyzed for gamma-emitting isotopes. Quarterly composites are analyzed for tritium.

Drinking water is collected weekly from the City of Minneapolis water supply, which is taken from the Mississippi River downstream of the Plant. Monthly composites are analyzed for gross beta, iodine-131, and gamma-emitting isotopes. Quarterly composites are analyzed for tritium.

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

3.3 Program Execution

The Program was executed as described in the preceding section with the following exceptions:

(1) TLD's

M-5S TLD was found to be missing in the field for the second quarter of 2018.

M-4B TLD was lost during shipment for the fourth quarter of 2018.

(2) Air Particulates / Air Iodine:

M-2, Air particulate / air iodine sample for the week ending 4/18/18 was only a partial sample, 12.3 hours run time was recorded.

M-2, Air Particulate / air iodine sample for the period 6/06/2018 - 6/12/18 was lost due to a loss of power at the air station. The power drop was rerouted 6/12/18.

M-2, Air particulate / air iodine filter sample for the week ending 6/20/18 was lost due to faulty pump. The pump was replaced 6/20/18.

(3) Surface Water:

M-8, river water was frozen for the entire first quarter of 2018, resulting in the loss of three monthly composite samples and one quarterly composite. Freezing conditions continued into April resulting in the April composite consisting of only the week ending 4/25/18, The second quarter sample also contained only the last week of April along with all of May and June. M-8, river water was again frozen for all but the first week of November 2018 and all of December 2018. Resulting in the November composite consisting of one weekly sample and no December composite sample. The fourth quarter composite consisted of October and one November weekly sample.

(4) Bottom Organisms:

M-8 upstream and M-9 downstream invertebrate samples were collected late due to unsafe river conditions. Future sampling will be changed from semi-annually to annually.

Deviations from the program are summarized in Table 5.3.

3.4 Program Modifications

No significant modifications were made to the MNGP Radiological Environmental Monitoring Program in 2018.

3.5 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 and solvent extraction and subsequent beta counting.

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

Tritium concentrations are 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 (ATI 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.

3.6 Land Use Census

The 2018 land use census was conducted between September 6 and September 13, 2018 by the REMP Coordinator in accordance with the MNGP Chemistry Manual, Procedure I.05.41, “Annual Land Use Census and Critical Receptor Identification”, The survey was performed in order to identify the nearest residence, milk animals, meat animals, and gardens of greater than 500 ft^2 with leafy green vegetables, in each of the 16 meteorological sectors within a five mile radius. In addition all milk animals, meat animals and all gardens of 500 ft^2 or greater with leafy green vegetables within a three mile radius of the plant were located. Distance, direction and dose pathway information is used to determine if any sampling locations that need to be changed in the REMP sampling program and for determining Critical Receptor data.

The 2018 survey was performed using door-to-door surveys and visual observations while driving; additionally, inputs from the 2017 field data forms and Homeland Security Emergency Management Monticello Basemap were used in determining changes in land use. Data was collected directly in Google Earth Pro using a USB GPS receiver. Google Earth Pro was used to determine receptor location distances and sectors for use in determining dispersion parameters for dose calculations.

No garden locations had an increase in D/Q of greater than 20%. The highest D/Q garden for 2018 remains in sector SSE at 1.20 miles from the plant. This is a different garden from 2017 (168° in 2018 vs. 146° in 2017), however there is no effect on the calculated receptor doses.

There was one sector where the highest D/Q value for Meat increased by greater than 20%. The change was driven by the updated D/Q values in ODCM-APP-A. The highest D/Q meat location changed from sectors W to WSW, due to the dispersion parameters in ODCM-APP-A.

There were no sectors in which the highest D/Q values for the nearest residence increased by more than 20% in 2018.

There are no milking animals within a five mile radius of the plant. Vegetation sampling is being performed in lieu of milk sampling. There are no crops being irrigated from the Mississippi River within five miles downstream of the plant. The nearest downstream drinking water supplies, drawn from the Mississippi River, remain St. Paul and Minneapolis water supplies as currently documented in the ODCM and USAR.

Doses due to ground plane, inhalation and ingestion of vegetables and meat were calculated for the highest D/Q Residence, Meat Animal, Vegetable Garden, and combined Vegetable/Meat locations identified in the 2018 Land Use Census. In accordance with the ODCM, the long- and short-duration gaseous releases from the Reactor Building Vent and the Off-gas Stack for the previous calendar year were used as the source terms.

Doses were calculated using the RADEAS computer program with the 2017 Annual Effluent Data report source term as input. This resulted in identifying the same Sector, Distance and Pathway as compared to last year's Critical Receptor. The location is residence GH garden located 1.20 miles away in the SSE sector (designated GH) and the pathway identified is the combination of ground plane, inhalation and vegetable ingestion to the THYROID of the CHILD Age Group. The critical receptor, for purposes of compliance with 10CFR50 Appendix I for this period, is defined as follows:

Sector: SSE;
Distance: 1.20 miles;
Pathways: Ground Plane, Inhalation and Vegetable;
mRem/year: 9.20E-02;
Age Group: Child;
Organ: Thyroid.

4.0 RESULTS AND DISCUSSION

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

All 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 2018. The Fukushima Daiichi nuclear accident occurred March 11, 2011.

There were no reported atmospheric nuclear tests in 2018. 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 Monticello Nuclear Generating Plant during the years 1968 to 1970, 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 to make, since background levels of radiation were much higher in these years due to radioactive fallout from the atmosphere. Gross beta measurements in fallout averaged 20,600 pCi/m^3 in 1969 and 12,000 pCi/m^3 in 1970. These levels are reflected throughout the various media tested.

In the air environment, ambient gamma radiation (TLDs) averaged 9.1 mRem/4 weeks during preoperational studies (1970). Gross beta in air particulates in 1969 and 1970 averaged 0.20 pCi/m^3. Present day levels have stabilized at around 0.025 pCi/m^3. Airborne radioiodine remained below detection levels of 0.03 pCi/m^3

In the terrestrial environment of 1968 to 1970, milk, agricultural crops, and soil were monitored. In milk samples, low levels of Cs-137 and Sr-90 were detected. Cs-137 levels averaged 16.7 pCi/L. Soybean crop measurements in 1969 averaged 35.5 pCi/g for gross beta and 0.3 pCi/g for Cs-137. Gross beta measured in soil averaged 51.7 pCi/g . Present day measurements for cesium- 137 are below detection levels in milk and agricultural crops.

The aqueous environment was monitored by testing of river water, 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 seven separate locations from 1968 to 1970, averaged 970 pCi/L. Present day environmental samples measure below detection levels. Values for gross beta, measured from 1968 to 1970, averaged 9.8 pCi/L in upstream and downstream Mississippi River water, 4.4 pCi/L for well waters, and 18.6 pCi/L for lake waters. Gamma emitters were below the lower limit of detection (LLD). In shoreline sediments, gross beta background levels in 1970 averaged 49.8 pCi/g for both upstream and downstream samples. Cs-137 activity averaged 0.10 pCi/g for both upstream and downstream samples. Low levels of Cs-137, occasionally observed today can still be attributed to residual activity from atmospheric fallout. Gross beta levels in fish flesh averaged 5.3 pCi/g in 1968 and 1969. Cs-137, measured in 1969 and 1970, averaged 0.044 pCi/g. Gross beta background levels, in 1970, for aquatic vegetation, algae, and periphyton samples measured 86.7 pCi/g, 76.5 pCi/g, and 28.1 pCi/g respectively.

4.3 Program Findings

Results obtained show background levels of radioactivity in environmental samples collected outside of the Site Protected Area in 2018.

Ambient Radiation (TLD's)

Ambient radiation was measured in the general area of the site boundary, inner ring, at an outer ring 4 - 5 mi. distant from the Plant, at special interest areas and at four control locations. The means were similar for both inner and outer rings (14.5 and 14.0 mRem/91 days, respectively). The mean for special interest locations was 14.5 mRem/91 days and the mean for the control locations was 13.9 mRem/91 days. Dose rates measured at the inner and outer ring locations were similar to those observed from 1999 through 2017 and are tabulated below. No plant effect on ambient gamma radiation is indicated (Figure 5-1).

Year	Inner Ring	Outer Ring	Control
	Dose rate (mRem/91 days)		
1999	15.1	14.3	15.7
2000	15.1	14.5	14.7
2001	14.3	13.7	14.1
2002	15.9	14.8	14.9
2003	15.6	15.0	15.0
2004	16.0	15.4	15.4
2005	15.6	15.2	15.1
2006	16.5	15.6	15.7
2007	16.1	15.1	15.5
2008	15.2	14.6	15.4
2009	14.9	14.4	15.0
2010	14.7	14.3	15.2
2011	14.8	14.3	15.5
2012	16.2	15.5	16.9
2013	14.4	14.0	15.5
2014	13.5	12.9	14.3
2015	14.8	14.2	15.3
2016	15.1	14.3	15.4
2017	16.1	15.1	14.7
2018	14.5	14.0	13.9

Ambient gamma radiation as measured by thermoluminescent dosimetry.
Average quarterly dose rates, Inner vs. Outer Ring locations.

Airborne Particulates

The average annual gross beta concentrations in airborne particulates were similar at the indicator and control locations (0.030 pCi/m^3 and 0.029 pCi/m^3 respectively for 2018), these results are comparable to levels observed from 1999 through 2017. The results are tabulated below.

Year	Indicators	Control
	Concentration (pCi/m^3)	
1999	0.023	0.025
2000	0.027	0.026
2001	0.027	0.026
2002	0.028	0.028
2003	0.027	0.027
2004	0.024	0.024
2005	0.025	0.025
2006	0.024	0.025
2007	0.027	0.028
2008	0.028	0.029
2009	0.029	0.030
2010	0.026	0.026
2011	0.029	0.027
2012	0.032	0.031
2013	0.029	0.032
2014	0.027	0.028
2015	0.030	0.028
2016	0.026	0.024
2017	0.028	0.028
2018	0.030	0.029

Average annual gross beta concentrations in airborne particulates.

Typically, the highest average readings occur during the months of January and December, and the first and fourth quarters, as observed in 1999 through 2016.

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 0.079 pCi/m^3 for the indicator locations and 0.082 pCi/m^3 for the control location. All other gamma-emitting isotopes were below their respective LLD limits.

Airborne Iodine

Weekly levels of airborne iodine-131 were below the lower limit of detection (LLD) of 0.03 pCi/m^3 for all samples analyzed.

River Water and Drinking Water

Tritium activity measured below the detection limit for all samples. Gamma isotopic results were all below detection limits. Gross beta was detected in 7 out of 12 samples tested at an average concentration of 1.6 pCi/L and was similar to average levels observed from 2000 through 2017. Gross beta averages are tabulated below. There was no indication of a plant effect.

Year	Gross Beta (pCi/L)		Year	Gross Beta (pCi/L)
2000	2.5		2010	2.9
2001	2.5		2011	2.2
2002	2.9		2012	2.4
2003	3.0		2013	2.6
2004	2.7		2014	2.8
2005	2.8		2015	2.3
2006	2.1		2016	2.6
2007	2.8		2017	2.0
2008	2.1		2018	1.6
2009	2.3			

Average annual concentrations; Gross beta in drinking water.

Well Water

Tritium was below the detection limit for all samples taken. Gamma isotopic results were also below detection limits.

The data for 2018 were consistent with previous year's results and no plant operational effects were indicated.

Vegetation in lieu of Milk Sampling

Vegetation samples were collected in July, August and September, 2018. Iodine-131 concentrations measured below the detection limit in all samples. These samples are required when milk samples are not available.

Crops

A corn and potatoes collection was not required for 2018. No crops within five miles of the plant were found to be using irrigation water from the Mississippi River, and the plant did not discharge radioactive liquid effluents.

Fish

Eight fish were analyzed in 2018 consisting of two fish collected from upstream locations and two collected from downstream locations in May and then again in September. Flesh was separated from the bones and analyzed by gamma spectroscopy. Only naturally-occurring potassium-40 was found with an average of 3.37 pCi/g wet weight for four upstream samples and 3.50 pCi/g wet weight for the four downstream samples. These results agree well with 2017 results. Other gamma-emitting isotopes remained below detection limits. There was no indication of a plant effect.

Aquatic Invertebrates

Upstream and Downstream invertebrate sample collections were made in August and September 2018. Only naturally occurring potassium-40 was detected in the September upstream and downstream samples at 1.55 pCi/g wet and 1.11 pCi/g wet respectively. There was no indication of a plant effect.

Shoreline Sediments

Upstream, downstream and downstream recreational area shoreline sediment collections were made in June and November 2018, and analyzed for gamma-emitting isotopes. Cesium-137 was detected in both collections for both downstream samples (M-9) and (M-15), at an average concentration of 0.070 pCi/g dry weight at location M-9 and an average concentration of 0.122 pCi/g dry weight at location M-15. Cesium-137 was also detected in the November control sample (M08) at a level of 0.021 pCi/g wet. Similar levels of activity have been observed since 1978, and are indicative of the influence of fallout deposition. Levels of Cs-137 in sediments are observed to fluctuate as silt distributions shift due to natural erosion and transport processes. Naturally-occurring beryllium-7 and potassium-40 were also detected. There was no indication of a plant effect.

ISFSI TLD Monitoring

Gamma and Neutron TLDs are located around the Independent Spent Fuel Storage Installation (ISFSI) to monitor direct radiation from stored fuel. Results for gamma monitoring are included in the Complete Data Analysis Tables.

Results for ISFSI TLD monitoring in 2018 indicated elevated gamma dose rates at the ISFSI fence during the second half of the year. This increase in detected dose rates was expected and was due to the transfer of an additional 14 Dry Shielded Canisters (DSCs) containing spent fuel to the ISFSI pad between August 17th and November 29th, 2018. No detectable dose rate increases were observed at the site boundary TLD's during 2018.

5.0 FIGURES AND TABLES

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

Medium	No.	Location Codes (and Type) [a]	Collection Type and Frequency [b]	Analysis Type and Frequency [c]
REMP Ambient radiation(TLDs)	40	M-01A - M-14A, M-01B - M-16B M-01S - M-06S, M-01C - M-04C	C/Q	Ambient gamma
ISFSI Ambient radiation (TLDs)	13	I-01 to I-13	C/Q	Ambient Gamma
Airborne Particulates	5	M-1(C), M-2, M-3, M-4, M-5	C/W	GB, GS (QC of each location)
Airborne Iodine	5	M-1(C), M-2, M-3, M-4, M-5	C/W	I-131
Pasture grass, Vegetation [d]	3	M-41, M-42, M-43(C)	3x/year	GS
Surface water	2	M-8(C), M-9	G/W	GS(MC), H-3(QC)
Drinking water	1	M-14	G/W	GB(MC), I-131(MC) GS (MC), H-3 (QC)
Well water	4	M-11, M-12, M-55, M-43(C)	G/Q	H-3, GS
Fish (game species, edible portion)	2	M-8(C), M-9	G/SA	GS
Invertebrates	2	M-8(C), M-9	G/SA	GS
Shoreline sediment	3	M-8(C), M-9, M-15	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.

[d] Pasture grass and vegetation collections added to supplement dairy sampling.

Table 5.2. Sampling locations, Monticello Nuclear Generating Plant.

Code	Type [a]	Collection Site	Sample Type [b]	Distance and Direction from Reactor
M-1	C	Air Station M-1	AP, AI	11.0 mi @ 307°/NW
M-2		Air Station M-2	AP, AI	0.8 mi @ 140°/SE
M-3		Air Station M-3	AP, AI	0.6 mi @ 104°/ESE
M-4		Air Station M-4	AP, AI	0.8 mi @ 147°/SSE
M-5		Air Station M-5	AP, AI	2.6 mi @ 134°/SE
M-8	C	Upstream of Plant Intake	SW, SS, BO, F	< 1000' upstream
M-9		Downstream of Plant Discharge	SW, SS, BO, F	< 1000' downstream
M-11		City of Monticello	WW	3.3 mi @ 127°/SE
M-12		Plant Well #11	WW	0.26 mi @ 252°/WSW
M-14		City of Minneapolis	DW	37.0 mi @ 132°/SE
M-15		Montissippi Park	SS	1.27 mi @ 114°/ESE
M-27		Highest D/Q garden		1.15 mi @ 148°/SSE
M-41		Training Center	VE	0.8 mi @ 151°/SSE
M-42		Biology Station Road	VE	0.6 mi @ 134°/SE
M-43	C	Imholte Farm	VE, WW	12.3 mi @ 313°/NW
M-55		Hasbrouck Residence	WW	1.60 mi @ 255°/WSW

Table 5.2. Sampling locations, Monticello Nuclear Generating Plant.

Code	Type[a]	Collection Site	Sample Type[b]	Distance and Direction from Reactor
General Area of the Site Boundary				
M-01A		Sherburne Ave. So.	TLD	0.75 mi @ 353°/N
M-02A		Sherburne Ave. So.	TLD	0.79 mi @ 23°/NNE
M-03A		Sherburne Ave. So.	TLD	1.29 mi @ 56°/NE
M-04A		Biology Station Road	TLD	0.5 mi @ 92°/E
M-05A		Biology Station Road	TLD	0.48 mi @ 122°/ESE
M-06A		Biology Station Road	TLD	0.54 mi @ 138°/SE
M-07A		Parking Lot H	TLD	0.47 mi @ 158°/SSE
M-08A		Parking Lot F	TLD	0.45 mi @ 175°/S
M-09A		County Road 75	TLD	0.38 mi @ 206°/SSW
M-10A		County Road 75	TLD	0.38 mi @ 224°/SW
M-11A		County Road 75	TLD	0.4 mi @ 237°/WSW
M-12A		County Road 75	TLD	0.5 mi @ 262°/W
M-13A		North Boundary Road	TLD	0.89 mi @ 322°/NW
M-14A		North Boundary Road	TLD	0.78 mi @ 335°/NNW
Approximately 4 to 5 miles Distant from the Plant				
M-01B		117th Street	TLD	4.65 mi @ 01°/N
M-02B		County Road 11	TLD	4.4 mi @ 18°/NNE
M-03B		County Road 73 & 81	TLD	4.3 mi @ 51°/NE
M-04B		County Road 73 (196th St.)	TLD	4.2 mi @ 67°/ENE
M-05B		City of Big Lake	TLD	4.3 mi @ 89°/E
M-06B		County Road 14 and 196th St.	TLD	4.3 mi @ 117°/ESE
M-07B		Monticello Industrial Drive	TLD	4.3 mi @ 136°/SE
M-08B		Residence, Hwy 25 & Davidson Ave.	TLD	4.6 mi @ 162°/SSE
M-09B		Weinand Farm	TLD	4.7 mi @ 178°/S
M-10B		Reisewitz Farm, Acacia Ave.	TLD	4.2 mi @ 204°/SSW
M-11B		Vanlith Farm, 97th Ave.	TLD	4.0 mi @ 228°/SW
M-12B		Lake Maria State Park	TLD	4.2 mi @ 254°/WSW
M-13B		Bridgewater Station	TLD	4.1 mi @ 270°/W
M-14B		Anderson Residence, Cty Rd. 111	TLD	4.3 mi @ 289°/WNW
M-15B		Red Oak Wild Bird Farm	TLD	4.3 mi @ 309°/NW
M-16B		Sand Plain Research Farm	TLD	4.4 mi @ 341°/NNW

Table 5.2. Sampling locations, Monticello Nuclear Generating Plant.

Code	Type[a]	Collection Site	Sample Type[b]	Distance and Direction from Reactor
Special Interest Locations				
M-01S		Telephone pole on 127th St. NE	TLD	0.66 mi @ 241°/WSW
M-02S		Krone Residence	TLD	0.5 mi @ 220°/SW
M-03S		Big Oaks Park	TLD	1.53 mi @ 103°/ESE
M-04S		Pinewood School	TLD	2.3 mi @ 131°/SE
M-05S		Rivercrest Christian Academy	TLD	3.0 mi @ 118°/ESE
M-06S		Monticello Public Works	TLD	2.6 mi @ 134°/SE
ISFSI-11		I-11 (gamma)	TLD	0.31 mi @ 222°/SW
ISFSI-12		I-12 (gamma)	TLD	0.32 mi @ 230°/SW
ISFSI-13		I-13 (gamma)	TLD	0.34 mi @ 240°/WSW
Control Locations				
M-01C	C	Kirchenbauer Farm	TLD	11.5 mi @ 323°/NW
M-02C	C	County Roads 4 and 15	TLD	11.2 mi @ 47°/NE
M-03C	C	County Rd 19 and Jason Ave.	TLD	11.6 mi @ 130°/SE
M-04C	C	Maple Lake Water Tower	TLD	10.3 mi @ 226°/ SW
ISFSI TLD Locations		(Non-REMP TLD's)		
ISFSI-1		I-01 (gamma)	TLD	NE corner of ISFSI
ISFSI-2		I-02 (gamma)	TLD	North side of ISFSI, center
ISFSI-3		I-03 (gamma)	TLD	NW corner of ISFSI
ISFSI-4		I-04 (gamma)	TLD	West side of ISFSI, middle
ISFSI-5		I-05 (gamma)	TLD	West side of ISFSI, at center of array
ISFSI-6		I-06 (gamma)	TLD	SW corner of ISFSI
ISFSI-7		I-07 (gamma)	TLD	South side of ISFSI, center
ISFSI-8		I-08 (gamma)	TLD	SE corner of ISFSI
ISFSI-9		I-09 (gamma)	TLD	East side of ISFSI, at center of array
ISFSI-10		I-10 (gamma)	TLD	East side of ISFSI, middle

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

[b] Sample Codes:

AP	Airborne particulates	F	Fish
AI	Airborne Iodine	SW	River Water
BS	Bottom (river) sediments	SS	Shoreline Sediments
BO	Bottom organisms	TLD	Thermoluminescent Dosimeter
DW	Drinking Water	VE	Vegetation / vegetables
		WW	Well Water

Table 5.3 Missed Collections and Analyses.

All required samples were collected and analyzed as scheduled with the following exceptions:					
Sample Type	Analysis	Location	Collection Date or Period	Reason for not conducting REMP as required	Plans for Preventing Recurrence
SW	Gamma	M-8	January '18	Water frozen entire month, no composite.	None
SW	Gamma	M-8	February '18	Water frozen entire month, no composite.	None
SW	Gamma	M-8	March '18	Water frozen entire month, no composite.	None
SW	Tritium	M-8	1st Qtr '18	Water frozen entire quarter, no composite.	None
AP/AI	Beta, I-131	M-2	4/18/2018	Only 12.3 hours run time indicated. Filter color was comparable to other filters. Could have been caused by either a temporary loss of power or a timer issue.	Tested pump and timer Replaced filter.
SW	Gamma	M-8	April '18	Only one sample for month, 04/25/18. Water from other weeks was frozen. No composite.	None
AP/AI	Beta, I-131	M-2	6/06/2018-6/12/18	Station lost power from the service drop. Sampler was restarted on 6/8/18 with temporary power.	Rerouted power drop.
AP/AI	Beta, I-131	M-2	6/20/2018	Pump running, no flow to the sampler. Loss of flow was found to be caused by a broken filter plug resulting in a loss of vacuum.	Replaced pump.
BO	Gamma	M-8,M-9	Spring 2018	Invertebrate sample collected late due to unsafe river conditions.	Reducing sampling frequency to annual.
TLD	Gamma	M-5S	2nd Qtr '18	TLD missing in field.	Searched area, reattached TLD holder to telephone pole.
SW	Gamma	M-8	November '18	November '18 composite included only sample from week of 11/07/2018.	None
TLD	Gamma	M-4B	4th Qtr '18	Sample missing during shipment. Could not be located by vendor or plant.	None. Cause of missing TLD could not be determined.
SW	Gamma	M-8	December '18	Water frozen entire month, no composite.	None
SW	Tritium	M-8	4th Qtr '18	The quarterly composite ends 11/07/18, water froze afterwards.	None

Figure 5-1. Offsite Ambient Radiation (TLDs); Inner Ring versus Outer Ring versus Control locations.

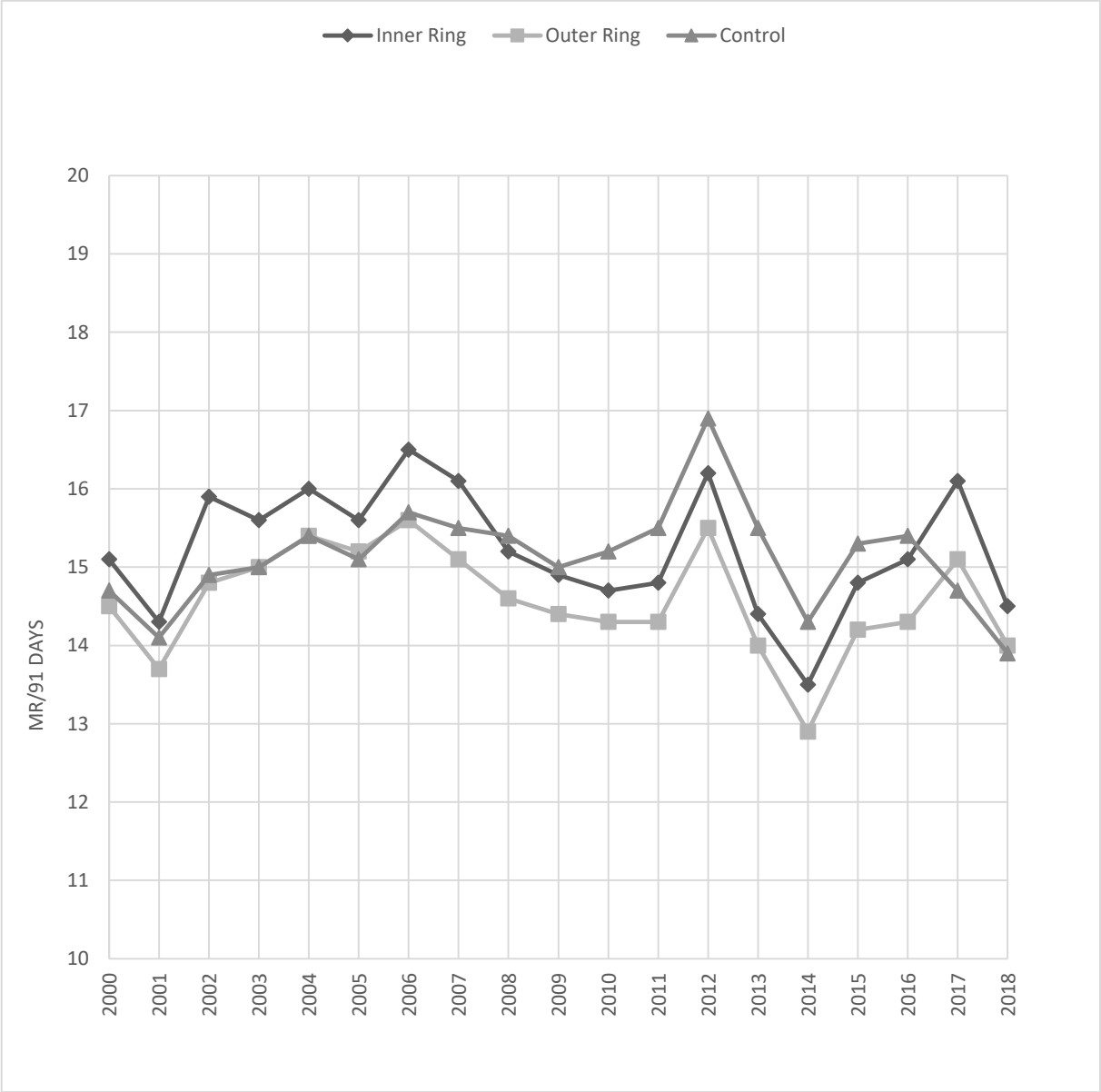

Figure 5-2. Airborne Particulates; analysis for gross beta, average mean of all indicator locations versus control location.

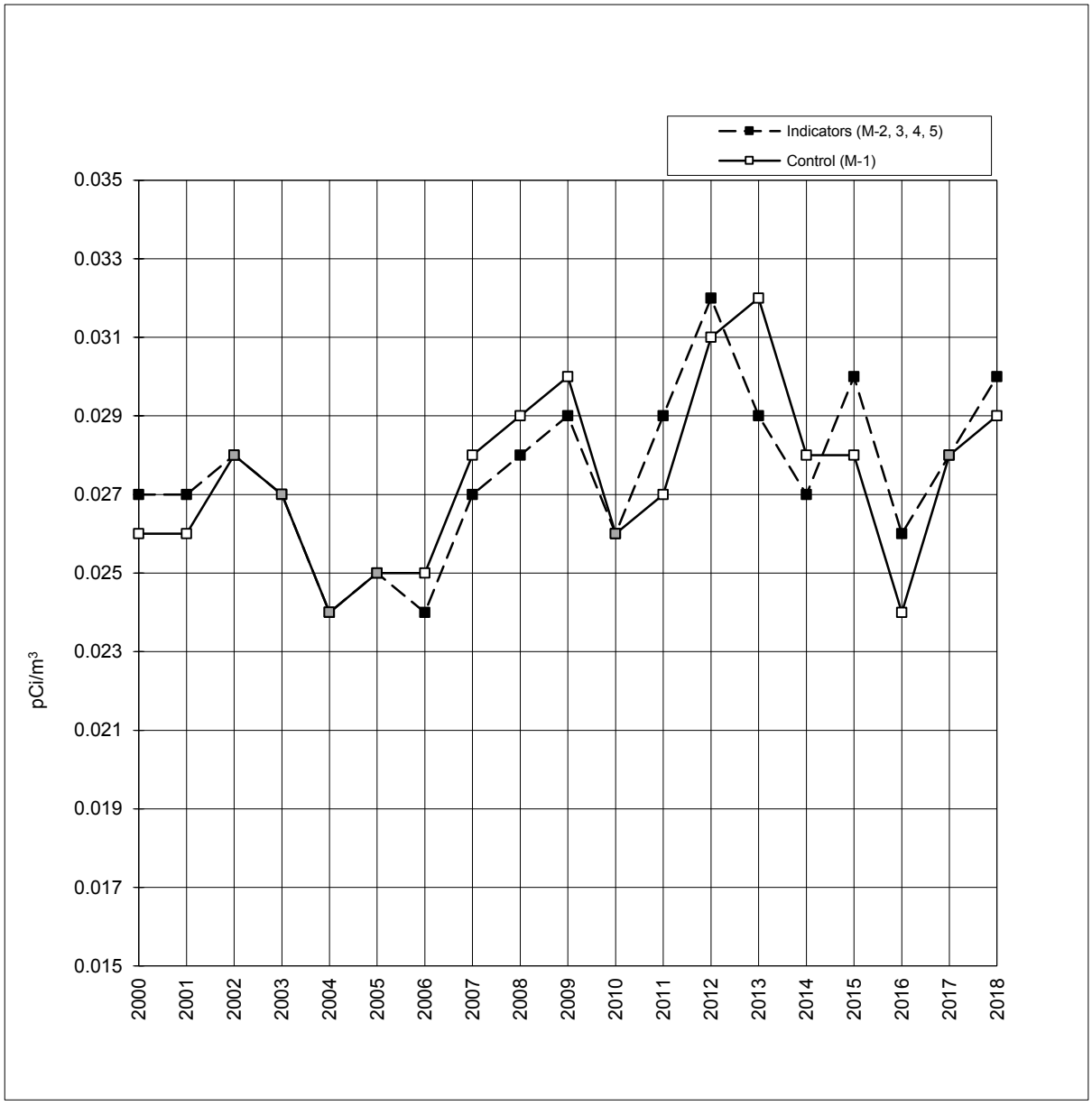

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility	Monticello Nuclear Generating Plant	Docket No.	50-263
Location of Facility	Wright, Minnesota	Reporting Period	January-December, 2018
	(County, State)		

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean		Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
				Location[d]	Mean (F)[c] Range[c]		
Direct Radiation							
TLD (Inner Ring, General Area at Site Boundary) mRem/91 days)	Gamma 56	3.0	14.5 (56/56) (9.7-17.2)	M-11A, 0.4 mi @ 237°/WSW	15.7 (4/4) (14.5-17.2)	(See Control below.)	0
TLD (Outer Ring, 4-5 mi. distant) mRem/91 days)	Gamma 63	3.0	14.0 (63/63) (10.0-17.1)	M-14B 4.3 mi @ 289°/NW	16.0 (4/4) (14.9-17.1)	(See Control below.)	0
TLD (Special Interest Areas) mRem/91 days)	Gamma 35	3.0	14.5 (35/35) (9.6-17.8)	M-I-13 OCA fence North	16.3 (4/4) (15.2-17.8)	(See Control below.)	0
TLD (Control) mRem/91 days)	Gamma 16	3.0	None	M-03C 11.6 mi @ 130°/SE	15.0 (4/4) (12.8-16.8)	13.9 (16/16) (11.5-16.8)	0
Airborne Pathway							
Airborne Particulates (pCi/m^3)	GB 256	0.002	0.030 (204/204) (0.007-0.070)	M-3, Air Station 0.6 mi @ 104°/ESE	0.031 (52/52) (0.007-0.070)	0.029 (52/52) (0.006-0.064)	0
	GS 20						
	Be-7	0.015	0.079 (16/16) (0.044-0.113)	M-3, Air Station 0.6 mi @ 104°/ESE	0.085 (4/4) (0.058-0.112)	0.082 (4/4) (0.059-0.100)	0
	Mn-54	0.0012	< LLD	-	-	< LLD	0
	Co-58	0.0015	< LLD	-	-	< LLD	0
	Co-60	0.0011	< LLD	-	-	< LLD	0
	Zn-65	0.0026	< LLD	-	-	< LLD	0
	Zr-Nb-95	0.0022	< LLD	-	-	< LLD	0
	Ru-103	0.0018	< LLD	-	-	< LLD	0
	Ru-106	0.0104	< LLD	-	-	< LLD	0
	Cs-134	0.0011	< LLD	-	-	< LLD	0
	Cs-137	0.0010	< LLD	-	-	< LLD	0
	Ba-La-140	0.0048	< LLD	-	-	< LLD	0
	Ce-141	0.0025	< LLD	-	-	< LLD	0
	Ce-144	0.0059	< LLD	-	-	< LLD	0
Airborne Iodine (pCi/m^3)	I-131 256	0.03	< LLD	-	-	< LLD	0

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility	Monticello Nuclear Generating Plant	Docket No.	50-263
Location of Facility	Wright, Minnesota	Reporting Period	January-December,2018
	(County, State)		

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							
River Water (pCi/L)	H-3 7	500	< 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	36	< LLD	-	-	< LLD	0
Drinking Water (pCi/L)	GB 12	1.0	1.6 (7/12) (1.1-3.0)	M-14 City of Minneapolis 37.0 mi @ 132°/SE	1.6 (7/12) (1.1-3.0)	None	0
	I-131 12	1.0	< LLD	-	-	None	0
	H-3 4	500	< 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	40	< LLD	-	-	None	0
Well Water (pCi/L)	H-3 16	500	< LLD	-	-	< LLD	0
	GS 16						
	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	40	< LLD	-	-	< LLD	0

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility	Monticello Nuclear Generating Plant	Docket No.	50-263
Location of Facility	Wright, Minnesota	Reporting Period	January-December, 2018
		(County, State)	

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							
Aquatic Invertebrates (pCi/g wet)	GS 4						
	Be-7	0.79	< LLD	-	-	< LLD	0
	K-40	1.86	1.11(1/2)	M-8 Upstream- < 1000ft upstream	1.55(1/2)	1.55(1/2)	0
	Mn-54	0.068	< LLD	-	-	< LLD	0
	Fe-59	0.15	< LLD	-	-	< LLD	0
	Co-58	0.061	< LLD	-	-	< LLD	0
	Co-60	0.058	< LLD	-	-	< LLD	0
	Zn-65	0.143	< LLD	-	-	< LLD	0
	Zr-Nb-95	0.076	< LLD	-	-	< LLD	0
	Ru103	0.083	< LLD	-	-	< LLD	0
	Ru-106	0.67	< LLD	-	-	< LLD	0
	Cs-134	0.093	< LLD	-	-	< LLD	0
	Cs-137	0.100	< LLD	-	-	< LLD	0
	Ba-La-140	0.17	< LLD	-	-	< LLD	0
	Ce-144	0.40	< LLD	-	-	< LLD	0
Shoreline Sediments (pCi/g dry)	GS 6						
	Be-7	0.20	0.69 (1/4)	M-15 Montissippi Park 1.27 mi. @ 114°/ESE	0.69 (1/2)	0.30 (1/2)	0
	K-40	0.10	11.52 (4/4) (11.02-11.90)	M-9, Downstream < 1000 ft downstream	11.66 (2/2) (11.42-11.90)	9.65 (2/2) (9.54-9.76)	0
	Mn-54	0.025	< LLD	-	-	< LLD	0
	Fe-59	0.074	< LLD	-	-	< LLD	0
	Co-58	0.021	< LLD	-	-	< LLD	0
	Co-60	0.015	< LLD	-	-	< LLD	0
	Zn-65	0.049	< LLD	-	-	< LLD	0
	Nb-95	0.028	< LLD	-	-	< LLD	0
	Zr-95	0.050	< LLD	-	-	< LLD	0
	Ru-103	0.026	< LLD	-	-	< LLD	0
	Ru-106	0.17	< LLD	-	-	< LLD	0
	Cs-134	0.021	< LLD	-	-	< LLD	0
	Cs-137	0.018	0.096 (4/4) (0.041-0.203)	M-15, Montissippi Park 1.27 mi. @ 114°/ESE	0.122 (2/2) (0.041-0.203)	0.021 (1/2)	0
	Ba-La-140	0.090	< LLD	-	-	< LLD	0
	Ce-144	0.098	< LLD	-	-	< LLD	0

Table 5.4 Radiological Environmental Monitoring Program Summary

Name of Facility	Monticello Nuclear Generating Plant	Docket No.	50-263
Location of Facility	Wright, Minnesota (County, State)	Reporting Period	January-December, 2018

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]
Ingestion Pathway							
Vegetation (Pasture Grass, Weeds, Leaves) (pCi/g wet)	GS 9						
	Mn-54	0.014	< LLD	-	-	< LLD	0
	Fe-59	0.035	< LLD	-	-	< LLD	0
	Co-58	0.014	< LLD	-	-	< LLD	0
	Co-60	0.015	< LLD	-	-	< LLD	0
	Zn-65	0.048	< LLD	-	-	< LLD	0
	Nb-95	0.022	< LLD	-	-	< LLD	0
	I-131	0.044	< LLD	-	-	< LLD	0
	Cs-134	0.017	< LLD	-	-	< LLD	0
	Cs-137	0.017	< LLD	-	-	< LLD	0
Fish (pCi/g wet)	GS 8						
	K-40	0.10	3.50 (4/4) (3.05-3.92)	M-9, Downstream < 1000 ft downstream	3.50 (4/4) (3.05-3.92)	3.37 (4/4) (3.05-3.64)	0
	Mn-54	0.028	< LLD	-	-	< LLD	0
	Fe-59	0.059	< LLD	-	-	< LLD	0
	Co-58	0.029	< LLD	-	-	< LLD	0
	Co-60	0.026	< LLD	-	-	< LLD	0
	Zn-65	0.069	< LLD	-	-	< LLD	0
	Zr-Nb-95	0.048	< LLD	-	-	< LLD	0
	Cs-134	0.026	< LLD	-	-	< LLD	0
	Cs-137	0.026	< LLD	-	-	< LLD	0
	Ba-La-140	0.094	< LLD	-	-	< LLD	0
	Ce144	0.132	< 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.

6.0 REFERENCES CITED

Arnold, J. R. and H. A. Al-Salih. 1955. Beryllium-7 Produced by Cosmic Rays. Science 121: 451-453.

Eisenbud, M. 1963. Environmental Radioactivity, McGraw-Hill, New York, New York, pp. 213, 275, 276.

ATI Environmental, Inc., Midwest Laboratory.

_____2001a through 2018a. Radiation Environmental Monitoring for Monticello Nuclear Generating Plant, Complete Analysis Data Tables, January-December, 2000 through 2017.

_____2001b through 2018b. Radiation Environmental Monitoring for Prairie Island Nuclear Generating Plant, Complete Analysis Data Tables, January - December, 2000 through 2017.

_____1984a to 2000a. (formerly Teledyne Brown Engineering Environmental Services, Midwest Laboratory) Radiation Environmental Monitoring for Monticello Nuclear Generating Plant, Complete Analysis Data Tables, January - December, 1983 through 1999.

_____1984b to 2000b. (formerly Teledyne Brown Engineering Environmental Services, Midwest Laboratory) Radiation Environmental Monitoring for Prairie Island Nuclear Generating Plant, Complete Analysis Data Tables, January - December, 1983 through 1999.

_____1979a to 1983a. (formerly Hazleton Environmental Sciences Corporation) Radiation Environmental Monitoring for Monticello Nuclear Generating Plant, Complete Analysis Data Tables, January - December, 1978 through 1982.

_____1979b to 1983b. (formerly Hazleton Environmental Sciences Corporation) Radiation Environmental Monitoring for Prairie Island Nuclear Generating Plant, Complete Analysis Data Tables, January - December, 1978 through 1982.

_____2016 .Quality Control Procedures Manual, Rev. 3, 03 March 2016.

_____2018. Quality Manual, Rev.6, 20 July 2018.

Gold, S., H.W. Barkhau, B. Shlein, and B. Kahn, 1964. Measurement of Naturally Occurring Radionuclides in Air, in the Natural Environment, University of Chicago Press, Illinois, 369-382.

National Center for Radiological Health, 1968. Radiological Health and Data Reports, Vol. 9, Number 12, 730-746.

Northern States Power Company.

_____1969 through 1971. Monticello Nuclear Generating Plant, Environmental Radiation Monitoring Program, Annual Report, June 18, 1968 to December 31, 1968, 1969, 1970. Minneapolis, Minnesota.

_____1978 through 2008. Monticello Nuclear Generating Plant, Annual Radiation Environmental Monitoring Report to the U.S. Nuclear Regulatory Commission, January 1, to December 31, 1977 through 2007.

6.0 REFERENCES CITED (continued)

U.S. Dep't of Energy 1997 HASL-300, Edition 28, Procedures Manual, Environmental Measurements Laboratory, New York, NY.

U.S. Environmental Protection Agency .

_____1980. Prescribed Procedures for Measurement of Radioactivity in Drinking Water, Cincinnati, Ohio (EPA-600/4-80-032).

_____1984. Eastern Environmental Radiation Facility, Radiochemistry Procedures Manual, Montgomery, Alabama (EPA-520/5-84-006).

Wilson, D. W., G. M. Ward and J. E. Johnson. 1969. In Environmental Contamination by Radioactive Materials, International Atomic Energy Agency. p.125.

Xcel Energy Corporation.

_____2009 to 2018. Monticello Nuclear Generating Plant, Annual Radiation Environmental Monitoring Report to the U.S. Nuclear Regulatory Commission, January 1 to December 31, 2008 through 2017. Minneapolis, Minnesota.

_____2009 to 2018. Prairie Island Nuclear Generating Plant, Annual Radiation Environmental Monitoring Report to the U.S. Nuclear Regulatory Commission, January 1 to December 31, 2008 through 2017. Minneapolis, Minnesota.

ATI Environmental, Inc.
Midwest Laboratory
700 Landwehr Road • Northbrook, IL 60062-2310
phone (847) 564-0700 • fax (847) 564-4517

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, 2018 through December, 2018

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.

Table A-2 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-3 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-4 lists results of the analyses on in-house "blank" samples for the past twelve months. Data for previous years available upon request.

Table A-5 lists analytical results from the in-house "duplicate" program for the past twelve months. Acceptance is based on the difference of the results being less than the sum of the errors. Complete analytical data for duplicate analyses is available upon request.

The results in Table A-6 were obtained through participation in the Mixed Analyte Performance Evaluation Program.

Results in Table A-7 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	Analysis	Concentration (pCi/L) Laboratory Result	ERA Result	Control Limits	Acceptance
ERW-52	1/8/2018	Sr-89	61.6 ± 5.8	65.2	52.9 - 73.2	Pass
ERW-52	1/8/2018	Sr-90	39.7 ± 2.3	39.2	28.2 - 45.1	Pass
ERW-54	1/8/2018	Ba-133	89.7 ± 4.7	95.1	80.2 - 105	Pass
ERW-54	1/8/2018	Cs-134	62.1 ± 5.4	65.6	53.4 - 72.2	Pass
ERW-54	1/8/2018	Cs-137	111.2 ± 6.1	112	101 - 126	Pass
ERW-54	1/8/2018	Co-60	115.8 ± 4.7	114.0	103.0 - 128.0	Pass
ERW-54	1/8/2018	Zn-65	292.2 ± 14.0	277.0	249 - 324	Pass
ERW-52	1/8/2018	Gr. Alpha	70.1 ± 3.0	72.4	38.1 - 89.2	Pass
ERW-52	1/8/2018	Gr. Beta	47.4 ± 1.4	54.8	37.5 - 61.7	Pass
ERW-58	1/8/2018	I-131	25.3 ± 1.0	28.1	23.4 - 33.0	Pass
ERW-61	1/8/2018	Ra-226	12.4 ± 0.4	14.20	10.60 - 16.30	Pass
ERW-60	1/8/2018	Ra-228	4.9 ± 0.8	4.21	2.43 - 5.81	Pass
ERW-60	1/8/2018	Uranium	52.2 ± 0.9	58.6	47.8 - 64.5	Pass
ERW-62	1/8/2018	H-3	21,780 ± 437	21,200	18,600 - 23,300	Pass
ERW-2555	7/9/2018	Sr-89	62.8 ± 4.0	62.7	50.7 - 70.6	Pass
ERW-2555	7/9/2018	Sr-90	40.1 ± 1.3	40.1	29.5 - 46.1	Pass
ERW-2557	7/9/2018	Ba-133	23.1 ± 2.3	25.6	19.9 - 29	Pass
ERW-2557	7/9/2018	Cs-134	15.2 ± 1.7	15.7	11.4 - 18.2	Pass
ERW-2557	7/9/2018	Cs-137	22.3 ± 4.9	192	173 - 213	Fail[b]
ERW-2557	7/9/2018	Co-60	110.4 ± 3.7	119.0	107 - 133	Pass
ERW-2557	7/9/2018	Zn-65	189.5 ± 7.5	177.0	159 - 208	Pass
ERW-2559	7/9/2018	Gr. Alpha	13.5 ± 0.7	16.0	7.79 - 22.6	Pass
ERW-2559	7/9/2018	Gr. Beta	41.1 ± 0.9	49.0	33.2 - 56.1	Pass
ERW-2561	7/9/2018	I-131	24.9 ± 0.9	28.1	23.4 - 33.0	Pass
ERW-2563	7/9/2018	Ra-226	9.0 ± 0.3	9.08	6.81 - 10.6	Pass
ERW-2563	7/9/2018	Ra-228	3.2 ± 0.4	2.28	1.07 - 3.60	Pass
ERW-2563	7/9/2018	Uranium	38.2 ± 1.4	51.8	42.2 - 57.1	Fail[c]
ERW-2565	7/9/2018	H-3	21,039 ± 302	20,400	17,900 - 22,400	Pass
ERW-3832[b]	10/7/2016	Ba-133	57.0 ± 3.1	54.9	45 - 61	Pass
ERW-3832[b]	10/7/2016	Cs-134	79.2 ± 3.0	81.8	67 - 90	Pass
ERW-3832[b]	10/7/2016	Cs-137	222.4 ± 4.5	210	189 - 233	Pass
ERW-3832[b]	10/7/2016	Co-60	67.7 ± 3.5	64.5	58 - 73	Pass
ERW-3832[b]	10/7/2016	Zn-65	274.1 ± 3.0	245	220 - 287	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] A transcription error caused the Cs-137 result submitted to be understated by a factor of 10.
The actual result obtained was slightly higher than the acceptance criteria for the study.
A "Quick Response" proficiency test was analyzed to help determine the cause of the high result. (See ERW-3832 above)
No definitive cause for the previous high Cs-137 result was determined.

[c] An investigation was conducted on the apparent cause of failure in the Uranium isotopic PT analysis. In order to get to the root cause of the failure a NIST U-natural 4321d-standard was purchased and a new U-232 diluted tracer was standardized.
The analysis was rerun and the results were found to be within the acceptance criteria. It appears that the original U-232 tracer used in the analysis may have been compromised (concentrated) and therefore resulted in a very high negative bias.

TABLE A-2. 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				
2018-1	11/15/2018	Spike 1	97.0	81.6	-0.16	
2018-1	11/15/2018	Spike 2	97.0	88.5	-0.09	
2018-1	11/15/2018	Spike 3	97.0	87.9	-0.09	
2018-1	11/15/2018	Spike 4	97.0	85.6	-0.12	
2018-1	11/15/2018	Spike 5	97.0	86.5	-0.11	
2018-1	11/15/2018	Spike 6	97.0	89.0	-0.08	
2018-1	11/15/2018	Spike 7	97.0	85.1	-0.12	
2018-1	11/15/2018	Spike 8	97.0	90.6	-0.07	
2018-1	11/15/2018	Spike 9	97.0	91.3	-0.06	
2018-1	11/15/2018	Spike 10	97.0	84.5	-0.13	
2018-1	11/15/2018	Spike 11	97.0	90.8	-0.06	
2018-1	11/15/2018	Spike 12	97.0	93.8	-0.03	
2018-1	11/15/2018	Spike 13	97.0	85.3	-0.12	
2018-1	11/15/2018	Spike 14	97.0	85.5	-0.12	
2018-1	11/15/2018	Spike 15	97.0	86.9	-0.10	
2018-1	11/15/2018	Spike 16	97.0	88.6	-0.09	
2018-1	11/15/2018	Spike 17	97.0	83.1	-0.14	
2018-1	11/15/2018	Spike 18	97.0	85.4	-0.12	
2018-1	11/15/2018	Spike 19	97.0	83.3	-0.14	
2018-1	11/15/2018	Spike 20	97.0	85.5	-0.12	
Mean (Spike 1-20)				86.9	-0.10	Pass[d]
Standard Deviation (Spike 1-20)				3.1	0.03	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 mean of the P values, nor the standard deviation of the P values exceed 0.15.

TABLE A-2. Thermoluminescent Dosimetry, (TLD, $CaSO_4$: Dy Cards).[a]

				mrem		
Lab Code	Irradiation Date	Description	Delivered Dose	Reported[b] Dose	Performance[c] Quotient (P)	
Environmental, Inc.		Group 2				
2018-2	11/15/2018	Spike 21	143.0	130.3	-0.09	
2018-2	11/15/2018	Spike 22	143.0	128.1	-0.10	
2018-2	11/15/2018	Spike 23	143.0	134.4	-0.06	
2018-2	11/15/2018	Spike 24	143.0	129.0	-0.10	
2018-2	11/15/2018	Spike 25	143.0	132.5	-0.07	
2018-2	11/15/2018	Spike 26	143.0	126.1	-0.12	
2018-2	11/15/2018	Spike 27	143.0	126.2	-0.12	
2018-2	11/15/2018	Spike 28	143.0	122.4	-0.14	
2018-2	11/15/2018	Spike 29	143.0	118.8	-0.17	
2018-2	11/15/2018	Spike 30	143.0	123.2	-0.14	
2018-2	11/15/2018	Spike 31	143.0	137.2	-0.04	
2018-2	11/15/2018	Spike 32	143.0	144.4	0.01	
2018-2	11/15/2018	Spike 33	143.0	137.8	-0.04	
2018-2	11/15/2018	Spike 34	143.0	140.2	-0.02	
2018-2	11/15/2018	Spike 35	143.0	143.8	0.01	
2018-2	11/15/2018	Spike 36	143.0	146.7	0.03	
2018-2	11/15/2018	Spike 37	143.0	150.0	0.05	
2018-2	11/15/2018	Spike 38	143.0	126.1	-0.12	
2018-2	11/15/2018	Spike 39	143.0	136.2	-0.05	
2018-2	11/15/2018	Spike 40	143.0	144.8	0.01	
Mean (Spike 21-40)				133.9	-0.06	Pass[d]
Standard Deviation (Spike 21-40)				9.0	0.06	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 mean of the P values, nor the standard deviation of the P values exceed 0.15.

TABLE A-3. 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-1749	4/21/2016	Fe-55	1,576 ± 81	1,482	1,186 - 1,778	Pass	1.06
SPW-95	1/11/2018	H-3	16,457 ± 381	16,507	13,206 - 19,808	Pass	1.00
SPW-109	1/12/2018	Sr-90	18.9 ± 1.7	17.9	14.3 - 21.5	Pass	1.06
SPW-175	1/19/2018	H-3	16,261 ± 382	16,507	13,206 - 19,808	Pass	0.99
SPW-210	1/23/2018	H-3	16,461 ± 382	16,507	13,206 - 19,808	Pass	1.00
SPW-212	1/10/2018	Ra-226	12.9 ± 0.4	12.3	8.6 - 16.0	Pass	1.05
SPW-272	1/30/2018	H-3	16,607 ± 384	16,507	13,206 - 19,808	Pass	1.01
W-013118	4/29/2016	Cs-134	33.9 ± 7.4	36.2	29.0 - 43.4	Pass	0.94
W-013118	4/29/2016	Cs-137	80.0 ± 7.9	71.9	57.5 - 86.3	Pass	1.11
SPW-330	2/1/2018	Ni-63	168 ± 2	198	139 - 258	Pass	0.85
SPW-338	2/2/2018	H-3	16,512 ± 381	16,507	13,206 - 19,808	Pass	1.00
SPW-384	2/6/2018	H-3	16,429 ± 380	16,507	13,206 - 19,808	Pass	1.00
W-020618	4/29/2016	Cs-134	39.0 ± 12.0	36.2	29.0 - 43.4	Pass	1.08
W-020618	4/29/2016	Cs-137	81.0 ± 15.7	71.9	57.5 - 86.3	Pass	1.13
SPW-461	2/13/2018	H-3	16,799 ± 385	16,507	13,206 - 19,808	Pass	1.02
SPW-516	2/19/2018	H-3	16,323 ± 382	16,507	13,206 - 19,808	Pass	0.99
SPW-556	2/8/2018	Ra-226	12.2 ± 0.3	12.3	8.6 - 16.0	Pass	0.99
SPW-582	2/22/2018	H-3	16,200 ± 380	16,507	13,206 - 19,808	Pass	0.98
SPW-609	2/23/2018	H-3	16,467 ± 383	16,507	13,206 - 19,808	Pass	1.00
SPW-650	2/21/2018	Ra-226	11.8 ± 0.5	12.3	8.6 - 16.0	Pass	0.96
SPW-666	2/28/2018	Gr. Alpha	67.1 ± 2.8	72.4	36.2 - 108.6	Pass	0.93
SPW-666	2/28/2018	Gr. Beta	48.1 ± 1.4	54.8	43.8 - 65.8	Pass	0.88
W-022818	4/29/2016	Cs-134	32.7 ± 8.5	36.2	29.0 - 43.4	Pass	0.90
W-022818	4/29/2016	Cs-137	73.8 ± 9.3	71.9	57.5 - 86.3	Pass	1.03
SPW-748	3/6/2018	H-3	16,209 ± 381	16,507	13,206 - 19,808	Pass	0.98
SPW-787	3/8/2018	H-3	16,934 ± 388	16,507	13,206 - 19,808	Pass	1.03
W-030718	4/29/2016	Cs-134	33.4 ± 7.9	36.2	29.0 - 43.4	Pass	0.92
W-030718	4/29/2016	Cs-137	78.9 ± 9.6	71.9	57.5 - 86.3	Pass	1.10
SPW-885	3/15/2018	H-3	16,475 ± 384	16,507	13,206 - 19,808	Pass	1.00
SPW-931	3/20/2018	H-3	16,467 ± 384	16,507	13,206 - 19,808	Pass	1.00
SPW-957	3/12/2018	Ra-226	11.4 ± 0.4	12.3	8.6 - 16.0	Pass	0.93
SPW-969	3/23/2018	Ni-63	260 ± 12	329	230 - 428	Pass	0.79
W-031418	4/29/2016	Cs-134	36.9 ± 11.2	36.2	29.0 - 43.4	Pass	1.02
W-031418	4/29/2016	Cs-137	82.3 ± 15.5	71.9	57.5 - 86.3	Pass	1.14
SPW-985	3/27/2018	H-3	16,544 ± 386	16,507	13,206 - 19,808	Pass	1.00
SPW-1037	4/4/2018	H-3	16,298 ± 384	16,507	13,206 - 19,808	Pass	0.99
SPW-1149	4/12/2018	H-3	16,361 ± 383	16,507	13,206 - 19,808	Pass	0.99
SPW-1200	4/13/2018	U-238	44.2 ± 2.3	41.7	29.2 - 54.2	Pass	1.06
SPW-1426	4/20/2018	H-3	16,573 ± 390	16,507	13,206 - 19,808	Pass	1.00
SPW-1454	4/24/2018	H-3	16,495 ± 384	16,507	13,206 - 19,808	Pass	1.00
SPW-1493	4/26/2018	Ra-228	4.59 ± 1.10	4.21	2.95 - 5.47	Pass	1.09
SPW-1518	4/27/2018	H-3	16,483 ± 382	16,507	13,206 - 19,808	Pass	1.00
SPW-1522	4/27/2018	Tc-99	105 ± 2	108	75 - 140	Pass	0.98
W-050118	4/29/2016	Cs-134	35.2 ± 9.9	36.2	29.0 - 43.4	Pass	0.97
W-050118	4/29/2016	Cs-137	82.4 ± 7.7	71.9	57.5 - 86.3	Pass	1.15

TABLE A-3. 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-1573	5/2/2018	Gr. Alpha	25.2 ± 0.5	20.1	10.1 - 30.2	Pass	1.25
SPW-1573	5/2/2018	Gr. Beta	28.2 ± 0.3	27.5	22.0 - 33.0	Pass	1.03
SPW-1618	5/3/2018	H-3	14,834 ± 366	16,507	13,206 - 19,808	Pass	0.90
W-050318	4/29/2016	Cs-134	32.9 ± 7.6	36.2	29.0 - 43.4	Pass	0.91
W-050318	4/29/2016	Cs-137	83.1 ± 8.5	71.9	57.5 - 86.3	Pass	1.16
SPW-1644	5/4/2018	Sr-90	20.0 ± 1.3	17.9	14.3 - 21.5	Pass	1.12
W-050718	4/29/2018	Cs-134	42.4 ± 8.5	36.2	29.0 - 43.4	Pass	1.17
W-050718	4/29/2018	Cs-137	80.6 ± 13.6	71.9	57.5 - 86.3	Pass	1.12
SPW-1695	5/8/2018	H-3	16,450 ± 384	16,507	13,206 - 19,808	Pass	1.00
W-050818	4/29/2016	Cs-134	32.3 ± 6.9	36.2	29.0 - 43.4	Pass	0.89
W-050818	4/29/2016	Cs-137	73.0 ± 8.2	71.9	57.5 - 86.3	Pass	1.02
SPW-1780	5/11/2018	H-3	16,784 ± 388	16,507	13,206 - 19,808	Pass	1.02
W-051518	4/29/2016	Cs-134	33.0 ± 6.7	36.2	29.0 - 43.4	Pass	0.91
W-051518	4/29/2016	Cs-137	76.0 ± 7.4	71.9	57.5 - 86.3	Pass	1.06
W-051718	4/29/2016	Cs-134	35.1 ± 5.7	36.2	29.0 - 43.4	Pass	0.97
W-051718	4/29/2016	Cs-137	73.7 ± 6.7	71.9	57.5 - 86.3	Pass	1.03
SPW-1897	5/18/2018	H-3	16,650 ± 387	16,507	13,206 - 19,808	Pass	1.01
SPW-1899	5/18/2018	H-3	16,754 ± 365	16,507	13,206 - 19,808	Pass	1.01
W-052418	4/29/2016	Cs-134	33.9 ± 6.2	36.2	29.0 - 43.4	Pass	0.94
W-052418	4/29/2016	Cs-137	78.8 ± 7.4	71.9	57.5 - 86.3	Pass	1.10
SPW-1994	5/24/2018	H-3	16,488 ± 384	16,507	13,206 - 19,808	Pass	1.00
W-053118	4/29/2016	Cs-134	38.9 ± 9.5	36.2	29.0 - 43.4	Pass	1.07
W-053118	4/29/2016	Cs-137	74.0 ± 7.5	71.9	57.5 - 86.3	Pass	1.03
SPW-2042	5/31/2018	H-3	16,901 ± 390	16,507	13,206 - 19,808	Pass	1.02
W-060518	4/29/2016	Cs-134	33.0 ± 10.1	36.2	29.0 - 43.4	Pass	0.91
W-060518	4/29/2016	Cs-137	83.3 ± 8.7	71.9	57.5 - 86.3	Pass	1.16
SPW-2186	6/6/2018	H-3	16,551 ± 385	16,507	13,206 - 19,808	Pass	1.00
SPW-2914	6/19/2018	Ra-226	12.7 ± 0.4	12.3	8.6 - 16.0	Pass	1.03
SPW-2437	6/27/2018	Sr-90	18.0 ± 1.1	17.9	14.3 - 21.5	Pass	1.00
SPW-2447	6/29/2018	H-3	16,595 ± 387	16,507	13,206 - 19,808	Pass	1.01
W-070518	4/29/2016	Cs-134	38.9 ± 8.1	36.2	29.0 - 43.4	Pass	1.08
W-070518	4/29/2016	Cs-137	73.4 ± 9.4	71.9	57.5 - 86.3	Pass	1.02
SPW-2546	7/10/2018	H-3	15,949 ± 373	16,507	13,206 - 19,808	Pass	0.97
W-071218	4/29/2016	Cs-134	33.1 ± 7.7	36.2	29.0 - 43.4	Pass	0.91
W-071218	4/29/2016	Cs-137	74.5 ± 7.7	71.9	57.5 - 86.3	Pass	1.04
SPW-2706	7/16/2018	H-3	15,474.7 ± 366.6	16,507	13,206 - 19,808	Pass	0.94
SPW-2772	7/19/2018	H-3	15,994.0 ± 374.0	16,507	13,206 - 19,808	Pass	0.97
SPW-2811	7/20/2018	Gr. Alpha	21.1 ± 0.4	20.1	10.1 - 30.2	Pass	1.05
SPW-2811	7/20/2018	Gr. Beta	26.9 ± 0.3	27.5	22.0 - 33.0	Pass	0.98
W-072118	4/29/2016	Cs-134	33.6 ± 7.3	36.2	29.0 - 43.4	Pass	0.93
W-072118	4/29/2016	Cs-137	80.3 ± 7.9	71.9	57.5 - 86.3	Pass	1.12
SPW-3689	7/23/2018	Ra-226	12.7 ± 0.3	12.3	8.6 - 16.0	Pass	1.03
W-072718	2/1/2017	U-234	26.8 ± 3.4	31.4	22.0 - 40.8	Pass	0.85
W-072718	2/1/2017	U-238	24.1 ± 3.2	32.4	22.7 - 42.1	Pass	0.74
SPW-3018	7/31/2018	H-3	16,166 ± 376	16,507	13,206 - 19,808	Pass	0.98
SPW-3154	8/6/2018	H-3	15,686 ± 370	16,507	13,206 - 19,808	Pass	0.95
W-081218	4/29/2016	Cs-134	38.6 ± 11.5	36.2	29.0 - 43.4	Pass	1.07
W-081218	4/29/2016	Cs-137	83.7 ± 13.4	71.9	57.5 - 86.3	Pass	1.16

TABLE A-3. 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-3278	8/16/2018	H-3	15,587 ± 370	16,507	13,206 - 19,808	Pass	0.94
SPW-3378	8/23/2018	Ni-63	378 ± 44	465	325 - 604	Pass	0.81
SPW-3420	8/23/2018	H-3	15,536 ± 368	16,507	13,206 - 19,808	Pass	0.94
SPW-3691	8/23/2018	Ra-226	15.5 ± 0.4	12.3	8.6 - 16.0	Pass	1.26
SPW-3477	8/27/2018	Ra-228	11.3 ± 1.6	15.1	10.6 - 19.7	Pass	0.75
W-082818	4/29/2016	Cs-134	33.0 ± 2.7	36.2	29.0 - 43.4	Pass	0.91
W-082818	4/29/2016	Cs-137	80.7 ± 3.0	71.9	57.5 - 86.3	Pass	1.12
SPW-3648	9/7/2018	H-3	15,876 ± 371	16,507	13,206 - 19,808	Pass	0.96
SPW-4755	9/7/2018	Ra-226	11.2 ± 0.3	12.3	8.6 - 16.0	Pass	0.91
W-091118	4/29/2016	Cs-134	35.3 ± 2.7	36.2	29.0 - 43.4	Pass	0.98
W-091118	4/29/2016	Cs-137	80.7 ± 3.2	71.9	57.5 - 86.3	Pass	1.12
SPW-3843	9/19/2018	H-3	15,759 ± 372	16,507	13,206 - 19,808	Pass	0.95
W-092818	4/29/2016	Cs-134	36.1 ± 10.0	36.2	29.0 - 43.4	Pass	1.00
W-092818	4/29/2016	Cs-137	73.6 ± 9.9	71.9	57.5 - 86.3	Pass	1.02
SPW-3991	10/1/2018	H-3	15,614 ± 369	16,507	13,206 - 19,808	Pass	0.95
SPW-4105	10/5/2018	H-3	15,669 ± 370	16,507	13,206 - 19,808	Pass	0.95
W-101118	4/29/2016	Cs-134	33.5 ± 3.1	36.2	29.0 - 43.4	Pass	0.92
W-101118	4/29/2016	Cs-137	79.7 ± 3.2	71.9	57.5 - 86.3	Pass	1.11
SPW-4205	10/12/2018	H-3	15,821 ± 372	16,507	13,206 - 19,808	Pass	0.96
SPW-4274	10/17/2018	H-3	15,575 ± 369	16,507	13,206 - 19,808	Pass	0.94
SPW-4596	10/31/2018	H-3	15,650 ± 369	16,507	13,206 - 19,808	Pass	0.95
SPW-4682	11/1/2018	H-3	15,742 ± 371	16,507	13,206 - 19,808	Pass	0.95
SPW-4684	11/1/2018	Sr-90	19.1 ± 1.2	17.9	14.3 - 21.5	Pass	1.07
SPW-4790	11/9/2018	H-3	15,887 ± 373	16,507	13,206 - 19,808	Pass	0.96
SPW-4839	11/13/2018	Ni-63	381 ± 43	465	326 - 605	Pass	0.82
SPW-4863	11/16/2018	H-3	15,610 ± 370	16,507	13,206 - 19,808	Pass	0.95
W-111618	4/29/2016	Cs-134	38.0 ± 12.4	36.2	29.0 - 43.4	Pass	1.05
W-111618	4/29/2016	Cs-137	83.8 ± 13.8	71.9	57.5 - 86.3	Pass	1.17
SPW-5049	11/30/2018	H-3	15,370 ± 366	16,507	13,206 - 19,808	Pass	0.93
SPW-5148	12/7/2018	H-3	15,522 ± 368	16,507	13,206 - 19,808	Pass	0.94
W-121118	4/29/2016	Cs-134	39.4 ± 7.9	36.2	29.0 - 43.4	Pass	1.09
W-121118	4/29/2016	Cs-137	78.5 ± 7.7	71.9	57.5 - 86.3	Pass	1.09
W-121218	4/29/2016	Cs-134	42.0 ± 13.8	36.2	29.0 - 43.4	Pass	1.16
W-121218	4/29/2016	Cs-137	79.2 ± 13.1	71.9	57.5 - 86.3	Pass	1.10
W-121318	4/29/2016	Cs-134	35.1 ± 7.8	36.2	29.0 - 43.4	Pass	0.97
W-121318	4/29/2016	Cs-137	77.5 ± 8.4	71.9	57.5 - 86.3	Pass	1.08
SPW-5279	12/14/2018	H-3	15,686 ± 370	16,507	13,206 - 19,808	Pass	0.95
W-121418	4/29/2016	Cs-134	34.5 ± 8.2	36.2	29.0 - 43.4	Pass	0.95
W-121418	4/29/2016	Cs-137	82.7 ± 8.0	71.9	57.5 - 86.3	Pass	1.15
W-121718	4/29/2016	Cs-134	34.9 ± 10.5	36.2	29.0 - 43.4	Pass	0.96
W-121718	4/29/2016	Cs-137	80.3 ± 8.1	71.9	57.5 - 86.3	Pass	1.12
SPW-5351	12/19/2018	H-3	15,855 ± 375	16,507	13,206 - 19,808	Pass	0.96
SPW-5404	12/31/2018	H-3	15,179 ± 365	16,507	13,206 - 19,808	Pass	0.92

[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.

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

TABLE A-4. 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-94	Water	1/11/2018	H-3	154	1 ± 74	200
SPW-108	Water	1/12/2018	Sr-89	0.63	0.41 ± 0.53	5
SPW-108	Water	1/12/2018	Sr-90	0.55	0.05 ± 0.26	1
SPW-174	Water	1/19/2018	H-3	152	23 ± 73	200
SPW-209	Water	1/23/2018	H-3	154	78 ± 78	200
SPW-211	Water	1/10/2018	Ra-226	0.03	0.19 ± 0.03	2
SPW-213	Water	1/23/2018	I-131	0.23	-0.05 ± 0.13	1
SPW-271	Water	1/30/2018	H-3	156	- 36 ± 77	200
SPW-329	Water	2/1/2018	Ni-63	74	-13 ± 45	200
SPW-337	Water	2/2/2018	H-3	154	-16 ± 71	200
SPW-385	Water	2/6/2018	H-3	150	-19 ± 71	200
SPW-461	Water	2/13/2018	H-3	156	56 ± 80	200
SPW-515	Water	2/19/2018	H-3	153	-1 ± 80	200
SPW-555	Water	2/8/2018	Ra-226	0.04	0.14 ± 0.03	2
SPW-581	Water	2/22/2018	H-3	156	43 ± 77	200
SPW-608	Water	2/23/2018	H-3	151	58 ± 75	200
SPW-649	Water	2/21/2018	Ra-226	0.04	0.17 ± 0.03	2
SPW-665	Water	2/28/2018	Gr. Alpha	0.43	0.70 ± 0.36	2
SPW-665	Water	2/28/2018	Gr. Beta	0.68	0.86 ± 0.51	4
SPW-747	Water	3/6/2018	H-3	154	11 ± 82	200
SPW-786	Water	3/8/2018	H-3	156	62 ± 76	200
SPW-865	Water	3/14/2018	I-131	0.18	0.07 ± 0.10	1
SPW-930	Water	3/20/2018	H-3	155	44 ± 84	200
SPW-956	Water	3/12/2018	Ra-226	0.03	0.18 ± 0.03	2
SPW-984	Water	3/27/2018	H-3	153	32 ± 82	200
SPW-1036	Water	4/4/2018	H-3	162	14 ± 77	200
SPW-1148	Water	4/12/2018	H-3	159	-15 ± 73	200
SPW-1202	Water	4/13/2018	U-234	0.15	0.00 ± 0.09	1
SPW-1202	Water	4/13/2018	U-238	0.15	0.06 ± 0.13	1
SPW-1425	Water	4/20/2018	H-3	159	45 ± 98	200
SPW-1453	Water	4/24/2018	H-3	155	43 ± 77	200
SPW-1492	Water	4/26/2018	Ra-228	0.68	0.25 ± 0.35	2
SPW-1517	Water	4/27/2018	H-3	150	54 ± 75	200
SPW-1521	Water	4/27/2018	Tc-99	5.38	2.64 ± 3.31	10
SPW-1572	Water	5/2/2018	Gr. Alpha	0.41	-0.23 ± 0.26	2
SPW-1572	Water	5/2/2018	Gr. Beta	0.69	-0.28 ± 0.47	4
SPW-1617	Water	5/3/2018	H-3	155	-113 ± 68	200
SPW-1643	Water	5/4/2018	Sr-89	0.66	0.36 ± 0.50	5
SPW-1643	Water	5/4/2018	Sr-90	0.57	-0.07 ± 0.25	1

[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-4. 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-1694	Water	5/8/2018	H-3	157	86 ± 80	200
SPW-1779	Water	5/11/2018	H-3	156	11 ± 74	200
SPW-1895	Water	5/17/2018	I-131	0.12	0.00 ± 0.08	1
SPW-1896	Water	5/18/2018	H-3	155	46 ± 75	200
SPW-1898	Water	5/18/2018	H-3	186	2 ± 92	200
SPW-1993	Water	5/24/2018	H-3	158	103 ± 79	200
SPW-2041	Water	5/31/2018	H-3	156	115 ± 81	200
SPW-2185	Water	6/6/2018	H-3	150	29 ± 74	200
SPW-2383	Water	6/6/2018	Ra-226	0.03	0.20 ± 0.02	2
SPW-2264	Water	6/11/2018	Gr. Alpha	0.39	-0.02 ± 0.27	2
SPW-2264	Water	6/11/2018	Gr. Beta	0.73	-0.35 ± 0.50	4
SPW-2913	Water	6/19/2018	Ra-226	0.02	0.18 ± 0.02	2
SPW-2436	Water	6/27/2018	Sr-89	0.66	0.00 ± 0.46	5
SPW-2436	Water	6/27/2018	Sr-90	0.61	-0.10 ± 0.27	1
SPW-2447	Water	6/29/2018	H-3	160	-6 ± 79	200
SPW-2545	Water	7/10/2018	H-3	154	20 ± 74	200
SPW-2705	Water	7/16/2018	H-3	153	15 ± 73	200
SPW-2771	Water	7/19/2018	H-3	156	-27 ± 71	200
SPW-2810	Water	7/20/2018	Gr. Alpha	0.42	-0.09 ± 0.29	2
SPW-2810	Water	7/20/2018	Gr. Beta	0.70	0.31 ± 0.50	4
SPW-3688	Water	7/23/2018	Ra-226	0.02	0.21 ± 0.02	2
SPW-3017	Water	7/31/2018	H-3	157	-5 ± 74	200
SPW-3153	Water	8/6/2018	H-3	152	13 ± 72	200
SPW-3377	Water	8/23/2018	Ni-63	66	18 ± 40	200
SPW-3446	Water	8/27/2018	H-3	151	-15 ± 69	200
SPW-3476	Water	8/27/2018	Ra-228	0.77	0.05 ± 0.36	2
SPW-3648	Water	9/7/2018	H-3	148	89 ± 75	200
SPW-4754	Water	9/7/2018	Ra-226	0.03	0.13 ± 0.08	2
SPW-3842	Water	9/19/2018	H-3	156	29 ± 74	200
SPW-3990	Water	10/1/2018	H-3	153	-6 ± 71	200
SPW-4105	Water	10/5/2018	H-3	150	7 ± 71	200
SPW-4565	Water	10/11/2018	Ra-228	0.86	-0.26 ± 0.36	2
SPW-4205	Water	10/12/2018	H-3	154	-9 ± 71	200
SPW-4273	Water	10/17/2018	H-3	153	67 ± 76	200
SPW-4595	Water	10/30/2018	H-3	150	75 ± 74	200
SPW-4681	Water	11/1/2018	H-3	152	19 ± 72	200
SPW-4789	Water	11/9/2018	H-3	148	27 ± 73	200
SPW-4862	Water	11/16/2018	H-3	154	15 ± 77	200
SPW-5048	Water	11/30/2018	H-3	151	-6 ± 69	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-4. 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-4681	Water	11/1/2018	H-3	152	19 ± 72	200
SPW-4683	Water	11/1/2018	Sr-89	0.64	0.25 ± 0.45	5
SPW-4683	Water	11/1/2018	Sr-90	0.51	-0.10 ± 0.22	1
SPW-4799	Water	11/9/2018	I-131	0.43	-0.01 ± 0.20	1
SPW-4838	Water	11/13/2018	Ni-63	62	34 ± 38	200
SPW-5028	Water	11/19/2018	Ra-226	0.04	-0.14 ± 0.03	2
SPW-5028	Water	11/19/2018	Ra-228	0.96	-0.11 ± 0.43	2
SPW-5147	Water	12/7/2018	H-3	151	14 ± 71	200
SPW-5278	Water	12/14/2018	H-3	153	83 ± 76	200
SPW-5350	Water	12/19/2018	H-3	153	71 ± 75	200
SPW-5403	Water	12/31/2018	H-3	156	51 ± 75	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-5. In-House "Duplicate" Samples

			Concentration[a]			
Lab Code[b]	Date	Analysis	First Result	Second Result	Averaged Result	Acceptance
AP-010218	1/2/2018	Gr. Beta	0.048 ± 0.004	0.057 ± 0.004	0.052 ± 0.003	Pass
AP-010218	1/2/2018	Be-7	0.073 ± 0.008	0.073 ± 0.007	0.073 ± 0.005	Pass
AP-010318	1/3/2018	Gr. Beta	0.039 ± 0.005	0.034 ± 0.005	0.037 ± 0.003	Pass
AP-6846,6847	1/3/2018	Be-7	0.058 ± 0.010	0.062 ± 0.010	0.060 ± 0.007	Pass
AP-010318	1/3/2018	Be-7	0.059 ± 0.009	0.059 ± 0.007	0.059 ± 0.006	Pass
AP-010818	1/8/2018	Gr. Beta	0.053 ± 0.007	0.055 ± 0.007	0.054 ± 0.005	Pass
WW-164,165	1/11/2018	Gr. Beta	21.9 ± 2.2	20.4 ± 2.1	21.1 ± 1.5	Pass
WW-189,190	1/11/2018	H-3	501 ± 100	498 ± 100	499 ± 71	Pass
AP-011518	1/15/2018	Gr. Beta	0.032 ± 0.005	0.033 ± 0.005	0.032 ± 0.003	Pass
AP-012318	1/23/2018	Gr. Beta	0.031 ± 0.005	0.032 ± 0.005	0.031 ± 0.003	Pass
LW-280,281	1/25/2018	Gr. Beta	1.10 ± 0.52	1.19 ± 0.55	1.15 ± 0.38	Pass
AP-013018	1/30/2018	Gr. Beta	0.024 ± 0.005	0.023 ± 0.005	0.024 ± 0.003	Pass
SG-301,302	1/30/2018	Ac-228	3.01 ± 0.49	3.11 ± 0.71	3.06 ± 0.43	Pass
SG-301,302	1/30/2018	Pb-214	2.47 ± 0.31	2.22 ± 0.35	2.34 ± 0.23	Pass
SG-301,302	1/30/2018	K-40	7.44 ± 1.93	6.52 ± 2.25	6.98 ± 1.48	Pass
SWU-322,323	1/30/2018	Gr. Beta	1.48 ± 1.10	3.06 ± 1.31	2.27 ± 0.85	Pass
P-391,392	2/2/2018	H-3	428 ± 94	332 ± 89	380 ± 65	Pass
S-433,434	2/7/2018	Pb-214	0.16 ± 0.04	0.13 ± 0.05	0.15 ± 0.03	Pass
S-433,434	2/7/2018	Ac-228	0.24 ± 0.06	0.26 ± 0.07	0.25 ± 0.05	Pass
S-433,434	2/7/2018	K-40	6.45 ± 0.58	6.50 ± 0.59	6.48 ± 0.41	Pass
AP-454,455	2/8/2018	Be-7	0.233 ± 0.102	0.271 ± 0.111	0.252 ± 0.075	Pass
AP-021218	2/12/2018	Gr. Beta	0.037 ± 0.005	0.035 ± 0.005	0.036 ± 0.004	Pass
CF-477,478	2/12/2018	Be-7	0.31 ± 0.17	0.21 ± 0.08	0.26 ± 0.09	Pass
AP-021918	2/19/2018	Gr. Beta	0.036 ± 0.005	0.033 ± 0.008	0.035 ± 0.005	Pass
AP-022118	2/21/2018	Gr. Beta	0.030 ± 0.003	0.025 ± 0.003	0.028 ± 0.002	Pass
SWU-704,705	2/27/2018	Gr. Beta	2.50 ± 0.65	1.72 ± 0.58	2.11 ± 0.44	Pass
W-849,850	2/28/2018	H-3	567 ± 105	730 ± 112	649 ± 77	Pass
AP-030518	3/5/2018	Gr. Beta	0.024 ± 0.005	0.025 ± 0.005	0.024 ± 0.004	Pass
DW-90026,90027	3/7/2018	Gr. Alpha	55.4 ± 2.5	60.3 ± 2.6	57.8 ± 1.8	Pass
DW-90026,90027	3/7/2018	Gr. Beta	28.0 ± 1.2	27.4 ± 1.2	27.7 ± 0.8	Pass
S-800,801	3/8/2018	Ra-226	1.06 ± 0.15	1.17 ± 0.17	1.12 ± 0.11	Pass
S-800,801	3/8/2018	Ra-228	1.08 ± 0.19	1.05 ± 0.20	1.07 ± 0.14	Pass
S-800,801	3/8/2018	K-40	15.5 ± 1.3	15.7 ± 1.4	15.6 ± 0.9	Pass
SG-863,864	3/8/2018	Ra-226	5.56 ± 0.28	5.92 ± 0.27	5.74 ± 0.19	Pass
SG-863,864	3/8/2018	Ra-228	7.77 ± 0.44	8.19 ± 0.53	7.98 ± 0.34	Pass
SG-863,864	3/8/2018	K-40	10.75 ± 1.29	12.28 ± 1.39	11.52 ± 0.95	Pass
WW-842,843	3/9/2018	H-3	415 ± 99	423 ± 99	419 ± 70	Pass
AP-030918	3/9/2018	Gr. Beta	0.027 ± 0.004	0.021 ± 0.004	0.024 ± 0.003	Pass
AP-031318	3/13/2018	Gr. Beta	0.030 ± 0.004	0.031 ± 0.004	0.031 ± 0.003	Pass
AP-031318	3/13/2018	Gr. Beta	0.026 ± 0.005	0.024 ± 0.005	0.025 ± 0.003	Pass
WW-934,935	3/13/2018	H-3	266 ± 95	294 ± 96	280 ± 68	Pass
S-972,973	3/20/2018	K-40	23.1 ± 3.3	19.8 ± 2.5	21.4 ± 2.1	Pass

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

			Concentration[a]			
Lab Code[b]	Date	Analysis	First Result	Second Result	Averaged Result	Acceptance
AP-032018	3/20/2018	Gr. Beta	0.021 ± 0.005	0.023 ± 0.005	0.022 ± 0.004	Pass
WW-1016,1017	3/22/2018	H-3	716 ± 110	790 ± 113	753 ± 79	Pass
SW-995,996	3/26/2018	H-3	14,538 ± 364	14,647 ± 365	14,593 ± 258	Pass
WW-1900,1901	3/30/2018	H-3	863 ± 123	865 ± 123	864 ± 87	Pass
AP-1299,1300	4/3/2018	Be-7	0.075 ± 0.017	0.073 ± 0.014	0.074 ± 0.011	Pass
SG-1470,1471	4/3/2018	Pb-214	1.45 ± 0.14	1.39 ± 0.12	1.42 ± 0.09	Pass
SG-1470,1471	4/3/2018	Ac-228	2.39 ± 0.31	2.55 ± 0.31	2.47 ± 0.22	Pass
WW-1123,1124	4/5/2018	H-3	11,266 ± 319	11,175 ± 320	11,220 ± 226	Pass
DW-90035,90036	4/6/2018	Ra-226	1.04 ± 0.13	0.88 ± 0.14	0.96 ± 0.10	Pass
DW-90035,90036	4/6/2018	Ra-228	0.84 ± 0.13	1.08 ± 0.42	0.96 ± 0.22	Pass
AP-041018	4/10/2018	Gr. Beta	0.023 ± 0.004	0.019 ± 0.004	0.021 ± 0.003	Pass
SS-1611,1612	4/18/2018	K-40	10.01 ± 0.54	8.93 ± 0.56	9.47 ± 0.39	Pass
SW-1427,1428	4/18/2018	H-3	180 ± 84	114 ± 81	147 ± 58	Pass
WW-1494,1495	4/20/2018	H-3	326 ± 84	270 ± 89	298 ± 61	Pass
AP-042518	4/25/2018	Gr. Beta	0.028 ± 0.004	0.023 ± 0.004	0.026 ± 0.003	Pass
SO-1634,1635	4/25/2018	K-40	5.72 ± 0.51	6.36 ± 0.56	6.04 ± 0.38	Pass
BS-1546,1547	4/26/2018	K-40	8.35 ± 0.53	8.54 ± 0.57	8.44 ± 0.39	Pass
AP-042618	4/26/2018	Gr. Beta	0.023 ± 0.004	0.021 ± 0.004	0.022 ± 0.003	Pass
DW-90043,90044	4/27/2018	Gr. Alpha	11.9 ± 1.1	11.3 ± 1.1	11.6 ± 0.8	Pass
AP-050118	5/1/2018	Gr. Beta	0.020 ± 0.006	0.022 ± 0.006	0.021 ± 0.004	Pass
AP-050218	5/2/2018	Gr. Beta	0.020 ± 0.002	0.019 ± 0.002	0.020 ± 0.002	Pass
F-2333,2334	5/2/2018	Cs-137	2.53 ± 0.34	2.51 ± 0.32	2.52 ± 0.24	Pass
DW-90048,90049	5/2/2018	Ra-226	0.18 ± 0.11	0.14 ± 0.08	0.16 ± 0.07	Pass
DW-90048,90049	5/2/2018	Ra-228	0.86 ± 0.60	0.78 ± 0.60	0.82 ± 0.42	Pass
WW-1833,1834	5/8/2018	H-3	182 ± 83	304 ± 98	243 ± 64	Pass
SG-1747,1748	5/8/2018	Pb-214	13.0 ± 0.6	13.0 ± 0.6	13.0 ± 0.4	Pass
SG-1747,1748	5/8/2018	Ac-228	21.0 ± 1.2	21.1 ± 1.4	21.0 ± 0.9	Pass
AP-050818	5/8/2018	Gr. Beta	0.027 ± 0.005	0.025 ± 0.004	0.026 ± 0.003	Pass
F-1812,1813	5/9/2018	K-40	4.30 ± 0.47	3.40 ± 0.47	3.85 ± 0.33	Pass
SG-1767,1768	5/9/2018	Pb-214	0.96 ± 0.24	0.72 ± 0.24	0.84 ± 0.17	Pass
SG-1767,1768	5/9/2018	Ac-228	1.28 ± 0.34	1.15 ± 0.37	1.22 ± 0.25	Pass
AP-051418	5/14/2018	Gr. Beta	0.038 ± 0.006	0.033 ± 0.005	0.036 ± 0.004	Pass
DW-90061,90062	5/17/2018	Ra-226	1.53 ± 0.13	1.78 ± 0.15	1.66 ± 0.10	Pass
DW-90061,90062	5/17/2018	Ra-228	0.82 ± 0.45	0.87 ± 0.44	0.85 ± 0.31	Pass
F-2201,2202	5/18/2018	K-40	2.73 ± 0.40	2.68 ± 0.45	2.71 ± 0.30	Pass
AP-051818	5/18/2018	Gr. Beta	0.020 ± 0.004	0.026 ± 0.004	0.023 ± 0.003	Pass
WW-2050,2051	5/22/2018	H-3	28,404 ± 502	28,666 ± 504	28,535 ± 356	Pass
AP-052218	5/22/2018	Gr. Beta	0.024 ± 0.004	0.021 ± 0.004	0.023 ± 0.003	Pass
AP-052918	5/29/2018	Gr. Beta	0.028 ± 0.004	0.024 ± 0.004	0.026 ± 0.003	Pass
AP-052918	5/29/2018	Gr. Beta	0.023 ± 0.005	0.025 ± 0.005	0.024 ± 0.003	Pass

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

			Concentration[a]			
Lab Code[b]	Date	Analysis	First Result	Second Result	Averaged Result	Acceptance
G-2133,2134	6/4/2018	Be-7	0.55 ± 0.64	0.32 ± 0.16	0.43 ± 0.33	Pass
G-2133,2134	6/4/2018	K-40	7.12 ± 0.64	6.53 ± 0.58	6.82 ± 0.43	Pass
WW-2270,2271	6/8/2018	H-3	90 ± 84	71 ± 83	80 ± 59	Pass
VE-2312,2313	6/11/2018	K-40	6.06 ± 0.17	5.50 ± 0.46	5.78 ± 0.24	Pass
AP-2375,2376	6/14/2018	Be-7	0.310 ± 0.134	0.240 ± 0.100	0.275 ± 0.084	Pass
AP-2893,2894	6/27/2018	Be-7	0.111 ± 0.016	0.111 ± 0.016	0.111 ± 0.011	Pass
SG-24511,2512	7/2/2018	Gr. Alpha	19.60 ± 3.08	19.55 ± 3.06	19.58 ± 2.17	Pass
SG-2469,2470	7/2/2018	Pb-214	9.16 ± 0.48	9.46 ± 0.37	9.31 ± 0.30	Pass
SG-2469,2470	7/2/2018	Ac-228	9.94 ± 0.87	10.00 ± 0.64	9.97 ± 0.54	Pass
SG-2511,2512	7/2/2018	Pb-214	4.46 ± 0.31	4.57 ± 0.34	4.52 ± 0.23	Pass
SG-2511,2512	7/2/2018	Ac-228	6.15 ± 0.57	5.83 ± 0.66	5.99 ± 0.44	Pass
VE-2610,2611	7/9/2018	K-40	6.52 ± 0.75	5.92 ± 0.75	6.22 ± 0.53	Pass
F-2851,2852	7/11/2018	K-40	2.93 ± 0.38	2.83 ± 0.32	2.88 ± 0.25	Pass
AP-071218	7/12/2018	Gr. Beta	0.021 ± 0.003	0.024 ± 0.004	0.023 ± 0.002	Pass
AP-2721,2722	7/12/2018	Be-7	0.204 ± 0.100	0.275 ± 0.127	0.240 ± 0.081	Pass
WW-2742,2743	7/12/2018	H-3	253 ± 86	278 ± 97	265 ± 65	Pass
DW-90123,90124	7/24/2018	Ra-226	0.97 ± 0.18	1.06 ± 0.12	1.02 ± 0.11	Pass
DW-90123,90124	7/24/2018	Ra-228	3.61 ± 0.74	4.05 ± 0.80	3.83 ± 0.54	Pass
G-3000,3001	7/24/2018	Be-7	3.29 ± 0.25	3.24 ± 0.26	3.26 ± 0.18	Pass
G-3000,3001	7/24/2018	K-40	4.98 ± 0.40	5.06 ± 0.41	5.02 ± 0.29	Pass
S-2916,2917	7/24/2018	Pb-214	1.00 ± 0.51	0.94 ± 0.53	0.97 ± 0.37	Pass
S-2916,2917	7/24/2018	Ac-228	0.98 ± 0.11	0.98 ± 0.09	0.98 ± 0.07	Pass
AP-073018	7/30/2018	Gr. Beta	0.029 ± 0.004	0.022 ± 0.004	0.026 ± 0.003	Pass
DW-90133,90134	8/7/2018	Ra-228	2.34 ± 0.68	3.28 ± 0.73	2.81 ± 0.50	Pass
DW-90138,90139	8/10/2018	Gr. Alpha	4.02 ± 0.68	3.87 ± 0.66	3.95 ± 0.51	Pass
VE-3281,3282	8/14/2018	K-40	11.40 ± 0.831	11.39 ± 0.524	11.39 ± 0.491	Pass
VE-3323,3324	8/14/2018	K-40	3.41 ± 0.227	3.67 ± 0.262	3.54 ± 0.173	Pass
VE-3323,3324	8/14/2018	Be-7	0.25 ± 0.069	0.33 ± 0.092	0.29 ± 0.058	Pass
AP-081518	8/15/2018	Gr. Beta	0.022 ± 0.003	0.028 ± 0.003	0.025 ± 0.002	Pass
PM-3365,3366	8/16/2018	K-40	14.77 ± 0.76	14.19 ± 0.69	14.48 ± 0.51	Pass
S-3478,3479	8/27/2018	Pb-214	0.70 ± 0.05	0.70 ± 0.05	0.70 ± 0.04	Pass
S-3478,3479	8/27/2018	Ac-228	0.84 ± 0.11	0.89 ± 0.08	0.87 ± 0.07	Pass
SWT-3501,3502	8/27/2018	Gr. Beta	0.64 ± 0.48	1.42 ± 0.56	1.03 ± 0.37	Pass
VE-3522,3523	8/28/2018	K-40	2.51 ± 0.20	2.63 ± 0.20	2.57 ± 0.14	Pass
WW-3745,3746	8/31/2018	H-3	1035 ± 119	1056 ± 99	1045 ± 77	Pass
S-3542,3543	8/30/2018	K-40	6.10 ± 0.72	5.69 ± 0.63	5.90 ± 0.48	Pass
W-3703,3704	9/11/2018	Gr. Alpha	0.71 ± 0.80	1.03 ± 0.81	0.87 ± 0.57	Pass
W-3703,3704	9/11/2018	Gr. Beta	1.67 ± 1.08	0.53 ± 1.00	1.10 ± 0.74	Pass
SG-3796,3797	9/14/2018	Gr. Alpha	42.3 ± 3.6	50.9 ± 3.8	46.6 ± 2.6	Pass

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

			Concentration[a]			
Lab Code[b]	Date	Analysis	First Result	Second Result	Averaged Result	Acceptance
SG-3796,3797	9/14/2018	Gr. Beta	43.9 ± 1.9	44.1 ± 1.8	44.0 ± 1.3	Pass
SG-3796,3797	9/14/2018	Pb-214	10.4 ± 0.6	14.2 ± 0.5	12.3 ± 0.4	Pass
SG-3796,3797	9/14/2018	Ac-228	15.8 ± 1.2	15.7 ± 1.2	15.8 ± 0.8	Pass
DW-90173,90174	10/24/2018	Ra-226	1.13 ± 0.15	1.38 ± 0.17	1.26 ± 0.11	Pass
DW-90173,90174	10/24/2018	Ra-228	5.09 ± 0.84	6.59 ± 0.89	5.84 ± 0.61	Pass
SW-4782,4783	11/7/2018	H-3	192 ± 82	238 ± 84	215 ± 59	Pass
WW-4959,4960	11/13/2018	H-3	330 ± 88	286 ± 86	308 ± 61	Pass
SG-4850,4851	11/14/2018	Pb-214	15.0 ± 0.4	14.7 ± 0.4	14.9 ± 0.3	Pass
SG-4850,4851	11/14/2018	Ac-228	17.5 ± 0.7	16.7 ± 0.6	17.1 ± 0.5	Pass
VE-4917,4918	11/20/2018	K-40	4.54 ± 0.45	4.05 ± 0.46	4.30 ± 0.32	Pass
VE-4917,4918	11/20/2018	Be-7	9.42 ± 0.45	9.42 ± 0.46	9.42 ± 0.32	Pass
SG-5046,5047	11/21/2018	K-40	8.65 ± 1.18	9.12 ± 1.02	8.88 ± 0.78	Pass
SG-5046,5047	11/21/2018	Cs-137	0.18 ± 0.06	0.10 ± 0.05	0.14 ± 0.04	Pass
SG-5046,5047	11/21/2018	Gr. Alpha	22.8 ± 5.6	17.5 ± 4.8	20.2 ± 3.7	Pass
SG-5046,5047	11/21/2018	Gr. Beta	31.8 ± 3.5	26.8 ± 3.1	29.3 ± 2.4	Pass
SG-6286,6287	12/1/2018	Pb-214	11.3 ± 0.4	10.7 ± 0.5	11.0 ± 0.3	Pass
SG-6286,6287	12/1/2018	Ac-228	13.5 ± 0.9	13.2 ± 1.0	13.4 ± 0.7	Pass
SWU-5132,5133	12/4/2018	H-3	159 ± 82	204 ± 80	181 ± 57	Pass
SWU-5132,5133	12/4/2018	Gr. Beta	1.32 ± 0.56	1.33 ± 0.57	1.32 ± 0.40	Pass
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

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] Laboratory codes: AP (Air Particulate), BS (Bottom Sediment), CF (Cattle Feed), 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-6. 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
MASO-765	2/1/2018	Am-241	1.57 ± 4.46	0	NA [c]	Pass
MASO-765	2/1/2018	Cs-137	4.69 ± 2.59	4.6	NA [d]	Pass
MASO-765	2/1/2018	Co-57	886 ± 7	826	578 - 1074	Pass
MASO-765	2/1/2018	Co-60	579 ± 7	560	392 - 728	Pass
MASO-765	2/1/2018	Mn-54	1135 ± 15	1010	707 - 1313	Pass
MASO-765	2/1/2018	K-40	653 ± 47	577	404 - 750	Pass
MASO-765	2/1/2018	Zn-65	1096 ± 19	960	672 - 1248	Pass
MASO-765	2/1/2018	Pu-238	54.4 ± 5.6	45.2	31.6 - 58.8	Pass
MASO-765	2/1/2018	Pu-239/240	58.9 ± 5.6	50.8	35.6 - 66.0	Pass
MASO-765	2/1/2018	Sr-90	1.07 ± 1.15	0	NA [c]	Pass
MAAP-769	2/1/2018	Am-241	0.070 ± 0.021	0.067	0.047 - 0.087	Pass
MAAP-769	2/1/2018	Cs-134	0.55 ± 0.04	0.675	0.473 - 0.878	Pass
MAAP-769	2/1/2018	Cs-137	0.01 ± 0.01	0	NA [c]	Pass
MAAP-769	2/1/2018	Co-57	1.06 ± 0.04	1.18	0.83 - 1.53	Pass
MAAP-769	2/1/2018	Co-60	0.01 ± 0.01	0	NA [c]	Pass
MAAP-769	2/1/2018	Mn-54	1.01 ± 0.05	1.03	0.72 - 1.34	Pass
MAAP-769	2/1/2018	Zn-65	1.37 ± 0.11	1.33	0.93 - 1.73	Pass
MAAP-769	2/1/2018	Pu-238	0.042 ± 0.017	0.0445	0.0312 - 0.0579	Pass
MAAP-769	2/1/2018	Pu-239/240	-0.001 ± 0.006	0	NA [c]	Pass
MAAP-769	2/1/2018	Sr-90	1.12 ± 0.13	1.01	0.71 - 1.31	Pass
MAAP-769	2/1/2018	U-234/233	0.117 ± 0.023	0.124	0.087 - 0.161	Pass
MAAP-769	2/1/2018	U-238	0.126 ± 0.023	0.128	0.090 - 0.166	Pass
MAVE-767	2/1/2018	Cs-134	3.03 ± 0.10	3.23	2.26 - 4.20	Pass
MAVE-767	2/1/2018	Cs-137	3.86 ± 0.05	3.67	2.57 - 4.77	Pass
MAVE-767	2/1/2018	Co-57	4.86 ± 0.09	4.42	3.09 - 5.75	Pass
MAVE-767	2/1/2018	Co-60	2.24 ± 0.06	2.29	1.60 - 2.98	Pass
MAVE-767	2/1/2018	Mn-54	2.75 ± 0.08	2.66	1.86 - 3.46	Pass
MAVE-767	2/1/2018	Zn-65	0.02 ± 0.05	0	NA [c]	Pass
MAW-656	2/1/2018	I-129	1.66 ± 0.07	1.93	1.35 - 2.51	Pass
MAW-662	2/1/2018	Am-241	0.581 ± 0.050	0.709	0.496 - 0.922	Pass
MAW-662	2/1/2018	Cs-134	9.35 ± 0.38	10.2	7.1 - 13.3	Pass
MAW-662	2/1/2018	Cs-137	13.0 ± 0.2	12.2	8.5 - 15.9	Pass
MAW-662	2/1/2018	Co-57	0.003 ± 0.039	0	NA [c]	Pass
MAW-662	2/1/2018	Co-60	11.73 ± 0.19	11.5	8.1 - 15.0	Pass
MAW-662	2/1/2018	Mn-54	0.060 ± 0.019	0	NA [c]	Pass
MAW-662	2/1/2018	Zn-65	15.85 ± 0.27	14.3	10.0 - 18.6	Pass
MAW-662	2/1/2018	Fe-55	10.7 ± 11.7	11.1	7.80 - 14.40	Pass
MAW-662	2/1/2018	Ni-63[e]	11.0 ± 1.4	14.0	9.8 - 18.2	Warning
MAW-662	2/1/2018	Ni-63[e]	12.9 ± 1.7	14.0	9.8 - 18.2	Pass
MAW-662	2/1/2018	H-3	-0.3 ± 3.0	0	NA [c]	Pass
MAW-662	2/1/2018	Pu-238	0.02 ± 0.01	0.023	NA [d]	Pass
MAW-662	2/1/2018	Pu-239/240	0.585 ± 0.056	0.600	0.420 - 0.780	Pass
MAW-662	2/1/2018	Ra-226[f]	0.340 ± 0.040	0.257	0.180 - 0.334	Fail
MAW-662	2/1/2018	Ra-226[f]	0.297 ± 0.048	0.257	0.180 - 0.334	Pass

TABLE A-6. 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
MAW-662	2/1/2018	Sr-90	9.92 ± 0.75	11.4	8.0 - 14.8	Pass
MAW-662	2/1/2018	Tc-99	4.9 ± 0.4	4.37	3.06 - 5.68	Pass
MAW-662	2/1/2018	U-233/234	0.404 ± 0.041	0.430	0.301 - 0.559	Pass
MAW-662	2/1/2018	U-238	0.396 ± 0.041	0.437	0.306 - 0.568	Pass
MASO-3638	8/1/2018	Cs-134	688.7 ± 26.2	781	547 - 1015	Pass
MASO-3638	8/1/2018	Cs-137	605.9 ± 22.7	572	400 - 744	Pass
MASO-3638	8/1/2018	Co-57	976.7 ± 37.6	958	671 - 1245	Pass
MASO-3638	8/1/2018	Co-60	604.5 ± 24.9	608	426 - 790	Pass
MASO-3638	8/1/2018	Mn-54	5.2 ± 5.2	0	NA [c]	Pass
MASO-3638	8/1/2018	K-40	630 ± 31	566	396 - 736	Pass
MASO-3638	8/1/2018	Zn-65	556.4 ± 26.8	500	350 - 650	Pass
MAAP-3636	8/1/2018	Cs-134	0.37 ± 0.04	0.444	0.311 - 0.577	Pass
MAAP-3636	8/1/2018	Cs-137	0.34 ± 0.05	0.345	0.242 - 0.449	Pass
MAAP-3636	8/1/2018	Co-57	0.56 ± 0.04	0.592	0.414 - 0.770	Pass
MAAP-3636	8/1/2018	Co-60	0.28 ± 0.03	0.294	0.206 - 0.382	Pass
MAAP-3636	8/1/2018	Mn-54	0.26 ± 0.05	0.266	0.186 - 0.346	Pass
MAAP-3636	8/1/2018	Zn-65	0.22 ± 0.07	0.201	NA [d]	Pass
MAVE-3640	8/1/2018	Cs-134	1.87 ± 0.10	1.94	1.36 - 2.52	Pass
MAVE-3640	8/1/2018	Cs-137	2.69 ± 0.15	2.36	1.65 - 3.07	Pass
MAVE-3640	8/1/2018	Co-57	3.90 ± 0.12	3.31	2.32 - 4.30	Pass
MAVE-3640	8/1/2018	Co-60	1.76 ± 0.09	1.68	1.18 - 2.18	Pass
MAVE-3640	8/1/2018	Mn-54	2.91 ± 0.16	2.53	1.77 - 3.29	Pass
MAVE-3640	8/1/2018	Zn-65	1.53 ± 0.21	1.37	0.96 - 1.78	Pass
MAW-3480	8/1/2018	H-3	336.0 ± 10.7	338	237 - 439	Pass
MAW-3480	8/1/2018	Cs-134	7.86 ± 0.31	8.7	6.1 - 11.3	Pass
MAW-3480	8/1/2018	Cs-137	7.55 ± 0.33	6.9	4.8 - 9.0	Pass
MAW-3480	8/1/2018	Co-57	15.67 ± 0.36	14.9	10.4 - 19.4	Pass
MAW-3480	8/1/2018	Co-60	0.12 ± 0.12	0	NA [c]	Pass
MAW-3480	8/1/2018	Mn-54	13.38 ± 0.44	12.5	8.8 - 16.3	Pass
MAW-3480	8/1/2018	Zn-65	7.80 ± 0.53	7.53	5.27 - 9.79	Pass
MAW-3634	8/1/2018	I-129	1.32 ± 0.08	1.62	1.13 - 2.11	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] The lab was in the "warning zone" on this study(biased low). The sample was rerun applying an aggressive oxidation technique to remove a complexing agent that is utilized in the early steps of the procedure. Reanalysis was acceptable with this enhanced technique.

[f] An investigation was performed to determine reason for the failure of the Ra-226 result. A backup solution was reanalyzed with acceptable results. The current study as well as a past study were reanalyzed with acceptable results. No conclusion has been currently drawn from the results of this investigation.

TABLE A-7. Interlaboratory Comparison Crosscheck Program, Environmental Resource Associates (ERA)[a].

MRAD-28 Study

Lab Code [b]	Concentration [a]					
	Date	Analysis	Laboratory Result	ERA Result	Control Limits [c]	Acceptance
ERAP-942	3/19/2018	Am-241[d]	24.6	7.86	5.61 - 10.5	Fail
ERAP-942	3/19/2018	Am-241[d]	7.30	7.86	5.61 - 10.5	Pass
ERAP-942	3/19/2018	Cs-134	174	204	132 - 250	Pass
ERAP-942	3/19/2018	Cs-137	969	865	710 - 1130	Pass
ERAP-942	3/19/2018	Co-60	672	665	565 - 845	Pass
ERAP-942	3/19/2018	Fe-55	701	771	281 - 1230	Pass
ERAP-942	3/19/2018	Mn-54	< 50	< 50.0	0.00 - 50.0	Pass
ERAP-942	3/19/2018	Zn-65	594	668	548 - 1020	Pass
ERAP-942	3/19/2018	Pu-238	56.8	55.6	42.0 - 68.3	Pass
ERAP-942	3/19/2018	Pu-239	54.4	52.3	39.1 - 63.1	Pass
ERAP-942	3/19/2018	Sr-90	113	124	78.4 - 169	Pass
ERAP-942	3/19/2018	U-234	22.8	24.6	18.2 - 28.8	Pass
ERAP-942	3/19/2019	U-238	22.7	24.4	18.4 - 29.1	Pass
ERAP-944	3/19/2018	Gross Alpha	49.1	43.4	22.7 - 71.5	Pass
ERAP-944	3/19/2018	Gross Beta	44.8	52.0	31.5 - 78.6	Pass
ERSO-946	3/19/2018	Ac-228	1,480	1,240	818 - 1560	Pass
ERSO-946	3/19/2018	Am-241	48	74.7	40.3 - 106	Pass
ERSO-946	3/19/2018	Bi-212[e]	1,980	1,240	355 - 1,850	Fail
ERSO-946	3/19/2018	Bi-212[e]	1,285	1,240	355 - 1,850	Pass
ERSO-946	3/19/2018	Bi-214	2,180	1,760	845 - 2,620	Pass
ERSO-946	3/19/2018	Cs-134	5,230	5,330	3,640 - 6,370	Pass
ERSO-946	3/19/2018	Cs-137	4,820	4,210	3,180 - 5,320	Pass
ERSO-946	3/19/2018	Co-60	8,390	8,060	6,350 - 9,950	Pass
ERSO-946	3/19/2018	K-40[e]	14,100	10,600	7,300 - 12,700	Fail
ERSO-946	3/19/2018	K-40[e]	12,160	10,600	7,300 - 12,700	Pass
ERSO-946	3/19/2018	Mn-54	< 1000	< 1000	0 - 1,000	Pass
ERSO-946	3/19/2018	Pb-212	1,140	1,240	865 - 1,570	Pass
ERSO-946	3/19/2018	Pb-214	2,330	1,850	777 - 2910	Pass
ERSO-946	3/19/2018	Pu-238	1,830	1,470	733 - 2230	Pass
ERSO-946	3/19/2018	Pu-239	1,520	1,330	725 - 1910	Pass
ERSO-946	3/19/2018	Sr-90	3,500	4,500	1,400 - 7,010	Pass
ERSO-946	3/19/2018	Th-234	1,800	1,800	680 - 3,080	Pass
ERSO-946	3/19/2018	U-234	1,610	1,820	853 - 2,380	Pass
ERSO-946	3/19/2018	U-238	1,800	1,800	988 - 2,420	Pass
ERSO-946	3/19/2018	Zn-65	2,440	1,990	1,590 - 2,710	Pass
ERW-952	3/19/2018	Gr. Alpha	25.3	29.0	10.6 - 40.0	Pass
ERW-952	3/19/2018	Gr. Beta	61.3	73.1	36.6 - 101	Pass
ERW-954	3/19/2018	H-3	22,300	21,700	16,400 - 26,400	Pass

TABLE A-7. Interlaboratory Comparison Crosscheck Program, Environmental Resource Associates (ERA)[a].

MRAD-28 Study

Lab Code [b]	Concentration [a]					
	Date	Analysis	Laboratory Result	ERA Result	Control Limits [c]	Acceptance
ERVE-948	3/19/2018	Am-241	3,800	3,880	2,400 - 5,480	Pass
ERVE-948	3/19/2018	Cm-244	2,490	2,630	1,480 - 3,270	Pass
ERVE-948	3/19/2018	Co-60	579	491	385 - 642	Pass
ERVE-948	3/19/2018	Cs-134	2,090	1,950	1,290 - 2,600	Pass
ERVE-948	3/19/2018	Cs-137	2,640	2,160	1,660 - 2,910	Pass
ERVE-948	3/19/2018	K-40	34,000	30,900	23,200 - 39,100	Pass
ERVE-948	3/19/2018	Mn-54	< 300	< 300	0.00 - 300	Pass
ERVE-948	3/19/2018	Zn-65	3,080	2,400	1,790 - 3,560	Pass
ERVE-948	3/19/2018	Pu-238	2,400	2,020	1,400 - 2,600	Pass
ERVE-948	3/19/2018	Pu-239	5,140	4,160	2,880 - 5,270	Pass
ERVE-948	3/19/2018	Sr-90	3,570	3,330	1,880 - 4340	Pass
ERVE-948	3/19/2018	U-233/234	4,130	4,050	2,850 - 5,170	Pass
ERVE-948	3/19/2018	U-238	4,190	4,010	2,830 - 5,020	Pass
ERW-950	3/19/2018	Am-241	72.5	103	70.7 - 132	Pass
ERW-950	3/19/2018	Co-60	1,550	1,480	1,280 - 1,700	Pass
ERW-950	3/19/2018	Cs-134	1,280	1,330	1,000 - 1,460	Pass
ERW-950	3/19/2018	Cs-137	343	328	281 - 373	Pass
ERW-950	3/19/2018	Mn-54	< 100	< 100	0.00 - 100	Pass
ERW-950	3/19/2018	Pu-238	59.8	66.1	39.7 - 85.6	Pass
ERW-950	3/19/2018	Pu-239	84.8	91.8	56.8 - 113	Pass
ERW-950	3/19/2018	U-234	111	132	100 - 151	Pass
ERW-950	3/19/2018	U-238	113	131	102 - 154	Pass
ERW-950	3/19/2018	Zn-65	1,450	1,300	1160 - 1640	Pass
ERW-950	3/19/2018	Fe-55	533	445	261 - 647	Pass
ERW-950	3/19/2018	Sr-90	754	781	562 - 965	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 codes as follows: ERW (water), ERAP (air filter), ERSO (soil), ERVE (vegetation). Results are reported in units of pCi/L, except for air filters (pCi/Filter), vegetation and soil (pCi/kg).

[c] Results are presented as the known values, expected laboratory precision (2 sigma, 1 determination) and control limits as provided by ERA.

[d] Reported result was higher than ERA's upper acceptance limit. An investigation was initiated. The sample was run with a pre-treatment technique. Rerunning the analysis with this pre-treatment gave a result of 7.30 pCi/total. Going forward all samples for Am-241 will be analyzed utilizing this pre-treatment.

[e] The ERA results for Bi-212 and K-40 were outside the acceptable limits. The sample analysis was rerun utilizing a different library with acceptable results. The library used in the original analysis contained many more energies, than the second library used rendering a less reliable result for Bi-212. The K-40 value was overstated due to the use of a background spectrum analysis that had not fully quantified the K-40 present. Going forward a table has been created to track the historical results for the background subtraction for each HPGe detector so that any changes in background can be more easily identified.

ATI Environmental, Inc.
Midwest Laboratory
700 Landwehr Road • Northbrook, IL 60062-2310
phone (847) 564-0700 • fax (847) 564-4517

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.

ATI Environmental, Inc.
Midwest Laboratory
700 Landwehr Road • Northbrook, IL 60062-2310
phone (847) 564-0700 • fax (847) 564-4517

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

Sampling Location Maps

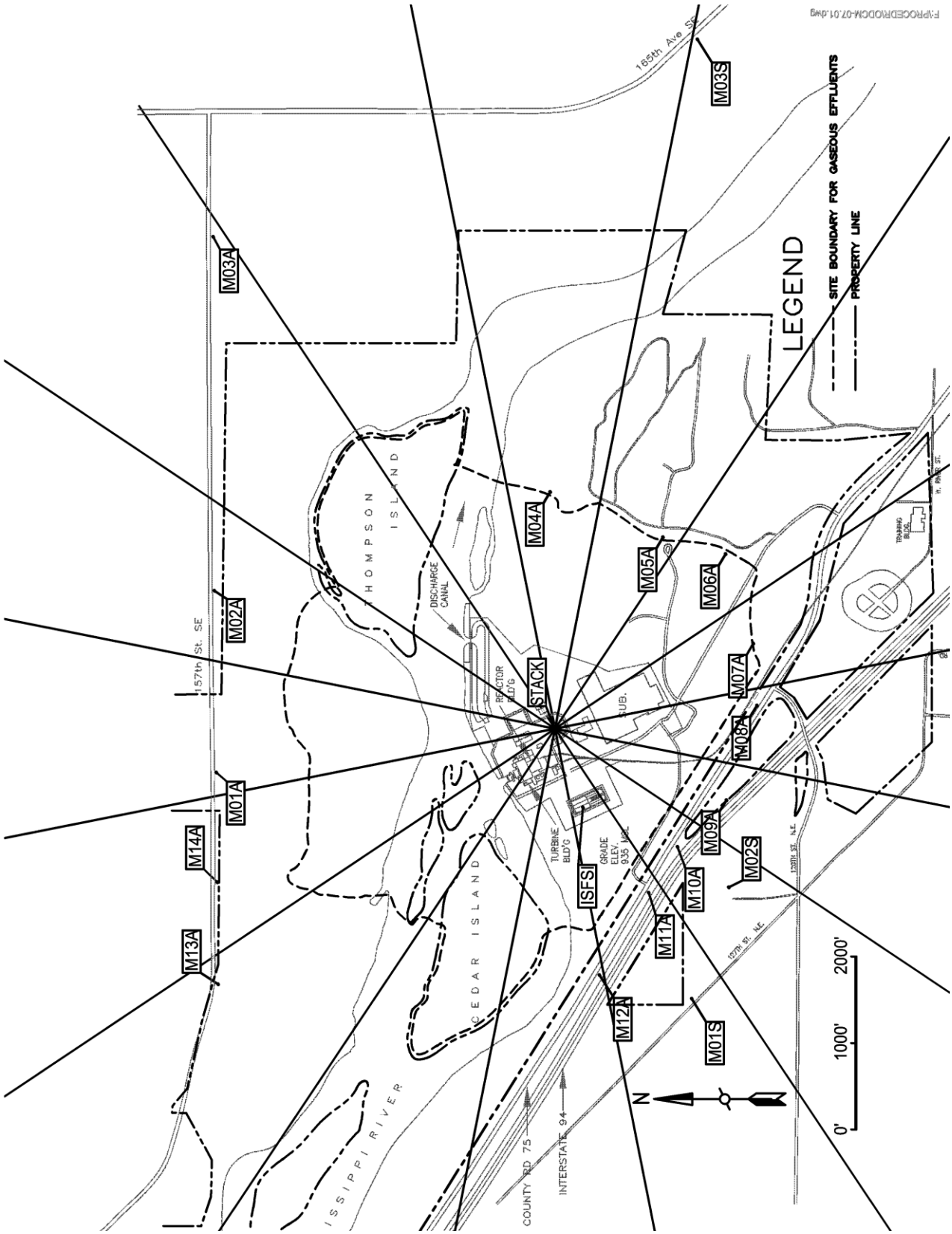

Figure D-1, Sample Collection and Analysis Program: TLD locations, Inner Ring (Table 5.2)

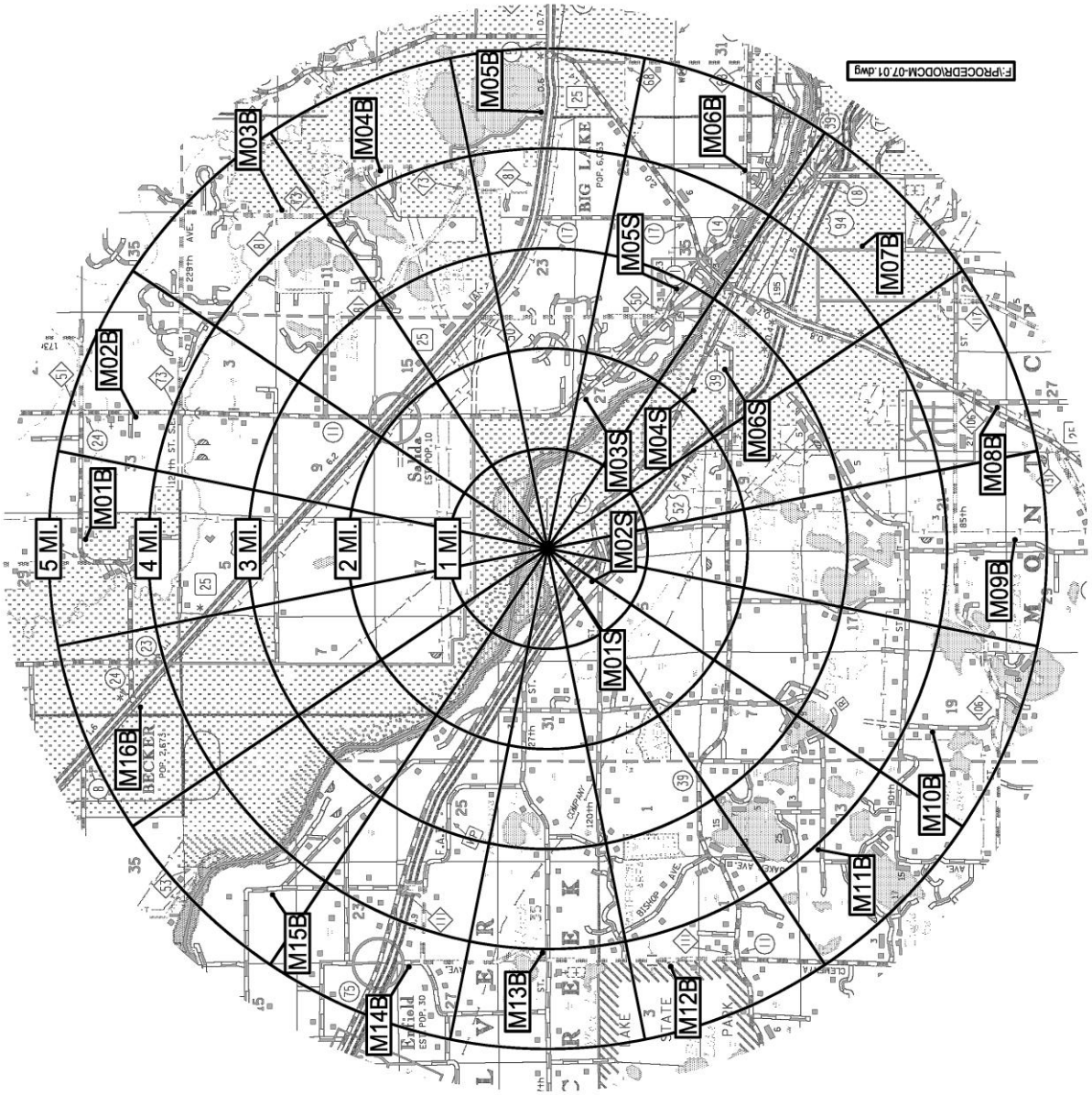

Figure D-2, Sample Collection and Analysis Program: TLD locations, Outer Ring. (Table 5.2)

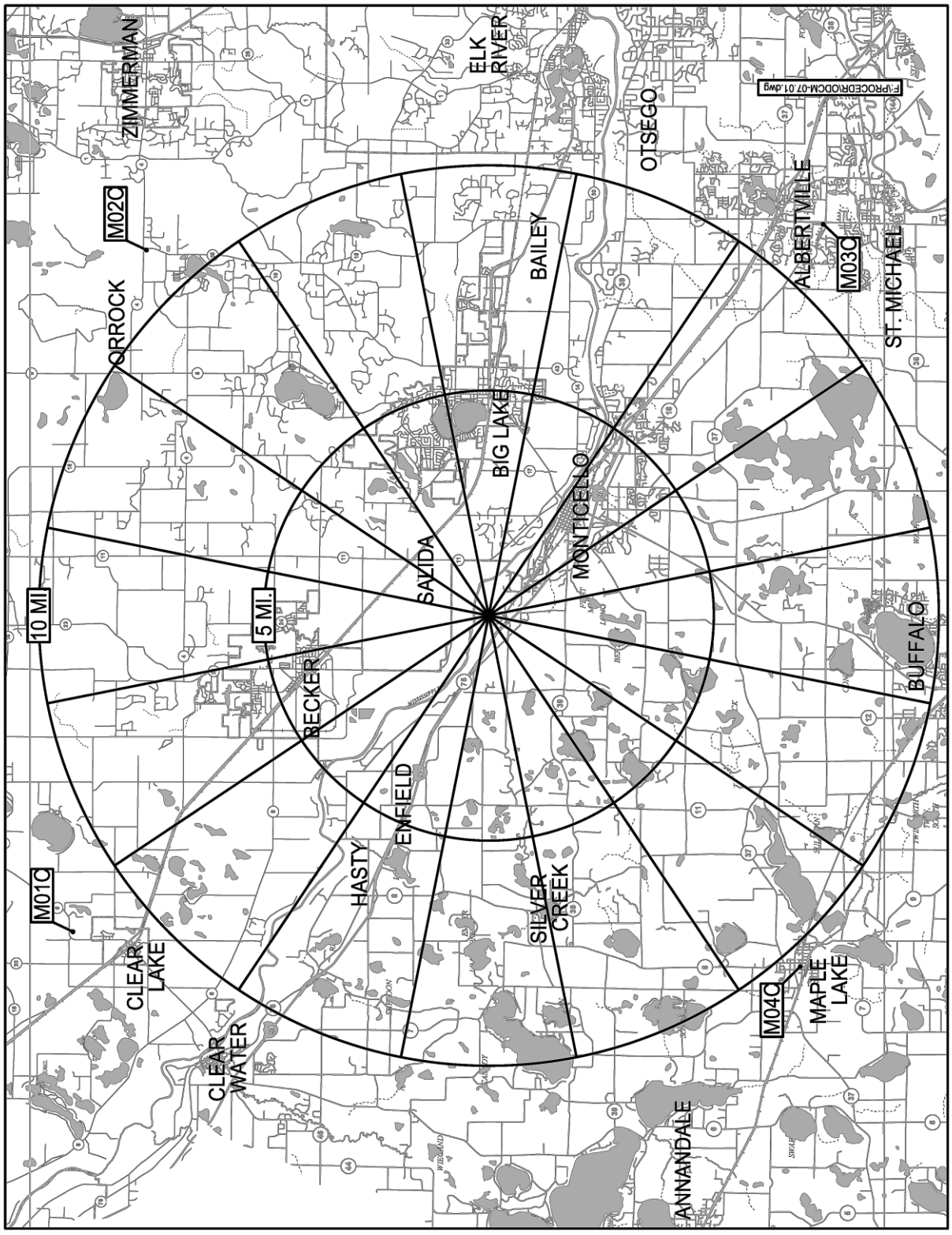

Figure D-3, Sample Collection and Analysis Program: TLD locations, Controls. (Table 5.2)

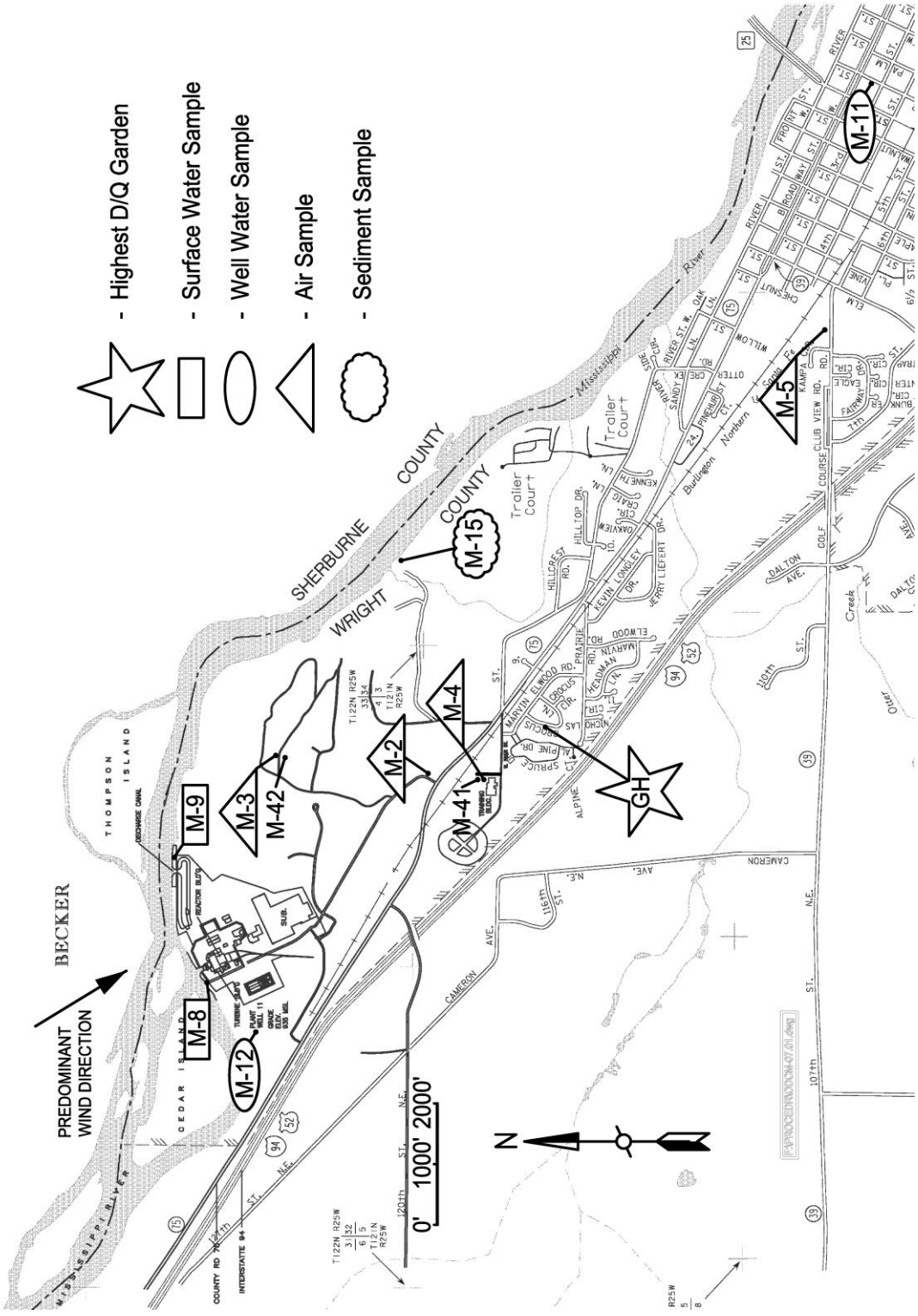

Figure D-4, Sample Collection and Analysis Program: Radiological Environmental Monitoring Program, Well Water and Shoreline sampling locations. (Table 5.2)

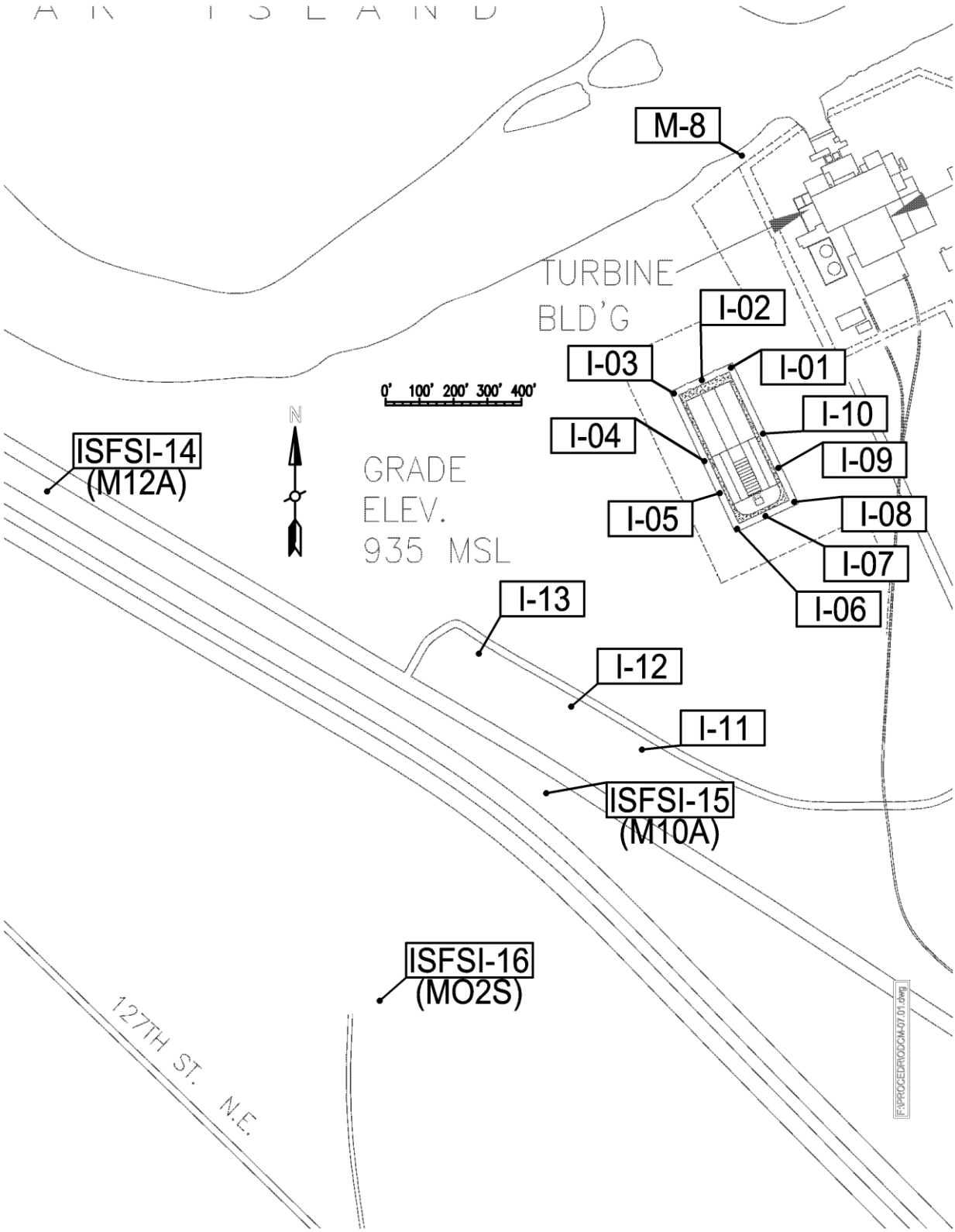

Figure D-5, Sample Collection and Analysis Program: TLD locations, ISFSI TLD locations. (Table 5.2)

ATI Environmental, Inc.
Midwest Laboratory
700 Landwehr Road • Northbrook, IL 60062-2310
phone (847) 564-0700 • fax (847) 564-4517

XCEL ENERGY CORPORATION

MONTICELLO NUCLEAR GENERATING PLANT
DOCKET No. 50-263 LICENSE No. DPR-22

2018 AREOR

Part 2: Complete Analysis Data Tables

January 1 to December 31, 2018

Prepared under contract by

ENVIRONMENTAL, INC
MIDWEST LABORATORY

PROJECT No. 8010

Reviewed and
Approved

Ashok Banavali, Ph.D.
Laboratory Manager

TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

The following constitutes the final 2018 report for the Environmental Radiological Monitoring Program conducted at the Monticello Nuclear Generating Plant in Monticello, Minnesota. Results of completed analyses are presented in the attached tables

All concentrations, except gross beta, are decay corrected to the time of collection

All samples were collected within the scheduled period unless noted otherwise in the Listing of Missed Samples

2.0 LISTING OF MISSED SAMPLES

All required samples were collected and analyzed as scheduled with the following exceptions:

Sample Type	Analysis	Location	Collection Date or Period	Reason for not conducting REMP as required	Plans for Preventing Recurrence
SW	Gamma	M-8	January '18	Water frozen entire month, no composite.	None
SW	Gamma	M-8	February '18	Water frozen entire month, no composite.	None
SW	Gamma	M-8	March '18	Water frozen entire month, no composite.	None
SW	Tritium	M-8	1st Qtr '18	Water frozen entire quarter, no composite.	None
AP/AI	Beta, I-131	M-2	4/18/2018	Only 12.3 hours run time indicated. Filter color was comparable to other filters. Could have been caused by either a temporary loss of power or a timer issue.	Tested pump and timer. Replaced filter.
SW	Gamma	M-8	April '18	Only one sample for month, 04-25-18. Water from other weeks was frozen. No composite.	None
AP/AI	Beta, I-131	M-2	6/06/2018-6/12/2018	Station lost power from the service drop. Sampler was restarted on 6/8/18 with temporary power.	Rerouted power drop.
AP/AI	Beta, I-131	M-2	6/20/2018	Pump running, no flow to the sampler. Loss of flow was found to be caused by a broken filter plug resulting in a loss of vacuum.	Replaced pump.
BO	Gamma	M-8, M-9	Spring 2018	Invertebrate samples collected late due to unsafe river conditions.	Reducing sampling frequency to annual.
TLD	Gamma	M-5S	2nd Qtr '18	TLD missing in field.	Searched area, reattached TLD holder to telephone pole.
SW	Gamma	M-8	November '18	November '18 composite included only sample from week of 11/07/2018.	None
TLD	Gamma	M-4B	4th Qtr 18	Sample missing during shipment. Could not be located by vendor or plant.	None. Cause of missing TLD could not be determined.
SW	Gamma	M-8	December '18	Water frozen entire month, no composite.	None
SW	Tritium	M-8	4th Qtr 18	The quarterly composite ends 11/07/18, water froze afterwards.	None

3.0 DATA TABLES

Table 1. Ambient gamma radiation as measured by thermoluminescent dosimeters (TLD's).

Location	mRem/91 days 1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Cumulative Average	Previous Annual Average
			Indicators (Inner Ring, General Area of Site Boundary)			
M-01A	12.8 ± 1.4	14.3 ± 2.0	15.5 ± 1.7	15.8 ± 2.1	14.6	16.6
M-02A	13.3 ± 1.5	14.7 ± 1.0	16.6 ± 2.0	16.1 ± 1.0	15.2	16.2
M-03A	12.0 ± 0.9	14.9 ± 1.2	14.3 ± 1.4	15.8 ± 1.2	14.2	15.7
M-04A	9.7 ± 1.2	15.5 ± 1.9	14.8 ± 1.1	16.6 ± 0.8	14.1	15.1
M-05A	13.1 ± 0.7	13.0 ± 0.9	15.9 ± 1.0	16.4 ± 0.9	14.6	15.6
M-06A	13.7 ± 0.9	12.9 ± 1.0	16.0 ± 1.2	14.5 ± 1.1	14.3	16.4
M-07A	10.9 ± 1.0	15.0 ± 1.1	14.4 ± 1.3	17.0 ± 1.0	14.3	15.7
M-08A	12.8 ± 0.8	14.6 ± 0.8	15.5 ± 1.1	15.1 ± 1.1	14.5	16.2
M-09A	13.2 ± 0.9	14.5 ± 1.5	15.5 ± 1.3	13.3 ± 1.0	14.1	15.5
M-10A	12.5 ± 1.1	15.0 ± 1.2	14.7 ± 1.3	13.9 ± 0.9	14.0	15.6
M-11A	15.1 ± 1.0	15.8 ± 1.0	17.2 ± 1.7	14.5 ± 0.9	15.7	17.3
M-12A	14.7 ± 0.9	15.3 ± 1.2	15.8 ± 1.5	14.2 ± 1.0	15.0	17.1
M-13A	14.1 ± 1.0	14.5 ± 1.0	15.6 ± 1.4	12.9 ± 1.2	14.3	15.7
M-14A	12.0 ± 0.9	15.6 ± 1.0	15.1 ± 1.1	13.7 ± 1.0	14.1	16.0
Mean ± s.d.	12.8 ± 1.4	14.7 ± 0.9	15.5 ± 0.8	15.0 ± 1.3	14.5	16.1
			Indicators (Outer Ring, 4-5 Miles Distant)			
M-01B	11.4 ± 0.8	14.4 ± 1.6	14.1 ± 1.3	13.6 ± 1.3	13.4	15.1
M-02B	13.4 ± 1.0	13.7 ± 1.0	15.1 ± 1.1	13.6 ± 0.9	13.9	15.1
M-03B	10.0 ± 0.8	11.4 ± 1.1	12.1 ± 1.0	12.3 ± 0.8	11.5	12.3
M-04B	11.1 ± 0.7	14.2 ± 0.8	13.3 ± 1.0	ND[a]	12.9	14.5
M-05B	12.1 ± 0.7	14.6 ± 1.1	14.6 ± 1.1	14.9 ± 1.0	14.1	15.1
M-06B	10.4 ± 1.1	14.7 ± 0.8	14.5 ± 1.5	15.0 ± 0.8	13.7	14.7
M-07B	14.2 ± 1.0	14.9 ± 1.4	16.5 ± 1.6	15.3 ± 1.5	15.2	15.9
M-08B	12.7 ± 0.9	14.4 ± 1.0	14.2 ± 1.1	13.6 ± 1.0	13.7	14.7
M-09B	12.7 ± 1.0	13.5 ± 1.1	15.4 ± 1.1	14.1 ± 0.9	13.9	15.7
M-10B	14.0 ± 1.0	13.9 ± 1.2	15.9 ± 1.2	16.0 ± 0.9	15.0	15.7
M-11B	13.8 ± 1.4	15.2 ± 1.3	16.4 ± 1.4	16.0 ± 1.1	15.4	16.4
M-12B	12.0 ± 1.1	15.2 ± 1.2	14.4 ± 1.3	15.1 ± 1.0	14.2	15.2
M-13B	13.4 ± 1.2	13.5 ± 1.2	14.1 ± 1.4	14.6 ± 0.9	13.9	15.2
M-14B	14.9 ± 1.4	16.0 ± 0.9	17.1 ± 1.4	15.9 ± 0.9	16.0	17.0
M-15B	12.6 ± 0.6	15.0 ± 1.3	15.1 ± 1.0	15.0 ± 1.2	14.4	15.1
M-16B	13.2 ± 0.8	13.7 ± 1.0	14.0 ± 1.1	12.9 ± 0.9	13.5	14.7
Mean ± s.d.	12.6 ± 1.4	14.3 ± 1.0	14.8 ± 1.3	14.5 ± 1.1	14.0	15.1

[a] Sample lost during shipment. See Table 2.0, Listing of Missed Samples.

Table 1. Ambient gamma radiation as measured by thermoluminescent dosimeters (TLD's), (continued).

Location	mRem/91 days 1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Cumulative Average	Previous Annual Average
			Control			
M-01C	11.5 ± 1.4	13.1 ± 1.2	14.9 ± 1.3	13.2 ± 1.1	13.2	13.8
M-02C	11.6 ± 1.3	12.5 ± 1.1	13.7 ± 1.1	13.3 ± 1.1	12.8	14.4
M-03C	12.8 ± 0.8	14.3 ± 1.0	16.0 ± 1.2	16.8 ± 1.1	15.0	15.4
M-04C	14.8 ± 1.1	13.5 ± 0.9	16.6 ± 1.1	14.5 ± 0.8	14.8	15.1
Mean ± s.d.	12.7 ± 1.5	13.4 ± 0.7	15.3 ± 1.3	14.5 ± 1.7	13.9	14.7
			Indicators (Special Interest Areas)			
M-01S	9.6 ± 1.2	11.2 ± 0.8	12.7 ± 1.6	11.8 ± 0.8	11.3	12.6
M-02S	12.9 ± 1.2	13.3 ± 1.1	14.2 ± 1.4	14.0 ± 1.1	13.6	14.4
M-03S	12.1 ± 1.0	13.8 ± 1.2	14.9 ± 1.9	14.7 ± 0.9	13.9	14.8
M-04S	15.1 ± 1.2	15.0 ± 1.3	17.1 ± 1.4	15.8 ± 0.9	15.8	16.3
M-05S	12.4 ± 0.8	ND[a]	14.6 ± 1.3	14.0 ± 0.9	13.7	15.0
M-06S	13.7 ± 1.1	15.0 ± 0.9	15.6 ± 1.1	15.4 ± 1.0	15.0	15.7
M-I-11	15.7 ± 2.2	16.1 ± 1.2	16.8 ± 2.0	15.9 ± 1.2	16.1	16.5
M-I-12	14.1 ± 0.9	15.2 ± 1.2	16.9 ± 1.2	14.9 ± 1.2	15.3	15.0
M-I-13	15.2 ± 1.4	16.4 ± 2.2	17.8 ± 1.1	15.7 ± 1.4	16.3	15.2
Mean ± s.d.	13.4 ± 1.9	14.5 ± 1.7	15.6 ± 1.7	14.7 ± 1.3	14.5	15.0
			ISFSI Fence (Non-REMP TLDs)			
M-I-01	38.4 ± 1.2	39.0 ± 3.5	40.7 ± 1.8	42.9 ± 2.2	40.2	38.7
M-I-02	34.5 ± 0.8	32.8 ± 0.9	37.2 ± 1.0	37.6 ± 0.9	35.5	33.8
M-I-03	31.4 ± 2.5	28.4 ± 1.6	34.8 ± 1.5	34.2 ± 1.8	32.2	30.6
M-I-04	37.6 ± 2.3	33.3 ± 2.1	38.2 ± 2.2	119.9 ± 5.6	57.2	36.3
M-I-05	51.3 ± 2.3	48.6 ± 2.4	53.3 ± 2.1	66.7 ± 3.6	55.0	56.7
M-I-06	28.1 ± 1.9	24.9 ± 1.7	30.8 ± 2.2	32.4 ± 2.1	29.0	26.4
M-I-07	31.0 ± 1.5	26.2 ± 1.9	33.9 ± 3.2	36.8 ± 2.1	32.0	29.2
M-I-08	28.7 ± 2.3	26.9 ± 2.2	31.9 ± 2.5	31.3 ± 2.3	29.7	27.6
M-I-09	46.1 ± 1.8	43.3 ± 2.5	59.4 ± 2.5	70.5 ± 3.5	54.8	44.5
M-I-10	35.6 ± 1.0	33.6 ± 1.7	82.4 ± 3.6	150.3 ± 6.1	75.5	33.3
Mean ± s.d.	36.3 ± 7.5	33.7 ± 7.8	44.3 ± 16.3	62.3 ± 41.4	44.1	35.7

[a] Sample missing in field. See Table 2.0, Listing of Missed Samples.

Table 2. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: M-1 (C)

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010
01-10-18	308	0.048 ± 0.005	07-05-18	389	0.025 ± 0.003
01-17-18	311	0.051 ± 0.005	07-11-18	283	0.024 ± 0.004
01-24-18	333	0.045 ± 0.004	07-18-18	317	0.029 ± 0.004
01-31-18	322	0.048 ± 0.004	07-25-18	314	0.023 ± 0.003
			08-01-18	317	0.022 ± 0.003
02-07-18	309	0.030 ± 0.004			
02-13-18	290	0.042 ± 0.005	08-08-18	378	0.025 ± 0.003
02-21-18	358	0.042 ± 0.004	08-15-18	377	0.033 ± 0.003
02-28-18	324	0.042 ± 0.004	08-22-18	381	0.029 ± 0.003
			08-28-18	303	0.030 ± 0.004
03-07-18	316	0.034 ± 0.004			
03-14-18	340	0.034 ± 0.004	09-05-18	435	0.018 ± 0.002
03-21-18	315	0.028 ± 0.004	09-12-18	353	0.027 ± 0.003
03-28-18	315	0.026 ± 0.004	09-19-18	352	0.018 ± 0.003
			09-26-18	352	0.019 ± 0.003
			10-03-18	325	0.022 ± 0.003
1st Quarter Mean ± s.d.		0.039 ± 0.008	3rd Quarter Mean ± s.d.		0.025 ± 0.005
04-04-18	316	0.028 ± 0.004	10-10-18	326	0.006 ± 0.002
04-10-18	294	0.028 ± 0.004	10-17-18	328	0.020 ± 0.003
04-18-18	363	0.032 ± 0.004	10-24-18	325	0.020 ± 0.003
04-25-18	339	0.026 ± 0.003	10-31-18	352	0.031 ± 0.003
05-02-18	316	0.020 ± 0.004			
			11-07-18	354	0.015 ± 0.003
05-09-18	316	0.025 ± 0.004	11-14-18	353	0.026 ± 0.003
05-16-18	320	0.019 ± 0.003	11-21-18	353	0.038 ± 0.004
05-23-18	334	0.019 ± 0.003	11-28-18	354	0.039 ± 0.004
05-30-18	342	0.036 ± 0.004			
			12-05-18	352	0.033 ± 0.004
06-06-18	341	0.013 ± 0.003	12-12-18	324	0.064 ± 0.005
06-12-18	295	0.021 ± 0.003	12-19-18	326	0.041 ± 0.004
06-20-18	388	0.020 ± 0.003	12-26-18	353	0.035 ± 0.004
06-27-18	330	0.022 ± 0.003	01-02-19	327	0.024 ± 0.004
2nd Quarter Mean ± s.d.		0.024 ± 0.006	4th Quarter Mean ± s.d.		0.030 ± 0.014
			Cumulative Average		0.029
			Previous Annual Average		0.028

[a] Iodine-131 concentrations are < 0.03 pCi/m^3 unless otherwise noted.

Table 3. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: M-2

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010			0.010
01-10-18	312	0.044 ± 0.004	07-05-18	436	0.021 ± 0.003
01-17-18	315	0.043 ± 0.004	07-11-18	317	0.024 ± 0.004
01-24-18	313	0.040 ± 0.004	07-18-18	351	0.029 ± 0.003
01-31-18	289	0.052 ± 0.005	07-25-18	342	0.024 ± 0.003
			08-01-18	351	0.021 ± 0.003
02-07-18	286	0.030 ± 0.004			
02-13-18	268	0.045 ± 0.005	08-08-18	385	0.026 ± 0.003
02-21-18	362	0.034 ± 0.004	08-15-18	380	0.030 ± 0.003
02-28-18	282	0.045 ± 0.005	08-22-18	382	0.028 ± 0.003
			08-28-18	325	0.027 ± 0.003
03-07-18	286	0.034 ± 0.004			
03-14-18	312	0.041 ± 0.004	09-05-18	443	0.017 ± 0.002
03-21-18	286	0.032 ± 0.004	09-12-18	350	0.026 ± 0.003
03-28-18	285	0.032 ± 0.004	09-19-18	381	0.022 ± 0.003
			09-26-18	352	0.016 ± 0.003
			10-03-18	326	0.026 ± 0.004
1st Quarter Mean ± s.d.		0.039 ± 0.007	3rd Quarter Mean ± s.d.		0.024 ± 0.004
04-04-18	287	0.028 ± 0.004	10-10-18	324	0.007 ± 0.002
04-10-18	290	0.027 ± 0.004	10-17-18	357	0.020 ± 0.003
04-18-18		ND[b]	10-24-18	347	0.018 ± 0.003
04-25-18	336	0.029 ± 0.004	10-31-18	352	0.028 ± 0.003
05-02-18	343	0.022 ± 0.003			
			11-07-18	384	0.012 ± 0.003
05-09-18	317	0.030 ± 0.004	11-14-18	354	0.026 ± 0.003
05-16-18	344	0.021 ± 0.003	11-21-18	353	0.036 ± 0.004
05-23-18	309	0.021 ± 0.003	11-28-18	354	0.039 ± 0.004
05-30-18	286	0.043 ± 0.004			
			12-05-18	352	0.026 ± 0.003
06-06-18		ND[b]	12-12-18	356	0.061 ± 0.005
06-12-18	171	0.028 ± 0.005[c]	12-19-18	349	0.041 ± 0.004
06-20-18		ND[b]	12-26-18	353	0.034 ± 0.004
06-27-18	368	0.017 ± 0.003	01-02-19	383	0.023 ± 0.003
2nd Quarter Mean ± s.d.		0.027 ± 0.007	4th Quarter Mean ± s.d.		0.029 ± 0.003
			Cumulative Average		0.030
			Previous Annual Average		0.027

[a] Iodine-131 concentrations are < 0.03 pCi/m^3 unless otherwise noted.

[b] "ND" = No data; see Table 2.0, Listing of Missed Samples.

[c] Partial Sample. Sample pump was started 6/8/18 when power was restored to air sampler.

Table 4. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: M-3

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010			0.010
01-10-18	312	0.049 ± 0.005	07-05-18	358	0.028 ± 0.003
01-17-18	315	0.042 ± 0.004	07-11-18	275	0.026 ± 0.004
01-24-18	341	0.036 ± 0.004	07-18-18	282	0.039 ± 0.004
01-31-18	318	0.044 ± 0.004	07-25-18	285	0.026 ± 0.004
			08-01-18	283	0.024 ± 0.004
02-07-18	314	0.032 ± 0.004			
02-13-18	292	0.044 ± 0.005	08-08-18	357	0.027 ± 0.003
02-21-18	392	0.035 ± 0.003	08-15-18	351	0.036 ± 0.004
02-28-18	315	0.045 ± 0.004	08-22-18	353	0.035 ± 0.004
			08-28-18	300	0.027 ± 0.004
03-07-18	314	0.039 ± 0.004			
03-14-18	312	0.036 ± 0.004	09-05-18	375	0.021 ± 0.003
03-21-18	314	0.027 ± 0.004	09-12-18	320	0.025 ± 0.003
03-28-18	285	0.036 ± 0.004	09-19-18	322	0.026 ± 0.003
			09-26-18	323	0.019 ± 0.003
			10-03-18	326	0.026 ± 0.004
1st Quarter Mean ± s.d.		0.039 ± 0.006	3rd Quarter Mean ± s.d.		0.028 ± 0.006
04-04-18	287	0.033 ± 0.004	10-10-18	324	0.007 ± 0.002
04-10-18	242	0.028 ± 0.004	10-17-18	298	0.022 ± 0.004
04-18-18	327	0.034 ± 0.004	10-24-18	289	0.020 ± 0.004
04-25-18	313	0.032 ± 0.004	10-31-18	311	0.036 ± 0.004
05-02-18	286	0.021 ± 0.004			
			11-07-18	344	0.013 ± 0.003
05-09-18	318	0.023 ± 0.004	11-14-18	312	0.028 ± 0.004
05-16-18	285	0.024 ± 0.004	11-21-18	342	0.037 ± 0.004
05-23-18	310	0.024 ± 0.003	11-28-18	312	0.041 ± 0.004
05-30-18	315	0.043 ± 0.004			
			12-05-18	311	0.038 ± 0.004
06-06-18	289	0.020 ± 0.003	12-12-18	315	0.070 ± 0.005
06-12-18	266	0.022 ± 0.004	12-19-18	307	0.047 ± 0.004
06-20-18	362	0.021 ± 0.003	12-26-18	312	0.037 ± 0.004
06-27-18	315	0.021 ± 0.003	01-02-19	312	0.031 ± 0.004
2nd Quarter Mean ± s.d.		0.027 ± 0.007	4th Quarter Mean ± s.d.		0.033 ± 0.016
			Cumulative Average		0.031
			Previous Annual Average		0.029

[a] Iodine-131 concentrations are < 0.03 pCi/m^3 unless otherwise noted.

Table 5. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: M-4

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010			0.010
01-10-18	325	0.046 ± 0.004	07-05-18	433	0.025 ± 0.003
01-17-18	327	0.044 ± 0.004	07-11-18	328	0.019 ± 0.003
01-24-18	351	0.035 ± 0.004	07-18-18	377	0.022 ± 0.003
01-31-18	330	0.044 ± 0.004	07-25-18	382	0.020 ± 0.003
			08-01-18	351	0.024 ± 0.003
02-07-18	327	0.033 ± 0.004			
02-13-18	301	0.040 ± 0.004	08-08-18	379	0.023 ± 0.003
02-21-18	390	0.034 ± 0.003	08-15-18	375	0.033 ± 0.003
02-28-18	327	0.039 ± 0.004	08-22-18	352	0.034 ± 0.003
			08-28-18	299	0.032 ± 0.004
03-07-18	329	0.029 ± 0.004			
03-14-18	339	0.034 ± 0.004	09-05-18	436	0.018 ± 0.002
03-21-18	316	0.031 ± 0.004	09-12-18	350	0.024 ± 0.003
03-28-18	314	0.031 ± 0.004	09-19-18	351	0.020 ± 0.003
			09-26-18	351	0.018 ± 0.003
			10-03-18	329	0.024 ± 0.004
1st Quarter Mean ± s.d.		0.037 ± 0.006	3rd Quarter Mean ± s.d.		0.024 ± 0.005
04-04-18	316	0.032 ± 0.004	10-10-18	327	0.007 ± 0.002
04-10-18	291	0.024 ± 0.004	10-17-18	356	0.017 ± 0.003
04-18-18	365	0.034 ± 0.004	10-24-18	347	0.016 ± 0.003
04-25-18	336	0.026 ± 0.003	10-31-18	351	0.028 ± 0.003
05-02-18	342	0.017 ± 0.003			
			11-07-18	354	0.012 ± 0.003
05-09-18	318	0.022 ± 0.003	11-14-18	378	0.024 ± 0.003
05-16-18	322	0.018 ± 0.003	11-21-18	352	0.041 ± 0.004
05-23-18	366	0.022 ± 0.003	11-28-18	353	0.044 ± 0.004
05-30-18	353	0.036 ± 0.004			
			12-05-18	351	0.024 ± 0.003
06-06-18	356	0.012 ± 0.003	12-12-18	354	0.059 ± 0.004
06-12-18	300	0.024 ± 0.004	12-19-18	349	0.044 ± 0.004
06-20-18	405	0.016 ± 0.003	12-26-18	352	0.035 ± 0.004
06-27-18	381	0.018 ± 0.003	01-02-19	353	0.029 ± 0.004
2nd Quarter Mean ± s.d.		0.023 ± 0.007	4th Quarter Mean ± s.d.		0.029 ± 0.015
			Cumulative Average		0.028
			Previous Annual Average		0.027

[a] Iodine-131 concentrations are < 0.03 pCi/m^3 unless otherwise noted.

Table 6. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: M-5

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010			0.010
01-10-18	312	0.054 ± 0.005	07-05-18	390	0.026 ± 0.003
01-17-18	315	0.047 ± 0.004	07-11-18	294	0.025 ± 0.004
01-24-18	342	0.039 ± 0.004	07-18-18	284	0.028 ± 0.004
01-31-18	317	0.047 ± 0.004	07-25-18	287	0.024 ± 0.004
			08-01-18	285	0.025 ± 0.004
02-07-18	315	0.032 ± 0.004			
02-13-18	269	0.047 ± 0.005	08-08-18	353	0.025 ± 0.003
02-21-18	369	0.038 ± 0.004	08-15-18	352	0.034 ± 0.004
02-28-18	292	0.045 ± 0.005	08-22-18	352	0.032 ± 0.003
			08-28-18	326	0.028 ± 0.003
03-07-18	324	0.030 ± 0.004			
03-14-18	321	0.037 ± 0.004	09-05-18	441	0.020 ± 0.003
03-21-18	294	0.029 ± 0.004	09-12-18	381	0.024 ± 0.003
03-28-18	293	0.027 ± 0.004	09-19-18	352	0.024 ± 0.003
			09-26-18	352	0.016 ± 0.003
			10-03-18	325	0.023 ± 0.004
1st Quarter Mean ± s.d.		0.039 ± 0.009	3rd Quarter Mean ± s.d.		0.025 ± 0.004
04-04-18	295	0.031 ± 0.004	10-10-18	324	0.008 ± 0.003
04-10-18	251	0.032 ± 0.004	10-17-18	357	0.021 ± 0.003
04-18-18	338	0.033 ± 0.004	10-24-18	350	0.018 ± 0.003
04-25-18	292	0.031 ± 0.004	10-31-18	313	0.033 ± 0.004
05-02-18	295	0.021 ± 0.004			
			11-07-18	316	0.012 ± 0.003
05-09-18	296	0.028 ± 0.004	11-14-18	315	0.030 ± 0.004
05-16-18	296	0.022 ± 0.003	11-21-18	314	0.044 ± 0.004
05-23-18	337	0.022 ± 0.003	11-28-18	315	0.050 ± 0.004
05-30-18	315	0.041 ± 0.004			
			12-05-18	313	0.029 ± 0.004
06-06-18	316	0.016 ± 0.003	12-12-18	315	0.067 ± 0.005
06-12-18	293	0.024 ± 0.004	12-19-18	312	0.044 ± 0.004
06-20-18	359	0.020 ± 0.003	12-26-18	315	0.037 ± 0.004
06-27-18	315	0.023 ± 0.003	01-02-19	315	0.028 ± 0.004
2nd Quarter Mean ± s.d.		0.026 ± 0.007	4th Quarter Mean ± s.d.		0.032 ± 0.016
			Cumulative Average		0.031
			Previous Annual Average		0.028

[a] Iodine-131 concentrations are < 0.03 pCi/m^3 unless otherwise noted.

Table 7. Airborne particulate data, gross beta analyses, monthly averages, minima and maxima.

January

Location	Average	Minima	Maxima
Control	0.048	0.045	0.051
M-1	0.048	0.045	0.051
Indicators	0.044	0.035	0.054
M-2	0.045	0.040	0.052
M-3	0.043	0.036	0.049
M-4	0.042	0.035	0.046
M-5	0.047	0.039	0.054

February

Location	Average	Minima	Maxima
Control	0.039	0.030	0.042
M-1	0.039	0.030	0.042
Indicators	0.039	0.030	0.047
M-2	0.039	0.030	0.045
M-3	0.039	0.032	0.045
M-4	0.036	0.033	0.040
M-5	0.040	0.032	0.047

March

Location	Average	Minima	Maxima
Control	0.030	0.026	0.034
M-1	0.030	0.026	0.034
Indicators	0.033	0.027	0.041
M-2	0.035	0.032	0.041
M-3	0.034	0.027	0.039
M-4	0.031	0.029	0.034
M-5	0.031	0.027	0.037

April

Location	Average	Minima	Maxima
Control	0.027	0.020	0.032
M-1	0.027	0.020	0.032
Indicators	0.028	0.017	0.034
M-2	0.027	0.022	0.029
M-3	0.030	0.021	0.034
M-4	0.026	0.017	0.034
M-5	0.029	0.021	0.033

May

Location	Average	Minima	Maxima
Control	0.025	0.019	0.036
M-1	0.025	0.019	0.036
Indicators	0.028	0.018	0.043
M-2	0.029	0.021	0.043
M-3	0.028	0.023	0.043
M-4	0.024	0.018	0.036
M-5	0.028	0.022	0.041

June

Location	Average	Minima	Maxima
Control	0.019	0.013	0.022
M-1	0.019	0.013	0.022
Indicators	0.020	0.012	0.028
M-2	0.022	0.017	0.028
M-3	0.021	0.020	0.022
M-4	0.018	0.012	0.024
M-5	0.021	0.016	0.024

Note: unless otherwise specified, samples collected on the first, second or third day of the month are grouped with data of the previous month.

Table 7. Airborne particulate data, gross beta analyses, monthly averages, minima and maxima.

July

Location	Average	Minima	Maxima
Control	0.025	0.022	0.029
M-1	0.025	0.022	0.029
Indicators	0.025	0.019	0.039
M-2	0.024	0.021	0.029
M-3	0.029	0.024	0.039
M-4	0.022	0.019	0.025
M-5	0.026	0.024	0.029

August

Location	Average	Minima	Maxima
Control	0.029	0.025	0.033
M-1	0.029	0.025	0.033
Indicators	0.030	0.023	0.036
M-2	0.028	0.026	0.030
M-3	0.031	0.027	0.036
M-4	0.030	0.023	0.034
M-5	0.030	0.025	0.034

September

Location	Average	Minima	Maxima
Control	0.021	0.018	0.027
M-1	0.021	0.018	0.027
Indicators	0.022	0.016	0.026
M-2	0.022	0.016	0.026
M-3	0.023	0.019	0.026
M-4	0.021	0.018	0.024
M-5	0.021	0.016	0.024

October

Location	Average	Minima	Maxima
Control	0.020	0.006	0.031
M-1	0.020	0.006	0.031
Indicators	0.019	0.007	0.036
M-2	0.018	0.007	0.028
M-3	0.021	0.007	0.036
M-4	0.017	0.007	0.028
M-5	0.020	0.008	0.033

November

Location	Average	Minima	Maxima
Control	0.030	0.015	0.039
M-1	0.030	0.015	0.039
Indicators	0.031	0.012	0.050
M-2	0.028	0.012	0.039
M-3	0.030	0.013	0.041
M-4	0.030	0.012	0.044
M-5	0.034	0.012	0.050

December

Location	Average	Minima	Maxima
Control	0.039	0.024	0.064
M-1	0.039	0.024	0.064
Indicators	0.040	0.023	0.070
M-2	0.037	0.023	0.061
M-3	0.044	0.031	0.070
M-4	0.038	0.024	0.059
M-5	0.041	0.028	0.067

Note: unless otherwise specified, samples collected on the first, second or third day of the month are grouped with data of the previous month.

Table 8. Airborne particulates, quarterly composites from each location, analysis for gamma-emitting isotopes.

Activity (pCi/m^3)						
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Cumulative Average	Previous Average
M-1 (C)						
Lab Code	MAP- 1277	MAP- 2891	MAP- 4365	MAP- 5511		
Volume(m^3)	3841	4293	4874	4426		
Be-7	0.096 ± 0.015	0.100 ± 0.012	0.073 ± 0.011	0.059 ± 0.011	0.082	0.080
Mn-54	< 0.0007	< 0.0004	< 0.0008	< 0.0006	<0.0008	<0.0007
Co-58	< 0.0006	< 0.0004	< 0.0009	< 0.0004	<0.0009	<0.0007
Co-60	< 0.0005	< 0.0004	< 0.0007	< 0.0003	<0.0007	<0.0008
Zn-65	< 0.0005	< 0.0010	< 0.0011	< 0.0005	<0.0011	<0.0016
Zr-Nb-95	< 0.0007	< 0.0009	< 0.0008	< 0.0003	<0.0009	<0.0010
Ru-103	< 0.0010	< 0.0008	< 0.0009	< 0.0009	<0.0010	<0.0011
Ru-106	< 0.0056	< 0.0046	< 0.0040	< 0.0057	<0.0057	<0.0063
Cs-134	< 0.0007	< 0.0006	< 0.0008	< 0.0007	<0.0008	<0.0009
Cs-137	< 0.0005	< 0.0006	< 0.0005	< 0.0006	<0.0006	<0.0009
Ba-La-140	< 0.0026	< 0.0021	< 0.0018	< 0.0008	<0.0026	<0.0023
Ce-141	< 0.0017	< 0.0013	< 0.0009	< 0.0007	<0.0017	<0.0019
Ce-144	< 0.0046	< 0.0027	< 0.0042	< 0.0031	<0.0046	<0.0051
M-2						
Lab Code	MAP- 1278	MAP- 2892	MAP- 4366	MAP- 5512		
Volume(m^3)	3594	3050	5121	4619		
Be-7	0.081 ± 0.016	0.111 ± 0.016	0.055 ± 0.010	0.044 ± 0.008	0.073	0.074
Mn-54	< 0.0005	< 0.0012	< 0.0006	< 0.0005	<0.0012	<0.0008
Co-58	< 0.0004	< 0.0015	< 0.0007	< 0.0005	<0.0015	<0.0010
Co-60	< 0.0005	< 0.0005	< 0.0004	< 0.0005	<0.0005	<0.0006
Zn-65	< 0.0008	< 0.0023	< 0.0010	< 0.0006	<0.0023	<0.0016
Zr-Nb-95	< 0.0007	< 0.0017	< 0.0004	< 0.0006	<0.0017	<0.0015
Ru-103	< 0.0006	< 0.0018	< 0.0004	< 0.0008	<0.0018	<0.0014
Ru-106	< 0.0037	< 0.0090	< 0.0052	< 0.0056	<0.0090	<0.0071
Cs-134	< 0.0006	< 0.0011	< 0.0008	< 0.0006	<0.0011	<0.0008
Cs-137	< 0.0005	< 0.0010	< 0.0007	< 0.0005	<0.0010	<0.0007
Ba-La-140	< 0.0029	< 0.0029	< 0.0019	< 0.0007	<0.0029	<0.0036
Ce-141	< 0.0015	< 0.0025	< 0.0009	< 0.0007	<0.0025	<0.0020
Ce-144	< 0.0022	< 0.0039	< 0.0030	< 0.0024	<0.0039	<0.0042

Table 8. Airborne particulates, quarterly composites from each location, analysis for gamma-emitting isotopes.

Activity (pCi/m^3)						
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Cumulative Average	Previous Average
M-3						
Lab Code	MAP- 1280	MAP- 2893	MAP- 4367	MAP- 5513		
Volume(m^3)	3823	3914	4509	4087		
Be-7	0.093 ± 0.015	0.112 ± 0.016	0.075 ± 0.013	0.058 ± 0.015	0.085	0.076
Mn-54	< 0.0005	< 0.0009	< 0.0006	< 0.0011	<0.0011	<0.0008
Co-58	< 0.0007	< 0.0010	< 0.0008	< 0.0011	<0.0011	<0.0008
Co-60	< 0.0005	< 0.0007	< 0.0003	< 0.0011	<0.0011	<0.0006
Zn-65	< 0.0013	< 0.0016	< 0.0014	< 0.0026	<0.0026	<0.0023
Zr-Nb-95	< 0.0006	< 0.0013	< 0.0010	< 0.0011	<0.0013	<0.0015
Ru-103	< 0.0009	< 0.0012	< 0.0006	< 0.0013	<0.0013	<0.0014
Ru-106	< 0.0053	< 0.0058	< 0.0041	< 0.0051	<0.0058	<0.0082
Cs-134	< 0.0006	< 0.0008	< 0.0006	< 0.0009	<0.0009	<0.0009
Cs-137	< 0.0005	< 0.0008	< 0.0007	< 0.0007	<0.0008	<0.0010
Ba-La-140	< 0.0016	< 0.0016	< 0.0015	< 0.0012	<0.0016	<0.0026
Ce-141	< 0.0011	< 0.0017	< 0.0010	< 0.0012	<0.0017	<0.0023
Ce-144	< 0.0026	< 0.0040	< 0.0031	< 0.0032	<0.0040	<0.0050
M-4						
Lab Code	MAP- 1281	MAP- 2895	MAP- 4368	MAP- 5514		
Volume(m^3)	3976	4452	5091	4575		
Be-7	0.083 ± 0.015	0.094 ± 0.013	0.071 ± 0.011	0.055 ± 0.012	0.076	0.076
Mn-54	< 0.0006	< 0.0009	< 0.0006	< 0.0005	<0.0009	<0.0009
Co-58	< 0.0006	< 0.0010	< 0.0006	< 0.0003	<0.0010	<0.0008
Co-60	< 0.0005	< 0.0006	< 0.0005	< 0.0006	<0.0006	<0.0009
Zn-65	< 0.0016	< 0.0021	< 0.0005	< 0.0007	<0.0021	<0.0013
Zr-Nb-95	< 0.0007	< 0.0015	< 0.0008	< 0.0007	<0.0015	<0.0013
Ru-103	< 0.0011	< 0.0007	< 0.0005	< 0.0005	<0.0011	<0.0010
Ru-106	< 0.0071	< 0.0067	< 0.0040	< 0.0020	<0.0071	<0.0072
Cs-134	< 0.0009	< 0.0008	< 0.0007	< 0.0007	<0.0009	<0.0008
Cs-137	< 0.0006	< 0.0008	< 0.0005	< 0.0006	<0.0008	<0.0008
Ba-La-140	< 0.0021	< 0.0035	< 0.0013	< 0.0008	<0.0035	<0.0023
Ce-141	< 0.0014	< 0.0018	< 0.0009	< 0.0007	<0.0018	<0.0017
Ce-144	< 0.0029	< 0.0029	< 0.0030	< 0.0031	<0.0031	<0.0041

Table 8. Airborne particulates, quarterly composites from each location, analysis for gamma-emitting isotopes.

	Activity (pCi/m^3)					
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Cumulative Average	Previous Average
			M-5			
Lab Code	MAP- 1282	MAP- 2896	MAP- 4370	MAP- 5515		
Volume(m^3)	3763	3998	4775	4173		
Be-7	0.097 ± 0.020	0.113 ± 0.017	0.065 ± 0.010	0.056 ± 0.012	0.083	0.081
Mn-54	< 0.0012	< 0.0005	< 0.0006	< 0.0005	<0.0012	<0.0008
Co-58	< 0.0010	< 0.0008	< 0.0009	< 0.0004	<0.0010	<0.0008
Co-60	< 0.0009	< 0.0005	< 0.0003	< 0.0005	<0.0009	<0.0008
Zn-65	< 0.0011	< 0.0014	< 0.0010	< 0.0008	<0.0014	<0.0011
Zr-Nb-95	< 0.0022	< 0.0004	< 0.0008	< 0.0006	<0.0022	<0.0012
Ru-103	< 0.0017	< 0.0010	< 0.0006	< 0.0009	<0.0017	<0.0013
Ru-106	< 0.0104	< 0.0063	< 0.0063	< 0.0076	<0.0104	<0.0065
Cs-134	< 0.0010	< 0.0007	< 0.0009	< 0.0007	<0.0010	<0.0008
Cs-137	< 0.0010	< 0.0005	< 0.0004	< 0.0005	<0.0010	<0.0009
Ba-La-140	< 0.0048	< 0.0026	< 0.0020	< 0.0008	<0.0048	<0.0023
Ce-141	< 0.0020	< 0.0013	< 0.0010	< 0.0007	<0.0020	<0.0021
Ce-144	< 0.0059	< 0.0043	< 0.0025	< 0.0035	<0.0059	<0.0063

Table 9. Pasture grass, vegetation, analysis for gamma-emitting isotopes.
Collection: 3x per year

	Sample Description and Concentration (pCi/g wet)			Annual Average	Previous Annual Average
Location:	M-41 (Training Center)				
Date Collected	07-11-18	08-08-18	09-05-18		
Lab Code	MVE- 2757	MVE- 3193	MVE- 3631		
Mn-54	< 0.011	< 0.013	< 0.011	< 0.013	< 0.009
Fe-59	< 0.035	< 0.029	< 0.029	< 0.035	< 0.029
Co-58	< 0.010	< 0.011	< 0.012	< 0.012	< 0.012
Co-60	< 0.009	< 0.012	< 0.015	< 0.015	< 0.009
Zn-65	< 0.027	< 0.025	< 0.048	< 0.048	< 0.022
Nb-95	< 0.014	< 0.014	< 0.022	< 0.022	< 0.011
I-131	< 0.027	< 0.019	< 0.025	< 0.027	< 0.026
Cs-134	< 0.013	< 0.013	< 0.017	< 0.017	< 0.010
Cs-137	< 0.011	< 0.015	< 0.017	< 0.017	< 0.011
Location:	M-42 (Biology Station Road)				
Date Collected	07-11-18	08-08-18	09-05-18		
Lab Code	MVE- 2758	MVE- 3195	MVE- 3632		
Mn-54	< 0.012	< 0.012	< 0.014	< 0.014	< 0.012
Fe-59	< 0.024	< 0.016	< 0.018	< 0.024	< 0.023
Co-58	< 0.011	< 0.014	< 0.012	< 0.014	< 0.016
Co-60	< 0.009	< 0.011	< 0.010	< 0.011	< 0.016
Zn-65	< 0.030	< 0.016	< 0.016	< 0.030	< 0.026
Nb-95	< 0.015	< 0.015	< 0.016	< 0.016	< 0.017
I-131	< 0.016	< 0.044	< 0.023	< 0.044	< 0.028
Cs-134	< 0.013	< 0.015	< 0.013	< 0.015	< 0.014
Cs-137	< 0.013	< 0.015	< 0.011	< 0.015	< 0.014
Location:	M-43 (Imholte Farm, Control)				
Date Collected	07-11-18	08-08-18	09-05-18		
Lab Code	MVE- 2759	MVE- 3196	MVE- 3633		
Mn-54	< 0.008	< 0.008	< 0.009	< 0.009	< 0.014
Fe-59	< 0.018	< 0.010	< 0.023	< 0.023	< 0.035
Co-58	< 0.007	< 0.009	< 0.010	< 0.010	< 0.012
Co-60	< 0.008	< 0.006	< 0.005	< 0.008	< 0.014
Zn-65	< 0.010	< 0.010	< 0.017	< 0.017	< 0.020
Nb-95	< 0.011	< 0.014	< 0.007	< 0.014	< 0.019
I-131	< 0.015	< 0.035	< 0.019	< 0.035	< 0.023
Cs-134	< 0.009	< 0.011	< 0.009	< 0.011	< 0.017
Cs-137	< 0.008	< 0.009	< 0.010	< 0.010	< 0.017

Table 10. River water, analysis of monthly composites for gamma-emitting isotopes.
Location: M-8 (C)
Collection: Weekly

Sample Description and Concentration (pCi/L)					
Period Collected	January	February	March	April	May
Lab Code	NS [a]	NS [a]	NS [a]	MSW-1567 [b]	MSW-2340
Mn-54	-	-	-	< 10	< 10
Fe-59	-	-	-	< 30	< 30
Co-58	-	-	-	< 10	< 10
Co-60	-	-	-	< 10	< 10
Zn-65	-	-	-	< 30	< 30
Zr-Nb-95	-	-	-	< 15	< 15
Cs-134	-	-	-	< 10	< 10
Cs-137	-	-	-	< 10	< 10
Ba-La-140	-	-	-	< 15	< 15
Ce-144	-	-	-	< 22	< 26
Period Collected	June	July	August	September	October
Lab Code	MSW-2570	MSW-3310	MSW-3844	MSW-4302	MSW-4826
Mn-54	< 10	< 10	< 10	< 10	< 10
Fe-59	< 30	< 30	< 30	< 30	< 30
Co-58	< 10	< 10	< 10	< 10	< 10
Co-60	< 10	< 10	< 10	< 10	< 10
Zn-65	< 30	< 30	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15	< 15	< 15
Ce-144	< 20	< 29	< 28	< 34	< 36
Period Collected	November	December		Cumulative	Previous Annual
Lab Code	MSW-5234 [c]	NS [a]		Average	Average
Mn-54	< 10	-		< 10	< 10
Fe-59	< 30	-		< 30	< 30
Co-58	< 10	-		< 10	< 10
Co-60	< 10	-		< 10	< 10
Zn-65	< 30	-		< 30	< 30
Zr-Nb-95	< 15	-		< 15	< 15
Cs-134	< 10	-		< 10	< 10
Cs-137	< 10	-		< 10	< 10
Ba-La-140	< 15	-		< 15	< 15
Ce-144	< 12	-		< 36	< 42

[a] "NS" = No sample; see Table 2.0, Listing of Missed Samples.

[b] April composite included only one weekly sample (04-25-18); see Table 2.0, Listing of Missed Samples.

[c] November composite included only one weekly sample (11-07-18); see Table 2.0, Listing of Missed Samples.

Table 10. River water, analysis of monthly composites for gamma-emitting isotopes.
Location: M-9
Collection: Weekly

Sample Description and Concentration (pCi/L)					
Period Collected	January	February	March	April	May
Lab Code	MSW-460	MSW-858	MSW-1365	MSW-1569	MSW-2341
Mn-54	< 10	< 10	< 10	< 10	< 10
Fe-59	< 30	< 30	< 30	< 30	< 30
Co-58	< 10	< 10	< 10	< 10	< 10
Co-60	< 10	< 10	< 10	< 10	< 10
Zn-65	< 30	< 30	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15	< 15	< 15
Ce-144	< 20	< 18	< 18	< 32	< 30
Period Collected	June	July	August	September	October
Lab Code	MSW-2571	MSW-3311	MSW-3845	MSW-4303	MSW-4827
Mn-54	< 10	< 10	< 10	< 10	< 10
Fe-59	< 30	< 30	< 30	< 30	< 30
Co-58	< 10	< 10	< 10	< 10	< 10
Co-60	< 10	< 10	< 10	< 10	< 10
Zn-65	< 30	< 30	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15	< 15	< 15
Ce-144	< 22	< 21	< 36	< 33	< 33
Period Collected	November	December		Cumulative	Previous Annual
Lab Code	MSW-5235	MSW-5464		Average	Average
Mn-54	< 10	< 10		< 10	< 10
Fe-59	< 30	< 30		< 30	< 30
Co-58	< 10	< 10		< 10	< 10
Co-60	< 10	< 10		< 10	< 10
Zn-65	< 30	< 30		< 30	< 30
Zr-Nb-95	< 15	< 15		< 15	< 15
Cs-134	< 10	< 10		< 10	< 10
Cs-137	< 10	< 10		< 10	< 10
Ba-La-140	< 15	< 15		< 15	< 15
Ce-144	< 23	< 26		< 36	< 39

Table 11. Drinking water, City of Minneapolis, M-14, analysis of monthly composites for gross beta, iodine-131, and gamma-emitting isotopes.
Collection: Weekly

Sample Description and Concentration (pCi/L)

Period Collected Lab Code	January MDW-481	February MDW-859	March MDW-1126	April MDW-1793	May MDW-2325
Gross beta	1.2 ± 0.5	< 0.9	1.0 ± 0.5	3.0 ± 0.7	1.6 ± 0.6
I-131	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Mn-54	< 10	< 10	< 10	< 10	< 10
Fe-59	< 30	< 30	< 30	< 30	< 30
Co-58	< 10	< 10	< 10	< 10	< 10
Co-60	< 10	< 10	< 10	< 10	< 10
Zn-65	< 30	< 30	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15	< 15	< 15
Ce-144	< 30	< 26	< 20	< 26	< 24

Period Collected Lab Code	June MDW-2572	July MDW-3252	August MDW-3687	September MDW-4304	October MDW-4800
Gross beta	< 0.8	< 1.0	< 0.9	1.8 ± 0.6	1.6 ± 0.6
I-131	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Mn-54	< 10	< 10	< 10	< 10	< 10
Fe-59	< 30	< 30	< 30	< 30	< 30
Co-58	< 10	< 10	< 10	< 10	< 10
Co-60	< 10	< 10	< 10	< 10	< 10
Zn-65	< 30	< 30	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15	< 15	< 15
Ce-144	< 39	< 29	< 40	< 31	< 21

Period Collected Lab Code	November MDW-5233	December MDW-5465		Cumulative Average	Previous Average
Gross beta	< 0.9	1.1 ± 0.5		1.6	2.0
I-131	< 1.0	< 1.0		< 1.0	< 1.0
Mn-54	< 10	< 10		< 10	< 10
Fe-59	< 30	< 30		< 30	< 30
Co-58	< 10	< 10		< 10	< 10
Co-60	< 10	< 10		< 10	< 10
Zn-65	< 30	< 30		< 30	< 30
Zr-Nb-95	< 15	< 15		< 15	< 15
Cs-134	< 10	< 10		< 10	< 10
Cs-137	< 10	< 10		< 10	< 10
Ba-La-140	< 15	< 15		< 15	< 15
Ce-144	< 38	< 17		< 40	< 42

Table 12. River water and drinking water, analysis of quarterly composites for tritium.
Collection: Quarterly composites of weekly collections.

Sample Type, Location and Collection Period	Lab Code	Concentration (pCi/L) H-3	
River Water Upstream, M-8 (C)		Required LLD	Result
1st Quarter	ND [a]	-	-
2nd Quarter	MSW- 2595	< 500	< 154
3rd Quarter	MSW- 4308	< 500	< 154
4th Quarter	MSW- 5469 [b]	< 500	< 149
Cumulative Average		< 500	< 154
Previous Annual Average		< 500	< 183
River Water Downstream, M-9			
1st Quarter	MSW- 1385	< 500	< 156
2nd Quarter	MSW- 2596	< 500	< 154
3rd Quarter	MSW- 4309	< 500	< 154
4th Quarter	MSW- 5470	< 500	< 148
Cumulative Average		< 500	< 156
Previous Annual Average		< 500	< 183
Drinking Water Minneapolis, M-14			
1st Quarter	MDW- 1238	< 500	< 156
2nd Quarter	MDW- 2597	< 500	< 154
3rd Quarter	MDW- 4310	< 500	< 154
4th Quarter	MDW- 5471	< 500	< 148
Cumulative Average		< 500	< 156
Previous Annual Average		< 500	< 183

[a] Water frozen entire 1st quarter.

[b] The composite only up to 11-07-18; see Table 2.0, Listing of Missed Samples.

Table 13. Well water, analysis for tritium and gamma-emitting isotopes.

Sample Description and Concentration (pCi/L)												
Date Collected	Lab Code	H-3 (< 500 pCi/L)	Mn-54	Fe-59	Co-58	Co-60	Zn-65	Zr-Nb-95	Cs-134	Cs-137	Ba-La-140	Ce-144
						Monticello (M-11)						
1/17/2018	MWW- 230	< 156	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 18
4/18/2018	MWW- 1501	< 156	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 40
7/16/2018	MWW- 2880	< 158	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 28
10/17/2018	MWW-4418	< 153	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 28
Cumulative Averages		< 158	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 40
						Plant Well No. 1 (M-12)						
1/17/2018	MWW- 231	< 156	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 21
4/18/2018	MWW- 1502	< 156	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 27
7/18/2018	MWW- 2881	< 158	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 30
10/17/2018	MWW-4419	< 153	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 21
Cumulative Averages		< 158	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 30
						Hasbrouck (M-55)						
1/17/2018	MWW- 233	< 156	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 25
4/18/2018	MWW- 1504	< 156	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 25
7/18/2018	MWW- 2883	< 158	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 22
10/17/2018	MWW-4421	< 153	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 15
Cumulative Averages		< 158	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 25
						Imholte (M-43C)						
1/17/2018	MWW- 232	< 156	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 27
4/18/2018	MWW- 1503	< 156	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 21
7/18/2018	MWW- 2882	< 158	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 25
10/17/2018	MWW-4420	< 153	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 19
Cumulative Averages		< 158	< 10	< 30	< 10	< 10	< 30	< 15	< 10	< 10	< 15	< 27

Table 14. Fish, analysis of edible portions for gamma-emitting isotopes.
Collection: Semiannually

Sample Description and Concentration (pCi/g wet)

Upstream 1000' M-8 (C)

Date Collected	05-24-18	05-24-18	09-19-18	09-19-18
Lab Code	MF- 2069	MF- 2070	MF- 3932	MF- 3933
Sample Type	Smallmouth Bass	Shorthead Redhorse	Shorthead Redhorse	Smallmouth Bass
K-40	3.49 ± 0.43	3.64 ± 0.52	3.05 ± 0.45	3.30 ± 0.46
Mn-54	< 0.017	< 0.028	< 0.014	< 0.016
Fe-59	< 0.032	< 0.047	< 0.035	< 0.046
Co-58	< 0.016	< 0.029	< 0.019	< 0.019
Co-60	< 0.014	< 0.026	< 0.014	< 0.014
Zn-65	< 0.026	< 0.069	< 0.028	< 0.034
Nb-95	< 0.023	< 0.048	< 0.022	< 0.021
Zr-95	< 0.031	< 0.044	< 0.033	< 0.036
Cs-134	< 0.016	< 0.026	< 0.010	< 0.019
Cs-137	< 0.020	< 0.020	< 0.012	< 0.012
Ba-La-140	< 0.033	< 0.044	< 0.035	< 0.069
Ce-144	< 0.074	< 0.132	< 0.079	< 0.083

	Cumulative Average	Previous Average
K-40	3.37	2.85
Mn-54	< 0.028	< 0.017
Fe-59	< 0.047	< 0.065
Co-58	< 0.029	< 0.023
Co-60	< 0.026	< 0.020
Zn-65	< 0.069	< 0.032
Nb-95	< 0.048	< 0.033
Zr-95	< 0.044	< 0.037
Cs-134	< 0.026	< 0.020
Cs-137	< 0.020	< 0.018
Ba-La-140	< 0.069	< 0.161
Ce-144	< 0.132	< 0.110

Table 14. Fish, analysis of edible portions for gamma-emitting isotopes.
Collection: Semiannually

Sample Description and Concentration (pCi/g wet)

	Downstream 1000' M-9			
Date Collected	05-24-18	05-24-18	09-19-18	09-19-18
Lab Code	MF- 2071	MF- 2073	MF- 3934	MF- 3935
Sample Type	Smallmouth Bass	Shorthead Redhorse	Shorthead Redhorse	Smallmouth Bass
K-40	3.52 ± 0.51	3.92 ± 0.42	3.05 ± 0.45	3.50 ± 0.45
Mn-54	< 0.018	< 0.015	< 0.013	< 0.025
Fe-59	< 0.059	< 0.027	< 0.045	< 0.053
Co-58	< 0.016	< 0.013	< 0.022	< 0.015
Co-60	< 0.020	< 0.017	< 0.013	< 0.012
Zn-65	< 0.033	< 0.026	< 0.026	< 0.046
Nb-95	< 0.033	< 0.021	< 0.018	< 0.030
Zr-95	< 0.040	< 0.020	< 0.032	< 0.030
Cs-134	< 0.023	< 0.022	< 0.022	< 0.020
Cs-137	< 0.024	< 0.015	< 0.013	< 0.026
Ba-La-140	< 0.021	< 0.040	< 0.063	< 0.094
Ce-144	< 0.100	< 0.087	< 0.082	< 0.105

	Cumulative Average	Previous Average
K-40	3.50	2.83
Mn-54	< 0.025	< 0.015
Fe-59	< 0.059	< 0.045
Co-58	< 0.022	< 0.023
Co-60	< 0.020	< 0.020
Zn-65	< 0.046	< 0.038
Nb-95	< 0.033	< 0.034
Zr-95	< 0.040	< 0.036
Cs-134	< 0.023	< 0.019
Cs-137	< 0.026	< 0.014
Ba-La-140	< 0.094	< 0.104
Ce-144	< 0.105	< 0.094

Table 15. Aquatic invertebrates, analysis for gamma-emitting isotopes.
Collection: Semiannually

Sample Description and Concentration (pCi/g wet)			Cumulative Average	Previous Average
	Upstream 1000' M-8 (C)			
Date Collected	08-14-18	09-21-18		
Lab Code	MBO- 3265	MBO- 3988		
Be-7	< 0.39	< 0.58	<0.58	< 0.57 [a]
K-40	< 1.01	1.55 ± 0.72	1.55	< 0.84
Mn-54	< 0.032	< 0.053	< 0.053	< 0.024
Fe-59	< 0.103	< 0.104	< 0.104	< 0.130
Co-58	< 0.045	< 0.053	<0.053	< 0.068
Co-60	< 0.046	< 0.054	< 0.054	< 0.052
Zn-65	< 0.078	< 0.101	< 0.101	< 0.094
Zr-Nb-95	< 0.055	< 0.074	< 0.074	< 0.064
Ru-103	< 0.037	< 0.078	< 0.078	< 0.075
Ru-106	< 0.408	< 0.404	< 0.408	< 0.386
Cs-134	< 0.034	< 0.049	< 0.049	< 0.040
Cs-137	< 0.034	< 0.052	< 0.052	< 0.049
Ba-La-140	< 0.071	< 0.167	< 0.167	< 0.411
Ce-144	< 0.145	< 0.308	< 0.308	< 0.205
	Downstream 1000' M-9			
Date Collected	08-14-18	09-21-18		
Lab Code	MBO- 3266	MBO- 3989		
Be-7	< 0.79	< 0.52	< 0.79	< 1.27
K-40	< 1.86	1.11 ± 0.61	1.11	< 2.23
Mn-54	< 0.068	< 0.046	< 0.068	< 0.097
Fe-59	< 0.154	< 0.066	< 0.154	< 0.301
Co-58	< 0.061	< 0.042	< 0.061	< 0.076
Co-60	< 0.058	< 0.035	< 0.058	< 0.096
Zn-65	< 0.143	< 0.075	< 0.143	< 0.218
Zr-Nb-95	< 0.076	< 0.073	< 0.076	< 0.216
Ru-103	< 0.083	< 0.068	< 0.083	< 0.175
Ru-106	< 0.666	< 0.359	< 0.666	< 0.764
Cs-134	< 0.093	< 0.042	< 0.093	< 0.109
Cs-137	< 0.100	< 0.048	< 0.100	< 0.131
Ba-La-140	< 0.072	< 0.104	< 0.104	< 0.541
Ce-144	< 0.396	< 0.251	< 0.396	< 0.454

[a] "Previous Average" is from 2016; no samples available from location in 2017.

Table 16. Shoreline (SS) sediments, analysis for gamma-emitting isotopes.
Collection: Semiannually

Sample Description and Concentration (pCi/g dry)			Cumulative Average	Previous Average
		Upstream 1000' M-8 (C)		
Date Collected	06-28-18	11-08-18		
Lab Code	MSS- 2457	MSS- 4786		
Be-7	0.30 ± 0.16	< 0.12	0.30	< 0.13
K-40	9.54 ± 0.55	9.76 ± 0.54	9.65	10.82
Mn-54	< 0.014	< 0.013	< 0.014	< 0.013
Fe-59	< 0.041	< 0.036	< 0.041	< 0.042
Co-58	< 0.018	< 0.013	< 0.018	< 0.018
Co-60	< 0.013	< 0.013	< 0.013	< 0.014
Zn-65	< 0.033	< 0.030	< 0.033	< 0.041
Nb-95	< 0.018	< 0.022	< 0.022	< 0.022
Zr-95	< 0.027	< 0.030	< 0.030	< 0.030
Ru-103	< 0.018	< 0.016	< 0.018	< 0.016
Ru-106	< 0.124	< 0.105	< 0.124	< 0.089
Cs-134	< 0.014	< 0.016	< 0.016	< 0.014
Cs-137	< 0.018	0.021 ± 0.011	0.021	< 0.012
Ba-La-140	< 0.036	< 0.060	< 0.060	< 0.069
Ce-144	< 0.098	< 0.077	< 0.098	< 0.077
		Downstream 1000' M-9		
Date Collected	06-28-18	11-08-18		
Lab Code	MSS- 2458	MSS- 4787		
Be-7	< 0.20	< 0.15	< 0.20	< 0.15
K-40	11.90 ± 0.73	11.42 ± 0.64	11.66	10.25
Mn-54	< 0.025	< 0.017	< 0.025	< 0.016
Fe-59	< 0.074	< 0.046	< 0.074	< 0.041
Co-58	< 0.021	< 0.017	< 0.021	< 0.018
Co-60	< 0.014	< 0.014	< 0.014	< 0.014
Zn-65	< 0.049	< 0.039	< 0.049	< 0.037
Nb-95	< 0.028	< 0.025	< 0.028	< 0.024
Zr-95	< 0.050	< 0.034	< 0.050	< 0.033
Ru-103	< 0.026	< 0.021	< 0.026	< 0.016
Ru-106	< 0.167	< 0.117	< 0.167	< 0.115
Cs-134	< 0.021	< 0.018	< 0.021	< 0.016
Cs-137	0.085 ± 0.025	0.056 ± 0.021	0.070	0.042
Ba-La-140	< 0.052	< 0.090	< 0.090	<0.091
Ce-144	< 0.091	< 0.083	< 0.091	<0.077

Table 16. Shoreline (SS) sediments, analysis for gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/g dry)			Cumulative Average	Previous Average
	Montissippi Park M-15			
Date Collected	06-28-18	11-08-18		
Lab Code	MSS- 2459	MSS- 4788		
Be-7	< 0.17	0.69 ± 0.31	0.69	< 0.13
K-40	11.02 ± 0.64	11.75 ± 0.63	11.39	9.69
Mn-54	< 0.015	< 0.015	< 0.015	< 0.018
Fe-59	< 0.048	< 0.051	< 0.051	< 0.042
Co-58	< 0.016	< 0.017	< 0.017	< 0.017
Co-60	< 0.014	< 0.015	< 0.015	< 0.015
Zn-65	< 0.037	< 0.033	< 0.037	< 0.032
Nb-95	< 0.022	< 0.026	< 0.026	< 0.027
Zr-95	< 0.033	< 0.030	< 0.033	< 0.034
Ru-103	< 0.015	< 0.021	< 0.021	< 0.019
Ru-106	< 0.127	< 0.111	< 0.127	< 0.117
Cs-134	< 0.015	< 0.018	< 0.018	< 0.013
Cs-137	0.203 ± 0.028	0.041 ± 0.016	0.122	0.032
Ba-La-140	< 0.025	< 0.054	< 0.054	< 0.155
Ce-144	< 0.084	< 0.084	< 0.084	<0.082