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PNP 2020-012

Technical Specification 5.6.2

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

Subject: 2019 Radiological Environmental Operating Report

Palisades Nuclear Plant
Docket 50-255
Renewed Facility Operating License No. DPR-20

Dear Sir or Madam:

Entergy Nuclear Operations, Inc. is submitting the enclosed Radiological Environmental Operating Report for the Palisades Nuclear Plant. This report was prepared in accordance with the requirements of Technical Specification 5.6.2. The period covered by the enclosed report is January 1, 2019, through December 31, 2019.

If you have any questions regarding this submittal, please contact Mike Soja, Chemistry Manager, at 269-764-2536.

This letter contains no new commitments and no revision to existing commitments.

Respectfully,

A handwritten signature in blue ink, appearing to read "JAH".

JAH/bed

Enclosure: Annual Radiological Environmental Operating Report

CC Administrator, Region III, USNRC
Project Manager, Palisades, USNRC
Resident Inspector, Palisades, USNRC



Plant: Palisades	Page 1 of 57
	YEAR: 2019
Document Number: 2020-012	
Annual Radiological Environmental Operating Report	

Annual Radiological Environmental Operating Report**TABLE OF CONTENTS**

1.0	EXECUTIVE SUMMARY.....	3
2.0	INTRODUCTION	4
3.0	RADIOLOGICAL ENVIRONMENTAL SAMPLING PROGRAM REQUIREMENTS	5
4.0	INTERPRETATION AND TRENDS OF RESULTS.....	12
5.0	RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY.....	20

ATTACHMENTS

Attachment 1 - Sample Deviations.....	25
Attachment 2 - Monitoring Results Tables	27
Attachment 3 - Interlaboratory Comparison Program Results	54
Attachment 4 - Previous AREOR ERRATA.....	57

Annual Radiological Environmental Operating Report**1.0 EXECUTIVE SUMMARY****1.1 Radiological Environmental Monitoring Program**

The Annual Radiological Environmental Operating Report (AREOR) presents data obtained through analyses of environmental samples collected for Palisades Radiological Environmental Monitoring Program (REMP). The reporting period for this report is from January 1 through December 31, 2019. This report fulfills the requirements of Palisades Technical Specification 5.6.2.

No measurable levels of radiation above baseline levels attributable to Palisades operation were detected in the environment. The 2019 REMP thus substantiated the adequacy of source control and effluent monitoring at Palisades with no detectable impact of plant operations on the environment.

Palisades established the REMP prior to the station becoming operational to provide data on background radiation and radioactivity normally present in the area. Palisades has continued to monitor the environment by sampling air, water, sediment, broad leaf vegetation, fish, and food products, as well as measuring direct radiation. Palisades also samples milk if milk-producing animals used for human consumption are present within five miles (8 km) of the plant. The requirements of the REMP are formally described in the offsite dose calculation manual (ODCM), a site specific regulatory document.

The REMP includes sampling indicator and control locations. The REMP utilizes indicator locations near Palisades to identify buildup of radioactivity and control locations to provide a comparison for indicator locations. Indicator, control, and pre-operational results are used to assess any impact Palisades operation might have had on the surrounding environment.

All 2019 REMP results support the conclusion that the surrounding environment is minimally affected by Palisades' effluents. No activity in any REMP sample from 2019 was attributed to Palisades' effluents.

1.2 Reporting Levels

No samples equaled or exceeded reporting levels.

1.3 Sample Deviations

During 2019, environmental sampling was performed for eight media types (airborne, surface water, drinking water, offsite groundwater, sediment, broad leaf vegetation, fish, and food products) and for direct radiation. All REMP samples were obtained as required by the ODCM in 2019 with the exception of six instances of sample deviations which are further discussed in Attachment 1 Table 8.

Annual Radiological Environmental Operating Report**1.4 Program Modifications**

1. There was one program modification as a result of the 2019 land use census. This modification was for a new, identified critical goat location and will be used in offsite dose modeling calculations. Goat milk sampling will be performed in accordance with Palisades ODCM assuming the goat milk is available to be sampled. Broad leaf vegetation samples will continue to be collected in accordance with Palisades ODCM. There is no expected impact to trending of REMP data due to this change.

2.0 INTRODUCTION**2.1 Radiological Environmental Monitoring Program**

Palisades established the REMP as defined in the ODCM to fulfill 10 CFR Part 50 Appendix I Section IV.B.2. The REMP supplements the radiological effluent monitoring program by verifying that the concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways.

2.2 Pathways Monitored

The airborne, direct radiation, waterborne, and ingestion pathways are monitored as required by Table 1 through Table 4.

Section 4.0 of this report provides a discussion of 2019 sampling results and Section 5.0 provides a summary of results for the monitored exposure pathways.

2.3 Land Use Census

Palisades conducts a land use census annually to identify changes in uses of land within five miles of the site that would require modifications to the REMP and the ODCM. The purpose of this census is to identify critical receptor pathways for the purpose of effluent modeling and REMP sampling.

3.0 RADIOLOGICAL ENVIRONMENTAL SAMPLING PROGRAM REQUIREMENTS

Table 1, Exposure Pathway – Airborne

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
<p><u>RADIOIODINE AND PARTICULATES</u></p> <p>Six samples total. Four samples from within 6 km (3.7 miles) of the site boundary in different sectors. One sample from the vicinity of a community having the highest calculated annual average ground level deposition factor. One control sample in the least prevalent wind direction (considering practical direction and distance).</p>	<ul style="list-style-type: none"> • A8 (0.595 miles NE) - onsite near state park • A19 (0.423 miles SSE) - onsite near Bluestar Hwy • A9 (1.525 miles SSW) - offsite near blue star highway • A4 (3.882 miles SE) - offsite in Covert township • A5 (3.590 miles ESE) - offsite in Covert township • A10 (50.765 miles NE) - offsite near Grand Rapids 	<p>Continuous sampler operation with sample collection every week, or more frequently if required by dust loading.</p>	<p>I-131 analysis weekly for each filter change.</p> <p>Gross beta radioactivity analysis weekly for each filter change.</p> <p>Gamma isotopic analysis quarterly for a composite of all filters collected.</p> <p>IF filter gross beta is greater than 10 times the yearly mean of the control sample THEN gamma isotopic is performed on the filter.</p>

Table 2, Exposure Pathway – Direct Radiation

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency of Analyses
<p>TLDS</p> <p>23 routine monitoring stations either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows:</p> <p>One onsite TLD in the vicinity of the plant. An inner ring of stations consisting of one in each overland meteorological sector, one in the general area of the state park camping area in the NE sector, and one in the general area of the site boundary.</p>	<ul style="list-style-type: none"> • TLD-1 (0.213 miles E) - onsite inner ring TLD • TLD-8 (0.602 miles NE)- inner ring TLD • TLD-13 (0.530 miles NNE) - inner ring TLD • TLD-14 (0.551 miles NE)- inner ring TLD • TLD-15 (0.834 miles ENE)- inner ring TLD • TLD-16 (0.804 miles E)- inner ring TLD • TLD-17 (0.572 miles ESE) - inner ring TLD • TLD-18 (0.469 miles SE) - inner ring TLD • TLD-19 (0.443 miles SSE)- inner ring TLD • TLD-20 (0.412 miles S)- inner ring TLD • TLD-21 (0.382 miles SSW) - inner ring TLD 	<p>Quarterly</p>	<p>Gamma dose (units of milliRoentgen, abbreviated mR) quarterly</p>

Table 2, Exposure Pathway – Direct Radiation

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency of Analyses
<p>An outer ring of stations one in each overland meteorological sector within the 12 km range from the site.</p> <p>Three control stations sufficiently far from the plant as to not be affected from the plant.</p>	<ul style="list-style-type: none"> • TLD-2 (5.560 miles SE) - outer ring TLD • TLD-3 (5.684 miles SSE) - outer ring TLD • TLD-4 (3.668 miles S) - outer ring TLD • TLD-5 - (3.475 miles ESE) - outer ring TLD • TLD-6 - (5.314 miles NE) - outer ring TLD • TLD-7 (4.115 miles NNE) - outer ring TLD • TLD-9 (1.670 miles SSW) - outer ring TLD • TLD-23 (3.189 miles ENE) - outer ring TLD • TLD-24 (6.021 miles E) - outer ring TLD • TLD-10 (50.746 miles NE) - control TLD • TLD-11 (39.472 miles E) - control TLD • TLD-12 (27.971 miles SSE) - control TLD 	<p>Quarterly</p>	<p>Gamma dose (mR) quarterly</p>

Table 3, Exposure Pathway – Waterborne

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency of Analyses
<p><u>SURFACE WATER</u> Lake in (plant intake lake water)</p>	Lake in - Lake Michigan intake water used in plant systems. Sample is collected onsite.	Daily samples are used to make a monthly composite sample.	Gamma isotopic, gross beta (not ODCM required), and tritium analysis monthly
<p><u>DRINKING WATER</u> South Haven drinking water Palisades Park (Pal Park) community drinking water is sampled when in operation (summer months) Domestic water (not ODCM required) is sampled onsite.</p>	<p>City of South Haven drinking water intake structure (5.6 miles NNE of Palisades)</p> <p>Pal Park community drinking water (0.7 miles SSW of Palisades)</p> <p>Domestic water is sampled onsite from any potable water source, typically an eye wash station.</p>	<p>Daily South Haven drinking water samples are used to make a monthly composite sample.</p> <p>1 grab sample of Palisades Park (Pal Park) community drinking water is sampled monthly when in operation (summer months).</p> <p>Daily samples are used to make a monthly composite.</p>	<p>Gamma isotopic, gross beta, and tritium analysis monthly</p> <p>Gamma isotopic, gross beta (not ODCM required), and tritium analysis monthly when operational</p> <p>Gamma isotopic, gross beta, and tritium analysis monthly</p>
<p><u>Surface Water and Drinking Water Control</u> Lake water from Ludington Pump-house is analyzed as a control sample for drinking and surface water.</p>	Ludington Control - Lake Michigan intake water from Ludington Pump-house (201 km North of Palisades).	Daily samples are used to make a monthly composite sample.	Gamma isotopic, gross beta, and tritium analysis monthly
<p><u>OFFSITE GROUNDWATER</u> Palisades Park (Pal Park) commercial water is sampled when in operation (summer months). This sample is not ODCM required.</p>	0.7 miles S of Palisades	1 grab sample is sampled monthly when in operation (summer months)	Gamma isotopic, gross beta, and tritium analysis monthly
<p><u>SEDIMENT FROM SHORELINE</u> North sediment sample</p>	1 sample between the north site boundary and Van Buren State Park beach, approximately 1/2 mile north of the plant discharge.	Semiannually	Gamma isotopic analysis semiannually.

Table 4, Exposure Pathway – Ingestion

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
<p><u>MILK</u> Samples from milking animals in 3 locations between 5-8km distance 1 sample from milking animals at a control location.</p>	<p>For 2019 goat milk samples were not available to be sampled from the indicator locations. A control location was sampled from 91 miles from the plant in the ENE direction for three different months to establish a baseline background.</p>	<p>Monthly</p>	<p>Gamma isotopic and I-131 monthly</p>
<p><u>Broad leaf Vegetation</u> Samples of three different kinds of broad leaf vegetation grown nearest each of two different offsite locations of highest predicted annual average ground level deposition and one sample of each of the similar broad leaf vegetation grown 15-30 km distance in the least prevalent wind direction IF milk sample is not performed.</p>	<p>0.7 miles SE from Palisades. 0.4 miles SSE from Palisades. 13.6 miles NNE from Palisades.</p>	<p>Monthly during growing season</p>	<p>Gamma isotopic and I-131 monthly during growing season</p>
<p><u>FISH</u> Sample 2 species of commercially and/or recreationally important species in the vicinity of the plant discharge area. 1 sample of the same species in areas not influenced by plant discharge.</p>	<p>The indicator sample is obtained from Lake Michigan onsite within a few hundred feet of the main liquid discharge point The control sample is obtained from Lake Michigan near Ludington MI (201 km North of Palisades).</p>	<p>Semiannually</p>	<p>Gamma isotopic analysis semiannually</p>
<p><u>FOOD PRODUCTS</u> 1 sample of each of two principal fruit crops (blueberries and apples).</p>	<p>3.7 miles SE from Palisades.</p>	<p>Annually at time of harvest</p>	<p>Gamma isotopic and I-131 annually</p>

Annual Radiological Environmental Operating Report

Figure 1, Exposure Pathway

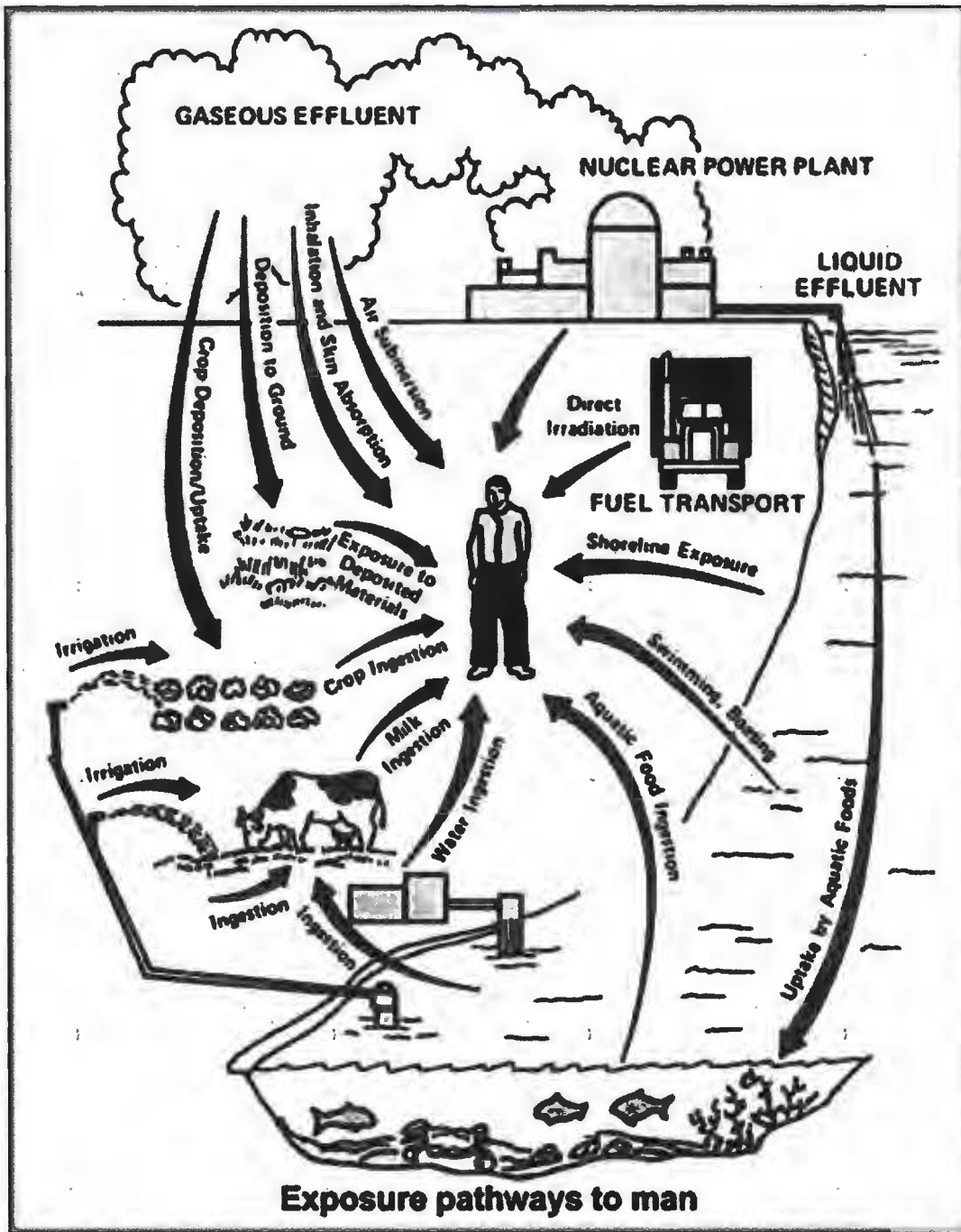
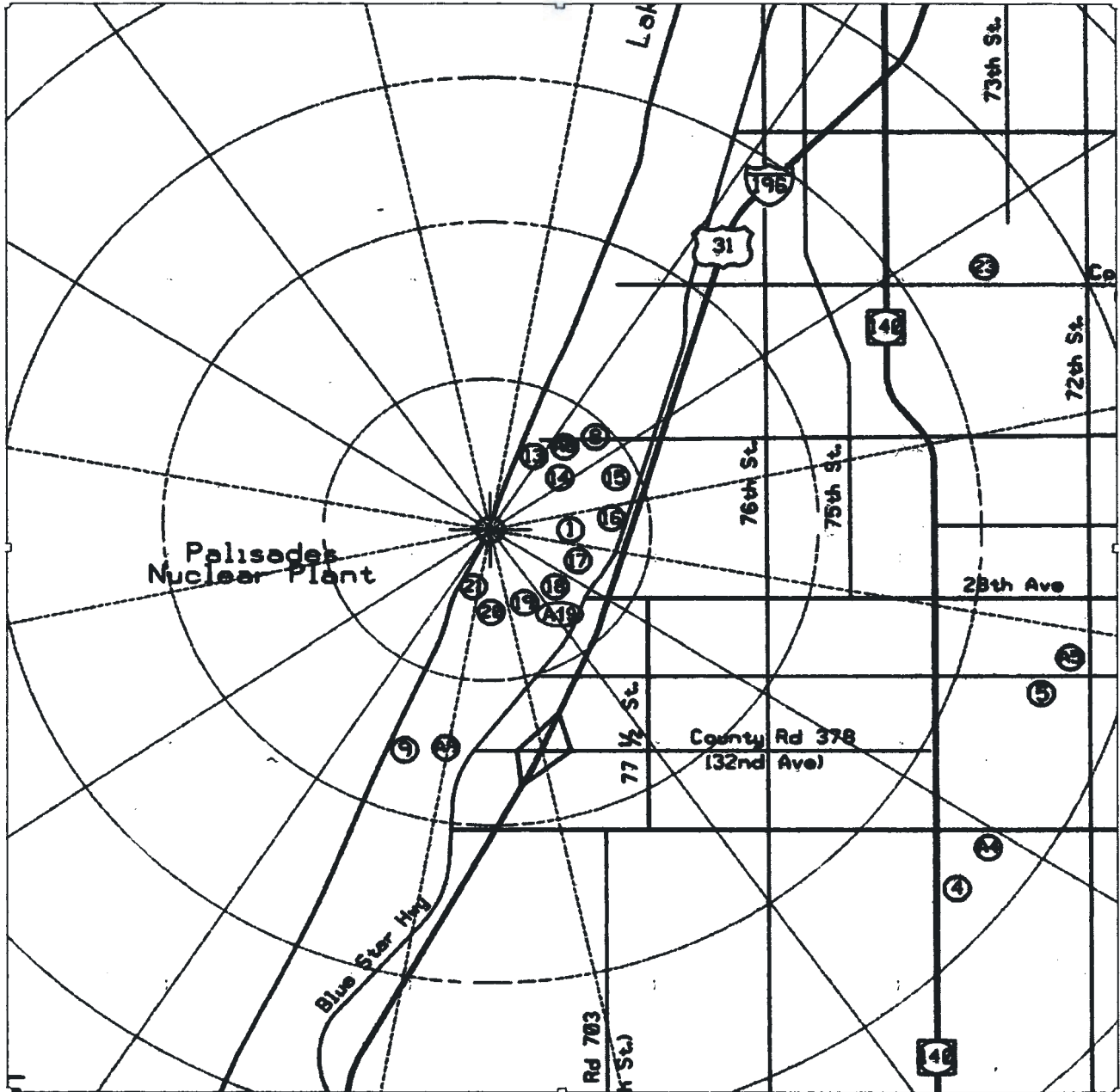


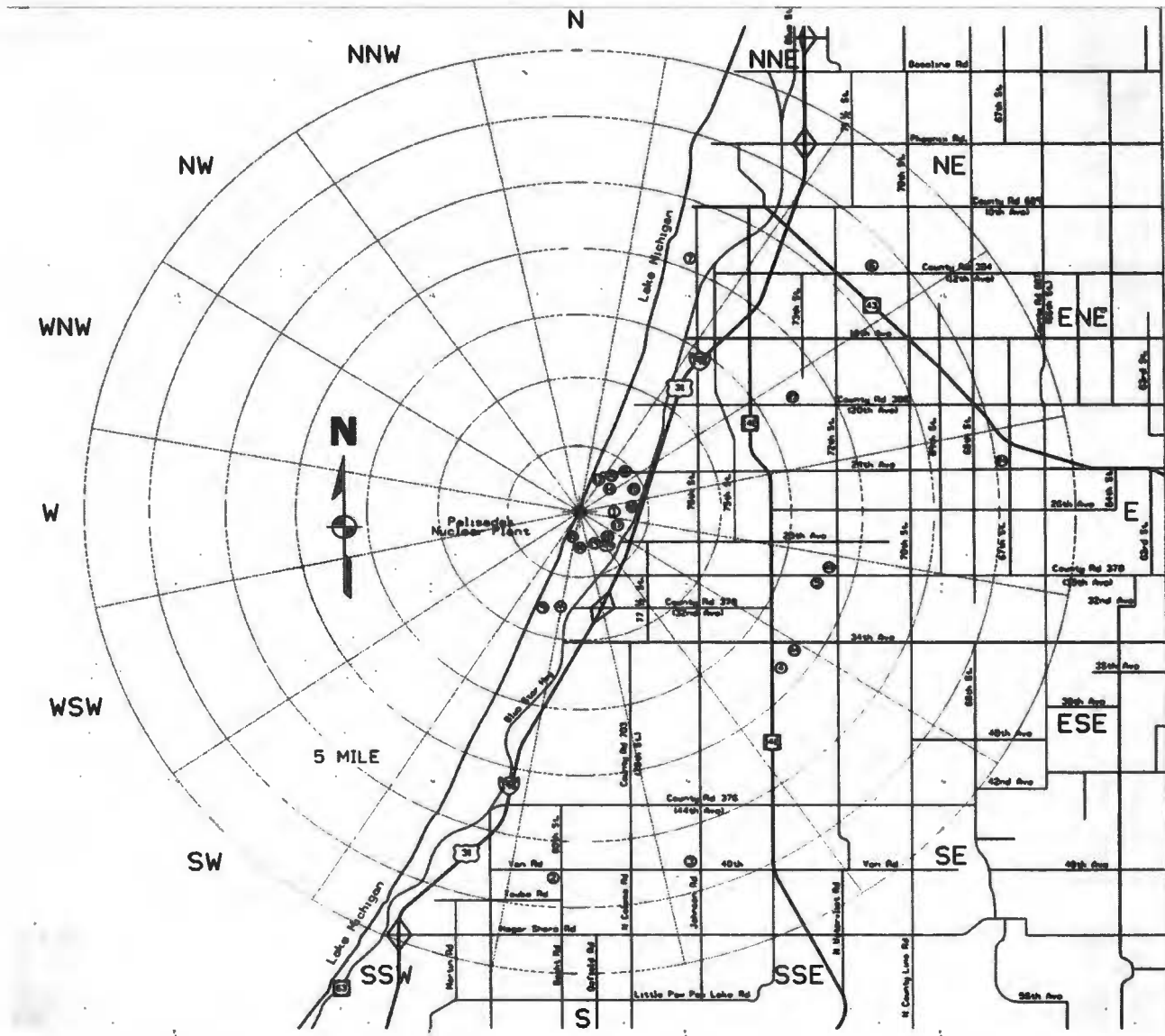
Figure 2, Sample Collection Sites –Near Field



The locations in Figure 2 correspond to the TLD and Air Sampler locations in Table 1 and Table 2.

Annual Radiological Environmental Operating Report

Figure 3, Sample Collection Sites - Far Field



The locations in Figure 3 correspond to the TLD and Air Sampler locations in Table 1 and Table 2.

4.0 INTERPRETATION AND TRENDS OF RESULTS

4.1 Air Particulate and Radioiodine Sample Results

There were 312 air samples collected and analyzed for gross beta and I-131 during 2019. Air iodine and particulate samples are collected weekly from six air-sampling locations. Air is metered into the sampling unit through a 47-mm air filter (for particulate) and an air iodine cartridge. The filters are in series with one another and housed within the same filter holder. An "as found" and "as left" leak test is performed at each station during each sample collection. Weekly samples were sent to Teledyne Brown Engineering Environmental Services for analysis.

Annual Radiological Environmental Operating Report

Analysis of the airborne particulate sample data, between the five near-site indicator locations and the control location, indicate no difference between indicator and control locations. The average concentration of gross beta activity among all indicator locations was $2.16\text{E-}02$ pCi/m³ and was $2.07\text{E-}02$ pCi/m³ for the control location. All I-131 activity results, for both indicator and control locations, were below the minimum detectable activity (MDA). Gamma isotopic analysis is performed quarterly on a quarterly composite of the filter papers. All radionuclides detected (Be-7) were naturally occurring radionuclides which are not attributed to plant effluents.

Palisades' pre-operational environmental study showed naturally occurring gross beta radiation between 0.03 and 3.0 pCi/m³ with a similar trend between stations onsite, in the surrounding community, and control stations. The activity results from 2019 indicate there is no measureable change between pre-operational airborne gross beta activity and present day airborne gross beta activity.

There was one REMP deviation in 2019 involving air sampling. This instance is discussed in Attachment 1 Table 8.

In the absence of plant-related gamma radionuclides, gross beta activity is attributed to naturally occurring radionuclides. The air sample results collected in accordance with the REMP support the conclusions of the effluents monitoring program for 2019. This conclusion is that the surrounding environment is minimally affected by Palisades' effluents. No REMP air samples from 2019 contained measurable radiological materials attributed to Palisades' effluents.

Annual Radiological Environmental Operating Report

4.2 Thermoluminescent Dosimetry (TLD) Sample Results

Palisades reports measured dose as net exposure (subtracting transit reading) normalized to 92 days. TLDs are oriented in an inner ring, outer ring, and control locations. The inner ring consists of 11 TLDs, the outer ring consists of 9 TLDs, and there are 3 control locations. This orientation allows for monitoring all 9 overland compass sectors surrounding Palisades. To assess the effect of direct and shine radiation from Palisades to the environment the inner ring, outer ring, and control TLDs are compared to one another. Additionally, each individual TLD location is compared to a baseline of data which was created from a comprehensive review of data from 2011 through 2016. The high and low values for the baseline are based upon two standard deviations for each data point from 2011 through 2016. If a value is measured outside the baseline additional follow-up investigation is performed to evaluate the cause. During 2019 all TLDs trended normal and no TLDs were outside the baseline. This evaluation identified no noticeable trend that would indicate that the ambient radiation levels are being affected by plant operations. During 2019 there was one instance of a REMP deviations involving one TLD. This instance is discussed in Attachment 1 Table 8. Table 5 shows the consistent trend of average inner ring, outer ring, and control TLDs.

TLD measurements taken as part of Palisades' pre-operational environmental study used different instrumentation which had difficulty in achieving desired sensitivity and accuracy. A more sensitive type of TLD was implemented in 1971 and the present day TLD device used is the industry standard. TLD data has trended consistently throughout the several most recent independent spent fuel storage installation (ISFSI) loading campaigns which indicates these loading campaigns have had no measurable effect on the environment.

Activity from TLD measurements in the environment is attributed to naturally occurring background radiation and not from Palisades' direct or shine radiation.

Table 5, Direct Radiation Annual Summary

Year	Inner Ring (mR/Qtr)	Outer Ring (mR/Qtr)	Control Location (mR/Qtr)
2012	9.7	11.9	11.6
2013	9.9	11.6	11.7
2014	9.1	10.9	10.7
2015	9.5	11.2	10.9
2016	9.6	11.3	11.2
2017	9.3	11.2	10.9
2018	9.3	11.1	11.0
2019	9.4	11.2	11.0

Annual Radiological Environmental Operating Report**4.3 Waterborne Sample Results**

During 2019 Palisades implemented the REMP in accordance with the ODCM for collection of surface, drinking, and groundwater. For all surface, drinking, and groundwater indicator samples, the same control sample is used as a baseline for comparison. That control sample is referred to as the "Ludington Control" and is collected 201 km north of Palisades. The Ludington Control sample is analyzed monthly and is a composite of daily samples. The Ludington Control sample is analyzed for gamma radionuclide, tritium, and gross beta activity. In 2019 the only radionuclide activity detected in Ludington Control water was naturally occurring isotopes (K-40). Of the twelve Ludington Control samples collected in 2019, four contained detectable gross beta with an average value of 2.81 pCi/L. The gross beta activity is a result of naturally occurring radionuclide and is not attributed to Palisades' effluents.

4.3.1 Surface Water

The indicator surface water samples collected and analyzed for the REMP include "Lake In" water. This sample is Lake Michigan water after it has traveled through the Palisades' intake structure and traveling screens. This sample is collected daily and composited into a monthly sample which is analyzed for gamma radionuclide and tritium onsite. This sample is also analyzed by Teledyne Brown Engineering Environmental Services for gamma, tritium, and gross beta activity. All radionuclide detected (K-40, Ra-226, and Th-228) were naturally occurring and are not attributed to Palisades' effluents. Three out of the twelve monthly samples contained measurable gross beta with the average detectable gross beta activity at 2.88 pCi/L.

Palisades' pre-operational environmental study established a baseline of gross beta activity for the site before Palisades was operational. The study results for surface water showed consistently measurable results for gross beta activity between 11 - 18 (+/- 5) pCi/L.

The surface water sample results collected in accordance with the REMP support the conclusions of the effluents monitoring program for 2019. This conclusion is that the surrounding environment is minimally affected by Palisades' effluents. No REMP surface water samples from 2019 contained measurable radiological materials attributed to Palisades' effluents.

4.3.2 Drinking Water

The indicator drinking water samples collected and analyzed for the REMP include "Domestic Water", "South Haven Drinking Water", and "Palisades Park Community Water". All samples are analyzed for gamma, tritium, and gross beta by Teledyne Brown Engineering Environmental Services.

Annual Radiological Environmental Operating Report

Domestic Water is collected onsite from a potable water system, typically an eyewash station. This sample is collected daily and composited into a monthly sample which is analyzed for gamma radionuclide and tritium onsite. All radionuclide detected (K-40, Ra-226, and Th-228) were naturally occurring and are not attributed to Palisades' effluents. Four out of the twelve monthly samples contained measurable gross beta activity with the average detectable gross beta activity at 2.56 pCi/L. The gross beta activity is attributed to naturally occurring radionuclide. Domestic water is not required by the ODCM for the REMP. This sample is collected as part of the NRC bulletin 80-10 commitments and is included in this report because the data strengthens the REMP.

South Haven Drinking Water is collected from the City of South Haven Water Treatment facility located in South Haven. All radionuclide detected (K-40 and Th-228) were naturally occurring and are not attributed to Palisades' effluents. Four out of the twelve monthly samples contained measurable gross beta with the average detectable gross beta activity at 2.78 pCi/L. The gross beta activity is attributed to naturally occurring radionuclide.

Palisades Park Community Water is collected once per month as a grab sample from a community just south of Palisades while the facility is operational (summer months). This sample is analyzed for gamma, tritium, and gross beta activity. No radionuclides were detected via gamma spectroscopy and no tritium was detected in any samples. Three out of the six monthly samples contained measurable gross beta activity with the average detectable gross beta activity at 3.27 pCi/L. The gross beta activity is attributed to naturally occurring radionuclide. Gross beta activity is not required by the ODCM for this sample but is performed for trending purposes and to strengthen the REMP.

Palisades' pre-operational environmental study established a baseline of gross beta activity for the site before Palisades was operational. The study results relied upon as a baseline for drinking water analysis are the same results as with surface water, that being consistent gross beta activity between 11 - 18 (+/- 5) pCi/L.

The drinking water sample results collected, in accordance with the REMP, support the conclusions of the effluents monitoring program for 2019. This conclusion is that the surrounding environment is minimally affected by Palisades' effluents. No REMP drinking water samples from 2019 contained measurable radiological materials attributed to Palisades' effluents.

Annual Radiological Environmental Operating Report

4.3.3 Groundwater

Palisades implements an extensive groundwater monitoring program in accordance with NEI-0707, "Industry Ground Water Protection Initiative - Final Guidance Document". This program is designed to identify onsite leaks to groundwater to allow for prompt repair or isolation of the leak. The results of the onsite groundwater program are described in the Annual Radioactive Effluent Release Report (ARERR). Palisades samples one offsite groundwater location. This sample is not required by Palisades ODCM but is procedurally implemented to strengthen the program overall. The REMP groundwater sample is the "Palisades Park Commercial Well Water" sample. This sample is collected once per month as a grab sample from a community just south of Palisades while the facility is operational (summer months). This sample is analyzed for gamma, tritium, and gross beta activity by Teledyne Brown Engineering Environmental Services. No radionuclides were detected via gamma spectroscopy and no tritium was detected in any samples. Four out of the six monthly samples contained measurable gross beta with the average detectable gross beta activity at 4.41 pCi/L. The gross beta activity is attributed to naturally occurring radionuclide.

Palisades' pre-operational environmental study established a baseline of gross beta activity for the site before Palisades was operational. The study results were that five well water samples from Palisades contained gross beta activity above 5 pCi/L with the highest value being 16 pCi/L. Two samples from Covert Park well water contained gross beta activity at 6 and 7 pCi/L.

The groundwater sample results collected in accordance with the REMP support the conclusions of the effluents monitoring program for 2019. This conclusion is that the surrounding environment is minimally affected by Palisades' effluents. No REMP groundwater samples from 2019 contained measurable radiological materials attributed to Palisades' effluents.

Annual Radiological Environmental Operating Report**4.4 Soil Sample Results**

Sediment samples are collected two times per year north and south of the plant from the beach on Lake Michigan. One sample is collected at the southern edge of the property and a second sample is collected approximately 0.5 miles north of the plant. The sample south of the plant is not required by the ODCM but is collected and analyzed to strengthen the REMP. Both the north and south sediment samples are analyzed for gamma radionuclide. In 2019, the only radionuclides detected were naturally occurring (Ac-228, K-40, Th-228, Th-232, and Ra-226) isotopes which are not attributed to Palisades' effluents. In accordance with the ODCM, no control sample is collected for this sample type.

Soil samples were not specifically part of the Palisades' pre-operational environmental study however a study of Cs-137 found in soil (due to global events such as historical atomic testing and fallout) was performed by Palisades in 2011. Analysis was performed of soil in the surrounding area (Southwest Michigan) which showed Cs-137 concentrations between $1.41\text{E-}08$ uCi/g and $5.68\text{E-}07$ uCi/g with an average of $2.68\text{E-}07$ uCi/g. Considering similar studies performed by other utilities, a conservative (low) background of $1.8\text{E-}07$ uCi/g Cs-137 in soil is assumed to be due to global fallout.

The sediment sample results collected in accordance with the REMP support the conclusions of the effluents monitoring program for 2019. This conclusion is that the surrounding environment is minimally affected by Palisades' effluents. No REMP sediment samples from 2019 contained measurable radiological materials attributed to Palisades' effluents.

4.5 Ingestion Sample Results**4.5.1 Milk Sample Results**

Indicator milk samples were not available to be collected during 2019. The control milk samples were collected for three months to establish a baseline of data if the indicator samples were to become available. All radionuclide detected in these samples (K-40) were naturally occurring and are not attributed to Palisades' effluents.

4.5.2 Broad leaf Sample Results

In accordance with Palisades ODCM three different kinds of broad leaf vegetation is sampled from two onsite (indicator) locations and one offsite (control) location due to the fact that milk sampling is not performed. Broad leaf samples are collected once per month during the growing season and analyzed for gamma radionuclides including iodine-131. Naturally occurring radionuclide detected in broad leaf vegetation (Be-7, K-40, and Th-228) are not attributed to Palisades' effluents. Cs-137 detected in broad leaf vegetation was attributed to historical global atomic testing and biological uptake. Cs-137 was detected at location BV1 (0.4 miles SSE) for two out of the five monthly samples. The average concentration of Cs-137 was 87.9 pCi/kg. It is not abnormal to detect Cs-137 in broad leaf samples. Palisades procedurally implements a conservative administrative action value to perform additional reviews if the activity of broad leaf samples exceeds 146 pCi/kg Cs-137. The absence of Cs-134 and the absence of other radionuclides measured in the plant effluent and coolant systems further support that the Cs-137 detected in broadleaf is not a result of Palisades activity.

Annual Radiological Environmental Operating Report

The pre-operational environmental study consisted in part of Cs-137 and Sr-90 analysis for crops and milk. These (and broadleaf) sample results are a result of historical global atomic testing and biological uptake. The pre-operational study identified Cs-137 in milk samples ranging from 2 to 70 pCi/L and Sr-90 ranging from 5 to 15 pCi/L. For crop samples, gross gamma activity was generally between 0.11 and 0.22 pCi/g and gross beta activity was generally between 0.72 to 3.31 pCi/g.

The broad leaf sample results collected in accordance with the REMP support the conclusions of the effluents monitoring program for 2019. This conclusion is that the surrounding environment is minimally affected by Palisades' effluents. No REMP broadleaf samples from 2019 contained measurable radiological materials attributed to Palisades' effluents.

4.5.3 Fish Sample Results

Indicator and Control fish samples are collected and analyzed twice per year. The filet of the fish is analyzed for gamma radionuclide. The indicator fish are collected near Palisades lake-out discharge point. At least 2 species of commercial or recreational importance are collected and analyzed. At least one sample of the same species is collected as a control sample. The control fish are collected 201 km north of Palisades near Ludington, MI. In 2019, the only radionuclides detected among all fish samples were naturally occurring radionuclides (K-40 and Th-228) which were not attributed to Palisades' effluents.

Palisades' pre-operational environmental study established a baseline for radiological material in fish. The study established that gross beta activity is generally between 2 and 4 pCi/g and gross gamma activity is generally between 0.04 and 0.4 pCi/g in fish. Cs-137 and Sr-90 were measured in the pre-operational study and were expected to be measured due to known worldwide contamination from historical global atomic testing. Cs-137 detected was generally between 0.10 and 0.25 pCi/g and Sr-90 detected was generally between 0.01 to 0.04 pCi/g in the pre-operational environmental study.

The fish sample results collected in accordance with the REMP support the conclusions of the effluents monitoring program for 2019. This conclusion is that the surrounding environment is minimally affected by Palisades' effluents. No REMP fish water samples from 2019 contained measurable radiological materials attributed to Palisades' effluents.

4.5.4 Food Product Sample Results

Two principal fruit crops are collected once per year and analyzed for gamma radionuclides including Iodine-131 in accordance with the REMP. The two crops sampled in 2019 were blueberries and apples. The results of all sample analysis show that only naturally occurring radionuclides (K-40 and Be-7) were present. In accordance with the ODCM, no control sample is collected for this sample type.

Palisades' pre-operational environmental study performed radiological analysis on a variety of crop samples. Gross gamma activity was generally between 0.11 and 0.22 pCi/g and gross beta activity was generally between 0.72 to 3.31 pCi/g.

Annual Radiological Environmental Operating Report

The fruit sample results collected in accordance with the REMP support the conclusions of the effluents monitoring program for 2019. This conclusion is that the surrounding environment is minimally affected by Palisades' effluents. No REMP fruit samples from 2019 contained measurable radiological materials attributed to Palisades' effluents.

4.6 Land Use Census Results

The 2019 land use census results are tabulated in Table 6. The results of the census yielded a new critical receptor (goat in ESE sector) for dose modeling purposes. Goat milk sampling will be performed as available (seasonally) in 2020.

Table 6, Land Use Census –2020 Nearest Receptors (units = miles)

Sector	Direction	Residence	Garden	Beef Cattle	Dairy Cow	Goat
2	NNE	1.67	2.52	> 5	> 5	> 5
3	NE	1.14	3.95	> 5	> 5	2.45
4	ENE	1.19	3.94	2.29	> 5	> 5
5	E	1.67	2.46	3.51	> 5	3.46
6	ESE	1.35	> 5	2.04	> 5	2.04
7	SE	0.87	2.20	3.88	> 5	3.88
8	SSE	0.80	0.70	> 5	> 5	> 5
9	S	0.51	> 5	> 5	> 5	> 5
10	SSW	0.48	> 5	> 5	> 5	> 5

4.7 Interlaboratory Comparison Results

Attachment 3 contains a summary for Interlaboratory Comparison program for Teledyne Brown Engineering.

5.0 **RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY**

1. Table 7, Radiological Environmental Monitoring Program Summary, summarizes data for the 2019 REMP program.

Table 7, Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses	LLD ^[Note 1]	Indicator Locations Mean (F) ^[Note 2] [Range]	Location ^[Note 3] [Highest Annual Mean]	Mean (F) ^[Note 2] [Range]	Control Locations Mean (F) ^[Note 2] [Range]	Number of Reportable Occurrences ^[Note 4]
Air (pCi/m ³)	Gross Beta / 312	0.01	0.0216 (259 / 259) [0.0104 – 0.0422]	Station A19 (0.423 miles SSE)	0.0232 (51/51) [0.0112 - 0.0422]	0.0207 (53 / 53) [0.00930 - 0.0335]	0
	I-131 / 312	0.07	< MDA (0 / 259)	N/A	N/A	< MDA (0 / 53)	0
	Cs-134 / 24	0.05	< MDA (0 / 20)	N/A	N/A	< MDA (0 / 4)	0
	Cs-137 / 24	0.06	< MDA (0 / 20)	N/A	N/A	< MDA (0 / 4)	0
Inner Ring TLDs (mR/Qtr)	Gamma / 56	Sensitivity of 3 mR	9.38 (44 / 44) [7.79 – 11.41]	Station 1 (onsite 0.213 miles E)	10.60 (4 / 4) [10.13 – 11.41]	10.98 (12/12) [9.96 – 12.28]	0
Outer Ring TLDs (mR/Qtr)	Gamma / 47	Sensitivity of 3 mR	11.18 (35 / 35) [9.10 – 14.57]	Station 2 (5.560 miles SE)	13.97 (4 / 4) [13.34 - 14.57]	10.98 (12/12) [9.96 – 12.28]	0

Plant: Palisades	Year: 2019	Page 22 of 57
Annual Radiological Environmental Operating Report		

Surface Water (pCi/L)	Gross Beta / 24	4.0	2.88 (3 / 12) (2.69 - 3.06)	Lake In (Plant lake intake)	2.88 (3 / 12) (2.69 - 3.06)	2.81 (4 / 12) (2.14 - 3.65)	0
	H-3 / 24	2000	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Mn-54 / 24	15	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Fe-59 / 24	30	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Co-58 / 24	15	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Co-60 / 24	15	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Zn-65 / 24	30	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Zr-95 / 24	15	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Nb-95 / 24	15	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Cs-134 / 24	15	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Cs-137 / 24	18	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	Ba-140 / 24	60	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
	La-140 / 24	15	<MDA (0 / 12)	N/A	N/A	<MDA (0 / 12)	0
Goat Milk	I-131 / 3	1					
	Cs-134 / 3	15	N/A ^[Note 5]	N/A ^[Note 5]	N/A ^[Note 5]	<MDA (0 / 3)	0
	Cs-137 / 3	18					
	Ba-140 / 3	60					

Plant: Palisades	Year: 2019	Page 23 of 57
Annual Radiological Environmental Operating Report		

Drinking Water (pCi/L)	Gross Beta / 44	4	2.83 (11 / 32) [2.02 – 3.60]	Pal Park Community Water (0.7 miles SSW)	3.27 (3 / 6) [2.73 – 3.60]	2.81 (4 / 12) (2.14 - 3.65)	0
	H-3 / 44	2000	<MDA (0 / 32)	N/A	N/A	<MDA (0 / 12)	0
	Mn-54 / 44	15	<MDA (0 / 32)	N/A	N/A	<MDA (0 / 12)	0
	Fe-59 / 44	30	<MDA (0 / 32)	N/A	N/A	<MDA (0 / 12)	0
	Co-58 / 44	15	<MDA (0 / 32)	N/A	N/A	<MDA (0 / 12)	0
	Co-60 / 44	15	<MDA (0 / 32)	N/A	N/A	<MDA (0 / 12)	0
	Zn-65 / 44	30	<MDA (0 / 32)	N/A	N/A	<MDA (0 / 12)	0
	Zr-95 / 44	15	<MDA (0 / 32)	N/A	N/A	<MDA (0 / 12)	0
	Nb-95 / 44	15	<MDA (0 / 32)	N/A	N/A	<MDA (0 / 12)	0
	Cs-134 / 44	15	<MDA (0 / 32)	N/A	N/A	<MDA (0 / 12)	0
	Cs-137 / 44	18	<MDA (0 / 32)	N/A	N/A	<MDA (0 / 12)	0
	Ba-140 / 44	60	<MDA (0 / 32)	N/A	N/A	<MDA (0 / 12)	0
La-140 / 44	15	<MDA (0 / 32)	N/A	N/A	<MDA (0 / 12)	0	
Fish (pCi/kg)	Mn-54 / 11	130	<MDA (0 / 7)	N/A	N/A	<MDA (0 / 4)	0
	Fe-59 / 11	260	<MDA (0 / 7)	N/A	N/A	<MDA (0 / 4)	0
	Co-58 / 11	130	<MDA (0 / 7)	N/A	N/A	<MDA (0 / 4)	0
	Co-60 / 11	130	<MDA (0 / 7)	N/A	N/A	<MDA (0 / 4)	0
	Zn-65 / 11	260	<MDA (0 / 7)	N/A	N/A	<MDA (0 / 4)	0
	Cs-134 / 11	130	<MDA (0 / 7)	N/A	N/A	<MDA (0 / 4)	0
	Cs-137 / 11	150	<MDA (0 / 7)	N/A	N/A	<MDA (0 / 4)	0
Food Products (pCi/kg)	I-131 / 2	60	<MDA (0 / 2)	N/A	N/A	Control sample not required	0
	Cs-134 / 2	60	<MDA (0 / 2)	N/A	N/A	Control sample not required	0
	Cs-137 / 2	80	<MDA (0 / 2)	N/A	N/A	Control sample not required	0

Plant: Palisades	Year: 2019	Page 24 of 57
Annual Radiological Environmental Operating Report		

Broad leaf Vegetation (pCi/kg)	I-131 / 15	60	<MDA (0 / 10)	N/A	N/A	<MDA (0 / 5)	0
	Cs-134 / 15	60	<MDA (0 / 10)	N/A	N/A	<MDA (0 / 5)	0
	Cs-137 / 15	80	87.9 (2 / 10) [34.9 – 141]	BV1 (onsite 0.4 miles SSE)	87.9 (2 / 5) [34.9 – 141]	<MDA (0 / 5)	0
Sediment (pCi/kg)	Cs-134 / 4	150	<MDA (0 / 4)	N/A	N/A	Control sample not required	0
	Cs-137 / 4	180	<MDA (0 / 4)	N/A	N/A	Control sample not required	0
Offsite Groundwater (Pal Park Commercial Well) (pCi/L)	Gross Beta / 18	4	4.41 (4 / 6) [2.12 – 5.69]	Pal Park Commercial Well (0.7 miles SSW)	4.41 (4 / 6) [2.12 – 5.69]	2.81 (4 / 12) (2.14 - 3.65)	0
	H-3 / 18	2000	<MDA (0 / 6)	N/A	N/A	N/A	0
	Mn-54 / 18	15	<MDA (0 / 6)	N/A	N/A	N/A	0
	Fe-59 / 18	30	<MDA (0 / 6)	N/A	N/A	N/A	0
	Co-58 / 18	15	<MDA (0 / 6)	N/A	N/A	N/A	0
	Co-60 / 18	15	<MDA (0 / 6)	N/A	N/A	N/A	0
	Zn-65 / 18	30	<MDA (0 / 6)	N/A	N/A	N/A	0
	Zr-95 / 18	15	<MDA (0 / 6)	N/A	N/A	N/A	0
	Nb-95 / 18	15	<MDA (0 / 6)	N/A	N/A	N/A	0
	Cs-134 / 18	15	<MDA (0 / 6)	N/A	N/A	N/A	0
	Cs-137 / 18	18	<MDA (0 / 6)	N/A	N/A	N/A	0
	Ba-140 / 18	60	<MDA (0 / 6)	N/A	N/A	N/A	0
	La-140 / 18	15	<MDA (0 / 6)	N/A	N/A	N/A	0

[Note 1] - LLD = Required lower limit of detection.

[Note 2] - Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parenthesis (F).

[Note 3] - Locations are specified (1) by name and (2) compass sector relative to the site.

[Note 4] - A reportable occurrence is a situation in which an NRC report was submitted in accordance with the requirements in Palisades ODCM.

[Note 5] - No indicator goat milk sample was able to be obtained in 2019 as described in section 4.5.1.

Table 8, Sample Deviations Table

Comment No.	Sample Media Affected	Sample Location	Date	Problem	Evaluation / Actions
1	Domestic Water	Onsite	10/26/19 through 11/06/19	System isolation due to necessary repair work.	On 10/26/2019 domestic water (Palisades potable water) sample was not obtained due to the entire system being isolated for repair work. On 10/27/2019 the sample regiment was resumed as normal with a change in sample location (still onsite but outside the protected area) due to portions of the domestic water system being still isolated. This continued until the end of the month. From 11/01/2019 through 11/06/2019 domestic water was composited and analyzed as its own composite sample from the alternate sample point. Since 11/7/2019 the domestic water resumed the normal sampling frequency from the normal sample location.
2	Domestic Water	Onsite	12/07/19	System inoperable	Domestic water (Palisades potable water) was sampled from an alternative sample location (still onsite but outside the protected area) on 12/7/19 due to freezing conditions restricting water flow through a temporary system modification. The sampling regiment was resumed as normal on 12/8/19. The sample from 12/7/19 was included in December's monthly composite analysis.
3	Ludington Control Water	Ludington Pump House	11/04/19	Equipment Malfunction	The control water sample (Ludington water) for October was a grab sample, not a composite sample. This was due to an equipment malfunction. The grab sample was collected on 11/04/19. The equipment malfunction was not corrected until later in November. Starting on 11/04/19 samples were manual composited until the compositor was fixed, at which time the compositor collected the sample as normal. Therefore the November Ludington Control sample is a composite from 11/04/19 through 12/01/19.

Sample Deviations

Table 8, Sample Deviations Table

Comment No.	Sample Media Affected	Sample Location	Date	Problem	Evaluation / Actions
4	Air particulate and air iodine	A19	04/15/19	Equipment Malfunction	The air sample location A19 was discovered to have a failed pump during the weekly sample collection. The sample pump was replaced the same day of discovery and sample flow was initiated. The air meter indicated that only 11.3 m ³ of air was collected on the filter media. This is less than the procedurally defined value (50 m ³) for accepting the sample results for statistical analysis in this report. Therefore the sample results for this sample were not incorporated into this report.
5	TLD	TLD #4	04/25/19	Equipment Malfunction	The first quarter TLD number 4 was missing and could not be located during the TLD collection. Therefore there is no measurement for the first quarter TLD number 4. Upon discovering that the TLD was missing a new TLD was installed.
6	Broadleaf	BV1	05/21/19	Seasonal Availability	The broadleaf sample BV1 collected on 5/21/2019 consisted of only Maple leaves, not three different species, due to seasonal availability.

Monitoring Results Tables

Table 9, Air Particulate Data Summary Table

Analysis: Gross Beta				Units: pCi/m ³			
Start Date	End Date	Station A4 (Indicator)	Station A5 (Indicator)	Station A8 (Indicator)	Station A9 (Indicator)	Station A19 ^(Note 1) (Indicator)	Station A10 ^(Note 2) (Control)
REQUIRED LLD →		1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
12/27/18	01/02/19	NA ^(Note 3)	NA ^(Note 3)	NA ^(Note 3)	NA ^(Note 3)	NA ^(Note 3)	1.91E-02
12/31/18	01/08/19	2.40E-02	2.68E-02	2.85E-02	2.82E-02	2.74E-02	3.03E-02
01/08/19	01/14/19	1.93E-02	1.87E-02	2.01E-02	1.97E-02	1.85E-02	1.85E-02
01/14/19	01/21/19	1.12E-02	1.37E-02	1.70E-02	1.04E-02	1.57E-02	1.94E-02
01/21/19	01/29/19	2.61E-02	2.11E-02	2.59E-02	2.23E-02	2.50E-02	2.36E-02
01/29/19	02/04/19	2.62E-02	2.94E-02	2.44E-02	2.82E-02	2.69E-02	2.25E-02
02/04/19	02/11/19	1.37E-02	1.37E-02	1.88E-02	1.39E-02	1.61E-02	1.58E-02
02/11/19	02/19/19	2.15E-02	2.85E-02	2.42E-02	2.09E-02	1.85E-02	2.28E-02
02/19/19	02/25/19	3.07E-02	2.84E-02	3.54E-02	2.75E-02	3.00E-02	2.73E-02
02/25/19	03/05/19	1.76E-02	2.29E-02	1.99E-02	1.72E-02	1.65E-02	1.36E-02
03/05/19	03/11/19	1.50E-02	1.58E-02	1.84E-02	1.72E-02	1.55E-02	2.41E-02
03/11/19	03/18/19	2.86E-02	2.99E-02	3.05E-02	2.76E-02	2.56E-02	3.22E-02
03/18/19	03/25/19	2.19E-02	2.17E-02	2.50E-02	2.09E-02	1.95E-02	2.14E-02
03/25/19	04/02/19	1.67E-02	2.03E-02	1.80E-02	1.75E-02	1.78E-02	1.62E-02
04/02/19	04/08/19	2.06E-02	1.83E-02	2.15E-02	1.75E-02	1.98E-02	2.28E-02
04/08/19	04/15/19	1.49E-02	1.73E-02	1.66E-02	1.17E-02	NA ^(Note 4)	9.30E-03
04/15/19	04/22/19	1.34E-02	1.47E-02	1.53E-02	1.63E-02	1.59E-02	1.53E-02
04/22/19	04/29/19	2.05E-02	1.77E-02	2.04E-02	2.02E-02	1.82E-02	2.19E-02
04/29/19	05/06/19	1.29E-02	1.66E-02	1.92E-02	1.34E-02	1.12E-02	1.63E-02
05/06/19	05/13/19	1.42E-02	1.83E-02	1.58E-02	1.46E-02	1.60E-02	1.88E-02
05/13/19	05/20/19	1.98E-02	2.01E-02	2.44E-02	2.03E-02	2.00E-02	2.15E-02
05/20/19	05/28/19	1.54E-02	1.15E-02	2.00E-02	1.57E-02	1.57E-02	1.32E-02
05/28/19	06/03/19	1.15E-02	1.18E-02	1.20E-02	1.34E-02	1.62E-02	1.68E-02
06/03/19	06/10/19	2.14E-02	2.22E-02	1.76E-02	1.85E-02	1.93E-02	2.12E-02

Monitoring Results Tables

Table 9, Air Particulate Data Summary Table

Analysis: Gross Beta				Units: pCi/m ³			
Start Date	End Date	Station A4 (Indicator)	Station A5 (Indicator)	Station A8 (Indicator)	Station A9 (Indicator)	Station A19 ^(Note 1) (Indicator)	Station A10 ^(Note 2) (Control)
06/10/19	06/17/19	1.63E-02	1.37E-02	2.02E-02	1.44E-02	1.83E-02	1.79E-02
06/17/19	06/24/19	1.54E-02	1.67E-02	1.72E-02	1.27E-02	1.56E-02	1.55E-02
06/24/19	07/02/19	2.49E-02	1.99E-02	2.41E-02	2.28E-02	2.59E-02	1.84E-02
07/02/19	07/08/19	1.86E-02	2.73E-02	2.60E-02	2.29E-02	2.79E-02	1.72E-02
07/08/19	07/15/19	1.39E-02	1.75E-02	1.88E-02	1.76E-02	1.81E-02	2.22E-02
07/15/19	07/22/19	1.66E-02	2.05E-02	2.31E-02	1.80E-02	2.46E-02	1.95E-02
07/22/19	07/29/19	2.77E-02	2.28E-02	3.17E-02	2.39E-02	2.90E-02	2.51E-02
07/29/19	08/06/19	2.13E-02	2.27E-02	2.03E-02	1.88E-02	2.47E-02	2.11E-02
08/06/19	08/12/19	2.06E-02	2.37E-02	3.00E-02	2.35E-02	2.73E-02	1.72E-02
08/12/19	08/19/19	1.94E-02	2.31E-02	2.11E-02	1.28E-02	2.79E-02	2.11E-02
08/19/19	08/26/19	1.85E-02	1.70E-02	2.07E-02	2.30E-02	2.44E-02	1.89E-02
08/26/19	09/03/19	2.07E-02	1.69E-02	2.35E-02	1.98E-02	2.43E-02	2.08E-02
09/03/19	09/09/19	1.95E-02	1.83E-02	2.61E-02	2.03E-02	2.74E-02	1.86E-02
09/09/19	09/16/19	2.88E-02	3.71E-02	3.44E-02	3.06E-02	3.46E-02	2.12E-02
09/16/19	09/23/19	3.25E-02	3.07E-02	3.63E-02	3.17E-02	3.42E-02	2.86E-02
09/23/19	10/01/19	2.25E-02	2.50E-02	2.12E-02	1.98E-02	2.33E-02	2.00E-02
10/01/19	10/07/19	1.48E-02	1.53E-02	1.95E-02	1.15E-02	2.42E-02	1.38E-02
10/07/19	10/14/19	1.89E-02	2.41E-02	2.21E-02	1.75E-02	2.35E-02	2.27E-02
10/14/19	10/21/19	2.09E-02	2.03E-02	2.00E-02	1.68E-02	2.34E-02	1.79E-02
10/21/19	10/28/19	1.57E-02	1.38E-02	1.76E-02	1.51E-02	2.08E-02	1.82E-02
10/28/19	11/04/19	1.63E-02	1.48E-02	1.32E-02	1.55E-02	1.79E-02	1.82E-02
11/04/19	11/12/19	1.98E-02	2.43E-02	2.13E-02	2.13E-02	2.60E-02	1.95E-02
11/12/19	11/18/19	2.85E-02	2.68E-02	2.90E-02	3.30E-02	3.07E-02	2.80E-02
11/18/19	11/25/19	2.47E-02	2.50E-02	2.29E-02	2.17E-02	2.22E-02	2.70E-02
11/25/19	12/02/19	1.93E-02	1.67E-02	1.91E-02	1.79E-02	2.44E-02	1.69E-02

Monitoring Results Tables

Table 10, Air Sample Radioiodine Cartridge Data Table Summary

Analysis: I-131		Units: pCi/m ³					
Start Date	End Date	Station A4 (Indicator)	Station A5 (Indicator)	Station A8 (Indicator)	Station A9 (Indicator)	Station A19 (Indicator)	Station A10 ^[Note 1] (Control)
08/12/19	08/19/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
08/19/19	08/26/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
08/26/19	09/03/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
09/03/19	09/09/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
09/09/19	09/16/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
09/16/19	09/23/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
09/23/19	10/01/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
10/01/19	10/07/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
10/07/19	10/14/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
10/14/19	10/21/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
10/21/19	10/28/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
10/28/19	11/04/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
11/04/19	11/12/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
11/12/19	11/18/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
11/18/19	11/25/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
11/25/19	12/02/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
12/02/19	12/09/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
12/09/19	12/16/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
12/16/19	12/23/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA
12/23/19	12/30/19	< MDA	< MDA	< MDA	< MDA	< MDA	< MDA

[Note 1] – The sample date range is accurate to plus or minus 2 days for station A10

[Note 2] – There is no sample result for the indicator stations from 12/27/18 - 01/02/19 because the date ranges ended on 12/31/19 for these samples.

[Note 3] – Reference Attachment 1, Sample Deviations, Table 8, Sample Deviations Table

Monitoring Results Tables

Analysis: Gamma Isotopic			Units: pCi/m ³		
Location	Start Date	End Date	Cs-134	Cs-137	Be-7 ^[Note 1]
REQUIRED LLD →			0.05	0.06	NA
Station A4	12/31/18	04/02/19	<MDA	<MDA	1.49E-01
Station A4	04/02/19	07/02/19	<MDA	<MDA	1.23E-01
Station A4	07/02/19	10/01/19	<MDA	<MDA	1.39E-01
Station A4	10/01/19	12/30/19	<MDA	<MDA	1.04E-01
Station A5	12/31/18	04/02/19	<MDA	<MDA	9.60E-02
Station A5	04/02/19	07/02/19	<MDA	<MDA	1.57E-01
Station A5	07/02/19	10/01/19	<MDA	<MDA	1.44E-01
Station A5	10/01/19	12/30/19	<MDA	<MDA	1.04E-01
Station A8	12/31/18	04/02/19	<MDA	<MDA	1.20E-01
Station A8	04/02/19	07/02/19	<MDA	<MDA	1.02E-01
Station A8	07/02/19	10/01/19	<MDA	<MDA	1.32E-01
Station A8	10/01/19	12/30/19	<MDA	<MDA	1.22E-01
Station A9	12/31/18	04/02/19	<MDA	<MDA	1.44E-01
Station A9	04/02/19	07/02/19	<MDA	<MDA	1.32E-01
Station A9	07/02/19	10/01/19	<MDA	<MDA	1.32E-01
Station A9	10/01/19	12/30/19	<MDA	<MDA	8.99E-02
Station A19	12/31/18	04/02/19	<MDA	<MDA	1.18E-01
Station A19	04/02/19	07/02/19	<MDA	<MDA	1.80E-01
Station A19	07/02/19	10/01/19	<MDA	<MDA	1.40E-01
Station A19	10/01/19	12/30/19	<MDA	<MDA	1.03E-01
Station A10	12/31/18	04/02/19	<MDA	<MDA	1.37E-01
Station A10	04/02/19	07/02/19	<MDA	<MDA	1.36E-01
Station A10	07/02/19	10/01/19	<MDA	<MDA	1.32E-01
Station A10	10/01/19	12/30/19	<MDA	<MDA	8.14E-02

[Note 1] - This nuclide is naturally occurring and there is no ODCM required LLD.

Monitoring Results Tables

Table 12, Thermoluminescent Dosimeters – Inner Ring

Analysis: Gamma Dose			Units: mR		
Station	1 st Qtr 2019	2 nd Qtr 2019	3 rd Qtr 2019	4 th Qtr 2019	Annual Mean
1 ^[Note 1]	10.13	10.45	10.40	11.41	10.60
8	9.39	10.03	10.02	10.76	10.05
13	8.92	9.20	9.25	10.02	9.35
14	7.79	8.29	9.37	8.49	8.49
15	8.49	8.94	8.84	9.68	8.99
16	8.80	8.91	9.01	9.36	9.02
17	8.44	8.65	8.22	9.26	8.64
18	8.71	10.51	9.40	10.58	9.80
19	8.71	9.92	9.03	10.36	9.51
20	8.73	9.70	8.58	9.84	9.21
21	8.91	10.11	9.06	10.15	9.56

[Note 1] - Station with the highest annual mean

Monitoring Results Tables

Table 13, Thermoluminescent Dosimeters – Outer Ring

Analysis: Gamma Dose			Units: mR		
Station	1 st Qtr 2019	2 nd Qtr 2019	3 rd Qtr 2019	4 th Qtr 2019	Annual Mean
2 ^[Note 1]	13.34	13.76	14.19	14.57	13.97
3	10.37	10.70	10.83	11.43	10.83
4	NA ^[Note 2]	12.13	11.94	12.81	12.29
5	10.28	10.71	10.96	11.21	10.79
6	9.70	10.55	10.70	11.15	10.53
7	9.10	9.44	9.45	10.20	9.55
9	9.51	10.27	9.95	11.02	10.19
23	10.93	11.68	10.44	11.75	11.20
24	11.30	11.86	11.37	11.61	11.54

[Note 1] – Station with highest annual mean.

[Note 2] - Reference Attachment 1, Sample Deviations, Table 8, Sample Deviations Table

Table 14, Thermoluminescent Dosimeters – Control

Analysis: Gamma Dose			Units: mR		
Station	1 st Qtr 2019	2 nd Qtr 2019	3 rd Qtr 2019	4 th Qtr 2019	Annual Mean
10	9.96	10.09	10.04	11.14	10.31
11	11.26	11.63	11.82	12.28	11.75
12	10.08	10.94	10.75	11.77	10.89

Monitoring Results Tables

Table 15, Surface Water –Gamma Isotopic

Analysis: Gamma Isotopic								Units: pCi/L								
Location	Start Date	End Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140	K-40	Th-228	Ra-226
REQUIRED LLD →			15	15	30	15	30	15	15	15	18	60	15	NA <small>[Note 1]</small>	NA <small>[Note 1]</small>	NA <small>[Note 1]</small>
Lake In	01/01/19	02/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	23.8	<MDA	<MDA
Lake In	02/01/19	03/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Lake In	03/01/19	04/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Lake In	04/01/19	05/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Lake In	05/01/19	06/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Lake In	06/01/19	07/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Lake In	07/01/19	08/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Lake In	08/01/19	09/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	56.8
Lake In	09/01/19	10/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	57.1
Lake In	10/01/19	11/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Lake In	11/01/19	12/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	4.19	<MDA

Monitoring Results Tables

Table 15, Surface Water –Gamma Isotopic

Analysis: Gamma Isotopic								Units: pCi/L								
Location	Start Date	End Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140	K-40	Th-228	Ra-226
REQUIRED LLD →			15	15	30	15	30	15	15	15	18	60	15	NA [Note 1]	NA [Note 1]	NA [Note 1]
Ludington Control	09/01/19	10/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	11/04/19 [Note 2]	NA [Note 2]	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	11/04/19 [Note 2]	12/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	12/01/19	01/01/20	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA

[Note 1] - This nuclide is naturally occurring and there is no ODCM required LLD.

[Note 2] - Reference Attachment 1, Sample Deviations, Table 8, Sample Deviations Table

Monitoring Results Tables

Table 16, Surface Water – Tritium and Gross Beta

Analysis: Tritium and Gross Beta			Units: pCi/L	
Location	Start Date	End Date	H-3	Gross Beta
REQUIRED LLD →			2000	4.00
Lake In	01/01/19	02/01/19	<MDA	<MDA
Lake In	02/01/19	03/01/19	<MDA	<MDA
Lake In	03/01/19	04/01/19	<MDA	<MDA
Lake In	04/01/19	05/01/19	<MDA	<MDA
Lake In	05/01/19	06/01/19	<MDA	<MDA
Lake In	06/01/19	07/01/19	<MDA	<MDA
Lake In	07/01/19	08/01/19	<MDA	2.69
Lake In	08/01/19	09/01/19	<MDA	<MDA
Lake In	09/01/19	10/01/19	<MDA	<MDA
Lake In	10/01/19	11/01/19	<MDA	<MDA
Lake In	11/01/19	12/01/19	<MDA	3.06
Lake In	12/01/19	01/01/20	<MDA	2.89
Ludington Control	01/01/19	02/01/19	<MDA	<MDA
Ludington Control	02/01/19	03/01/19	<MDA	<MDA

Monitoring Results Tables

Table 16, Surface Water – Tritium and Gross Beta

Analysis: Tritium and Gross Beta			Units: pCi/L	
Location	Start Date	End Date	H-3	Gross Beta
REQUIRED LLD →			2000	4.00
Ludington Control	03/01/19	04/01/19	<MDA	2.56
Ludington Control	04/01/19	05/01/19	<MDA	2.89
Ludington Control	05/01/19	06/01/19	<MDA	<MDA
Ludington Control	06/01/19	07/01/19	<MDA	<MDA
Ludington Control	07/01/19	08/01/19	<MDA	<MDA
Ludington Control	08/01/19	09/01/19	<MDA	3.65
Ludington Control	09/01/19	10/01/19	<MDA	<MDA
Ludington Control	11/04/19 ^[Note 1]	NA ^[Note 1]	<MDA	<MDA
Ludington Control	11/04/19 ^[Note 1]	12/01/19	<MDA	2.14
Ludington Control	12/01/19	01/01/20	<MDA	<MDA

[Note 1] - Reference Attachment 1, Sample Deviations Table 8, Sample Deviations Table

Monitoring Results Tables

Table 17, Drinking Water –Gamma Isotopic

Analysis: Gamma Isotopic								Units: pCi/L								
Location	Start Date	End Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140	K-40	Th-228	Ra-226
REQUIRED LLD →			15	15	30	15	30	15	15	15	18	60	15	NA <small>[Note 2]</small>	NA <small>[Note 2]</small>	NA <small>[Note 2]</small>
South Haven	08/01/19	09/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
South Haven	09/01/19	10/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
South Haven	10/01/19	11/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
South Haven	11/01/19	12/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
South Haven	12/01/19	01/01/20	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA

[Note 1] - This is a grab sample and therefore there is no "end date".

[Note 2] - This nuclide is naturally occurring and there is no ODCM required LLD.

[Note 3] - Reference Attachment 1, Sample Deviations, Table 8, Sample Deviations Table

Monitoring Results Tables

Table 18, Drinking Water

Analysis: H-3 and Gross Beta			Units: pCi/L	
Location	Start Date	End Date	H-3	Gross Beta
REQUIRED LLD →			2000	4.00
Domestic Water	01/01/19	02/01/19	<MDA	<MDA
Domestic Water	02/01/19	03/01/19	<MDA	2.53
Domestic Water	03/01/19	04/01/19	<MDA	2.81
Domestic Water	04/01/19	05/01/19	<MDA	<MDA
Domestic Water	05/01/19	06/01/19	<MDA	<MDA
Domestic Water	06/01/19	07/01/19	<MDA	<MDA
Domestic Water	07/01/19	08/01/19	<MDA	<MDA
Domestic Water	08/01/19	09/01/19	<MDA	<MDA
Domestic Water	09/01/19	10/01/19	<MDA	<MDA
Domestic Water ^(note 1)	10/01/19	10/29/19	<MDA	<MDA
Domestic Water ^(note 1)	10/29/19	11/01/19	<MDA	2.02
Domestic Water ^(note 1)	11/01/19	11/07/19	<MDA	2.87
Domestic Water ^(note 1)	11/06/19	12/01/19	<MDA	<MDA
Domestic Water ^(note 1)	12/01/19	01/01/20	<MDA	<MDA

Monitoring Results Tables

Table 18, Drinking Water

Analysis: H-3 and Gross Beta			Units: pCi/L	
Location	Start Date	End Date	H-3	Gross Beta
Pal Park Community	05/20/19	NA ^[Note 2]	<MDA	2.73
Pal Park Community	06/24/19	NA ^[Note 2]	<MDA	3.60
Pal Park Community	07/23/19	NA ^[Note 2]	<MDA	<MDA
Pal Park Community	08/26/19	NA ^[Note 2]	<MDA	<MDA
Pal Park Community	09/16/19	NA ^[Note 2]	<MDA	<MDA
Pal Park Community	10/07/19	NA ^[Note 2]	<MDA	3.48
South Haven	01/01/19	02/01/19	<MDA	<MDA
South Haven	02/01/19	03/01/19	<MDA	<MDA
South Haven	03/01/19	04/01/19	<MDA	<MDA
South Haven	04/01/19	05/01/19	<MDA	<MDA
South Haven	05/01/19	06/01/19	<MDA	2.85
South Haven	06/01/19	07/01/19	<MDA	<MDA
South Haven	07/01/19	08/01/19	<MDA	2.39
South Haven	08/01/19	09/01/19	<MDA	<MDA
South Haven	09/01/19	10/01/19	<MDA	<MDA

Monitoring Results Tables

Table 18, Drinking Water

Analysis: H-3 and Gross Beta			Units: pCi/L	
Location	Start Date	End Date	H-3	Gross Beta
South Haven	10/01/19	11/01/19	<MDA	<MDA
South Haven	11/01/19	12/01/19	<MDA	3.52
South Haven	12/01/19	01/01/20	<MDA	2.36

[Note 1] - Reference Attachment 1, Sample Deviations, Table 8, Sample Deviations Table

[Note 2] - This is a grab sample and therefore there is no end date.

Table 19, Sediment

Analysis: Gamma Isotopic		Units: pCi/kg						
Location	Collection Date	Cs-134	Cs-137	K-40	Ra-226	Th-228	Th-232	Ac-228
REQUIRED LLD →		150	180	NA [Note 1]	NA [Note 1]	NA [Note 1]	NA [Note 1]	NA [Note 1]
North Sediment	05/15/19	<MDA	<MDA	312	<MDA	174	<MDA	<MDA
North Sediment	11/01/19	<MDA	<MDA	5280	<MDA	<MDA	260	295
South Sediment	05/15/19	<MDA	<MDA	4190	1480	433	407	<MDA
South Sediment	11/01/19	<MDA	<MDA	2690	<MDA	276	321	<MDA

[Note 1] - This nuclide is naturally occurring and there is no ODCM required LLD.

Monitoring Results Tables

Table 20, Fish

Analysis: Gamma Isotopic				Units: pCi/kg						
Location / species	Collection Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Cs-134	Cs-137	K-40	Th-228
REQUIRED LLD →		130	130	260	130	260	130	150	NA [Note 1]	NA [Note 1]
Palisades / Carp	04/25/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	3350	<MDA
Palisades / Carp	07/25/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	2940	124
Palisades / Drum	07/25/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	3090	<MDA
Palisades / Gizzard Shad	04/25/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	3120	<MDA
Palisades / Gizzard Shad	07/25/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	3180	<MDA
Palisades / Trout	04/25/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	3770	<MDA
Palisades / Redhorse Sucker	07/25/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	4110	<MDA
Ludington / Carp	04/24/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	2580	<MDA
Ludington / Drum	07/24/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	2090	<MDA
Ludington / Trout	04/24/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	3570	<MDA
Ludington / Redhorse Sucker	08/01/19	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	4240	<MDA

[Note 1] - This nuclide is naturally occurring and there is no ODCM required LLD.

Monitoring Results Tables

Table 23, Offsite Groundwater

Analysis: H-3 and Gross Beta		Units: pCi/L	
Location	Collection Date	H-3	Gross Beta
REQUIRED LLD →		2000	4.00
Pal Park Commercial Well	05/20/19	<MDA	4.83
Pal Park Commercial Well	06/24/19	<MDA	5.69
Pal Park Commercial Well	07/23/19	<MDA	4.98
Pal Park Commercial Well	08/26/19	<MDA	<MDA
Pal Park Commercial Well	09/16/19	<MDA	<MDA
Pal Park Commercial Well	10/07/19	<MDA	2.12

Monitoring Results Tables

Table 24, Broad Leaf Vegetation

Analysis: I-131, Gamma Isotopic		Units: pCi/kg					
Location	Collection Date	I-131	Cs-134	Cs-137	K-40	Be-7	Th-228
REQUIRED LLD →		60	60	80	NA [Note 1]	NA [Note 1]	NA [Note 1]
Location BV1, 0.4 miles SSE	05/21/19 [Note 2]	<MDA	<MDA	34.9	3190	944	<MDA
Location BV1, 0.4 miles SSE	06/12/19	<MDA	<MDA	141	2100	1240	<MDA
Location BV1, 0.4 miles SSE	07/18/19	<MDA	<MDA	<MDA	2030	2640	<MDA
Location BV1, 0.4 miles SSE	08/21/19	<MDA	<MDA	<MDA	1890	3300	<MDA
Location BV1, 0.4 miles SSE	09/16/19	<MDA	<MDA	<MDA	1710	5060	<MDA
Location BV2, 0.7 miles SSE	05/21/19	<MDA	<MDA	<MDA	4020	1450	<MDA
Location BV2, 0.7 miles SSE	06/12/19	<MDA	<MDA	<MDA	3380	596	<MDA
Location BV2, 0.7 miles SSE	07/18/19	<MDA	<MDA	<MDA	2840	875	<MDA
Location BV2, 0.7 miles SSE	08/21/19	<MDA	<MDA	<MDA	2560	1490	<MDA

Monitoring Results Tables

Table 24, Broad Leaf Vegetation

Analysis: I-131, Gamma Isotopic		Units: pCi/kg					
Location	Collection Date	I-131	Cs-134	Cs-137	K-40	Be-7	Th-228
Location BV2, 0.7 miles SSE	09/16/19	<MDA	<MDA	<MDA	3280	3460	<MDA
Location BVC, 13.6 miles SSE	05/21/19	<MDA	<MDA	<MDA	3380	1190	<MDA
Location BVC, 13.6 miles SSE	06/12/19	<MDA	<MDA	<MDA	3350	637	<MDA
Location BVC, 13.6 miles SSE	07/18/19	<MDA	<MDA	<MDA	3250	616	57.5
Location BVC, 13.6 miles SSE	08/21/19	<MDA	<MDA	<MDA	4210	2000	<MDA
Location BVC, 13.6 miles SSE	09/16/19	<MDA	<MDA	<MDA	3300	2036	<MDA

[Note 1] - This nuclide is naturally occurring and there is no ODCM required LLD

[Note 2] - Reference Attachment 1, Sample Deviations, Table 8, Sample Deviations Table

Monitoring Results Tables

Table 25, Goat Milk

Analysis: I-131, Gamma Isotopic		Units: pCi/L			
Location	Collection Date	I-131	Cs-134	Cs-137	K-40
<u>REQUIRED LLD →</u>		60	60	80	NA <small>[Note 1]</small>
Control Goat Milk	03/25/19	<MDA	<MDA	<MDA	1850
Control Goat Milk	04/30/19	<MDA	<MDA	<MDA	1540
Control Goat Milk	05/29/19	<MDA	<MDA	<MDA	2290

[Note 1] - This nuclide is naturally occurring and there is no ODCM required LLD.

Annual Radiological Environmental Operating Report

Attachment 3

Page 1 of 3

Interlaboratory Comparison Program Results

1.0 Summary

Summary of Results – Inter-laboratory Comparison Program (ICP)

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

A. Analytics Evaluation Criteria

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

B. ERA Evaluation Criteria

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

C. DOE Evaluation Criteria

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

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

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

Annual Radiological Environmental Operating Report

Attachment 3

Page 2 of 3

Interlaboratory Comparison Program Results

A non-conformance report (NCR) is generated for conditions adverse or potentially adverse to quality.

Interlaboratory Cross-Check Program

(1) Analytics Environmental Cross Check Program

Thirteen nuclides in milk, air particulate, air iodine (charcoal), soil, and water samples were evaluated. All of the environmental analyses performed were evaluated as within the acceptable/acceptable with warning range except for one Cr-51 in soil sample. NCR 19-27 was initiated to address the failure and Corrective Actions were issued. All raw data and associated QC data were reviewed and fell within acceptance limits. No client data was affected by the failure.

(2) DOE's MAPEP Quality Assessment Program

Sixteen nuclides in water, air particulate, soil, and vegetation samples were evaluated. All of the environmental analyses performed were evaluated as within the acceptable/acceptable with warning criteria except for the following: one Sr-90 in soil sample, one Sr-90 in vegetation sample (statistical failure for false positive), Ni-63 in soil sample, and two Am-241 in water samples. NCRs 19-12, 19-13, 19-14, 19-25 and 19-26 were initiated to address the failures and Corrective Actions were issued. All raw data and associated QC data were reviewed and fell within acceptance limits. No client data was affected by the failures.

(3) ERA Environmental Cross Check Program

Twelve nuclides were evaluated in water samples. All analyses performed were within the acceptable criteria except for the following: Cs-134, Sr-89, Sr-90 and Gross Alpha in water samples (one each). NCRs 19-10, 19-11, 19-23 and 19-24 were initiated to address the failures and Corrective Actions were issued. All raw data and associated QC data were reviewed and fell within acceptance limits. No client data was affected by the failures.

Intralaboratory Cross-Check Program

During this reporting period, 37 nuclides in various matrices, including air particulate, charcoal, vegetation, fish, milk, soil/solid, and water were analyzed by means of the laboratory's internal process control program. The TBE-ES laboratory's internal process control program evaluated 6755 analyses during this period.

- (1) Blanks - During this reporting period, 1587/1588 environmental blanks analyzed were less than the MDC. One QC blank was positive, but the sample results were greater than 10 times the level of activity in the blank. A case narrative was included with the sample results.

Annual Radiological Environmental Operating Report

Attachment 3

Page 3 of 3

Interlaboratory Comparison Program Results

(2) Spikes - During this reporting period, all 1573 environmental spikes and matrix spikes analyzed were within the acceptance criteria.

(3) Duplicates - All of the 3594 duplicate sets analyzed were within acceptance criteria.

The interlaboratory and intralaboratory comparison program provides evidence of "in control" counting systems and methods, and that the laboratories are producing accurate and reliable data.

Thermoluminescent dosimeters (TLDs) are analyzed by an offsite vendor, "Environmental Dosimetry Company" (EDC). The TLDs used are Panasonic 814 Environmental dosimeters. EDC implements an internal quality assurance program and audits the program annually. Some of EDC's vendors also perform independent testing on the TLDs accuracy and precision. During 2019 100% (72/72) of the individual dosimeters met the criterion for accuracy (plus or minus 15%) and 100% (72/72) met the criterion for precision (plus or minus 12.8%). Also, 100% (12/12) of the dosimeter sets evaluated met EDC acceptance criteria for mean bias and precision and 100% (6/6) of independent testing passed the performance criteria. One internal assessment was performed in 2019. There were no findings identified.

Annual Radiological Environmental Operating Report

Attachment 4

Previous AREOR ERRATA

There were five errors identified in the 2018 AREOR . All five errors were considered “small errors” in accordance with the guidance given in Regulatory Guide 1.21 Revision 2 (a guidance document published by the NRC for annual effluent reporting). More specifically the errors do not impede the NRC’s ability to adequately assess the information and the errors do not alter the intent of the report. Following this page there are five corrected pages from the 2018 AREOR showing the errors and the corrected information.

- (1) In Table 7 the fraction of detectable results for the indicator and control column was listed as “(0 / 30)” for all analyses. The fraction of detectable results for the indicator and control column should have been “(0 / 6)” for all analyses.
- (2) Page 21 of 54 through 31 of 54 should have listed “Palisades” and “2018” in the header instead of “Enter Plant Name” and “YEAR”. Page 22 of 54 was included in the ERRATA section of this report to show this error. Other pages affected are not included in the ERRATA section of this report.
- (3) In Table 15 the required LLD for Zr-95 was listed as “30” and should have been listed as “15”
- (4) In Table 21 the collection data for blueberries and apples was incorrect. The date “06/28/2016” should have been “07/09/2018” and the date “06/28/2016” should have been “09/24/2018”.
- (5) In Table 24 there were two columns for K-40 results. The left most K-40 column should have been deleted.

Annual Radiological Environmental Operating Report

Table 7, Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses	LLD ^[Note 1]	Indicator Locations Mean (F) ^[Note 2] [Range]	Location ^[Note 3] [Highest Annual Mean]	Mean (F) ^[Note 2] [Range]	Control Locations Mean (F) ^[Note 2] [Range]	Number of Reportable Occurrences ^[Note 4]
Drinking Water (pCi/L)	Gross Beta / 42	4	2.80 (14 / 30) [2.27 – 3.96]	Pal Park Community Water (0.7 miles SSW)	2.99 (2 / 6) [2.57 – 3.40]	2.64 (3 / 12) [2.31 – 3.10]	0
	H-3 / 42	2000	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0
	Mn-54 / 42	15	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0
	Fe-59 / 42	30	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0
	Co-58 / 42	15	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0
	Co-60 / 42	15	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0
	Zn-65 / 42	30	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0
	Zr-95 / 42	15	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0
	Nb-95 / 42	15	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0
	Cs-134 / 42	15	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0
	Cs-137 / 42	18	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0
	Ba-140 / 42	60	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0
La-140 / 42	15	<MDA (0 / 30)	N/A	N/A	<MDA (0 / 12)	0	
Fish (pCi/kg)	Mn-54 / 12	130	<MDA (0+30) (0/6)	N/A	N/A	<MDA (0+30) (0/6)	0
	Fe-59 / 12	260	<MDA (0+30) (0/6)	N/A	N/A	<MDA (0+30) (0/6)	0
	Co-58 / 12	130	<MDA (0+30) (0/6)	N/A	N/A	<MDA (0+30) (0/6)	0
	Co-60 / 12	130	<MDA (0+30) (0/6)	N/A	N/A	<MDA (0+30) (0/6)	0
	Zn-65 / 12	260	<MDA (0+30) (0/6)	N/A	N/A	<MDA (0+30) (0/6)	0
	Cs-134 / 12	130	<MDA (0+30) (0/6)	N/A	N/A	<MDA (0+30) (0/6)	0
	Cs-137 / 12	150	<MDA (0+30) (0/6)	N/A	N/A	<MDA (0+30) (0/6)	0

Monitoring Results Tables

Table 24, Broad Leaf Vegetation

Analysis: I-131, Gamma Isotopic		Units: pCi/kg						
Location	Collection Date	I-131	Cs-134	Cs-137	K-40	Be-7	K-40	Th-228
REQUIRED LLD →		60	60	80	NA <small>[Note 1]</small>	NA <small>[Note 1]</small>	NA <small>[Note 1]</small>	NA <small>[Note 1]</small>
Location BV1, 0.4 miles SSE	05/29/18	<MDA	<MDA	92.3	1260	1240	2360	55.0
Location BV1, 0.4 miles SSE	06/25/18	<MDA	<MDA	46.4	836	3860	1740	<MDA
Location BV1, 0.4 miles SSE	07/25/18	<MDA	<MDA	72.6	<MDA	3410	1610	<MDA
Location BV1, 0.4 miles SSE	08/24/18	<MDA	<MDA	62.1	<MDA	3230	2040	<MDA
Location BV1, 0.4 miles SSE	09/24/18	<MDA	<MDA	39.7	<MDA	5000	2130	<MDA
Location BV2, 0.7 miles SSE	05/29/18	<MDA	<MDA	<MDA	<MDA	634	4010	<MDA
Location BV2, 0.7 miles SSE	06/25/18	<MDA	<MDA	<MDA	<MDA	1530	2430	<MDA
Location BV2, 0.7 miles SSE	07/25/18	<MDA	<MDA	<MDA	<MDA	1570	2920	<MDA
Location BV2, 0.7 miles SSE	08/24/18	<MDA	<MDA	<MDA	<MDA	832	2900	<MDA

Monitoring Results Tables

Table 24, Broad Leaf Vegetation

Analysis: I-131, Gamma Isotopic		Units: pCi/kg						
Location	Collection Date	I-131	Cs-134	Cs-137	K-40	Be-7	K-40	Th-228
Location BV2, 0.7 miles SSE	09/24/18	<MDA	<MDA	<MDA	<MDA	1700	2660	<MDA
Location BVC, 13.6 miles SSE	05/29/18	<MDA	<MDA	<MDA	<MDA	1390	3820	<MDA
Location BVC, 13.6 miles SSE	06/25/18	<MDA	<MDA	<MDA	<MDA	1320	2910	51.1
Location BVC, 13.6 miles SSE	07/25/18	<MDA	<MDA	<MDA	<MDA	1330	2900	<MDA
Location BVC, 13.6 miles SSE	08/24/18	<MDA	<MDA	<MDA	<MDA	2230	3160	<MDA
Location BVC, 13.6 miles SSE	09/24/18	<MDA	<MDA	<MDA	<MDA	1810	4170	<MDA

[Note 1] - This nuclide is naturally occurring and there is no ODCM required LLD.