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HDI PNP 2023-008

Technical Specification 5.6.2

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U.S. Nuclear Regulatory Commission
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Palisades Nuclear Plant
Docket Nos. 50-255 and 72-007
Renewed Facility Operating License No. DPR-20

Subject: 2022 Radiological Environmental Operating Report

In accordance with the requirements of Palisades Nuclear Plant (PNP) Defueled Technical Specifications Section 5.6.2, *Radiological Environmental Operating Report*, Holtec Decommissioning International, LLC (HDI) on behalf of Holtec Palisades, LLC (Holtec Palisades) is submitting the 2022 Radiological Environmental Operating Report for PNP. The report was prepared in accordance with the requirements of 10 CFR 50, Appendix I, Section IV.B and 1V.C. The period covered by the enclosed report is January 1, 2022, through December 31, 2022

This letter contains no new and no revised regulatory commitments.

Should you have any questions or require additional information, please contact Jim Miksa, Regulatory Assurance Engineer at (269) 764-2945.

Respectfully,

Jean A. Fleming

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Jean A. Fleming
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Enclosure: Palisades Nuclear Plant Annual Radiological Environmental Operating Report

cc: NRC Region III Regional Administrator
NRC Decommissioning Inspector – Palisades Nuclear Plant
NRC NMSS Project Manager – Palisades Nuclear Plant

Enclosure to
HDI PNP 2023-008
Palisades Nuclear Plant
Annual Radiological Environmental Operating Report

49 Pages Follow



Plant: Palisades	Page 1 of 49
	YEAR: 2022
Document Number: 2023-008	
Annual Radiological Environmental Operating Report	

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY.....3

2.0 INTRODUCTION4

3.0 RADIOLOGICAL ENVIRONMENTAL SAMPLING PROGRAM REQUIREMENTS5

4.0 INTERPRETATION AND TRENDS OF RESULTS.....13

5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY.....21

ATTACHMENTS

Attachment 1 - Sample Deviations.....27

Attachment 2 - Monitoring Results Tables29

Attachment 3 - Interlaboratory Comparison Program Results47

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

The Annual Radiological Environmental Operating Report presents data obtained through analyses of environmental samples collected for Palisades Radiological Environmental Monitoring Program (REMP) for the period January 1 through December 31, 2022. 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 vicinity of Palisades in 2022. The 2022 REMP thus substantiated the adequacy of source control and effluent monitoring at Palisades with no observed 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. All analyses have required, nuclide specific, lower limit of detections (LLDs) which must be achieved. 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 the site to determine if any increases of radioactivity has occurred due to station operation and control locations farther away from the site to indicate the presence of only naturally occurring radioactivity. Palisades personnel compare indicator results with control and preoperational results to assess any impact Palisades operation might have had on the surrounding environment.

In 2022, REMP samples were collected for radiological analysis. The results of indicator locations were compared with control locations and previous studies. All 2022 REMP results support the conclusion that the surrounding environment is not adversely affected by Palisades' effluents. No activity in any REMP sample from 2022 was attributed to Palisades' effluents.

1.2 Reporting Levels

No samples equaled or exceeded reporting levels.

1.3 Sample Deviations

During 2022, environmental sampling was performed for eight media types (airborne, surface water, drinking water, offsite groundwater, sediment, broad leaf vegetation, fish, and food products) and analyzed for direct radiation. All REMP samples were obtained as required by the ODCM in 2022 apart from seven instances of sample deviations which are further discussed in Attachment 1 Table 8.

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

The REMP was modified slightly in 2022. All changes were made via the Offsite Dose Calculation Manual (ODCM) change process (Technical Specification 5.5.1 c.). The changes included updating the LLD value for Zr-95 in water (to 30 pCi/L in accordance with regulatory guidance), and a change to some of the direct radiation measuring stations (discussed in more detail in section 4.2). As required by the ODCM change process, the revised ODCM is included in the 2022 Annual Radioactive Effluent Release Report (ARERR).

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 Palisades ODCM. These requirements are also listed in this report in Table 1 through Table 4.

Section 4.0 of this report provides a discussion of 2022 sampling results and Section 5.0 providing 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> 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. Gross beta radioactivity analysis weekly for each filter change. Gamma isotopic analysis quarterly for a composite of all filters collected. 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>

Annual Radiological Environmental Operating Report

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>21 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 facility.</p> <p>An inner ring of stations consisting of one in each overland meteorological sector in the general area of the site boundary and one additional location near the State Park camping area in the NE sector.</p> <p>An outer ring of stations one in each overland meteorological sector within the 12 km range from the site.</p> <p>One control TLD between 25 and 55 miles from the site.</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>

Annual Radiological Environmental Operating Report

Table 2, Exposure Pathway – Direct Radiation

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
	<ul style="list-style-type: none"> • TLD-2 (5.560 miles S) - outer ring TLD • TLD-3 (5.684 miles SSE) - outer ring TLD • TLD-4-21 (3.882 miles SE) - outer ring TLD • TLD-5-21 (3.590 miles ESE) - outer ring TLD • TLD-6 (5.314 miles NE) - outer ring TLD • TLD-7 (4.115 miles NNE) - outer ring TLD • TLD-9-21 (1.525 miles SSW) - outer ring TLD • TLD-23 (3.189 miles ENE) - outer ring TLD • TLD-24 (6.021 miles E) - outer ring TLD • TLD-11-21 (28.72 miles E) - control TLD 	<p>Quarterly</p>	<p>Gamma dose (units of milliRoentgen, abbreviated mR) quarterly</p>

Annual Radiological Environmental Operating Report

Table 3, Exposure Pathway – Waterborne

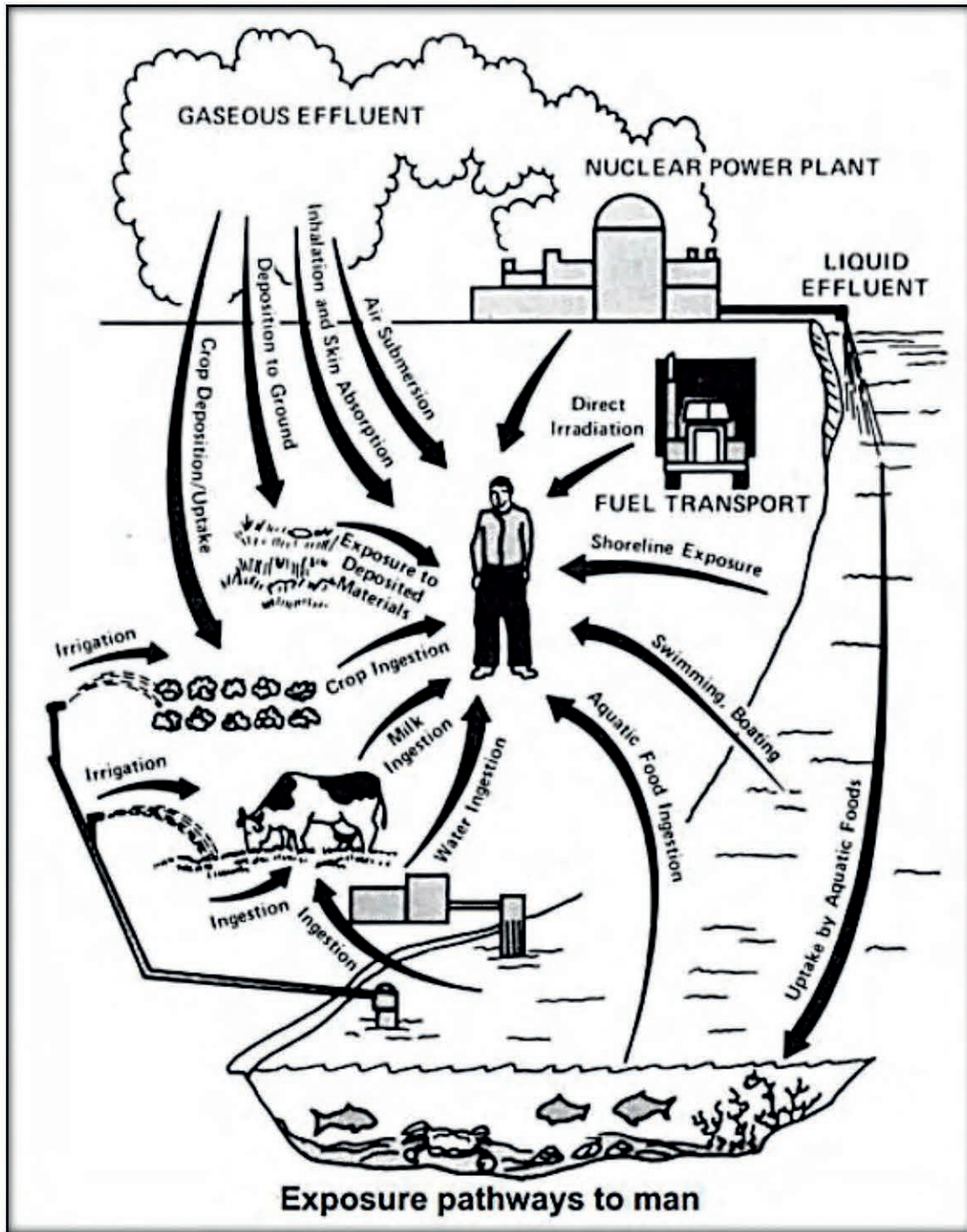
Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
<u>SURFACE WATER</u> Lake in (plant intake lake water)	Lake in - Lake Michigan intake water used in plant systems. Sample is collected onsite.	Daily samples are used to make a monthly composite sample.	Gamma isotopic, gross beta (not ODCM required), and tritium analysis monthly
<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.	City of South Haven drinking water intake structure (5.6 miles NNE of Palisades) Pal Park community drinking water (0.7 miles SSW of Palisades) Domestic water is sampled onsite from any potable water source, typically an eye wash station.	Daily South Haven drinking water samples are used to make a monthly composite sample. 1 grab sample of Palisades Park (Pal Park) community drinking water is sampled monthly when in operation (summer months). Daily samples are used to make a monthly composite.	Gamma isotopic, gross beta, and tritium analysis monthly Gamma isotopic, gross beta (not ODCM required), and tritium analysis monthly when operational Gamma isotopic, gross beta, and tritium analysis monthly
<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.	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
<u>OFFSITE GROUNDWATER</u> Palisades Park (Pal Park) commercial water is sampled when in operation (summer months). This sample is not ODCM required.	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
<u>SEDIMENT FROM SHORELINE</u> North sediment sample South sediment sample (not ODCM required)	1 sample between the north site boundary and Van Buren State Park beach, approximately 1/2 mile north of the plant discharge. 1 sample from beach near south boundary of site property	Semiannually Semiannually	Gamma isotopic analysis 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 2022 goat milk samples were not available to be sampled from the indicator locations. Therefore no control samples were obtained, and broad leaf vegetation was sampled as described below.</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>(blueberries) 3.7 to 4.7 miles SE or ESE from Palisades (apples) 3.5 to 3.7 miles E or SE from Palisades</p>	<p>Annually at time of harvest</p>	<p>Gamma isotopic and I-131 annually</p>

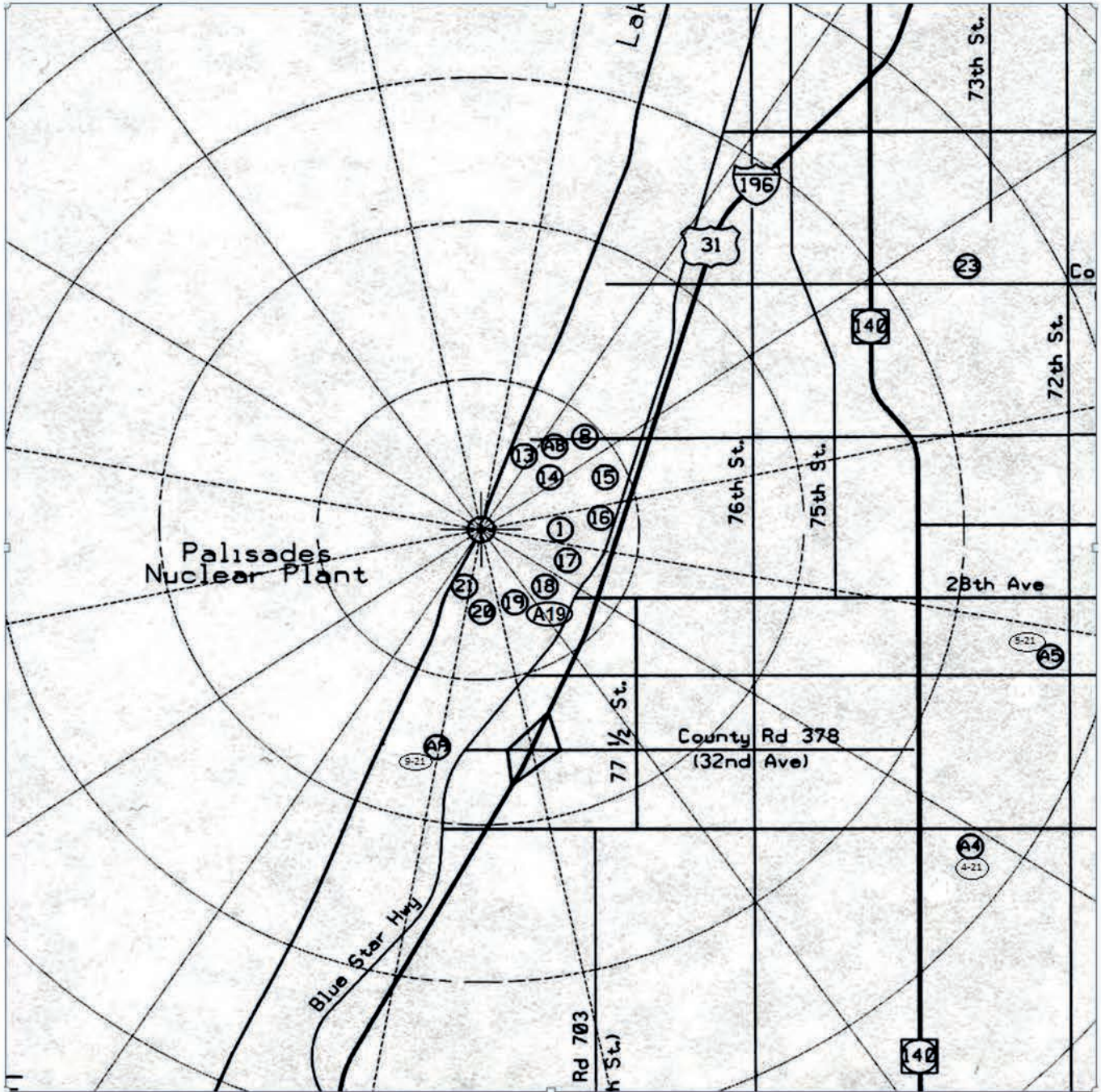
Annual Radiological Environmental Operating Report

Figure 1, Exposure Pathway



Annual Radiological Environmental Operating Report

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**4.0 INTERPRETATION AND TRENDS OF RESULTS****4.1 Air Particulate and Radioiodine Sample**

There were 312 air samples collected and analyzed for gross beta and I-131 during 2022. 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.

Analysis of the airborne particulate sample data, between the five near-site indicator locations and the control location, validates that the surrounding environment is not adversely affected by Palisades' effluents. The average concentration of gross beta activity among all indicator locations was $2.69\text{E-}02$ pCi/m³ and was $2.54\text{E-}02$ 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 2022 indicate there is no measurable change between pre-operational airborne gross beta activity and present day airborne gross beta activity.

There was five REMP deviations in 2022 involving air sampling. Two of the deviations involved a tripped GFCI outlet, two of the deviations involved a seized pump, and one deviation involved a loss of power supply. Sufficient volume was obtained from all REMP air samples to perform analysis and all results were incorporated in the statistics in this report. These instances are discussed in more detail 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 2022. This conclusion is that the surrounding environment is not adversely affected by Palisades' effluents. No REMP air samples from 2022 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 is 1 control location. 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 2021, four additional locations were added (identified as 4-21, 5-21, 9-21, and 11-21) to establish a new baseline at these locations. Starting in the first quarter of 2022, locations 4, 5, 9, 10, 11, and 12 were discontinued and locations 4-21, 5-21, 9-21, and 11-21 were implemented into the program. Essentially this resulted in a relocation of three of the outer ring TLDs, a relocation of one of the control TLDs, and a discontinuation of two control TLDs. All changes made were in accordance with the ODCM and the ODCM change process (technical specification 5.5.1 c.).

There was two REMP deviations in 2022 involving TLDs. In October, TLD number 23 was found on the ground by a member of the public and was re-installed within a few days. During collections of the 4th quarter TLDs, TLD number 24 was found on the ground about 10 feet from its designated location. The 4th quarter results for TLD 23 and 24 are recorded in Attachment 2 Table 13, but are not included in the calculations in Table 5 or Table 7 due to the deviations. These instances are also discussed in Attachment 1 Table 8.

During 2022, three of the 82 valid results trended at a value above the baseline. These TLDs were numbers 1, 7, and 9-21 from the 4th quarter 2022. An evaluation was performed which included other TLD programs (ISFSI monitoring), REMP TLD data, other REMP data, and effluents data. The conclusion is that activity from REMP TLD's is from naturally occurring background radiation and not from Palisades' direct or shine radiation.

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.

Annual Radiological Environmental Operating Report

Table 5, Direct Radiation Annual Summary

Year	Inner Ring (mR/Qtr)	Outer Ring (mR/Qtr)	Control Location (mR/Qtr)
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
2020	9.3	11.2	11.1
2021	9.3	11.3	11.1
2022	9.7	11.4	12.0

4.3 Waterborne Sample Results

During 2022 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 2022 the only radionuclide activity detected in Ludington Control water was naturally occurring isotopes (K-40 and Th-228). Of the twelve Ludington Control samples collected in 2022, five contained detectable gross beta with an average value of 3.03 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 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 2.66 pCi/L. The gross beta activity is attributed to naturally occurring radionuclide.

Annual Radiological Environmental Operating Report

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 2022. This conclusion is that the surrounding environment is not adversely affected by Palisades' effluents. No REMP surface water samples from 2022 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.

Domestic Water is collected onsite from a potable water system. This sample is collected daily and composited into a monthly sample which is analyzed for gamma radionuclide and tritium onsite. All radionuclide detected (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 activity with the average detectable gross beta activity at 3.15 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, MI. All radionuclide detected (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 2.68 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 radionuclide were detected from gamma spectroscopy or tritium analysis. Zero out of the six monthly samples contained measurable gross beta activity. 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 2022. This conclusion is that the surrounding environment is not affected by Palisades' effluents. No REMP drinking water samples from 2022 contained measurable radiological materials attributed to Palisades' effluents.

Annual Radiological Environmental Operating Report4.3.3 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. In 2022, the only radionuclides detected (Th-228) were naturally occurring isotopes which are not attributed to Palisades' effluents. No tritium was detected. Five out of the Six monthly samples contained measurable gross beta with the average detectable gross beta activity at 3.79 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 2022. This conclusion is that the surrounding environment is not adversely affected by Palisades' effluents. No REMP groundwater samples from 2022 contained measurable radiological materials attributed to Palisades' effluents.

Annual Radiological Environmental Operating Report**4.4 Sediment 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 2022, the only radionuclides detected (K-40, Th-228) were naturally occurring 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 2022. This conclusion is that the surrounding environment is not adversely affected by Palisades' effluents. No REMP sediment samples from 2022 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 2022. In accordance with Palisades ODCM, broadleaf sampling is performed when milk sampling is not performed.

Annual Radiological Environmental Operating Report

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 and K-40) 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 four out of the five monthly samples with an average activity of 73.5 pCi/kg. Cs-137 was detected in none of the samples from location BV2 or BVC. 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. This administrative action value was developed in 2013 based upon Cs-137 trends in broadleaf samples. The absence of other more prominent 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.

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 2022. This conclusion is that the surrounding environment is not adversely affected by Palisades' effluents. No REMP broadleaf samples from 2022 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 2022, 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.

Annual Radiological Environmental Operating Report

The fish sample results collected in accordance with the REMP support the conclusions of the effluents monitoring program for 2022. This conclusion is that the surrounding environment is not adversely affected by Palisades' effluents. No REMP fish water samples from 2022 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 2022 were blueberries and apples. The results of all sample analysis show that only naturally occurring radionuclides (K-40) 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.

The fruit sample results collected in accordance with the REMP support the conclusions of the effluents monitoring program for 2022. This conclusion is that the surrounding environment is not adversely affected by Palisades' effluents. No REMP fruit samples from 2022 contained measurable radiological materials attributed to Palisades' effluents.

4.6 Land Use Census Results

The latest land use census (performed in 2022) did not identify any new locations that prompt a change to the REMP or to the atmospheric dispersion or deposition factors used for offsite dose modeling. The sectors in Table 6 include all overland compass sectors.

Table 6, Land Use Census – Nearest Residence Within Five Miles

Sector	Direction	Residence (miles)	Garden (miles)	Beef Cattle (miles)	Dairy Cow (miles)	Goat (miles)
2	NNE	1.67	2.52	> 5	> 5	> 5
3	NE	1.14	2.76	> 5	> 5	> 5
4	ENE	1.19	2.11	2.29	> 5	>5
5	E	1.62	2.46	3.51	> 5	3.46
6	ESE	1.35	1.66	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	3.51	> 5	> 5	> 5
10	SSW	0.48	>5	> 5	> 5	> 5

Annual Radiological Environmental Operating Report**4.7 Interlaboratory Comparison Results**

Attachment 3 contains result summary for Interlaboratory Comparison program for Teledyne Brown Engineering Environmental Services.

5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

1. Table 7, Radiological Environmental Monitoring Program Summary, summarizes data for the 2022 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/m³)	GB / 312	0.01	2.69E-02 (260/260) [5.84E-03 – 6.60E-02]	Station A4 (3.882 miles SE)	2.95E-02 (52/52) [6.18E-03 – 6.60E-02]	2.54E-02 (52/52) [9.82E-03 - 5.53E-02]	0
	I-131 / 312	0.07	<MDA (0/260)	N/A	N/A	<MDA (0/52)	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 / 48	Sensitivity of 3 mR	9.70 (44/44) [8.10 – 12.01]	Station 1 (onsite 0.213 miles E)	11.09 (4/4) [10.68 – 12.01]	11.98 (4/4) [11.57 – 12.75]	0
	Gamma / 38	Sensitivity of 3 mR	11.36 (34/34) [9.31 - 15.02]	Station 2 (5.560 miles S)	14.43 (4/4) [13.66 - 15.02]	11.98 (4/4) [11.57 – 12.75]	0

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]
Surface Water (pCi/L)	Gross Beta / 24	4.0	2.66 (3 / 12) [2.35 -2.92]	Lake In (Plant lake intake)	2.66 (3 / 12) [2.35 -2.92]	3.03 (5 / 12) [2.62 - 3.59]	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	30	<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

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	2.92 (6 / 30) [2.27 - 3.62]	Domestic Water (On-site)	3.15 (3 / 12) [2.43 - 3.62]	3.03 (5 / 12) [2.62 - 3.59]	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	30	<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 / 9	130	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 3)
Fe-59 / 9		260	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 3)	0
Co-58 / 9		130	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 3)	0
Co-60 / 9		130	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 3)	0
Zn-65 / 9		260	<MDA (0 / 6)	N/A	N/A	<MDA (0 / 3)	0
Cs-134 / 9 Cs-137 / 9		130 150	<MDA (0 / 6) <MDA (0 / 6)	N/A N/A	N/A N/A	<MDA (0 / 3) <MDA (0 / 3)	0 0

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]
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		0
	Cs-137 / 2	80	<MDA (0 / 2)	N/A	N/A		0
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	73.5 (4 / 10) [37.4 – 95.5]	BV1 (onsite 0.4 miles SSE)	73.5 (4 / 5) [37.4 – 95.5]	<MDA (0 / 5) [N/A]	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		0

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]
Offsite Groundwater (Pal Park Commercial Well) (pCi/L)	Gross Beta / 18	4	3.79 (5 / 6) [2.62 – 5.03]	Pal Park Commercial Well (0.7 miles S)	3.79 (5 / 6) [2.62 – 5.03]	3.03 (5 / 12) [2.62 - 3.59]	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	30	<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 reactor site.
 [Note 4] – A reportable occurrence is a situation in which an NRC report was submitted in accordance with the requirements in Palisades ODCM.

Attachment 1
Sample Deviations
Page 1 of 2

Table 8, Sample Deviations Table

Comment No.	Sample Media Affected	Sample Location	Date	Problem	Evaluation / Actions
1	Air Sample	A4	05/30/22	GFCI trip	During normal weekly sample collection (on 05/30/22) the pump at air sample station A4 was found tripped off. The GFCI outlet was reset and the pump resumed sampling as normal. The volume of air sampled indicates that the pump was running for about two thirds of the previous week. The sample volume was sufficient to analyze the filter media and incorporate the results into the statistics in this report.
2	Air Sample	A8	06/13/22	GFCI trip	During normal weekly sample collection (on 06/13/22) the pump at air sample station A8 was found tripped off. The GFCI outlet was reset and the pump resumed sampling as normal. The volume of air sampled indicates that the pump was running for about two thirds of the previous week. The sample volume was sufficient to analyze the filter media and incorporate the results into the statistics in this report.
3	Air Sample	A9	06/14/22	Power loss	On 06/14/22 air sample station location A9 was validated to be without power after reports of power outages in the area due to a storm the previous day. Power was restored and sampling resumed on 06/16/22. The sample volume was sufficient to analyze the filter media and incorporate the results into the statistics in this report.
4	Air Sample	A10	10/10/22	Pump found seized	During normal weekly sample collection (on 10/10/22) the pump at air sample station A10 was found seized. The pump was replaced the same day. The volume of air sampled indicates that the pump was running for about half the previous week. The sample volume was sufficient to analyze the filter media and incorporate the results into the statistics in this report.

Sample Deviations

Table 8, Sample Deviations Table

Comment No.	Sample Media Affected	Sample Location	Date	Problem	Evaluation / Actions
5	Air Sample	A8	10/24/22	Pump found seized	During normal weekly sample collection (on 10/24/22) the pump at air sample station A8 was found seized. The pump was replaced the same day. The volume of air sampled indicates that the pump was running for about half the previous week. The sample volume was sufficient to analyze the filter media and incorporate the results into the statistics in this report.
6	TLD	23	10/22/22 through 10/25/22	TLD found on ground by member of the public	TLD number 23 was found on the ground by a member of the public over the 10/22/22 – 10/23/22 weekend, underneath the siren pole where it is typically mounted. The TLD was brought to Palisades support building Monday 10/24 and re-deployed on Tuesday 10/25 with a new holder. The old holder had potentially failed during a windstorm about 1 week prior to being found. The results from this TLD are listed in Table 13 but are not included in the statistics in Table 7 due to this deviation.
7	TLD	24	01/10/23	TLD found on ground during routine change-out	TLD number 24 was found on the ground about 10 feet from its designated location during the collection of 4 th quarter TLDs. A new TLD was installed at the normal location for 1 st quarter 2023 monitoring. The results from this TLD are listed in Table 13 but are not included in the statistics in Table 7 due to this deviation.

Annual Radiological Environmental Operating Report

Attachment 2

Page 1 of 18

Monitoring Results Tables

Table 9, Air Gross Beta Data Summary Table

Analysis: Gross Beta				Units: pCi/m ³			
Start Date	End Date	Station A4 ^[Note 1] (Indicator)	Station A5 (Indicator)	Station A8 (Indicator)	Station A9 (Indicator)	Station A19 (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
01/04/22	01/11/22	2.94E-02	3.08E-02	2.86E-02	3.29E-02	2.80E-02	2.86E-02
01/11/22	01/17/22	4.38E-02	4.11E-02	3.73E-02	3.36E-02	4.16E-02	3.42E-02
01/17/22	01/24/22	2.46E-02	2.32E-02	2.23E-02	2.17E-02	2.48E-02	2.64E-02
01/24/22	01/31/22	3.13E-02	2.83E-02	2.65E-02	3.18E-02	2.66E-02	2.12E-02
01/31/22	02/07/22	3.23E-02	2.83E-02	2.90E-02	3.06E-02	2.86E-02	2.94E-02
02/07/22	02/14/22	3.60E-02	3.57E-02	2.62E-02	3.16E-02	2.86E-02	2.27E-02
02/14/22	02/21/22	3.07E-02	3.13E-02	3.55E-02	2.51E-02	2.79E-02	2.99E-02
02/21/22	03/01/22	3.03E-02	2.75E-02	2.32E-02	3.23E-02	2.10E-02	2.57E-02
03/01/22	03/07/22	2.48E-02	3.02E-02	2.28E-02	2.48E-02	2.70E-02	2.93E-02
03/07/22	03/14/22	2.67E-02	3.00E-02	2.58E-02	2.68E-02	2.67E-02	2.48E-02
03/14/22	03/21/22	2.97E-02	2.83E-02	3.21E-02	2.79E-02	2.66E-02	2.68E-02
03/21/22	03/28/22	2.10E-02	2.16E-02	1.84E-02	1.94E-02	1.78E-02	1.39E-02
03/28/22	04/05/22	2.15E-02	1.90E-02	1.80E-02	1.81E-02	2.09E-02	1.70E-02
04/05/22	04/11/22	1.98E-02	2.51E-02	1.48E-02	1.95E-02	2.10E-02	1.63E-02
04/11/22	04/18/22	1.75E-02	2.13E-02	1.96E-02	1.74E-02	1.45E-02	1.73E-02
04/18/22	04/25/22	2.40E-02	2.49E-02	1.91E-02	2.11E-02	2.00E-02	2.00E-02
04/25/22	05/02/22	2.99E-02	2.04E-02	1.91E-02	1.94E-02	1.73E-02	1.70E-02
05/02/22	05/09/22	2.09E-02	2.18E-02	2.03E-02	2.01E-02	1.78E-02	1.70E-02
05/09/22	05/16/22	2.83E-02	2.38E-02	2.80E-02	2.42E-02	2.77E-02	2.44E-02
05/16/22	05/23/22	2.66E-02	2.48E-02	2.12E-02	2.23E-02	1.91E-02	1.87E-02
05/23/22	05/30/22	2.75E-02 ^[Note3]	1.91E-02	1.37E-02	1.62E-02	1.70E-02	1.88E-02
05/30/22	06/06/22	2.23E-02	2.81E-02	2.18E-02	2.79E-02	2.54E-02	2.54E-02
06/06/22	06/13/22	2.43E-02	1.88E-02	2.57E-02 ^[Note3]	2.21E-02	2.40E-02	1.72E-02
06/13/22	06/20/22	2.55E-02	2.49E-02	2.43E-02	2.59E-02 ^[Note3]	2.00E-02	1.91E-02
06/20/22	06/27/22	2.17E-02	2.70E-02	1.97E-02	2.07E-02	2.15E-02	1.76E-02
06/27/22	07/05/22	2.65E-02	2.08E-02	2.05E-02	1.46E-02	1.68E-02	2.72E-02

Annual Radiological Environmental Operating Report

Attachment 2

Page 2 of 18

Monitoring Results Tables

Table 9, Air Gross Beta Data Summary Table

Analysis: Gross Beta				Units: pCi/m ³			
Start Date	End Date	Station A4 ^[Note 1] (Indicator)	Station A5 (Indicator)	Station A8 (Indicator)	Station A9 (Indicator)	Station A19 (Indicator)	Station A10 ^[Note 2] (Control)
07/05/22	07/11/22	3.01E-02	2.25E-02	2.15E-02	2.69E-02	2.46E-02	2.14E-02
07/11/22	07/19/22	2.59E-02	2.48E-02	2.35E-02	2.72E-02	2.60E-02	2.22E-02
07/19/22	07/25/22	3.64E-02	2.69E-02	2.81E-02	2.15E-02	2.81E-02	1.86E-02
07/25/22	08/01/22	2.08E-02	2.15E-02	1.23E-02	1.49E-02	1.79E-02	2.47E-02
08/01/22	08/09/22	2.41E-02	2.23E-02	2.33E-02	2.32E-02	2.15E-02	2.44E-02
08/09/22	08/15/22	2.85E-02	3.34E-02	2.45E-02	2.70E-02	2.19E-02	1.86E-02
08/15/22	08/22/22	3.29E-02	2.65E-02	2.80E-02	2.64E-02	2.82E-02	2.74E-02
08/22/22	08/29/22	3.38E-02	3.08E-02	2.72E-02	3.32E-02	2.97E-02	9.82E-03
08/29/22	09/05/22	6.18E-03	5.84E-03	8.96E-03	8.77E-03	6.11E-03	2.13E-02
09/05/22	09/13/22	2.54E-02	2.70E-02	2.10E-02	2.43E-02	2.32E-02	3.04E-02
09/13/22	09/19/22	3.69E-02	3.14E-02	3.48E-02	3.11E-02	3.27E-02	3.56E-02
09/19/22	09/26/22	2.54E-02	2.74E-02	2.71E-02	2.10E-02	2.38E-02	2.79E-02
09/26/22	10/03/22	1.81E-02	1.37E-02	1.79E-02	1.72E-02	1.44E-02	1.49E-02
10/03/22	10/11/22	3.04E-02	2.96E-02	2.74E-02	2.31E-02	2.60E-02	3.33E-02 [Note3]
10/11/22	10/17/22	3.04E-02	2.67E-02	2.55E-02	3.37E-02	2.63E-02	2.75E-02
10/17/22	10/24/22	3.79E-02	3.58E-02	3.68E-02 [Note3]	2.52E-02	3.18E-02	2.74E-02
10/24/22	11/01/22	3.33E-02	3.15E-02	2.85E-02	2.62E-02	2.44E-02	2.68E-02
11/01/22	11/07/22	5.24E-02	4.96E-02	4.70E-02	4.43E-02	4.94E-02	5.53E-02
11/07/22	11/14/22	2.98E-02	2.69E-02	2.59E-02	2.43E-02	2.12E-02	1.62E-02
11/14/22	11/21/22	1.81E-02	1.79E-02	1.72E-02	1.95E-02	1.45E-02	2.00E-02
11/21/22	11/28/22	4.68E-02	4.88E-02	5.00E-02	5.25E-02	4.64E-02	4.85E-02
11/28/22	12/05/22	3.20E-02	3.62E-02	2.99E-02	3.22E-02	3.33E-02	3.28E-02
12/05/22	12/12/22	5.00E-02	4.35E-02	4.52E-02	4.40E-02	4.05E-02	4.76E-02
12/12/22	12/19/22	2.97E-02	2.59E-02	2.51E-02	2.80E-02	2.62E-02	2.67E-02
12/19/22	12/27/22	3.41E-02	2.75E-02	2.95E-02	3.25E-02	2.90E-02	2.78E-02
12/27/22	01/03/23	6.60E-02	4.89E-02	4.53E-02	4.53E-02	4.81E-02	4.71E-02

Annual Radiological Environmental Operating Report

Attachment 2

Page 3 of 18

Monitoring Results Tables

[Note 1] – Station with highest annual mean.

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

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

Table 10, Air Radioiodine 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)
REQUIRED LLD →		7.00E-02	7.00E-02	7.00E-02	7.00E-02	7.00E-02	7.00E-02
01/04/22	01/11/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
01/11/22	01/17/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
01/17/22	01/24/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
01/24/22	01/31/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
01/31/22	02/07/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
02/07/22	02/14/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
02/14/22	02/21/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
02/21/22	03/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
03/01/22	03/07/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
03/07/22	03/14/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
03/14/22	03/21/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
03/21/22	03/28/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
03/28/22	04/05/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
04/05/22	04/11/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
04/11/22	04/18/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
04/18/22	04/25/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
04/25/22	05/02/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
05/02/22	05/09/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
05/09/22	05/16/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
05/16/22	05/23/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
05/23/22	05/30/22	<MDA ^[Note 2]	<MDA	<MDA	<MDA	<MDA	<MDA
05/30/22	06/06/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
06/06/22	06/13/22	<MDA	<MDA	<MDA ^[Note 2]	<MDA	<MDA	<MDA
06/13/22	06/20/22	<MDA	<MDA	<MDA	<MDA ^[Note 2]	<MDA	<MDA

Annual Radiological Environmental Operating Report

Attachment 2

Page 5 of 18

Monitoring Results Tables

Table 10, Air Radioiodine 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)
12/27/22	01/03/23	<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] – Reference Attachment 1, Sample Deviations, Table 8, Sample Deviations Table,

Table 11, Air Sample Gamma Isotopic

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	01/04/22	03/28/22	<MDA	<MDA	1.37E-01
Station A4	03/28/22	06/27/22	<MDA	<MDA	1.60E-01
Station A4	06/27/22	10/03/22	<MDA	<MDA	1.16E-01
Station A4	10/03/22	01/03/23	<MDA	<MDA	1.28E-01
Station A5	01/04/22	03/28/22	<MDA	<MDA	1.19E-01
Station A5	03/28/22	06/27/22	<MDA	<MDA	1.40E-01
Station A5	06/27/22	10/03/22	<MDA	<MDA	1.01E-01
Station A5	10/03/22	01/03/23	<MDA	<MDA	1.30E-01
Station A8	01/04/22	03/28/22	<MDA	<MDA	1.31E-01
Station A8	03/28/22	06/27/22	<MDA	<MDA	1.33E-01
Station A8	06/27/22	10/03/22	<MDA	<MDA	1.28E-01
Station A8	10/03/22	01/03/23	<MDA	<MDA	9.89E-02
Station A9	01/04/22	03/28/22	<MDA	<MDA	1.20E-01
Station A9	03/28/22	06/27/22	<MDA	<MDA	1.06E-01
Station A9	06/27/22	10/03/22	<MDA	<MDA	8.02E-02
Station A9	10/03/22	01/03/23	<MDA	<MDA	9.95E-02
Station A19	01/04/22	03/28/22	<MDA	<MDA	7.55E-02
Station A19	03/28/22	06/27/22	<MDA	<MDA	1.18E-01
Station A19	06/27/22	10/03/22	<MDA	<MDA	1.07E-01
Station A19	10/03/22	01/03/23	<MDA	<MDA	1.03E-01
Station A10	01/03/22	03/28/22	<MDA	<MDA	1.29E-01
Station A10	03/28/22	06/28/22	<MDA	<MDA	1.58E-01
Station A10	06/28/22	10/04/22	<MDA	<MDA	1.15E-01
Station A10	10/04/22	01/03/23	<MDA	<MDA	6.45E-02

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

Annual Radiological Environmental Operating Report

Attachment 2

Page 6 of 18

Monitoring Results Tables

Table 12, Thermoluminescent Dosimeters – Inner Ring					
Analysis: Gamma Dose			Units: mR		
Station	1 st Qtr	2 nd Qtr	3 rd Qtr	4 th Qtr	Annual Mean
1 ^[Note 1]	10.80	10.85	10.68	12.01	11.09
8	9.82	10.26	9.94	11.16	10.30
13	9.85	9.70	9.22	10.23	9.75
14	8.57	8.59	8.10	9.11	8.59
15	8.97	9.56	8.96	9.86	9.34
16	9.09	9.32	8.96	10.18	9.39
17	9.17	8.91	8.60	10.00	9.17
18	9.54	9.76	9.64	10.90	9.96
19	9.49	9.77	9.27	10.29	9.71
20	9.36	9.47	9.13	10.62	9.65
21	9.54	9.72	9.14	10.54	9.74

[Note 1] – Station with highest annual mean.

Table 13, Thermoluminescent Dosimeters – Outer Ring					
Analysis: Gamma Dose			Units: mR		
Station	1 st Qtr	2 nd Qtr	3 rd Qtr	4 th Qtr	Annual Mean
2 ^[Note 1]	13.66	14.18	14.87	15.02	14.43
3	11.06	11.04	11.39	12.54	11.51
4-21	10.09	10.04	10.23	11.41	10.44
5-21	10.87	11.83	11.84	12.61	11.79
6	10.87	10.70	10.63	11.98	11.05
7	10.14	9.97	9.31	11.24	10.17

Annual Radiological Environmental Operating Report

Attachment 2

Page 8 of 18

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	Zr-95	Nb-95	Cs-134	Cs-137	Ba-140	La-140	K-40	Th-228
Lake In	09/01/22	10/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Lake In	10/01/22	11/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	3.16
Lake In	11/01/22	12/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Lake In	12/01/22	01/01/23	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	01/01/22	02/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	02/01/22	03/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	03/01/22	04/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	04/01/22	05/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	05/01/22	06/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	06/01/22	07/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	07/01/22	08/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	08/01/22	09/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	09/01/22	10/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	25.24	<MDA
Ludington Control	10/01/22	11/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ludington Control	11/01/22	12/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	3.97
Ludington Control	12/01/22	01/01/23	<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.

Annual Radiological Environmental Operating Report

Attachment 2

Page 9 of 18

Monitoring Results Tables

Table 16, Surface Water – Tritium and Gross Beta

Analysis: Tritium and Gross Beta		Units: pCi/L		
Location	Start Date	End Date	Tritium	Gross Beta
REQUIRED LLD →			2000	4.00
Lake In	01/01/22	02/01/22	<MDA	<MDA
Lake In	02/01/22	03/01/22	<MDA	<MDA
Lake In	03/01/22	04/01/22	<MDA	<MDA
Lake In	04/01/22	05/01/22	<MDA	<MDA
Lake In	05/01/22	06/01/22	<MDA	<MDA
Lake In	06/01/22	07/01/22	<MDA	2.35
Lake In	07/01/22	08/01/22	<MDA	<MDA
Lake In	08/01/22	09/01/22	<MDA	<MDA
Lake In	09/01/22	10/01/22	<MDA	<MDA
Lake In	10/01/22	11/01/22	<MDA	2.92
Lake In	11/01/22	12/01/22	<MDA	<MDA
Lake In	12/01/22	01/01/23	<MDA	2.71
Ludington Control	01/01/22	02/01/22	<MDA	2.89
Ludington Control	02/01/22	03/01/22	<MDA	<MDA
Ludington Control	03/01/22	04/01/22	<MDA	2.77
Ludington Control	04/01/22	05/01/22	<MDA	<MDA
Ludington Control	05/01/22	06/01/22	<MDA	3.59
Ludington Control	06/01/22	07/01/22	<MDA	<MDA
Ludington Control	07/01/22	08/01/22	<MDA	<MDA
Ludington Control	08/01/22	09/01/22	<MDA	<MDA

Annual Radiological Environmental Operating Report

Attachment 2

Page 12 of 18

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	Th-228	RA-226
REQUIRED LLD →			15	15	30	15	30	15	30	15	18	60	15	[Note 1]	[Note 1]
South Haven	07/01/22	08/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	4.78	<MDA
South Haven	08/01/22	09/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
South Haven	09/01/22	10/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
South Haven	10/01/22	11/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
South Haven	11/01/22	12/01/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	5.12	<MDA
South Haven	12/01/22	01/01/23	<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.

Table 18, Drinking Water – Tritium and Gross Beta

Analysis: Tritium and Gross Beta			Units: pCi/L	
Location	Start Date	End Date	Tritium	Gross Beta
REQUIRED LLD →			2000	4.00
Domestic Water	01/01/22	02/01/22	<MDA	<MDA
Domestic Water	02/01/22	03/01/22	<MDA	<MDA
Domestic Water	03/01/22	04/01/22	<MDA	3.62
Domestic Water	04/01/22	05/01/22	<MDA	<MDA
Domestic Water	05/01/22	06/01/22	<MDA	<MDA
Domestic Water	06/01/22	07/01/22	<MDA	<MDA
Domestic Water	07/01/22	08/01/22	<MDA	<MDA

Annual Radiological Environmental Operating Report

Attachment 2

Page 13 of 18

Monitoring Results Tables

Table 18, Drinking Water – Tritium and Gross Beta

Analysis: Tritium and Gross Beta		Units: pCi/L		
Location	Start Date	End Date	Tritium	Gross Beta
Domestic Water	08/01/22	09/01/22	<MDA	<MDA
Domestic Water	09/01/22	10/01/22	<MDA	3.41
Domestic Water	10/01/22	11/01/22	<MDA	<MDA
Domestic Water	11/01/22	12/01/22	<MDA	<MDA
Domestic Water	12/01/22	01/01/23	<MDA	2.43
Pal Park Community	05/22/22	NA ^[Note 1]	<MDA	<MDA
Pal Park Community	06/13/22	NA ^[Note 1]	<MDA	<MDA
Pal Park Community	07/12/22	NA ^[Note 1]	<MDA	<MDA
Pal Park Community	08/15/22	NA ^[Note 1]	<MDA	<MDA
Pal Park Community	09/13/22	NA ^[Note 1]	<MDA	<MDA
Pal Park Community	10/03/22	NA ^[Note 1]	<MDA	<MDA
South Haven	01/01/22	02/01/22	<MDA	<MDA
South Haven	02/01/22	03/01/22	<MDA	<MDA
South Haven	03/01/22	04/01/22	<MDA	3.37
South Haven	04/01/22	05/01/22	<MDA	<MDA
South Haven	05/01/22	06/01/22	<MDA	2.41
South Haven	06/01/22	07/01/22	<MDA	<MDA
South Haven	07/01/22	08/01/22	<MDA	<MDA
South Haven	08/01/22	09/01/22	<MDA	<MDA
South Haven	09/01/22	10/01/22	<MDA	<MDA
South Haven	10/01/22	11/01/22	<MDA	<MDA
South Haven	11/01/22	12/01/22	<MDA	<MDA

Annual Radiological Environmental Operating Report

Attachment 2

Page 14 of 18

Monitoring Results Tables

Table 18, Drinking Water – Tritium and Gross Beta

Analysis: Tritium and Gross Beta		Units: pCi/L		
Location	Start Date	End Date	Tritium	Gross Beta
South Haven	12/01/22	01/01/23	<MDA	2.27

[Note 1] – 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	Th-228
REQUIRED LLD →		150	180	[Note 1]	[Note 1]
North Sediment	05/09/22	<MDA	<MDA	4187	147
North Sediment	09/08/22	<MDA	<MDA	3657	151
South Sediment	05/09/22	<MDA	<MDA	2700	179
South Sediment	09/08/22	<MDA	<MDA	4210	167

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

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	[Note 1]	[Note 1]
Ludington / Brown Trout	05/14/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	3219	<MDA
Ludington / Chinook Salmon	08/17/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	2690	<MDA
Ludington / Lake Trout	08/17/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	3845	<MDA
Palisades / Brown Trout	05/04/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	2708	<MDA

Annual Radiological Environmental Operating Report

Attachment 2

Page 15 of 18

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
Palisades / Chinook Salmon	08/16/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	3017	<MDA
Palisades / Drum	05/04/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	2413	<MDA
Palisades / Gizzard Shad	05/04/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	2547	80.61
Palisades / Lake Trout	08/16/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	3110	<MDA
Palisades / Rainbow Trout	08/16/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	3066	<MDA

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

Table 21, Food Products

Analysis: I-131, Gamma Isotopic		Units: pCi/kg			
Sample / Location	Collection Date	I-131	Cs-134	Cs-137	K-40
REQUIRED LLD →		60	60	80	[Note 1]
Blueberries / Covert MI	07/05/22	<MDA	<MDA	<MDA	1398
Apples / Covert MI	10/04/22	<MDA	<MDA	<MDA	1465

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

Annual Radiological Environmental Operating Report

Attachment 2

Page 16 of 18

Monitoring Results Tables

Table 22, Offsite Groundwater - Gamma isotopic

Analysis: Gamma Isotopic						Units: pCi/L							
Location	Collection Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140	Th-228
REQUIRED LLD →		15	15	30	15	30	15	30	15	18	60	15	[Note 1]
Pal Park Commercial Well	05/22/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	10.59
Pal Park Commercial Well	06/13/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pal Park Commercial Well	07/12/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pal Park Commercial Well	08/15/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pal Park Commercial Well	09/13/22	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pal Park Commercial Well	10/03/22	<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.

Annual Radiological Environmental Operating Report

Attachment 2

Page 17 of 18

Monitoring Results Tables

Table 23, Offsite Groundwater – Tritium and Gross Beta			
Analysis: Tritium and Gross Beta		Units: pCi/L	
Location	Collection Date	Tritium	Gross Beta
REQUIRED LLD →		2000	4.00
Pal Park Commercial Well	05/22/22	<MDA	5.03
Pal Park Commercial Well	06/13/22	<MDA	<MDA
Pal Park Commercial Well	07/12/22	<MDA	2.73
Pal Park Commercial Well	08/15/22	<MDA	4.68
Pal Park Commercial Well	09/13/22	<MDA	3.90
Pal Park Commercial Well	10/03/22	<MDA	2.62

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
REQUIRED LLD →		60	60	80	[Note 1]	[Note 1]
Location BV1, 0.4 miles SSE	05/22/22	<MDA	<MDA	37.4	2644	765
Location BV1, 0.4 miles SSE	06/11/22	<MDA	<MDA	72.0	2571	1684
Location BV1, 0.4 miles SSE	07/13/22	<MDA	<MDA	95.5	2104	1915
Location BV1, 0.4 miles SSE	08/17/22	<MDA	<MDA	<MDA	2428	2366
Location BV1, 0.4 miles SSE	09/15/22	<MDA	<MDA	89.2	2248	3558
Location BV2, 0.7 miles SSE	05/22/22	<MDA	<MDA	<MDA	4011	1230

Annual Radiological Environmental Operating Report

Attachment 2

Page 18 of 18

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
Location BV2, 0.7 miles SSE	06/11/22	<MDA	<MDA	<MDA	4708	2876
Location BV2, 0.7 miles SSE	07/13/22	<MDA	<MDA	<MDA	4621	1406
Location BV2, 0.7 miles SSE	08/17/22	<MDA	<MDA	<MDA	3216	2280
Location BV2, 0.7 miles SSE	09/15/22	<MDA	<MDA	<MDA	3780	2252
Location BVC, 13.6 miles SSE	05/22/22	<MDA	<MDA	<MDA	4018	1003
Location BVC, 13.6 miles SSE	06/11/22	<MDA	<MDA	<MDA	4770	1801
Location BVC, 13.6 miles SSE	07/13/22	<MDA	<MDA	<MDA	3984	1748
Location BVC, 13.6 miles SSE	08/17/22	<MDA	<MDA	<MDA	3374	3088
Location BVC, 13.6 miles SSE	09/15/22	<MDA	<MDA	<MDA	3254	1757

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

Interlaboratory Comparison Program Results

1.0 Summary

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

The TBE Laboratory analyzed Performance Evaluation (PE) samples of air particulate (AP), 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 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 US EPA, National Environmental Laboratory Accreditation Conference (NELAC), state-specific Performance Testing (PT) program requirements or ERA's 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.

For the TBE laboratory, 142 out of 150 analyses performed met the specified acceptance criteria. Eight analyses did not meet the specified acceptance criteria and were addressed through the TBE Corrective Action Program.

TBE implements a non-conformance report (NCR) program to formally document QC investigations which include the root cause of the failure, the corrective action taken, and actions taken to prevent reoccurrence.

Annual Radiological Environmental Operating Report

Attachment 3

Page 2 of 3

Interlaboratory Comparison Program Results

NOTE: Two analyses (soil for Tc-99 and U-238) that did not meet acceptance criteria was performed for TBE information and is not on the list of required ICP analyses. A summary is found below:

- 1 The Analytics March 2022 AP Ce-141 result was evaluated as Not Acceptable. The reported value for Ce-141 was 60.9 pCi and the known result was 42.0 pCi/L (1.45 ratio of reported result vs. known; TBE's internal acceptance range is 0.70 - 1.30). This sample was used as the workgroup duplicate with a result of 45.7 (109% of known) and was also counted on a different detector with a result of 50.9 (121% of known). This was TBE's first failure for AP Ce-141. (NCR 22-04)
- 2 The MAPEP February 2022 Urine U-234 & U-238 results were evaluated as Not Acceptable. TBE's reported values of 0.142 and 0.0254 were above the known upper ranges of 0.0096 and 0.0134 respectively for U-234 and U-238. These spiked values were below TBE's typical MDC for urine client samples. The samples were re-prepped using a larger sample aliquot and counted for 60 hours as opposed to 48 hours. The recount results were 0.00732 for U-234 and 0.0119 for U-238 (both within acceptable range). MAPEP urine samples will be flagged to use a larger sample aliquot and counting time than typical client samples. MAPEP did not include any urine cross-check samples in August. (NCR 22-05)
- 3 The ERA MRAD September 2022 AP Pu-238 was evaluated as Not Acceptable. The reported value was 38.8 pCi and the known result was 29.9 (acceptance range 22.6 – 36.7). The AP filter was cut in half prior to digestion (shared with Fe-55) but should have been completely digested together and aliquotted afterwards like typical client samples. This is the first failure for AP Pu-238. (NCR 22-19)
- 4 The ERA October 2022 water Uranium result was evaluated as Not Acceptable. The reported value was 10.54 pCi/L and the known was 8.53 (acceptance range 6.60 – 9.88) or 124% of the known (acceptable for TBE QC). The 2-sigma error was 3.2, placing the reported result well within the acceptable range. This sample was used as the workgroup duplicate with a result of 8.2 +/- 2.9 pCi/L (also within the acceptable range). All other QA was reviewed with no anomalies. (NCR 22-20)
- 5 The Analytics AP Co-60 result was evaluated as Not Acceptable. The reported value was 207 pCi and the known was 147 (141% of the known). TBE's internal QC acceptance is 70 - 130%. All QA was reviewed with no anomalies. This sample was used as the workgroup duplicate and counted on a different detector with a result of 167 pCi (114% of the known). This is the first failure for AP Co-60 – average result ratio compared to the known is 109%. (NCR 22-21)

Annual Radiological Environmental Operating Report

Attachment 3

Page 3 of 3

Interlaboratory Comparison Program Results

- 6 The MAPEP August 2022 water Tc-99 result was evaluated as Not Acceptable. The reported value was 1.86 +/- 0.414 Bq/L for this "false positive" test. The evaluation of the submitted result to the 3 times the uncertainty indicated a slight positive. This sample was used as the workgroup duplicate with a result of 0.88 +/- 0.374 Bq/L. All QC was reviewed, and no anomalies found. This is the first unacceptable since the resumption of reporting water Tc-99 for the 3rd quarter of 2020. TBE to known ratios have ranged from 94-109% during this time. (NCR 22-22)

The Inter-Laboratory 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. There were no findings from the 2022 audit. Some of EDC's vendors also perform independent testing on the TLDs accuracy and precision. During 2022, 100% (72/72) of the individual dosimeters met the criterion for accuracy and precision. Also, 100% (12/12) of the dosimeter sets met the criterion for mean bias and precision and 100% (9/9) of independent blind testing passed the performance criteria for mean bias. Acceptance criteria for mean bias is +/-15% and for precision is +/-12.8% in accordance with EDC Quality System Manual..