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GNRO-2019/00020

April 30, 2019

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

**SUBJECT:** Grand Gulf Nuclear Station Annual Radiological Operating Report  
(AREOR)  
Grand Gulf Nuclear Station, Unit 1  
Docket No. 50-416  
License No. NPF-29

Dear Sir or Madam:

In accordance with Grand Gulf Nuclear Station Unit 1 Technical Specification 5.6.2, attached is the Annual Radiological Environmental Operating Report (AREOR) for the time period of January 1, 2018 through December 31, 2018.

This letter contains no new commitments. If you have any questions or require additional information, please contact George Wynn at 601-437-1426.

Sincerely,

A handwritten signature in black ink that reads "Eric A. Larson".

Eric A. Larson

EAL/dre

Attachment: Grand Gulf Nuclear Station 2018 Annual Radiological Environmental Operating Report (AREOR)

cc: see next page

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Attachment to GNRO-2019/00020

Grand Gulf Nuclear Station 2018 Annual Radioactive Environmental Operating Report  
(AREOR)



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	<b>YEAR: 2018</b>
<b>Document Number: GNRO 2019-00020</b>	
<b>Annual Radiological Environmental Operating Report</b>	

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**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 Grand Gulf Nuclear Station (GGNS) Radiological Environmental Monitoring Program (REMP) for the period January 1 through December 31, 2018. This report fulfills the requirements of Grand Gulf Nuclear Station Technical Specification 5.6.2.

All required lower limit of detection (LLD) capabilities were achieved in all sample analyses during 2018, as required by the GGNS Offsite Dose Calculation Manual (ODCM) Specifications Table 6.12.1-3. No measurable levels of radiation above baseline levels attributable to GGNS operation were detected in the vicinity of GGNS. The 2018 Radiological Environmental Monitoring Program thus substantiated the adequacy of source control and effluent monitoring at GGNS with no observed impact of plant operations on the environment.

GGNS established the REMP in 1978 prior to the station's becoming operational (1985) to provide data on background radiation and radioactivity normally present in the area. GGNS has continued to monitor the environment by sampling air, water, sediment, fish and food products, as well as measuring direct radiation. GGNS also samples milk if milk-producing animals used for human consumption are present within five miles (8 km) of the plant.

The REMP includes sampling indicator and control locations within an approximate 20-mile radius of the plant. The REMP utilizes indicator locations near the site to show any increases or buildup of radioactivity that might occur due to station operation and control locations farther away from the site to indicate the presence of only naturally occurring radioactivity. GGNS personnel compare indicator results with control and preoperational results to assess any impact GGNS operation might have had on the surrounding environment.

In 2018, environmental samples were collected for radiological analysis. The results of indicator locations were compared with control locations and previous studies. It was concluded that no significant relationship exists between GGNS operation and effect on the area around the plant. The review of 2018 data showed radioactivity levels in the environment were undetectable in many locations and near background levels in significant pathways.

**1.2 Reporting Levels**

When averaged over any calendar quarter, no environmental samples equaled or exceeded reporting levels for radioactivity as outlined in ODCM Specifications Table 6.12.1-2; the analytical results did not trigger any Radiological Monitoring Program Special Reports.

**Annual Radiological Environmental Operating Report****1.3 Comparison to State and/or Federal Program (if applicable)**

GGNS personnel compared REMP data to state monitoring programs as results became available. Historically, the programs used for comparison have included the U.S. Nuclear Regulatory Commission (NRC) Thermoluminescent Dosimeter (TLD) Direct Radiation Monitoring Network and the Mississippi State Department of Health (MSDH), Division of Radiological Health monitoring program.

The NRC TLD Network Program was discontinued in 1998. Historically these results have compared to those from the GGNS REMP. GGNS TLD results continue to remain similar to the historical average and continue to verify that plant operation is not affecting the ambient radiation levels in the environment.

The MSDH and the GGNS REMP entail similar radiological environmental monitoring program requirements. These programs include collecting air samples and splitting or sharing sample media such as water, sediment and fish. Both programs have obtained similar results over previous years.

**1.4 Sample Deviations**

During 2018, environmental sampling was performed for 5 media types addressed in the ODCM and for direct radiation. A total of 347 samples of the 351 scheduled were obtained. Of the scheduled samples, 99 percent were collected and analyzed in accordance with the requirements specified in the ODCM. Attachment 1 contains the listing of sample deviations and actions taken.

**1.5 Program Modifications**

There were no program modifications during the reporting period.

**Annual Radiological Environmental Operating Report****2.0 INTRODUCTION****2.1 Radiological Environmental Monitoring Program**

GGNS established the REMP to ensure that plant operating controls properly function to minimize any associated radiation endangerment to human health or the environment. The REMP is designed for:

Analyzing applicable pathways for anticipated types and quantities of radionuclides released into the environment.

- Considering the possibility of a buildup of long-lived radionuclides in the environment and identifying physical and biological accumulations that may contribute to human exposures.
- Considering the potential radiation exposure to plant and animal life in the environment surrounding GGNS.
- Correlating levels of radiation and radioactivity in the environment with radioactive releases from station operation.

**2.2 Pathways Monitored**

The airborne, direct radiation, waterborne and ingestion pathways are monitored as required by GGNS ODCM Table 6.12.1-1. A description of the REMP utilized to monitor the exposure pathways is described in the attached Tables and Figures.

Section 4.0 of this report provides a discussion of 2018 sampling results with Section 5.0 providing a summary of results for the monitored exposure pathways.

**2.3 Land Use Census**

GGNS conducts a land use census biennially, as required by Section 6.12.2 of the ODCM. The purpose of this census is to identify changes in uses of land within five miles of GGNS that would require modifications to the REMP and the ODCM. The most important criteria during this census are to determine the location in each sector of the nearest occupied residence, unoccupied residence, garden, and milking animal.



### 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><b><u>RADIOIODINE AND PARTICULATES</u></b> 1 sample close to the SITE BOUNDARY having the highest calculated annual average ground level D/Q.</p>	AS-7 (Sector H, 0.5 miles) – South-southeast of GGNS at the IBEW Union Hall	7 days, or more frequently if required by dust loading.	<ul style="list-style-type: none"> <li>• Radioiodine Canisters – I-131 analysis every 7 days</li> <li>• Air Particulate – Gross beta radioactivity analysis following filter change</li> <li>• Air Particulate – Gamma Isotopic composite (by location) every 92 days</li> </ul>
<p><b><u>RADIOIODINE AND PARTICULATES</u></b> 1 sample from the vicinity of a community having the highest calculated annual average ground level D/Q.</p>	AS-1 (Sector G, 5.5 miles) – Southeast of GGNS at the Port Gibson City Barn		
<p><b><u>RADIOIODINE AND PARTICULATES</u></b> 1 sample from the vicinity of a community having the highest calculated annual average ground level D/Q.</p>	AS-20 (Sector L, 0.9 miles) – South-southeast of GGNS at the former Glodjo residence		
<p><b><u>RADIOIODINE AND PARTICULATES</u></b> 1 sample from a control location 15 - 30 km distance.</p>	AS-3 (Sector B, 18 miles) – North of the Vicksburg Airport		

## 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><b>TLDS</b> An inner ring of stations in the general areas of the SITE BOUNDARY.</p>	<ul style="list-style-type: none"> <li>• <b>M-16 (Sector A, Radius 0.9 Miles)</b> – Meteorological Tower.</li> <li>• <b>M-19 (Sector E, Radius 0.5 Miles)</b> – Eastern SITE BOUNDARY Property line, North-northeast of HWSA.</li> <li>• <b>M-21 (Sector J, Radius 0.4 Miles)</b> – Near Former Training Center Building on Bald Hill Road.</li> <li>• <b>M-22 (Sector G, Radius 0.5 Miles)</b> – Former RR Entrance Crossing On Bald Hill Road.</li> <li>• <b>M-23 (Sector Q, Radius 0.5 Miles)</b> – Gin Lake Road 50 Yards North of Heavy Haul Road on Power Pole.</li> <li>• <b>M-25 (Sector N, Radius 1.6 Miles)</b> – Radial Well Number 1.</li> <li>• <b>M-28 (Sector L, Radius 0.9 Miles)</b> – Bald Hill Road.</li> <li>• <b>M-94 (Sector R, Radius 0.8 Miles)</b> – Sector R Near Meteorological Tower.</li> <li>• <b>M-95 (Sector F, Radius 0.5 mi)</b> – Spoils Area, fence of old storage area, near entrance gate</li> </ul>	92 days	Gamma dose; 92 days

**Table 2, Exposure Pathway – Direct Radiation**

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
<p><b>TLDS</b> An inner ring of stations in the general areas of the SITE BOUNDARY.</p>	<ul style="list-style-type: none"> <li>• M-96 (Sector B, Radius 0.7 mi.) – North Gate Fence</li> <li>• M-97 (Sector D, Radius 0.8 mi.) – Grand Gulf Road entrance gate to spoils area</li> <li>• M-98 (Sector H, Radius 0.5 mi.) – Bald Hill Road, across from Union Hall, in curve</li> <li>• M-99 (Sector K, Radius 0.4 mi.) – North Fence of old Ball Field near utility pole</li> <li>• M-100 (Sector C, Radius 0.6 mi.) – Grand Gulf Road</li> </ul>	<p>92 days</p>	<p>Gamma dose; 92 days</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><b>TLDS</b></p> <p>An outer ring of stations approximately 3 to 5 miles from the site.</p>	<ul style="list-style-type: none"> <li>• <b>M-36 (Sector P, Radius 5.0 Miles)</b> – Curve on HW 608, Point Nearest GGNS at Power Pole.</li> <li>• <b>M-40 (Sector M, Radius 2.3 Miles)</b> – Headly Drive, Near River Port Entrance.</li> <li>• <b>M-48 (Sector K, Radius 4.8 Miles)</b> – 0.4 Miles South on Mont Gomer Road on West Side.</li> <li>• <b>M-49 (Sector H, Radius 4.5 Miles)</b> – Fork in Bessie Weathers Road/Shafter Road.</li> <li>• <b>M-50 (Sector B, Radius 5.3 Miles)</b> – Panola Hunting Club Entrance.</li> <li>• <b>M-55 (Sector D, Radius 5.0 Miles)</b> – Near Ingelside Karnac Ferry Road/Ashland Road Intersection.</li> <li>• <b>M-57 (Sector F, Radius 4.5 Miles)</b> – Hwy 61, Behind the Welcome to Port Gibson Sign at Glensdale Subdivision.</li> </ul>	92 days	Gamma dose; 92 days

**Table 2, Exposure Pathway – Direct Radiation**

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
<p><b>TLDS</b></p> <p>Additional stations in special interest areas such as population centers, nearby residences, schools, and in 1 or 2 areas to serve as control locations.</p>	<ul style="list-style-type: none"> <li>• <b>M-01 (Sector E, Radius 3.5 Miles)</b> – Across the road from Lake Claiborne Entry Gate. (Special)</li> <li>• <b>M-07 (Sector G, Radius 5.5 Miles)</b> – AS-1 PG, Port Gibson City Barn. (Special)</li> <li>• <b>M-09 (Sector D, Radius 3.5 Miles)</b> – Warner Tully Y-Camp. (Special)</li> <li>• <b>M-10 (Sector A, Radius 1.5 Miles)</b> – Grand Gulf Military Park. (Special)</li> <li>• <b>M-14 (Sector B, Radius 18.0 Miles)</b> – AS-3-61VA, Hwy 61, North of Vicksburg Airport. (Control)</li> <li>• <b>M-33 (Sector P, Radius 12.5 Miles)</b> – Newellton, Louisiana Water Tower. (Control)</li> <li>• <b>M-38 (Sector M, Radius 9.5 Miles)</b> – Lake Bruin State Park, Entrance Road. (Special)</li> <li>• <b>M-39 (Sector M, Radius 13.0 Miles)</b> – St. Joseph, Louisiana, Auxiliary Water Tank. (Special)</li> </ul>	<p>92 days</p>	<p>Gamma dose; 92 days</p>

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Table 3, Exposure Pathway – Waterborne

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
<p><b><u>SURFACE WATER</u></b></p> <p>1 sample upstream and 1 sample downstream.</p>	<ul style="list-style-type: none"> <li>• <b>MRUP (Sector R, Radius 1.8 Miles)</b> - At least 4500 ft upstream of the GGNS discharge point into the Mississippi River to allow adequate mixing of the Mississippi and Big Black Rivers.</li> <li>• <b>MRDOWN (Sector N, Radius 1.6 Miles)</b> - At least 5000 ft downstream of the GGNS discharge point in the Mississippi River near Radial Well No. 1.</li> </ul>	92 days	Gamma isotopic and tritium analysis; 92 days
1 sample downstream during a Liquid Radwaste Discharge.	<ul style="list-style-type: none"> <li>• <b>MRDOWN (Sector P, Radius 1.3 Miles)</b> – Downstream of the GGNS discharge point in the Mississippi River near Radial Well No. 5.</li> </ul>	366 days	Gamma isotopic and tritium analysis; 366 days
1 sample from Outfall 007	<ul style="list-style-type: none"> <li>• <b>OUTFALL 007 (Sector N, Radius 0.2 Miles)</b> – Storm Drain System</li> </ul>	31 days	Tritium; 31 days
<p><b><u>GROUNDWATER</u></b></p> <p>Samples from 2 sources</p>	<ul style="list-style-type: none"> <li>• <b>PGWELL (Sector G, Radius 5.0 Miles)</b> - Port Gibson Wells – Taken from distribution system or one of the five wells.</li> <li>• <b>CONSTWELL (Sector Q, Radius 0.4 Miles)</b> – GGNS Construction Water Well – Taken from distribution system or the well.</li> </ul>	366 days	Gamma isotopic and tritium analysis; 366 days

**Table 3, Exposure Pathway – Waterborne**

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
<p><b><u>SEDIMENT FROM SHORELINE</u></b> 1 sample from downstream area and 1 sample from upstream area</p>	<ul style="list-style-type: none"> <li>• <b>SEDHAM (Sector N, Radius 1.6 Miles)</b> – Downstream of the GGNS discharge point in the Mississippi River near Hamilton Lake outlet.</li> <li>• <b>SEDCONT (Minimum of 100 yds)</b> – Upstream of the GGNS discharge point in the Mississippi River.</li> </ul>	366 days	Gamma isotopic; 366 days

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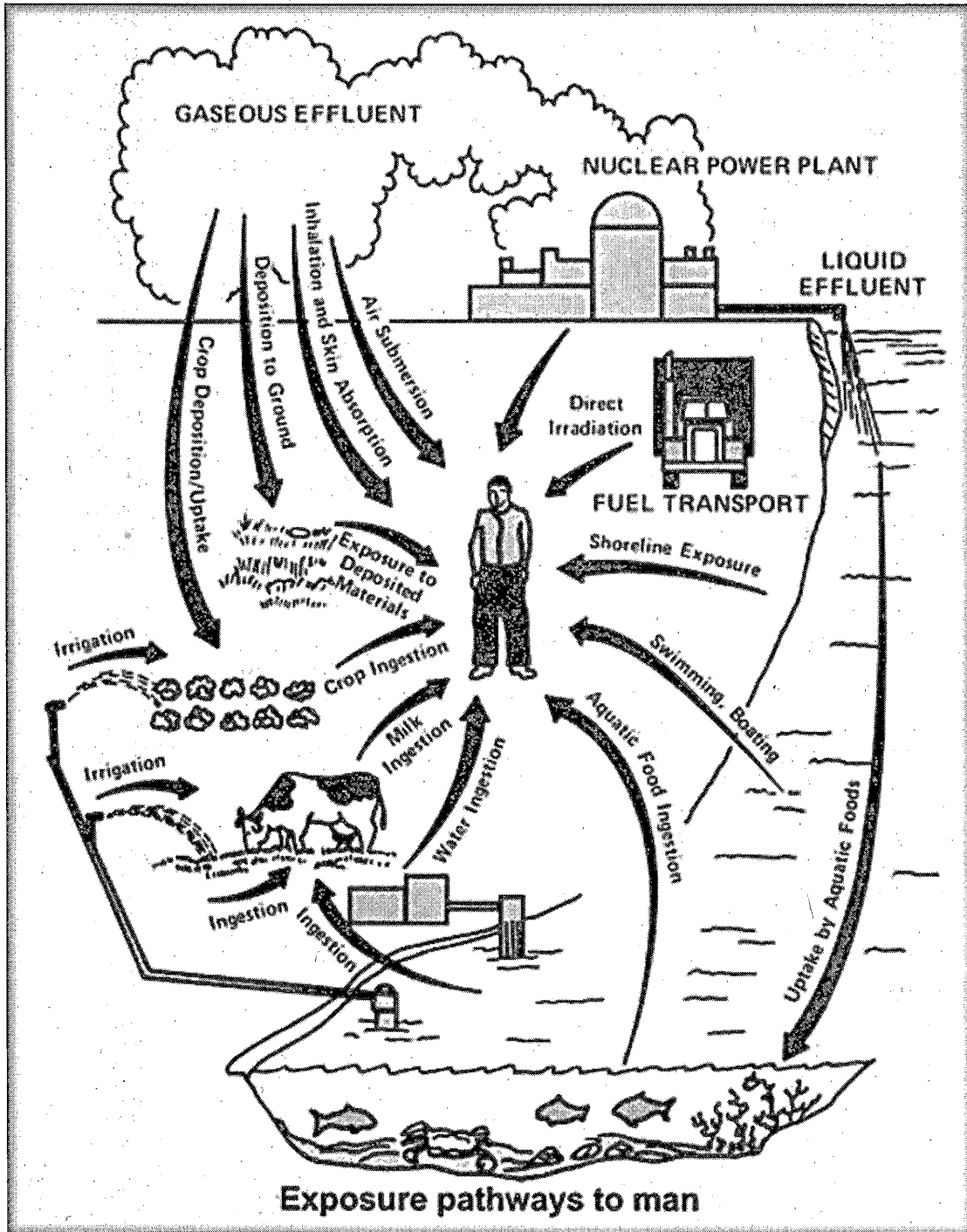
Table 4, Exposure Pathway – Ingestion

Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
<p><b><u>MILK</u></b></p> <ul style="list-style-type: none"> <li>If commercially available, 1 sample from milking animals within 8 km distant</li> <li>1 sample from milking animals at a control location &gt;8 km distant when an indicator location exists.</li> </ul>	<ul style="list-style-type: none"> <li>Currently, no available milking animals within 8 km of GGNS.</li> <li><b>ALCONT (Sector K, Radius 10.5 Miles)</b> - Located South-southwest of GGNS at Alcorn State University. (Control)</li> </ul>	92 days when required	Gamma isotopic and I-131; 92 days
<p><b><u>FISH AND INVERTEBRATES</u></b></p> <ul style="list-style-type: none"> <li>1 sample in vicinity of GGNS discharge point.</li> <li>1 sample uninfluenced by GGNS discharge.</li> </ul>	<ul style="list-style-type: none"> <li><b>FISHDOWN</b> – Downstream of the GGNS discharge point into the Mississippi River</li> <li><b>FISHUP</b> – Upstream of the GGNS discharge point into the Mississippi River uninfluenced by plant operations.</li> </ul>	366 days	Gamma isotopic on edible portions; 366 days
<p><b><u>FOOD PRODUCTS</u></b></p> <ul style="list-style-type: none"> <li>1 sample of broadleaf vegetation grown in one of two different offsite locations with highest anticipated annual average ground level D/Q if milk sampling is not performed.</li> <li>1 sample of similar vegetation grown 15 – 30 km distant if milk sampling is not performed.</li> </ul>	<ul style="list-style-type: none"> <li><b>VEG-J (Sector J, Radius 0.4 Miles)</b> – South of GGNS near former Training Center on Bald Hill Road.</li> <li><b>VEG-CONT (Sector K, Radius 10.5 Miles)</b> – Alcorn State University south-southwest of GGNS when available, otherwise a location 15-30 km distant. (Control)</li> </ul>	92 days when available	Gamma isotopic and I-131; 92 days



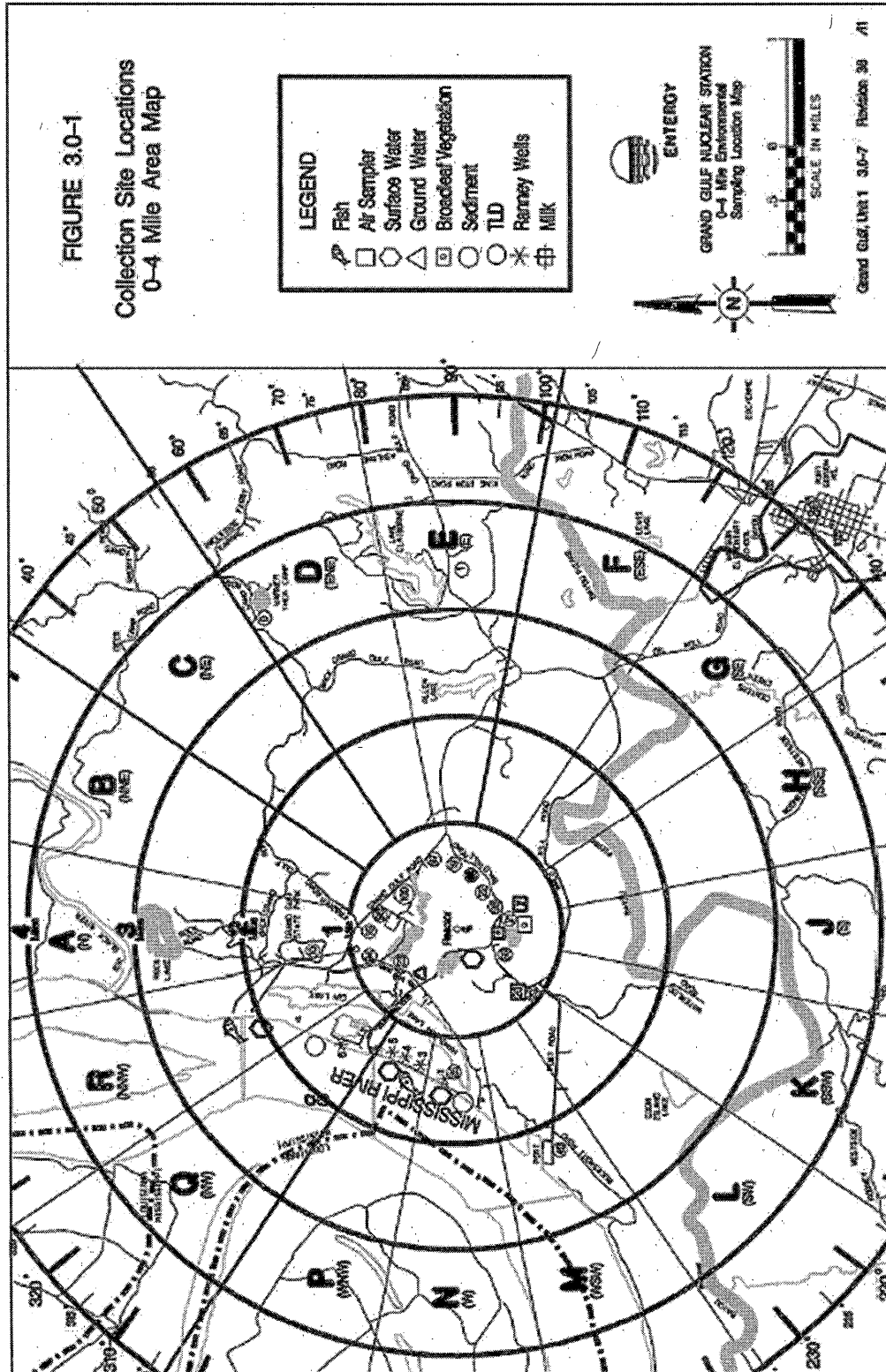
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Figure 1, Exposure Pathway



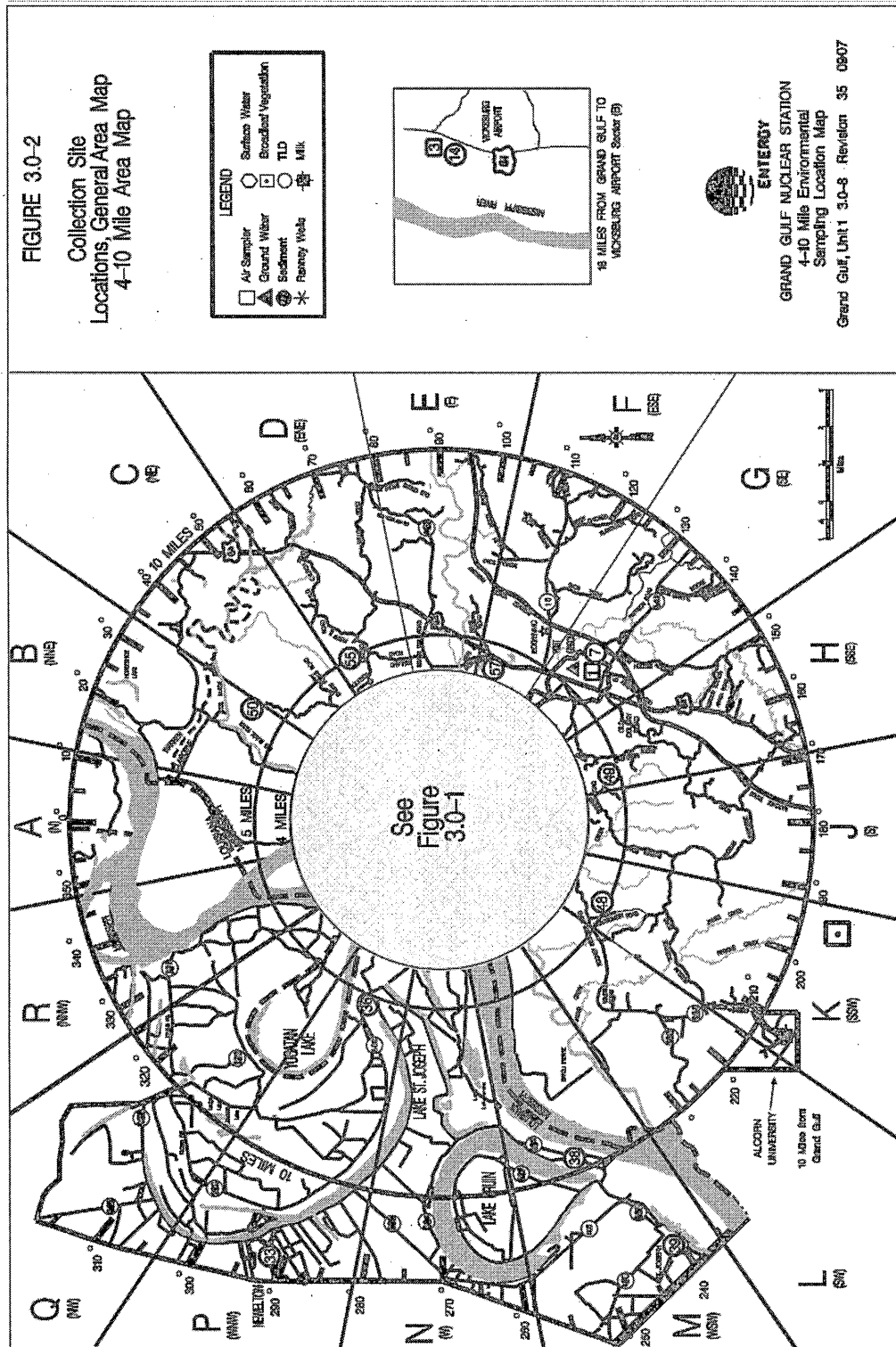
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Figure 2, Sample Collection Sites –Near Field



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Figure 3, Sample Collection Sites - Far Field



## Annual Radiological Environmental Operating Report

### 4.0 INTERPRETATION AND TRENDS OF RESULTS

#### 4.1 Air Particulate and Radioiodine Sample Results

GGNS did not detect any plant related gamma emitting radionuclides in the quarterly air particulate composites. The REMP had previously detected airborne radioactivity attributable to other sources in this pathway. These sources include the Chinese nuclear test in 1980 and the accident at the Chernobyl Nuclear Power Plant in 1986. The GGNS REMP detected radioactivity released from the Fukushima Dai-ichi Nuclear Power Plant following the March 11, 2011, Tohoku earthquake.

In 2018 there were no samples above the LLD for I-131. Listed below is a comparison of 2018 indicator results to the 2008 – 2017 operational years. Results are reported as pCi/m<sup>3</sup>.

<u>Monitoring Period</u>	<u>Result</u>
2008 – 2017 (Minimum Value)	0.009
2018 Average Value	0.017
2008 – 2017 (Maximum Value)	0.029

In the absence of plant-related gamma radionuclides, gross beta activity is attributed to naturally occurring radionuclides. Table 7, which includes gross beta concentrations and provides a comparison of the indicator and control means and ranges emphasizes the consistent trends seen in this pathway to support the presence of naturally occurring activity. Therefore, it can be concluded that the airborne pathway continues to be unaffected by GGNS operations.

#### 4.2 Thermoluminescent Dosimetry (TLD) Sample Results

Grand Gulf Nuclear Station reports measured dose as net exposure (field reading less transit reading) normalized to 92 days and relies on comparison of the indicator locations to the control as a measure of plant impact. Grand Gulf Nuclear Station's comparison of the inner ring and special interest area TLD results to the control, as seen in Table 7, identified no noticeable trend that would indicate that the ambient radiation levels are being affected by plant operations. In addition, the inner ring value of 9.7 millirem/quarter (mR/Qtr) shown in Table 7 for 2018 is within the historical bounds of 2008 – 2017 annual average results, which have ranged from 9.3 to 10.9 mrem. Overall, Grand Gulf Nuclear Station concluded that the ambient radiation levels are not being affected by plant operations.

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Table 5, Direct Radiation Annual Summary

Year	Inner Ring (mR/Qtr)	Outer Ring (mR/Qtr)	Control Location (mR/Qtr)
2008	10.0	9.4	11.5
2009	10.9	10.2	11.3
2010	10.8	10.5	12.1
2011	10.0	10.2	11.4
2012	9.5	9.7	11.0
2013	9.8	9.7	10.8
2014	10.0	9.9	11.0
2015	9.6	9.5	10.8
2016	9.3	9.3	10.7
2017	9.9	9.9	11.3

### 4.3 Waterborne Sample Results

Analytical results for 2018 drinking water and surface water samples were consistent with results seen in previous operational years. Results are further explained below:

#### 4.3.1 Surface Water

Samples were collected from two indicator locations (Outfall 007, MRDOWN) and one control location (MRUP) and analyzed for gamma emitting radionuclides and tritium. Plant related gamma emitting radionuclides and tritium remained undetectable in the upstream and downstream Mississippi River locations, which is consistent with previous operational years. Storm waters contribute to Outfall 007 and can include tritium as a result of washout and entrainment of normal, previously monitored gaseous effluents. As a result, tritium is occasionally observed. Tritium was measured during April (997 pCi/L), August (767 pCi/L), and December (863 pCi/L) at the Outfall 007 location. Tritium was also measured in the duplicate samples collected during March (683 pCi/L) and December (677 pCi/L). Tritium was not observed in the remaining Outfall 007 samples collected during 2018.

In addition to the tritium samples required by the REMP, six special surface water samples for gamma emitting radionuclides were collected at the Outfall 007 location. Plant related gamma emitting radionuclides remained undetectable in these samples.

Based on review of results and historical data, plant operations had no significant impact on this pathway during the reporting period.

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### 4.3.2 Drinking Water

Drinking water samples were collected from two locations, CONSTWELL (indicator) and PGWELL (control). Drinking water samples were analyzed for I-131, gamma radionuclides and tritium. During 2018, gamma radionuclides, I-131, and tritium concentrations were below the LLD limits at the indicator and control locations, which is consistent with previous operational years.

Grand Gulf Nuclear Station personnel have noted no definable trends associated with drinking water results at the indicator location. Therefore, the operation of Grand Gulf Nuclear Station had no definable impact on this waterborne pathway during 2018 and levels of radionuclides remain similar to those obtained in previous operational years. Results from 2018 are summarized in Table 7.

### 4.3.3 Groundwater

Groundwater monitoring data collected during administration of the Groundwater Protection Initiative (GPI) site program are included in the Annual Radioactive Effluent Release Report.

## 4.4 Soil Sample Results

Sediment samples were collected from two locations in 2018 and analyzed for gamma radionuclides. Listed below is a comparison of 2018 indicator results to the 2008 – 2017 operational years. Grand Gulf Nuclear Station operations had no significant impact on the environment or public by this waterborne pathway. Results are reported as pCi/kg.

<u>Monitoring Period</u>	<u>Result</u>
2008 – 2017 (Minimum Value)	< LLD
2018 Value	< LLD
2008 – 2017 (Maximum Value)	40.3

## 4.5 Ingestion Sample Results

### 4.5.1 Milk Sample Results

Milk samples were not collected during 2018 due to the unavailability of indicator locations within five-miles of Grand Gulf Nuclear Station.

### 4.5.2 Fish Sample Results

Fish samples were collected from two locations and analyzed for gamma radionuclides. In 2018, gamma radionuclides were below detectable limits which are consistent with the preoperational and operational years. Therefore, based on these measurements, Grand Gulf Nuclear Station operations had no significant radiological impact upon the environment or public by this ingestion pathway.

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4.5.3 Food Product Sample Results

The REMP has detected radionuclides prior to 1990 that are attributable to other sources. These include the radioactive plume release due to reactor core degradation at Chernobyl Nuclear Power Plant in 1986 and atmospheric weapons testing.

In 2018, food product samples were collected when available from two locations and analyzed for Iodine-131 and gamma radionuclides. The 2018 levels remained undetectable, as has been the case in previous years. Therefore, based on these measurements, Grand Gulf Nuclear Station operations had no significant radiological impact upon the environment or public by this ingestion pathway.

4.6 Land Use Census Results

The latest land use census did not identify any new locations that yielded a calculated dose or dose commitment greater than those currently calculated.

The land use census identified no milk-producing animals within a five-mile radius of the plant site. In accordance with ODCM Section 6.12.1, Grand Gulf Nuclear Station personnel sampled broadleaf vegetation.

**Table 6, Land Use Census – 2018 Nearest Residence Within Five Miles**

Sector	Direction	Nearest Residence (miles)	Nearest Garden (miles)
A	N	1.02	1.02
B	NNE	1.51	1.52
C	NE	0.70	4.14
D	ENE	2.60	4.50
E	E	0.83	0.91
F	ESE	2.25	4.51
G	SE	3.72	4.20
H	SSE	1.10	4.31
J	S	3.14	3.16
K	SSW	2.20	2.18
L	SW	0.89	0.89
M	WSW	none within 5 miles	none within 5 miles
N	W	none within 5 miles	none within 5 miles
P	WNW	none within 5 miles	none within 5 miles
Q	NW	none within 5 miles	none within 5 miles
R	NNW	1.44	none within 5 miles

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## Section 4.6 (Continued)

A land use census was conducted for the year 2018. The next land use census is scheduled to be conducted in 2020.

**4.7 Interlaboratory Comparison Results**

Attachment 3 contains result summary for Interlaboratory Comparison program for Teledyne Brown Engineering (TBE).

**5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY**

1. Table 7, Radiological Environmental Monitoring Program Summary, summarizes data for the 2018 REMP program.



**Table 7, Radiological Environmental Monitoring Program Summary**

Sample Type (Units)	Type / Number of Analyses [Note 1]	LLD [Note 2]	Indicator Locations Mean (F) <sup>[Note 3]</sup> [Range]	Location <sup>[Note 4]</sup> [Highest Annual Mean]	Mean (F) <sup>[Note 3]</sup> [Range]	Control Locations Mean (F) <sup>[Note 3]</sup> [Range]	Number of Non-Routine Results <sup>[Note 5]</sup>
<b>Air Particulates (pCi/m<sup>3</sup>)</b>	GB / 206	0.01	0.0173 (155 / 155) [0.0053 – 0.0291]	AS-1 PG (Sector G, 5.5 mi)	0.0179 (51 / 51) [0.0053 - 0.0291]	0.0184 (52 / 52) [0.0076 - 0.0310]	0
	GS / 16	0.05	<LLD	N/A	N/A	<LLD	0
	Cs-134 CS-137	0.06	<LLD	N/A	N/A	<LLD	0
<b>Airborne Iodine (pCi/ m<sup>3</sup>)</b>	I-131 / 206	0.07	< LLD	N/A	N/A	< LLD	0
<b>Inner Ring TLDs (mR/Qtr)</b>	Gamma / 54	[Note 6]	9.7 (54 / 54) [6.0 – 12.7]	M-99 (Sector J, 0.4 mi.)	12.1 (4 / 4) [11.7 – 12.6]	N/A	0
<b>Outer Ring TLDs (mR/Qtr)</b>	Gamma / 28	[Note 6]	9.8 (28 / 28) [4.3 – 13.1]	M-57 (Sector F, 4.5 mi.)	12.2 (4 / 4) [10.9 – 13.1]	N/A	0
<b>Special Interest TLDs (mR/Qtr)</b>	Gamma / 28	[Note 6]	9.6 (28 / 28) [7.4 – 12.2]	M-01 (Sector E, 3.5 mi.)	11.5 (4 / 4) [10.7 – 12.2]	N/A	0
<b>Control TLD (mR/Qtr)</b>	Gamma / 4	[Note 6]	N/A	N/A	N/A	10.6 (4 / 4) [10.0 – 11.4]	0

**Table 7, Radiological Environmental Monitoring Program Summary**

Sample Type (Units)	Type / Number of Analyses <small>[Note 1]</small>	LLD <small>[Note 2]</small>	Indicator Locations Mean (F) <small>[Note 3]</small> [Range]	Location <small>[Note 4]</small> [Highest Annual Mean]	Mean (F) <small>[Note 3]</small> [Range]	Control Locations Mean (F) <small>[Note 3]</small> [Range]	Number of Non-Routine Results <small>[Note 5]</small>
<b>Surface Water (pCi/l)</b>	H-3 / 39	3000	797 (5 / 32) [677 – 997]	Outfall 007 (Sector N, 0.2 mi.)	797 (5 / 23) [677 – 997]	< LLD	0
	GS / 16						
	Mn-54	15	< LLD	N/A	N/A	< LLD	0
	Fe-59	30	< LLD	N/A	N/A	< LLD	0
	Co-58	15	< LLD	N/A	N/A	< LLD	0
	Co-60	15	< LLD	N/A	N/A	< LLD	0
	Zn-65	30	< LLD	N/A	N/A	< LLD	0
	Zr-95	30	< LLD	N/A	N/A	< LLD	0
	Nb-95	15	< LLD	N/A	N/A	< LLD	0
	I-131	15	< LLD	N/A	N/A	< LLD	0
	Cs-134	15	< LLD	N/A	N/A	< LLD	0
	Cs-137	18	< LLD	N/A	N/A	< LLD	0
	Ba-140	60	< LLD	N/A	N/A	< LLD	0
La-140	15	< LLD	< LLD	N/A	N/A	< LLD	0

**Table 7, Radiological Environmental Monitoring Program Summary**

Sample Type (Units)	Type / Number of Analyses <small>[Note 1]</small>	LLD <small>[Note 2]</small>	Indicator Locations Mean (F) <small>[Note 3]</small> [Range]	Location <small>[Note 4]</small> [Highest Annual Mean]	Mean (F) <small>[Note 3]</small> [Range]	Control Locations Mean (F) <small>[Note 3]</small> [Range]	Number of Non-Routine Results <small>[Note 5]</small>
<b>Drinking Water (pCi/l)</b>	I-131 / 6	1	< LLD	N/A	N/A	< LLD	0
	H-3 / 6	2000	< LLD	N/A	N/A	< LLD	0
	GS / 6						
	Mn-54	15	< LLD	N/A	N/A	< LLD	0
	Fe-59	30	< LLD	N/A	N/A	< LLD	0
	Co-58	15	< LLD	N/A	N/A	< LLD	0
	Co-60	15	< LLD	N/A	N/A	< LLD	0
	Zn-65	30	< LLD	N/A	N/A	< LLD	0
	Zr-95	30	< LLD	N/A	N/A	< LLD	0
	Nb-95	15	< LLD	N/A	N/A	< LLD	0
	Cs-134	15	< LLD	N/A	N/A	< LLD	0
	Cs-137	18	< LLD	N/A	N/A	< LLD	0
	Ba-140	60	< LLD	N/A	N/A	< LLD	0
	La-140	15	< LLD	< LLD	N/A	N/A	< LLD
<b>Sediment (pCi/kg)</b>	GS / 2	150	< LLD	N/A	N/A	N/A	0
	Cs-134	180	< LLD	N/A	N/A	N/A	0
	Cs-137						

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Table 7, Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses [Note 1]	LLD [Note 2]	Indicator Locations Mean (F) [Range] [Note 3]	Location [Note 4] [Highest Annual Mean]	Mean (F) [Range] [Note 3]	Control Locations Mean (F) [Range] [Note 3]	Number of Non-Routine Results [Note 5]
Fish (pCi/kg)	GS / 2						
	Mn-54	130	< LLD	N/A	N/A	< LLD	0
	Fe-59	260	< LLD	N/A	N/A	< LLD	0
	Co-58	130	< LLD	N/A	N/A	< LLD	0
	Co-60	130	< LLD	N/A	N/A	< LLD	0
	Zn-65	260	< LLD	N/A	N/A	< LLD	0
	Cs-134	130	< LLD	N/A	N/A	< LLD	0
	Cs-137	150	< LLD	N/A	N/A	< LLD	0
Food Products (pCi/kg)	I-131 / 12	60	< LLD	N/A	N/A	N/A	0
	GS / 8						
	Cs-134	60	< LLD	N/A	N/A	N/A	0
	Cs-137	80	< LLD	N/A	N/A	N/A	0
Surface Water (Special) (pCi/l)	GS / 6						
	Mn-54	15	< LLD	N/A	N/A	< LLD	0
	Fe-59	30	< LLD	N/A	N/A	< LLD	0
	Co-58	15	< LLD	N/A	N/A	< LLD	0
	Co-60	15	< LLD	N/A	N/A	< LLD	0
	Zn-65	30	< LLD	N/A	N/A	< LLD	0
	Zr-95	30	< LLD	N/A	N/A	< LLD	0
	Nb-95	15	< LLD	N/A	N/A	< LLD	0
	Cs-134	15	< LLD	N/A	N/A	< LLD	0
	Cs-137	18	< LLD	N/A	N/A	< LLD	0
	Ba-140	60	< LLD	N/A	N/A	< LLD	0
	La-140	15	< LLD	N/A	N/A	< LLD	0

**Table 7, Radiological Environmental Monitoring Program Summary**

Sample Type (Units)	Type / Number of Analyses <small>[Note 1]</small>	LLD <small>[Note 2]</small>	Indicator Locations Mean (F) <small>[Note 3]</small> [Range]	Location <small>[Note 4]</small> [Highest Annual Mean]	Mean (F) <small>[Note 3]</small> [Range]	Control Locations Mean (F) <small>[Note 3]</small> [Range]	Number of Non-Routine Results <small>[Note 5]</small>
<b>Meat (Special) (pCi/kg)</b>	GS/ 1						
	Mn-54	130	< LLD	N/A	N/A	< LLD	0
	Fe-59	260	< LLD	N/A	N/A	< LLD	0
	Co-58	130	< LLD	N/A	N/A	< LLD	0
	Co-60	130	< LLD	N/A	N/A	< LLD	0
	Zn-65	260	< LLD	N/A	N/A	< LLD	0
	Cs-134	130	< LLD	N/A	N/A	< LLD	0
	Cs-137	150	< LLD	< LLD	N/A	< LLD	0

**LEGEND:**

[Note 1] - GB = Gross beta; I-131 = Iodine-131; H-3 = Tritium; GS = Gamma scan.  
 [Note 2] - LLD = Required lower limit of detection based on ODCM Table 6.12.1-3.  
 [Note 3] - Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parenthesis (F).  
 [Note 4] - Where applicable, locations are specified (1) by name, (2) distance from reactor site, and (3) meteorological sector.  
 [Note 5] - Non-routine results are those which exceed ten times the control station value. If no control station value is available, the result is considered non-routine if it exceeds ten times the preoperational value for the location.  
 [Note 6] - LLD is not defined in ODCM Table 6.12.1-3.

## Sample Deviations

Table 8, Sample Deviations Table

Comment No.	Sample Media Affected	Sample Location	Date	Problem	Evaluation / Actions
1	Air Sample	AS-1	02/13/2018	Pump Failure	The sample pump at air sample station AS-1 was found not operating. The failed pump was promptly replaced with a new pump. Due to the equipment malfunction, the required sample was not collected. Analytical results from the remaining REMP air sample locations were reviewed, and were found to be typical for the sampling period.
2	Air Sample	AS-3	02/13/2018	Pump Failure	The sample pump at air sample station AS-3 was found not operating. The failed pump was promptly replaced with a new pump. Due to the equipment malfunction, the required sample was not collected. Analytical results from the remaining REMP air sample locations were reviewed, and were found to be typical for the sampling period.
3	TLD	M-25	04/11/18	Inaccessible	During collection of 1st quarter 2018 TLDs, location M-25 was inaccessible due to high Mississippi River water level. The area was searched when water levels receded but the TLD was not found. A new TLD was installed for the following sampling period.
4	TLD	M-25	01/07/19	Inaccessible	During collection of 4th quarter 2018 TLDs, location M-25 was inaccessible due to high Mississippi River water level. The area was searched when water levels receded but the TLD was not found. A new TLD was installed for the following sampling period.

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## Monitoring Results Tables

Table 9, Air Gross Beta

Analysis: Gross Beta					
Start Date	End Date	Station AS-1 (Indicator)	Station AS-7 (Indicator)	Station AS-20 (Indicator)	Station AS-3 <sup>[Note 1]</sup> (Control)
<b>REQUIRED LLD →</b>		<b>0.01</b>	<b>0.01</b>	<b>0.01</b>	<b>0.01</b>
12/26/17	01/02/18	0.02660	0.02310	0.02270	0.02720
01/02/18	01/09/18	0.02910	0.02210	0.02790	0.02860
01/09/18	01/16/18	0.01240	0.01080	0.01110	0.01210
01/16/18	01/23/18	0.01890	0.02000	0.02180	0.02540
01/23/18	01/30/18	0.01280	0.01340	0.01260	0.00995
01/30/18	02/06/18	0.02240	0.01680	0.01670	0.02320
02/06/18	02/13/18	0.01430	0.01440	0.01430	0.01950
02/13/18	02/20/18	None <sup>[Note 2]</sup>	0.01100	0.00914	None <sup>[Note 3]</sup>
02/20/18	02/27/18	0.00881	0.00957	0.00954	0.01000
02/27/18	03/06/18	0.01340	0.01340	0.01300	0.01370
03/06/18	03/13/18	0.02070	0.01580	0.01820	0.01890
03/13/18	03/20/18	0.01960	0.01720	0.01690	0.02120
03/20/18	03/27/18	0.01720	0.02060	0.01670	0.02300
03/27/18	04/03/18	0.01480	0.01130	0.01220	0.01390
04/03/18	04/10/18	0.01610	0.01770	0.01880	0.01930
04/10/18	04/17/18	0.01890	0.01950	0.01930	0.02270
04/17/18	04/24/18	0.01590	0.01460	0.00973	0.01230
04/24/18	05/01/18	0.01630	0.01830	0.01340	0.01440
05/01/18	05/08/18	0.02090	0.02060	0.02060	0.01910
05/08/18	05/15/18	0.02280	0.02750	0.02380	0.02930
05/15/18	05/22/18	0.02290	0.02260	0.02210	0.02330
05/22/18	05/29/18	0.01030	0.01230	0.01200	0.01200
05/29/18	06/05/18	0.01430	0.01710	0.01560	0.01820
06/05/18	06/12/18	0.02260	0.02000	0.01740	0.02180
06/12/18	06/19/18	0.01540	0.01280	0.01350	0.01410
06/19/18	06/26/18	0.01320	0.01310	0.01500	0.01340
06/26/18	07/03/18	0.02120	0.02030	0.01820	0.02310
07/03/18	07/10/18	0.01440	0.01150	0.01200	0.01380

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## Monitoring Results Tables

Analysis: Gross Beta					
Start Date	End Date	Station AS-1 (Indicator)	Station AS-7 (Indicator)	Station AS-20 (Indicator)	Station AS-3 <sup>[Note 1]</sup> (Control)
07/10/18	07/17/18	0.01680	0.01450	0.01220	0.01780
07/17/18	07/24/18	0.01660	0.01990	0.02320	0.02050
07/24/18	07/31/18	0.02550	0.02580	0.02640	0.02830
07/31/18	08/07/18	0.01500	0.01340	0.01480	0.01360
08/07/18	08/14/18	0.01420	0.01030	0.01120	0.01250
08/14/18	08/21/18	0.01960	0.01820	0.01610	0.01850
08/21/18	08/28/18	0.02470	0.02560	0.02780	0.03100
08/28/18	09/04/18	0.00534	0.00765	0.00723	0.00765
09/04/18	09/11/18	0.00937	0.00809	0.00795	0.00949
09/11/18	09/18/18	0.01630	0.01780	0.01440	0.01420
09/18/18	09/25/18	0.01500	0.01360	0.01110	0.01500
09/25/18	10/02/18	0.01310	0.01610	0.01330	0.01420
10/02/18	10/09/18	0.02170	0.01910	0.01920	0.02040
10/09/18	10/16/18	0.01540	0.01660	0.01540	0.01620
10/16/18	10/23/18	0.01660	0.01590	0.01440	0.01800
10/23/18	10/30/18	0.02620	0.02540	0.02610	0.02540
10/30/18	11/06/18	0.02030	0.02130	0.01750	0.01930
11/06/18	11/13/18	0.02010	0.01980	0.01730	0.01750
11/13/18	11/20/18	0.02320	0.02260	0.02640	0.02440
11/20/18	11/27/18	0.02640	0.02600	0.02790	0.02320
11/27/18	12/04/18	0.02110	0.02000	0.01500	0.01620
12/04/18	12/11/18	0.02120	0.01920	0.01920	0.02000
12/11/18	12/18/18	0.01370	0.01370	0.01290	0.01640
12/18/18	12/26/18	0.02030	0.01640	0.01450	0.01680

[Note 1] – Station with highest annual mean.

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

[Note 3] – Reference Attachment 1, Sample Deviations, Table 8, Sample Deviations Table, Comment 2



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## Monitoring Results Tables

Table 10, Air Iodine

Analysis: I-131					
Start Date	End Date	Station AS-1 (Indicator)	Station AS-7 (Indicator)	Station AS-20 (Indicator)	Station AS-3 (Control)
<b>REQUIRED LLD →</b>		<b><u>0.07</u></b>	<b><u>0.07</u></b>	<b><u>0.07</u></b>	<b><u>0.07</u></b>
12/26/17	01/02/18	<0.04149	<0.04080	<0.04140	<0.04152
01/02/18	01/09/18	<0.04326	<0.04324	<0.04375	<0.04409
01/09/18	01/16/18	<0.03623	<0.03862	<0.03644	<0.03648
01/16/18	01/23/18	<0.04446	<0.04766	<0.04488	<0.04515
01/23/18	01/30/18	<0.02679	<0.03387	<0.03199	<0.03208
01/30/18	02/06/18	<0.05228	<0.05197	<0.05215	<0.05291
02/06/18	02/13/18	<0.04081	<0.03926	<0.04064	<0.04000
02/13/18	02/20/18	none <sup>[Note 1]</sup>	<0.04008	<0.03901	none <sup>[Note 2]</sup>
02/20/18	02/27/18	<0.04600	<0.04472	<0.04470	<0.04473
02/27/18	03/06/18	<0.04425	<0.04483	<0.04485	<0.04371
03/06/18	03/13/18	<0.04299	<0.04415	<0.04416	<0.04374
03/13/18	03/20/18	<0.04036	<0.04086	<0.04092	<0.04274
03/20/18	03/27/18	<0.05413	<0.05435	<0.05515	<0.05257
03/27/18	04/03/18	<0.05106	<0.05196	<0.05352	<0.05139
04/03/18	04/10/18	<0.03637	<0.03670	<0.03596	<0.03634
04/10/18	04/17/18	<0.04288	<0.04405	<0.04343	<0.04202
04/17/18	04/24/18	<0.03944	<0.03997	<0.03941	<0.03895
04/24/18	05/01/18	<0.03384	<0.04035	<0.04029	<0.04045
05/01/18	05/08/18	<0.03925	<0.04671	<0.04682	<0.04696
05/08/18	05/15/18	<0.05760	<0.05889	<0.05955	<0.05952
05/15/18	05/22/18	<0.03085	<0.03114	<0.03212	<0.03038
05/22/18	05/29/18	<0.02583	<0.02638	<0.02696	<0.02587
05/29/18	06/05/18	<0.02161	<0.02158	<0.02290	<0.02204
06/05/18	06/12/18	<0.06590	<0.06571	<0.06773	<0.06543
06/12/18	06/19/18	<0.04961	<0.04953	<0.05026	<0.04161
06/19/18	06/26/18	<0.04683	<0.04710	<0.04768	<0.04659
06/26/18	07/03/18	<0.03839	<0.03818	<0.03937	<0.03861

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## Monitoring Results Tables

Analysis: I-131					
Start Date	End Date	Station AS-1 (Indicator)	Station AS-7 (Indicator)	Station AS-20 (Indicator)	Station AS-3 (Control)
07/03/18	07/10/18	<0.01635	<0.02965	<0.03053	<0.02974
07/10/18	07/17/18	<0.02087	<0.02098	<0.02164	<0.02134
07/17/18	07/24/18	<0.05271	<0.05240	<0.05473	<0.05215
07/24/18	07/31/18	<0.03243	<0.03239	<0.03287	<0.03250
07/31/18	08/07/18	<0.04198	<0.04200	<0.03229	<0.04203
08/07/18	08/14/18	<0.01921	<0.04601	<0.04711	<0.04588
08/14/18	08/21/18	<0.03035	<0.03029	<0.03075	<0.03041
08/21/18	08/28/18	<0.02383	<0.02402	<0.02447	<0.02387
08/28/18	09/04/18	<0.03529	<0.02947	<0.03739	<0.03535
09/04/18	09/11/18	<0.05936	<0.05936	<0.06292	<0.05952
09/11/18	09/18/18	<0.02514	<0.02509	<0.02624	<0.02480
09/18/18	09/25/18	<0.01121	<0.02706	<0.02775	<0.02679
09/25/18	10/02/18	<0.05084	<0.05148	<0.05220	<0.05168
10/02/18	10/09/18	<0.04353	<0.04468	<0.04542	<0.04357
10/09/18	10/16/18	<0.06197	<0.06572	<0.06777	<0.06213
10/16/18	10/23/18	<0.04505	<0.04499	<0.04501	<0.04511
10/23/18	10/30/18	<0.04651	<0.04702	<0.04646	<0.04772
10/30/18	11/06/18	<0.04524	<0.06806	<0.04420	<0.04451
11/06/18	11/13/18	<0.05243	<0.05183	<0.05251	<0.05218
11/13/18	11/20/18	<0.05834	<0.05664	<0.05669	<0.05849
11/20/18	11/27/18	<0.04503	<0.04621	<0.04562	<0.04511
11/27/18	12/04/18	<0.01714	<0.01760	<0.01714	<0.01716
12/04/18	12/11/18	<0.02771	<0.02846	<0.02767	<0.02775
12/11/18	12/18/18	<0.01510	<0.01881	<0.01801	<0.01807
12/18/18	12/26/18	<0.03904	<0.04138	<0.03902	<0.03908

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

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

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## Monitoring Results Tables

Table 11, Air Gamma Quarterly Composite

Analysis: Gamma			
Location	Date	CS-134	CS-137
<b>REQUIRED LLD →</b>		<b>0.05</b>	<b>0.06</b>
AS-1	02/16/18	<0.001875	<0.001451
AS-3		<0.002039	<0.00171
AS-7		<0.002065	<0.00200
AS-20		<0.003306	<0.003137
AS-1	05/18/18	<0.001646	<0.001538
AS-3		<0.001933	<0.001880
AS-7		<0.001708	<0.001702
AS-20		<0.002213	<0.001461
AS-1	08/17/18	<0.002128	<0.001739
AS-3		<0.002084	<0.001615
AS-7		<0.001437	<0.001779
AS-20		<0.001633	<0.0009318
AS-1	11/17/18	<0.001735	<0.001721
AS-3		<0.001596	<0.001733
AS-7		<0.002264	<0.001627
AS-20		<0.002493	<0.002087

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## Monitoring Results Tables

Table 12, Thermoluminescent Dosimeters – Inner Ring

Analysis: Gamma Dose				Units: mrem	
Station	1 <sup>st</sup> Qtr 2018	2 <sup>nd</sup> Qtr 2018	3 <sup>rd</sup> Qtr 2018	4 <sup>th</sup> Qtr 2018	Annual Mean 2018
M-16	10.8	10.5	10.7	11.3	10.8
M-19	9.2	9.3	10.0	9.5	9.5
M-21	12.2	11.6	12.4	11.5	11.9
M-22	7.7	7.7	8.8	9.2	8.4
M-23	6.1	7.6	8.6	9.1	7.8
M-25	Lost <sup>[Note 2]</sup>	7.7	8.5	Lost <sup>[Note 3]</sup>	8.1
M-28	10.5	11.1	11.6	11.6	11.2
M-94	9.3	10.5	9.5	11.3	10.2
M-95	6.8	6.5	6.0	7.7	6.8
M-96	8.3	7.9	8.2	8.8	8.3
M-97	6.8	7.3	6.9	8.1	7.3
M-98	11.0	11.3	11.3	12.7	11.6
<b>M-99<sup>[Note 1]</sup></b>	<b>12.4</b>	<b>11.8</b>	<b>11.7</b>	<b>12.6</b>	<b>12.1</b>
M-100	10.8	10.8	11.0	11.7	11.1

[Note 1] – Station with highest annual mean.

[Note 2] - Reference Attachment 1, Sample Deviations, Table 8, Sample Deviations Table, Comment 3

[Note 3] - Reference Attachment 1, Sample Deviations, Table 8, Sample Deviations Table, Comment 4

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## Monitoring Results Tables

Table 13, Thermoluminescent Dosimeters – Outer Ring

Analysis: Gamma Dose			Units: mrem		
Station	1 <sup>st</sup> Qtr 2018	2 <sup>nd</sup> Qtr 2018	3 <sup>rd</sup> Qtr 2018	4 <sup>th</sup> Qtr 2018	Annual Mean 2018
M-36	7.5	8.1	9.3	8.8	8.4
M-40	4.4	4.3	5.3	4.8	4.7
M-48	9.5	10.8	11.3	10.9	10.6
M-49	11.4	11.7	11.5	12.2	11.7
M-50	9.6	9.4	10.1	10.5	9.9
M-55	10.1	11.2	12.3	12.0	11.4
<b>M-57<sup>[Note 1]</sup></b>	<b>10.9</b>	<b>12.4</b>	<b>12.2</b>	<b>13.1</b>	<b>12.2</b>

[Note 1] – Station with highest annual mean.

Table 14, Thermoluminescent Dosimeters – Special Interest Areas

Analysis: Gamma Dose			Units: mrem		
Station	1 <sup>st</sup> Qtr 2018	2 <sup>nd</sup> Qtr 2018	3 <sup>rd</sup> Qtr 2018	4 <sup>th</sup> Qtr 2018	Annual Mean 2018
<b>M-01<sup>[Note 1]</sup></b>	<b>10.7</b>	<b>12.2</b>	<b>11.9</b>	<b>11.4</b>	<b>11.5</b>
M-07	10.6	10.3	11.2	10.9	10.8
M-09	8.7	9.4	9.4	10.2	9.4
M-10	7.8	8.8	8.4	8.4	8.4
M-33	8.7	7.4	7.8	8.7	8.1
M-38	10.3	10.2	9.4	10.3	10.0
M-39	8.3	9.0	9.1	9.3	8.9

[Note 1] – Station with highest annual mean.

Table 15, Thermoluminescent Dosimeters – Control

Analysis: Gamma Dose			Units: mrem		
Station	1 <sup>st</sup> Qtr 2018	2 <sup>nd</sup> Qtr 2018	3 <sup>rd</sup> Qtr 2018	4 <sup>th</sup> Qtr 2018	Annual Mean 2018
M-14	10.1	11.0	11.4	10.0	10.6

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## Monitoring Results Tables

Table 16, Surface Water – Gamma

Analysis: Gamma Isotopic						Units: pCi/L							
Location	Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140
<b>REQUIRED LLD →</b>		<b>15</b>	<b>15</b>	<b>30</b>	<b>15</b>	<b>30</b>	<b>15</b>	<b>30</b>	<b>15</b>	<b>15</b>	<b>18</b>	<b>60</b>	<b>15</b>
MRDOWN (Indicator)	01/30/18	<5.813	<6.113	<10.15	<7.305	<12.33	<6.388	<10.84	<7.674	<7.398	<6.499	<22.92	<7.33
MRUP (Control)	01/30/18	<6.704	<5.348	<14.09	<7.136	<16.27	<7.081	<10.88	<7.412	<8.917	<7.673	<32.25	<7.099
MRDOWN GG (Indicator)	01/30/18	<9.178	<7.873	<16.84	<7.502	<20.09	<9.71	<16.12	<7.613	<10.88	<8.966	<36.29	<11.31
MRUP GG (Control)	01/30/18	<7.485	<7.712	<9.955	<7.05	<15.98	<9.461	<13.27	<8.378	<9.081	<8.011	<26.13	<10.99
MRDOWN (Indicator)	05/05/18	<7.053	<4.754	<13.49	<6.803	<14.41	<6.333	<13.14	<13.16	<6.479	<5.36	<41.02	<11.98
MRUP (Control)	05/05/18	<5.102	<4.102	<9.263	<6.521	<10.3	<5.076	<8.904	<13.05	<6.411	<5.309	<32.5	<7.222
MRDOWN (Indicator)	08/08/18	<6.224	<6.237	<15.07	<6.231	<12.76	<6.532	<12.41	<10.87	<8.153	<7.224	<31.3	<9.214
MRDOWN GG (Indicator)	08/08/18	<5.644	<5.317	<12.28	<5.508	<11.28	<5.689	<9.503	<10.79	<5.155	<4.267	<28.29	<6.554
MRUP (Control)	08/08/18	<3.289	<3.611	<6.985	<3.071	<6.731	<3.475	<6.292	<6.977	<3.377	<3.659	<17.75	<5.507
MRUP GG (Control)	08/08/18	<6.033	<5.731	<10.38	<5.413	<12.11	<5.786	<11.59	<11.21	<7.06	<6.262	<28.36	<9.142

**Monitoring Results Tables**

**Table 16, Surface Water – Gamma**

Analysis: Gamma Isotopic						Units: pCi/L							
Location	Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140
MRDOWN* (Indicator)	11/07/18	<5.064	<5.466	<12.48	<5.549	<10.65	<5.457	<8.261	<14.85	<5.268	<5.102	<32.26	<10.01
MRDOWN GG* (Indicator)	11/07/18	<7.184	<7.832	<13.22	<6.194	<10.76	<5.857	<11.07	<14.55	<4.998	<6.882	<38.3	<14.79
MRUP (Control)	11/07/18	<4.458	<4.645	<9.82	<3.744	<10.27	<4.966	<7.902	<11.82	<5.002	<4.552	<27.73	<8.067
MRUP GG (Control)	11/07/18	<4.945	<5.37	<10.56	<5.902	<12.71	<6.02	<7.975	<14.11	<4.657	<5.622	<26.37	<12.4
MRDOWN (Indicator)	11/07/18	<6.214	<5.827	<12.19	<5.71	<10.5	<5.898	<8.706	<14.89	<6.287	<5.236	<32.7	<13.41
MRDOWN GG (Indicator)	11/07/18	<4.591	<5.324	<9.771	<5.872	<9.704	<6.764	<8.214	<13.35	<5.525	<5.577	<32.73	<11.59

GG - indicates duplicate sample

\* - indicates Annual Sample collected during liquid discharge

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## Monitoring Results Tables

Table 17, Surface Water – Tritium

Analysis: H-3		Units: pCi/L
Location	Date	H-3
<b>REQUIRED LLD →</b>		<b>3000</b>
OUTFALL 007	01/04/18	<591
MRDOWN	01/30/18	<560
MRUP	01/30/18	<555
MRDOWN GG	01/30/18	<552
MRUP GG	01/30/18	<557
OUTFALL 007	02/07/18	<509
OUTFALL 007 GG	02/07/18	<495
OUTFALL 007	03/07/18	<529
OUTFALL 007 GG	03/07/18	683
OUTFALL 007	04/04/18	997
OUTFALL 007	05/02/18	<527
MRDOWN	05/05/18	<531
MRUP	05/05/18	<523
OUTFALL 007	05/30/18	<568
OUTFALL 007 GG	05/30/18	<555
OUTFALL 007	06/27/18	<570
OUTFALL 007 GG	06/27/18	<581
OUTFALL 007	08/06/18	<588
MRDOWN	08/08/18	<600
MRDOWN GG	08/08/18	<582
MRUP	08/08/18	<583
MRUP GG	08/08/18	<573
OUTFALL 007	08/16/18	<569
OUTFALL 007 GG	08/16/18	<571



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## Monitoring Results Tables

Table 17, Surface Water – Tritium

Analysis: H-3		Units: pCi/L
Location	Date	H-3
OUTFALL 007	08/27/18	767
OUTFALL 007 GG	08/27/18	<576
OUTFALL 007	09/27/18	<592
OUTFALL 007	10/31/18	<557
OUTFALL 007 GG	10/31/18	<548
MRDOWN	11/07/18	<511
MRDOWN GG	11/07/18	<504
MRUP	11/07/18	<518
MRUP GG	11/07/18	<516
MRDOWN*	11/07/18	<507
MRDOWN GG*	11/07/18	<520
OUTFALL 007	11/28/18	<571
OUTFALL 007 GG	11/28/18	<583
OUTFALL 007	12/20/18	863
OUTFALL 007 GG	12/20/18	677

GG - indicates duplicate sample

\* - indicates Annual Sample collected during liquid discharge

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## Monitoring Results Tables

Table 18, Drinking Water –Gamma, I-131

Analysis: Gamma Isotopic, I-131							Units: pCi/L						
Location	Date	I-131	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
<b>REQUIRED LLD →</b>		<b>1</b>	<b>15</b>	<b>15</b>	<b>30</b>	<b>15</b>	<b>30</b>	<b>15</b>	<b>30</b>	<b>15</b>	<b>18</b>	<b>60</b>	<b>15</b>
CONSTWELL 3	11/14/18	<0.944	<8.535	<7.77	<12.18	<8.508	<12.07	<9.423	<14.2	<7.493	<7.942	<33.97	<13
CONSTWELL 3 GG	11/14/18	<0.816	<4.993	<7.914	<11.66	<9.202	<14.09	<7.625	<11.92	<6.085	<7.741	<30.93	<10.2
CONSTWELL 4	11/14/18	<0.948	<5.652	<5.61	<14.02	<4.325	<10.66	<7.125	<10.66	<7.444	<6.793	<26	<8.304
CONSTWELL 4 GG	11/14/18	<0.638	<7.322	<6.596	<13	<6.351	<10.1	<7.877	<13.22	<7.783	<5.858	<25.97	<8.68
PGWELL	11/14/18	<0.793	<8.481	<6.953	<17.78	<8.753	<15.03	<8.109	<17.13	<8.173	<6.518	<35.37	<14.6
PGWELL GG	11/14/18	<0.707	<6.304	<6.648	<11.24	<8.19	<13.82	<8.043	<11.02	<7.758	<7.334	<32.96	<13.14

GG - indicates duplicate sample

Monitoring Results Tables

Table 19, Drinking Water – Tritium

Analysis: H-3		Units: pCi/L
Location	Date	H-3
<b>REQUIRED LLD →</b>		<b>2000</b>
CONSTWELL 3	11/14/18	<555
CONSTWELL 3 GG	11/14/18	<551
CONSTWELL 4	11/14/18	<548
CONSTWELL 4 GG	11/14/18	<558
PGWELL	11/14/18	<564
PGWELL GG	11/14/18	<560

GG - indicates duplicate sample

Table 20, Sediment

Analysis: Gamma Isotopic		Units: pCi/kg	
Location	Date	Cs-134	Cs-137
<b>REQUIRED LLD →</b>		<b>150</b>	<b>180</b>
SEDCONT	09/10/18	<45.14	<37.89
SEDHAM	09/10/18	<47.09	<42.18

Monitoring Results Tables

Table 21, Fish

Analysis: Gamma Isotopic				Units: pCi/kg				
Location	Collection Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Cs-134	Cs-137
<b>REQUIRED LLD →</b>		130	130	260	130	260	130	150
FISHDOWN	09/19/18	<48.86	<54.03	<109.6	<66.26	<129.9	<51.34	<48.11
FISHUP	09/19/18	<40.76	<37.64	<93.67	<69.43	<98.24	<52.83	<43.04

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## Monitoring Results Tables

Table 22, Food Products

Analysis: I-131, Gamma Isotopic		Units: pCi/kg		
Location	Collection Date	I-131	Cs-134	Cs-137
<b>REQUIRED LLD →</b>		<b>60</b>	<b>60</b>	<b>80</b>
VEG-CONT	01/24/18	<32.37	<29.53	<34.61
VEG-J	01/24/18	<36.72	<28.06	<39.77
VEG-CONT	05/18/18	<27.94	<12.95	<12.64
VEG-CONT GG	05/18/18	<41.79	<11.78	<14.64
VEG-J	05/18/18	<40.74	<17.36	<18.28
VEG-J GG	05/18/18	<42.03	<22.08	<20.79
VEG-CONT	08/09/18	<47.8	<31.44	<22.21
VEG-CONT GG	08/09/18	<44.86	<26.67	<26.96
VEG-J	08/09/18	<40.93	<21.47	<23.99
VEG-J GG	08/09/18	<39.42	<26.96	<25.29
VEG-CONT	10/30/18	<51.29	<37.07	<30.23
VEG-J	10/30/18	<31.5	<17.87	<23.76

GG - indicates duplicate sample

Monitoring Results Tables

Table 23, Special Samples, Surface Water

Analysis: Gamma Isotopic							Units: pCi/L						
Location	Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140
<b>REQUIRED LLD →</b>		15	15	30	15	30	15	30	15	15	18	60	15
OUTFALL 007	03/23/18	<5.044	<4.6	<8.874	<4.618	<9.185	<6.336	<8.451	<9.47	<5.616	<5.251	<22.99	<9.76
OUTFALL 007	06/27/18	<5.975	<7.973	<12.21	<7.689	<8.229	<6.525	<10.66	<12.78	<7.107	<7.539	<36.57	<13.4
OUTFALL 007 GG	06/27/18	<6.164	<7.225	<11.07	<6.59	<12.13	<5.783	<11.34	<14.4	<5.527	<6.489	<33.62	<8.563
OUTFALL 007	08/27/18	<5.550	<6.197	<12.13	<7.219	<10.33	<7.263	<10.05	<14.48	<6.407	<6.593	<36.17	<9.569
OUTFALL 007 GG	08/27/18	<6.469	<7.051	<14.89	<5.177	<12.91	<7.267	<15.27	<12.86	<5.923	<5.925	<39.92	<9.822
OUTFALL 007	12/06/18	<5.012	<6.341	<13.37	<7.927	<9.682	<6.025	<7.381	<11.8	<6.573	<6.352	<32.34	<8.665

GG - indicates duplicate sample

Table 24, Special Samples, Meat

Analysis: Gamma Isotopic			Units: pCi/L					
Location	Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Cs-134	Cs-137
<b>REQUIRED LLD →</b>		130	130	260	130	260	130	150
DEER	12/08/18	<81.74	<74	<170.9	<96.1	<197.2	<92.43	<85.79

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## Interlaboratory Comparison Program Results

**1.0 Summary**

The 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 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 USEPA, 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, 164 out of 172 analyses performed met the specified acceptance criteria. Six analyses did not meet the specified acceptance criteria for the following reasons and were addressed through the TBE Corrective Action Program.

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## Interlaboratory Comparison Program Results

For the TBE laboratory, 164 out of 172 analyses performed met the specified acceptance criteria. Six analyses did not meet the specified acceptance criteria for the following reasons and were addressed through the TBE Corrective Action Program.

1. TBE was unable to report the February 2018 DOE MAPEP vegetation Sr-90 result due to QC failure and limited sample amount. (NCR 18-09)
2. The Analytics September 2018 milk Fe-59 result was evaluated as *Not Acceptable* (Ratio of TBE to known result at 133%). The reported value was  $158 \pm 17.6$  pCi/L and the known value was  $119 \pm 19.9$  pCi/L. No cause for the failure could be determined. TBE has passed 24 of the previous 27 milk cross-check results since 2012. This sample was run in duplicate on a different detector with comparable results ( $162 \pm 16$  pCi/L). *NOTE: TBE's 4<sup>th</sup> Qtr result passed at 105%* (NCR 18-20)
3. The Analytics September milk I-131 result was evaluated as *Not Acceptable* (Ratio of TBE to known result at 143%). Due to a personnel change in the gamma prep lab, the sample was not prepped/counted in a timely manner such as to accommodate the I-131 8-day half-life. Analysts have been made aware of the urgency for this analysis and it will be monitored more closely by QA. *NOTE: TBE's 4<sup>th</sup> Qtr result passed at 101%* (NCR 18-24)
4. The Analytics September soil Cr-51 result was evaluated as *Not Acceptable* (Ratio of TBE to known result at 131%). As with #3 above, the sample was not prepped/counted in a timely manner such as to accommodate the Cr-51 27-day half-life. The same corrective action applies here as in #3. (NCR 18-21)
5. The MAPEP November vegetation Sr-90 result of 0.338 Bq/sample was evaluated as *Not Acceptable* (Lower acceptable range was 0.554 Bq/sample). It appears that there has been incomplete dissolution of Sr-90 due to the composition of the MAPEP vegetation "matrix". To resolve this issue, the TBE-2018 procedure has been modified to add H<sub>2</sub>O<sub>2</sub> to assist in breaking down the organic material that comprises this "matrix". This corrective action will be monitored closely by QA. (NCR 18-25).
6. The ERA November 2018 water Sr-90 sample was evaluated as *Not Acceptable*. TBE's initial reported result of 36.8 pCi/L exceeded the upper acceptance range (22.9 – 36.4 pCi/L). After reviewing the data for this sample, it was discovered that there was a typographical error at the time the results were entered at the ERA website. The correct result in LIMS of 36.2 should have been submitted instead. This result is within ERA's acceptance limits. In addition to the typo error, ERA's very stringent upper acceptance limit of 116% is not a reflection of TBE's ability to successfully perform this analysis. (NCR 18-23)

The Inter-Laboratory Comparison Program provides evidence of "in control" counting systems and methods, and that the laboratories are producing accurate and reliable data.