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RBG-47952

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Attn: Document Control Desk
U. S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

Subject: 2018 Annual Radiological Environmental Operating Report
River Bend Station – Unit 1
License No. NPF-47
Docket No. 50-458

Enclosed is the River Bend Station (RBS) Annual Radiological Environmental Operating Report for the period of January 1, 2018 through December 31, 2018. This report is submitted in accordance with the RBS Technical Specifications, Section 5.6.2.

Should you have any questions regarding the enclosed, please contact Tim Schenk, at (225) 381-4177.

Sincerely,

Tim Schenk

TAS/tf

Enclosure: 2018 Annual Radiological Environmental Operating Report

cc: NRC Region IV Regional Administrator, w/o Enclosure
NRC Senior Resident Inspector – River Bend Station, Unit 1
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IE25
NRR



Plant: River Bend Station	Page 1 of 45
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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 River Bend Station (RBS) Radiological Environmental Monitoring Program (REMP) for the period January 1 through December 31, 2018. This report fulfills the requirements of RBS Technical Specification 5.6.2 of Appendix A to RBS License Number NPF-47.

All required lower limit of detection (LLD) capabilities were achieved in all sample analyses during 2018, as required by the RBS Technical Requirement Manual (TRM). No measurable levels of radiation above baseline levels attributable to River Bend Station operation were detected in the vicinity of RBS. The 2018 Radiological Environmental Monitoring Program thus substantiated the adequacy of source control and effluent monitoring at River Bend Station with no observed impact of plant operations on the environment.

River Bend Station established the REMP prior to the station's becoming operational 1985 to provide data on background radiation and radioactivity normally present in the area. RBS has continued to monitor the environment by sampling air, water, sediment, fish and food products, as well as measuring direct radiation. RBS 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. RBS personnel compare indicator results with control and preoperational results to assess any impact RBS 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 RBS 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

No samples equaled or exceeded reporting levels.

Annual Radiological Environmental Operating Report**1.3 Comparison to State and Federal Program**

RBS 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 Louisiana Department of Environmental Quality – Office of Environmental Compliance (LDEQ-OEC).

The NRC TLD Network Program was discontinued in 1998. Historically these results have compared to those from the RBS REMP. RBS 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 LDEQ-OEC and the RBS REMP entail similar radiological environmental monitoring program requirements. These programs include co-located 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 five media types addressed in the ODCM and for direct radiation. A total of 120 samples of the 120 scheduled were obtained. Of the scheduled samples, 100 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**

River Bend Station 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 River Bend Station.
- 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 RBS TRM 3.12.1. 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

RBS conducts a land use census biennially, as required by 3.12.2 of the TRM. The purpose of this census is to identify changes in uses of land within five miles of RBS that would require modifications to the REMP and the Offsite Dose Calculation Manual (ODCM/TRM). The next scheduled land use census will be performed in 2020. Section 4.5 on the report contains a narrative on the results of the 2018 land use census.

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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> 2 samples from close to the 2 SITE BOUNDARY locations, in different sectors, of the highest calculated annual average ground level D/Q.</p>	<ul style="list-style-type: none"> • AN1 (0.9 km W) - RBS site Hwy 965; 0.4 km south of Activity Center. • AP1 (0.9 km WNW) – Behind River Bend Station Activity Center. 	Continuous sampler operation with sample collection every two weeks, or more frequently if required by dust loading.	<ul style="list-style-type: none"> • Radioiodine Canisters – I-131 analysis every two weeks. • Air Particulate – Gross beta radioactivity analysis following filter change.
<p><u>RADIOIODINE AND PARTICULATES</u> 1 sample from the vicinity of a community having the highest calculated annual average ground level D/Q.</p>	<ul style="list-style-type: none"> • AQS2 (5.8 km NW) - St. Francis Substation on US Hwy. (Bus.) 61 in St. Francisville. 	Continuous sampler operation with sample collection every two weeks, or more frequently if required by dust loading.	<ul style="list-style-type: none"> • Radioiodine Canisters – I-131 analysis every two weeks. • Air Particulate – Gross beta radioactivity analysis following filter change.
<p><u>RADIOIODINE AND PARTICULATES</u> 1 sample from a control location, as for example 15 - 30 km distance and in the least prevalent wind direction.</p>	<ul style="list-style-type: none"> • AGC (17.0 km SE) – Entergy Service Center compound in Zachary. (Control) 	Continuous sampler operation with sample collection every two weeks, or more frequently if required by dust loading.	<ul style="list-style-type: none"> • Radioiodine Canisters – I-131 analysis every two weeks. • Air Particulate – Gross beta radioactivity analysis following filter change.

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>One ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY.</p>	<ul style="list-style-type: none"> • TA1 (1.7 km N) - River Bend Training Center. • TB1 (0.5 km NNE) - Utility pole near River Bend Station cooling tower yard area. • TC1 (1.7 km NE) - Telephone pole at Jct. US Hwy. 61 and Old Highway 61. • TD1 (1.6 km ENE) – Stub pole along WF7, 150m S of Jct. WF7 and US Hwy. 61. • TE1 (1.3 km E) – Stub pole along WF7, 1 km S of Jct. WF7 and US Hwy. 61. • TF1 (1.3 km ESE) – Stub pole along WF7, 1.6 km S of Jct. WF7 and US Hwy. 61. • TG1 (1.6 km SE) – Stub pole along WF7, 2 km S of Jct. WF7 and US Hwy. 61. • TH1 (1.7 km SSE) – Stub pole at power line crossing of WF7 (near Grants Bayou). • TJ1 (1.5 km S) – Stub pole near River Bend Station Gate #23 on Powell Station Road (LA Hwy. 965). 	<p>Quarterly</p>	<ul style="list-style-type: none"> • mR exposure quarterly.

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>One ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY.</p>	<ul style="list-style-type: none"> • TK1 (0.9 km SSW) – Utility pole on Powell Station Road (LA Hwy. 965), 20 m S of River Bend Station River Access Road. • TL1 (1.0 km SW) – First utility pole on Powell Station Road (LA Hwy . 965) S of former Illinois Central Gulf RR crossing. • TM1 (0.9 km WSW) - Third utility pole on Powell Station Road (LA Hwy. 965) N of former Illinois Central Gulf RR crossing. • TN1 (0.9 km W) – Utility pole along Powell Station Road (LA Hwy. 965), near garden and AN1 air sampler location. • TP1 (0.9 km WNW) - Behind River Bend Station Activity Center at AP1 air sampler location. • TQ1 (0.6 km NW) – Across from MA-1 on RBS North Access Road. • TR1 (0.8 km NNW) – River Bend Station North Access Road across from Main Plant entrance. 	<p>Quarterly</p>	<ul style="list-style-type: none"> • mR exposure quarterly.

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>The balance of the stations (8) to be placed 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"> • TAC (15.8 km N) – Utility pole at Jct. of US Hwy. 61 and LA Hwy. 421, 7.9 km north of Bains. (Control) • TCS (12.3 km NE) – Utility pole at gate to East Louisiana State Hospital in Jackson. (Special) • TEC (16.0 km E) – Stub pole at jct. of Hwy. 955 and Greenbrier Road, 4.8 km North of Jct. of Hwys 955 and 964. (Control) • TGS (17.0 km SE) – Entergy Service Center compound in Zachary. (Special) • TNS (6.0 km W) – Utility pole with electrical meter at west bank ferry landing (LA Hwy. 10). (Special) • TQS1 (4.0 km NW) – Utility pole front of Pentecostal church (opposite West Feliciana Parish Hospital) near Jct. US Hwy. 61 and Commerce Street. (Special) • TQS2 (5.8 km NW) – St. Francis Substation on business US Hwy. 61 in St. Francisville. (Special) • TRS (9.2 km NNW) - Stub pole at Jct. of US Hwy. 61 and WF2 near Bains (West Feliciana High School). (Special) 	<p>Quarterly</p>	<ul style="list-style-type: none"> • mR exposure quarterly.

Table 3: Exposure Pathway – Waterborne

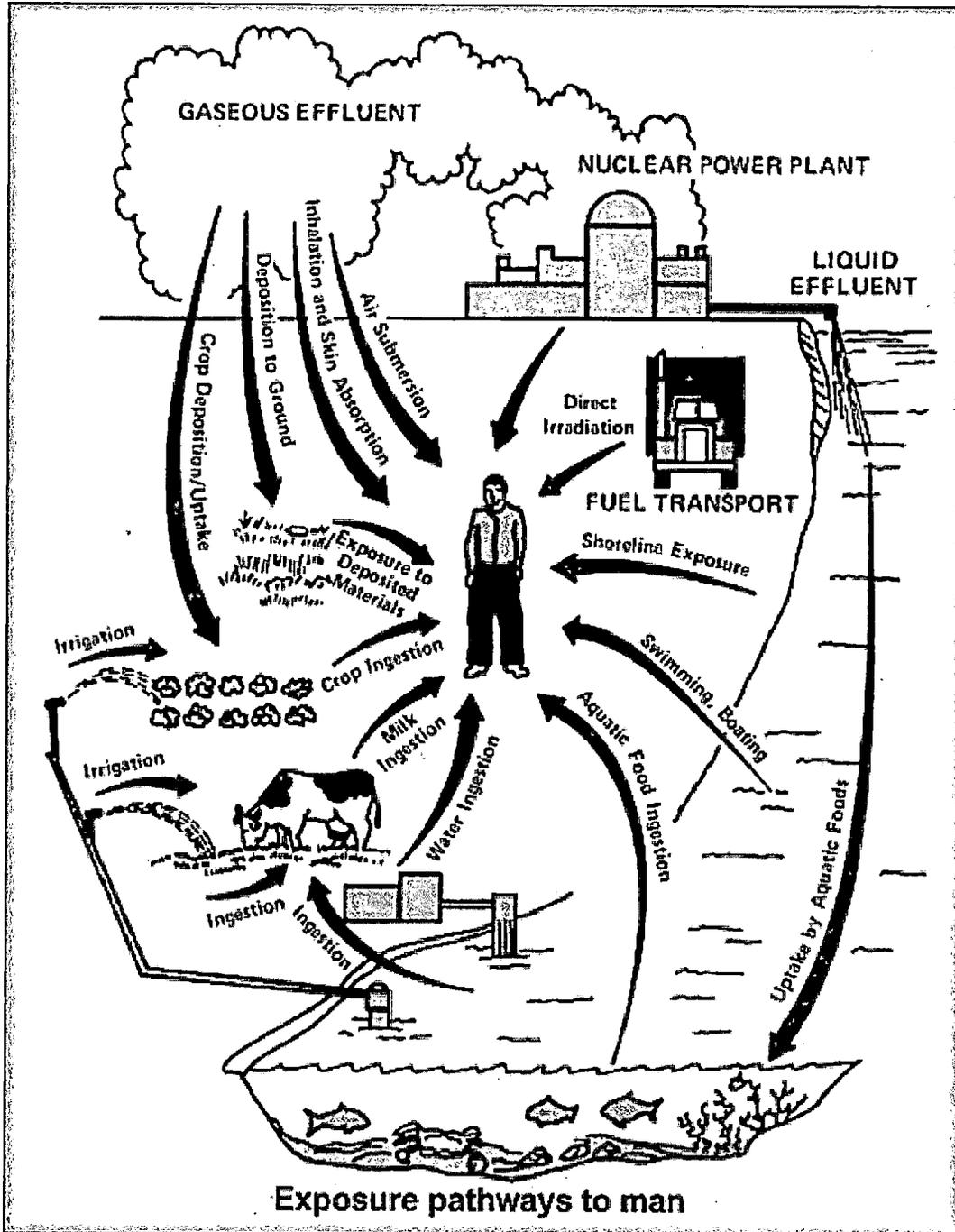
Requirement	Sample Point Description Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
<p><u>SURFACE WATER</u> 1 sample upstream and 1 sample downstream.</p>	<ul style="list-style-type: none"> • SWU (5.0 km W) - Mississippi River about 4 km upstream from the plant liquid discharge outfall, near LA Hwy. 10 ferry crossing. • SWD (7.75 km S) - Mississippi River about 4 km downstream from plant liquid discharge outfall, near paper mill. 	Grab samples quarterly	<ul style="list-style-type: none"> • Gamma isotopic analysis and tritium analysis quarterly.
<p><u>GROUNDWATER</u> Samples from 1 or 2 sources only if likely to be affected.</p>	<ul style="list-style-type: none"> • WU (~470 m NNE) - Upland Terrace Aquifer well upgradient from plant. • WD (~470 m SW) – Upland Terrace Aquifer well downgradient from plant. 	Semiannually	<ul style="list-style-type: none"> • Gamma isotopic and tritium analysis semiannually.
<p><u>SEDIMENT FROM SHORELINE</u> 1 sample from downstream area with existing or potential recreational value.</p>	<ul style="list-style-type: none"> • SEDD (7.75 km S) – Mississippi River about 4 km downstream from plant liquid discharge outfall, near paper mill. 	Annually	<ul style="list-style-type: none"> • Gamma isotopic analysis annually.

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></p> <ul style="list-style-type: none"> If commercially available, 1 sample from milking animals within 8 km distant where doses are calculated to be greater than 1 mrem per year. 1 sample from milking animals at a control location 15 – 30 km distant when an indicator location exists. 	<ul style="list-style-type: none"> Currently, no available milking animals within 8 km of RBS. 	<p>Quarterly when animals are on pasture.</p>	<p>Gamma isotopic and I-131 analysis quarterly when animals are on pasture.</p>
<p><u>FISH AND INVERTEBRATES</u></p> <ul style="list-style-type: none"> 1 sample of a commercially and/or recreationally important species in vicinity of plant discharge area. 1 sample of similar species in area not influenced by plant discharge. 	<ul style="list-style-type: none"> FD (7.75 km S) - One sample of a commercially and/or recreationally important species from downstream area influenced by plant discharge. FU (4.0 km WSW) - One sample of a commercially and/or recreationally important species from upstream area not influenced by plant discharge. 	<p>Annually</p>	<p>Gamma isotopic analysis on edible portions annually</p>
<p><u>FOOD PRODUCTS</u></p> <ul style="list-style-type: none"> 1 sample of one type of broadleaf vegetation grown near the SITE BOUNDARY location of highest predicted annual average ground level D/Q if milk sampling is not performed. 1 sample of similar broadleaf vegetation grown 15 – 30 km distant, if milk sampling is not performed. 	<ul style="list-style-type: none"> GN1 (0.9 km W) – Sampling will be performed in accordance with Table 3.12.1-1 Section 4.a of the Technical Requirements Manual. GQC (32.0 km NW) - One sample of similar vegetables from LA State Penitentiary at Angola. (Control) 	<p>Quarterly during the growing season.</p>	<p>Gamma isotopic and I-131 analysis quarterly.</p>

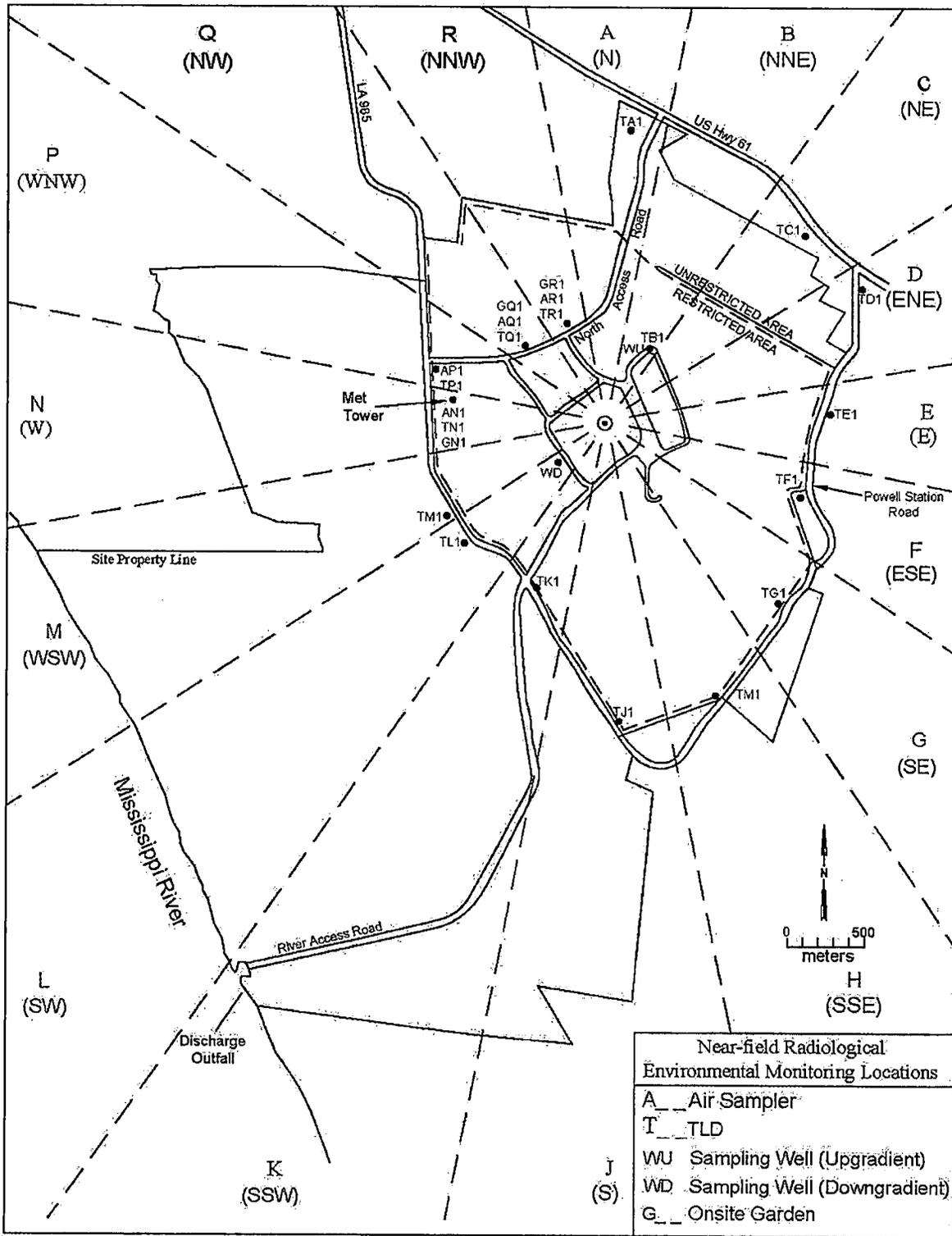
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Figure 1: Exposure Pathway



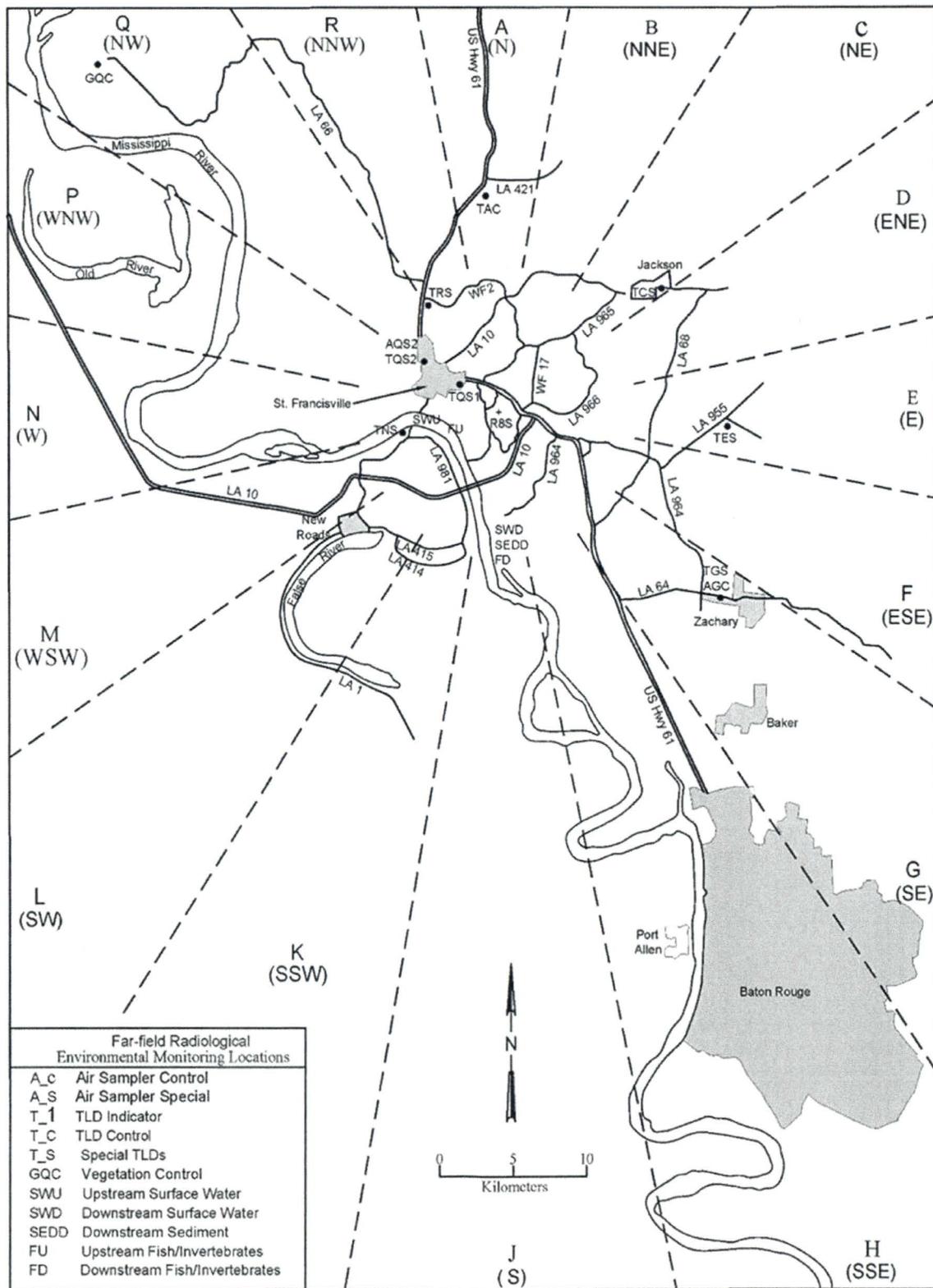
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Figure 2: Sample Collection Sites – Near Field



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Figure 3: Sample Collection Sites - Far Field



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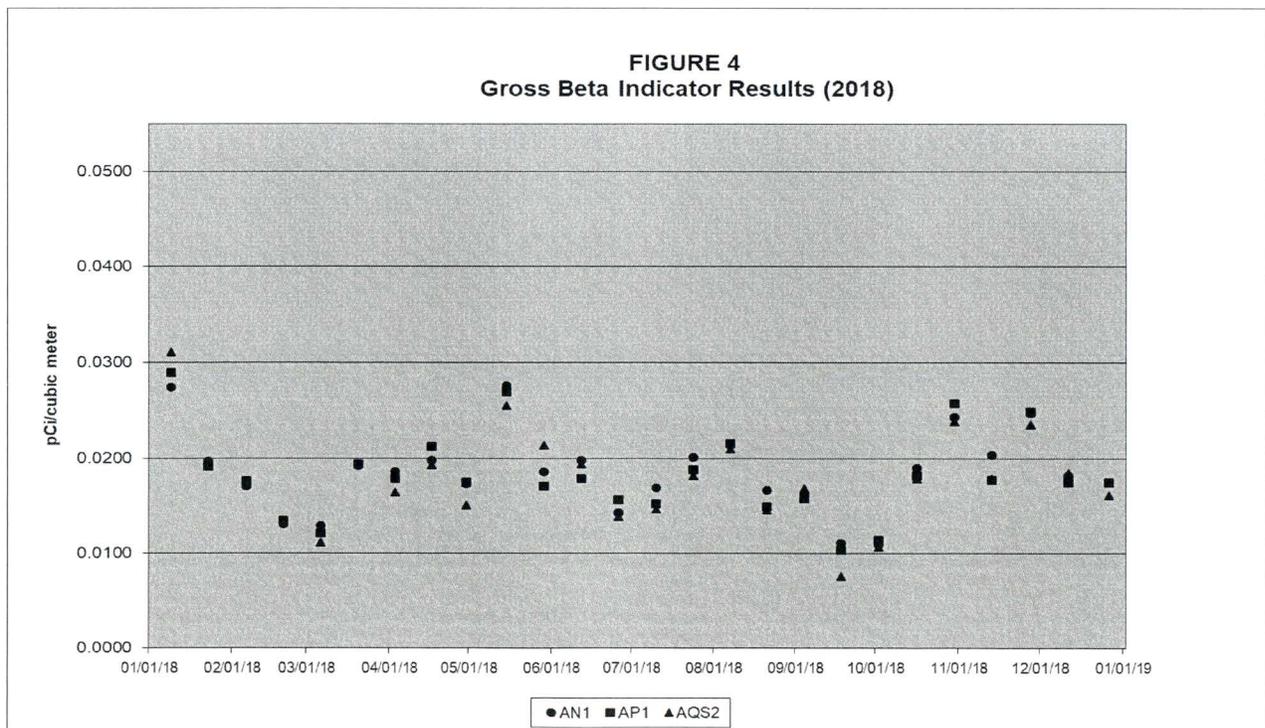
4.0 INTERPRETATION AND TRENDS OF RESULTS

4.1 Air Particulate and Radioiodine Sample Results

In 2018 there were no samples above the LLD for I-131. Indicator gross beta air particulate results for 2018 were comparable to results obtained from 2008-2017 of the operational REMP. Also, the 2018 gross beta annual average was less than the average for preoperational levels. Results are reported as annual average picocuries per cubic meter (pCi/m³).

<u>Monitoring Period</u>	<u>Result</u>
2008 – 2017 (Minimum Value)	0.017
2018 Average Value	0.018
2008 – 2017 (Maximum Value)	0.026
Preoperational	0.030

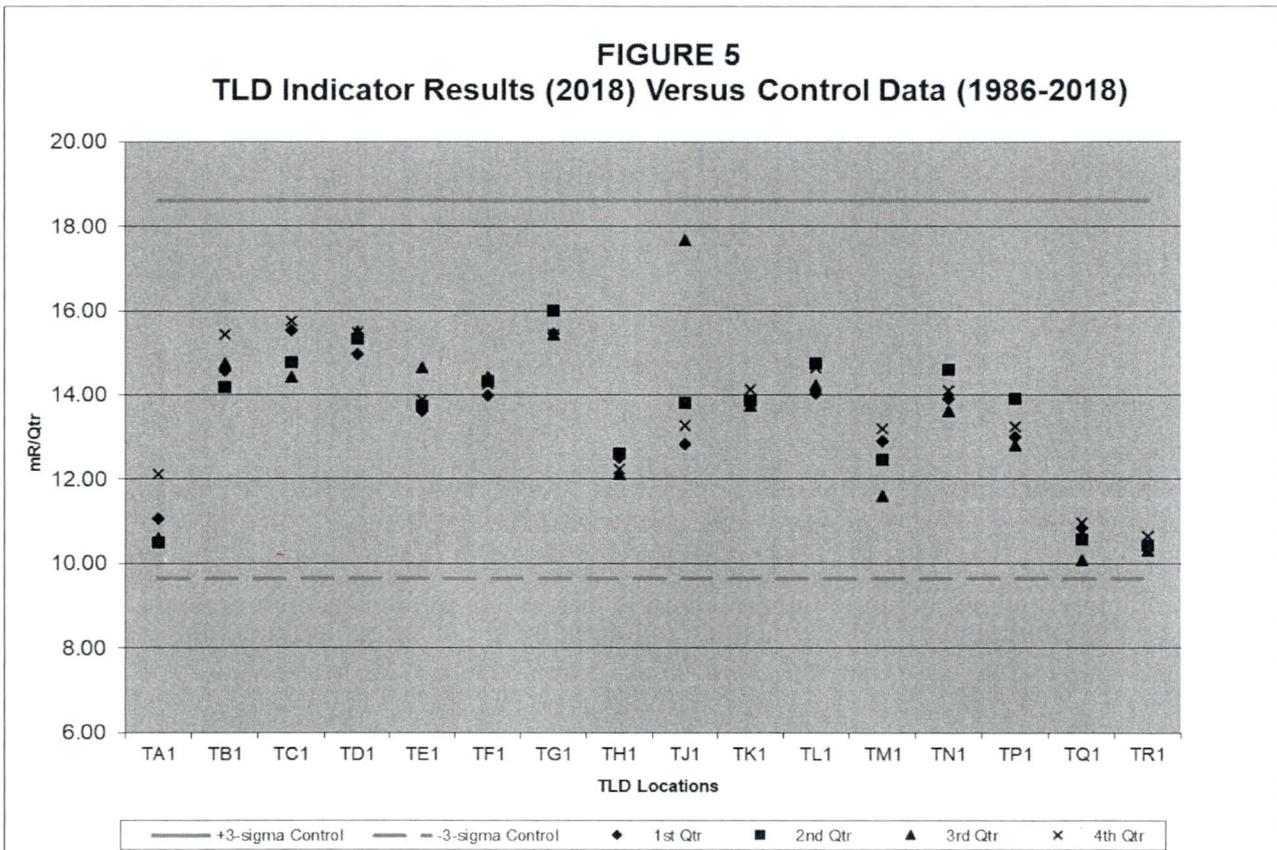
Gross beta activity is attributed to naturally occurring radionuclides. Table 6, which include gross beta concentrations and provide a comparison of the indicator and control means and ranges emphasizes the consistent trends seen in this pathway to support the presence of naturally occurring activity. Therefore, it can be concluded that the airborne pathway continues to be unaffected by River Bend Station operations.



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4.2 Thermoluminescent Dosimetry (TLD) Sample Results

River Bend Station reports measured dose as net exposure (field reading less transit reading) normalized to 90 days and relies on comparison of the indicator locations to the control as a measure of plant impact. River Bend Station's comparison of the indicator and special interest area TLD results to the control, as seen in Table 6, identified no noticeable trend that would indicate that the ambient radiation levels are being affected by plant operations. In addition, the indicator value of 13.5 millirem (mrem) shown in the TLD radiation dose comparison graph below shows the 2018 concentration is comparable to historic results. Overall, River Bend Station concluded that the ambient radiation levels are not being affected by plant operations.



4.3 Waterborne Sample Results

Analytical results for 2018 surface water and groundwater water samples were similar to those reported in previous years. Gamma radionuclides and tritium analytical results for 2018 waterborne samples were below the ODCM-required LLD similar to those reported in previous years. These results are further explained below.

4.3.1 Surface Water Results

Samples were collected from one indicator and one control location and analyzed for gamma radionuclides and tritium. Tritium and gamma radionuclides were below detectable limits which is consistent with results seen in previous operational years. Therefore, the operation of River Bend Station had no definable impact on this waterborne pathway during 2018.

Annual Radiological Environmental Operating Report**4.3.2 Groundwater Results**

Samples were collected from one indicator and one control location. Groundwater samples were analyzed for gamma radionuclides and tritium. Gamma radionuclides and tritium concentrations were below the LLD limits at the indicator and control locations. The operation of River Bend Station had no definable impact on this waterborne pathway during 2018.

4.3.3 Sediment Sample Results

Sediment samples were collected from one indicator and one control location in 2018 and analyzed for gamma radionuclides. Gamma radionuclides were below the LLD limits at both indicator and control locations. River Bend Station operations had no significant impact on the environment or public by this waterborne pathway.

4.4 Ingestion Sample Results**4.4.1 Fish Sample Results**

Fish samples were collected from one indicator and one control location and analyzed for gamma radionuclides. In 2018, gamma radionuclides were below detectable limits which are consistent with the preoperational monitoring period and operational results. Therefore, based on these measurements, River Bend Station operations had no significant radiological impact upon the environment or public by this ingestion pathway.

4.4.2 Food Products 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 products samples were collected when available from one indicator and one control location and analyzed for gamma radionuclides. The 2018 levels remained undetectable, as has been the case in previous years. Therefore, based on these measurements, River Bend Station operations had no significant radiological impact upon the environment or public by this ingestion pathway.

4.4.3 Milk Sample Results

In 2018 milk samples within five miles (8 km) of River Bend Station were unable to be collected due to the unavailability of milk-producing animals used for human consumption. The River Bend Station Technical Requirements Manual requires collection of milk samples if available commercially within 8 km (5 miles) of the plant. River Bend Station personnel collected food product samples to monitor the ingestion pathway, as specified in River Bend Station Technical Requirements Manual Table 3.12.1-1, because of milk unavailability. Food product sample results are in section 4.4.2.

4.5 Land Use Census Results

The latest land use census (performed in 2018) did not identify any new locations that yielded a calculated dose or dose commitment greater than those currently calculated (see Table 5).

A garden census is not conducted pursuant to the note in the TRM (TLCO 3.12.2) that allows the sampling of broad leaf vegetation in the highest calculated average ground-level D/Q sector near site boundary in lieu of the garden census.

The land use census identified one change. A new resident, located at a distance of 1.7 km in Sector A, was identified in 2018. This occupied residence is 0.2 km closer to the site than the residence reported in previous census. There were no changes in the milk cows or food products in 2018.

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Table 5: Land Use Census –2018 Nearest Residence And Milk Animal Within Five Miles

Sector	Direction	Nearest Residence	Range (Unit)	Nearest Milk Animal	Range (Unit)	Comment
A	N	5637 Hwy 61 St. Francisville, LA 70775	1.7	-	-	2
B	NNE	4549 Old Hwy 61 St. Francisville, LA 70775	1.4	-	-	2
C	NE	4553 Old Hwy 61 St. Francisville, LA 70775	1.5	-	-	2
D	ENE	12657 Powell Station Rd. St. Francisville, LA 70775	1.4	-	-	2
E	E	4635 Hwy 61 St. Francisville, LA 70775	2.4	-	-	2
F	ESE	12019 Fairview Way Jackson, LA 70748	2.6	-	-	2
G	SE	3319 Hwy 964 Jackson, LA 70748	3.7	-	-	2
H	SSE	11813 Powell Station Rd. St. Francisville, LA 70775	1.7	-	-	2
J	S	11649 Powell Station Rd. St. Francisville, LA 70775	1.8	-	-	2
K	SSW	8909 Hwy 981 New Roads, LA 70760	6.6	-	-	2
L	SW	--		-	-	1, 2
M	WSW	8809 Hwy 981 New Roads, LA 70760	5.1	-	-	2
N	W	--		-	-	1, 2
P	WNW	10426 Old Field Rd. St. Francisville, LA 70775	3.7	-	-	2
Q	NW	9537 Hwy 965 St. Francisville, LA 70775	1.3	-	-	2
R	NNW	9794 Hwy 965 St. Francisville, LA 70775	1.6	-	-	2

#	Comment
1	No Residence was located within a five-mile (8 km) radius of River Bend Station 3.
2	No Milk animals were found located within a five-mile (8 km) radius of River Bend Station 3.

4.6 Interlaboratory Comparison Results

Attachment 3 contains result summary for Interlaboratory Comparison program for Teledyne Brown Engineering to fulfill the requirements of River Bend Station's Technical Requirements Manual 3.12.3.

5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

1. Table 6, Radiological Environmental Monitoring Program Summary, summarizes data for the 2018 REMP program.

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Table 6: Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses ⁽¹⁾	LLD ⁽²⁾	Indicator Locations Mean (F) ⁽³⁾ [Range]	Location ⁽⁴⁾ [Highest Annual Mean]	Mean (F) ⁽³⁾ [Range]	Control Locations Mean (F) ⁽³⁾ [Range]	Number of Non Routine Results ⁽⁵⁾
Air Particulates (pCi/m ³)	GB / 104	0.01	0.0182 (78 / 78) [0.008 – 0.031]	AN1 (0.9 km W)	0.0186 (26 / 26) [0.011 - 0.028]	0.0182 (26 / 26) [0.008 - 0.028]	0
Airborne Iodine (pCi/m ³)	I-131 / 104	0.07	< LLD	N/A	N/A	< LLD	0
Indicator TLDs (mR/Qtr)	Gamma / 64	⁽⁶⁾	13.5 (64 / 64) [10.1 – 17.7]	TG1 (1.6 km SE)	15.6 (4 / 4) [15.4 – 16.0]	N/A	0
Special Interest TLDs (mR/Qtr)	Gamma / 24	⁽⁶⁾	13.9 (24 / 24) [12.1 – 15.8]	TGS (17.0 km SE)	15.3 (4 / 4) [14.3 – 15.8]	N/A	0
Control TLDs (mR/Qtr)	Gamma / 8	⁽⁶⁾	N/A	TAC (15.8 km N)	15.4 (4 / 4) (14.9-15.8)	14.6 (8 / 8) [13.7 – 15.8]	0
Surface Water (pCi/L)	H-3 / 8	700	< LLD	N/A	N/A	< LLD	0
	GS / 8						
	Mn-54	15	< LLD	N/A	N/A	< LLD	0
	Co-58	15	< LLD	N/A	N/A	< LLD	0
	Fe-59	30	< 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
	Nb-95	15	< LLD	N/A	N/A	< LLD	0
	I-131	15	< LLD	N/A	N/A	< LLD	0
	Zr-95	30	< 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	

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Table 6: Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses ⁽¹⁾	LLD ⁽²⁾	Indicator Locations Mean (F) ⁽³⁾ [Range]	Location ⁽⁴⁾ [Highest Annual Mean]	Mean (F) ⁽³⁾ [Range]	Control Locations Mean (F) ⁽³⁾ [Range]	Number of Non Routine Results ⁽⁵⁾
Groundwater (pCi/L)	H-3 / 4	700	< LLD	N/A	N/A	< LLD	0
	GS / 4						
	Mn-54	15	< LLD	N/A	N/A	< LLD	0
	Co-58	15	< LLD	N/A	N/A	< LLD	0
	Fe-59	30	< 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
	Nb-95	15	< LLD	N/A	N/A	< LLD	0
	I-131	15	< LLD	N/A	N/A	< LLD	0
	Zr-95	30	< 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 6: Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses ⁽¹⁾	LLD ⁽²⁾	Indicator Locations Mean (F) ⁽³⁾ [Range]	Location ⁽⁴⁾ [Highest Annual Mean]	Mean (F) ⁽³⁾ [Range]	Control Locations Mean (F) ⁽³⁾ [Range]	Number of Non Routine Results ⁽⁵⁾
Sediment (pCi/kg dry)	GS / 2						
	Cs-134	150	< LLD	N/A	N/A	< LLD	0
	Cs-137	180	< LLD	N/A	N/A	< LLD	0
Fish (pCi/kg wet)	GS / 2						
	Mn-54	130	< LLD	N/A	N/A	< LLD	0
	Co-58	130	< LLD	N/A	N/A	< LLD	0
	Fe-59	260	< 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 wet)	GS / 8						
	I-131	60	< LLD	N/A	N/A	N/A	0
	Cs-134	60	< LLD	N/A	N/A	N/A	0
	Cs-137	80	< LLD	N/A	N/A	N/A	0

LEGEND:

- ⁽¹⁾ - GB = Gross beta; I-131 = Iodine-131; H-3 = Tritium; GS = Gamma scan.
- ⁽²⁾ - LLD = Required lower limit of detection based on River Bend Station TRM.
- ⁽³⁾ - Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parenthesis (F).
- ⁽⁴⁾ - Locations are specified (1) by name and (2) direction relative to reactor site.
- ⁽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.
- ⁽⁶⁾ - LLD is not defined in River Bend Station TRM.

Sample Deviations

Table 7: Sample Deviations Table

Comment No.	Sample Media Affected	Sample Location	Date	Problem	Evaluation / Actions
1	Air Sample	AN1 AP1	11/01/18	Power Outage	Environmental air samplers at locations AN1 and AP1 indicated a loss of power for approximately 6.1 hours. The power outage was due to a loss of power to Grant Substation on 11-1-18. All air samplers were operating normally at the time of sample collection. Sample volumes are sufficient to meet lower limit of detection requirements. (CR-RBS-2018-6124)
2	Air Sample	AGC	11/21/18	Power Outage	Environmental air sampler at location AGC (Zachary) indicated a loss of power for approximately 50 minutes on 11/21/18. The air sampler was operating normally at the time of sample collection. The sample volume is sufficient to meet the lower limit of detection requirements. (CR-RBS-2018-6429)

Monitoring Results Tables

Table 8: Air Particulate Data Table

Analysis: Gross Beta				Units: pCi/m ³	
Start Date	End Date	AN1 ⁽¹⁾ (Indicator)	AP1 (Indicator)	AQS2 (Indicator)	AGC (Control)
REQUIRED LLD →		0.01	0.01	0.01	0.01
12/26/2017	01/09/2018	0.027	0.029	0.031	0.028
01/09/2018	01/23/2018	0.020	0.019	0.019	0.019
01/23/2018	02/06/2018	0.017	0.018	0.017	0.017
02/06/2018	02/20/2018	0.013	0.014	0.014	0.012
02/20/2018	03/06/2018	0.013	0.012	0.011	0.011
03/06/2018	03/20/2018	0.019	0.019	0.019	0.023
03/20/2018	04/03/2018	0.019	0.018	0.016	0.019
04/03/2018	04/17/2018	0.020	0.021	0.019	0.020
04/17/2018	04/30/2018	0.017	0.018	0.015	0.018
04/30/2018	05/15/2018	0.028	0.027	0.026	0.027
05/15/2018	05/29/2018	0.019	0.017	0.021	0.019
05/29/2018	06/12/2018	0.020	0.018	0.019	0.020
06/12/2018	06/26/2018	0.014	0.016	0.014	0.014
06/26/2018	07/10/2018	0.017	0.015	0.015	0.015
07/10/2018	07/24/2018	0.020	0.019	0.018	0.021
07/24/2018	08/07/2018	0.021	0.022	0.021	0.021
08/07/2018	08/21/2018	0.017	0.015	0.015	0.016
08/21/2018	09/04/2018	0.016	0.016	0.017	0.015
09/04/2018	09/18/2018	0.011	0.010	0.008	0.008
09/18/2018	10/02/2018	0.011	0.011	0.011	0.011
10/02/2018	10/16/2018	0.019	0.018	0.018	0.019
10/16/2018	10/30/2018	0.024	0.026	0.024	0.018
10/30/2018	11/13/2018	0.020 ⁽²⁾	0.018 ⁽²⁾	0.018	0.020
11/13/2018	11/27/2018	0.025	0.025	0.024	0.027 ⁽³⁾
11/27/2018	12/11/2018	0.018	0.018	0.018	0.020
12/11/2018	12/26/2018	0.018	0.018	0.016	0.016

(1) Station with highest annual mean.

(2) See Attachment 1, Table 7, Sample Deviations Table, Comment 1

(3) See Attachment 1, Table 7, Sample Deviations Table, Comment 2

Monitoring Results Tables

Table 9: Radioiodine Cartridge Data Table

Analysis: I-131				Units: pCi/m ³	
Start Date	End Date	AN1 (Indicator)	AP1 (Indicator)	AQS2 (Indicator)	AGC (Control)
REQUIRED LLD →		<u>0.07</u>	<u>0.07</u>	<u>0.07</u>	<u>0.07</u>
12/26/2017	01/09/2018	< 0.009	< 0.022	< 0.021	< 0.022
01/09/2018	01/23/2018	< 0.008	< 0.020	< 0.020	< 0.020
01/23/2018	02/06/2018	< 0.009	< 0.020	< 0.020	< 0.020
02/06/2018	02/20/2018	< 0.009	< 0.011	< 0.011	< 0.011
02/20/2018	03/06/2018	< 0.007	< 0.016	< 0.016	< 0.016
03/06/2018	03/20/2018	< 0.006	< 0.015	< 0.015	< 0.015
03/20/2018	04/03/2018	< 0.008	< 0.020	< 0.020	< 0.019
04/03/2018	04/17/2018	< 0.008	< 0.018	< 0.018	< 0.018
04/17/2018	04/30/2018	< 0.011	< 0.025	< 0.025	< 0.025
04/30/2018	05/15/2018	< 0.006	< 0.015	< 0.016	< 0.016
05/15/2018	05/29/2018	< 0.011	< 0.011	< 0.013	< 0.013
05/29/2018	06/12/2018	< 0.018	< 0.018	< 0.013	< 0.013
06/12/2018	06/26/2018	< 0.011	< 0.011	< 0.018	< 0.018
06/26/2018	07/10/2018	< 0.011	< 0.010	< 0.020	< 0.020
07/10/2018	07/24/2018	< 0.020	< 0.020	< 0.013	< 0.013
07/24/2018	08/07/2018	< 0.007	< 0.018	< 0.013	< 0.013
08/07/2018	08/21/2018	< 0.010	< 0.011	< 0.019	< 0.020
08/21/2018	09/04/2018	< 0.010	< 0.010	< 0.020	< 0.020
09/04/2018	09/18/2018	< 0.011	< 0.011	< 0.010	< 0.022
09/18/2018	10/02/2018	< 0.007	< 0.008	< 0.013	< 0.012
10/02/2018	10/16/2018	< 0.012	< 0.012	< 0.016	< 0.017
10/16/2018	10/30/2018	< 0.011	< 0.011	< 0.017	< 0.007
10/30/2018	11/13/2018	< 0.011 ⁽¹⁾	< 0.015 ⁽¹⁾	< 0.017	< 0.016
11/13/2018	11/27/2018	< 0.011	< 0.011	< 0.022	< 0.022 ⁽²⁾
11/27/2018	12/11/2018	< 0.010	< 0.009	< 0.020	< 0.019
12/11/2018	12/26/2018	< 0.013	< 0.013	< 0.012	< 0.013

(1) See Attachment 1, Table 7, Sample Deviations Table, Comment 1

(2) See Attachment 1, Table 7, Sample Deviations Table, Comment 2

Monitoring Results Tables

Table 10: Thermoluminescent Dosimeters – Indicators

Analysis: Gamma Dose			Units: mrem/Std. Qtr.		
Station	1 st Qtr 2018	2 nd Qtr 2018	3 rd Qtr 2018	4 th Qtr 2018	Annual Mean 2018
TA1	11.1	10.5	10.6	12.1	11.1
TB1	14.6	14.2	14.7	15.4	14.7
TC1	15.5	14.8	14.4	15.8	15.1
TD1	15.0	15.3	15.5	15.5	15.3
TE1	13.6	13.7	14.6	13.9	14.0
TF1	14.0	14.3	14.4	14.3	14.3
TG1⁽¹⁾	15.5	16.0	15.4	15.4	15.6
TH1	12.5	12.6	12.1	12.2	12.4
TJ1	12.8	13.8	17.7	13.3	14.4
TK1	13.8	13.9	13.7	14.1	13.9
TL1	14.0	14.7	14.2	14.6	14.4
TM1	12.9	12.5	11.6	13.2	12.5
TN1	13.9	14.6	13.6	14.1	14.1
TP1	13.0	13.9	12.8	13.2	13.2
TQ1	10.9	10.6	10.1	11.0	10.6
TR1	10.4	10.4	10.3	10.7	10.5

⁽¹⁾ Indicator station with highest annual mean.

Monitoring Results Tables

Table 11: Thermoluminescent Dosimeters – Special Interest Areas

Analysis: Gamma Dose			Units: mrem/Std. Qtr.		
Station	1st Qtr 2018	2nd Qtr 2018	3rd Qtr 2018	4th Qtr 2018	Annual Mean 2018
TCS	12.7	12.5	12.1	12.7	12.5
TGS⁽¹⁾	14.3	15.8	15.6	15.5	15.3
TNS	12.9	13.9	13.4	14.2	13.6
TRS	13.9	15.1	13.8	14.4	14.3
TQS1	14.2	15.4	15.1	15.4	15.0
TQS2	13.0	12.9	12.2	12.9	12.7

⁽¹⁾ Special interest station with highest annual mean.

Table 12: Thermoluminescent Dosimeters – Control

Analysis: Gamma Dose			Units: mrem/Std. Qtr.		
Station	1st Qtr 2018	2nd Qtr 2018	3rd Qtr 2018	4th Qtr 2018	Annual Mean 2018
TAC⁽¹⁾	14.9	15.4	15.4	15.8	15.4
TEC	13.9	13.9	13.7	14.2	13.9

⁽¹⁾ Control station with highest annual mean.

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Attachment 2

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Monitoring Results Tables

Table 13: Surface Water – Gamma

Analysis: Gamma Isotopic								Units: pCi/L						
Location	Start Date	End Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	I-131	Zr-95	Cs-134	Cs-137	Ba-140	La-140
REQUIRED LLD →			15	15	30	15	30	15	15	30	15	18	60	15
SWD (Indicator)	02/22/2018	02/22/2018	< 5.16	< 6.11	< 9.73	< 4.94	< 11.0	< 6.25	< 9.38	< 11.3	< 6.65	< 5.25	< 29.1	< 10.8
SWU (Control)	02/22/2018	02/22/2018	< 7.62	< 7.06	< 15.3	< 6.46	< 15.0	< 7.69	< 13.2	< 15.1	< 9.13	< 6.58	< 37.1	< 11.7
SWD (Indicator)	05/08/2018	05/08/2018	< 2.19	< 2.57	< 5.39	< 2.90	< 5.38	< 3.05	< 7.78	< 4.67	< 2.99	< 2.65	< 18.5	< 5.98
SWU (Control)	05/08/2018	05/08/2018	< 3.88	< 3.24	< 5.90	< 3.72	< 7.56	< 3.57	< 13.2	< 7.21	< 3.73	< 4.13	< 27.2	< 8.19
SWD (Indicator)	07/31/2018	07/31/2018	< 2.07	< 2.33	< 5.54	< 2.05	< 4.26	< 2.31	< 11.8	< 4.10	< 2.26	< 2.11	< 20.6	< 7.38
SWU (Control)	07/31/2018	07/31/2018	< 2.14	< 2.40	< 5.34	< 2.29	< 4.31	< 2.50	< 14.0	< 4.40	< 2.49	< 2.33	< 24.1	< 7.48
SWD (Indicator)	11/13/2018	11/13/2018	< 6.93	< 5.81	< 16.4	< 5.37	< 17.1	< 7.53	< 11.9	< 9.50	< 4.40	< 6.66	< 34.1	< 11.3
SWU (Control)	11/13/2018	11/13/2018	< 8.03	< 7.79	< 12.7	< 7.05	< 17.1	< 7.88	< 12.1	< 15.3	< 8.65	< 6.84	< 39.3	< 12.9

Monitoring Results Tables

Table 14: Surface Water – Tritium

Analysis: H-3		Units: pCi/L	
Location	Start Date	End Date	H-3
REQUIRED LLD →			700
SWD (Indicator)	02/22/2018	02/22/2018	< 599
SWU (Control)	02/22/2018	02/22/2018	< 590
SWD (Indicator)	05/08/2018	05/08/2018	< 547
SWU (Control)	05/08/2018	05/08/2018	< 555
SWD (Indicator)	07/31/2018	07/31/2018	< 634
SWU (Control)	07/31/2018	07/31/2018	< 641
SWD (Indicator)	11/13/2018	11/13/2018	< 624
SWU (Control)	11/13/2018	11/13/2018	< 628

Monitoring Results Tables

Table 15: Groundwater – Gamma

Analysis: Gamma Isotopic						Units: pCi/L							
Location	Collection Date	Min-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	I-131	Zr-95	Cs-134	Cs-137	Ba-140	La-140
REQUIRED LLD →		15	15	30	15	30	15	15	30	15	18	60	15
WD (Indicator)	05/08/2018	< 1.62	< 1.77	< 3.96	< 1.80	< 3.39	< 1.90	< 5.61	< 3.26	< 1.80	< 1.76	< 11.9	< 3.93
WU (Control)	05/08/2018	< 1.39	< 1.51	< 3.25	< 1.41	< 2.79	< 1.62	< 4.88	< 2.70	< 1.54	< 1.54	< 10.8	< 3.48
WD (Indicator)	11/14/2018	< 5.02	< 4.27	< 11.7	< 4.67	< 10.2	< 5.57	< 12.1	< 11.0	< 5.53	< 5.14	< 29.1	< 9.57
WU (Control)	11/14/2018	< 4.77	< 5.16	< 11.0	< 5.38	< 12.6	< 5.94	< 14.0	< 10.1	< 5.85	< 5.71	< 36.9	< 10.8

Monitoring Results Tables

Table 16: Groundwater – Tritium

Analysis: H-3		Units: pCi/L	
Location	Start Date	End Date	H-3
REQUIRED LLD →			700
WD (Indicator)	05/08/2018	05/08/2018	< 553
WU (Control)	05/08/2018	05/08/2018	< 553
WD (Indicator)	11/14/2018	11/14/2018	< 586
WU (Control)	11/14/2018	11/14/2018	< 596

Monitoring Results Tables

Table 17: Sediment - Gamma

Analysis: Gamma Isotopic		Units: pCi/kg (dry)	
Location	Collection Date	Cs-134	Cs-137
REQUIRED LLD →		<u>150</u>	<u>180</u>
SEDD (Indicator)	08/16/2018	< 57.01	< 50.72
SEDU (Control)	08/16/2018	< 87.49	< 66.75

Monitoring Results Tables

Table 18: Fish - Gamma

Analysis: Gamma Isotopic				Units: pCi/kg (wet)				
Location	Collection Date	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Cs-134	Cs-137
REQUIRED LLD →		<u>130</u>	<u>130</u>	<u>260</u>	<u>130</u>	<u>260</u>	<u>130</u>	<u>150</u>
FD (Indicator)	09/24/2018	< 24.66	< 25.51	< 74.39	< 34.01	< 66.74	< 33.38	< 32.99
FU (Control)	09/24/2018	< 49.73	< 52.67	< 115.0	< 42.44	< 133.6	< 35.62	< 43.32

Monitoring Results Tables

Table 19: Food Products - Gamma

Analysis: Gamma Isotopic		Units: pCi/kg (wet)		
Location	Collection Date	I-131	Cs-134	Cs-137
REQUIRED LLD →		<u>60</u>	<u>60</u>	<u>80</u>
GN1 (Indicator)	03/08/2018	< 51.45	< 21.20	< 19.47
GQC (Control)	03/12/2018	< 49.20	< 23.98	< 27.57
GN1 (Indicator)	06/04/2018	< 30.33	< 10.08	< 9.025
GQC (Control)	06/11/2018	< 24.37	< 17.33	< 13.90
GN1 (Indicator)	08/14/2018	< 32.68	< 9.072	< 8.673
GQC (Control)	08/16/2018	< 48.65	< 19.78	< 19.94
GN1 (Indicator)	11/14/2018	< 57.49	< 23.79	< 24.73
GQC (Control)	11/14/2018	< 13.73	< 5.935	< 5.393

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Interlaboratory Comparison Program Results

1.0 Summary

For the Teledyne Brown Engineering (TBE) laboratory, 166 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.

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.

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 132%). The reported value was 158 ± 17.6 pCi/L and the known value was 119 ± 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 ± 16 pCi/L). NOTE: TBE's 4th 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 4th 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 H₂O₂ to assist in breaking down the organic material that comprises this "matrix". This corrective action will be monitored closely by QA. (NCR 18-25).

Interlaboratory Comparison Program Results

6. The ERA October 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.

**Table 20: Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services**

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value ^(a)	Ratio of TBE to Analytics Result	Evaluation ^(b)
March 2018	E12133	Milk	Sr-89	pCi/L	76.1	90.1	0.84	A
			Sr-90	pCi/L	12.2	12.5	0.98	A
	E12134	Milk	Ce-141	pCi/L	77.8	77.0	1.01	A
			Co-58	pCi/L	105	114	0.92	A
			Co-60	pCi/L	181	187	0.97	A
			Cr-51	pCi/L	298	326	0.92	A
			Cs-134	pCi/L	150	180	0.84	A
			Cs-137	pCi/L	164	172	0.95	A
			Fe-59	pCi/L	140	139	1.01	A
			I-131	pCi/L	105	108.0	0.97	A
			Mn-54	pCi/L	133	131	1.01	A
			Zn-65	pCi/L	242	244	0.99	A
			E12135	Charcoal	I-131	pCi	93.7	95.4
	E12136	AP	Ce-141	pCi	92.6	85.3	1.09	A
			Co-58	pCi	130	126	1.03	A
			Co-60	pCi	237	207	1.14	A
			Cr-51	pCi	411	361	1.14	A
			Cs-134	pCi	194	199	0.98	A
			Cs-137	pCi	200	191	1.05	A
			Fe-59	pCi	160	154	1.04	A
Mn-54			pCi	152	145	1.05	A	
Zn-65	pCi	267	271	0.99	A			
E12137	Water	Fe-55	pCi/L	1990	1700	1.17	A	
E12138	Soil	Ce-141	pCi/g	0.148	0.118	1.26	W	
		Co-58	pCi/g	0.171	0.174	0.98	A	
		Co-60	pCi/g	0.297	0.286	1.04	A	
		Cr-51	pCi/g	0.537	0.498	1.08	A	
		Cs-134	pCi/g	0.274	0.275	1.00	A	
		Cs-137	pCi/g	0.355	0.337	1.05	A	
		Fe-59	pCi/g	0.243	0.212	1.15	A	
		Mn-54	pCi/g	0.228	0.201	1.14	A	
Zn-65	pCi/g	0.395	0.374	1.06	A			

(a) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) Analytics evaluation based on TBE internal QC limits:

A = Acceptable - reported result falls within ratio limits of 0.80-1.20

W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

**Table 20: Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services**

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value ^(a)	Ratio of TBE to Analytics Result	Evaluation ^(b)
June 2018	E12205	Milk	Sr-89	pCi/L	74.9	84.6	0.89	A
			Sr-90	pCi/L	10.5	11.4	0.92	A
	E12206	Milk	Ce-141	pCi/L	89.2	82.2	1.08	A
			Co-58	pCi/L	94.8	89	1.07	A
			Co-60	pCi/L	125	113	1.10	A
			Cr-51	pCi/L	256	239	1.07	A
			Cs-134	pCi/L	112	114	0.99	A
			Cs-137	pCi/L	107	98.8	1.08	A
			Fe-59	pCi/L	95.9	86.0	1.12	A
			I-131	pCi/L	69.8	71.9	0.97	A
			Mn-54	pCi/L	138	130	1.06	A
			Zn-65	pCi/L	186	157	1.18	A
	E12207	Charcoal	I-131	pCi	69.6	72.2	0.96	A
	E12208	AP	Ce-141	pCi	151	165	0.92	A
			Co-58	pCi	174	178	0.98	A
			Co-60	pCi	290	227	1.28	W
			Cr-51	pCi	452	478	0.95	A
			Cs-134	pCi	215	227	0.95	A
			Cs-137	pCi	206	198	1.04	A
			Fe-59	pCi	180	172	1.05	A
Mn-54			pCi	265	260	1.02	A	
Zn-65	pCi	280	315	0.89	A			
E12209	Water	Fe-55	pCi/L	1790	1740	1.03	A	
E12210	AP	Sr-89	pCi	77.8	90.3	0.86	A	
		Sr-90	pCi	9.54	12.2	0.78	W	

(a) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) Analytics evaluation based on TBE internal QC limits:

A = Acceptable - reported result falls within ratio limits of 0.80-1.20

W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

**Table 20: Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services**

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value ^(a)	Ratio of TBE to Analytics Result	Evaluation ^(b)			
September 2018	E12271	Milk	Sr-89	pCi/L	79.4	81.7	0.97	A			
			Sr-90	pCi/L	12.2	14.8	0.82	A			
September 2018	E12272	Milk	Ce-141	pCi/L	152	128	1.19	A			
			Co-58	pCi/L	161	144	1.12	A			
			Co-60	pCi/L	208	190	1.10	A			
			Cr-51	pCi/L	244	265	0.92	A			
			Cs-134	pCi/L	124	123	1.01	A			
			Cs-137	pCi/L	166	147	1.13	A			
			Fe-59	pCi/L	158	119	1.32	N ⁽¹⁾			
			I-131	pCi/L	83.1	58.2	1.43	N ⁽²⁾			
			Mn-54	pCi/L	191	167	1.14	A			
			Zn-65	pCi/L	229	201	1.14	A			
			E12273	Charcoal	I-131	pCi	83.0	80.7	1.03	A	
			September 2018	E12274	AP	Ce-141	pCi	101	85.6	1.18	A
						Co-58	pCi	92.7	96.0	0.97	A
						Co-60	pCi	142	127	1.12	A
Cr-51	pCi	218				177	1.23	W			
Cs-134	pCi	81.2				81.9	0.99	A			
Cs-137	pCi	99.0				98.5	1.01	A			
Fe-59	pCi	93.7				79.7	1.18	A			
Mn-54	pCi	116				112	1.04	A			
Zn-65	pCi	139	134	1.04	A						
September 2018	E12302	Water	Fe-55	pCi/L	2120	1820	1.17	A			
September 2018	E12276	Soil	Ce-141	pCi/g	0.259	0.221	1.17	A			
			Co-58	pCi/g	0.279	0.248	1.12	A			
			Co-60	pCi/g	0.367	0.328	1.12	A			
			Cr-51	pCi/g	0.597	0.457	1.31	N ⁽³⁾			
			Cs-134	pCi/g	0.261	0.212	1.23	W			
			Cs-137	pCi/g	0.376	0.330	1.14	A			
			Fe-59	pCi/g	0.248	0.206	1.20	A			
			Mn-54	pCi/g	0.317	0.289	1.10	A			
			Zn-65	pCi/g	0.407	0.347	1.17	A			

(a) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) Analytics evaluation based on TBE internal QC limits:

A = Acceptable - reported result falls within ratio limits of 0.80-1.20

W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

(1) See NCR 18-20

(2) See NCR 18-24

(3) See NCR 18-21

**Table 20: Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services**

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value ^(a)	Ratio of TBE to Analytics Result	Evaluation ^(b)
December 2018	E12313	Milk	Sr-89	pCi/L	71.9	91.9	0.78	W
			Sr-90	pCi/L	12.1	13.3	0.91	A
	E12314	Milk	Ce-141	pCi/L	124	133	0.93	A
			Co-58	pCi/L	110	119	0.93	A
			Co-60	pCi/L	202	212	0.95	A
			Cr-51	pCi/L	292	298	0.98	A
			Cs-134	pCi/L	146	171	0.85	A
			Cs-137	pCi/L	118	121	0.98	A
			Fe-59	pCi/L	120	114	1.05	A
			I-131	pCi/L	94.2	93.3	1.01	A
			Mn-54	pCi/L	151	154	0.98	A
			Zn-65	pCi/L	266	264	1.01	A
				E12315	Charcoal	I-131	pCi	94.8
	E12316A	AP	Ce-141	pCi	92.3	94.0	0.98	A
			Co-58	pCi	73.4	83.8	0.88	A
			Co-60	pCi	137	150	0.91	A
			Cr-51	pCi	202	210	0.96	A
			Cs-134	pCi	115	121	0.95	A
			Cs-137	pCi	85.0	85.4	1.00	A
			Fe-59	pCi	83.1	80.8	1.03	A
			Mn-54	pCi	104	109	0.96	A
		Zn-65	pCi	168	187	0.90	A	
	E12317	Water	Fe-55	pCi/L	2110	1840	1.15	A
	E12318	AP	Sr-89	pCi	81.1	83.0	0.98	A
			Sr-90	pCi	11.4	12.0	0.95	A

(a) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) Analytics evaluation based on TBE internal QC limits:

A = Acceptable - reported result falls within ratio limits of 0.80-1.20

W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

**Table 21: DOE's Mixed Analyte Performance Evaluation Program (MAPEP)
Teledyne Brown Engineering Environmental Services**

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value ^(a)	Acceptance Range	Evaluation ^(b)
February 2018	18-MaS38	Soil	Ni-63	Bq/kg	9.94		(1)	A
			Sr-90	Bq/kg	0.846		(1)	A
	18-MaW38	Water	Am-241	Bq/L	0.785	0.709	0.496 - 0.922	A
			Ni-63	Bq/L	12.6	14.0	9.8 - 18.2	A
			Pu-238	Bq/L	0.0214	0.023	(2)	A
			Pu-239/240	Bq/L	0.544	0.600	0.420 - 0.780	A
	18-RdF38	AP	U-234/233	Bq/sample	0.111	0.124	0.087 - 0.161	A
			U-238	Bq/sample	0.123	0.128	0.090 - 0.166	A
	18-RdV38	Vegetation	Cs-134	Bq/sample	2.46	3.23	2.26 - 4.20	W
			Cs-137	Bq/sample	3.14	3.67	2.57 - 4.77	A
			Co-57	Bq/sample	4.12	4.42	3.09 - 5.75	A
			Co-60	Bq/sample	1.86	2.29	1.60 - 2.98	A
			Mn-54	Bq/sample	2.21	2.66	1.86 - 3.46	A
			Sr-90	Bq/sample				NR ⁽³⁾
Zn-65			Bq/sample	-0.201		(1)	A	
November 2018	18-MaS39	Soil	Ni-63	Bq/kg	703	765	536 - 995	A
			Sr-90	Bq/kg	137	193	135 - 251	W
	18-MaW39	Water	Am-241	Bq/L	0.0363		(1)	A
			Ni-63	Bq/L	6.18	7.0	4.9 - 9.1	A
			Pu-238	Bq/L	0.73	0.674	0.472 - 0.876	A
			Pu-239/240	Bq/L	0.89	0.928	0.650 - 1.206	A
	18-RdF39	AP	U-234/233	Bq/sample	0.159	0.152	0.106 - 0.198	A
			U-238	Bq/sample	0.162	0.158	0.111 - 0.205	A
	18-RdV39	Vegetation	Cs-134	Bq/sample	1.85	1.94	1.36 - 2.52	A
			Cs-137	Bq/sample	2.5	2.36	1.65 - 3.07	A
			Co-57	Bq/sample	3.53	3.31	2.32 - 4.30	A
			Co-60	Bq/sample	1.6	1.68	1.18 - 2.18	A
			Mn-54	Bq/sample	2.61	2.53	1.77 - 3.29	A
			Sr-90	Bq/sample	0.338	0.791	0.554 - 1.028	N ⁽⁴⁾
Zn-65			Bq/sample	1.32	1.37	0.96 - 1.78	A	

(a) The MAPEP known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) DOE/MAPEP evaluation:

A = Acceptable - reported result falls within ratio limits of 0.80-1.20

W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

NR = No result reported

(1) False positive test

(2) Sensitivity evaluation

(3) See NCR 18-09

(4) See NCR 18-25

**Table 22: ERA Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services**

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value ^(a)	Acceptance Limits	Evaluation ^(b)
March 2018	MRAD-28	AP	GR-A	pCi/sample	65.7	43.4	22.7 - 71.5	A
			GR-B	pCi/sample	57.2	52	31.5 - 78.6	A
April 2018	RAD-113	Water	Ba-133	pCi/L	91.2	91.5	77.1 - 101	A
			Cs-134	pCi/L	70.4	75.9	62.0 - 83.5	A
			Cs-137	pCi/L	122	123	111 - 138	A
			Co-60	pCi/L	64.8	64.3	57.9 - 73.2	A
			Zn-65	pCi/L	98.6	86.7	78.0 - 104	A
			GR-A	pCi/L	32.8	28.6	14.6 - 37.5	A
			GR-B	pCi/L	62.9	73.7	51.4 - 81.1	A
			U-Nat	pCi/L	6.7	6.93	5.28 - 8.13	A
			H-3	pCi/L	17100	17200	15000 - 18900	A
			Sr-89	pCi/L	38.6	48.8	38.3 - 56.2	A
			Sr-90	pCi/L	27.1	26.5	19.2 - 30.9	A
			I-131	pCi/L	26.7	24.6	20.4 - 29.1	A
September 2018	MRAD-29	AP	GR-A	pCi/sample	49.7	55.3	28.9 - 91.1	A
			GR-B	pCi/sample	75.3	86.5	52.4 - 131	A
October 2018	RAD-115	Water	Ba-133	pCi/L	15.2	16.3	11.9 - 19.4	A
			Cs-134	pCi/L	85.9	93.0	76.4 - 102	A
			Cs-137	pCi/L	229	235	212 - 260	A
			Co-60	pCi/L	81.9	80.7	72.6 - 91.1	A
			Zn-65	pCi/L	348	336	302 - 392	A
			GR-A	pCi/L	38.9	60.7	31.8 - 75.4	A
			GR-B	pCi/L	36.5	41.8	27.9 - 49.2	A
			U-Nat	pCi/L	17.48	20.9	16.8 - 23.4	A
			H-3	pCi/L	2790	2870	2410 - 3170	A
			I-131	pCi/L	26.9	27.2	22.6 - 32.0	A
			Sr-89	pCi/L	57.2	56.9	45.5 - 64.6	A
			Sr-90	pCi/L	36.8	31.4	22.9 - 36.4	N ⁽¹⁾

(a) The ERA known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.

(b) ERA evaluation:

A = Acceptable - Reported value falls within the Acceptance Limits

N = Not Acceptable - Reported value falls outside of the Acceptance Limits

(1) See NCR 18-23