2020 ANNUAL REPORT

CARLSBAD ENVIRONMENTAL MONITORING & RESEARCH CENTER
1400 UNIVERSITY DRIVE
CARLSBAD, NM 88220

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Annual Independent Environmental Site Report for Calendar Year 2020

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Carlsbad Environmental Monitoring & Research Center

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ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

Am	americium
Al	aluminum
ANSI	American National Standards Institute
ASER	annual site environmental report
B	boron
Ba	barium
Bq	becquerel(s)
Bq/g	becquerels per gram
Bq/kg	becquerels per kilogram
Bq/L	becquerels per liter
Bq/m^3	becquerels per cubic meter
Bq/sample	becquerels per composite air filter sample
BOMAB	bottle mannikin absorber
CBFO	(U.S. Department of Energy) Carlsbad Field Office
CEMRC	Carlsbad Environmental Monitoring & Research Center
CFR	code of federal regulations
cm	centimeter
Ca	calcium
Ce	cerium
Co	cobalt
Cd	cadmium
Cs	cesium
Cr	chromium
Cu	copper
CY	calendar year
DOE	U.S. Department of Energy
Dy	dysprosium
EEG	environmental evaluation group
EPA	U.S. Environmental Protection Agency
Er	erbium
Eu	europium
FAS	fixed air sample(r/s)
Fe	iron
Ga	gallium
GC-MS	gas chromatography-mass spectrometry
Gd	gadolinium
HEPA	high-efficiency particulate air (filter)

Hg	mercury
HPGe	high purity germanium
ICP-MS	inductively coupled plasma mass spectrometry
ID	internal dosimetry
Ir	iridium
K	potassium
km	kilometer
L	liter
La	lanthanum
L_c	decision level
LDBC	lie down and be counted
LWBC	lung and whole-body counting (facility)
Li	lithium
LWA	(Waste Isolation Pilot Plant) land withdrawal act (as amended)
m	meter
m^3	cubic meter
m^3/min	cubic meters per minute
mBq	millibecquerel
MAPEP	mixed analyte performance evaluation program
MDC	minimum detectable concentration
MDL	method detection limit
mg/L	milligrams per liter
mi	mile
min	minute
mL	milliliter
Mn	manganese
Mo	molybdenum
MOC	management and operating contractor
Mg	magnesium
N/A	not applicable
Na	sodium
NATTS	national air toxics trends station
Nd	neodymium
NIST	National Institute of Standards and Technology
NMED	New Mexico Environment Department
NMSU	New Mexico State University
NRIP	National Institute of Standards and Technology Radiochemistry Intercomparison Program
NWP	Nuclear Waste Partnership LLC
P	phosphorus
Pb	lead
pCi/L	picocurie per liter

pH	negative logarithm of the hydrogen ion activity in a solution (a measure of the acidity or alkalinity of a solution)
Pr	praseodymium
PT	proficiency testing
Pu	plutonium
QA	quality assurance
QA/QC	quality assurance/quality control
Sb	antimony
Sc	scandium
Se	selenium
Si	silicon
Sr	strontium
Th	thorium
Tl	thallium
Ti	titanium
TRU	transuranic
U	uranium
Unc.	uncertainty
U.S.	United States
V	vanadium
VOC	volatile organic compound(s)
WIPP	Waste Isolation Pilot Plant
WIPP-EM	Waste Isolation Pilot Plant-Environmental Monitoring
Zn	zinc

SYMBOLS

˚C	degrees Celsius
>	greater than
<	less than
≤	less than or equal to
$\mu g/m^3$	micrograms per cubic meter
ng/m^3	nanograms per cubic meter
µg/L	micrograms per liter
%	percent

EXECUTIVE SUMMARY

The role of the Carlsbad Environmental Monitoring and Research Center's (CEMRC's) Environmental Monitoring Program is to establish and maintain a health and environmental monitoring program in the vicinity of the U.S. Department of Energy's (DOE's) Waste Isolation Pilot Plant (WIPP). The DOE funds CEMRC through a Financial Assistance Grant, in which an important distinguishing feature from other funding mechanisms is the absence of substantial federal involvement in or contribution to the technical aspects of the project. The project was implemented during the WIPP pre-operational phase and continues during the operational (disposal) phase. Under the CEMRC monitoring program, air (ambient as well as WIPP exhaust air), water (drinking and surface waters), soil, sediment, and people (whole-body counting for the public as well as workers) are regularly analyzed. The results of the monitoring program are easily available to all interested parties. Public access to the monitoring data and the public's ability to directly participate in CEMRC's whole-body counting program provides a key element of trust and transparency.

The mission of the WIPP is to provide permanent, underground disposal of defense-related transuranic (TRU) and TRU-mixed wastes (wastes that also have hazardous chemical components). TRU waste is defined as having alpha activity greater than 37000 Bq/g for radioactive isotopes with atomic numbers higher than uranium and half-life greater than 20 years. From the start of its operation in March 1999 through the end of 2020, 1.12×10^5 cubic meters (m^3) of TRU waste had been disposed of at the WIPP facility.

CEMRC's Environmental Monitoring Program is designed to monitor pathways that radionuclides and other contaminants could take to reach the environment surrounding the WIPP facility. Pathways monitored include people (whole-body counting for the public as well as workers), water (drinking and surface waters), soil, sediment, and air (ambient as well as WIPP effluent air), and volatile organic compounds (VOCs). The monitoring program's goal is to determine if the local ecosystem has been, or is being, adversely impacted by WIPP facility operations and, if so, to evaluate the severity, extent, and environmental significance of those impacts.

Important Aspects of the CEMRC Monitoring Program

Timely Analyses

- A monthly summary of gross alpha and beta measurements from airborne effluent monitoring is provided to the DOE within fourteen (14) days of the end of each month.
- Any anomalies in airborne effluent gross alpha and beta measurements because of rock falls or due to investigative and clean-up efforts by underground personnel are immediately reported to DOE verbally, and in writing, within eight (8) hours of discovery.

- While representative air samples have been collected from Station A by other entities, CEMRC is the only organization that has been continuously performing actinide analysis on Station A filters.

Unique Capabilities

- The CEMRC program has capabilities to detect radionuclides rapidly in case of accidental releases from the repository or nuclear facilities anywhere in the world.
- State-of-the-art whole-body counting system that can measure the body burden of radioactive elements, including transuranics, at extremely low levels.
- Ability to monitor below background levels by increasing the counting time on alpha spectroscopy to 5 days and on gamma to 2 days, unlike most environmental programs that only monitor down to compliance or action levels.
- Public's access to the monitoring data and their direct participation in CEMRC's whole-body counting program aids in minimizing concern in the region over radioactive releases.

Key Highlights of the Monitoring Results

- Gross alpha and beta activities remain mostly close to the normal background levels in 2020.
- Occasional detections of trace levels of ^{241}Am, ^{238}Pu, and $^{239+240}$Pu were recorded in a few weekly composite filters from Station A.
- There were few detections of transuranics in ambient air particulates. The levels detected were within the normal background for the area.
- Isotopes of U and the gamma-radiation-emitting radionuclides ^{137}Cs and ^{40}K were detected in all soil samples.
- No detection of transuranic radionuclides in any of the drinking and surface water samples.
- Trace levels of $^{239+240}$Pu, as well as isotopes of U were detected in sediments of three regional reservoirs. The radionuclide ^{241}Am was detected in one sample only. The levels detected were within the normal background for these reservoirs.
- Non-radiological monitoring of effluent air, drinking water, surface water, and the surface VOCs showed no increase in contaminants that could be attributed to the WIPP operations in any way.

In summary, the results of these programs, including observations, analytical data, interpretations, and trend analysis demonstrated that the operations at the WIPP facility have not impacted human health or the environment negatively.

CHAPTER 1 - INTRODUCTION

The Carlsbad Environmental Monitoring and Research Center (CEMRC) is an integral part of New Mexico State University's (NMSU's) College of Engineering. It receives funding from the U.S. Department of Energy (DOE) through a financial assistance grant process that ensures its independence in conducting and reporting environmental monitoring activities carried out at and near the Waste Isolation Pilot Plant (WIPP) site. CEMRC's primary objective is to consistently assess the radiological impact of the facility throughout its operational lifespan by utilizing a predetermined baseline established prior to the commencement of operations. This assessment aims to determine any potential influence of WIPP operations on the surrounding environment. Since 1998, CEMRC has been conducting independent health and environmental monitoring in the vicinity of WIPP, and the results are made readily accessible to the public. The transparency provided by public access to the monitoring data, as well as their ability to directly participate in CEMRC's whole-body counting program, fosters trust and transparency.

The WIPP facility, operated by the DOE, serves as a deep geologic repository for the disposal of defense-related transuranic (TRU) waste. The inventory of TRU waste intended for disposal at WIPP primarily consists of contaminated industrial waste, including items such as rags, tools, sludges from solidified liquids, glass, metal, construction debris, and other materials. The upper waste acceptance criteria for the facility require a total activity of less than 0.85 TBq/L (less than 23 Ci/L) and a dose rate of less than 10 Sv/h upon contact with unshielded waste containers. Currently, two types of TRU waste are stored in the WIPP repository: (1) TRU waste, containing radioactive elements primarily plutonium (Pu) and americium (Am), and (2) mixed transuranic waste (MTRU), which includes hazardous waste components in addition to the radioactive elements.

The WIPP facility commenced operations on March 26, 1999, with the first waste shipment received on April 28, 1999. The facility operated without incident until February 2014 when a fire on February 5 and an unrelated accidental radiological release on February 14 led to the temporary suspension of waste shipments. However, waste shipments resumed on April 10, 2017, once the necessary measures were implemented to address the incidents.

1.1 Environmental Setting of the WIPP

The WIPP facility is currently the world’s only licensed deep geologic repository permitted to permanently dispose of transuranic waste generated from defense operations. The WIPP facility is located in Eddy County, in southeastern New Mexico, approximately 42 km (26 mi) east of Carlsbad (Figure 1.1). The facility is located on a sandy plain at an elevation of 1,040 m (3,410 ft) above sea level. Prominent natural features near the facility include Livingston Ridge and Nash Draw, about 8 km (5 mi) west of the facility. Nash Draw is a shallow, dog bone-shaped drainage course between 14 km (8.5 mi) and 18 km (11 mi) wide and characterized by surface impoundments of brine. Livingston Ridge is a bluff that marks the eastern edges of Nash Draw. Other prominent features of the region include the Pecos River, located about 22 km (14 mi) west of the facility, and Carlsbad Caverns National Park, located about 68 km (42 mi) west-southwest of the WIPP facility.

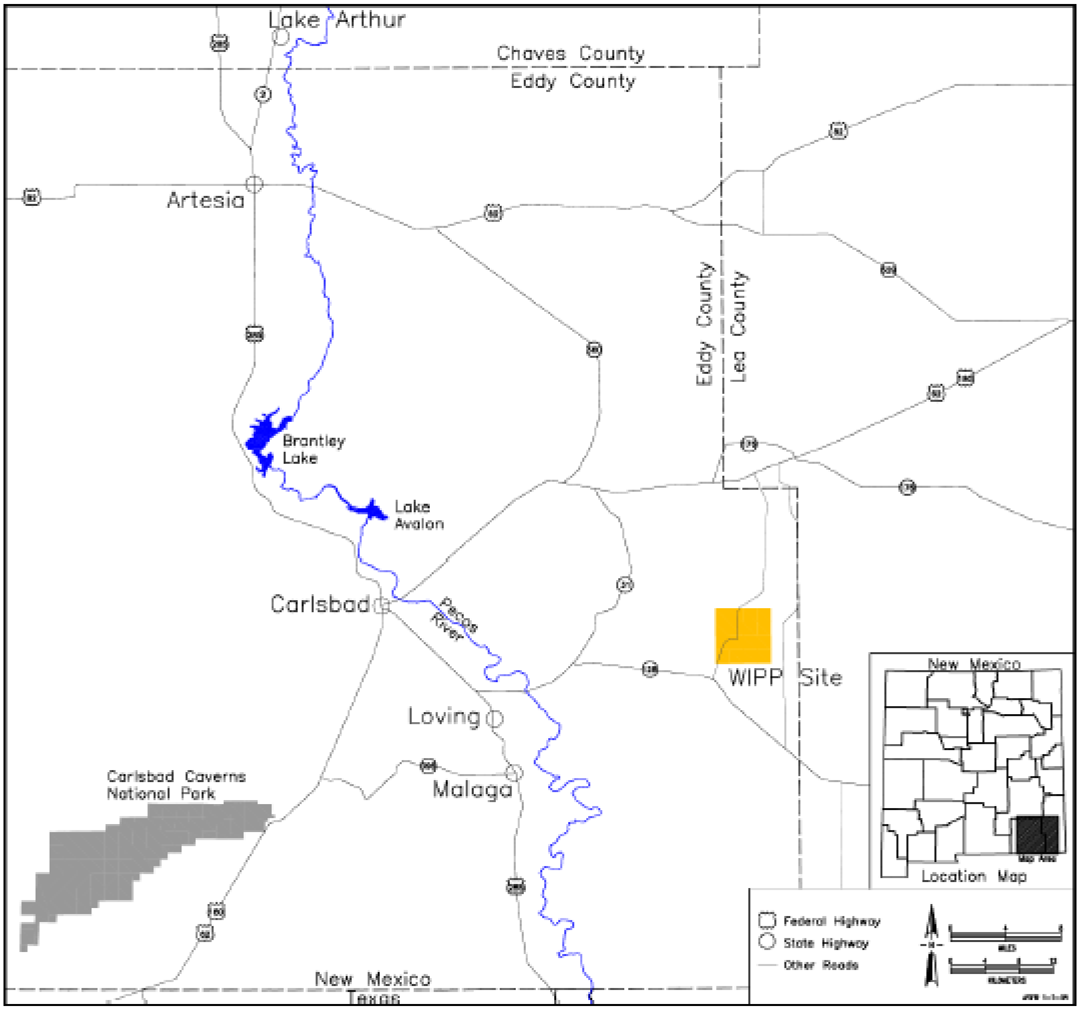


Figure 1.1. Location of the WIPP Site Identified by the Orange Box

The climate of the facility's region is semi-arid, with a typical annual precipitation ranging between 280 and 300 mm (11 to 13 inches), with much of this precipitation falling during intense thunderstorms in the spring and summer seasons. Winds are generally from the southeast with an average speed of 14 km/h (8.8 mi/h).

The majority of the local population within 80 km (50 mi) of the WIPP site is concentrated in and around the New Mexico communities of Carlsbad, Hobbs, Eunice, Loving, Jal, Lovington, and Artesia.

According to the latest census data, the estimated population within this radius was 88,952. The nearest community is the village of Loving (with an approximate population of 1,400), 29 km (18 mi) west-southwest of the WIPP site. The closest majorly populated area is Carlsbad, 42 km (26 mi) west of the WIPP site. The 2020 census reported the population of Carlsbad as 32,238.

The transient population within 10 miles of WIPP is associated with ranching, oil and gas exploration and production, and potash mining. Three ranchers, Mills, Smith, and Mobley, have properties in the vicinity of the WIPP facility. The Mills ranch headquarters is located 5.6 km (3.5 mi) south-southwest of the facility center, the Smith headquarters is 8.8 km (5.5 mi) west-northwest of the facility, and the Mobley ranch is 9.6 km (6 mi) southwest of the facility. Although there are no dairies near the WIPP facility, the area produces a large amount of alfalfa. The alfalfa crop is used in cattle-feeding operations, mainly in New Mexico and Texas. In addition to alfalfa, cotton and pecans are the other major crops grown in the Pecos Valley region.

1.2 Repository Configuration and Effluent Monitoring

Figure 1.2 shows the current configuration of the WIPP site. The site consists of surface facilities and an underground repository. The repository currently comprises eight waste-disposal panels, each consisting of seven waste disposal rooms approximately 91 m (300 ft) long, 10 m (33 ft) wide, and 4.5 m (15 ft) high.

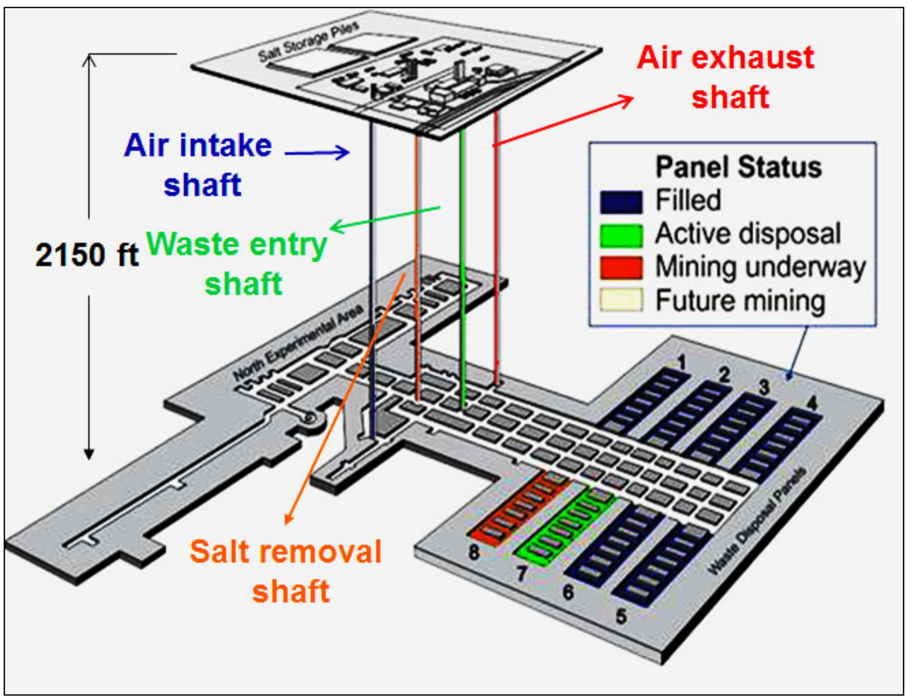


Figure 1.2. WIPP Layout

Seven of the panels have been excavated in the repository, while mining is currently underway in the eighth; the first six have been closed and sealed from ventilation air. The repository consists of common drifts for access and ventilation to the disposal panels as well as four shafts connecting surface operations to underground emplacement activities and above-ground waste receipt and handling facilities. Ventilation of the repository occurs by drawing air from the surface into the underground. Because the air in the repository exits to the surface through an exhaust shaft, this shaft is the sole potential pathway for any contaminants to be released from the repository during normal operations. The release of contaminants into the atmosphere is mitigated by High-Efficiency Particulate Air (HEPA) filters, which are located at the surface. Additionally, continuous air monitors (CAM) in the underground areas control whether ventilated air returning to the surface passes through the HEPA filter systems or is released directly into the atmosphere.

Both filtered and unfiltered exhaust air streams exiting the repository are monitored at the effluent air monitoring stations. Each station is equipped with at least one fixed air sampler (FAS), which collects representative particulate samples from the effluent air stream. Under normal operating conditions, unfiltered air is drawn through the repository and exhausted from the repository directly to the environment after passing by the Station A sampling port. Therefore, during normal operating conditions, the activities measured at Station A would represent the radiological activities present in the air within the repository and would be reflective of the level of contamination released directly to the environment. However, once contamination is detected within the underground repository via continuous air monitoring, the system shifts into "filtration mode" and the exhaust air is routed through the HEPA filters before being released into the environment. Monitoring of the exhaust air occurs at the Station B sampling port. Exhaust at Station B is representative of the level of contamination ultimately released into the environment while operating in filtration mode. Three organizations, CEMRC, the New Mexico Environment Department DOE Oversight Bureau (NMED-DOE-OB), and the WIPP Management and Operation contractor (M&OC) Nuclear Waste Partnership (NWP), independently analyze particulate samples collected at Stations A and B.

1.3 Environmental Monitoring

The scope of the CEMRC WIPP environmental monitoring activities is broad and generally falls into three categories:

1) Collecting and analyzing environmental samples for a variety of radiological, non-radiological, and hazardous contaminants

2) Radiological screening of workers and local citizens

3) Evaluating whether WIPP-related activities have any environmental impacts

The environmental samples analyzed include ambient air, surface- and drinking water, soil, and sediment. Ambient air monitoring establishes a baseline against which operational monitoring data are compared to identify any releases. For ambient air analyses, CEMRC operates four ambient air samplers in and around the WIPP site and two ambient air samplers in the two communities nearest to WIPP, Loving and Carlsbad. Public drinking water sources are sampled and analyzed to establish a baseline because water consumption is a primary pathway for contaminant ingestion. Soil, sediment, and surface water samples are also collected and analyzed to determine contaminant concentrations and establish the variability of background radioactivity as well as to allow the detection of potential releases.

CEMRC also performs routine monitoring of workers and residents living within a 100-mile radius of the WIPP facility for the presence of gamma-radiation-emitting radioisotopes through its *Lie Down and Be Counted* (LDBC) program. As in other aspects of the WIPP-EM program, *in vivo* bioassay testing was used to establish a baseline profile of internally deposited radionuclides in a sample of local residents before disposal phase operations began. This testing has continued throughout the disposal phase into the present.

This report describes sample collection and analysis from January 2020 through December 2020, with historical data for the past twenty years. It evaluates environmental monitoring data and identifies trends that are important for demonstrating any impact WIPP operations might have on the local environment. Results from this year's monitoring show that WIPP operations did not have an adverse effect on human health or the environment.

CHAPTER 2 - AIRBORNE EFFLUENT MONITORING

The WIPP repository is ventilated by drawing ambient air down three shafts (the air intake shaft, salt shaft, and waste handling shaft) into the underground repository and then exhausting it out the exhaust shaft. Unfiltered exhaust air is sampled at Station A to quantify radionuclides released from the repository. Effluent monitoring at Station A provides the means for monitoring repository exhaust for radionuclides and other potentially harmful substances. A second sampling station, Station B, is used to sample the underground exhaust air after HEPA filtration. Samples from Station B are analyzed by CEMRC, the New Mexico Environment Department (NMED), and WIPP's contractor Nuclear Waste Partnership (NWP).

Effluent monitoring at Stations A and B is a major component of both the WIPP Environmental Monitoring (WIPP-EM) program and CEMRC's monitoring program. CEMRC has been sampling and analyzing WIPP exhaust air since December 12, 1998. Before the 2014 accidental release, Station A was used to monitor exhaust air compliance. Since 2014, Station B has been the sample point of record for emissions from the underground. The current scope of work requires particulate matter in the repository exhaust air to be collected daily at all Fixed Air Sampler (FAS) locations and composited for analysis. Individual samples are analyzed to determine the total suspended particulates collected and to quantify gross alpha and gross beta activities. Radiological analyses are used to quantify gamma-emitting radionuclides and actinides of concern. Details of the sample collection and analyses are described in the following sections.

A schematic of the WIPP ventilation system and normal underground airflow is shown in Figure 2.1. WIPP effluent sampling systems are designed to collect at least 50% of the 10 µm diameter aerosols under the expected range of exhaust air velocities. Prior to the 2014 radiologic event, in normal operation, the ventilation system discharged unfiltered air. One or two of the unfiltered 700 fans were typically operated to generate approximately 225 m^3/s (475,000 ft^3/min) of unfiltered air underground. Since the radiologic event, the ventilation system has been maintained in filtration mode. In this mode, one of three filtration 860 fans operates to deliver 28.3 m^3/s (60,000 ft^3/min) to the underground.

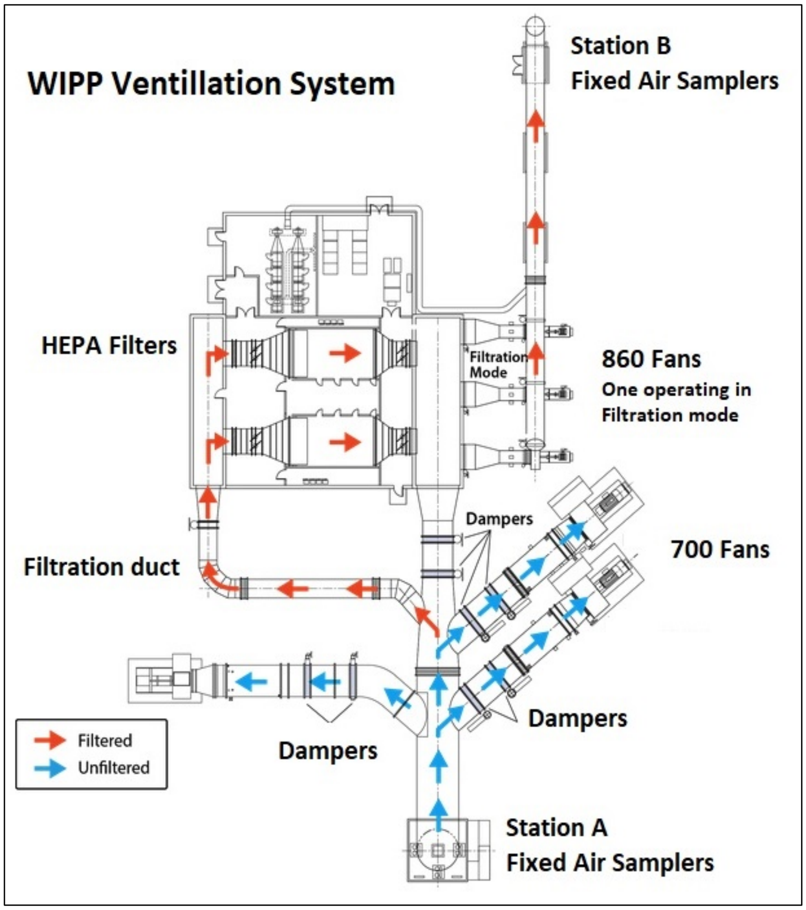


Figure 2.1. Schematic of WIPP Ventilation System

Quarterly composites were initially used to determine the actinide activities, but monthly compositing was implemented by CEMRC in July 2004 for better comparison with other groups that use monthly composites. These monthly composites are used to determine the gamma-emitting radionuclides as well. After the gamma measurements, the sample aliquot is archived.

For some time following the radiation release event, filters at Station A were changed every 8 hours; measurements were performed on each filter by CEMRC (and later daily combined filters) depending on the levels of contamination found. As airborne concentrations receded, the frequency of Station A filter collection was reduced to daily, but actinide measurements continue to be performed on weekly composite samples.

Both Station A and Station B are above-ground sampling platforms that collect particulates in exhaust air from the repository before and after HEPA filtration (Figure 2.2). Each station is equipped with three shrouded-probe aerosol samplers along with three separate sampling skids, denoted as A1, A2, and A3 (Figure 2.3). The airstream sampled by each skid is split among three legs allowing three concurrent samples to be collected from each skid. A total of three concurrent samples can be collected from each FAS, one each for CEMRC, the site contractor (WIPP Labs), and NMED.

Figure 2.2. Sampling Station A (left) and Station B (right)

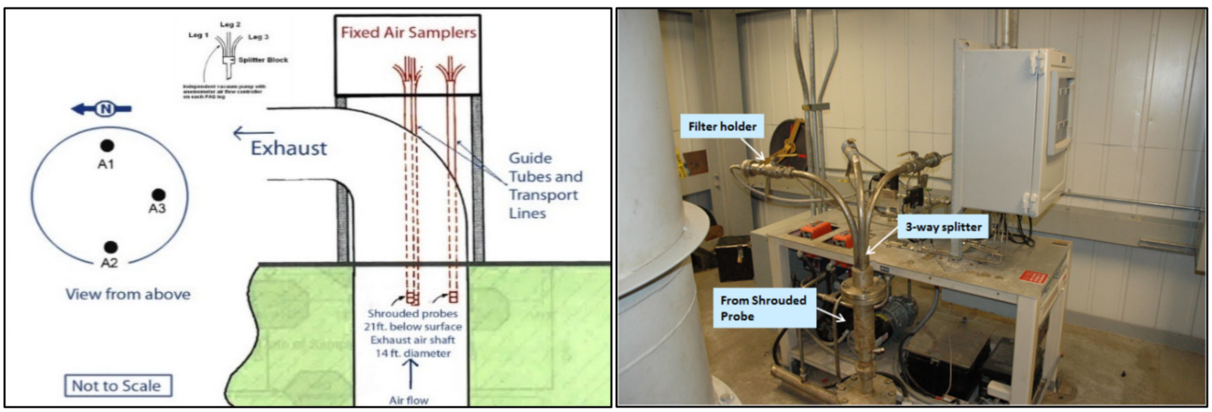


Figure 2.3. Schematic of Station A (left) and Fixed Air Samplers at Station A (right)

2.1 Sample Collection

Particulates in the exhaust air are collected on 47 mm diameter, pore size 3 µm membrane filters (Versapor™ membrane filter, PALL Corporation, Port Washington, NY, USA) with the use of a cylindrical shrouded probe, commonly referred to as a fixed air sampler or FAS. The airflow through the FAS is approximately 170 L/min (6.0 ft^3/min). The samples at Station A are typically collected daily except for weekends (the weekend samples run from Friday to Monday, so the coverage is continuous). Occasionally, however, more than one sample per day is still collected when the flow rate on any of the sampler legs drops below 50 L/min (1.8 ft^3/min). If this occurs, a low-flow alarm on the sampler is activated and the filters are changed as needed by WIPP radiological control technicians. Under normal operating conditions, approximately 81 m^3 (2,875 ft^3) of air is filtered through each of the Versapor™ membrane filters at Station A and Station B each day.

The ventilation flow capacity of the Station B exhaust duct was increased in the fall of 2016 from 60,000 ft^3/min to 114,000 ft^3/min by the addition of two more HEPA filter trains, parallel to the existing two HEPA filter trains, that have been in continuous use since the February

2014 radiological event. During 2020, the ventilation system associated with Station B operated normally at a nominal flow rate of 114,000 ft^3/min.

2.1.1 Sample Preparation and Analysis

2.1.1.1 Gross Alpha and Beta Analysis

Once the samples are collected from the site and brought back to the laboratory, the individual filters undergo a desiccation process lasting a minimum of 48 hours. This step is essential to ensure that any moisture present on the filters is completely evaporated and to facilitate the complete decay of the immediate daughter products of ^{222}Rn and ^{220}Rn. After the filters have been thoroughly dried, their weights are measured to determine the mass loading concentrations.

Following the desiccation and weighing procedures, the Station A and B filters are subjected to counting for gross alpha and beta activities. The counting is carried out using a Protean MPC 9604 low background gas proportional counter for a duration of 1200 minutes (20 hours). To maintain the accuracy and reliability of the measurements, daily performance checks are performed utilizing calibration sources. Specifically, ^{239}Pu is employed for alpha efficiency control charting, while ^{90}Sr/^{90}Y is utilized for beta efficiency control charting. These calibration sources are crucial in establishing the efficiency control chart, which includes 2σ warning limits and 3σ limits. The purpose of this control charting is to monitor the efficiency and ensure that the alpha/beta cross-talk remains within acceptable limits, specifically less than 0.1% alpha into beta and less than 0.1% beta into alpha.

To account for background radiation, sixty-minute background counts are recorded daily by counting an empty planchet. This allows for the subtraction of background radiation from the sample measurements, ensuring accurate determination of the actual alpha and beta activities.

It is worth noting that the mean counting efficiencies for the systems typically range around 25% for alpha activities and 38% for beta activities. These efficiencies provide an indication of the proportion of emitted radiation that is successfully detected and counted by the measurement system.

2.1.1.2 Radiochemical Analysis

After conducting gross alpha/beta measurements, the filters collected on a daily basis for one week are combined to create weekly composites for Station A, and monthly composites for Station B. To prepare the filter samples for radiochemical analysis, they undergo wet digestion using nitric acid (HNO_3), hydrochloric acid (HCl), and perchloric acid ($HClO_4$) until complete dissolution of the filter material is achieved. Typically, half of the sample is utilized for determining the activities of actinide radionuclides, while the other half is allocated for gamma analysis. The gamma-emitting radionuclides present in the air filters are measured using gamma spectroscopy, while the alpha-emitting radionuclides undergo co-precipitation, separation using anion exchange and chromatography columns, and subsequent analysis using alpha spectroscopy, as outlined in previous reports from CEMRC (http://www.cemrc.org/annual-reports).The samples are counted for a period of 24 hours for alpha radionuclides and 48 hours for gamma radionuclides, following the established standard counting protocol of CEMRC. Portions of digested solutions containing strontium are co-precipitated with barium as a carbonate, then dissolved in nitric acid and barium precipitated out as chromate. The supernatants obtained are mixed with ammonium hydroxide (NH_4OH) and saturated ammonium carbonate $(NH_4)_2CO_3$ to precipitate strontium as strontium carbonate ($SrCO_3$), and the beta-radiation-emitting radioactive isotope ^{90}Sr is then counted by liquid scintillation counting. Details are described in procedure WL-1011.

2.2 Results and Discussion

The activities of the radionuclides in the WIPP underground air samples are reported in the following two ways: Activity Concentration in Bq/m^3 and Specific Activity in Bq/g. Activity Concentration is calculated as the activity of radionuclides reported in Becquerel (Bq) divided by the volume of air in cubic meters (m^3). Specific Activity is calculated as the activity of radionuclides reported in Becquerel (Bq) divided by the aerosol mass collected on the filter in grams (g).

2.2.1 Gross Alpha and Beta Concentrations at Station A

The pre- and post-release gross alpha and gross beta concentrations in Station A filters are shown in Figures 2.4 and 2.5 for trend analysis purposes over a period of over twenty years. There are no data for the period between February and June 2014 because gross alpha and beta screening was not performed immediately following the February 14, 2014, underground radiation release event. Instead, an emergency actinide separation campaign was carried out for each individual or daily filter collected from Station A and Station B. However, as radiation levels receded, the gross alpha and beta analysis resumed beginning in March 2014 for the Station A filters and July 2014 for the Station B filters.

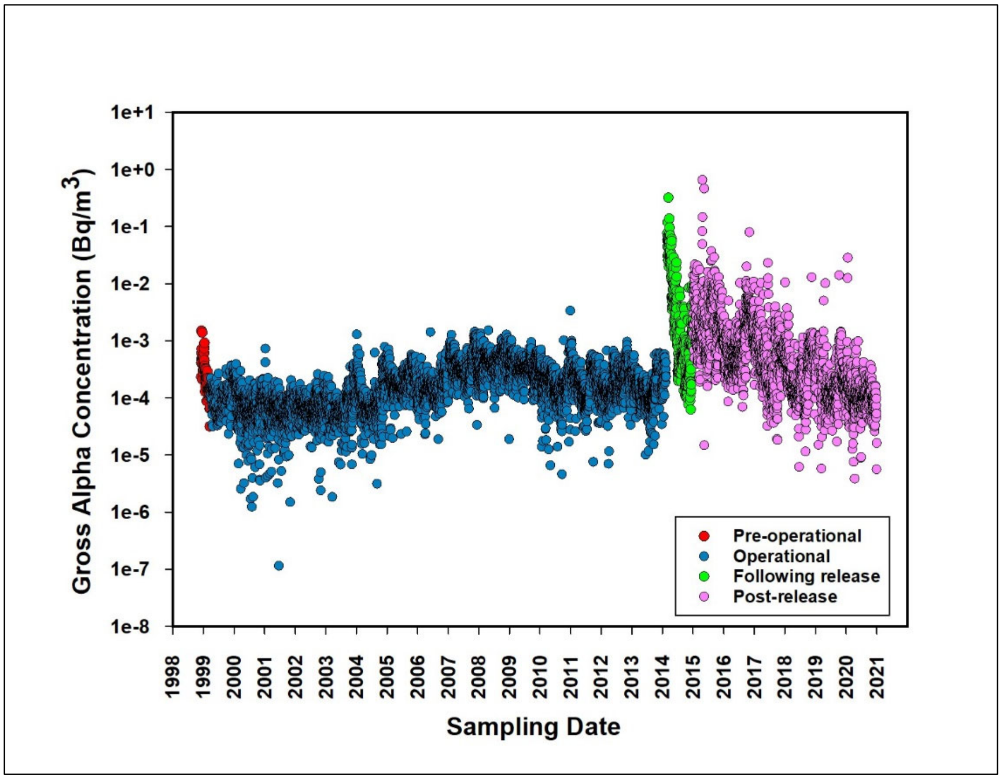


Figure 2.4. Historical Gross Alpha Concentrations at Station A

The two samples with elevated gross beta activity concentrations of approximately 0.058 Bq/m^3 observed in early 2001 are because of contamination released from an underground fire extinguisher (Figure 2.5). Follow-up measurements confirmed that the fire retardant containing ^{40}K was the cause of the elevated results and that WIPP waste had not been released.

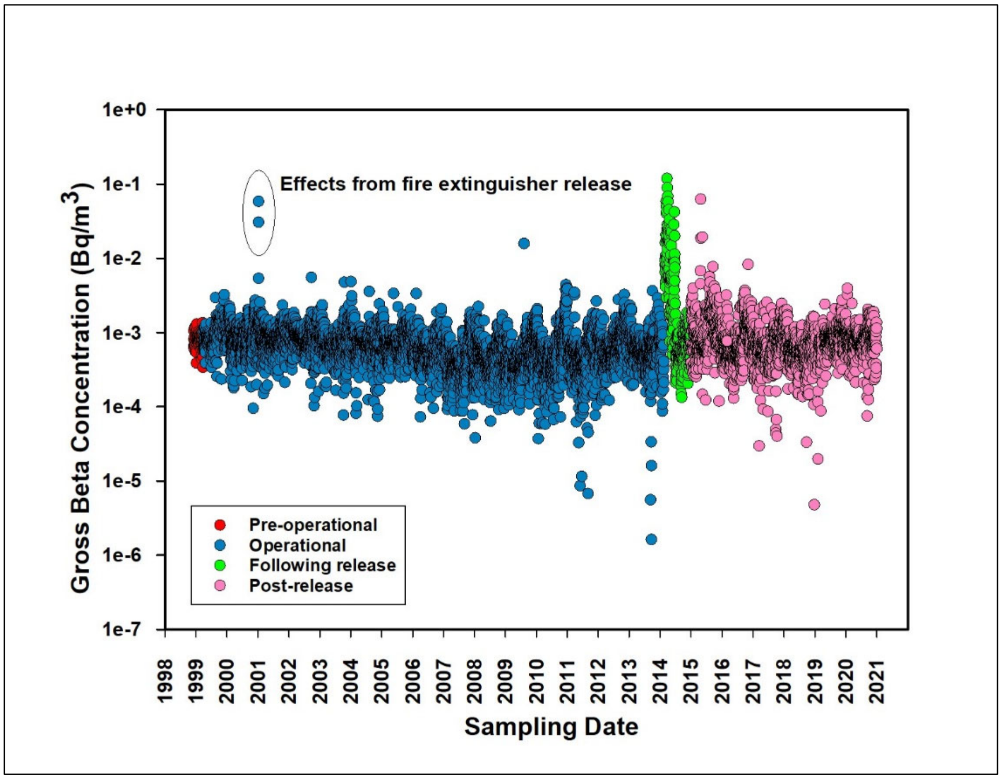


Figure 2.5. Historical Gross Beta Concentrations at Station A

The pre- and post-release gross alpha and gross beta specific activities (Bq/g) are shown in Figures 2.6 and 2.7, respectively, for trend analysis purposes over a period of over twenty years. The gross alpha and beta activities appear to have returned to the pre-release levels in recent years.

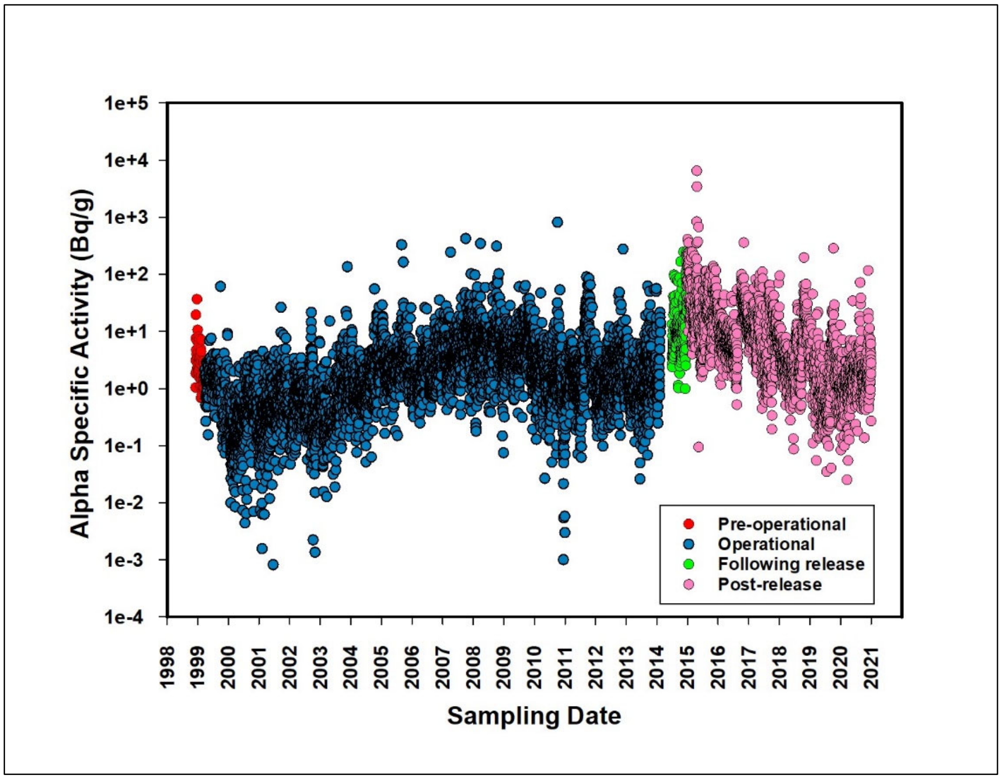


Figure 2.6. Historical Gross Alpha Specific Activities at Station A

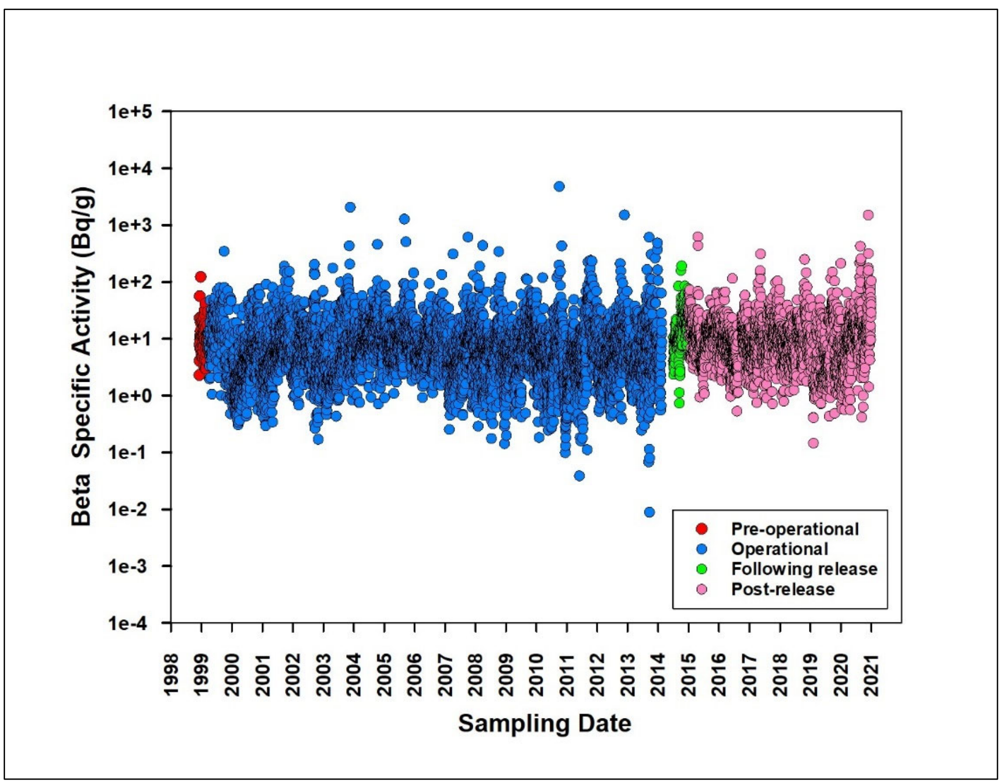


Figure 2.7. Historical Gross Beta Specific Activities at Station A

The daily gross alpha and gross beta concentrations in the unfiltered underground air are shown in Figures 2.8 and 2.9, respectively. The gross alpha and beta activity in the air filters before the arrival of waste at the WIPP were used as a baseline concentration. The baseline concentrations of gross alpha and gross beta activities were 1.49 mBq/m^3 for alpha and 4.90 mBq/m^3 for beta. The current levels are within the range of normal background levels for Station A.

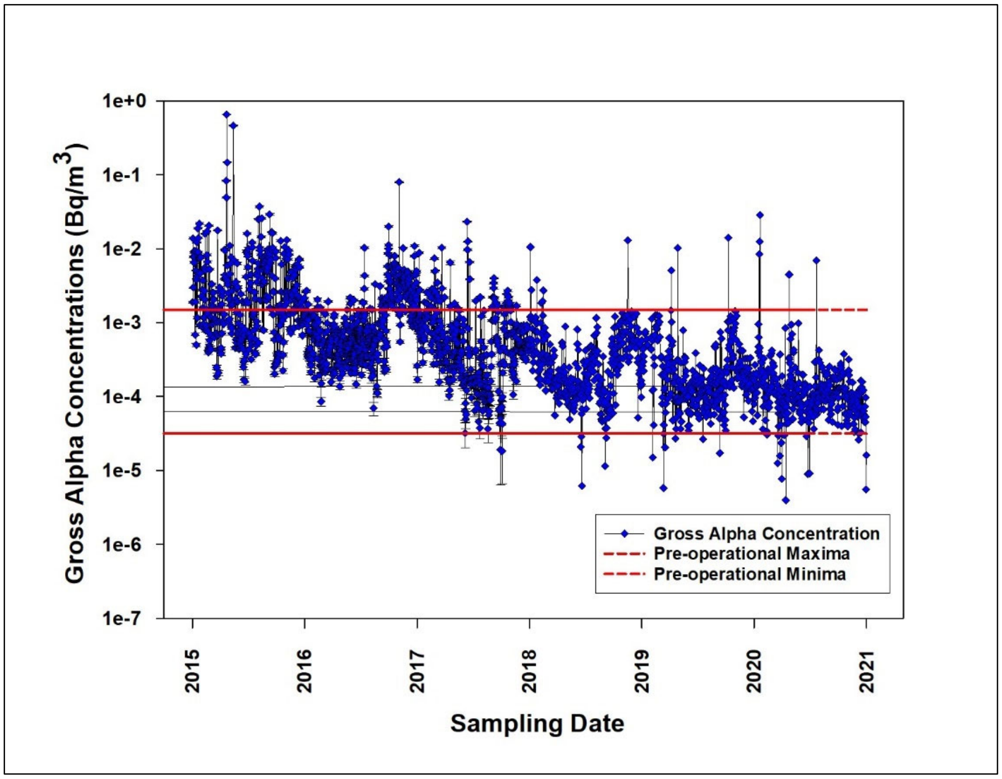


Figure 2.8. The Gross Alpha Concentrations at Station A during 2015-2020

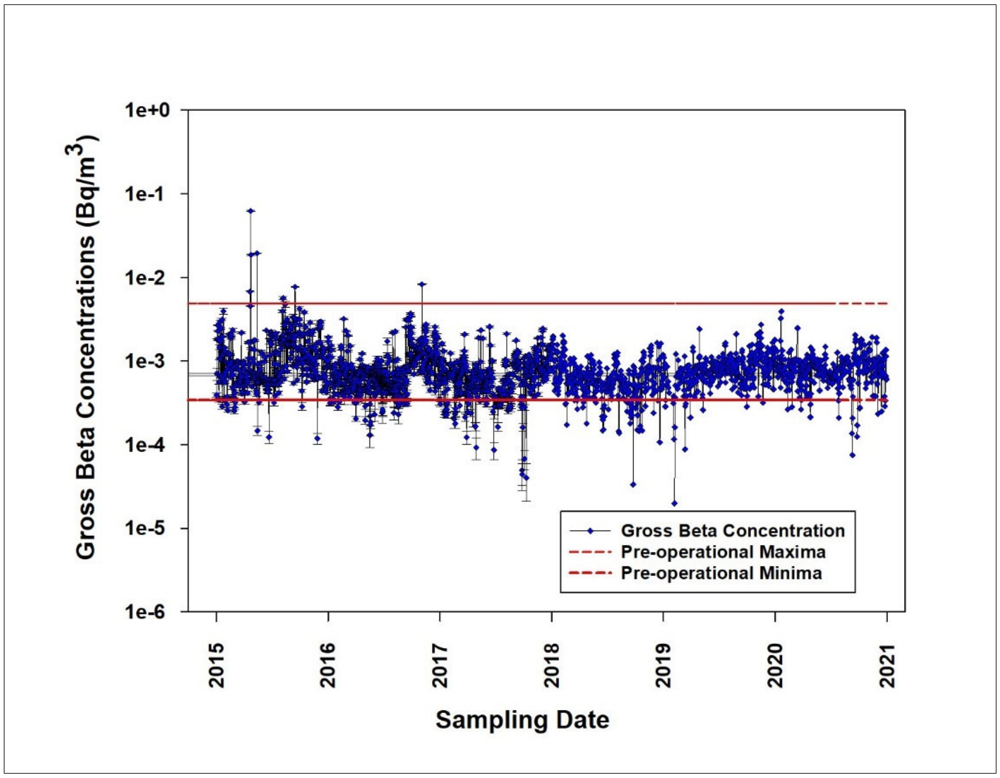


Figure 2.9. The Gross Beta Concentrations at Station A during 2015-2020

These data are utilized for evaluating the integrity of the Waste Isolation Pilot Plant (WIPP) project during the disposal phase. The minimum detectable activity concentrations and specific activity for gross alpha emitters are approximately 1×10^{-7} Bq/m^3 and 0.7 Bq/g, respectively. For gross beta emitters, the corresponding values are approximately 2×10^{-7} Bq/m^3 and 1.7 Bq/g, respectively. In 2020, the alpha activity in the unfiltered exhaust air ranged from <MDC-28.48 mBq/m^3, with a mean value of 0.24±0.03 mBq/m^3. The beta activity ranged from <MDC-3.94 mBq/m^3, with a mean value of 0.84±0.04 mBq/m^3. A noticeable increase in gross alpha activity during the third week of November 2018 is attributed to a rockfall incident in Room 6, Panel 7. Additional sporadic increases in gross alpha concentrations, as depicted in Figure 2.8, can be attributed to the disturbance of entrained materials due to ongoing investigative and clean-up activities conducted by underground personnel in the WIPP facility.

2.2.2 Actinide Concentrations at Station A

The weekly concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu at Station A are shown in Figure 2.10; the individual values are listed in Tables A.1 through A.3 (Appendix A). Although the values that were measured were above the pre-release background levels, it is important to note that the levels detected were very low and well below any level of public health or environmental concern. The specific activities of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu measured at Station A are shown in Figure 2.11 and the values are listed in Tables A.4 through A.6 (Appendix A).

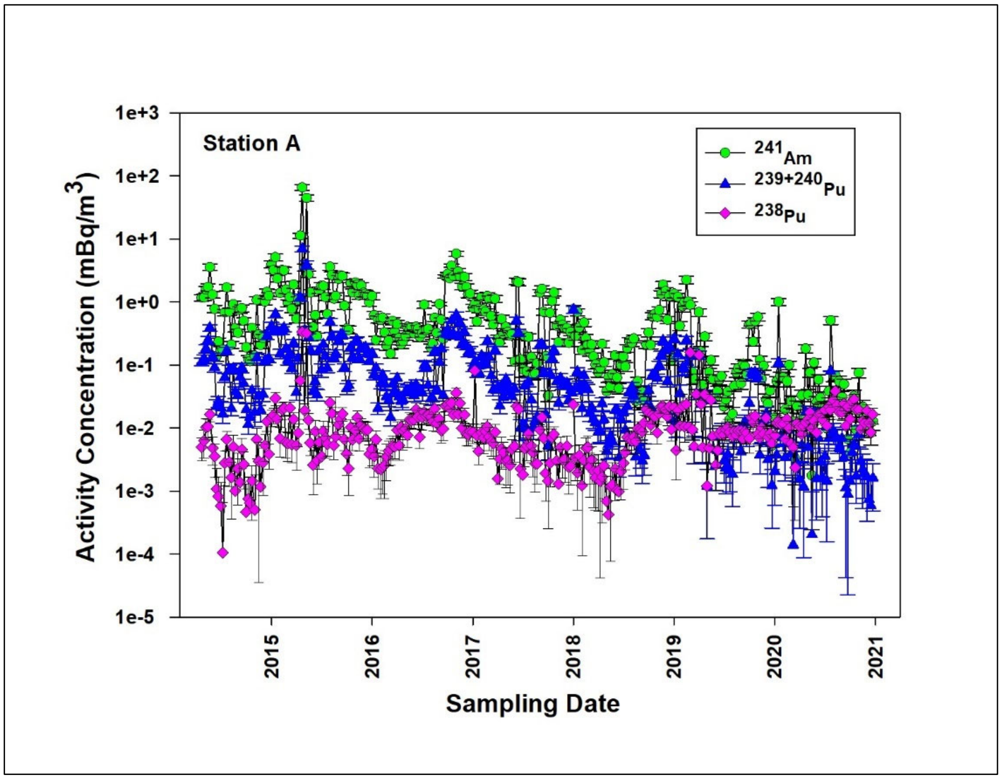


Figure 2.10. Weekly Concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu at Station A

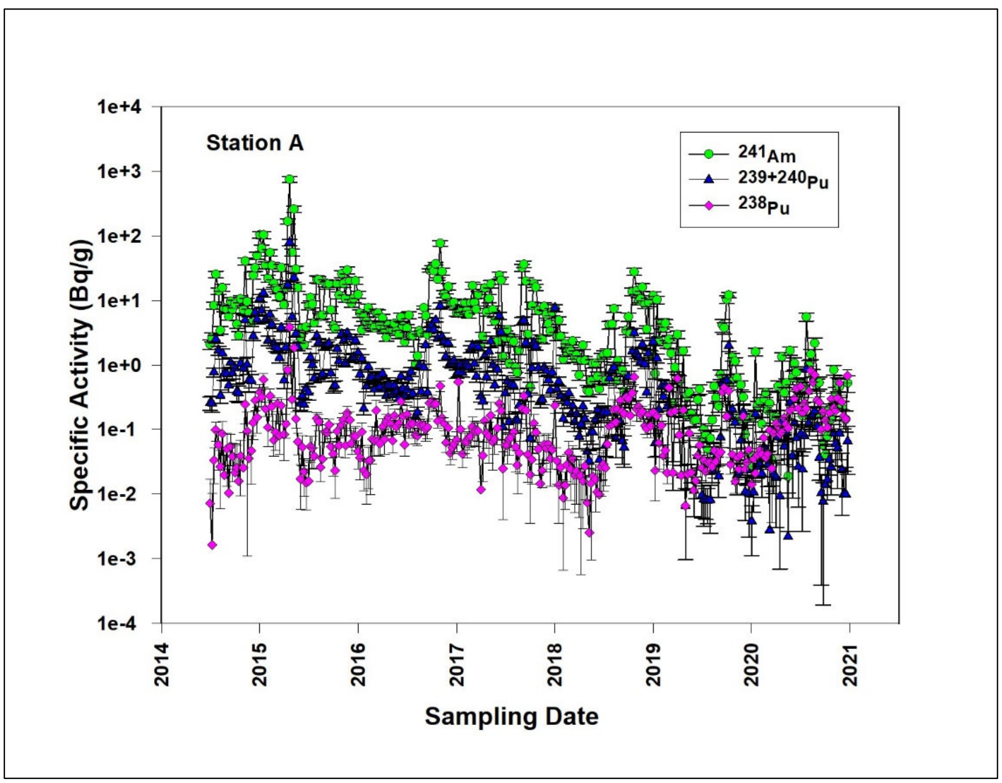
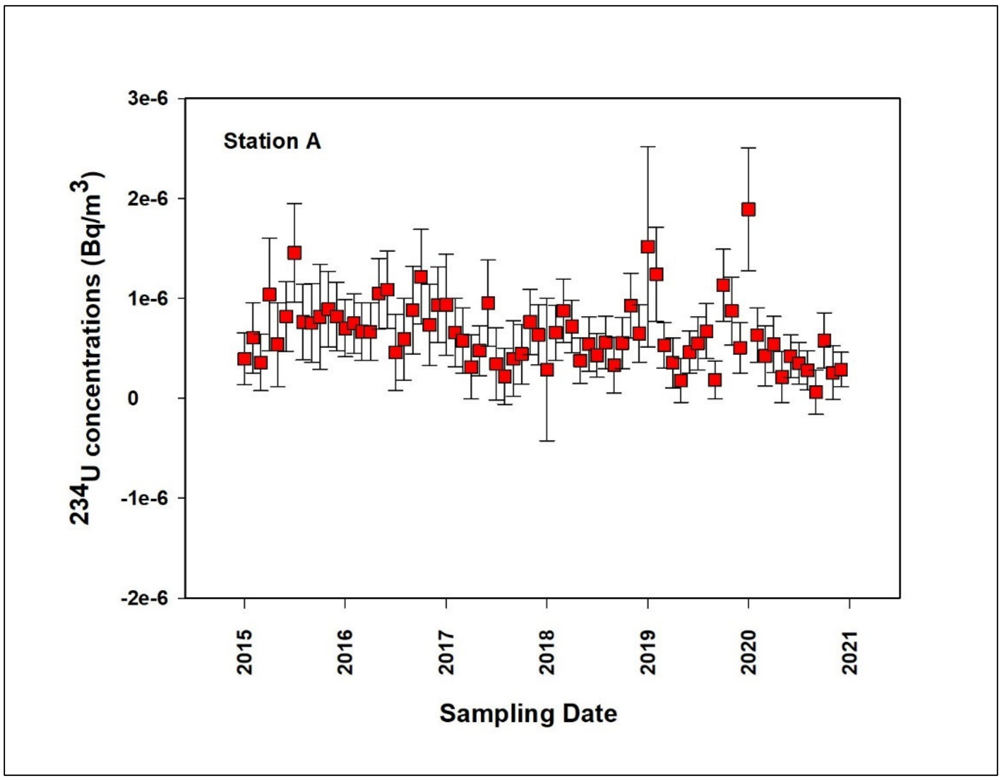


Figure 2.11. Weekly Specific Activities of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu at Station A

2.2.3 Uranium Concentrations at Station A

During 2020, certain monthly composite samples collected from Station A indicated the presence of uranium isotopes, which are naturally occurring radionuclides commonly found in the environment. Therefore, the detection of uranium (U) in the WIPP underground air is considered normal. The highest concentrations detected were 1.89×10^{-6} Bq/m^3 for ^{234}U and 7.40×10^{-7} Bq/m^3 for ^{238}U at Station A. These findings align with the results reported in previous reports from CEMRC. The activity concentrations of U isotopes in the Station A filter samples can be seen in Figure 2.12. Detailed information on the individual uranium activity concentrations and specific activity measured in the monthly composite samples is provided in Tables A.7 and A.8 (Appendix A).



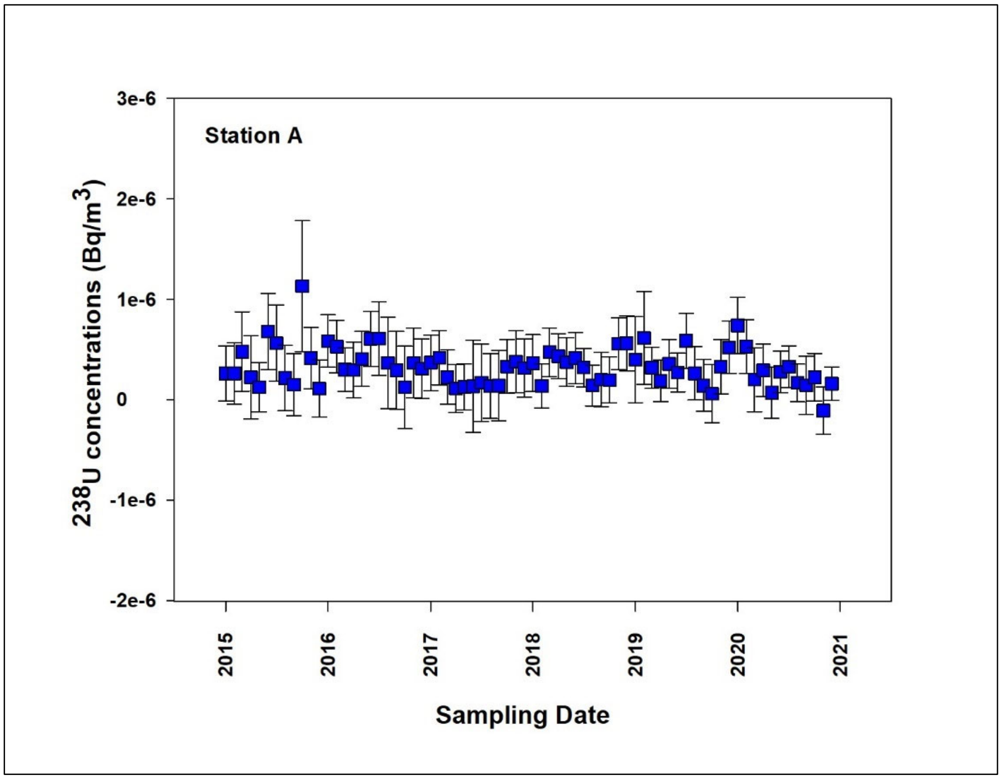
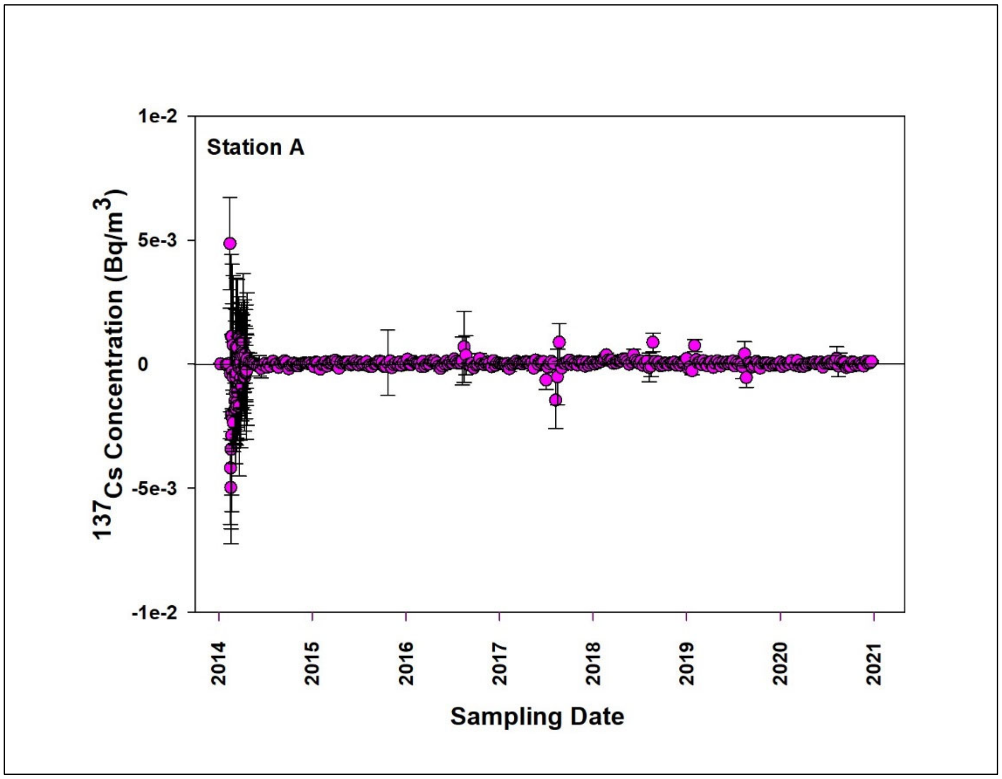
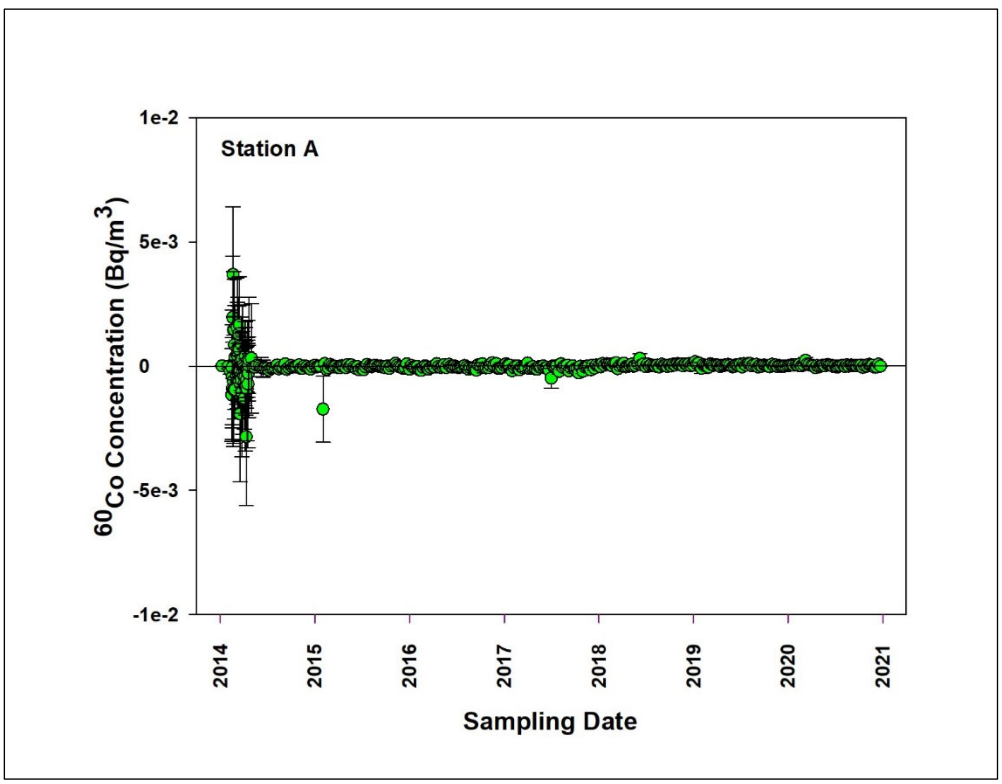


Figure 2.12. The ^{234}U and ^{238}U Activity Concentrations at Station A

2.2.4 Gamma Radionuclide Concentrations at Station A

The gamma-emitting radionuclides ^{137}Cs, ^{60}Co, and ^{40}K were not detected in any of the weekly composite samples during 2020. The concentrations of the gamma-emitting radionuclides ^{137}Cs, ^{40}K, and ^{60}Co measured in Station A filter samples are shown in Figure 2.13. The concentrations and specific activities of gamma emitting radionuclides are summarized in Appendix A, Tables A.9 through A.14. An analysis of historical operational data indicates that, except for the occasional detections of ^{40}K and the one-time detection of ^{137}Cs on February 14, 2014, immediately following the radiological release event at the WIPP, no detectable gamma-emitting radionuclides have been observed during the last sixteen years of monitoring.


Station A
1e-2
5e-3
0
-5e-3
-1e-2
137Cs Concentration (Bq/m3)
2014
2015
2016
2017
2018
2019
2020
2021
Sampling Date


Station A
1e-2
5e-3
0
-5e-3
-1e-2
60Co Concentration (Bq/m3)
2014
2015
2016
2017
2018
2019
2020
2021
Sampling Date

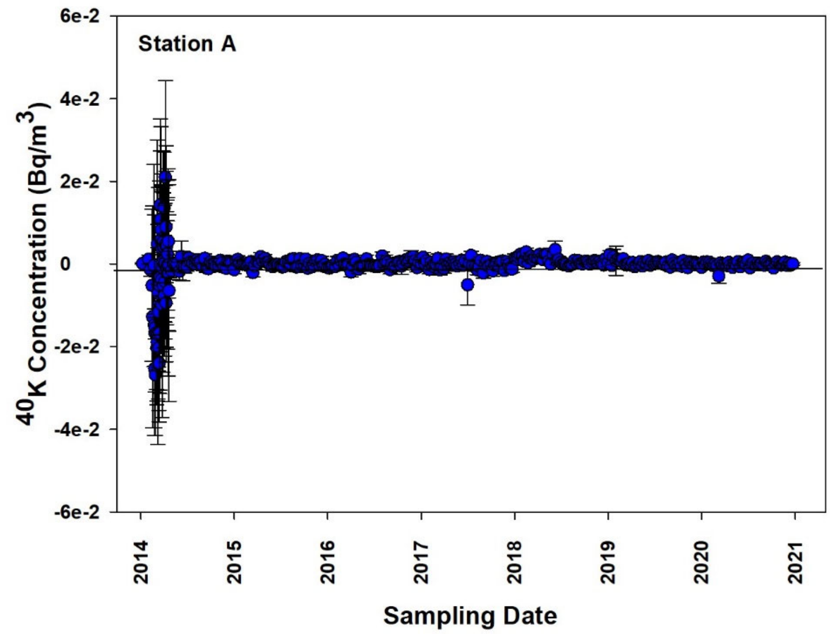


Figure 2.13. Concentrations of Gamma Emitting Radionuclides ^{137}Cs, ^{60}Co, and ^{40}K at Station A

2.2.5 Historical Concentrations of Actinides at Station A

An examination of historical operational data from Station A reveals intermittent detections of trace amounts of $^{239+240}Pu$, ^{238}Pu, and ^{241}Am in the exhaust air released from the Waste Isolation Pilot Plant (WIPP) over time, as depicted in Figure 2.14. From 2000 to 2013, only nine measurements at Station A exhibited detectable levels of radionuclides. Detectable concentrations of Pu isotopes ($^{239+240}Pu$ or ^{238}Pu) and ^{241}Am were observed in four monthly composite samples from the years 2003, 2008, 2009, and 2010, as documented in the CEMRC Report 2011. In two of the monthly composite samples (February 2008 and April 2009), the concentrations of ^{238}Pu exceeded the detection limits, enabling the calculation of activity ratios between ^{238}Pu and $^{239+240}Pu$. The activity ratio was found to be 0.039 for the February 2008 sample and 0.023 for the April 2009 sample. The mean ^{238}Pu /$^{239+240}Pu$ activity ratio of 0.025±0.004 (ranging from 0.019 to 0.039) is consistent with a global fallout origin, which is supported by findings from various studies (Kelly et al., 1999; Hardy et al., 1973). It is important to emphasize that the activities detected in these four composite samples were extremely low and did not trigger the underground Continuous Air Monitors (CAM) designed to detect any release of radioactivity. Based on extensive analyses of these data, CEMRC concludes that there is no definitive evidence of releases from WIPP operations prior to the underground radiation release event on February 14, 2014.

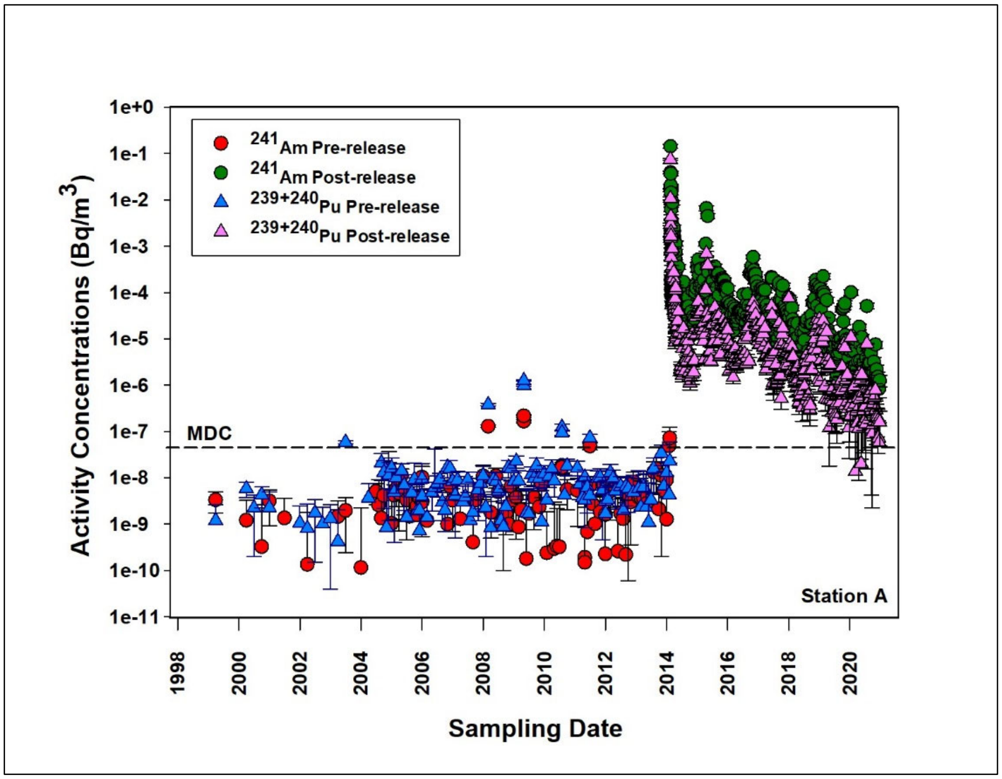


Figure 2.14. Historical Concentrations of $^{239+240}Pu$ and ^{241}Am at Station A

2.2.6 Strontium Concentrations at Station A

The beta-radiation-emitting radionuclide ^{90}Sr was not detected in any of the weekly composite samples during 2020.

2.2.7 Gross Alpha and Beta Concentrations at Station B

The daily gross alpha and gross beta activity concentrations at Station B are shown in Figure 2.15. It is important to note that CEMRC has been performing gross alpha and gross beta analyses on Station B filters since July 2014. Filter samples collected prior to July 2014 were not counted for gross alpha and gross beta concentrations; instead, an emergency actinide separation campaign was carried out on the individual or daily filters collected from Station B to provide isotopic results to interested parties as quickly as possible. The pre-operational gross alpha and gross beta concentration values measured at Station A were used as a baseline concentration for the filter samples collected from Station B because CEMRC had not routinely conducted gross alpha/beta analyses on Station B filters prior to February 14, 2014. As would be expected, the Station B analyses showed much lower levels of activity as compared to those of Station A.

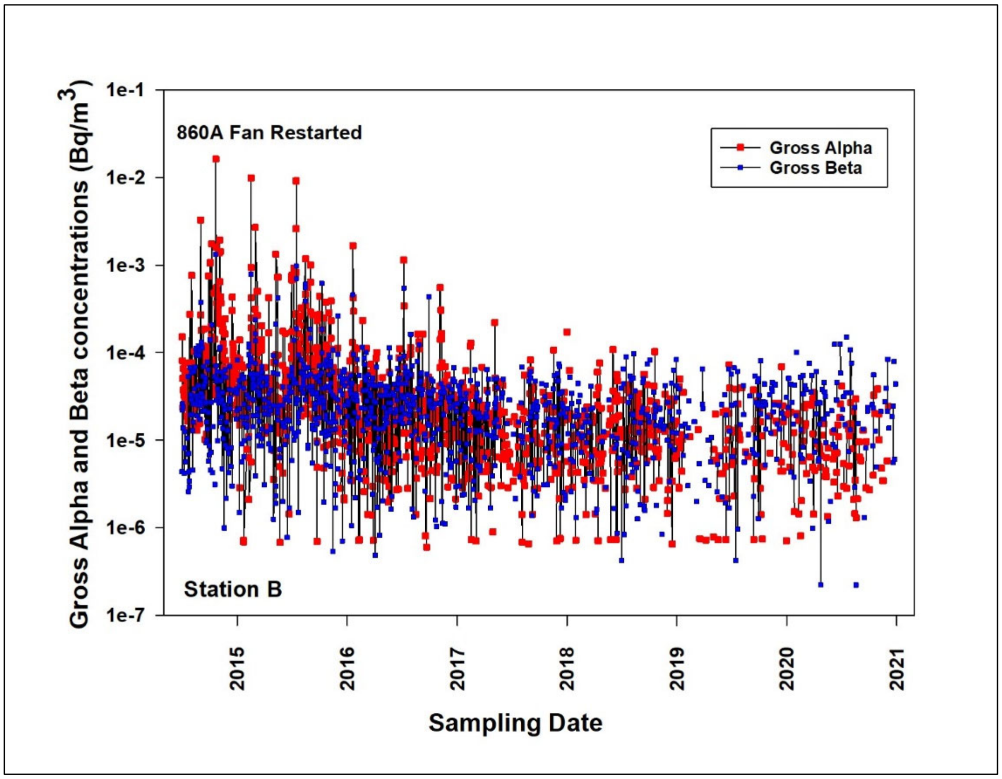
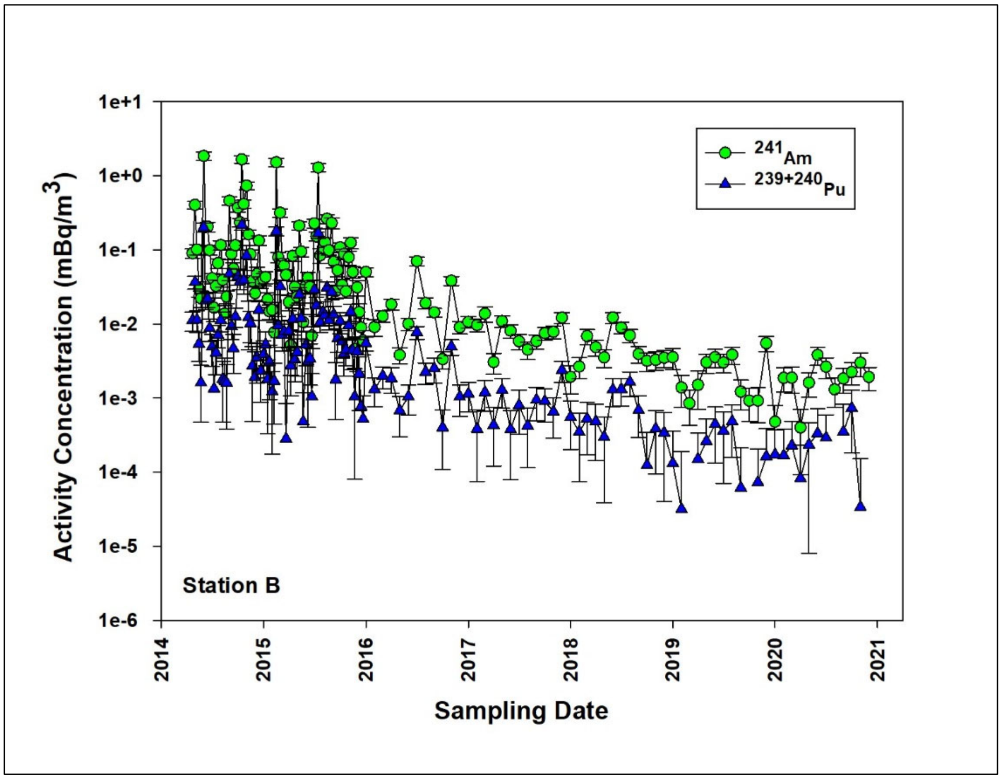


Figure 2.15. Daily Gross Alpha and Gross Beta Activity Concentrations at Station B

A spike in gross alpha activity during the third week of October 2014 is attributed to the restart of the 860A fan on October 21, 2014. The 860A fan ran for approximately two months following the February 2014 underground radiological incident before being taken off-line for maintenance-related activities. Since that time, the 860B or the 860C fans have been operated to continue the air filtration process. Because the 860A fan was operational immediately following the radiological release, it is expected that a small amount of residual contamination could be present in the adjacent ductwork and the interior workings of the fan, which could result in a low level of contamination being released, as seen in the spikes between 2015 - 2017. The current gross alpha and beta activities at Station B are comparable to the pre-operational gross alpha and beta values measured for Station A filters prior to the arrival of TRU wastes in the WIPP and are typical "background gross alpha and beta" values.

2.2.8 Actinide Concentrations at Station B

The concentrations and specific activities of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in monthly composite samples from Station B are summarized in Appendix A, Tables A.15 through A.20. The concentrations of ^{241}Am were in the range of 0.0004-0.0038 mBq/m^3, while that of $^{239+240}$Pu were in the range of -0.0001-0.0007 mBq/m^3. The specific activity of ^{241}Am at Station B was in the range of 0.045-0.715 Bq/g, while that of $^{239+240}$Pu was in the range of 0.032-0.174 Bq/g. The concentrations and specific activities of ^{241}Am and $^{239+240}$Pu measured at Station B are shown in Figure 2.16.



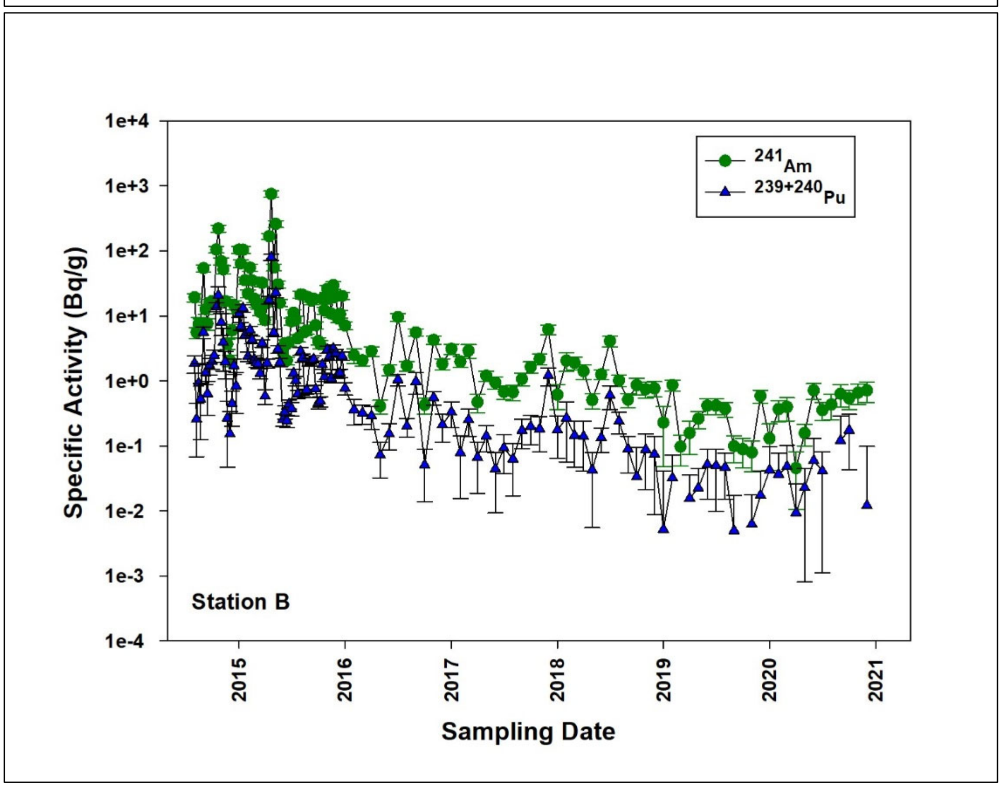
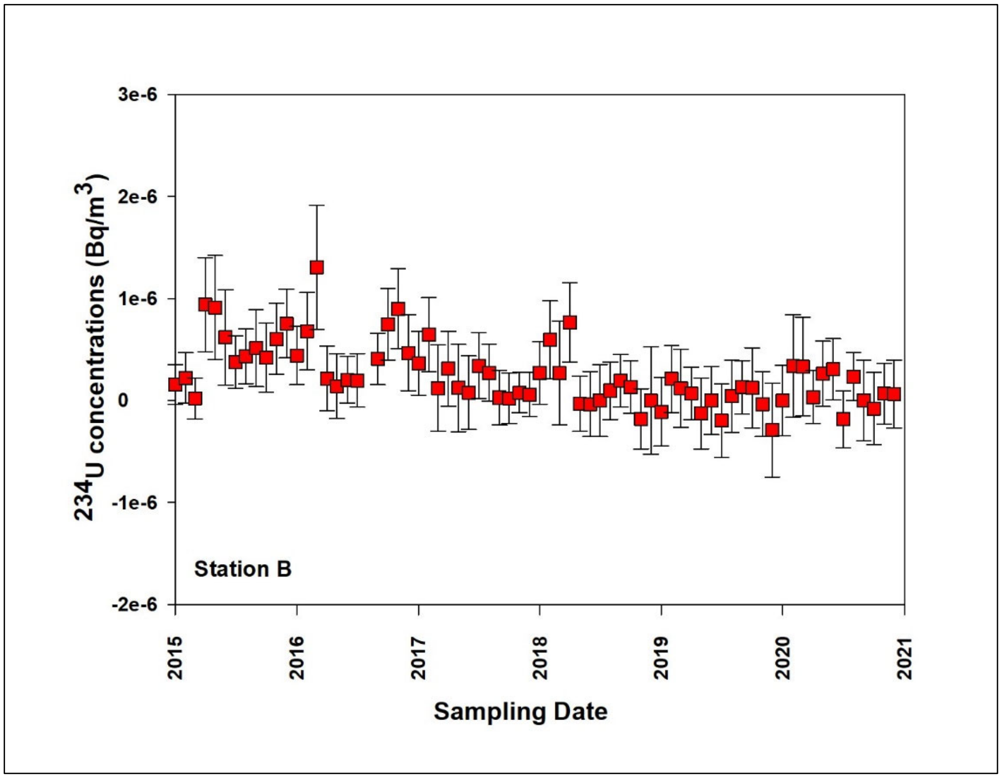


Figure 2.16. The Concentrations and Specific Activities of ^{241}Am and $^{239+240}$Pu at Station B

2.2.9 Uranium Concentrations at Station B

The naturally occurring isotopes of U were not detected above the MDC in any of the monthly composite samples from Station B in 2020. Isotopes of uranium have occasionally been detected at Station B. The activity concentrations of U isotopes measured in Station B filter samples are shown in Figure 2.17. The individual uranium activity concentrations and specific activities measured in monthly composite samples are summarized in Appendix A, Tables A.21 and A.22.



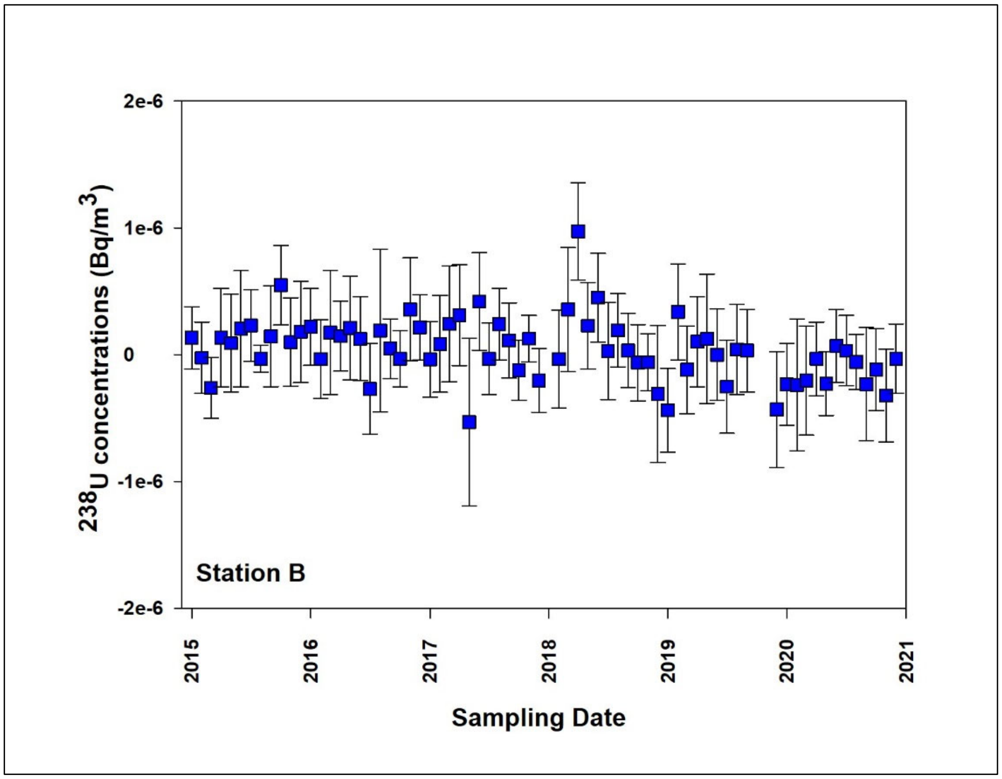
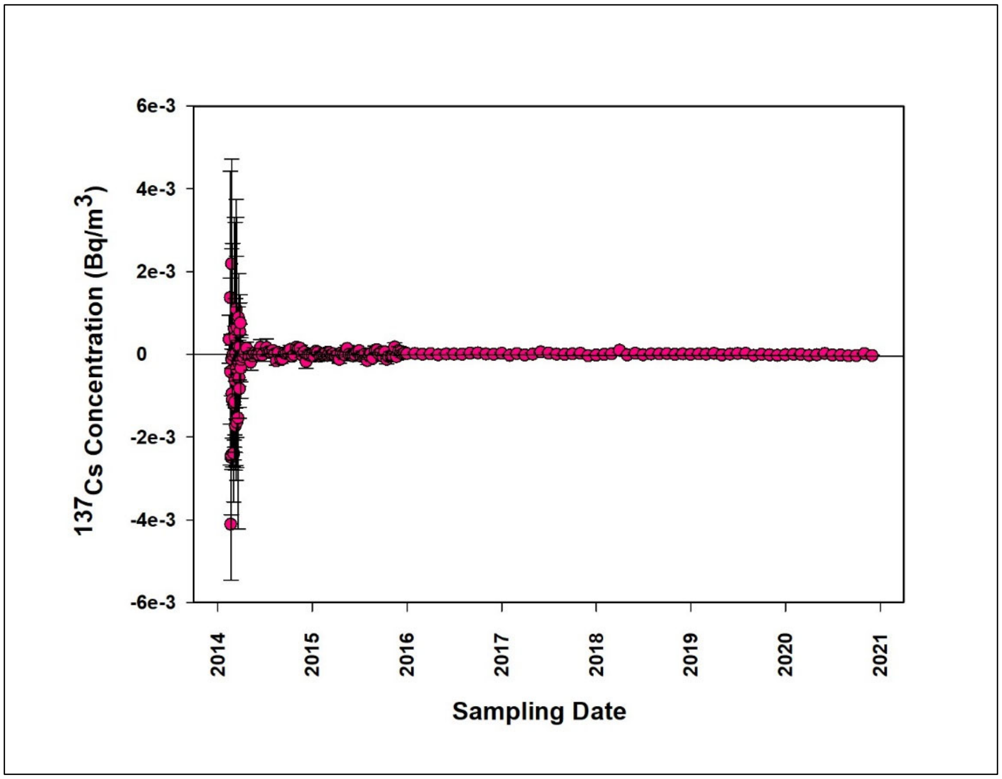
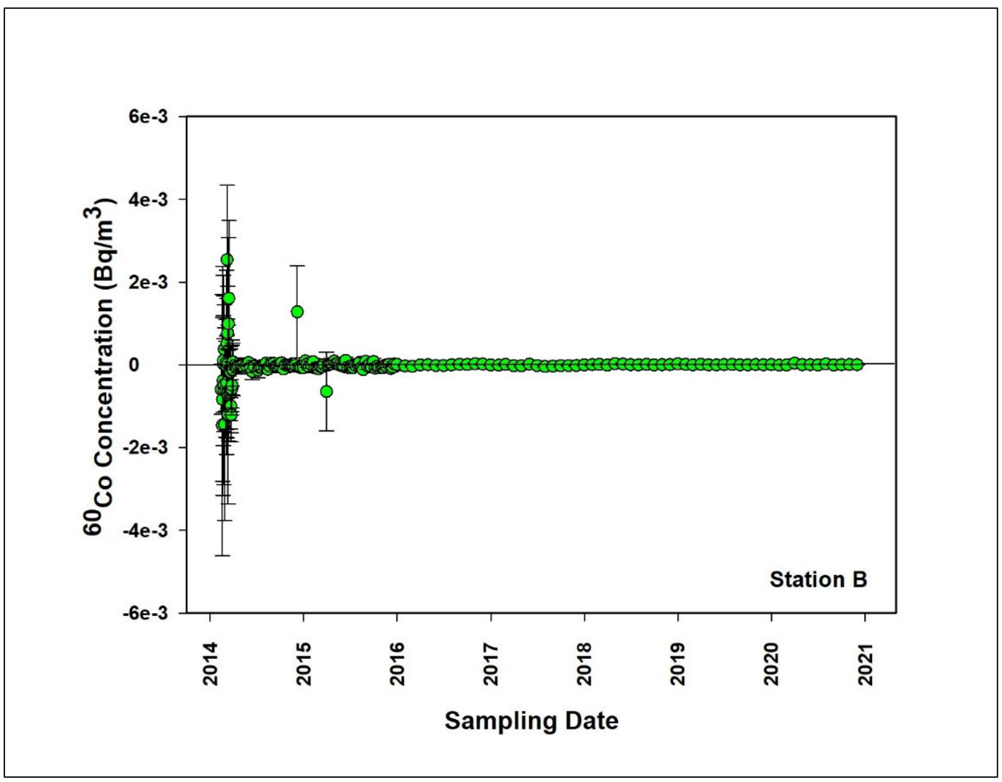


Figure 2.17. The ^{234}U and ^{238}U Activity Concentrations at Station B

2.2.10 Gamma Radionuclide Concentrations at Station B

The concentrations of the gamma-emitters ^{137}Cs, ^{60}Co, and ^{40}K in Station B filter samples are shown in Figure 2.18. No detectable gamma-emitting radionuclides were observed in any of the filter samples collected from Station B in 2020, which is consistent with the previous report. The concentrations and specific activities of these gamma-emitting radionuclides are summarized in Appendix A, Tables A.23 through A.28.


6e-3
4e-3
2e-3
0
-2e-3
-4e-3
-6e-3
137Cs Concentration (Bq/m3)
2014
2015
2016
2017
2018
2019
2020
2021
Sampling Date


6e-3
4e-3
2e-3
0
-2e-3
-4e-3
-6e-3
60Co Concentration (Bq/m3)
Station B
2014
2015
2016
2017
2018
2019
2020
2021
Sampling Date

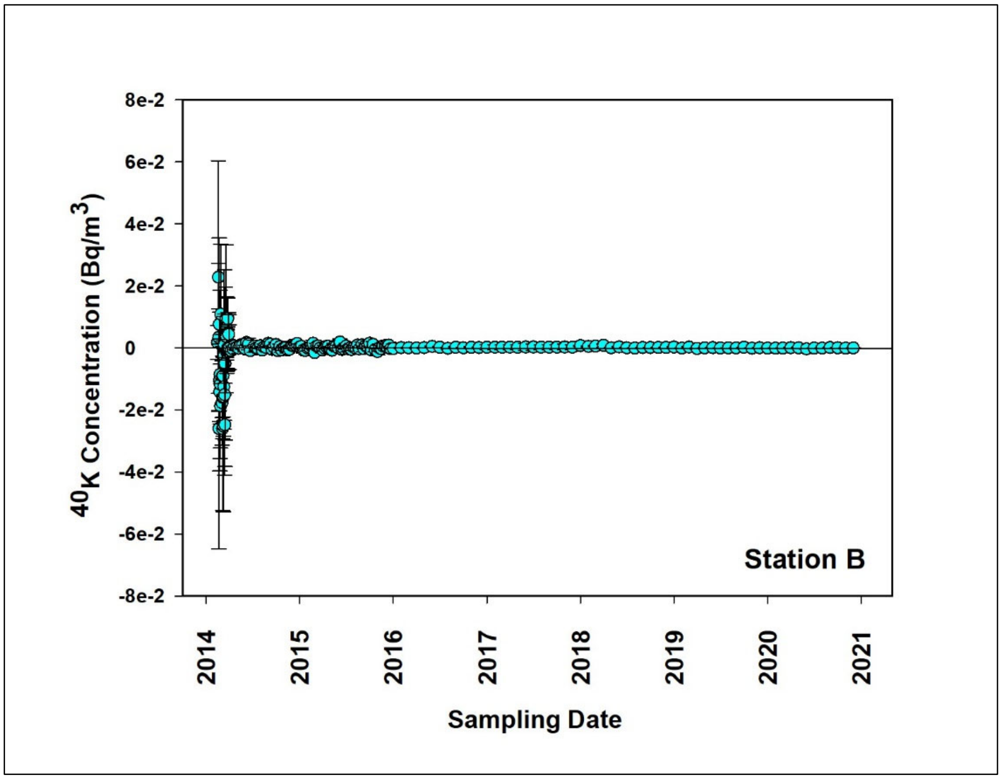


Figure 2.18. The Concentrations of Gamma Emitting Radionuclides ^{137}Cs, ^{60}Co, and ^{40}K at Station B

2.2.11 Historical Concentrations of Actinides at Station B

Before the 2014 accidental release, the concentrations of ^{241}Am and $^{239+240}Pu$ were all below the MDC. Since CEMRC was not performing Station B analyses before the events, the WIPP contractor's NWP data were used to show the historical trend (ASER Report, wipp.energy.gov). It should be noted that quarterly composite samples were used from 1999 until 2013 by the NWP to determine the actinides. The current concentrations of ^{241}Am and $^{239+240}Pu$ at Station B are close and, in some instances, below the corresponding MDC values.

2.2.12 Strontium Concentrations at Station B

The beta-radiation-emitting radionuclide ^{90}Sr was not detected in any of the monthly composite samples during 2020.

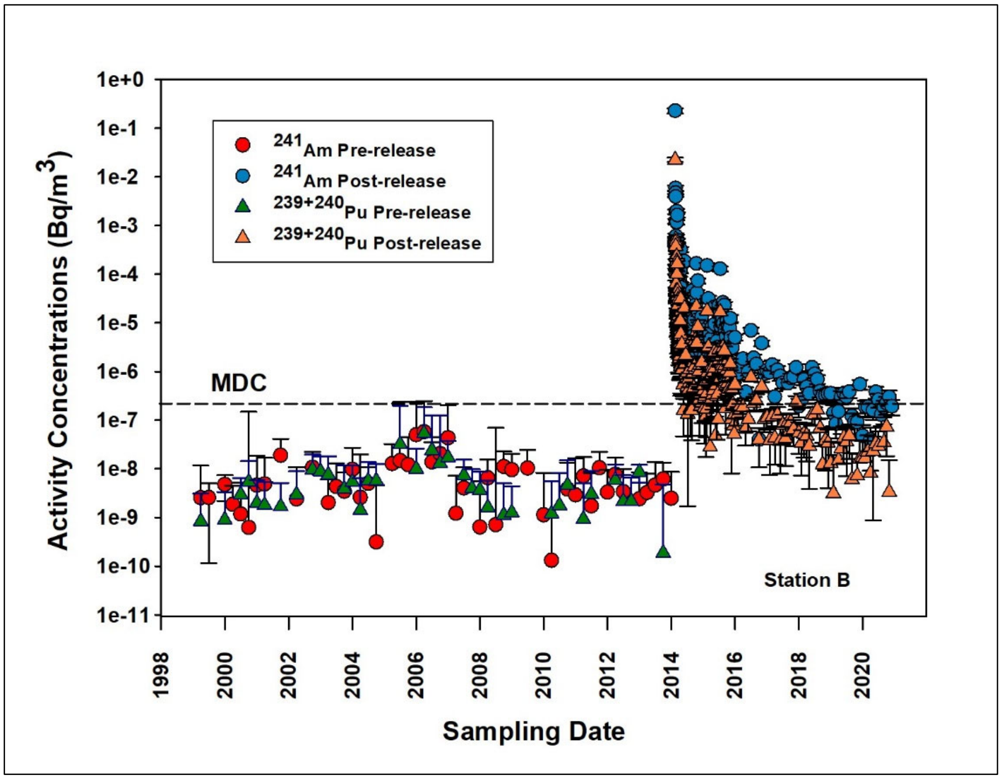


Figure 2.19. Historical Concentrations of $^{239+240}$Pu and ^{241}Am at Station B

2.3 Conclusion

This chapter provides an overview of the effluent air-monitoring program results for the calendar year 2020. During this monitoring period, the alpha activity at Station A ranged from below the minimum detectable concentration (MDC) to 28.48 mBq/m^3, with a mean value of 0.24±0.03 mBq/m^3. Similarly, the beta activity ranged from below the MDC to 3.94 mBq/m^3, with a mean value of 0.84±0.04 mBq/m^3. These levels indicate that the gross alpha and beta activities have returned to levels consistent with pre-release conditions in recent years.

The activity concentrations of actinides at Station A were within the range of 0.0018-1.01 mBq/m^3 for ^{241}Am, 0.00-0.11 mBq/m^3 for $^{239+240}$Pu, and 0.002-0.038 mBq/m^3 for ^{238}Pu. At Station B, the activity concentrations of actinides varied from 0.0004-0.0038 mBq/m^3 for ^{241}Am and -0.0001-0.0007 mBq/m^3 for $^{239+240}$Pu. These levels remained lower than those measured in previous years.

As expected, some monthly composite samples collected from Station A revealed the presence of naturally occurring isotopes of uranium (U). However, no uranium isotopes were detected in any of the Station B composite samples. Gamma radionuclides were also not detected in any of the weekly/monthly composite samples from both Station A and Station B. It is worth noting CEMRC's historical operational data showed occasional detections of ^{40}K at Station A. ^{40}K is a naturally occurring gamma-emitting radionuclide found in soils, and its occasional detection in the WIPP exhaust air samples is expected due to its ubiquitous presence. The beta-radiation-emitting radionuclide ^{90}Sr was not detected in any of the weekly composite samples from Station A, while at Station B it was not detected in any monthly composite samples.

These findings demonstrate the effectiveness of the monitoring program in ensuring that effluent air emissions from the WIPP facility remain within acceptable limits, with activities consistently below the established thresholds for alpha, beta, and gamma radionuclides.

CHAPTER 3 - AIRBORNE PARTICULATE MONITORING

Airborne particulate monitoring plays a crucial role in CEMRC's comprehensive environmental monitoring program. It encompasses the monitoring of the air in and around the WIPP facility, aiming to detect routine releases as well as unforeseen events, ensuring compliance with public radiological dose limits. The collected data can be used to assess any potential impacts on the environment over time and as a precautionary measure in the case of any accidental radioactivity release.

CEMRC maintains a network of continuously operating samplers located at six strategic locations near the WIPP site and in the neighboring communities of Loving and Carlsbad. These sites are strategically chosen to cover the prevailing wind directions from the facility and to provide additional information to the residents in the event of a future radiation release, maintaining public confidence and assurance. Loving and Carlsbad are particularly important as they are the nearest communities to WIPP.

Previous studies have revealed a correlation between plutonium activity and the concentration of aluminum in ambient air particles. This correlation is attributed to the re-suspension of dust particles contaminated with radioactive fallout from historical nuclear weapons tests. Similar correlations have been observed for americium and aluminum. Soil studies conducted in and around the WIPP site have also shown correlations among aluminum and naturally occurring and bomb-derived radionuclides, $^{239+240}$Pu (Kirchner et al., 2002)

The current scope of work involves the collection of particulate samples at frequencies determined by mass loading and airflow from all monitoring locations. These individual samples undergo analysis to determine the total suspended particulates collected and to quantify gamma-emitting radionuclides and relevant actinides. Further details regarding the sample collection and analysis methodologies are provided in the following sections.

3.1 Sample Collection

Particulates in the ambient air are collected using high-volume samplers (“HiVols,” flow rate approximately 1.13 m^3/min) from six monitoring stations. These stations are at the following locations. (1) Onsite, which is 0.1 km northwest of the WIPP exhaust shaft; (2) the East Side of the WIPP facility; (3) Near-Field, about 1 km northwest of the facility; (4) Cactus Flats, about 19 km southeast of the WIPP site; (5) Carlsbad (behind the CEMRC facility); and (6) the south side of Loving, about 25 km southeast of the facility. These samplers are primarily located in the prevailing downwind direction and were selected based on an analysis of probable wind direction and speed scenarios in the event of an accident involving a release of radioactivity during the operation of WIPP. Ambient air sampling locations and the typical high-volume air sampling station are shown in Figure 3.1.

Particulates in the ambient air were collected on 20×25 cm A/E^{TM} glass fiber filters with a pore size of 1 µm (Pall German Laboratory, Ann Arbor, MI, USA). A typical sampling period lasts about three to four weeks depending on the levels of particulate matter that accumulates on the filters. These samplers are operated to maximize particulate loading without impacting airflow; if the flow rate drops to 0.99 m^3/min, the filters are changed. Filter change-outs also occur in the event of a power outage or if a sampler stops due to some mechanical issue. Each filter is weighed before and after sampling to determine the mass of the aerosol material collected. Actinide analyses are performed on individual filters by CEMRC. The sampling height of each aerosol station is approximately 5 m from the ground.

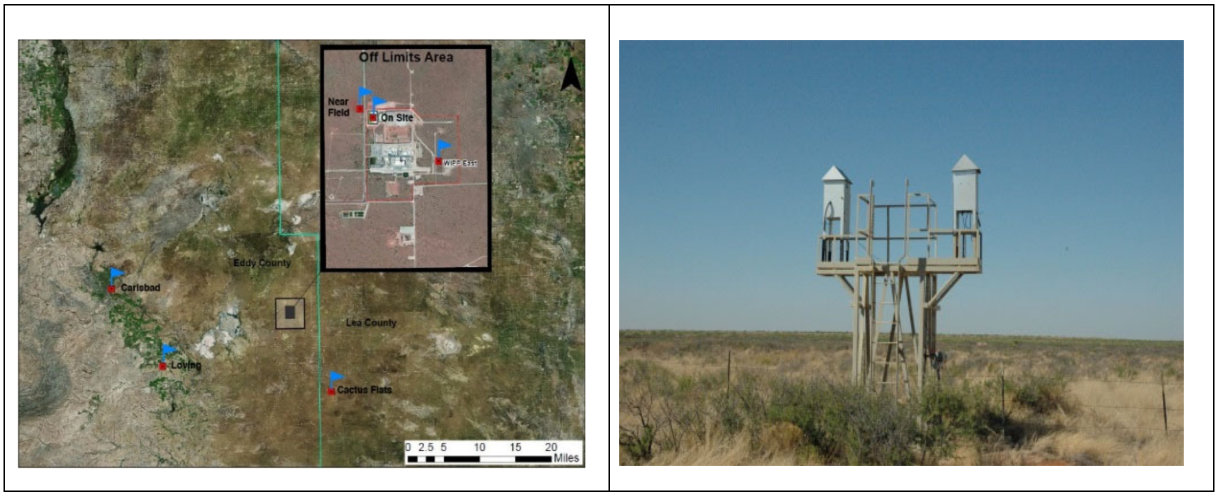


Figure 3.1. Ambient Air Sampling Locations Map (left) and Typical High-Volume Sampling Station (right)

3.2 Sample Preparation and Analysis

The individual filters are heated in a muffle furnace at 500 °C for six hours. Filter samples for radiochemical analysis are prepared by wet digestion with nitric acid (HNO_3), hydrochloric acid (HCl), and hydrofluoric acid (HF) until completely dry. The mixture is then heated with concentrated perchloric acid ($HClO_4$) to ensure that all residual HF is removed from the sample matrix. The residues are then dissolved in 1.0 M HCl for subsequent radionuclide separation and analysis. The activity measured is multiplied by two to account for the total activity in the filter.

3.3 Radiochemical Analysis

The acid digestate from the filter samples is then split into two fractions. One-half of each sample is used for gamma analysis of ^{137}Cs, ^{60}Co, and ^{40}K. The other half is analyzed for actinides after $Fe(OH)_3$ co-precipitation and separation occurs using an anion exchange and chromatography column as described in previous CEMRC reports (http://www.cemrc.org/annual-reports). Gamma-emitting radionuclides in the ambient air filters are measured by gamma spectroscopy for 48 hours, while alpha-emitting radionuclides are measured using alpha spectroscopy (Mirion Technologies Inc, San Ramon, CA, USA) for five days as per CEMRC's standard counting protocol. Portions of digested solutions containing strontium are co-precipitated with barium as a carbonate, then dissolved in nitric acid and barium precipitated out as chromate. The supernatants obtained are mixed with ammonium hydroxide (NH_4OH) and saturated ammonium carbonate $(NH_4)_2CO_3$ to precipitate strontium as strontium carbonate ($SrCO_3$), and the beta-radiation-emitting radioactive isotope ^{90}Sr is then counted by liquid scintillation counting. Details are described in procedure WL-1011

3.4 Results and Discussion

The activities of the actinides and gamma-emitting radionuclides in air samples are reported in the following two ways. Activity Concentration in Bq/m^3 and Specific Activity (Bq/g). Activity Concentration is calculated as the activity of radionuclides reported in Becquerel (Bq) divided by the volume of air in cubic meters (m^3). Specific Activity is calculated as the activity of radionuclides reported in Becquerel (Bq) divided by the aerosol mass collected on the filter in grams (g).

3.4.1 Actinide Concentrations in Ambient Air

The concentrations of ^{241}Am and $^{239+240}$Pu slightly above the MDC were detected in a few ambient air samples at all monitoring stations, while ^{238}Pu was detected above the MDC in only one air filter sample at the Onsite station. Detecting these radionuclides generally depends on the amount of dust collected on the filters. More dust is collected during dry and windy seasons, typically from March to June. Therefore, during most years studied, the positive detections of $^{239+240}$Pu or ^{241}Am occur during the March to June timeframe, which is when strong and gusty winds in the area frequently give rise to blowing dust. The concentrations of $^{239+240}$Pu measured were in the range of -5.04E-09 to 3.64E-08 Bq/m^3 at the onsite station, -9.08E-09 to 5.05E-08 Bq/m^3 at the Near Field station, 2.07E-09 to 3.54E-08 Bq/m^3 at the Cactus Flats station, 2.08E-09 to 3.70E-08 Bq/m^3 at the Loving station, 1.37E-09 to 5.58E-08 Bq/m^3 at the Carlsbad station, and 0.00 to 5.74E-08 Bq/m^3 at the WIPP's east station. The corresponding concentrations of ^{241}Am were in the range from 4.45E-09 to 1.32E-07 Bq/m^3 at the onsite station, -1.76E-09 to 1.52E-07 Bq/m^3 at the Near Field station, -1.29E-09 to 2.21E-08 Bq/m^3 at the Cactus Flats station, -1.60E-09 to 1.16E-07 Bq/m^3 at the Loving station, 4.12E-09 to 2.97E-08 Bq/m^3 at the Carlsbad station, and -3.62E-09 to 3.21E-08 Bq/m^3 at the WIPP's east station.

The WIPP's historical ambient air monitoring data indicate frequent detection of $^{239+240}$Pu and ^{241}Am in ambient aerosol samples collected on filters around the WIPP. The detection of ^{238}Pu is relatively infrequent because the origin of this radionuclide is not primarily weapons fallout but rather the burn-up of nuclear-powered satellites, such as the SNAP-9A (Hardy et al., 1973, Harley 1980). Peaks in the $^{239+240}$Pu and ^{241}Am activity concentrations in aerosol samples from the three study sites, as mentioned previously, generally occur from March to June. The observed seasonality in Pu and Am activity concentrations in the WIPP environment is, therefore, attributable to the re-suspension of contaminated soil dust. Furthermore, ^{241}Am and $^{239+240}$Pu activities were highly correlated, and their concentrations were similar at all stations. Figures 3.2 and 3.3 show the concentrations of $^{239+240}$Pu and ^{241}Am at the Cactus Flats, Near Field, and Onsite monitoring stations, while Figures 3.4 and 3.5 show the concentrations of these two radionuclides at the Carlsbad, Loving, and WIPP east monitoring stations.

The concentrations of $^{239+240}Pu$, ^{241}Am, and ^{238}Pu in ambient air filters measured during 2020 are listed in Appendix B, Tables B.1 to B.3 for the Onsite Station, Tables B.4 to B.6 for the Near Field Station, Tables B.7 to B.9 for the Cactus Flats Station, Table B.10 for the Loving monitoring station, Table B.11 for the Carlsbad monitoring station, and Table B.12 for the WIPP East monitoring station.

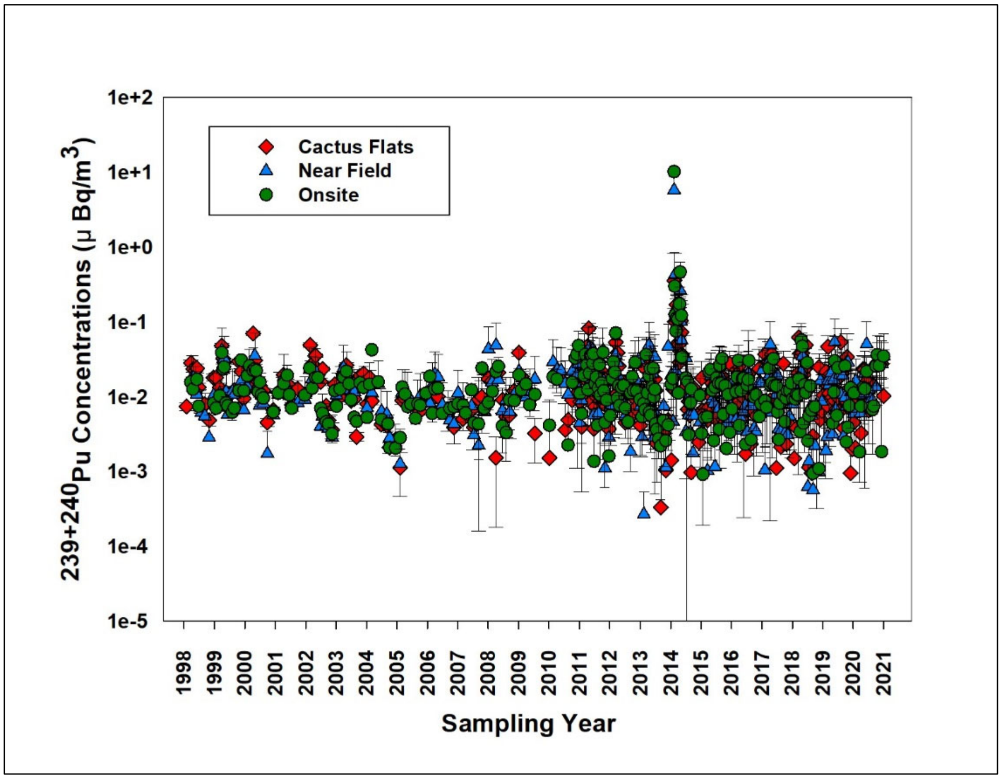


Figure 3.2. Historical $^{239+240}Pu$ Concentrations at the Cactus Flats, Near Field, and Onsite Stations

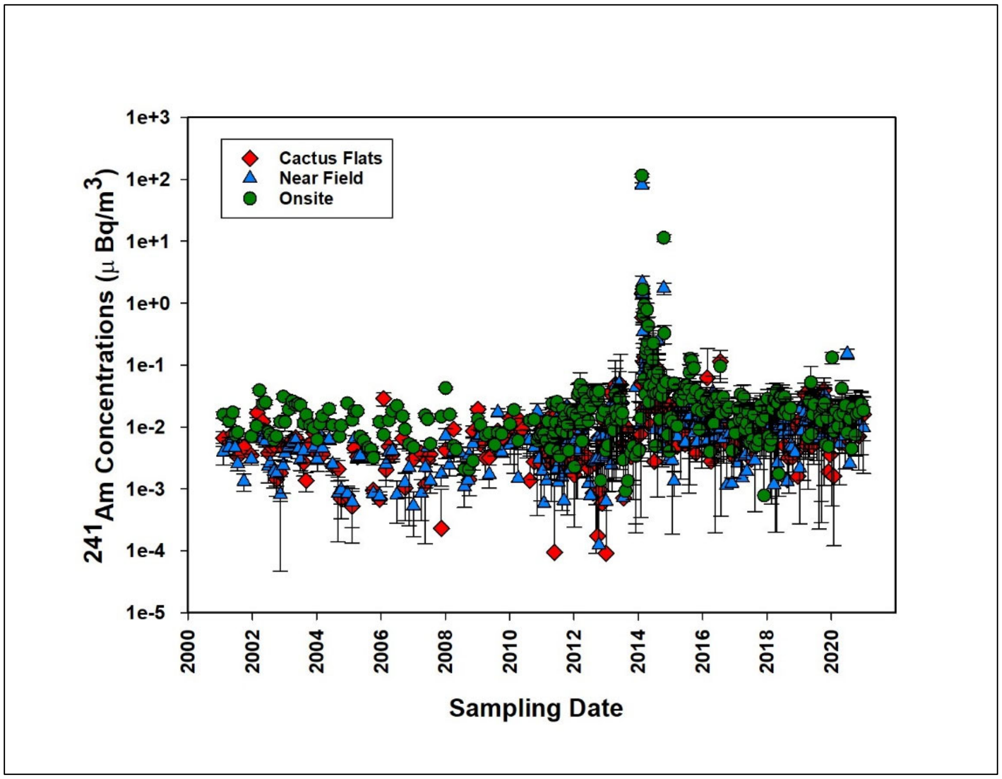


Figure 3.3. Historical ^{241}Am Concentrations at the Cactus Flats, Near Field, and Onsite Stations

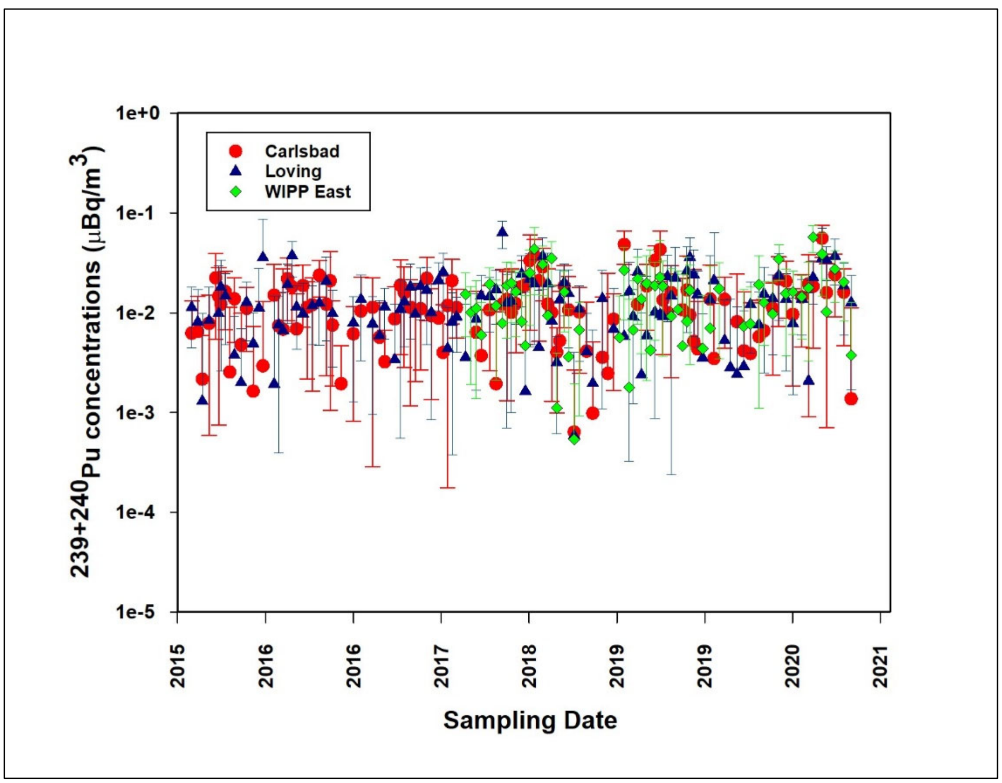


Figure 3.4. Historical $^{239+240}$Pu Concentrations at the Carlsbad, Loving. and WIPP East Stations

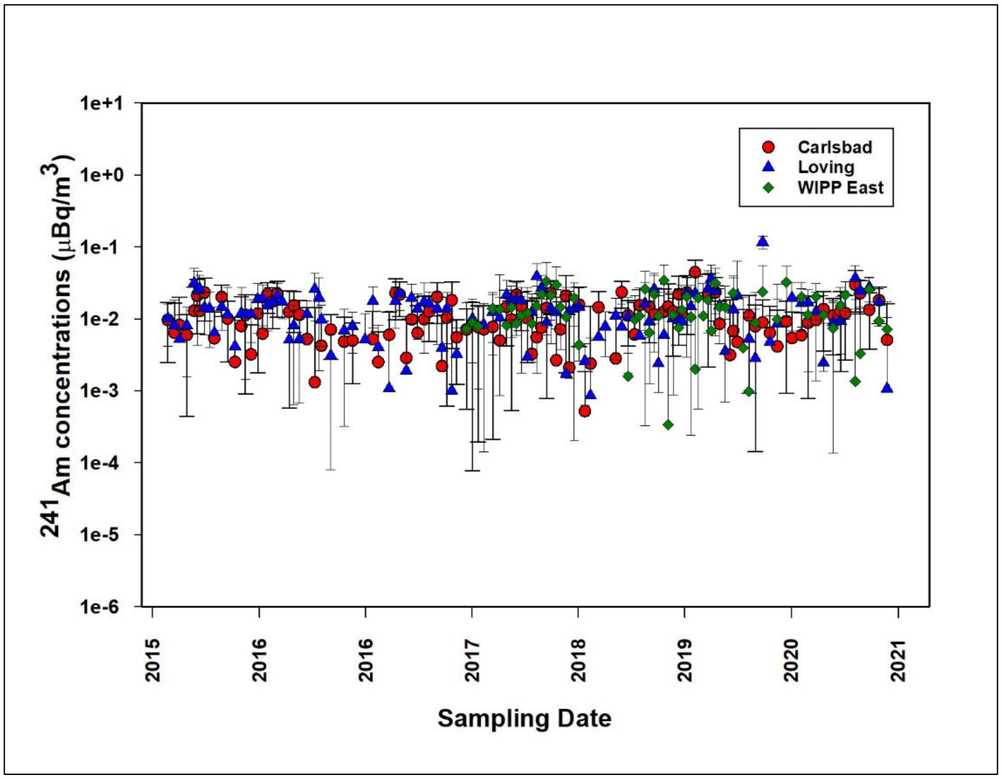


Figure 3.5. Historical ^{241}Am Concentrations at the Carlsbad, Loving, and WIPP East Stations

The $^{239+240}$Pu specific activities (activity per unit mass aerosol collected) were in the range of 0.00-0.44 mBq/g at the Onsite station, 0.00-0.82 mBq/g at the Near Field station, 0.08-0.47 mBq/g at the Cactus Flats station, 0.03-0.39 mBq/g at the Loving Station, 0.06-0.54 mBq/g at the Carlsbad station, and 0.00-0.72 mBq/g at the WIPP's east station. The ^{241}Am was in the range of 0.00-2.95 mBq/g at the Onsite station, 0.00-2.38 mBq/g at the Near Field station, 0.00-0.47 mBq/g at the Cactus Flats station, 0.00-2.24 mBq/g at the Loving Station, 0.10-0.32 mBq/g at the Carlsbad station, and 0.00-0.56 mBq/g at the WIPP's East station. The aerosol mass loadings recorded in these sampling stations were in the range from 0.74-2.83 g at the Onsite, 0.61-2.15 g at the Near Field, 0.68-2.46 g at the Cactus Flats, 0.85-2.96 g at the Loving station, 0.48-2.33 g at the Carlsbad station, and 0.50-2.28 g at the WIPP's East station. The mass loadings at all stations tend to track one another remarkably well as shown in Figure 3.6 for the Onsite, Near Field, and Cactus Flats monitoring stations and Figure 3.7 for for the Carlsbad, Loving, and WIPP east monitoring. The specific activities of $^{239+240}$Pu, ^{241}Am, and ^{238}Pu in ambient air filters during 2020 are listed in Appendix B Tables B.13 to B.15 (Onsite Station), Tables B.16 to B.18 (Near Field Station), Tables B.19 to B.21 (Cactus Flats Station), Table B.22 (Loving station), Table B.23 (Carlsbad Station) and Table B.24 (WIPP's East Tower).

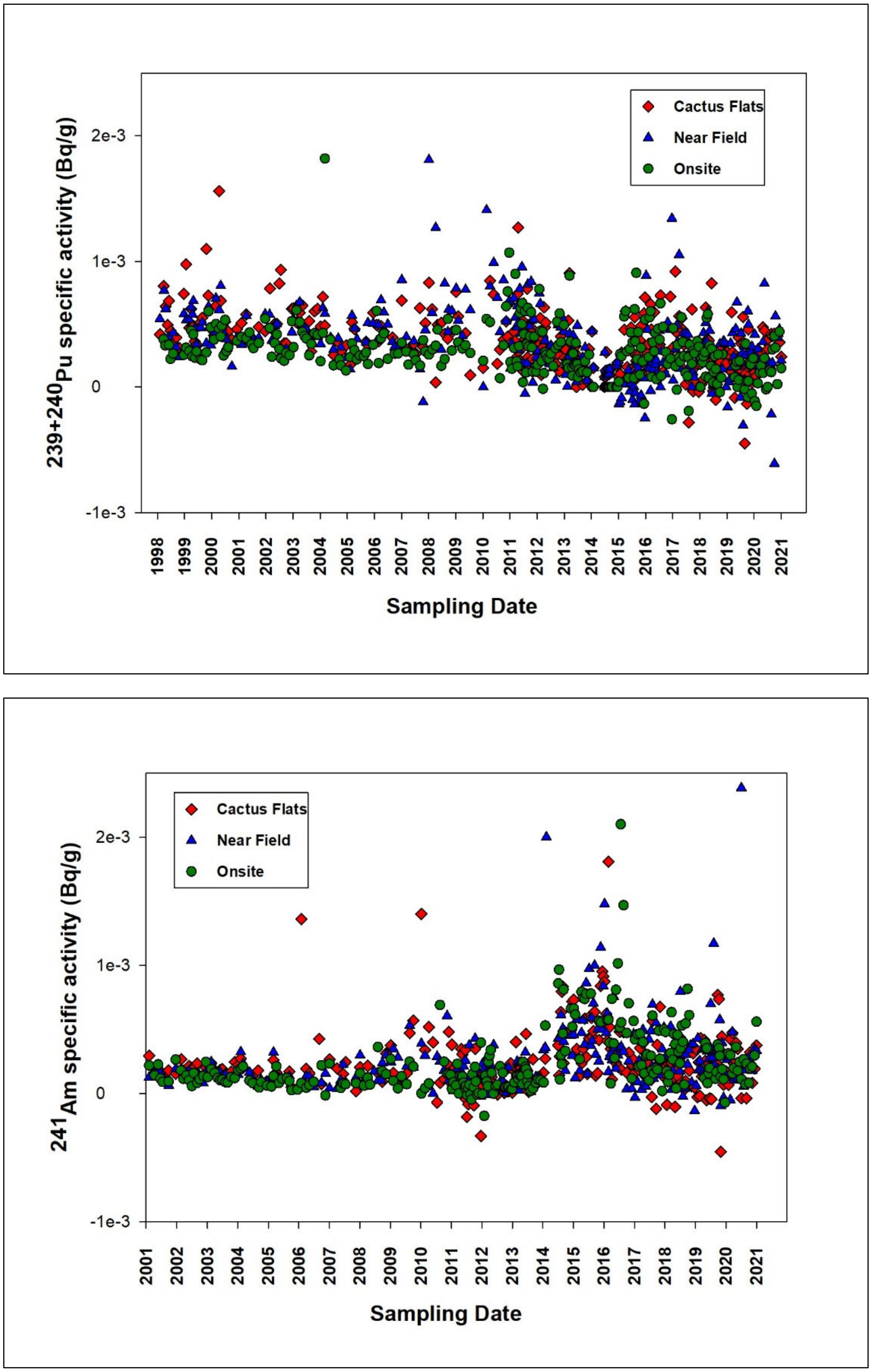


Figure 3.6. Historical $^{239+240}Pu$ and ^{241}Am Specific Activities at the Cactus Flats, Near Field, and Onsite Stations

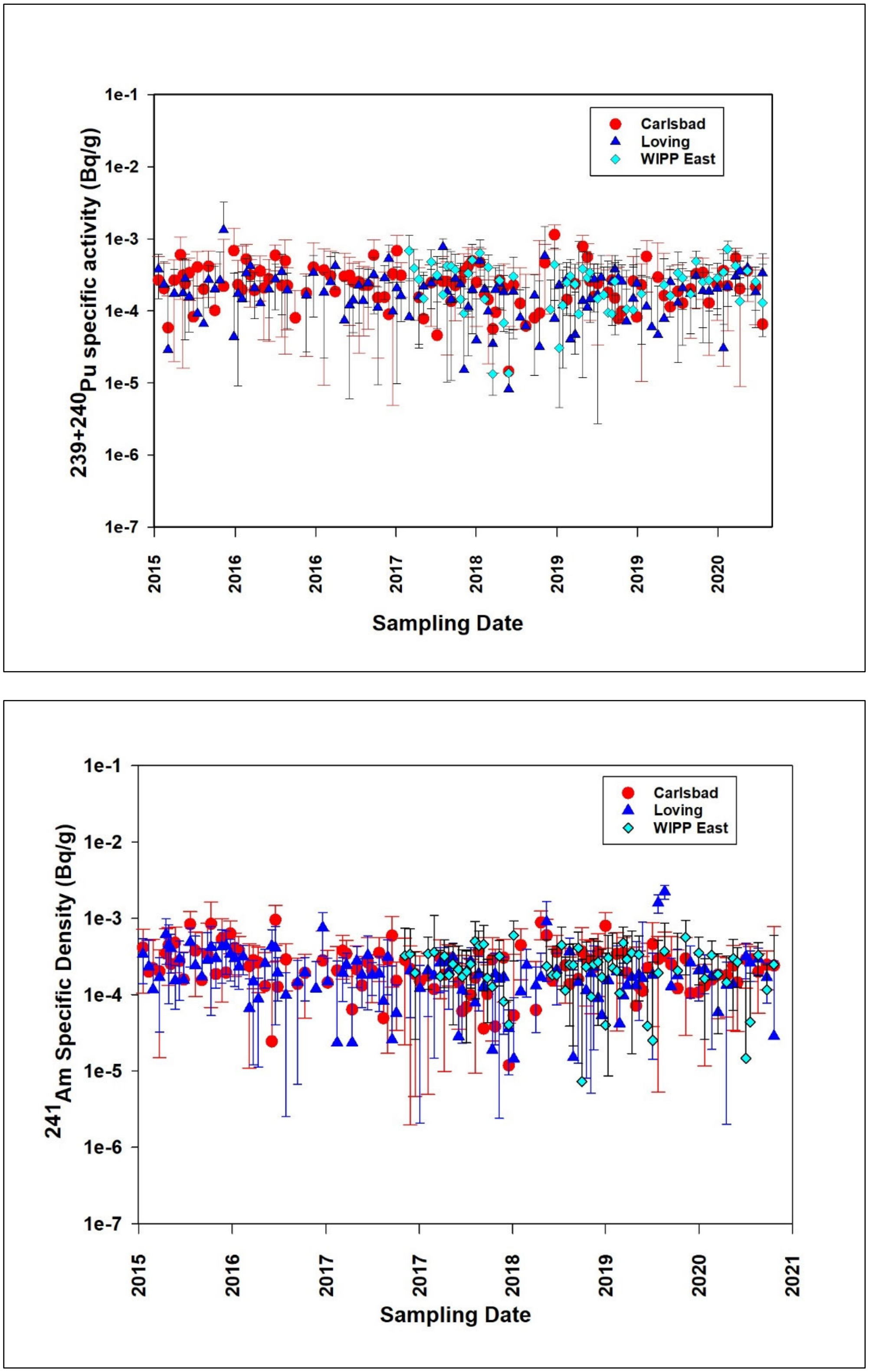
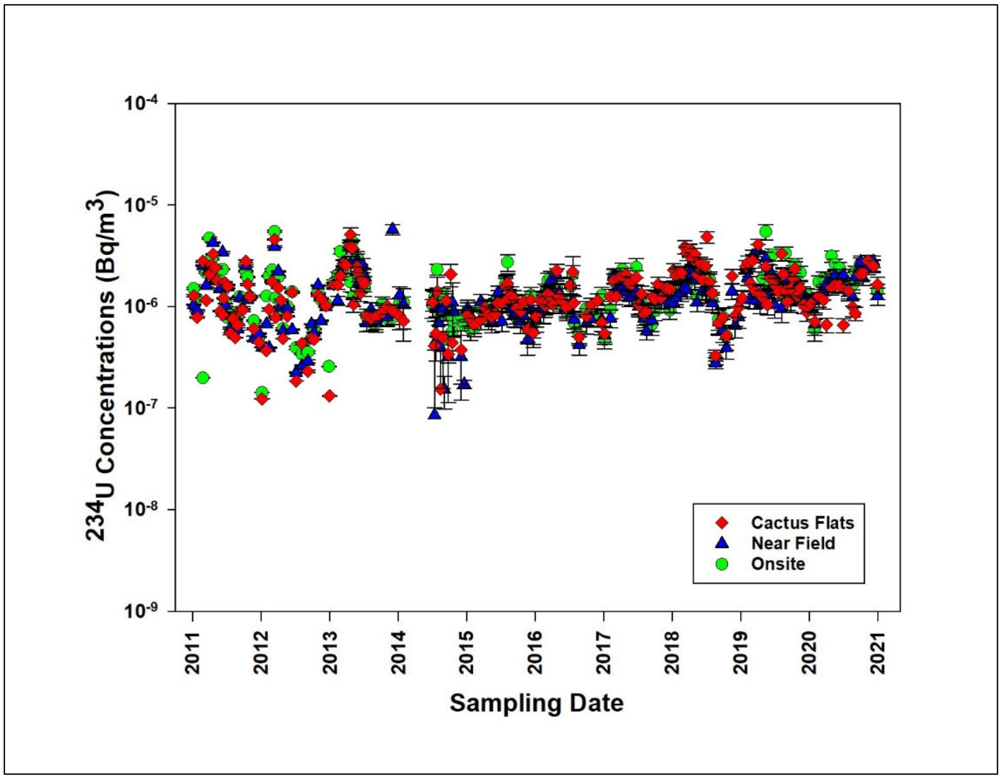
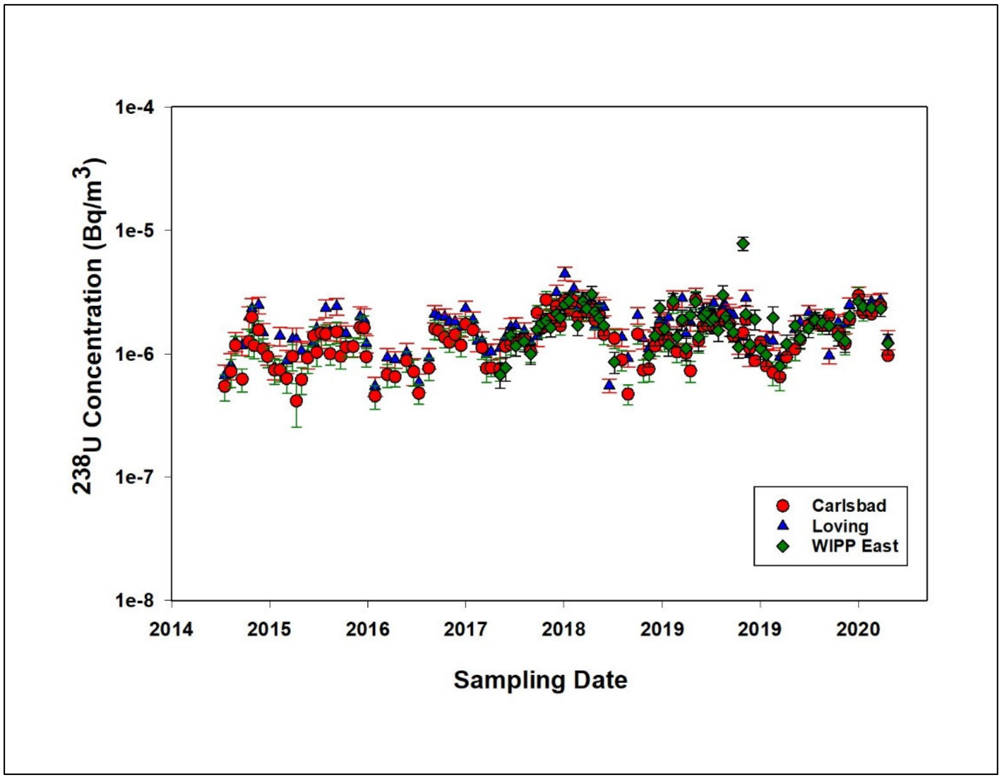


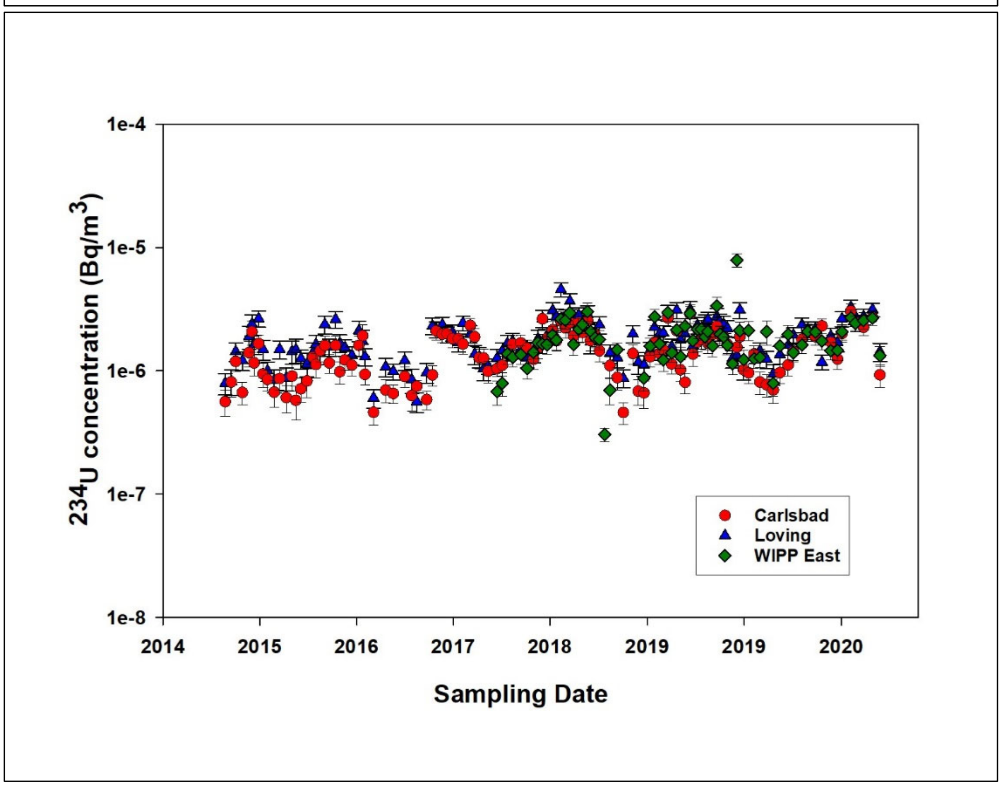
Figure 3.7. Historical $^{239+240}$Pu and ^{241}Am Specific Activities at the Carlsbad, Loving, and WIPP East Stations

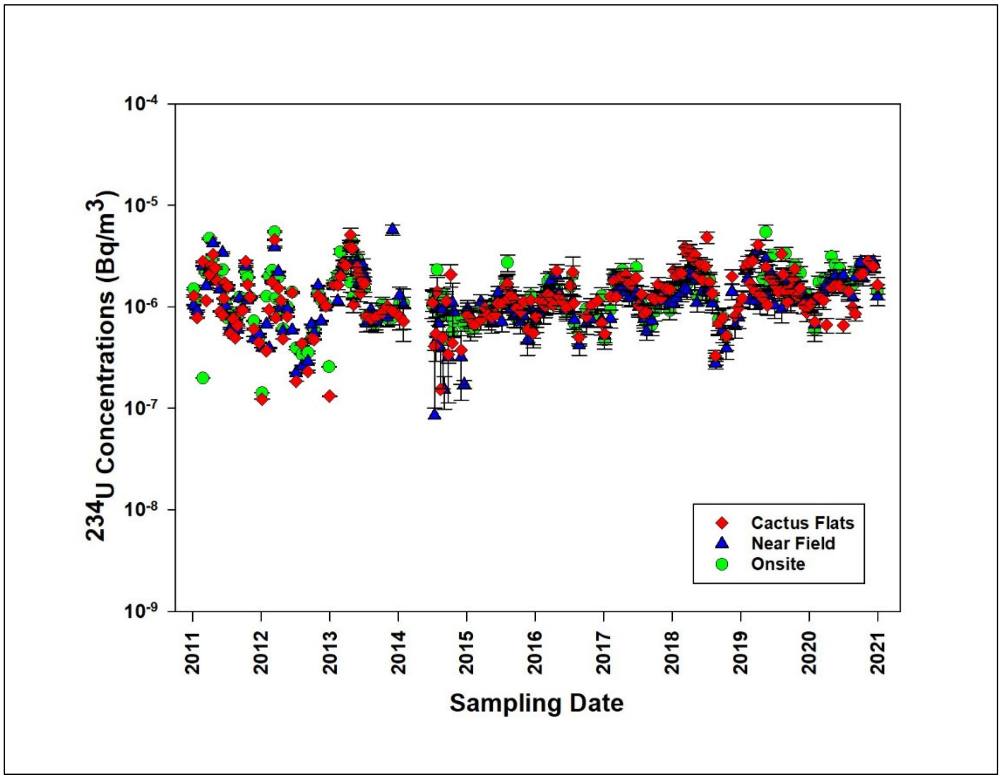
3.4.2 Uranium Concentrations in Ambient Air

Uranium isotopes were detected in all samples and at all sampling locations in 2020. Uranium occurs naturally in all rocks and soil with typical background levels ranging from approximately 2 to 4 mg/kg (Ahrens 1965, Wedepohl 1968). Thus, the detection of U in ambient air is normal. Natural sources of U in ambient air include re-suspended soil, volcanic eruptions (ATSDR 1999; Kuroda et al. 1984), and airborne particulates from coal and fuel combustion. The concentrations of uranium isotopes measured in ambient air samples are shown in Figure 3.8 for the Onsite, Near Field, and Cactus Flats stations and Figure 3.9 for for the Loving, Carlsbad, and WIPP East Tower.




1e-4
1e-5
1e-6
1e-7
1e-8
238U Concentration (Bq/m3)
2014
2015
2016
2017
2018
2019
2019
2020
Sampling Date
Carlsbad
Loving
WIPP East


1e-4
1e-5
1e-6
1e-7
1e-8
234U concentration (Bq/m3)
2014
2015
2016
2017
2018
2019
2019
2020
Sampling Date
Carlsbad
Loving
WIPP East



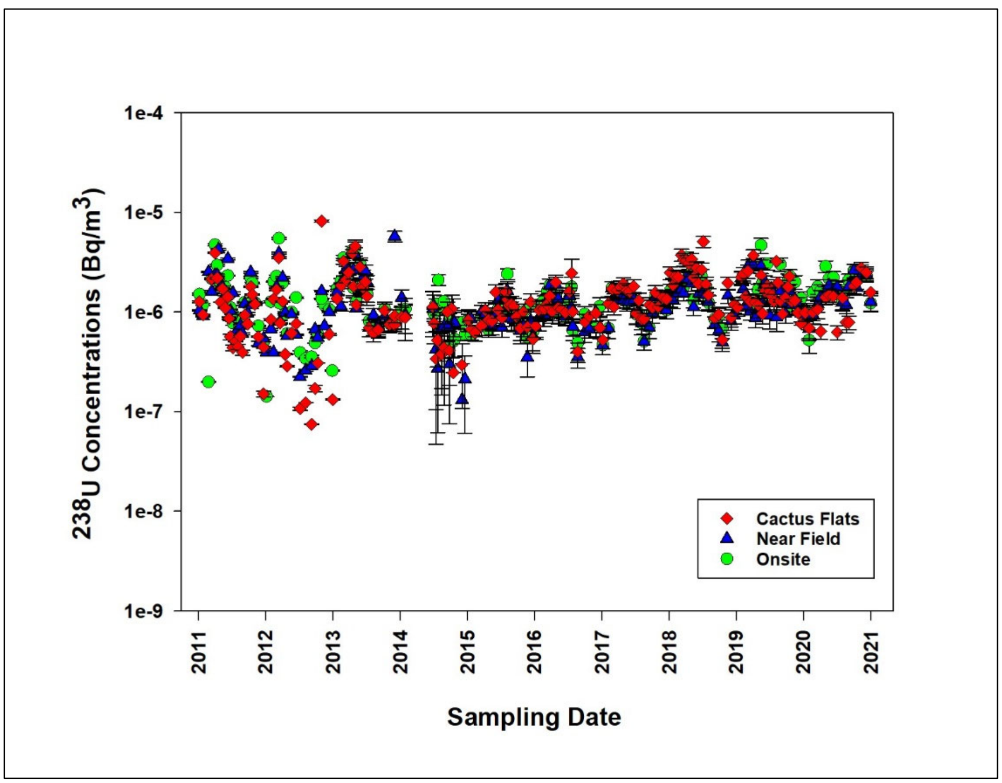
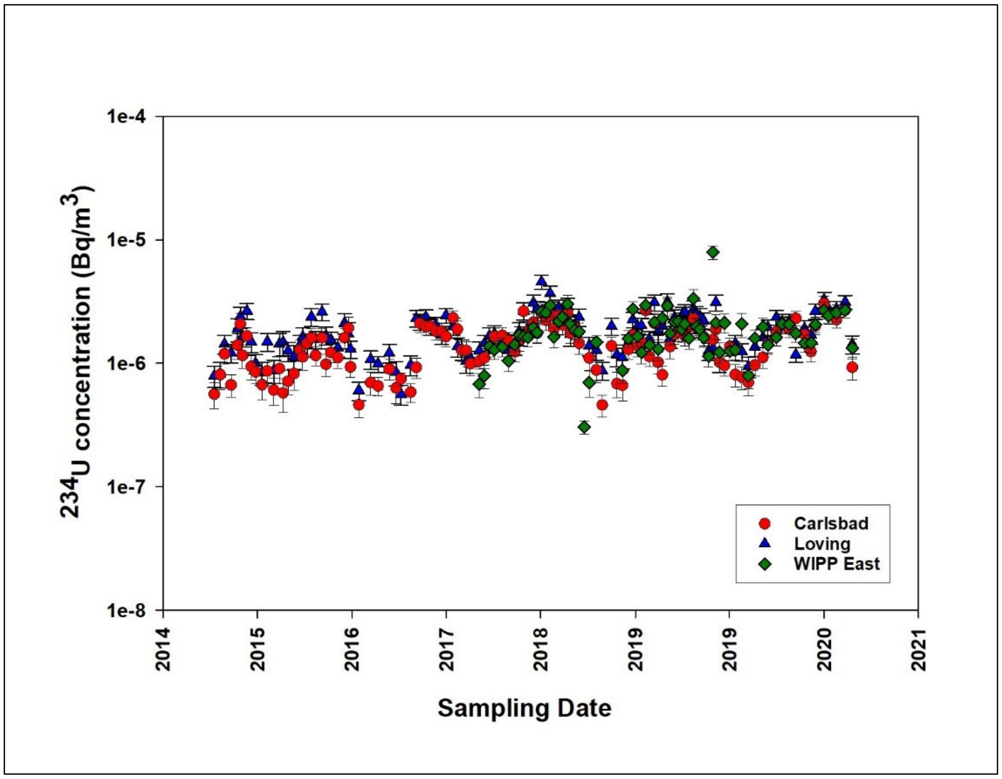


Figure 3.8. ^{234}U and ^{238}U Concentrations at the Onsite, Near Field, and Cactus Flats Stations



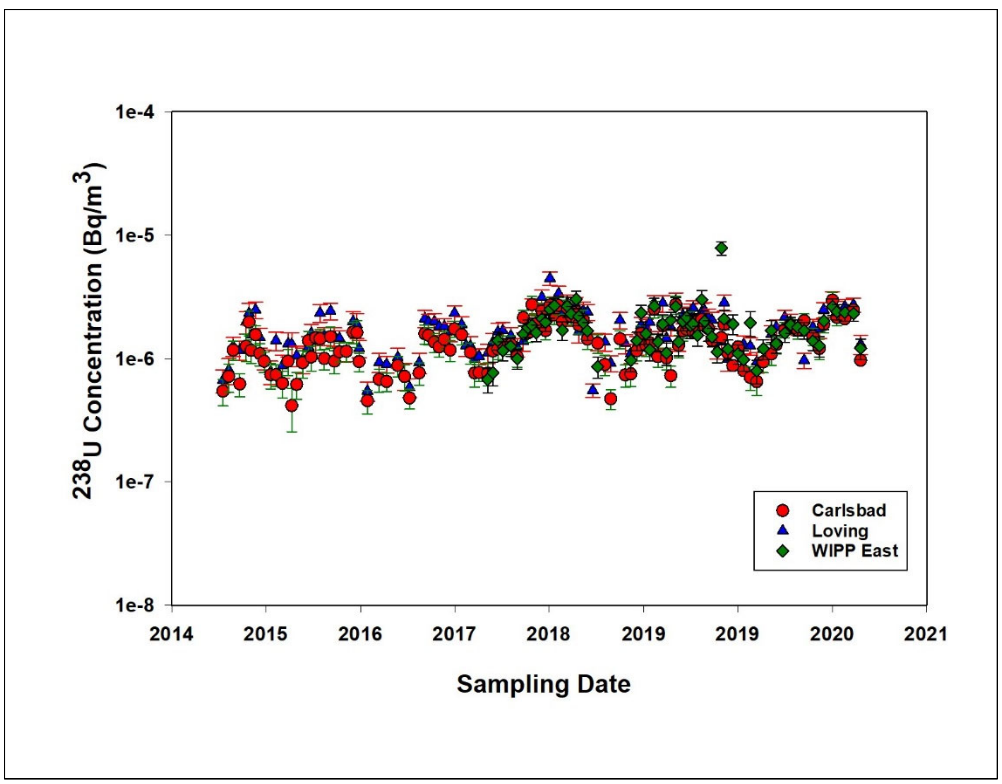


Figure 3.9. ^{234}U and ^{238}U Concentrations at the Carlsbad, Loving, and WIPP East Stations

The concentrations of ^{238}U measured were in the range of 5.23E-07 to 2.87E-06 Bq/m^3 at the Onsite station, 6.78E-07 to 2.60E-06 Bq/m^3 at the Near Field station, 6.26E-07 to 2.76E-06 Bq/m^3 at the Cactus Flats station, 9.37E-07 to 3.04E-06 Bq/m^3 at the Loving station, 6.49E-07 to 2.96E-06 Bq/m^3 at the Carlsbad station, and 7.93E-07 to 2.65E-06 Bq/m^3 at the WIPP's East Tower. The corresponding concentrations of ^{234}U were in the range of 6.00E-07 to 3.14E-06 Bq/m^3 at the Onsite station, 6.74E-07 to 2.79E-06 Bq/m^3 at the Near Field station, 6.58E-07 to 2.81E-06 Bq/m^3 at the Cactus Flats station, 9.41E-07 to 3.28E-06 Bq/m^3 at the Loving station, 6.98E-07 to 3.04E-06 Bq/m^3 at the Carlsbad station, and 7.93E-07 to 2.70E-06 Bq/m^3 at the WIPP's East Tower. There was no significant difference in the concentrations of U isotopes among locations. The individual concentrations of uranium isotopes in ambient air samples are summarized in Appendix B, Tables B.25 through B.30.

Uranium ratios are used to determine the type of uranium present in the environment. Natural uranium has a $^{235}U/^{238}U$ ratio of 0.00725 and $^{234}U/^{238}U$ ratio of 1.0. The average annual $^{234}U/^{238}U$ ratios at the sites are consistent with naturally occurring U. The specific activities of U isotopes measured in the ambient air at all the monitoring locations are listed in Appendix B, Tables B.31 through B.36.

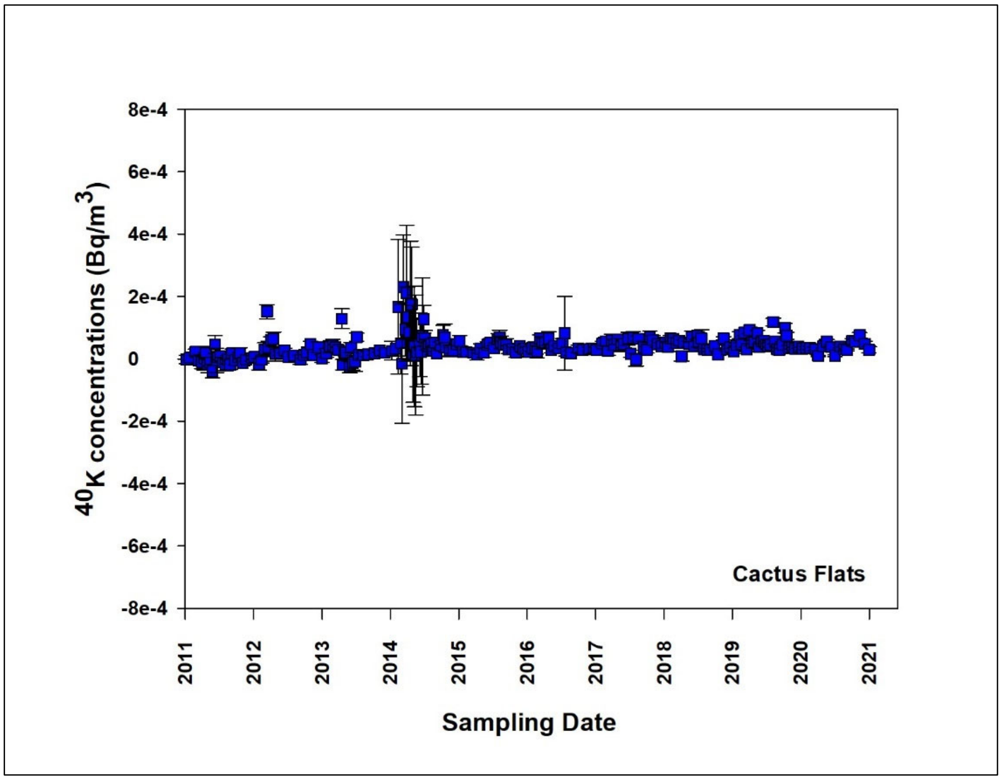
3.4.3 Gamma Radionuclide Concentrations in Ambient Air

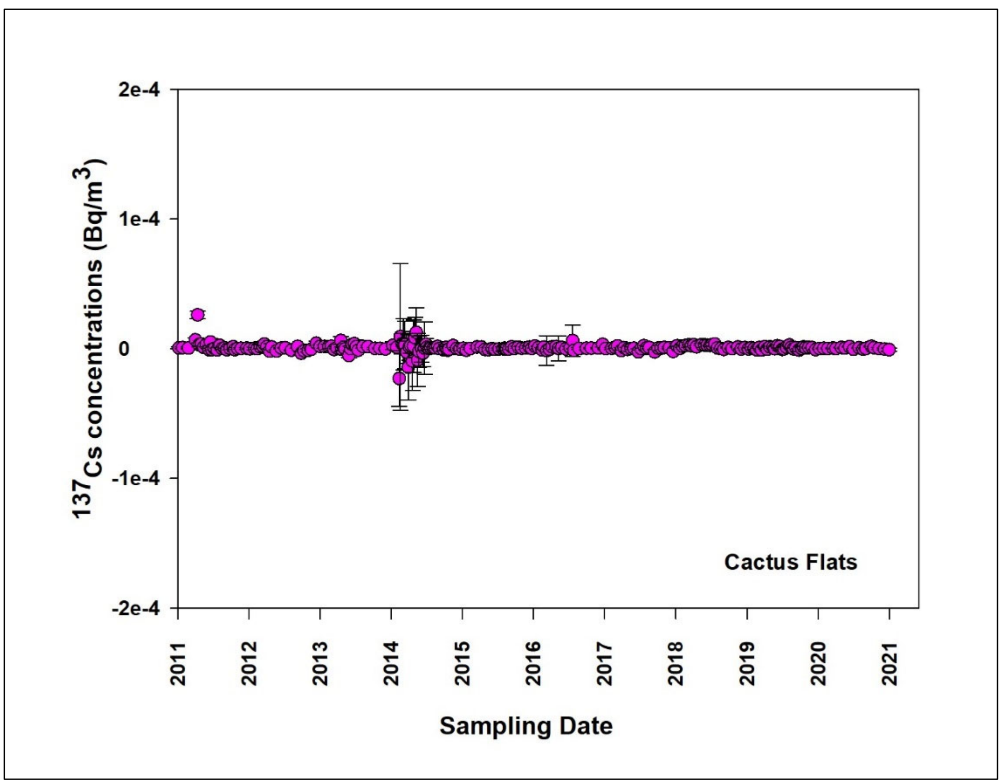
The gamma-radiation-emitting radionuclide ^{40}K was detected in most ambient air samples at all monitoring stations, while ^{137}Cs was detected 3 times at Onsite, twice at Cactus Flats, once in Loving, once in Carlsbad, and once at WIPP's East Station, and ^{60}Co was only detected once in WIPP's East Station. The ^{40}K is ubiquitous in the earth's crust and thus would be expected to show up in environmental air samples. On the other hand, ^{137}Cs is a fallout radionuclide and is expected to be detected from time to time in air samples depending on the dust loading on the filters.

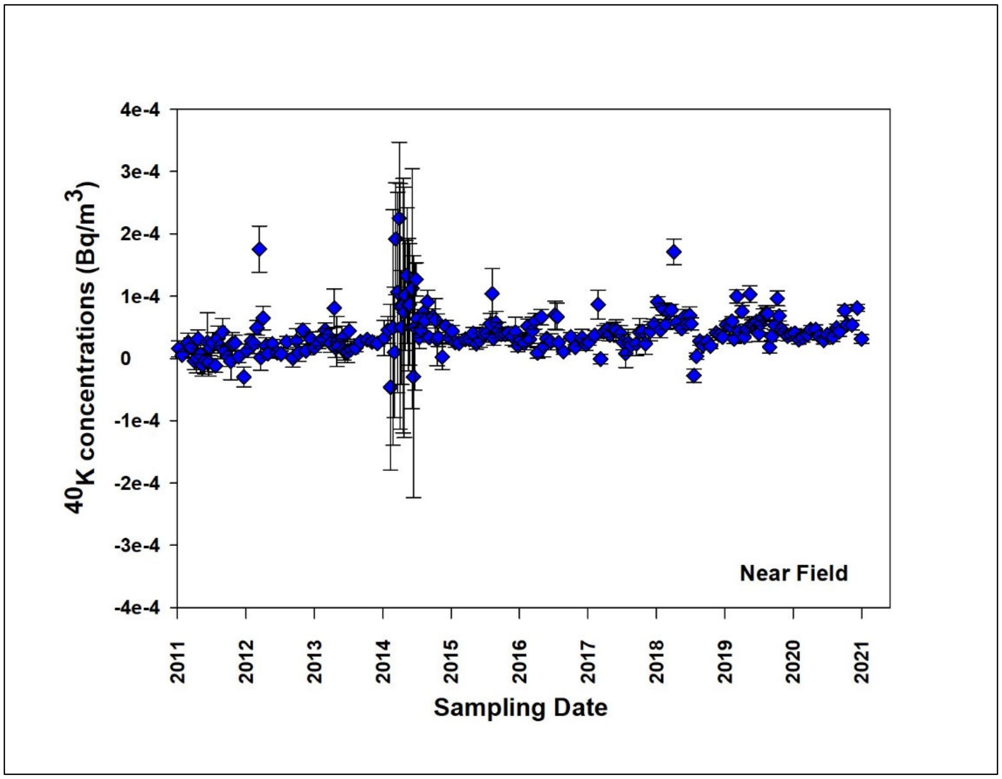
The ^{40}K concentrations measured were in the range of -2.21E-7 to 7.52E-5 Bq/m^3 at the Onsite station, 2.91E-5 to 8.09E-5 Bq/m^3 at the Near Field station, 9.46E-6 to 7.61E-5 Bq/m^3 at the Cactus Flats station, -5.37E-6 to 8.29E-5 Bq/m^3 at the Loving station, 1.98E-5 to 1.08E-4 Bq/m^3 at the Carlsbad station and -2.63E-5 to 1.31E-4 Bq/m^3 at the WIPP's east station. The detection of ^{137}Cs was less frequent than ^{40}K.

The number of ^{137}Cs detections was none at the Near Field station; one at the Loving, Carlsbad, and WIPP's east stations, three at the Onsite, and two at the Cactus flats station. The concentrations measured were in the range of -6.05E-7 to 2.58E-6 Bq/m^3 at the Onsite station, -5.52E-5 to 1.41E-6 Bq/m^3 at the Near Field station, -6.95E-7 to 1.91E-6 Bq/m^3 at the Cactus Flats station, -1.24E-6 to 1.35E-6 Bq/m^3 at the Loving station, -8.62E-7 to 1.46E-6 Bq/m^3 at the Carlsbad station, and -1.44E-6 to 3.33E-6 Bq/m^3 at the WIPP's East Tower.

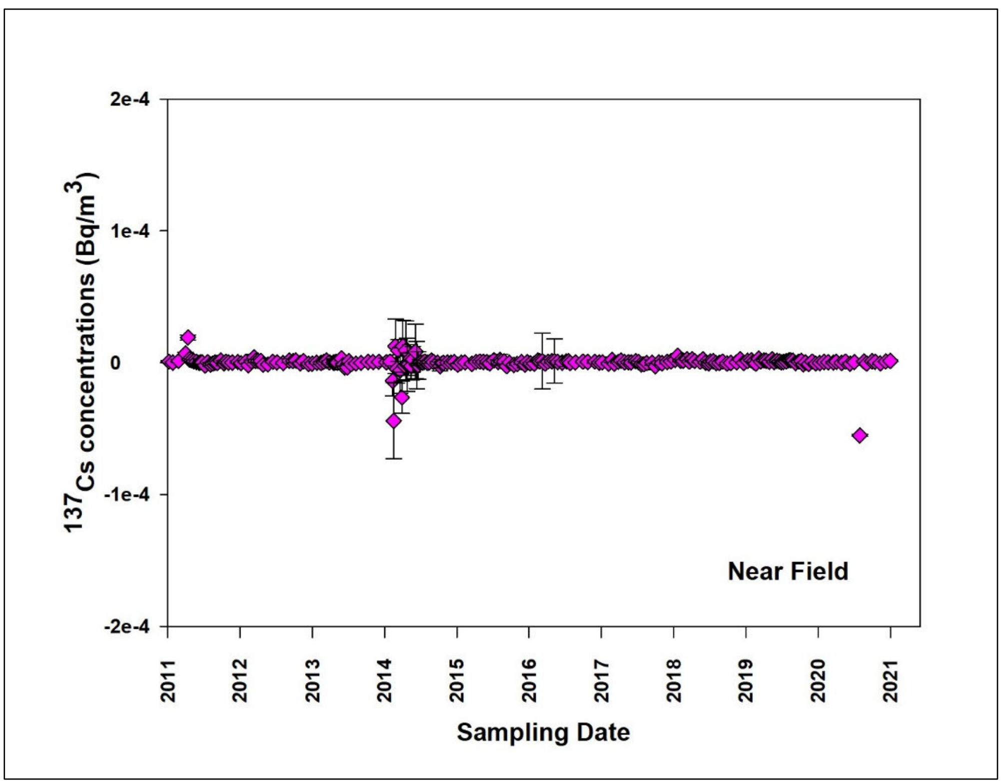
The concentrations of gamma-emitting radionuclides ^{137}Cs and ^{40}K in ambient air samples are shown in Figures 3.10 and 3.11. The individual concentrations measured are shown in Appendix B, Tables B.37 through B.42. There was no significant difference in the concentrations of ^{137}Cs and ^{40}K among locations. Additionally, the analysis of historical operational data shows an occasional detection of ^{137}Cs and ^{40}K in ambient air filters at all locations. The concentrations measured in 2020 were consistent with those measured in previous years.



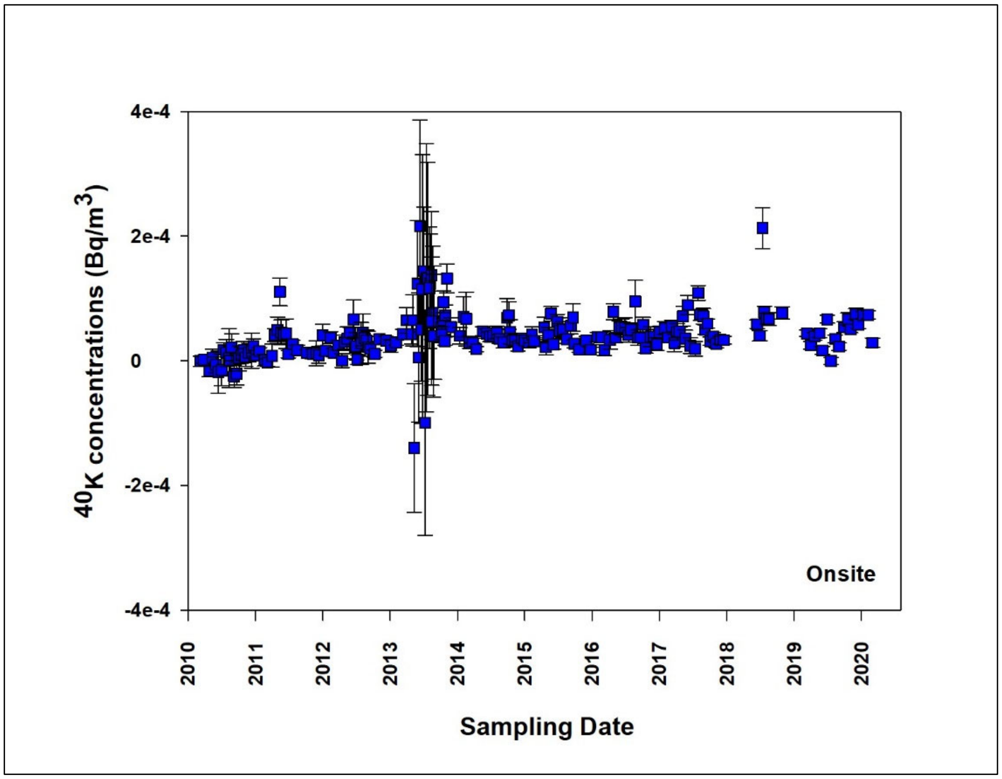




^{40}K concentrations (Bq/m^3)
4e-4
3e-4
2e-4
1e-4
0
-1e-4
-2e-4
-3e-4
-4e-4
Near Field
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Sampling Date



^{137}Cs concentrations (Bq/m^3)
2e-4
1e-4
0
-1e-4
-2e-4
Near Field
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Sampling Date



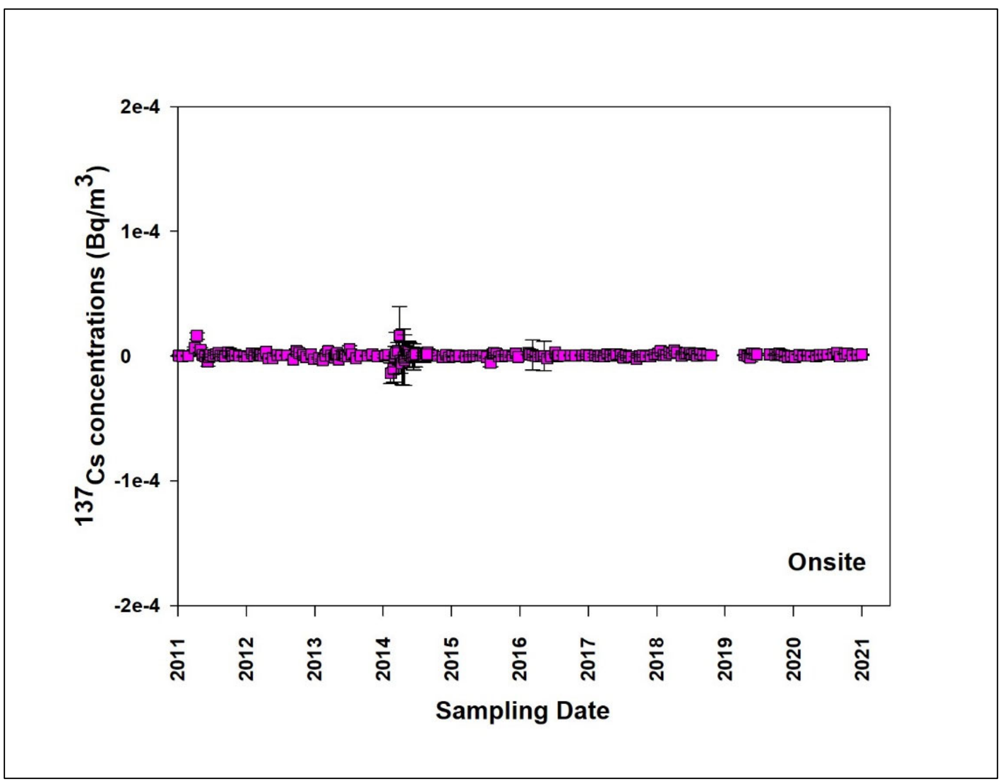
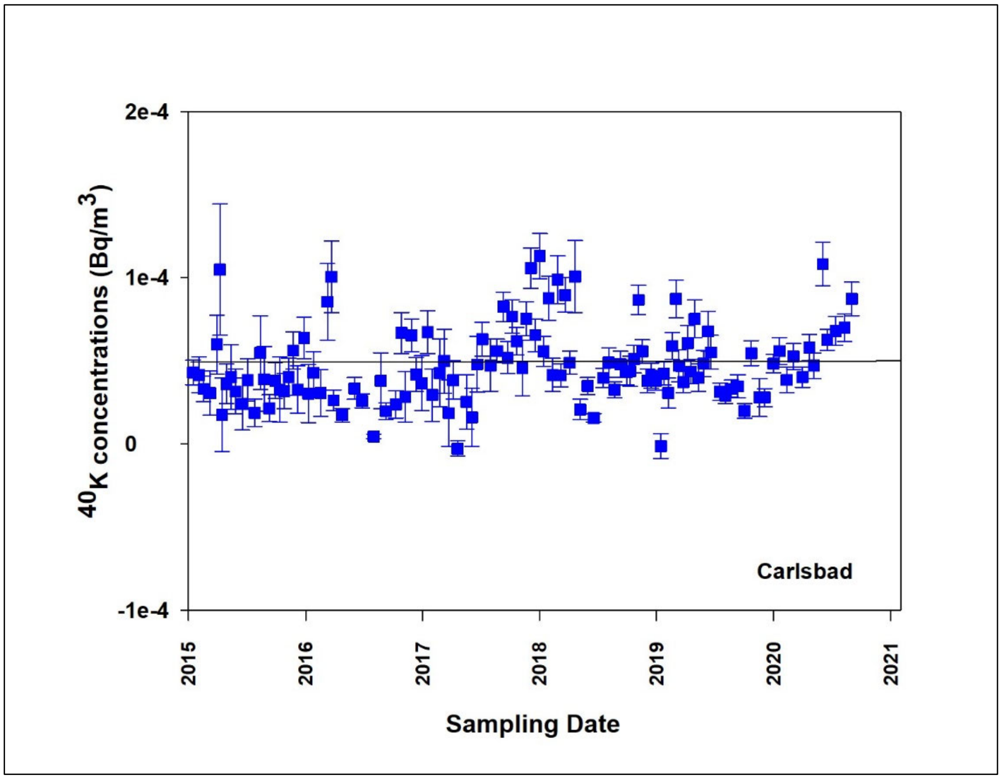
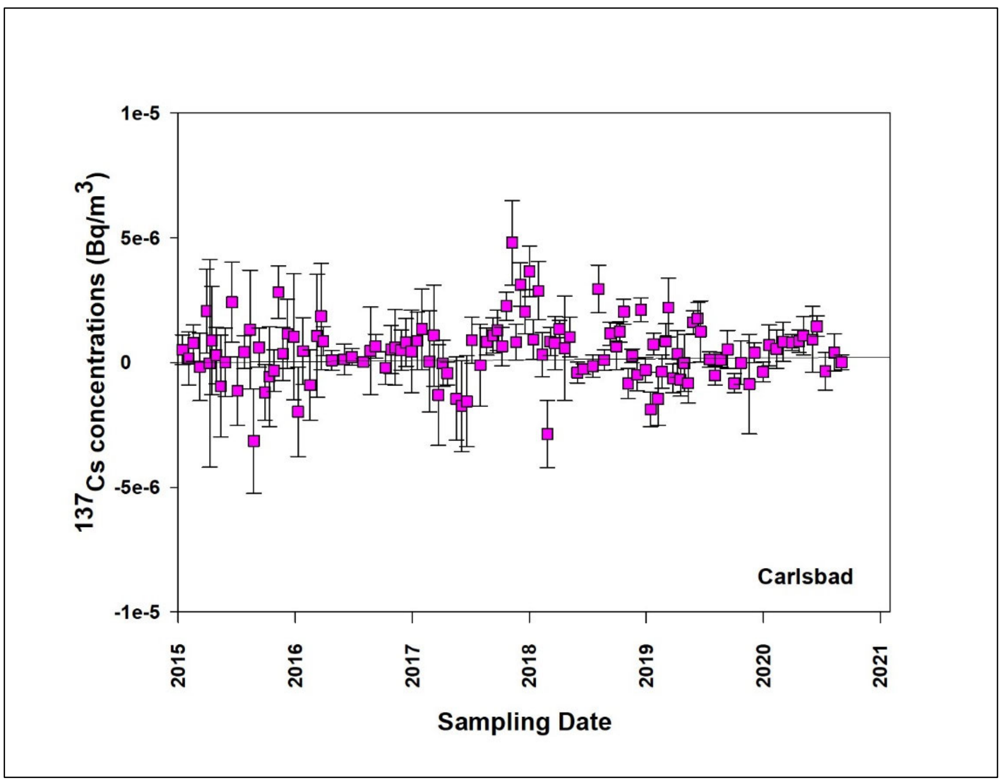
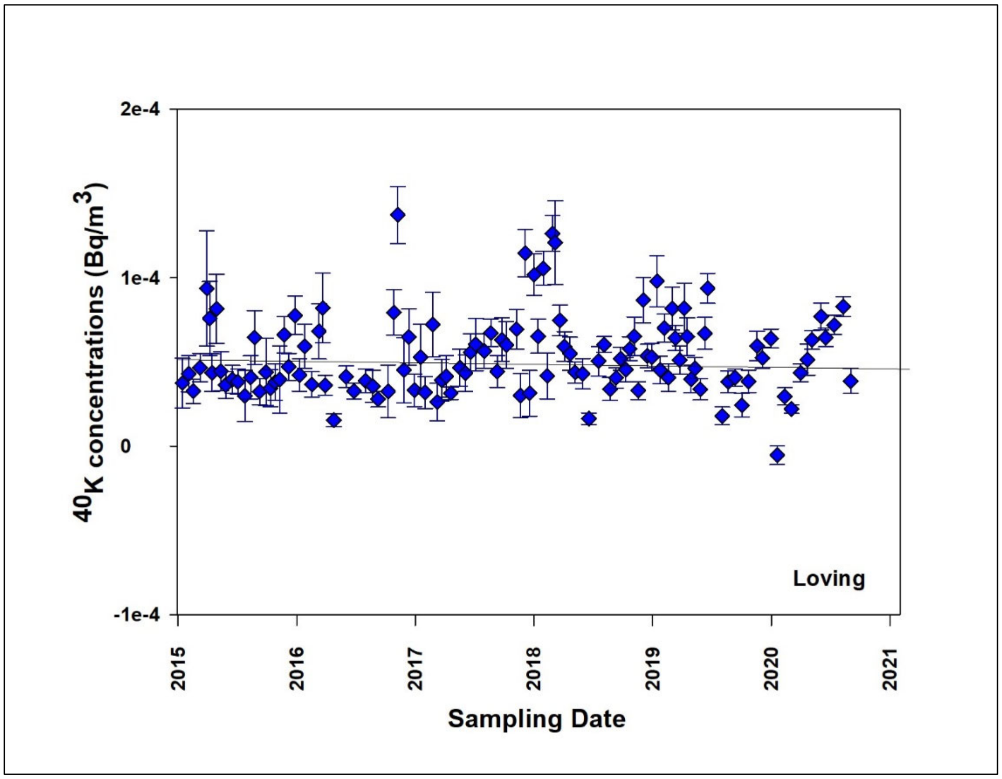
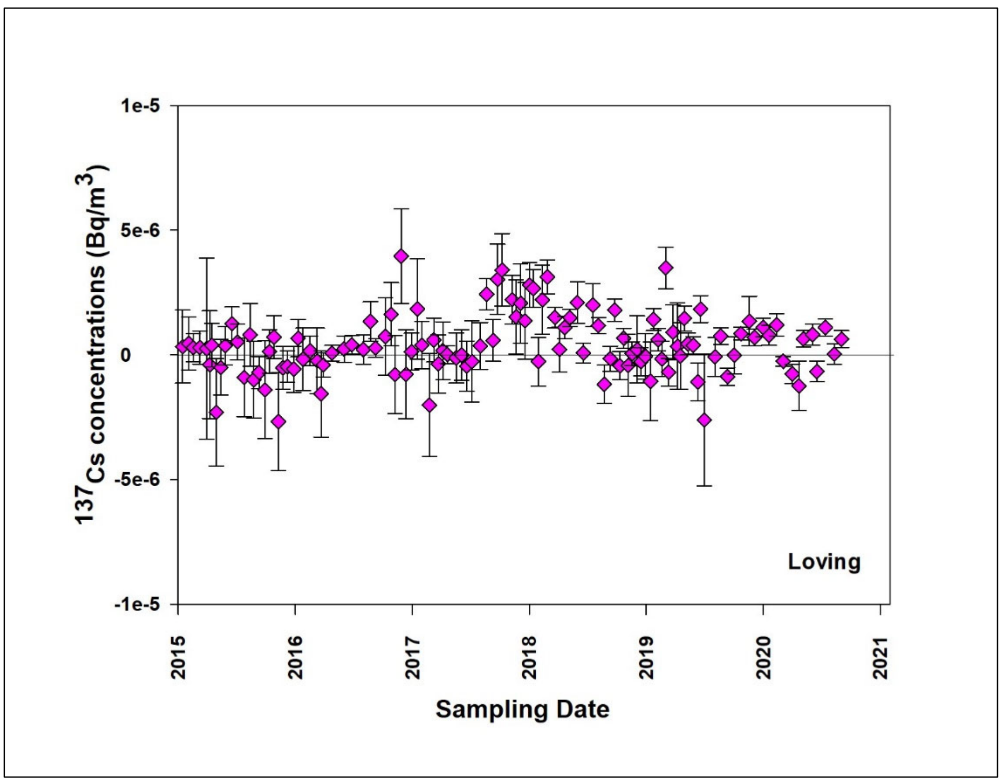


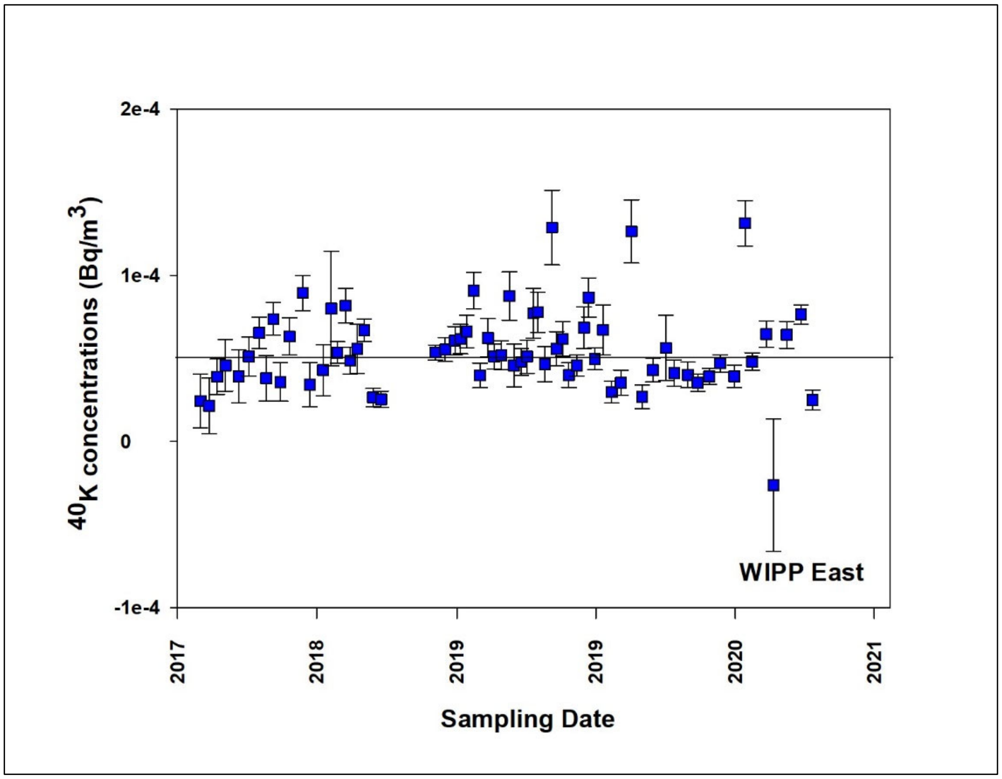
Figure 3.10. Concentrations of ^{40}K and ^{137}Cs at the Cactus Flats, Near Field, and Onsite Stations


2e-4
1e-4
0
-1e-4
^{40}K concentrations (Bq/m^3)
Carlsbad
2015
2016
2017
2018
2019
2020
2021
Sampling Date


1e-5
5e-6
0
-5e-6
-1e-5
^{137}Cs concentrations (Bq/m^3)
Carlsbad
2015
2016
2017
2018
2019
2020
2021
Sampling Date


2e-4
1e-4
0
-1e-4
40K concentrations (Bq/m3)
Loving
2015
2016
2017
2018
2019
2020
2021
Sampling Date


1e-5
5e-6
0
-5e-6
-1e-5
137Cs concentrations (Bq/m3)
Loving
2015
2016
2017
2018
2019
2020
2021
Sampling Date



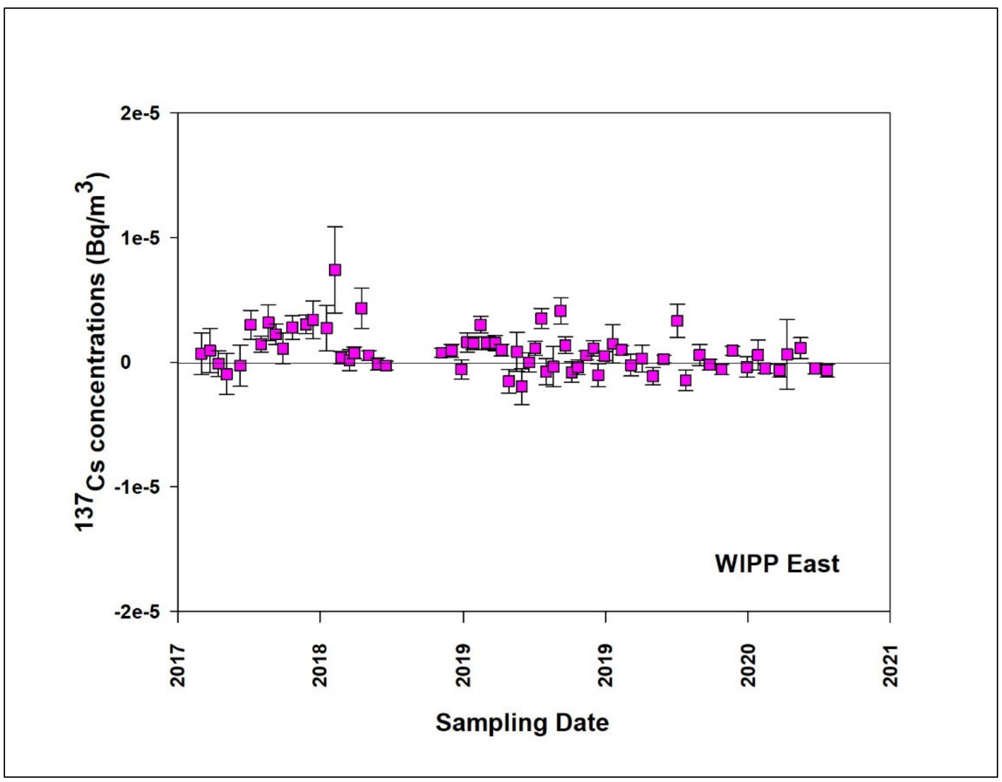


Figure 3.11. Concentrations of ^{40}K and ^{137}Cs at the Carlsbad, Loving, and WIPP East Stations

3.4.4 Strontium Concentrations in Ambient Air

The beta-emitting radionuclide ^{90}Sr was not detected in most ambient air samples and all monitoring stations in 2020. Only in the following samples was ^{90}Sr detected. In one sample at the Onsite station with concentration 5.78×10^{-4} Bq/m^3 and specific activity (activity per unit mass aerosol collected) 21.7 Bq/g. Two samples at the Near Field station had ^{90}Sr concentrations 2.82×10^{-4} and 1.38×10^{-5} Bq/m^3, respectively. The corresponding ^{90}Sr specific activities were 9.82 and 21.7 Bq/g, respectively. At the Cactus Flats station ^{90}Sr concentration was detected in only one sample. The concentration was 3.99×10^{-4} Bq/m^3 and the corresponding ^{90}Sr specific activity was 9.98 Bq/g. One additional sample had detectable ^{90}Sr concentration at the Carlsbad station, namely 3.21×10^{-4} Bq/m^3. The corresponding ^{90}Sr specific activity was 6.23 Bq/g. Finally, ^{90}Sr concentrations were detected in two samples at WIPP's East station, namely 2.72×10^{-4} and 2.55×10^{-4} Bq/m^3, respectively, with corresponding ^{90}Sr specific activities of 8.26 and 3.12 Bq/g, respectively.

3.5 Conclusion

This chapter summarizes the results of the airborne particulate monitoring program for the 2020 calendar year. For this monitoring period, $^{239+240}Pu$ and ^{241}Am were slightly above the MDC and were detected in all the monitoring stations. The concentrations of $^{239+240}Pu$ detected were in the range of -5.04E-09 to 3.64E-08 Bq/m^3 at the Onsite station, -9.08E-09 to 5.05E-08 Bq/m^3 at the Near Field station, 2.07E-09 to 3.54E-08 Bq/m^3 at the Cactus Flats station, 2.08E-09 to 3.70E-08 Bq/m^3 at the Loving station, 1.37E-09 to 5.58E-08 Bq/m^3 at the Carlsbad station, and 0.00 to 5.74E-08 Bq/m^3 at the WIPP's east station.

The corresponding concentrations of ^{241}Am were in the range from 4.45E-09 to 1.32E-07 Bq/m^3 at the onsite station, -1.76E-09 to 1.52E-07 Bq/m^3 at the Near Field station, -1.29E-09 to 2.21E-08 Bq/m^3 at the Cactus Flats station, -1.60E-09 to 1.16E-07 Bq/m^3 at the Loving station, 4.12E-09 to 2.97E-08 Bq/m^3 at the Carlsbad station, and -3.62E+09 to 3.21E-08 Bq/m^3 at the WIPP's east station. These levels are consistent with the levels measured in previous years.

As expected, isotopes of uranium were detected in all sampling locations. The highest concentration of uranium was detected at the Loving location at the level of 3.04E-06 Bq/m^3 for ^{238}U and 3.28E-06 Bq/m^3 for ^{234}U. The gamma-emitting radionuclide ^{40}K was detected in most ambient air samples at all monitoring stations, while ^{137}Cs was detected 3 times at Onsite, twice at Cactus Flats, once in Loving, once in Carlsbad, and once at WIPP's East Station, and ^{60}Co was only detected once in WIPP's East Station. The ^{40}K isotope is ubiquitous in the earth's crust and thus would be expected to show up in environmental air samples. On the other hand, ^{137}Cs is a fallout radionuclide and is expected to be detected from time to time in air samples depending on the dust loading on the filters.

The specific activities of ^{90}Sr detected were in the range of -0.32 – 15.4 Bq/g at the Onsite station, -0.36 – 3.27 Bq/g at the Near Field station, -0.53 – 9.61 Bq/g at the Cactus Flats station, -0.54-0.75 Bq/g at the Loving Station, -0.30 -2.83 Bq/g at the Carlsbad station, and -0.60-2.58 Bq/g at the WIPP's east station.

WIPP's historical ambient air data show that, except for the 2014 release event, the source and level of the Pu and Am in the environment surrounding the WIPP area are mainly due to the re-suspension of soil particles, which are contaminated from weapons fallout. Finally, ^{90}Sr was detected in one or two samples, at the most, in each station. There is no evidence of an increase in radionuclide activity concentrations in the region that could be attributed to releases from the WIPP.

CHAPTER 4 - SOIL MONITORING

Soil is a crucial component of the natural environment, formed through the weathering process of rocks and the accumulation of organic matter. It plays a vital role in sustaining plant growth and overall ecosystem health. However, soil can also be susceptible to contamination from various sources, including direct releases into the ground, atmospheric deposition, and liquid effluents.

The U.S. Department of Energy (DOE) provides guidance for environmental monitoring, emphasizing the importance of sampling soil to assess the long-term accumulation of radionuclides in terrestrial environments and estimate the inventories of environmental radionuclides (U.S. DOE, 1991). This guidance is particularly relevant to the CEMRC environmental monitoring program, as it aims to monitor the potential deposition of airborne contaminants from the repository into surface soils. These pollutants can serve as a continued source of contaminant exposure and uptake, through direct contact, food chain pathways, and re-suspension.

Implementing a soil monitoring program offers the most direct approach to determine the concentrations (activities), distribution, and long-term trends of radionuclides and chemicals present around nuclear facilities. In the case of the WIPP site, the main sources of transuranic radionuclides in the surrounding soil are primarily attributable to global fallout resulting from nuclear weapons testing, releases at the Gnome site near the WIPP facility, and regional fallout from above-ground nuclear weapons testing at the Nevada Test Site (NTS), now known as the Nevada National Security Site (NNSS). These sources exhibit characteristic radionuclide signatures or abundances that, in principle, enable their identification in soils and estimation of their concentrations.

CEMRC has been actively conducting surface soil monitoring near the WIPP site since 1998. The primary objective was to establish independent baseline data on various anthropogenic radionuclides present in WIPP soil before the commencement of operations. These baseline data are subsequently compared with data collected during the disposal phase to assess any potential increase in radioactivity resulting from WIPP operations. Currently, the monitoring program entails annual collection of soil samples from two designated locations within the established grid, namely Near Field and Cactus Flats. Each individual sample is then subjected to analysis to determine the presence and concentrations of gamma-emitting radionuclides and actinides of concern. The specific procedures for sample collection and analyses are elaborated upon in the subsequent sections.

4.1 Sample Collection

Soil samples were collected from the A and B grids around the WIPP site. Soil samples at the depth of 0-2 cm were collected at random short distances and orientations from both locations. The sampling location of soil is shown in Figure 4.1. Individual sampling sites were selected on the basis of relatively flat topography, minimum surface erosion, and minimum surface disturbance by human or livestock activity. Approximately 4 L of soil were collected from within a 50×50 cm area for radionuclide analyses. As shown in Figure 4.1, soil samples were excavated using a trowel and placed in plastic bags for transport and storage. Sampling equipment was cleaned between samples. Samples were sieved through a 2 mm mesh screen to remove rocks, roots, and other large material. The soil samples were then oven dried at 105 ˚C and ground using a shatter box grinder to a fine analytical powder.

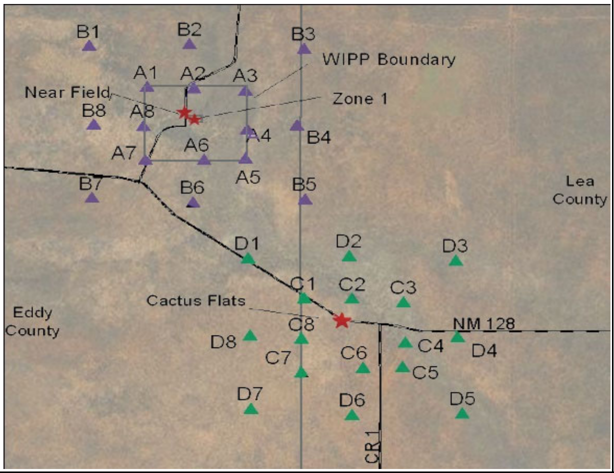


Figure 4.1. Soil Sampling Locations and Collection

4.2 Sample Preparation and Analysis

Soil samples were dried at 110 °C and blended before sampling. The samples for gamma analysis were sealed in a 300 mL paint can and stored for at least 21 days to allow radon progeny to reach equilibrium with parent radionuclides before counting. Dried and sieved soil samples were counted for 48 h in a high purity germanium detector, HpGe (Mirion Technologies). The counting containers held approximately 500 g of soil.

For actinide analyses, 4-5 g of sample were heated in a muffle furnace at 500 °C for at least 6 hours to combust organic material. Each sample was then spiked with a radioactive tracer and digested in a Teflon beaker with hydrochloric, nitric, and hydrofluoric acids. Sea sand was used as a matrix for Laboratory Control Standard (LCS) and reagent blank. To remove hydrofluoric acid, the sample residues were heated with perchloric acid and boric acids. Finally, the residues were dissolved in nitric acid for processing the individual radionuclide concentrations.

4.3 Radiochemical Analysis

The actinides were then separated as a group by co-precipitation on $Fe(OH)_3$. Plutonium was separated from americium and uranium using an anion exchange column, while uranium was separated from americium on a TRU chromatography column. After separation, plutonium and uranium fractions were purified on a second anion exchange column and the americium subsequently purified from lanthanides on TEVA. Finally, Pu, Am, and U were micro co-precipitated on stainless steel planchettes for alpha spectrometry (Mirion Technologies) and counted for five days per CEMRC's standard counting protocol. Portions of digested solutions containing strontium were co-precipitated with barium as a carbonate, then dissolved in nitric acid and barium precipitated out as chromate. The supernatants obtained were mixed with ammonium hydroxide (NH_4OH) and saturated ammonium carbonate $(NH_4)_2CO_3$ to precipitate strontium as strontium carbonate ($SrCO_3$), and the beta-radiation-emitting radioactive isotope ^{90}Sr was then counted by liquid scintillation counting. Details are described in procedure WL-1011.

4.4 Results and Discussion

The activities of the actinides and gamma radionuclides in the soil samples are reported as activity concentrations in Bq/kg. The activity concentration is calculated as the activity of radionuclides reported in Becquerel (Bq) divided by the mass of the soil in kilograms (kg).

4.4.1 Actinide Concentrations in WIPP Soil

The individual concentrations of ^{241}Am, $^{239+240}Pu$, and ^{238}Pu in the soil samples collected from the Near Field are presented in Figures 4.2, 4.3, and 4.4. The $^{239+240}Pu$ concentrations in the Near Field ranged from 0.027 to 0.165 Bq/kg, with a mean value of 0.071 Bq/kg, while that for ^{241}Am ranged from -0.016 to 0.342 Bq/kg, with a mean value of 0.060 Bq/kg.

The ^{238}Pu radionuclide was not detected in any of the soil samples. The concentrations of these nuclides are comparable to our historical data recorded for these areas prior to the arrival of TRU wastes in the WIPP and are typical of “background soil concentrations.” Historical plots of $^{239+240}Pu$, ^{238}Pu, and ^{241}Am concentrations in soil in the vicinity of the WIPP site are shown in Figures 4.2 to 4.4.

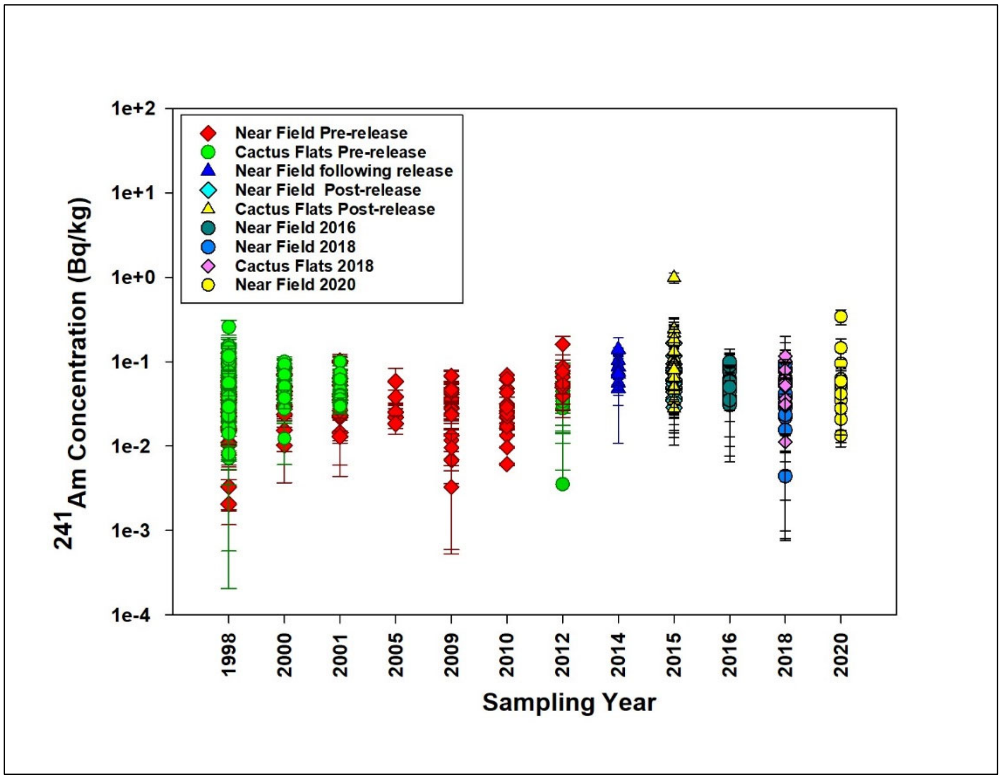


Figure 4.2. Historical Concentrations of ^{241}Am in WIPP Soil

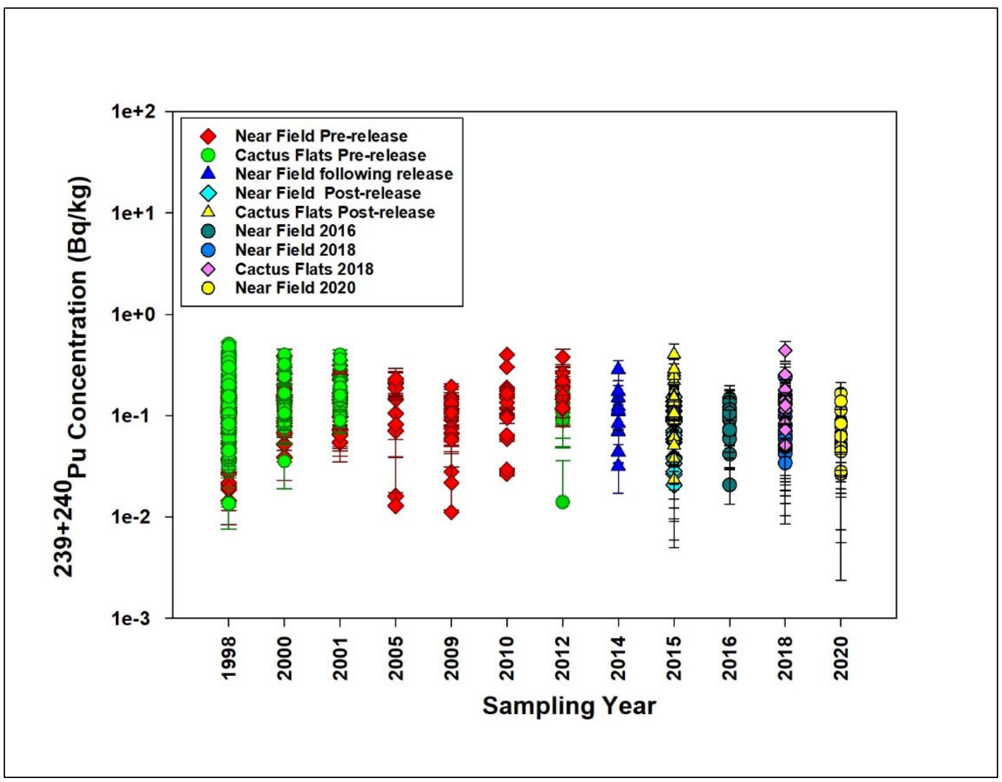


Figure 4.3. Historical Concentrations of $^{239+240}$Pu in WIPP Soil

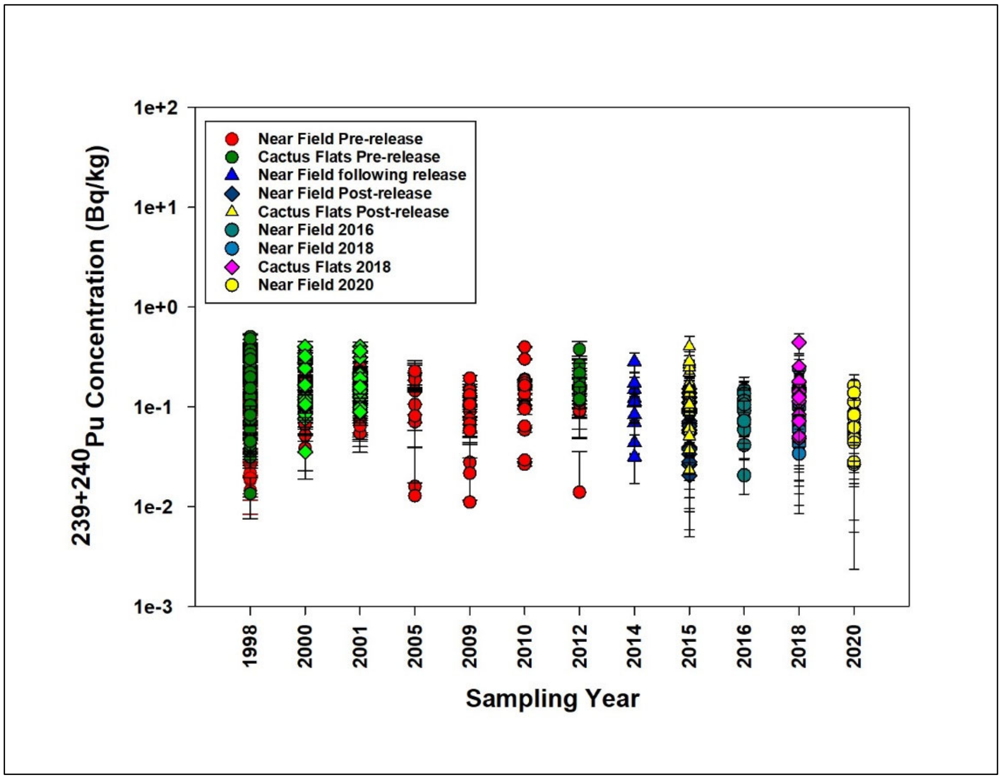
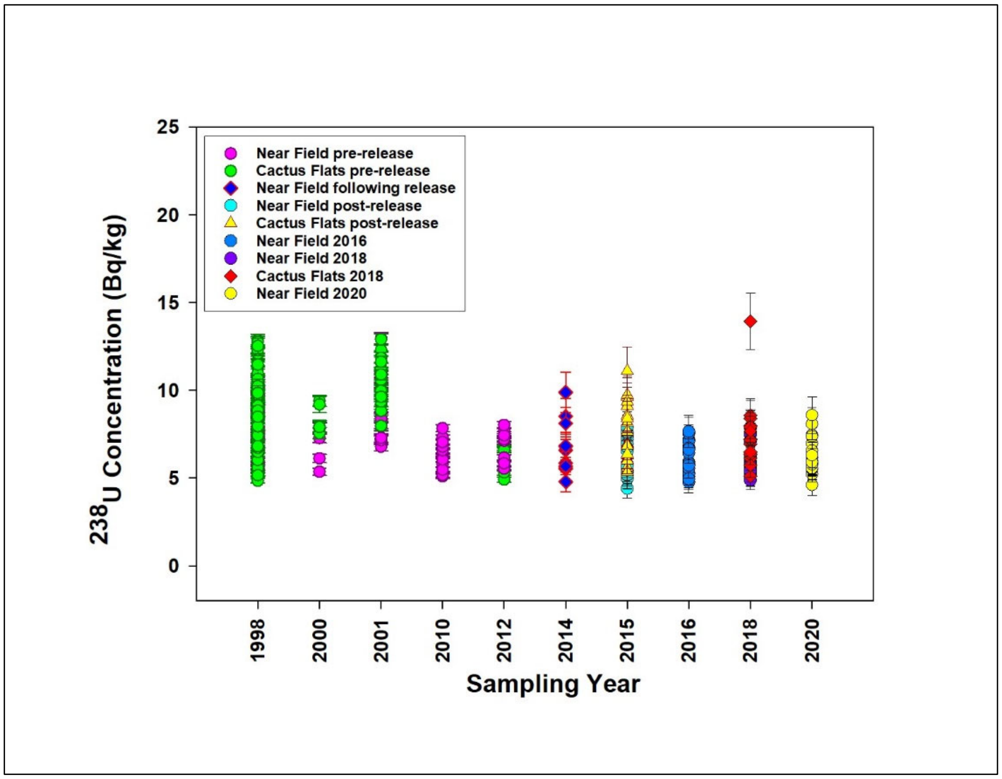


Figure 4.4. Historical Concentrations of ^{238}Pu in WIPP Soil

4.4.2 Uranium concentrations in WIPP Soil

The naturally occurring isotopes of U were detected in all soil samples. The uranium concentration data for individual soil samples are shown in Figures 4.5 and 4.6. The ^{234}U concentrations in the Near Field ranged from 4.29-7.79 Bq/kg, with a mean value of 5.92 Bq/kg, while that for ^{238}U ranged from 4.60-8.59 Bq/kg, with a mean value of 6.30 Bq/kg. These values are consistent with the values measured previously from the Near Field. Figure 4.4 shows the historical concentrations of ^{234}U and ^{238}U in WIPP soil since 1998. The uranium concentration in soil varies widely but typically contains about 74 Bq/kg (3 ppm). The calculated ^{234}U/^{238}U activity ratio in the vicinity of WIPP soil varied between 0.90 and 1.01 with an average value of 0.93±0.03 for the Near Field soils. Figure 4.6 shows the variation in the ^{234}U/^{238}U ratio in the soil samples collected from the Near Field grid during 2015-2018 and the Cactus Flats grid during 2015 and 2018. The ^{234}U/^{238}U activity ratio obtained indicated that these two uranium isotopes are in the state of secular radioactive equilibrium.



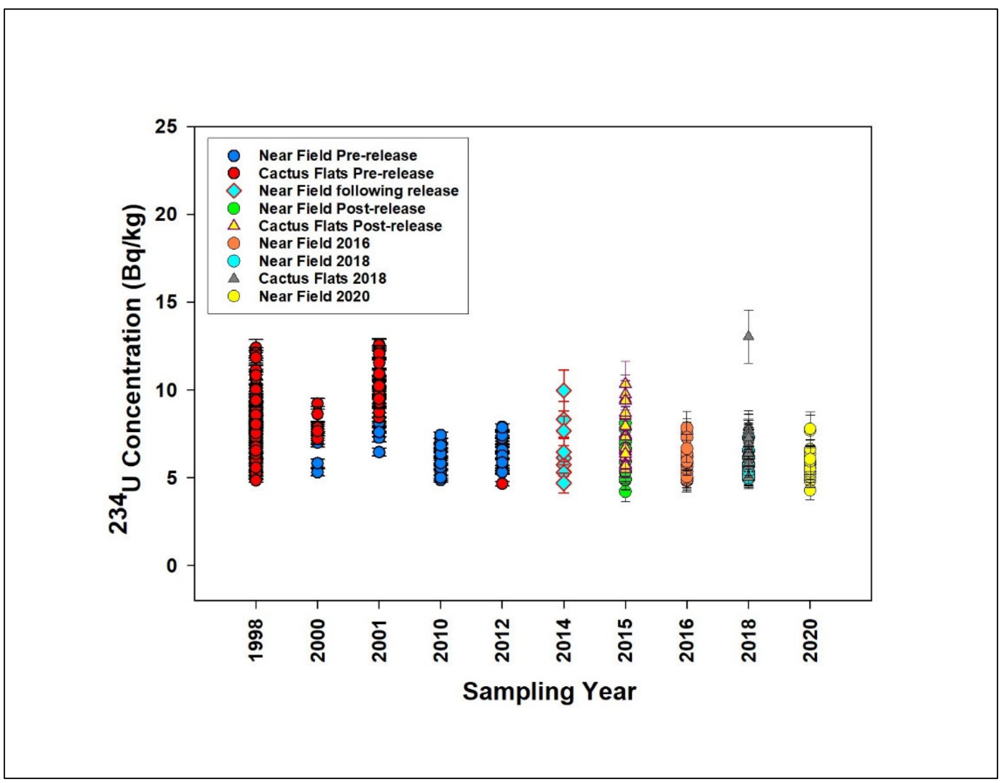
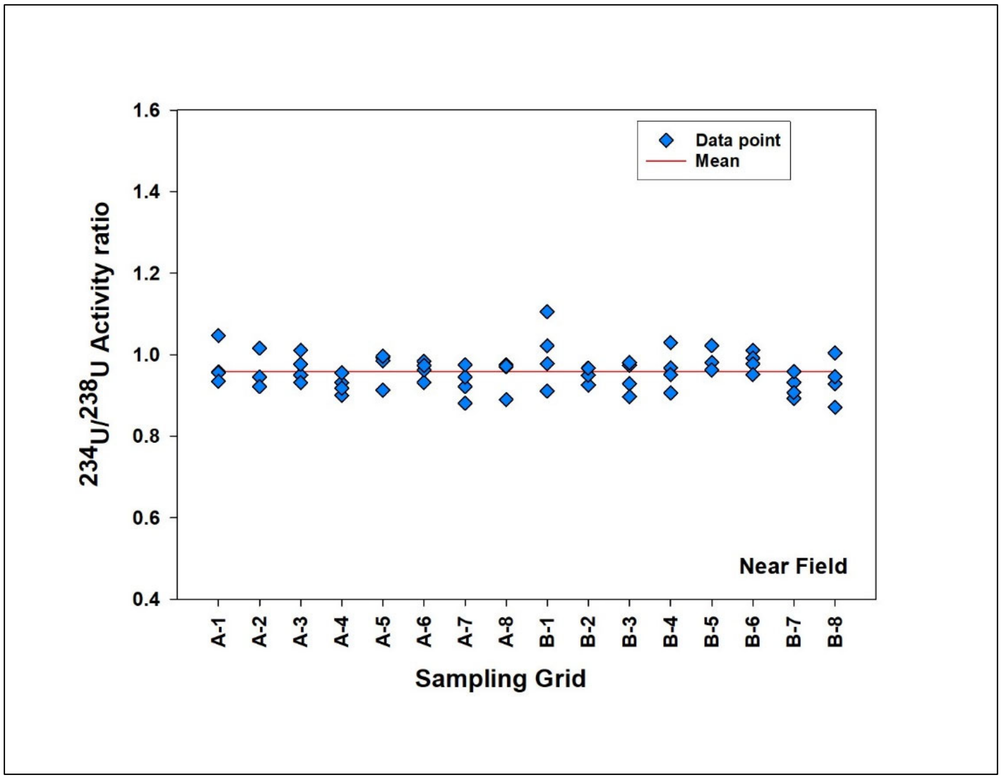


Figure 4.5. Historical Concentrations of ^{238}U and ^{234}U in WIPP Soil



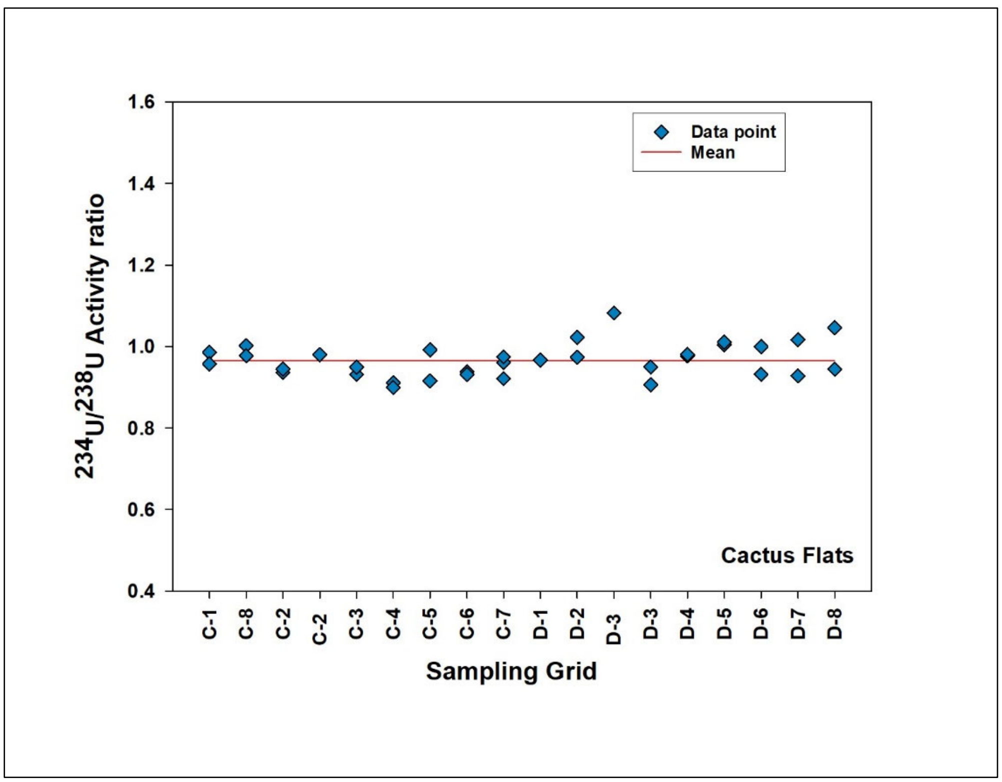
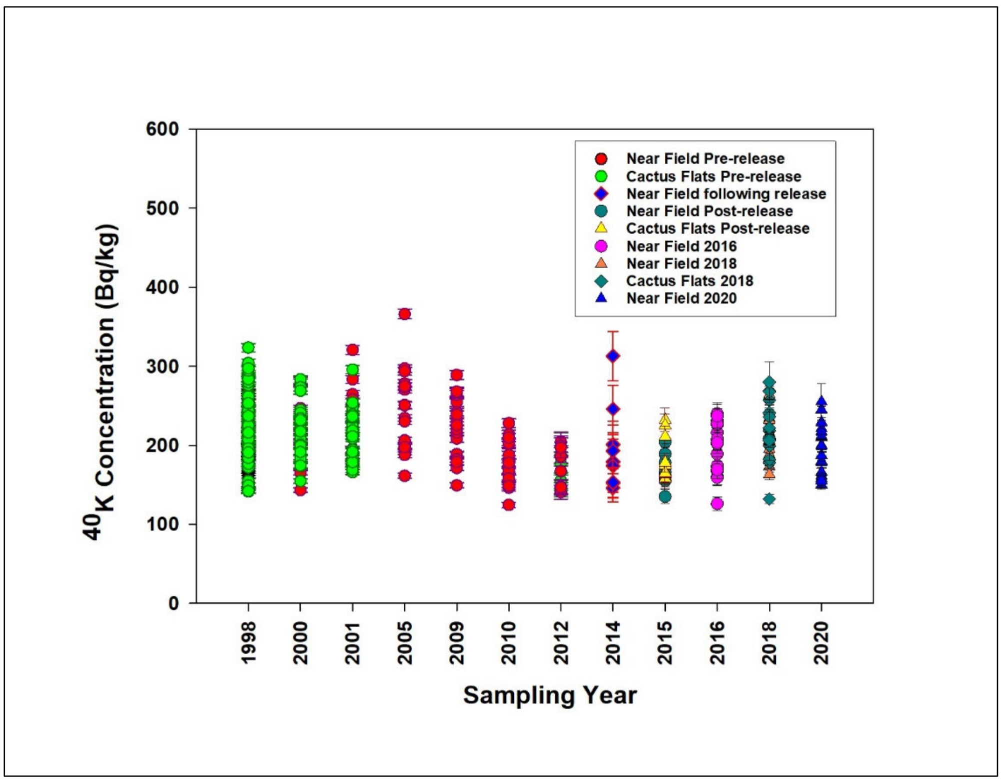


Figure 4.6. The $^{234}U/^{238}U$ Activity Ratio in WIPP Soil During 2015- 2018

4.4.3 Gamma Radionuclide Concentrations in WIPP Soil

The concentrations of gamma radionuclides in the WIPP soil are presented in Figure 4.8. The ^{137}Cs and ^{40}K were detected in all soil samples. The concentration of ^{137}Cs in the Near Field soil ranged from 0.50 to 3.50 Bq/kg, with a mean value of 1.75 Bq/kg. Variability among the ^{137}Cs concentrations was not very significant. Although ^{137}Cs is a fission product, it is ubiquitous in soils because of global fallout from atmospheric weapons testing (Beck and Bennett, 2002; UNSCEAR, 2000). The ^{40}K concentrations in the Near Field soil ranged from 150.5 to 254.9 Bq/kg, with a mean value of 193.7 Bq/kg . Like ^{137}Cs, the ^{40}K is a naturally occurring gamma-emitting radionuclide and is ubiquitous in soils. There was no significant difference between concentrations of ^{137}Cs and ^{40}K among sampling locations, and the values fell within the range of concentrations previously observed in WIPP soils.

The ^{60}Co isotope was not detected at any sampling locations. Historical plots of ^{40}K and ^{137}Cs concentrations in WIPP soil are shown in Figure 4.7. The concentrations have remained relatively constant over the past 10+ years and generally indicate worldwide fallout. Some degree of variability is always associated with collecting and analyzing environmental samples; therefore, variations in sample concentrations from year to year are expected.



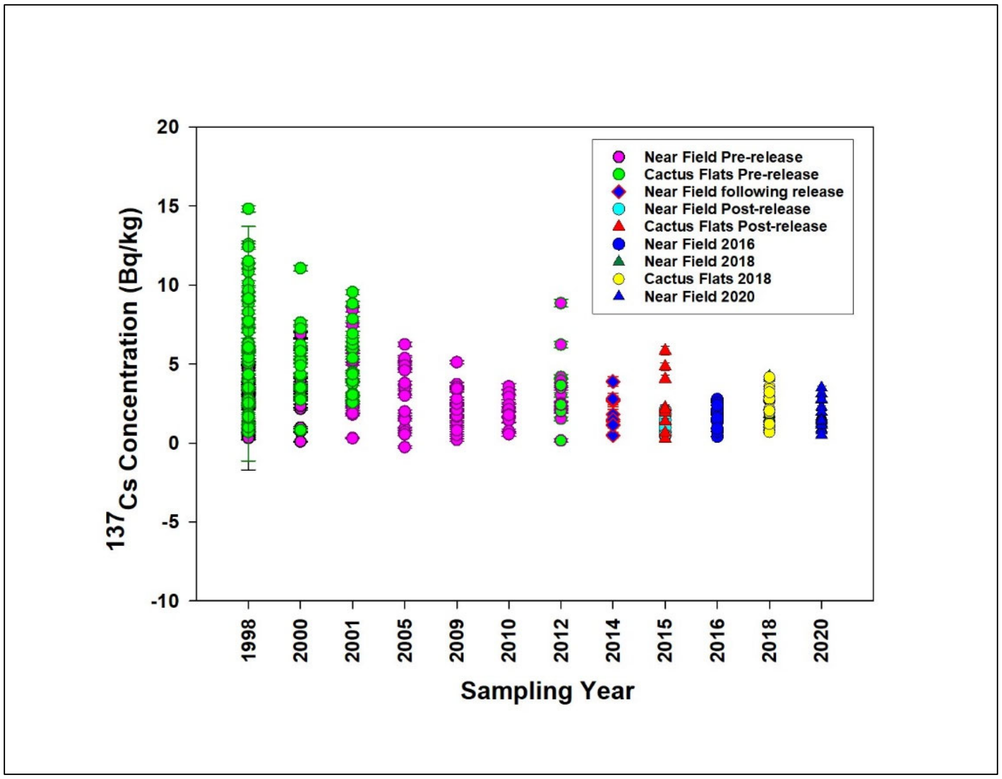


Figure 4.7. Historical Concentrations of ^{40}K and ^{137}Cs in WIPP Soil

4.4.4 Strontium Concentrations in WIPP Soil

The beta emitting radionuclide ^{90}Sr was not detected in any of the soil samples.

4.5 Conclusion

This chapter summarizes the results of the soil-monitoring program for the calendar year 2020. The $^{239+240}$Pu and ^{241}Am concentrations in the Near Field ranged from 0.027 to 0.165 Bq/kg and -0.016 to 0.342 Bq/kg, respectively. Isotopes of uranium were also detected in all soil samples with ^{234}U/^{238}U ratio close to unity (1.0) at both locations, indicating these two uranium isotopes are in secular equilibrium. The beta emitting radionuclide ^{90}Sr was not detected in any of the soil samples.

Gamma emitting radionuclides ^{137}Cs and ^{40}K were detected in all soil samples. The radionuclide concentrations in the Near Field location ranged from 0.50 to 3.50 Bq/kg for ^{137}Cs and 150.5 to 254.9 Bq/kg for ^{40}K. Furthermore, there is no apparent difference between the concentrations of the radionuclides in soil collected before and after WIPP started receiving TRU waste. The monitoring results indicate no evidence of an increase in soil radionuclide concentrations that can be attributed to the 2014 radiation release event at the WIPP or the normal operations of the WIPP.

CHAPTER 5 - SURFACE WATER MONITORING

Surface water is a term used to describe water in a watercourse, lake, or wetland, and includes water flowing over or lying on land after having precipitated naturally, or after having risen to the surface naturally from underground (groundwater). Rivers, lakes, streams, ponds, wetlands, and oceans are all examples of surface water. Retention of radionuclide fallout by catchment soils and river and lake sediments plays an important role in determining subsequent transport in aquatic systems. In rivers and small lakes, the radioactive contamination results mainly from erosion of the surface layers of soil in the watershed, followed by runoff into the water bodies; however, deposition of radioactive materials also occurs on water surfaces. The fraction of a radionuclide that is adsorbed to suspended particles, which varies considerably in surface waters, strongly influences both its transport and its bioaccumulation.

Samples of surface water in the vicinity of the WIPP site have been collected and analyzed routinely since the beginning of the WIPP environmental monitoring to evaluate the impacts of WIPP operations, if any, in the aquatic environment. The current scope of work requires surface water samples to be collected annually from the three regional reservoirs situated along the Pecos River at a considerable distance from the WIPP site. These locations include Brantley Lake, 55 km (34 mi) north-northwest of the WIPP site, Red Bluff Lake on the Pecos River, the upstream end of which is the nearest standing water body about 48 km (30 mi) to the southwest of the WIPP site, and Lake Carlsbad in the center of Carlsbad about 40 km (25 mi) northwest from the WIPP site. The Pecos River is the dominant surface-water body in the vicinity of the WIPP Site and is used for a variety of recreational activities including fishing, boating, water skiing, and swimming. Radiological analyses were used to quantify radionuclides of concern. Details of the sample collection and analyses are described in the following sections. In this chapter, radiological analyses results are reported for the surface samples collected in 2020.

5.1 Sample Collection

Surface water samples were collected from the three public water reservoirs in the area, Lake Carlsbad, Brantley Lake, and Red Bluff Lake as shown in Figure 5.1. At each sampling location, one sample was collected from the surface (0.5 to 1 m depth) and a second sample from approximately 0.5 to 1 m above the sediment bed. Surface water from each sampling location was collected in a 5-gallon plastic water bottle jug. Water from each sampling location was used to rinse containers at least three times prior to taking the sample. Approximately 8 L of surface water was collected from each location as shown in Figure 5.2.

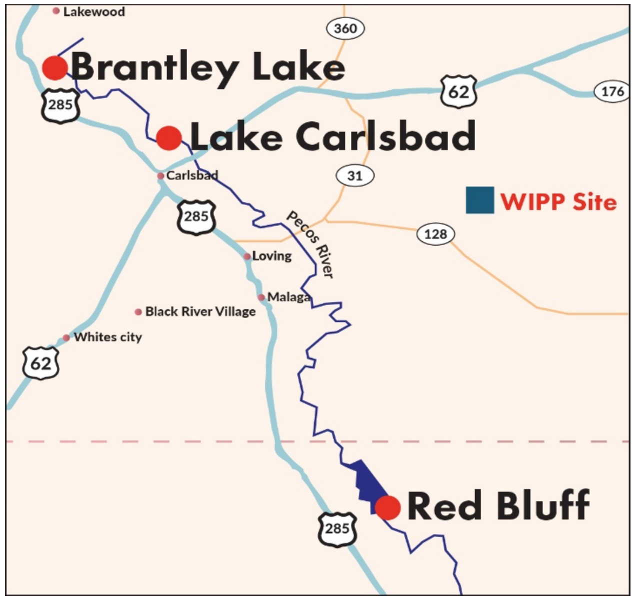


Figure 5.1. Surface Water Sampling Locations in the Vicinity of the WIPP Site

Figure 5.2. Surface Water Sample Collection from the Brantley Lake by CEMRC Personnel

5.2 Sample Preparation and Analysis

In the laboratory, surface water samples collected for radiological analyses were acidified with HNO_3 to a pH < 2 and the sample containers were shaken to distribute suspended material evenly. One 2 L portion was used for gamma spectroscopy and another 1 L portion was used for sequential analysis of the uranium/transuranic isotopes.

5.3 Determination of Individual Radionuclides

The first aliquot was transferred to 2 L Marinelli beakers for the measurement of the gamma-emitting radionuclides potassium (^{40}K), cobalt (^{60}Co), and cesium (^{137}Cs) by gamma spectroscopy using a high purity germanium (HPGe) detector. Before making the measurements, the gamma system was calibrated for energy and efficiency to enable both qualitative and quantitative analysis of the water samples. The energy and efficiency calibrations were carried out using a mixed standards material from Eckert & Ziegler Analytics Inc (Atlanta, GA) in the energy range between 60 to 2000 keV for a 2L Marinelli geometry. The counting time for each sample was 48 hours.

The second, 1 L aliquot, was used for actinide analyses. Tracers consisting of uranium, americium, and plutonium (^{232}U, ^{243}Am, and ^{242}Pu) were added to the samples and the samples were digested using concentrated nitric acid and 30% H_2O_2 on a hot plate until sample volume was reduced to 100-150 mL. The actinides are separated as a group by co-precipitation on $Fe(OH)_3$. The oxidation state of plutonium was adjusted by adding 1 mL of 1.0M NH_4I with a 10 min wait step, followed by 2 mL of 2M $NaNO_2$. Plutonium isotopes were then separated and purified using a two-column anion exchange resin (Dowex 1-× 8, 100-200 mesh), while TRU chromatography columns were used for the separation of Am and U. The samples were then micro-co-precipitated using an Nd-carrier and counted on the alpha spectrometer for 5 days.

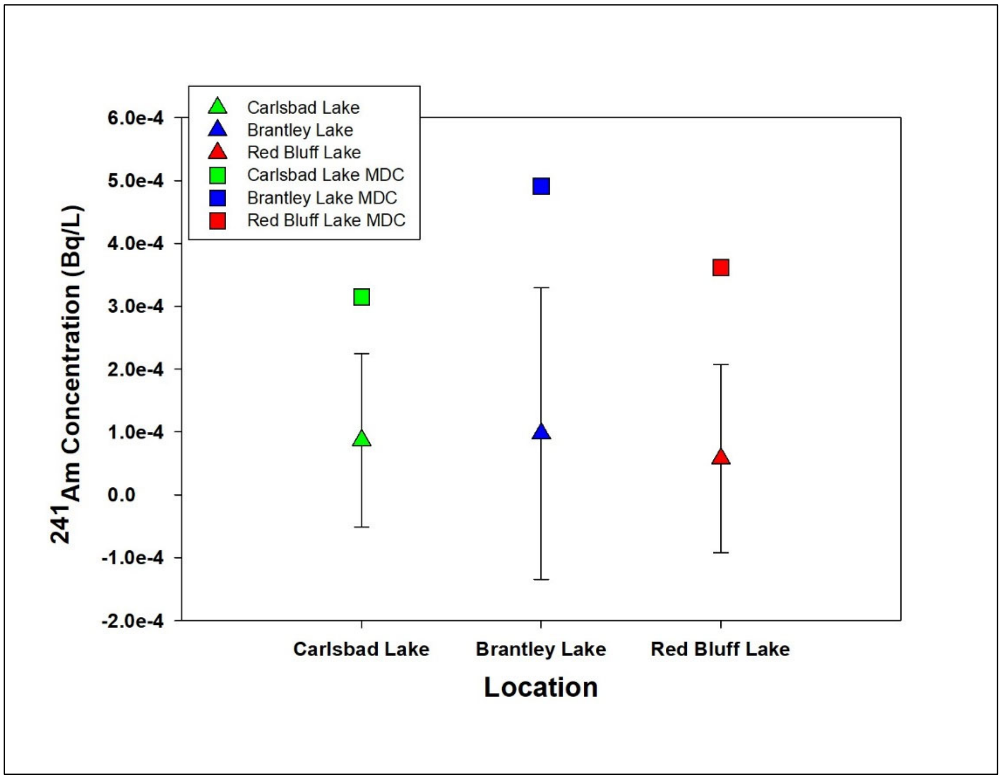
Portions of digested solutions containing strontium were co-precipitated with barium as a carbonate, then dissolved in nitric acid and barium precipitated out as chromate. The supernatants obtained were mixed with ammonium hydroxide (NH_4OH) and saturated ammonium carbonate $(NH_4)_2CO_3$ to precipitate strontium as strontium carbonate ($SrCO_3$), and the beta-radiation-emitting radioactive isotope ^{90}Sr was then counted by liquid scintillation counting. Details are described in procedure WL-1011.

5.4 Results and Discussion

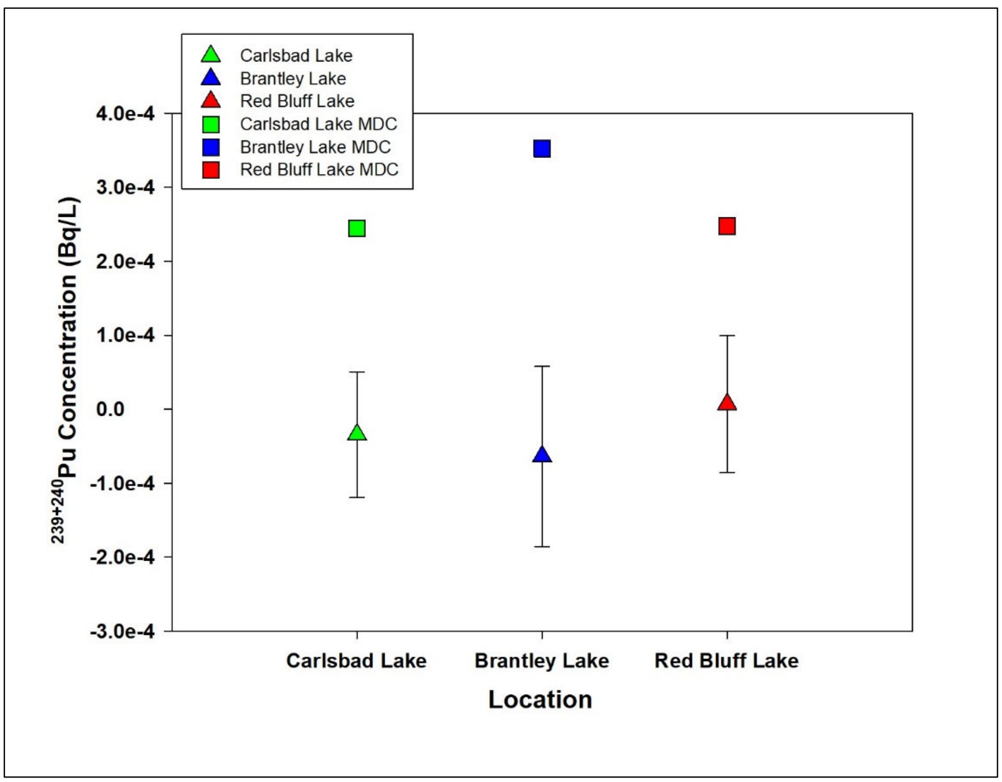
The activities of the radionuclides were reported as activity concentration in Bq/L. Activity concentration is calculated as the activity of radionuclides detected in Becquerel (Bq) divided by volume of the surface water in liters (L).

5.4.1 Actinide Concentrations in Surface Water

The concentrations of ^{241}Am, ^{238}Pu, and $^{239+240}Pu$ in regional surface water samples in 2020 are listed in Appendix C, Table C.1. The alpha-emitting radionuclides, ^{238}Pu, $^{239+240}Pu$, and ^{241}Am were not detected in any of the surface water samples in 2020, which is consistent with the results of the previous years. These radionuclides have not been detected in any of the surface water samples above the MDC since monitoring commenced in 1998. The individual concentrations of ^{241}Am, ^{238}Pu, and $^{239+240}Pu$ measured in the three reservoirs are shown in Figure 5.3. The absence of a detection of WIPP radionuclides in surface water samples indicates no measured impact of WIPP related activities to the regional reservoirs.



Carlsbad Lake
Brantley Lake
Red Bluff Lake
Carlsbad Lake MDC
Brantley Lake MDC
Red Bluff Lake MDC
6.0e-4
5.0e-4
4.0e-4
3.0e-4
2.0e-4
1.0e-4
0.0
-1.0e-4
-2.0e-4
241Am Concentration (Bq/L)
Carlsbad Lake
Brantley Lake
Red Bluff Lake
Location



Carlsbad Lake
Brantley Lake
Red Bluff Lake
Carlsbad Lake MDC
Brantley Lake MDC
Red Bluff Lake MDC
4.0e-4
3.0e-4
2.0e-4
1.0e-4
0.0
-1.0e-4
-2.0e-4
-3.0e-4
239+240Pu Concentration (Bq/L)
Carlsbad Lake
Brantley Lake
Red Bluff Lake
Location

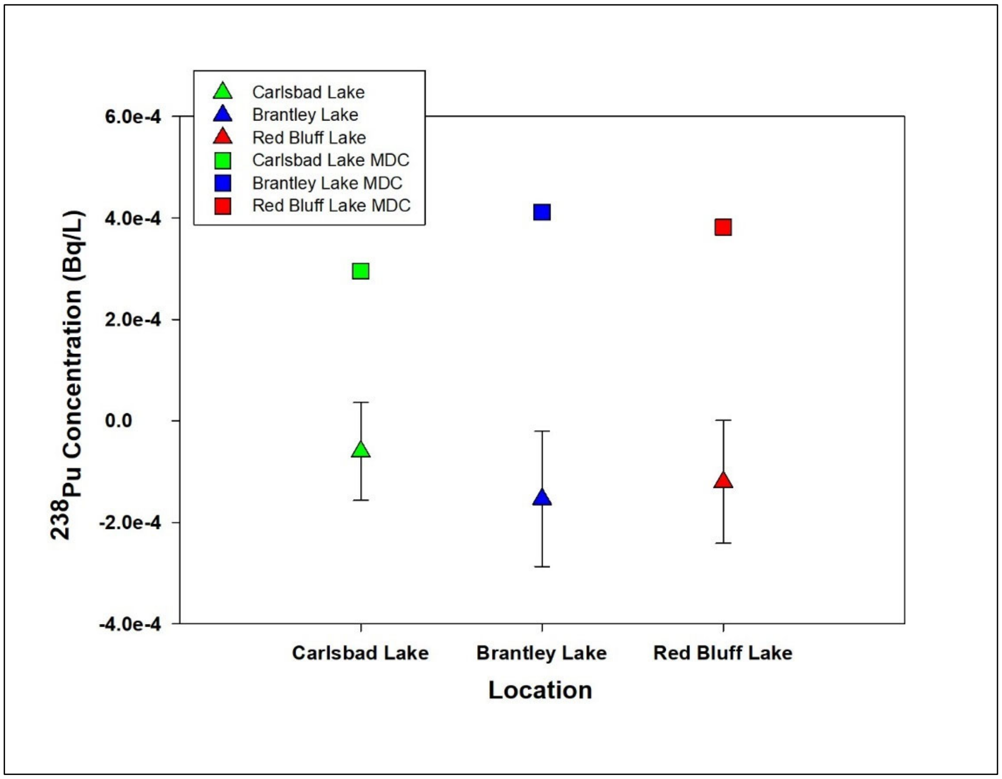


Figure 5.3. ^{241}Am, ^{238}Pu, and $^{239+240}$Pu Concentrations in Surface Water Samples in Three Regional Reservoirs in 2020

5.4.2 Uranium Concentrations in Surface Water

Isotopes of naturally occurring uranium were detected in all the surface water samples in 2020. Uranium concentrations measured in the in the three regional reservoirs near the WIPP site were in the range of 45.3-145.6 mBq/L for ^{238}U, 2.3-7.1 mBq/L for ^{235}U, and 105-303 mBq/L for ^{234}U as shown in Figure 5.4. The individual concentrations of these radionuclides measured in three reservoirs in 2020 are listed in Appendix C, Table C.2. The concentration ranges for these isotopes showed no significant difference between baseline and monitoring phases (CEMRC Report, 1998). The concentrations of the uranium isotopes were also compared between 2015 and 2017 and between sampling locations. There was no significant variation in the concentrations of the uranium isotopes in the surface water between 2015, 2017, and 2020. These observations further support our conclusion that there is no evidence of increases in radiological contaminants in the region that could be attributed to releases from WIPP. No significant difference between the baseline and monitoring phase concentrations was observed.

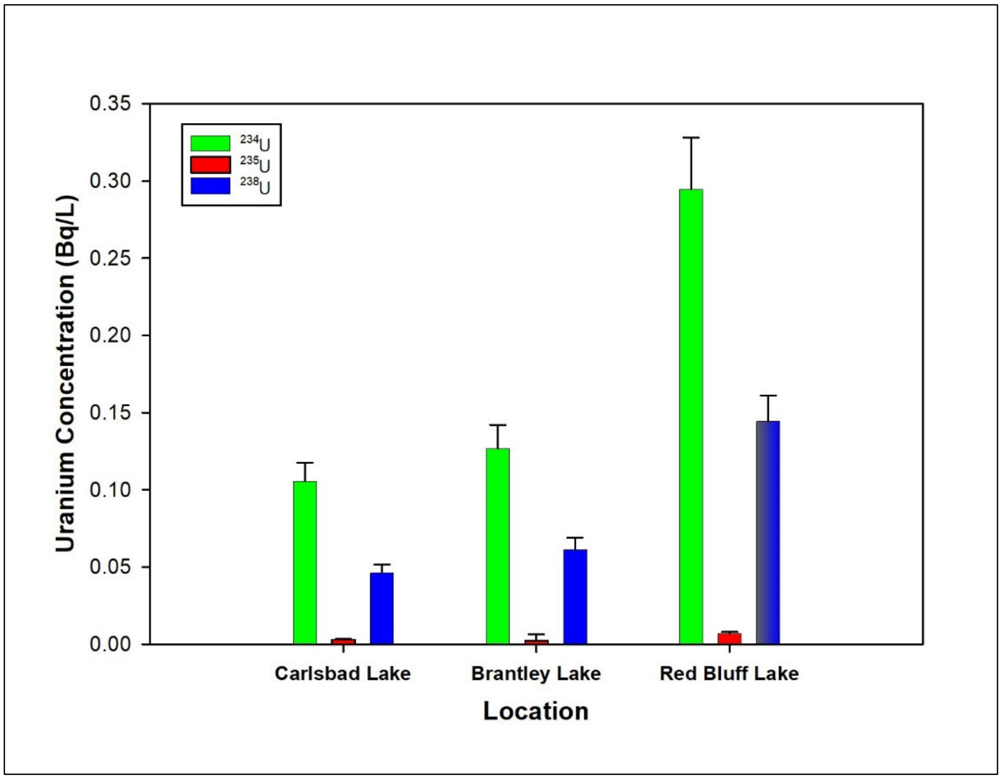


Figure 5.4. Uranium Concentrations in Surface Water Samples in Three Regional Reservoirs in 2020

The $^{234}U/^{238}U$ isotopic ratios were very similar among these three Lakes. The reservoirs appeared to be slightly enriched in ^{234}U compared to ^{238}U, with the activity ratios ranging from 2.04-2.29 (Figure 5.5). In natural bodies of water these isotopes do not occur in equilibrium and that, with a few exceptions, waters typically contain more ^{234}U than ^{238}U (Cothern et al. 1983; Skwarzec et al. 2002). The higher activity of ^{234}U in water is the result of the ^{234}U atom displacement from the crystal lattice. The recoil atom, ^{234}U, is liable to be oxidized to the hexavalent stage and can be leached into the water phase more easily than its parent nuclide ^{238}U. The oxidation of U(IV) to U(VI) is an important step in leaching, because compounds containing U(VI) have a higher solubility due to the formation of strong complexes between uranyl and carbonate ions (UNSCEAR, 1977). All U(IV) compounds of uranium are practically insoluble. The baseline concentration of uranium in surface water samples collected in 1998 is listed in Table C.3.

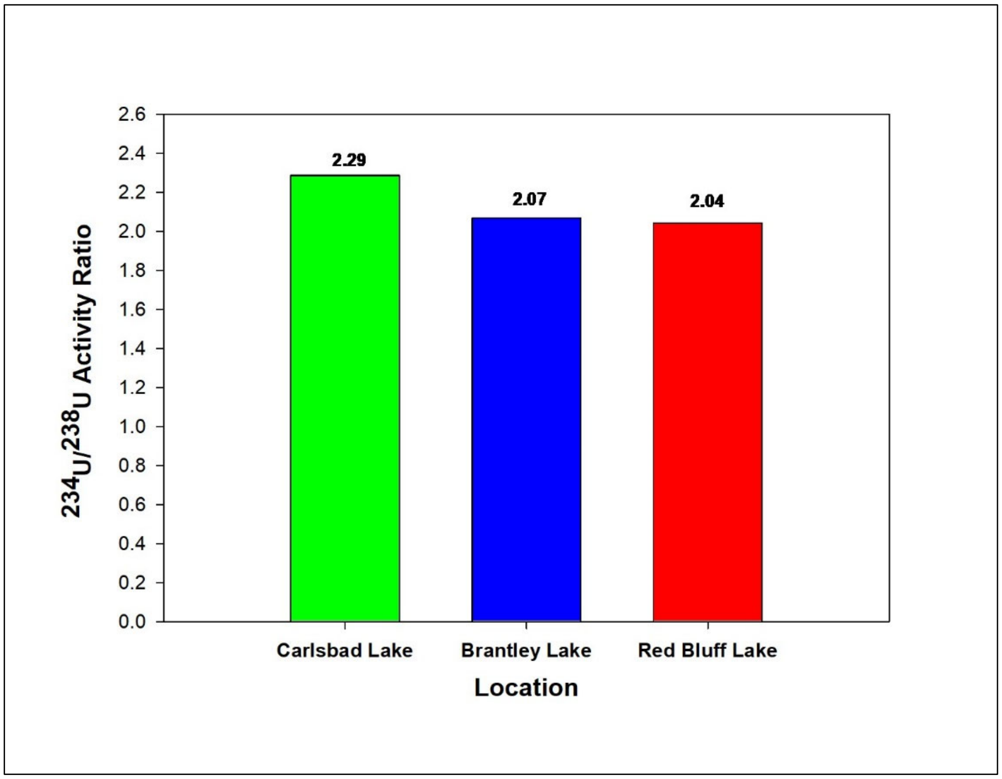


Figure 5.5. The $^{234}U/^{238}U$ Activity Ratio in Surface Water Samples of Three Reservoirs in the Vicinity of the WIPP Site

5.4.3 Gamma Radionuclide Concentrations in Surface Water

The gamma emitting radionuclides ^{137}Cs and ^{60}Co were not detected in any of the surface water samples, while naturally occurring gamma-emitting radionuclide, ^{40}K was detected in Red Bluff surface water in the range of 0.55-0.91 Bq/L as shown in Appendix C, Table C.3. The ^{40}K was also detected in 1998, 2000, 2012, 2017, and 2019 (CEMRC Annual Report, 1998, 2000, 2012, 2017, 2019) in surface water samples collected from Red Bluff Lake. The concentrations detected were in the range 0.81-1.25 Bq/L in 1998; 1.22-1.25 Bq/L in 2000, 2.47-2.72 Bq/L in 2012, 2.11 Bq/L in 2017, and 0.74-1.00 Bq/L in 2019. This naturally occurring gamma-emitting radionuclide is ubiquitous in nature; therefore, an occasional detection of ^{40}K in surface water is not unusual. There was no significant difference between concentrations of ^{40}K among sampling locations and the values fell within the range of concentrations observed previously in this location. Since these isotopes were not regularly detected, no comparisons between years or among locations were performed.

5.4.4 Strontium Concentrations in Surface Water

The beta-radiation-emitting ^{90}Sr radionuclide was not detected in any of the surface water samples.

5.5 Conclusion

This chapter summarizes the results of the surface water monitoring program for the calendar year 2020. It is important to note that after more than twenty years of monitoring, isotopes of plutonium (^{238}Pu and $^{239+240}$Pu) and ^{241}Am, have never been detected above MDC in any of the public water reservoirs in the area surrounding the WIPP. However, the isotopes of uranium ^{234}U, ^{238}U, and ^{235}U were detected in all surface water samples. The concentrations of uranium measured were in the range of 45.3-145.6 mBq/L for ^{238}U, 2.3-7.1 mBq/L for ^{235}U, and 104.5-302.9 mBq/L for ^{234}U. The levels detected were well below the EPA recommended level of 746 mBq/L for drinking water and are within the range expected in waters from this region. The ^{234}U/ ^{238}U activity ratio indicates its presence in surface water is most likely from natural sources. The beta-radiation-emitting ^{90}Sr radionuclide was not detected in any of the surface water samples. Present results, as well as the results of previous analyses of surface water, were consistent for each source across sampling periods. The 2020 monitoring results continue to show no evidence of any release from the WIPP contributing to radionuclide concentrations in the environment.

CHAPTER 6 - DRINKING WATER MONITORING

The quality of drinking water is of paramount importance to ensure its safety for human consumption and minimal risk to public health. Consequently, regular monitoring of the drinking water in the vicinity of the WIPP site is crucial to maintain compliance with health and environmental standards and to identify any potential changes in water quality that may have adverse effects on public health and the environment. The region surrounding the WIPP site encompasses several aquifers, including Dewey Lake, Culebra-Magenta, Ogallala, Dockum, Pecos River alluvium, and Capitan Reef (Mercer, 1983). The primary water source for the Carlsbad area is the Sheep Draw well field, which draws from the Capitan Reef aquifer. The Hobbs and WIPP (Double Eagle PRV4 formerly Double Eagle) public water supply systems rely on the Ogallala aquifer, while the Loving, Malaga, and Otis public water supply wells utilize the Pecos River as their water source.

In 1974, the United States Congress enacted the Safe Drinking Water Act, which mandated the U.S. Environmental Protection Agency (EPA) to establish safe levels of contaminants in drinking water. These safe levels are known as maximum contaminant levels (MCLs). MCLs have been established for various radionuclides. The MCL for radium, for instance, has been set at 0.185 Bq/L (5 pCi/L), while the MCL for uranium is 30 µg/L. For gross alpha radiation (excluding radon and uranium), the MCL is 0.55 Bq/L (15 pCi/L), and for gross beta radiation, the maximum level is 1.85 Bq/L (50 pCi/L). It is important to note that the focus of this report is to monitor the impact of WIPP operations on regional drinking water supplies and should not be used to assess regulatory compliance.

CEMRC has been conducting sampling of drinking water for radiochemical analyses since 1997, with non-radiological analyses being performed since 1998. Summaries of methods, data, and results from previous sampling efforts have been documented in earlier CEMRC reports available on the CEMRC website (http://www.cemrc.org) under the annual reports tab. The current scope of work necessitates the collection of drinking water samples on an annual basis from the six municipal water supply systems in the vicinity of the WIPP, including the City of Carlsbad (Sheep Draw and Double Eagle PRV4), Hobbs, Loving, Malaga, and Otis. These samples undergo both non-radiological and radiological analyses. Radiological analyses are employed to quantify gamma- and beta-radiation-emitting radionuclides, as well as relevant actinides. Further details regarding sample collection and analyses are outlined in the subsequent sections. This chapter presents radiological analysis results specifically for the drinking water samples collected in 2020.

6.1 Sample Collection

Drinking water samples were collected from the drinking water supplies used by communities in the WIPP region. The sources included the community water supplies of Carlsbad (Sheep Draw and Double Eagle PRV4), Loving, Otis, Hobbs, and Malaga. These locations are shown in Figure 6.1.

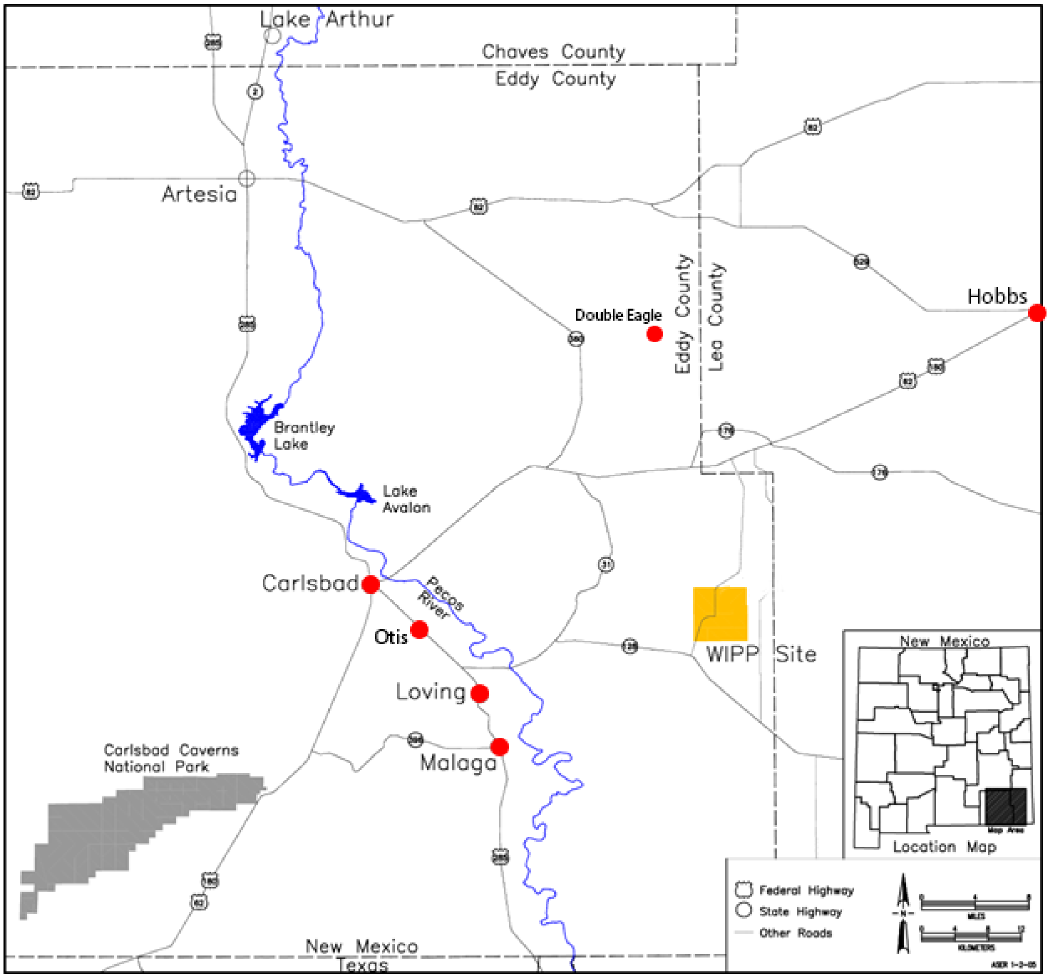


Figure 6.1. Drinking Water Sampling Locations

Drinking water from each sampling location was collected in a 5-gallon plastic water bottle. Water from each sampling location was also used to rinse containers at least three times prior to taking the sample. Approximately 8 L of water were collected from each location. Immediately after collection, the samples were acidified to pH ≤ 2 with concentrated nitric acid to avoid losses through microbial activity and adsorption onto the vessel walls.

6.2 Sample Preparation and Analysis

Drinking water sample containers were shaken and sample aliquots were measured into glass beakers - one 2 L portion for gamma analyses and another 1 L for alpha analyses. The first aliquot was transferred to 2 L Marinelli beakers to measure the gamma-emitting radionuclides by gamma spectroscopy. The second 1 L aliquot was used for the alpha analysis of uranium (U) and transuranic radionuclides by digesting the water samples with concentrated nitric and appropriate tracers on a hot plate. The samples were heated to dryness then wet-ashed using concentrated nitric acid and 30% hydrogen peroxide. Finally, the samples were heated to dryness, redissolved in 1 M HCl, and processed to separate the various isotopes.

6.3 Determination of Individual Radionuclides

A 2 L portion of the acidified water sample in Marinelli beakers was used directly for the gamma spectroscopy to measure the gamma-emitting radionuclides ^{40}K, ^{60}Co, and ^{137}Cs using a high purity germanium (HPGe) detector (Mirion Technologies Inc.) for 48 hours. The other 1 L portion of water was prepared by co-precipitating the target radionuclides and corresponding tracers with an iron carrier, performing ion exchange and chromatographic separations of the individual radionuclides, followed by micro-precipitating the separated radionuclides onto planchets for counting. The uranium isotopes and transuranics were counted using alpha spectroscopy for five days. Portions of digested solutions containing strontium were co-precipitated with barium as a carbonate, then dissolved in nitric acid and barium precipitated out as chromate. The supernatants obtained were mixed with ammonium hydroxide (NH_4OH) and saturated ammonium carbonate $(NH_4)_2CO_3$ to precipitate strontium as strontium carbonate ($SrCO_3$), and the beta-radiation-emitting radioactive isotope ^{90}Sr was then counted by liquid scintillation counting. Details are described in procedure WL-1011.

6.4 Results and Discussion

The radionuclide activities are reported as activity concentrations in Bq/L. Activity concentrations are calculated as the activity of radionuclides reported in Becquerel (Bq) divided by the volume of the drinking water in liters (L).

6.4.1 Actinide Concentrations in Drinking Water

The concentrations of ^{238}Pu, $^{239+240}Pu$, ^{241}Am, ^{234}U, ^{235}U, and ^{238}U in regional drinking water samples in 2020 are listed in Appendix E, Table E.1. The alpha-emitting radionuclides ^{238}Pu, $^{239+240}Pu$, and ^{241}Am were not detected in any of the drinking water samples in 2020, which is consistent with results from previous years. These radionuclides have not been detected in any of the drinking water samples above the MDC since monitoring commenced in 1997. The federal and state action level for gross alpha emitters, which includes isotopes of Pu and U, is 0.56 Bq/L. This level is over 10,000 times the MDCs used at CEMRC. The historical concentrations of $^{239+240}Pu$, ^{238}Pu, and ^{241}Am measured in the drinking water from the six municipal water supply systems in the vicinity of the WIPP site are shown in Figures 6.2 through 6.7.

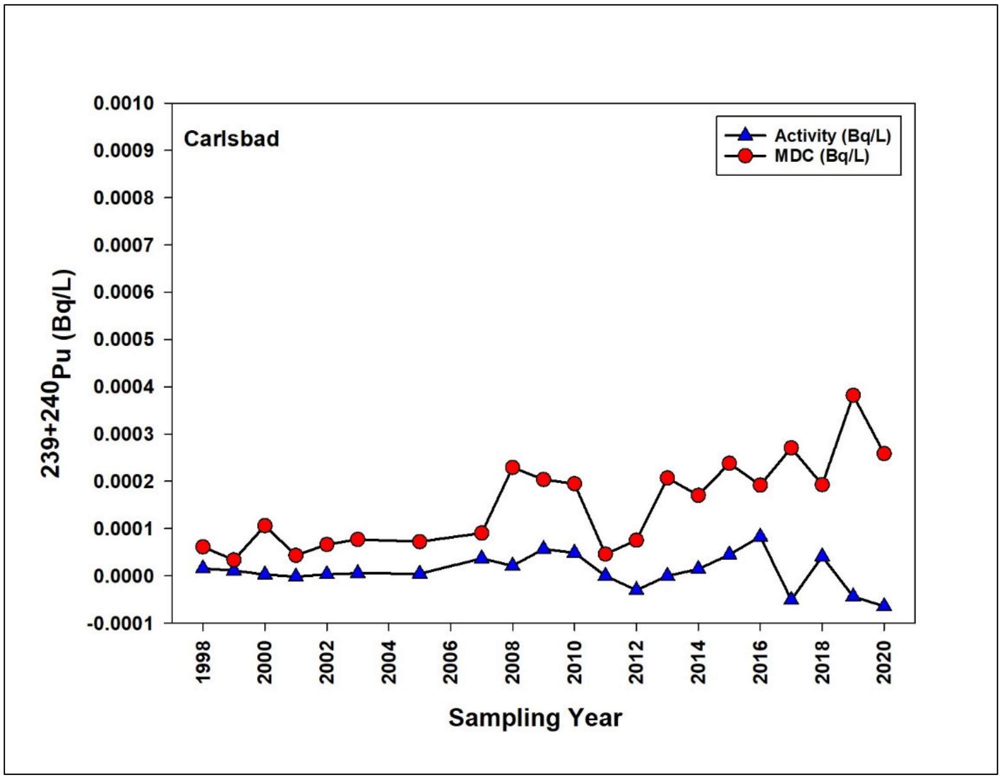
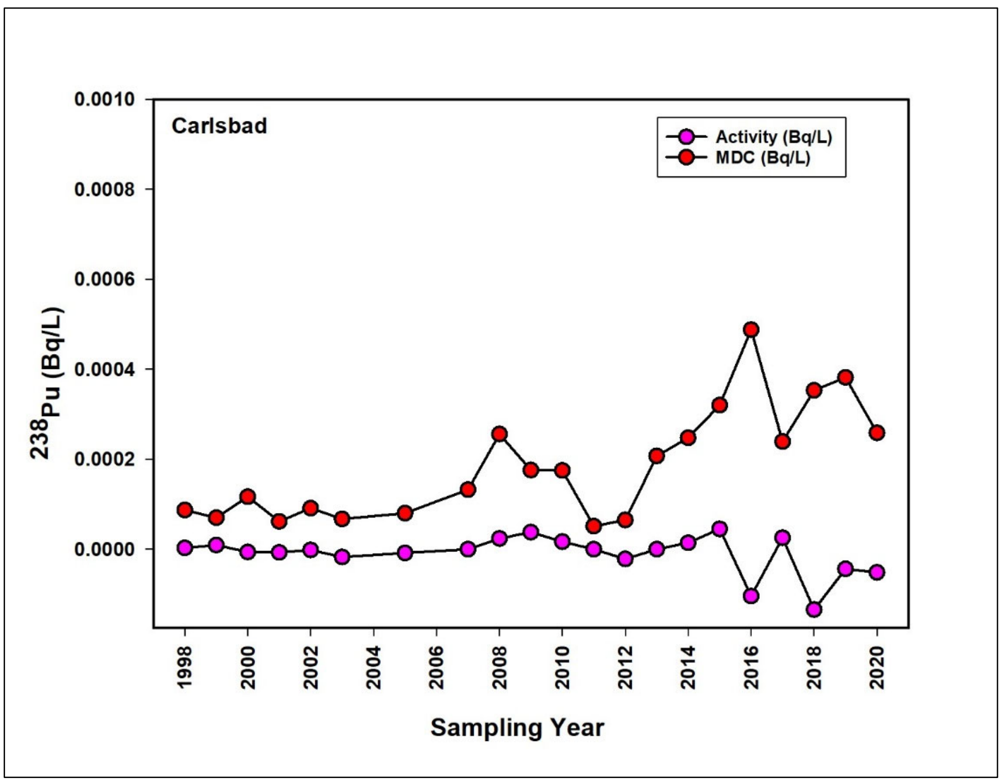


Figure 6.2. $^{239+240}Pu$ Concentrations in Carlsbad Drinking Water



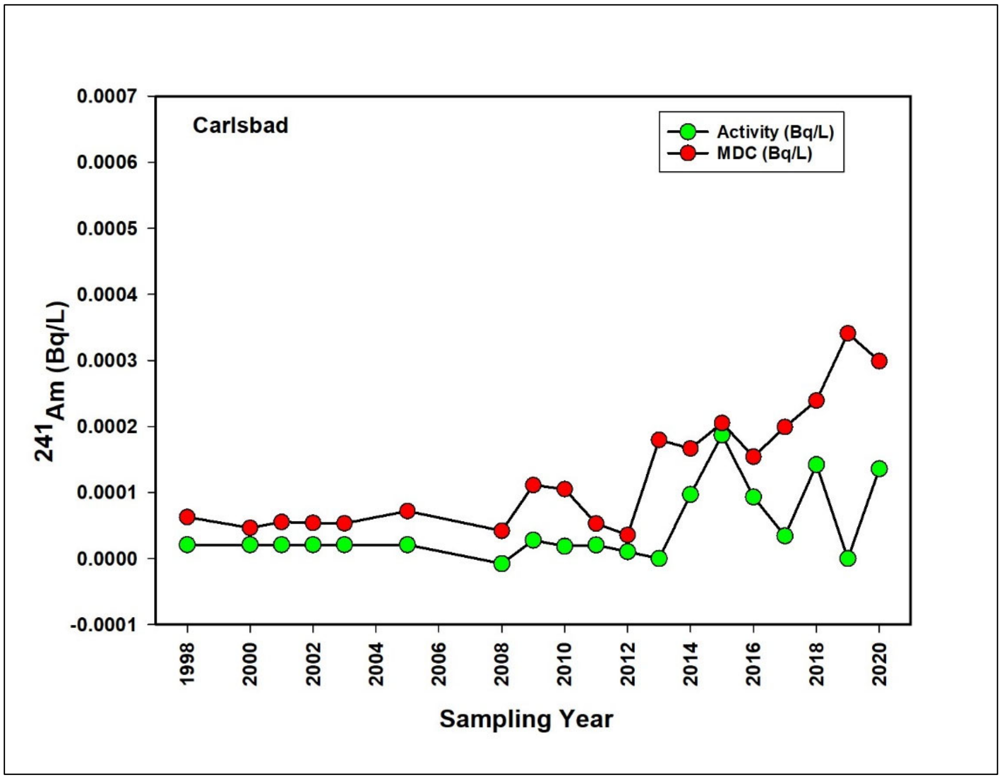
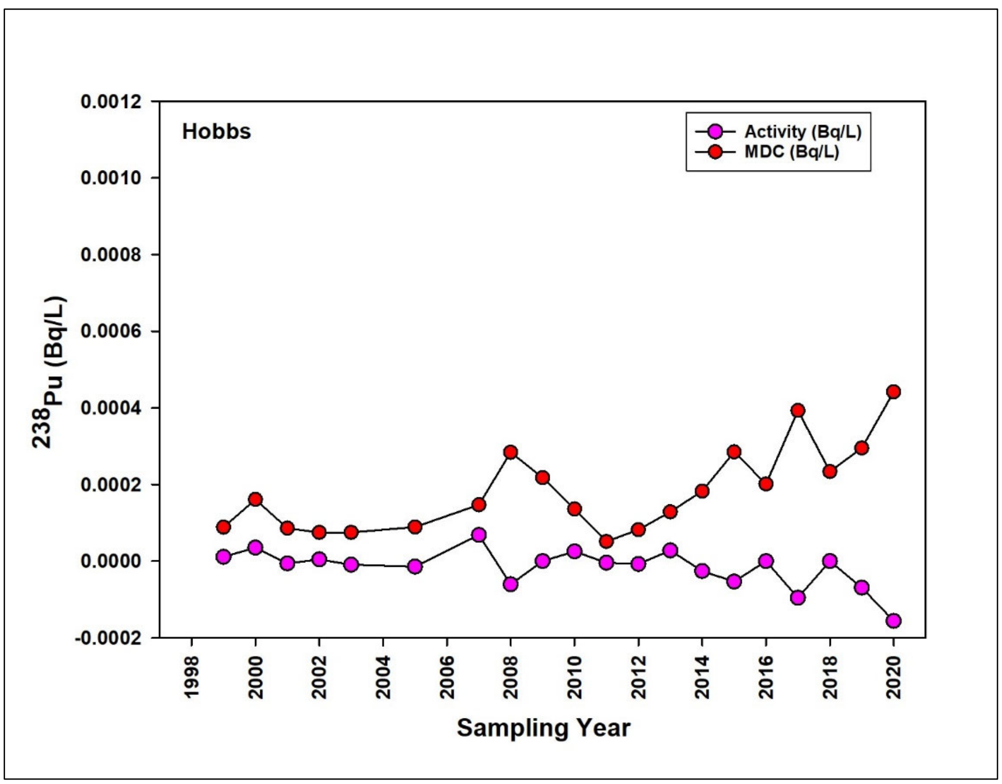


Figure 6.3. ^{238}**Pu and** ^{241}**Am Concentrations in Carlsbad Drinking Water**



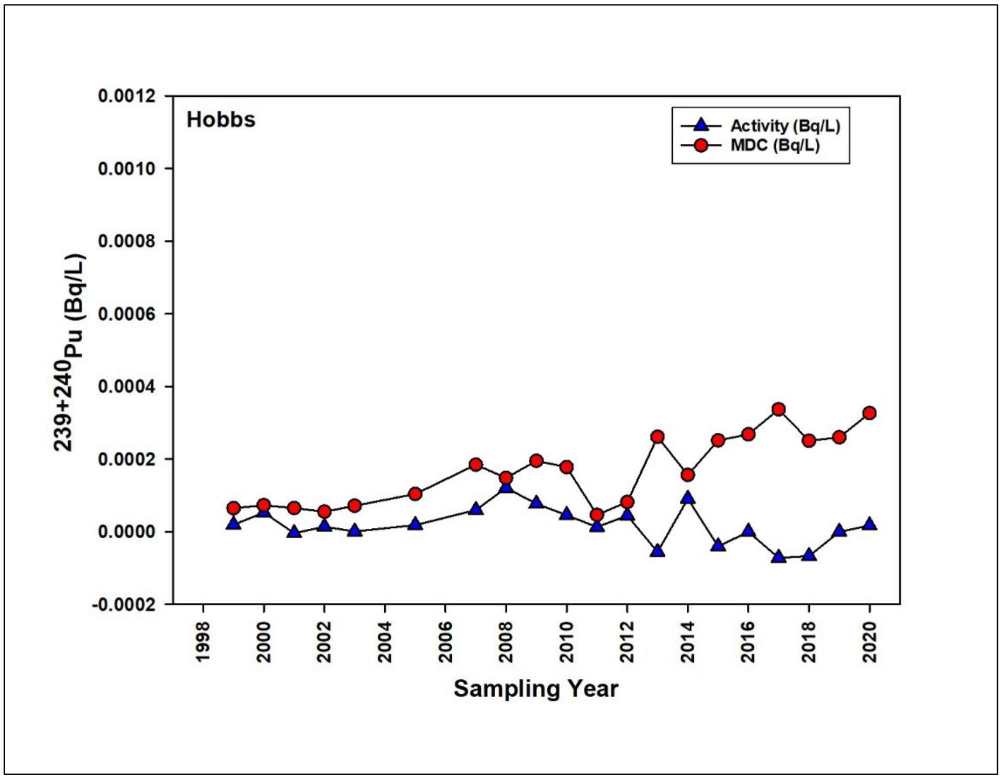
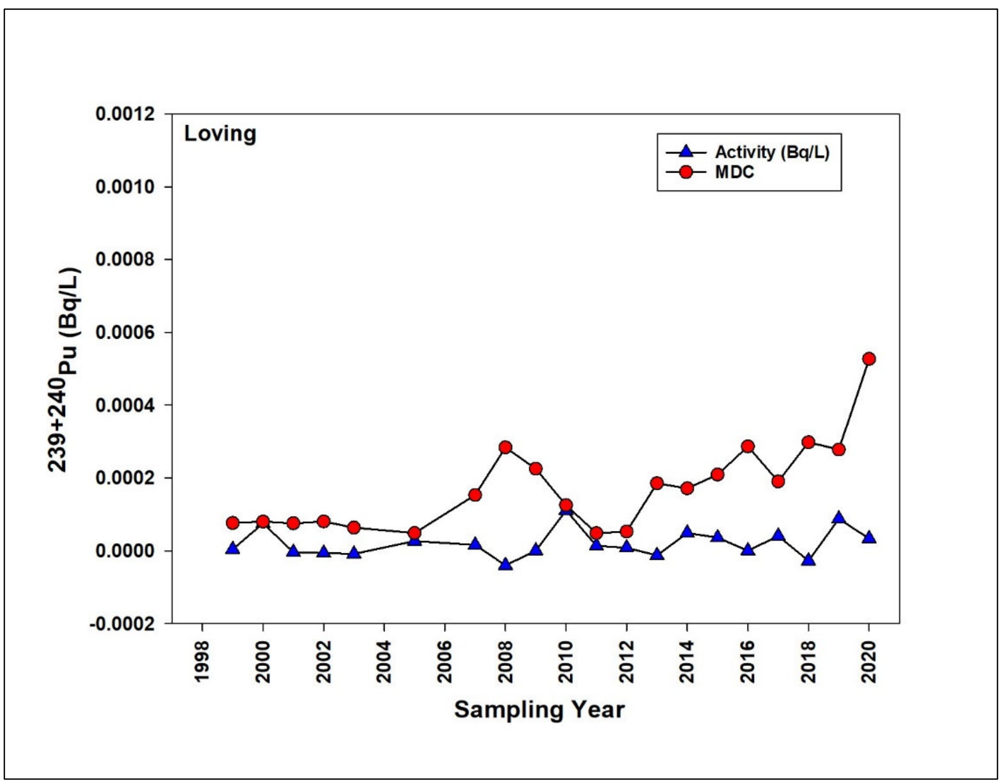


Figure 6.4. ^{238}Pu and $^{239+240}$Pu Concentrations in Hobbs Drinking Water



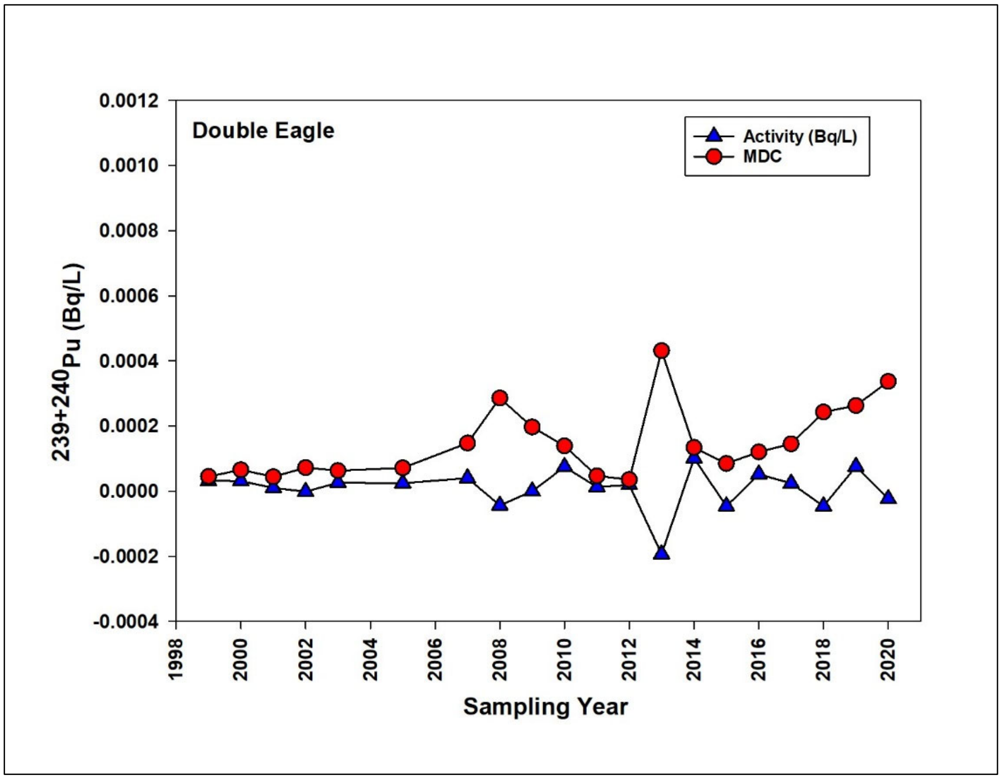
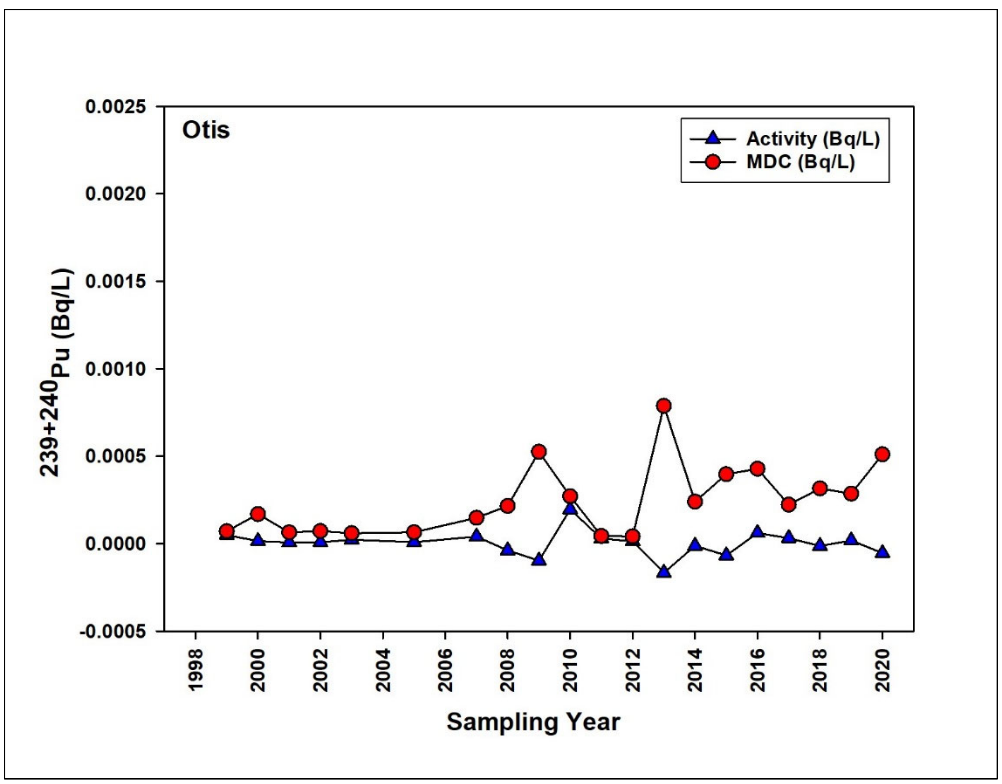


Figure 6.5. $^{239+240}$Pu Concentrations in Loving and Double Eagle Drinking Water



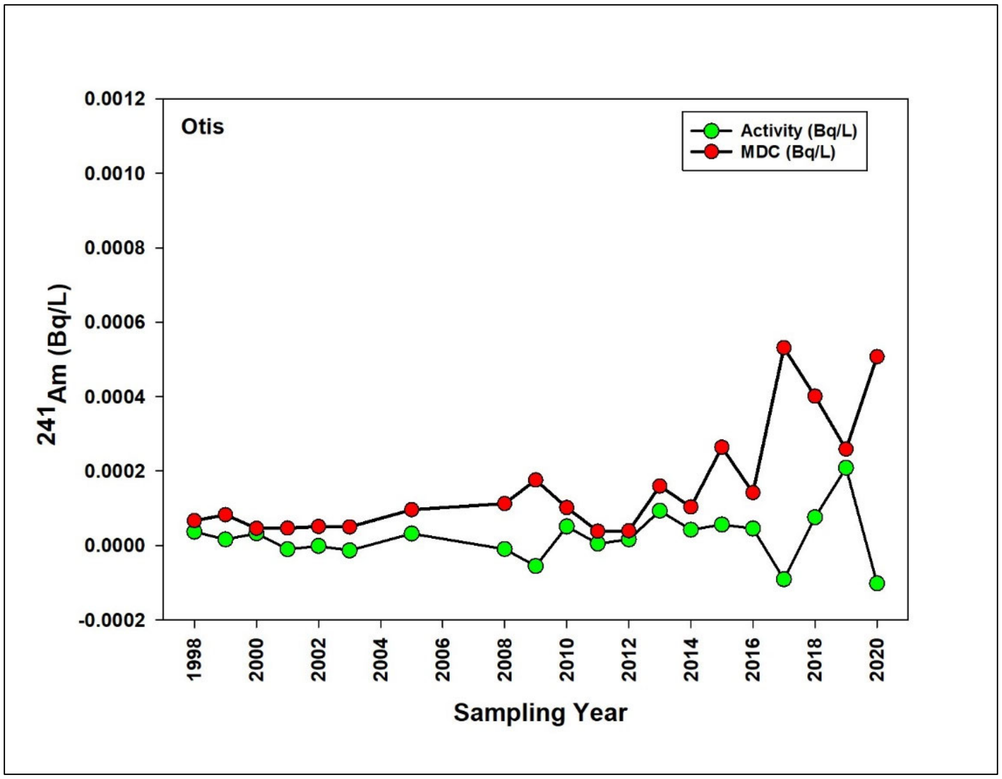
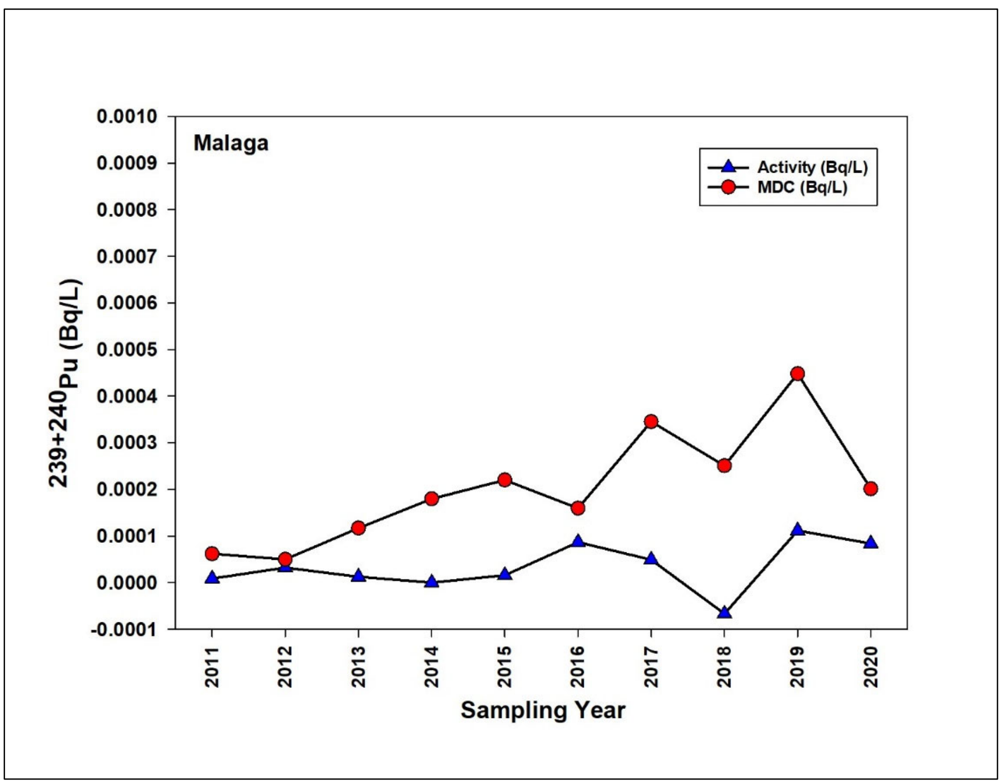


Figure 6.6. $^{239+240}$Pu and ^{241}Am Concentrations in Otis Drinking Water



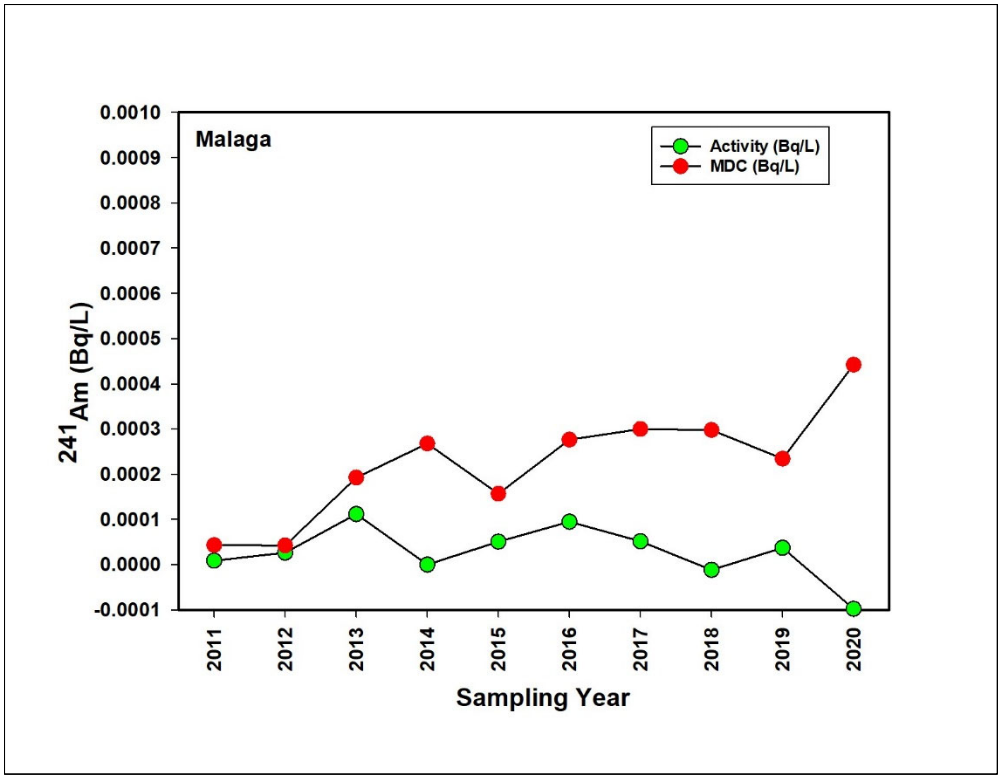


Figure 6.7. $^{239+240}$Pu and ^{241}Am Concentrations in Malaga Drinking Water

6.4.2 Uranium Concentrations in Drinking Water

Isotopes of naturally occurring uranium were detected in all drinking water samples in 2020. Uranium concentrations measured in the communities' drinking water near the WIPP site were in the range of 10.70-69.30 mBq/L for ^{238}U, 0.68-3.90 mBq/L for ^{235}U, and 27.90-186.00 mBq/L for ^{234}U, as shown in Appendix E, Table E.2. These uranium activity concentrations are well below the EPA recommended level of 746 mBq/L and are within the range expected in waters from this region. According to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 2008), the ^{238}U concentration in drinking water is about 0.5-149 mBq/L in the U.S. Cothern and Lappenbusch (1983), conducted an extensive investigation of radioactivity in drinking water in the U.S. Of the 59,812 community drinking water supplies tested in the U.S., a projected 25 to 650 exceeded a U concentration of 746 mBq/L; 100 to 2,000 exceeded 370 Bq/L; and 2,500 to 5,000 exceeded 185 mBq/L. The levels detected in the communities' drinking water sources near the WIPP site were also within the U.S.'s expected range. The concentrations of ^{234}U, ^{235}U, and ^{238}U in these drinking water locations measured in 2020 are shown in Figure 6.8. The historical activity concentrations of ^{234}U, ^{235}U, and ^{238}U measured at each site in the regional drinking water are summarized in Appendix E, Tables E.3 through E.8.

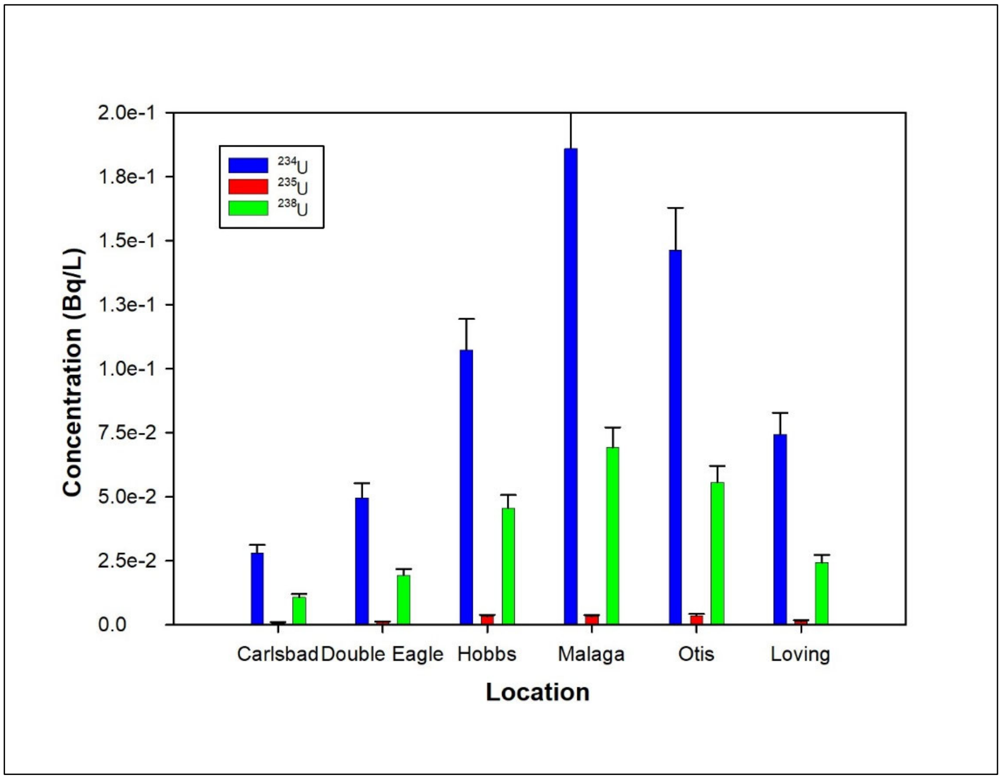


Figure 6.8. The ^{234}U, ^{235}U, and ^{238}U Concentrations (Bq/L) in Regional Drinking Water

The low activity concentration of ^{235}U in the water samples is consistent with the lower activity concentration of ^{235}U in the natural environment as compared to the activity concentrations of ^{234}U and ^{238}U. The highest activity concentrations were found in Malaga and Otis drinking waters.

Uranium in the environment occurs naturally as three radioactive isotopes. ^{238}U (99.27%), ^{235}U (0.72%), and ^{234}U (0.005%). These isotopes of uranium are also found in the earth's crust, in rocks and minerals such as granite, metamorphic rocks, lignite, monazite sand, in phosphate deposits, and in uranium minerals such as uraninite, carnotite, and pitchblende. It is also present as a trace element in coal, peat, asphalt, and some phosphate fertilizers at a level of about 100 µg/g or 2.5 Bq/g (Hess et al, 1985). All these sources can come in contact with water which may be used for drinking purposes. Thus, it is expected that some drinking and surface water sources will contain uranium.

The natural level of uranium in water can also be enhanced due to human activity. For example, the increased concentration of natural radionuclides in water can be caused by the intensive use of phosphate fertilizers in agriculture. The average phosphate fertilizers contain about 100 µg/g (or 24.8 Bq/g), of naturally occurring uranium (Cothern and Lappenbusch, 1983), which can leach from the soil to nearby rivers and lakes (Fleischer, 1980; UNSCEAR, 1982).

The $^{234}U/^{238}U$ activity ratio measured in regional drinking water from 1998 through 2020 is shown in Figure 6.9. Also shown in Figure 6.9 is the $^{234}U/^{238}U$ activity ratio measured in regional drinking water for 2020 for comparison. The $^{234}U/^{238}U$ activity ratio in these drinking water sources varies between 1.99 and 3.21 historically, which means that the two isotopes are not in radioactive equilibrium. Specifically, the activity of ^{234}U is higher than that of ^{238}U, as shown in Figure 6.8. The $^{234}U/^{238}U$ activity ratio usually ranges between 1.0 and 3.0 (Cherdynstev et al. 1971; Gilkeson et al. 1982). In radiochemical equilibrium, natural activity ratios are typically unity (1.0) for $^{234}U/^{238}U$ and 0.045 for $^{235}U/^{238}U$ (Pimple et al, 1992). However, many studies of ^{238}U and ^{234}U in natural bodies of water indicate that these isotopes are not in equilibrium and that, with a few exceptions, waters typically contain more ^{234}U than ^{238}U (Cothern et al. 1983; Skwarzec et al. 2002). Higher activity of ^{234}U in water is the result of the ^{234}U atom displacement from the crystal lattice. The recoil atom, ^{234}U, is liable to be oxidized to the hexavalent stage and can be leached into the water phase more easily than its parent nuclide ^{238}U. The oxidation of U(IV) to U(VI) is an important step in leaching because of the higher solubility of U(VI) compounds. All U(IV) compounds of uranium are practically insoluble. The variations in $^{234}U/^{238}U$ activity ratio measured in regional drinking water since 1998 are shown in Figure 6.10.

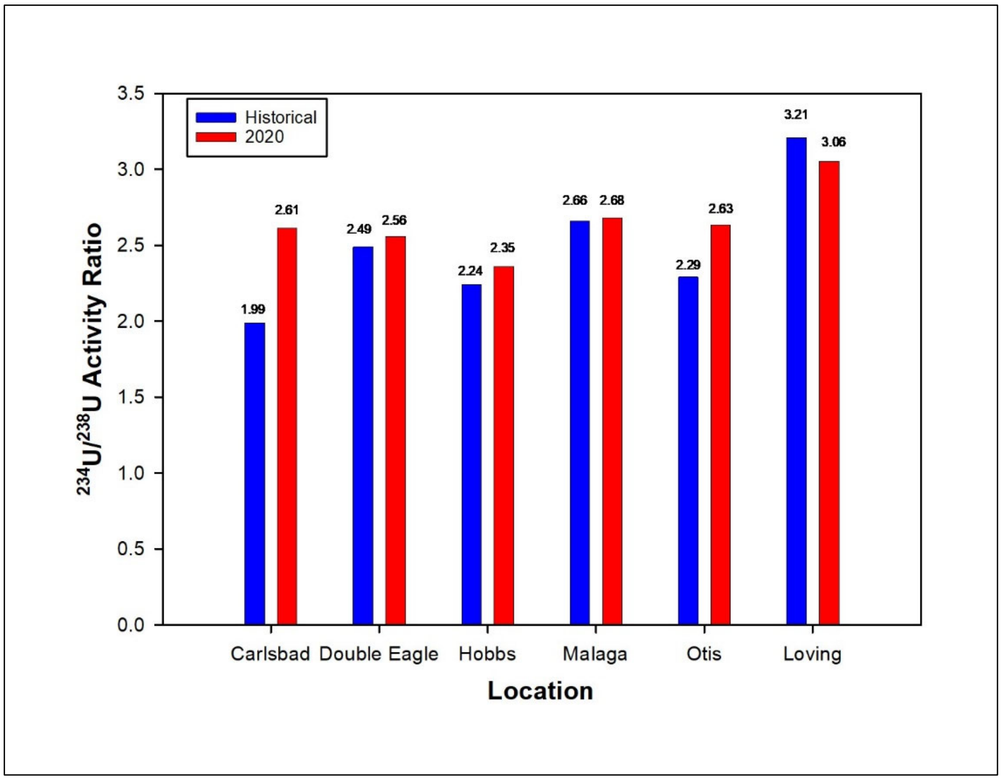


Figure 6.9. $^{234}U/^{238}U$ Activity Ratio in Regional Drinking Water from 1998-2020

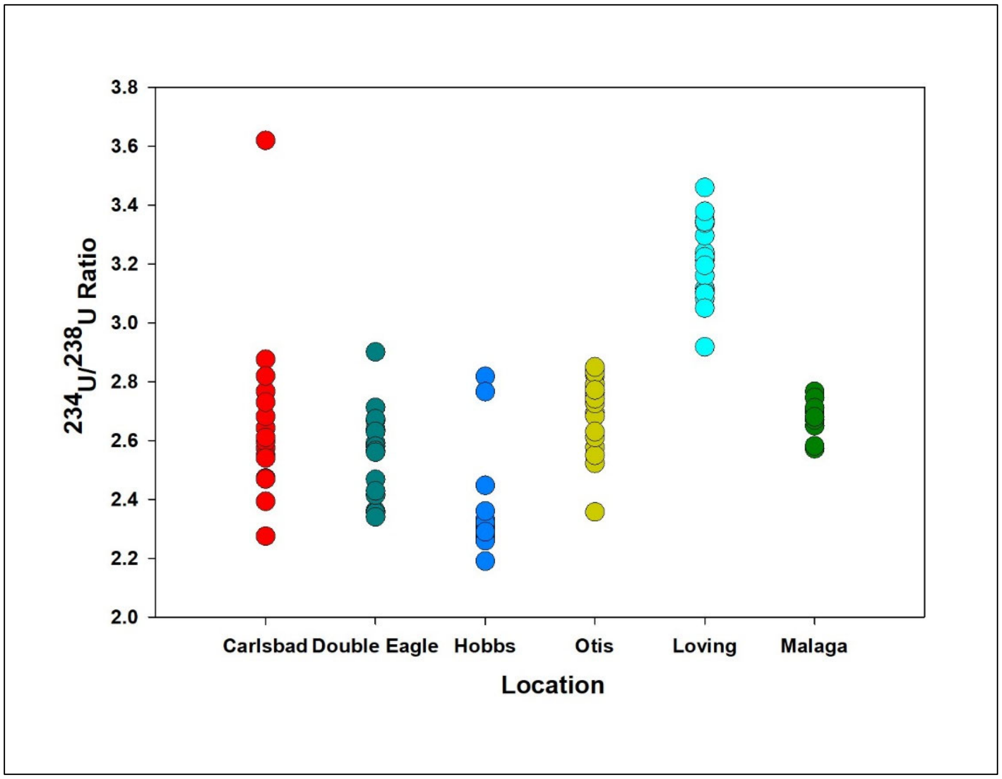


Figure 6.10. Variation in $^{234}U/^{238}U$ Activity Ratio in Regional Drinking Water from 1998-2020

6.4.3 Gamma Radionuclide Concentrations in Drinking water

The gamma emitting radionuclides ^{40}K, ^{137}Cs, and ^{60}Co were not detected in any of the drinking water samples in 2020. However, the naturally occurring gamma-emitting radionuclide ^{40}K was detected in Hobbs drinking water sample at a level of 1.35 Bq/L in 2014. ^{40}K was also detected in Carlsbad, Malaga, and Otis drinking waters at a level of 1.10-1.19 Bq/L in 2013. This naturally occurring gamma-emitting radionuclide is ubiquitous in nature; therefore, an occasional detection of ^{40}K in drinking water is not unusual. There was no significant difference between concentrations of ^{40}K among sampling locations; the values also fell within the range of concentrations observed previously in these drinking water locations. The other two gamma radionuclides, ^{137}Cs and ^{60}Co, were not detected in any of the drinking water samples, as shown in Appendix E, Table E.9. Because these isotopes were not detected, no comparisons between years or among locations were performed.

6.4.4 Strontium Concentrations in Drinking Water

The beta emitting radionuclide ^{90}Sr was not detected in any of the drinking water samples in 2020.

6.5 Conclusion

This chapter summarizes the results of the drinking water monitoring program for the calendar year 2020. It is important to note that after more than twenty years of monitoring, isotopes of plutonium (^{238}Pu and $^{239+240}Pu$) and ^{241}Am, have never been detected above the MDC in any of the sampling locations in and around the WIPP. However, the isotopes of uranium ^{234}U, ^{238}U, and ^{235}U were detected in all drinking water samples. The concentrations of uranium measured were in the range of 10.70-69.30 mBq/L for ^{238}U, 0.68-3.90 mBq/L for ^{235}U, and 27.90-186.00 mBq/L for ^{234}U. The levels detected were well below the EPA recommended level of 746 mBq/L and are within the range expected in waters from this region. The $^{234}U/^{238}U$ activity ratio indicates U presence in drinking water is most likely from natural sources. Present results, as well as the results of previous analyses of drinking water, were consistent for each source across sampling periods. The beta emitting radionuclide ^{90}Sr was not detected in any of the drinking water samples in 2020. There is no evidence of increases in radiological contaminants in the region that could be attributed to the 2014 release event at the WIPP or WIPP-related activities.

CHAPTER 7 - SEDIMENT MONITORING

7.1 Introduction

Sediments are finely divided solid materials that have settled out of a liquid stream or from standing water. The sediments accumulate soluble radionuclides by sorption on suspended sediment and insoluble radionuclides by settling. CEMRC has been monitoring sediment samples from the three public reservoirs in the vicinity of WIPP, Brantley Lake, Lake Carlsbad, and Red Bluff Lake, since 1998. Many sediment samples contained the fission-product ^{137}Cs; a few contained fission products ^{90}Sr and ^{134}Cs; activation-products ^{60}Co, ^{58}Co, ^{54}Mn, and ^{65}Zn; and the transuranic isotopes $^{239+240}$Pu and ^{241}Am. These radionuclides in sediments are mainly attributed to discharges at the monitored facilities. Some ^{137}Cs, ^{90}Sr, and ^{239}Pu are fallout from atmospheric nuclear tests, which peaked in 1962-1963 and, to a minor extent, from nuclear accidents, including the accidents at Chernobyl, Ukraine, and Fukushima, Japan. Naturally occurring radionuclides uranium, thorium, and ^{40}K were also detected. Many of the measured values were low, near the limits of detection. Assuming measured activities were high enough, the accumulation of radioactive materials in sediment could lead to human exposure through the ingestion of aquatic species, sediment re-suspension into drinking water supplies, or as an external radiation source (U.S. Department of Energy 1991).

To evaluate current conditions, CEMRC sampled sediment in the vicinity of the WIPP site in November 2020. The scope of work requires sediment samples to be collected annually from the same three public water reservoirs situated along the Pecos River. These locations include Brantley Lake, approximately 55 km (34 mi) north-northwest of the WIPP site, Red Bluff Lake on the Pecos River, the upstream end of which is the nearest standing water body approximately 48 km (30 mi) southwest of the WIPP site, and Lake Carlsbad in the center of Carlsbad about 40 km (25 mi) northwest from the WIPP site. Radiological analyses were performed to evaluate current radionuclide trends, especially Pu and Am, in the vicinity of the WIPP site. Details of the sample collection and analyses are described in the following sections. In this chapter, radiological analyses results are reported for the surface sediment samples collected in 2020.

7.1.1 Sample Collection

Sediment samples were collected at randomly selected locations within the deep basins of each reservoir. Deep basins were chosen for sampling to minimize the disturbance and particle mixing effects of current and wave action that occur at shallower depths. Also, many of the analytes of interest tend to concentrate on the fine sediments that settle in the deep reservoir basins; thus, measurements from these areas would typically represent the highest levels that might be expected for a given reservoir.

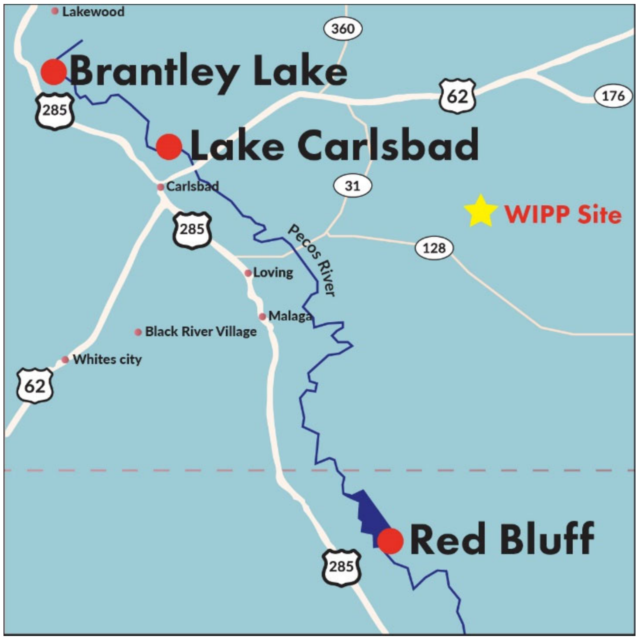


Figure 7.1. Sediment Sampling Locations

Sediment samples were collected at depths of 5-10 cm, using a grab sampler or Eckman dredge, to obtain approximately 5 L of sediment at each sampling site, as shown in Figure 7.2. Excess water was decanted from the sediment upon collection. The wet sediment was sealed in a pre-cleaned plastic bucket in the field and transported to the CEMRC laboratory for preparation before radiological analyses.

Figure 7.2. Sediment Sample Collection by CEMRC Personnel

7.2 Sample Preparation and Analysis

Sediment samples were dried at 105 °C for at least 12 hours and blended before sampling in the laboratory. The samples for gamma analysis were sealed in a 300 mL paint can and stored for at least 21 days to allow radon progeny to reach equilibrium with parent radionuclides before counting. Dried and sieved soil samples were counted for 48 h in a high purity germanium detector, HpGe (Mirion Technologies). The counting containers held approximately 500 g of sediments.

Samples for actinide analyses were dried at 105 ˚C and ground into a fine analytical powder using a shatter box grinder. For radiochemical analyses, 4-5 g of sample were heated in a muffle furnace at 500 ˚C for at least six hours to combust organic material. Each sample was then spiked with a radioactive tracer and digested in a Teflon beaker with hydrochloric, nitric, and hydrofluoric acids. Sea sand was used as a matrix for Laboratory Control Standard (LCS) and reagent blank. To remove hydrofluoric acid, the sample residues were heated with perchloric acid and boric acids. Finally, the residues were dissolved in nitric acid for processing the individual radionuclide concentrations.

7.2.1 Radiochemical Analysis

The actinides were then separated as a group by co-precipitation on $Fe(OH)_3$. Plutonium was separated from americium and uranium using an anion exchange column, while uranium was separated from americium on a TRU chromatography column. After separation, plutonium and uranium fractions were purified on the second anion exchange column, and the americium was subsequently purified from lanthanides on TEVA. Finally, Pu, Am, and U were micro co-precipitated on stainless steel planchettes for alpha spectrometry (Mirion Technologies) and counted for five days as per CEMRC's standard counting protocol. Portions of digested solutions containing strontium were co-precipitated with barium as a carbonate, then dissolved in nitric acid and barium precipitated out as chromate. The supernatants obtained were mixed with ammonium hydroxide (NH_4OH) and saturated ammonium carbonate $(NH_4)_2CO_3$ to precipitate strontium as strontium carbonate ($SrCO_3$), and the beta-radiation-emitting radioactive isotope ^{90}Sr was then counted by liquid scintillation counting. Details are described in procedure WL-1011.

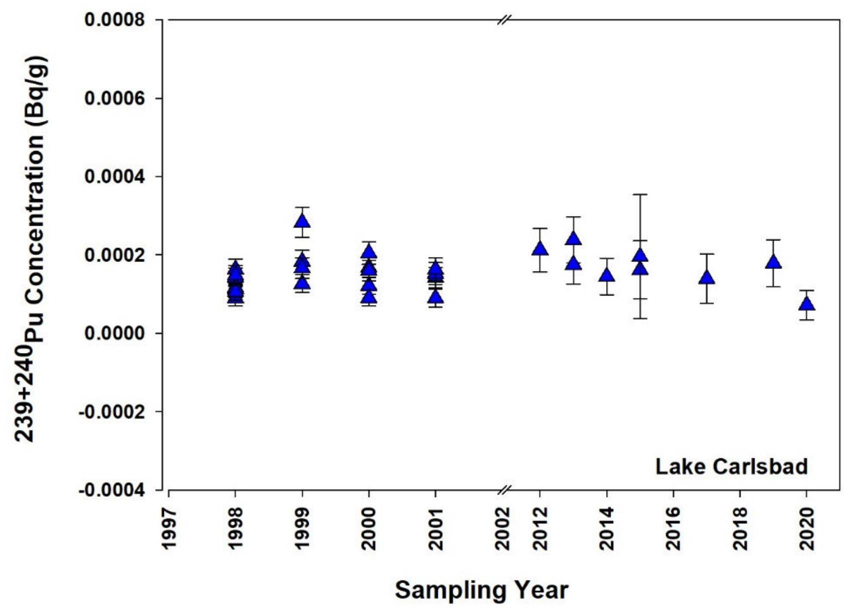
7.3 Results and Discussion

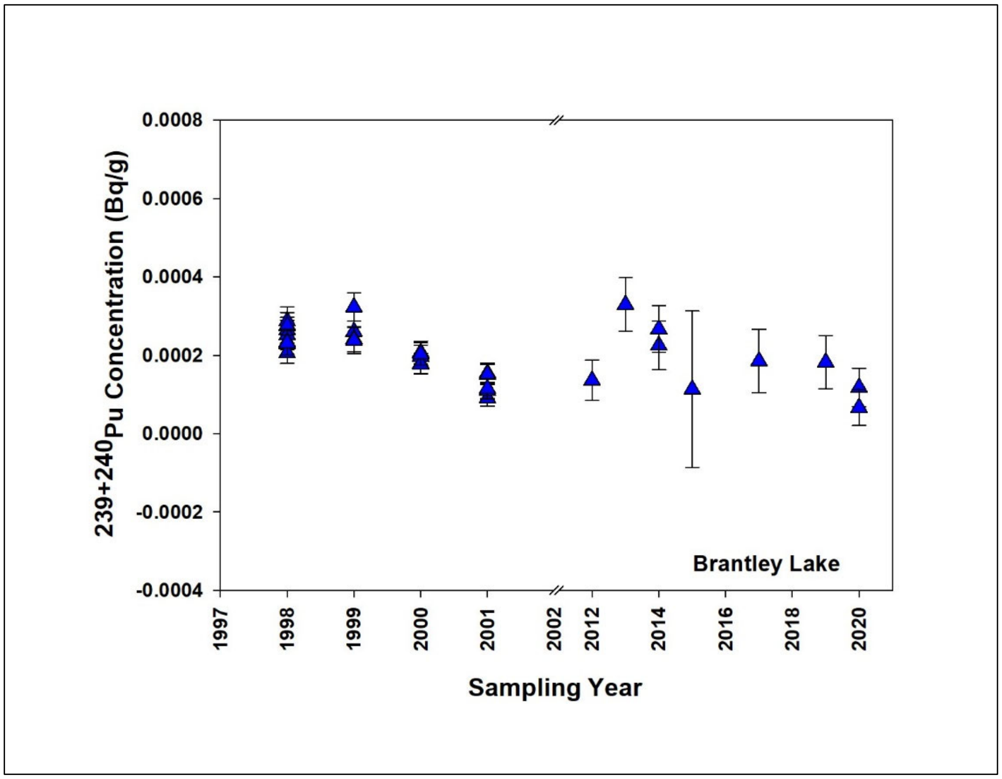
The activities of the radionuclides in the sediment samples are reported as activity concentrations in Bq/g. The activity concentration is calculated as the activity of radionuclides reported in Becquerel (Bq) divided by the mass of the sediment in grams (g).

7.3.1 Actinide Concentrations in Sediments

The individual concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the sediment samples collected from three regional reservoirs are summarized in Table F.1 (Appendix F). $^{239+240}$Pu concentrations slightly greater than MDC were detected in all sediment samples, whereas ^{238}Pu was not detected in any of the sediment samples collected in 2020 and ^{241}Am was detected only in Red Bluff Lake sediments. The baseline concentrations of $^{239+240}$Pu ranged from 0.07 to 0.41 mBq/g with the mean values of 0.13±0.03 mBq/g for Lake Carlsbad, 0.26±0.02 mBq/g for Brantley Lake, and 0.36±0.07 mBq/g for the Red Bluff Lake (CEMRC, 1998). The activity concentrations of $^{239+240}$Pu in Lake Carlsbad, Brantley Lake, and Red Bluff Lake varied between 0.066 and 0.165 mBq/g. Therefore, the concentrations of $^{239+240}$Pu measured in the sediment samples in 2020 were within the range of the 1998 baseline phase data.

The levels of radionuclides in the sediment samples from the three reservoirs in 2020 showed no detectable increases above those typical of previously measured natural variation. The $^{239+240}Pu$ activities are highest in the sediment collected from Red Bluff Lake (0.165 mBq/g). The activity concentrations of ^{241}Am in Lake Carlsbad, Brantley Lake, and Red Bluff Lake varied between 0.025 and 0.109 mBq/g. The comparison of activity concentrations of ^{241}Am, $^{239+240}Pu$, and ^{238}Pu determined that the baseline and monitoring phase activities reflect no increase in radionuclide concentrations for 2020, as shown in Figure 7.3.





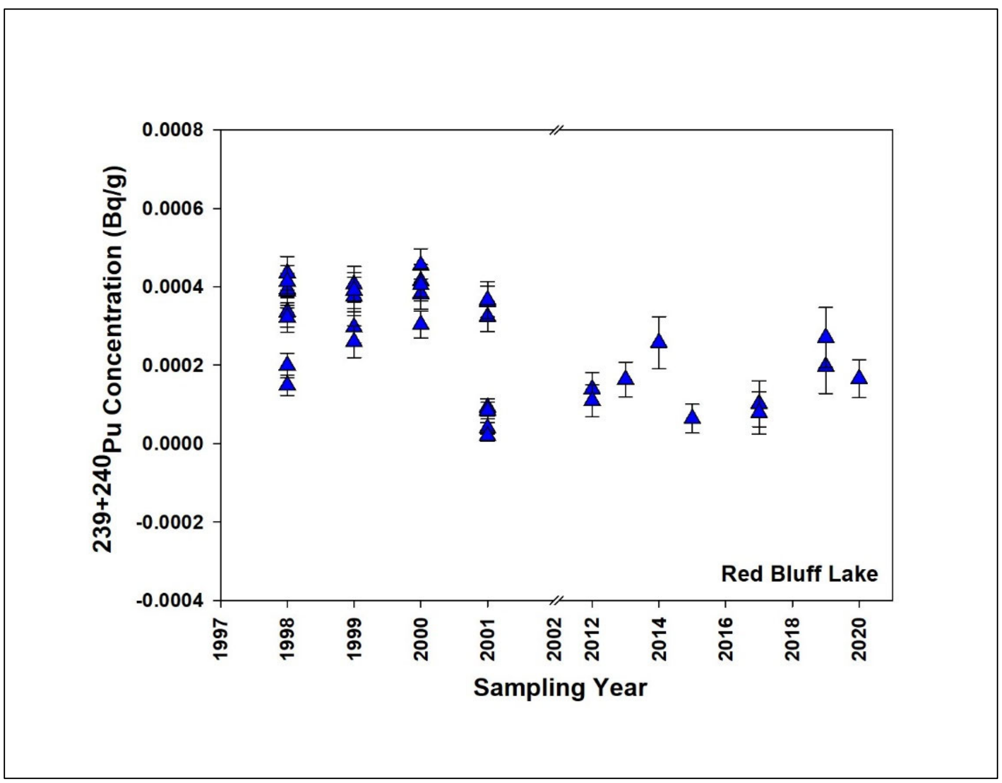
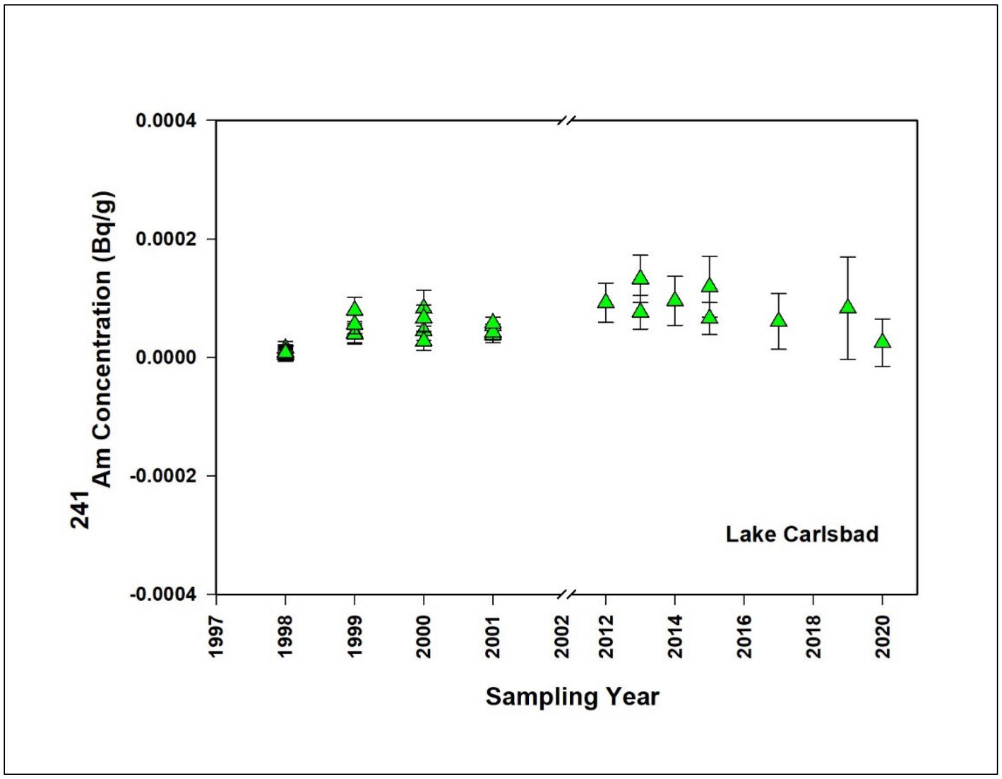
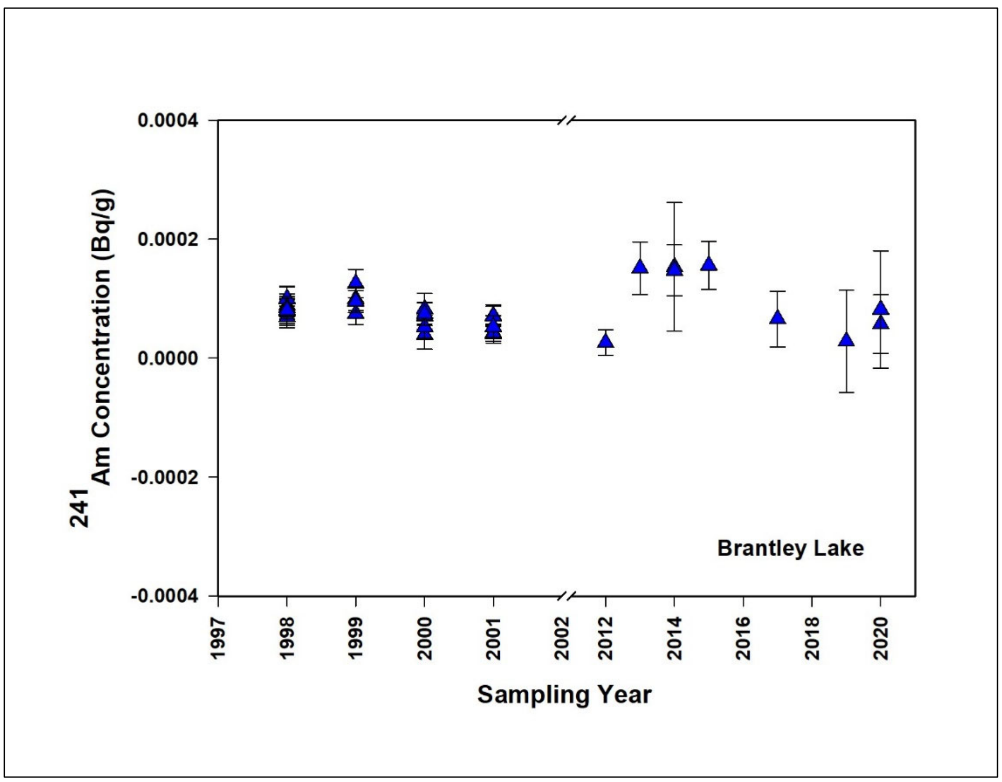


Figure 7.3. Historical Concentrations of $^{239+240}$Pu in Regional Reservoir Sediments


0.0004
0.0002
0.0000
-0.0002
-0.0004
241 Am Concentration (Bq/g)
Lake Carlsbad
1997
1998
1999
2000
2001
2002
2012
2014
2016
2018
2020
Sampling Year


0.0004
0.0002
0.0000
-0.0002
-0.0004
241 Am Concentration (Bq/g)
Brantley Lake
1997
1998
1999
2000
2001
2002
2012
2014
2016
2018
2020
Sampling Year

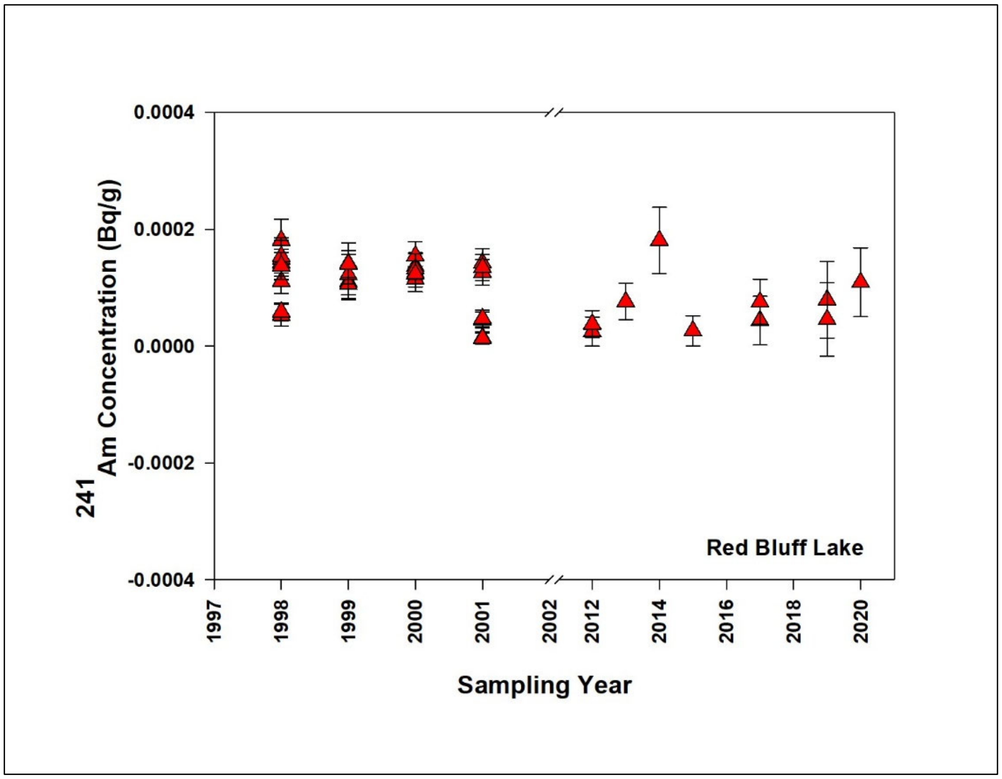


Figure 7.4. Historical Concentrations of ^{241}Am in Regional Reservoir Sediments

7.3.2 Uranium Concentrations in Sediments

Uranium isotopes (^{234}U, ^{235}U, and ^{238}U) were detected in all sediment samples collected in 2020. The concentrations of uranium isotopes measured in the sediment samples are presented in Table F.2 (Appendix F). The concentrations range of uranium isotopes measured in the sediment samples collected from all three reservoirs in 2020 are shown in Figure 7.5. The concentrations of ^{238}U were lowest in Lake Carlsbad and highest in Red Bluff Lake, while that of ^{234}U were lowest in Carlsbad Lake and highest in Brantley Lake.

Although the sediment concentrations of uranium isotopes were variable between reservoirs, the isotopic ratios were very similar between Carlsbad Lake and Red Bluff Lake. The Lakes appeared to be slightly enriched in ^{234}U compared to ^{238}U, with the activity ratios ranging from 1.53 to 1.62 as shown in Figure 7.6.

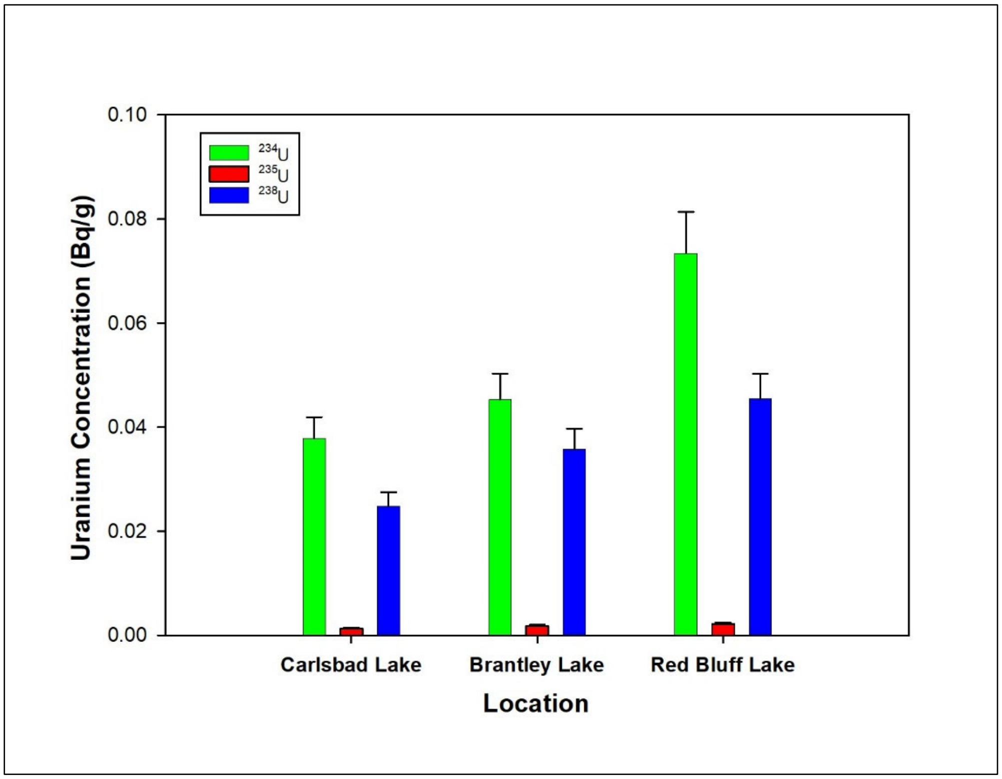


Figure 7.5. ^{234}U, ^{235}U, ^{238}U Concentrations in Sediment Samples in Three Regional Reservoirs in 2020

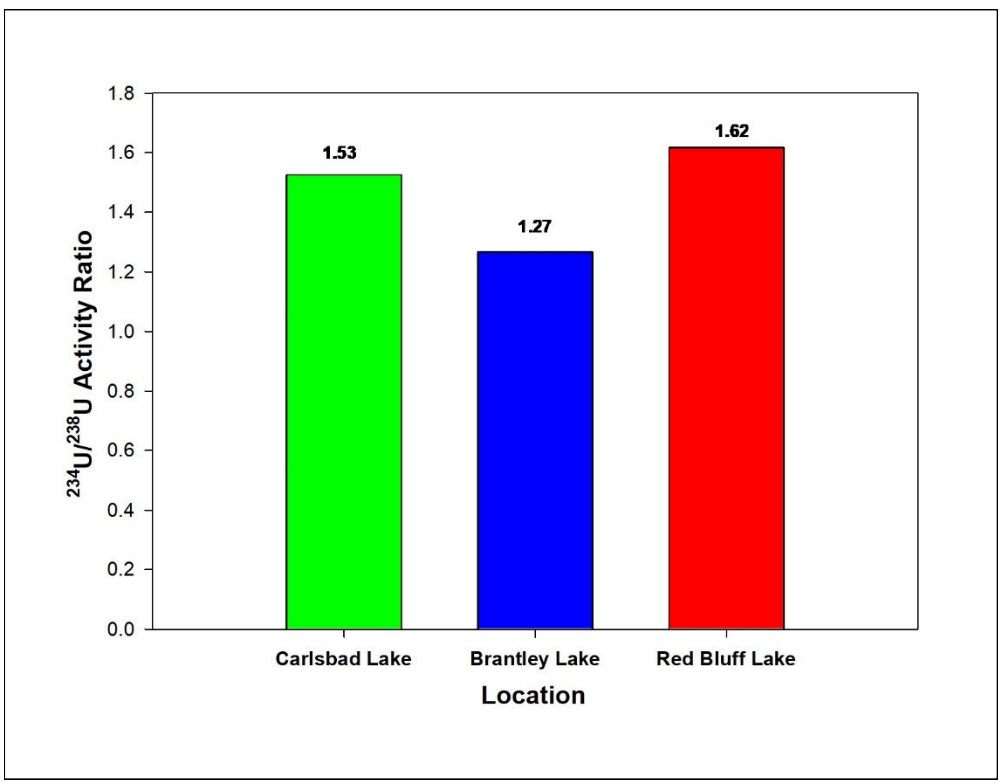
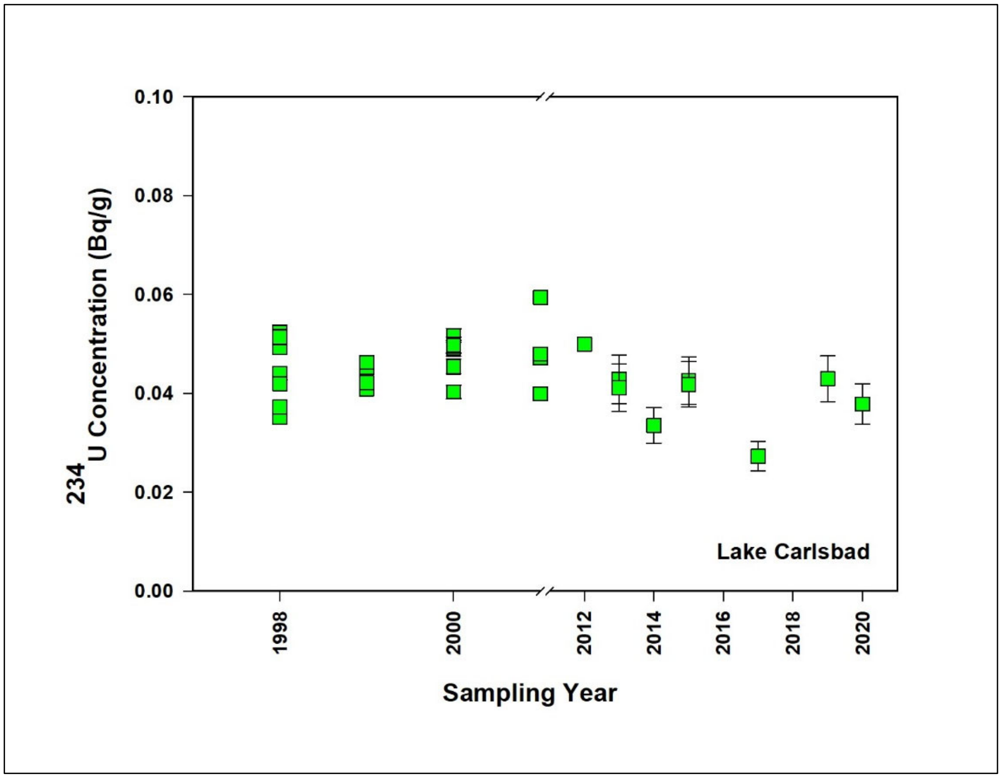
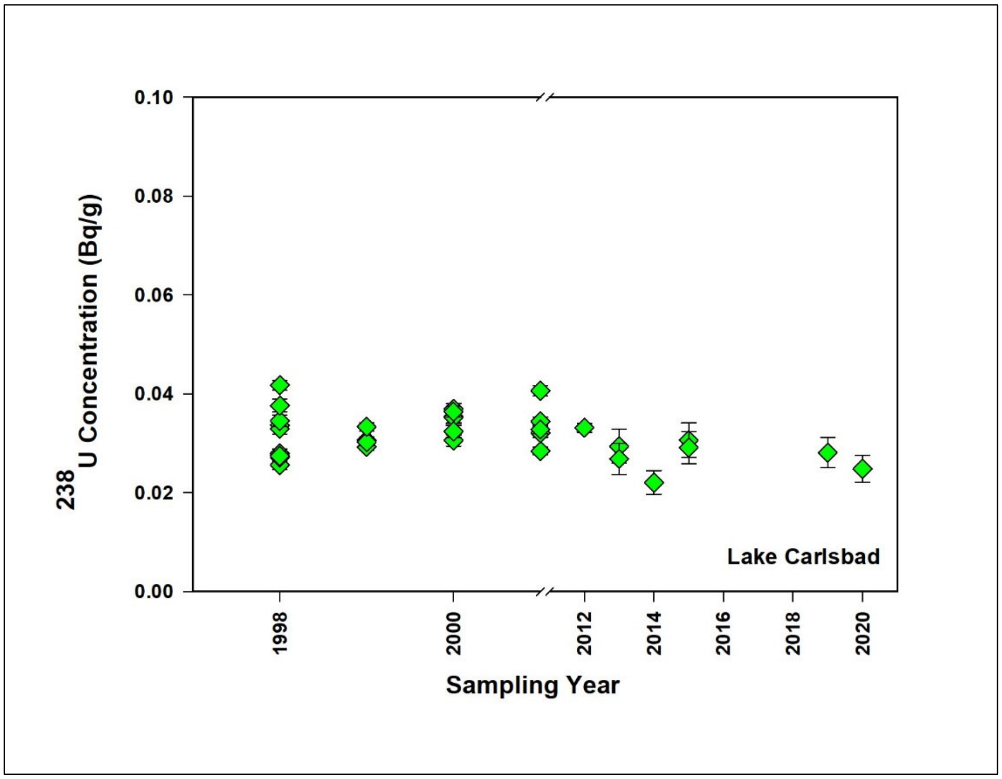
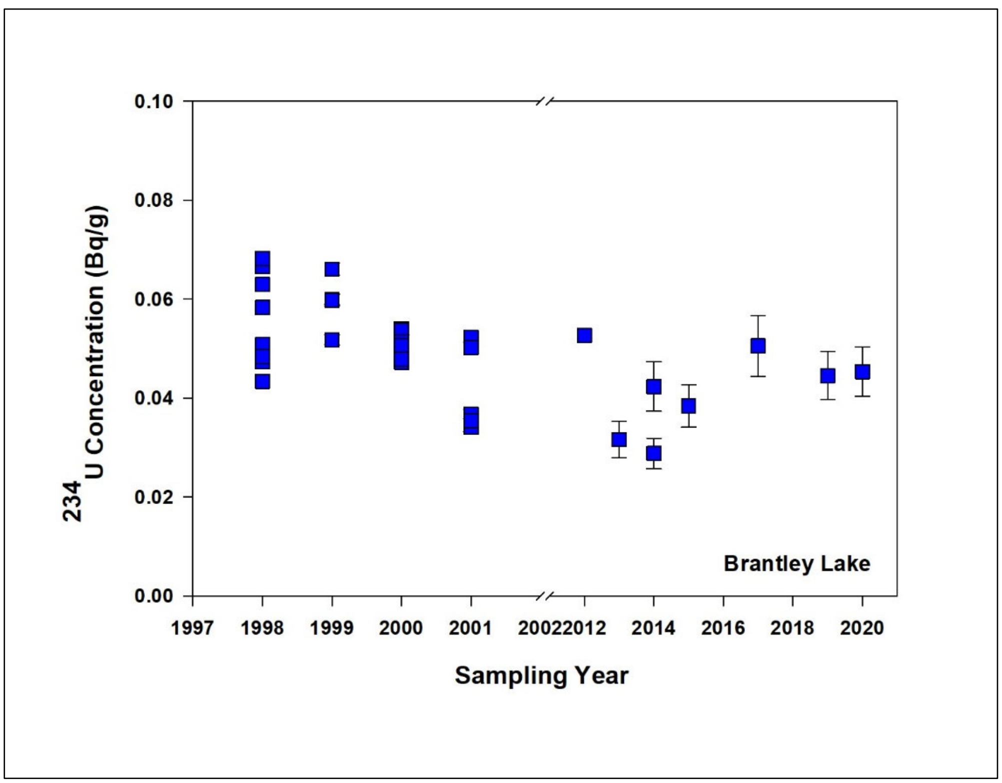


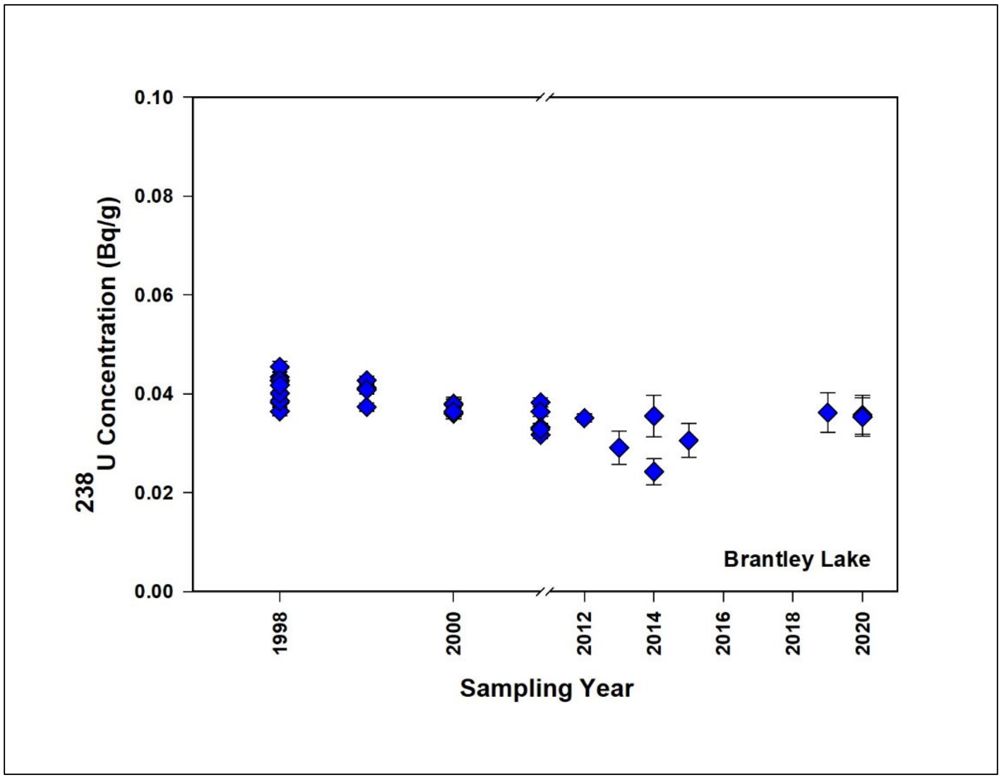
Figure 7.6. The $^{234}U/^{238}U$ Activity Ratio in Sediment Samples in Three Regional Reservoirs in 2020

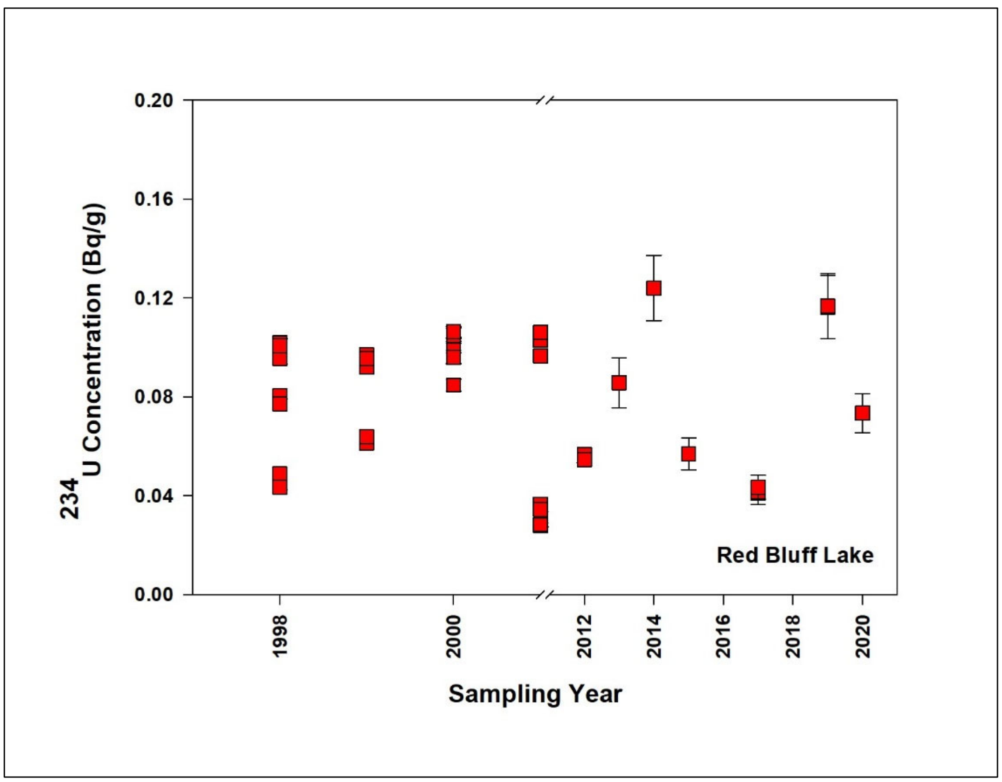
The historical concentrations of uranium isotopes measured in the sediment samples collected from the three reservoirs are shown in Figure 7.7. The activity concentration ranges for these isotopes showed no significant difference between baseline and monitoring phases, considering the 95% confidence intervals of the radioanalytical uncertainty.




0.10
0.08
0.06
0.04
0.02
0.00
238U Concentration (Bq/g)
Lake Carlsbad
1998
2000
2012
2014
2016
2018
2020
Sampling Year


0.10
0.08
0.06
0.04
0.02
0.00
234U Concentration (Bq/g)
Brantley Lake
1997
1998
1999
2000
2001
2002
2012
2014
2016
2018
2020
Sampling Year


0.10
0.08
0.06
0.04
0.02
0.00
238U Concentration (Bq/g)
Brantley Lake
1998
2000
2012
2014
2016
2018
2020
Sampling Year


0.20
0.16
0.12
0.08
0.04
0.00
234U Concentration (Bq/g)
Red Bluff Lake
1998
2000
2012
2014
2016
2018
2020
Sampling Year

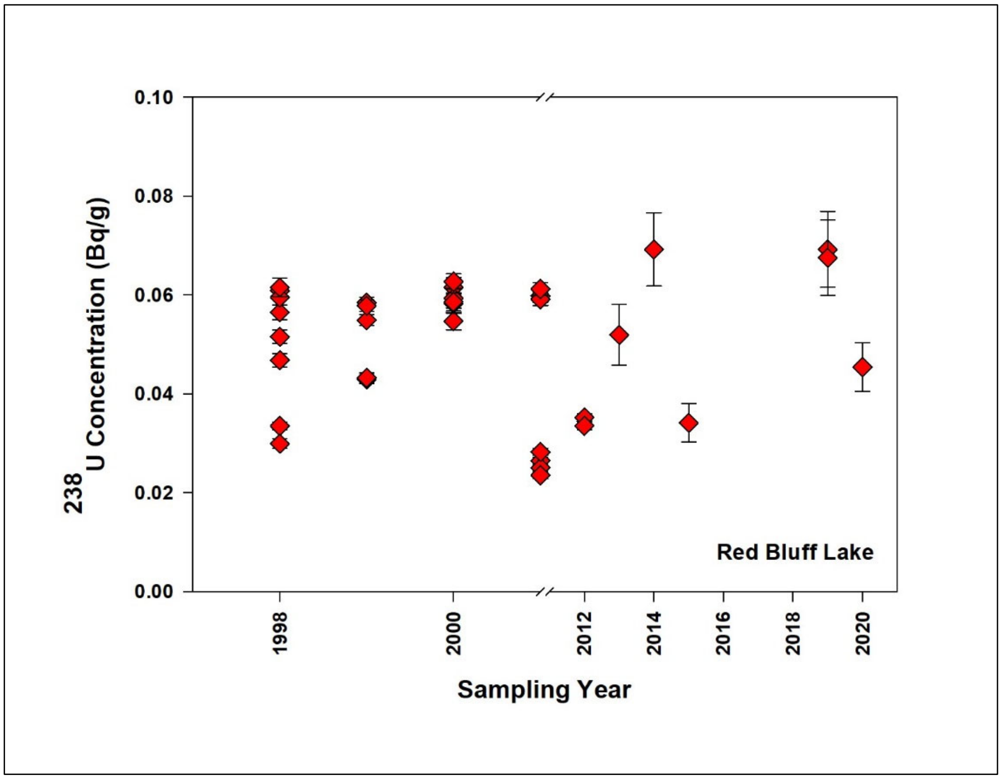
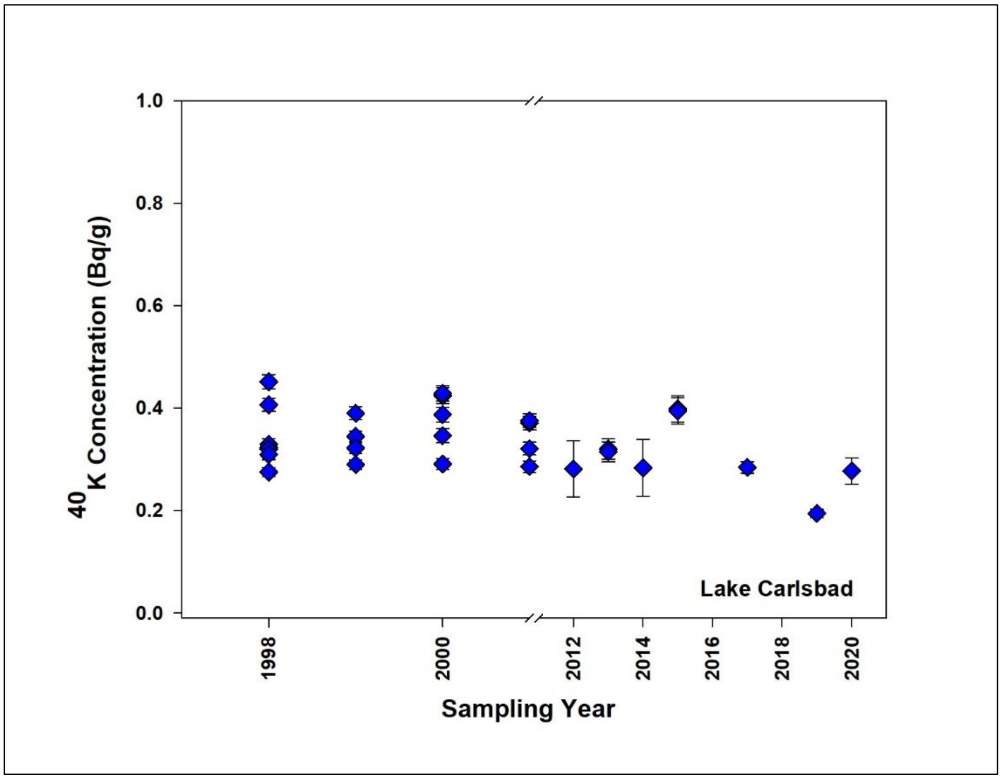


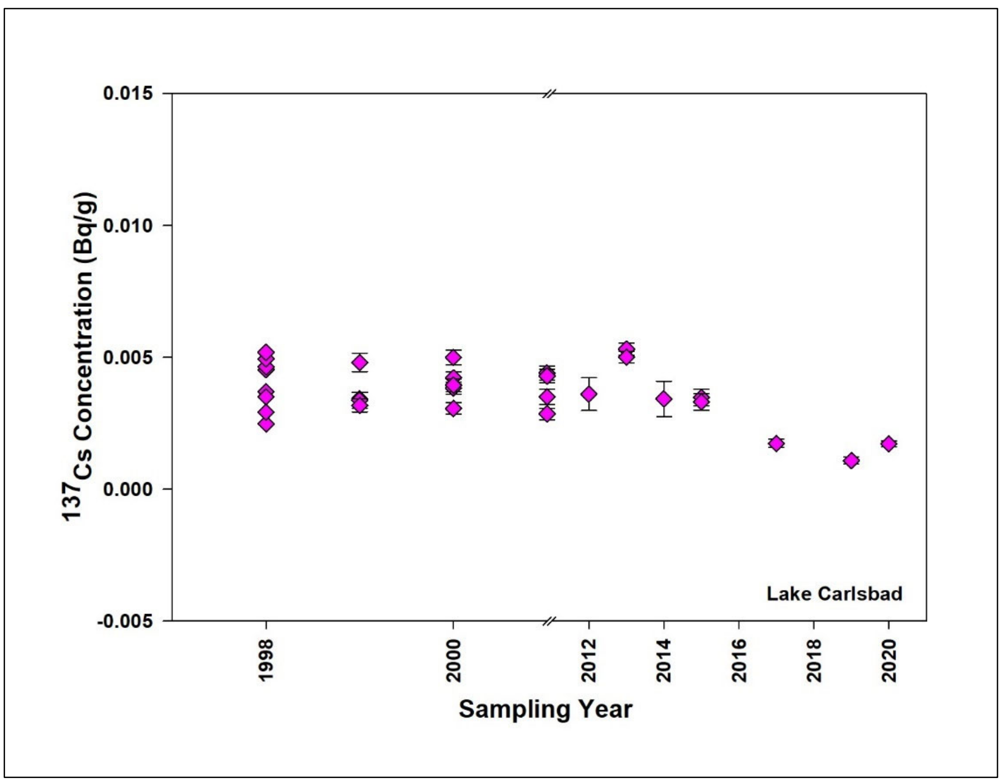
Figure 7.7. Historical Concentration of Uranium in Sediment Samples in Three Regional Reservoirs

7.3.3 Gamma Radionuclide Concentrations in Sediments

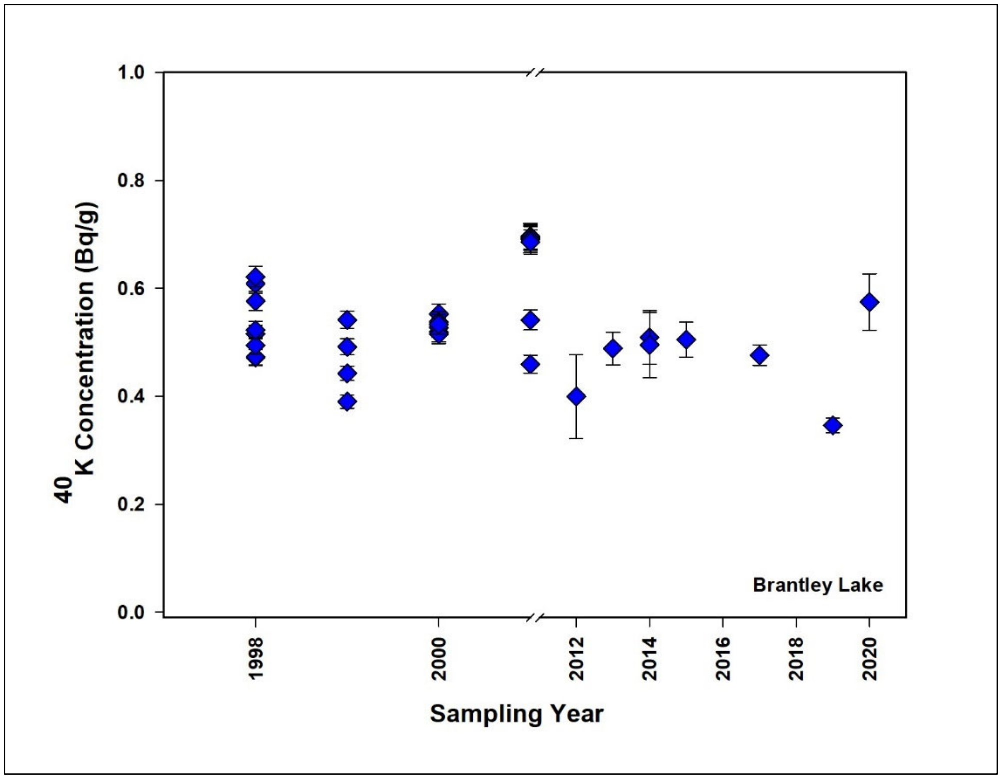
The concentrations of gamma radionuclides in sediment samples are presented in Table F.3 (Appendix F). ^{137}Cs and ^{40}K were detected in all sediment samples. Variability among the ^{137}Cs concentrations was not very significant. The maximum activity concentration for ^{137}Cs (3.61 mBq/g) was measured in Red Bluff sediment. The ^{137}Cs isotope is a fission product and is consistently found in sediment and soil because of global fallout from atmospheric nuclear weapons testing (Beck and Bennett, 2002; UNSCEAR, 2000). The ^{40}K isotope was also detected in every sediment sample. This naturally occurring gamma-emitting radionuclide is ubiquitous in sediments. There was no significant difference between concentrations of ^{40}K among sampling locations and the values fell within the range of concentrations observed previously in sediment samples in three regional reservoirs around the WIPP site. As shown in Table F.3 (Appendix F), ^{60}Co was not detected at any sampling location. Activity concentrations of ^{137}Cs and ^{40}K compared to that of the baseline and monitoring phase activities reflect no increase in radionuclide concentrations for 2020. Historical plots of ^{40}K and ^{137}Cs concentrations in sediment samples collected from three public reservoirs are shown in Figure 7.8. The concentrations have remained relatively constant over the past 10+ years and generally are indicative of worldwide fallout. Some degree of variability is always associated with collecting and analyzing environmental samples; therefore, variations in sample concentrations from year to year are expected.

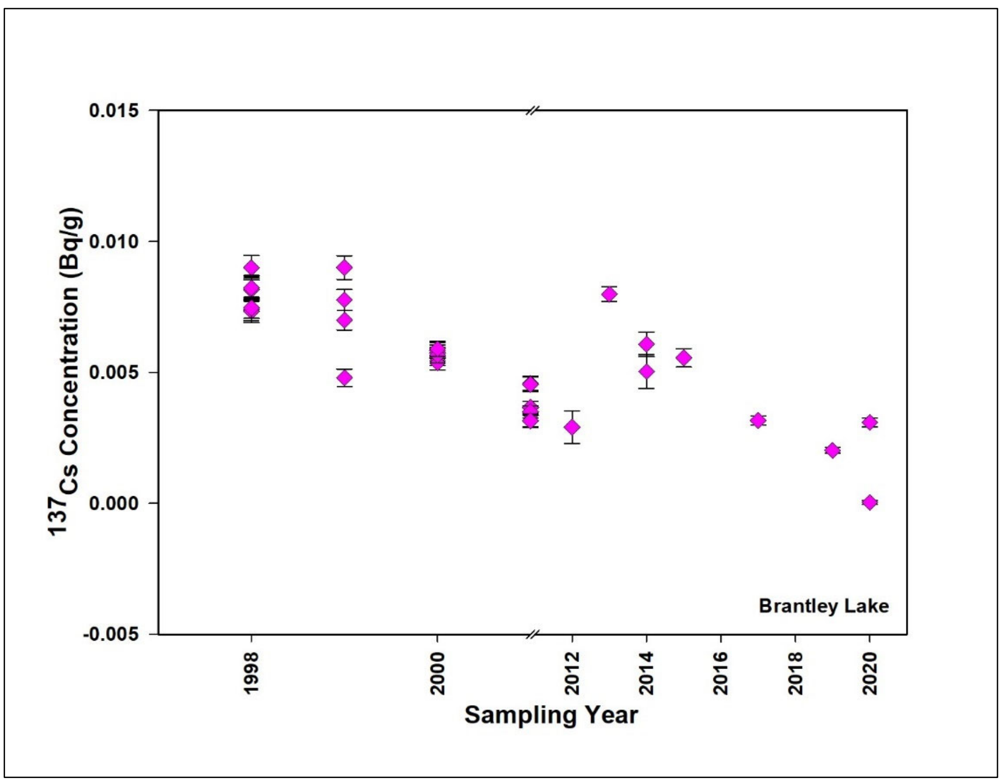


^{40}K Concentration (Bq/g)
1.0
0.8
0.6
0.4
0.2
0.0
1998
2000
2012
2014
2016
2018
2020
Sampling Year
Lake Carlsbad



^{137}Cs Concentration (Bq/g)
0.015
0.010
0.005
0.000
-0.005
1998
2000
2012
2014
2016
2018
2020
Sampling Year
Lake Carlsbad


1.0
0.8
0.6
0.4
0.2
0.0
^{40}K Concentration (Bq/g)
Brantley Lake
1998
2000
2012
2014
2016
2018
2020
Sampling Year


0.015
0.010
0.005
0.000
-0.005
^{137}Cs Concentration (Bq/g)
Brantley Lake
1998
2000
2012
2014
2016
2018
2020
Sampling Year

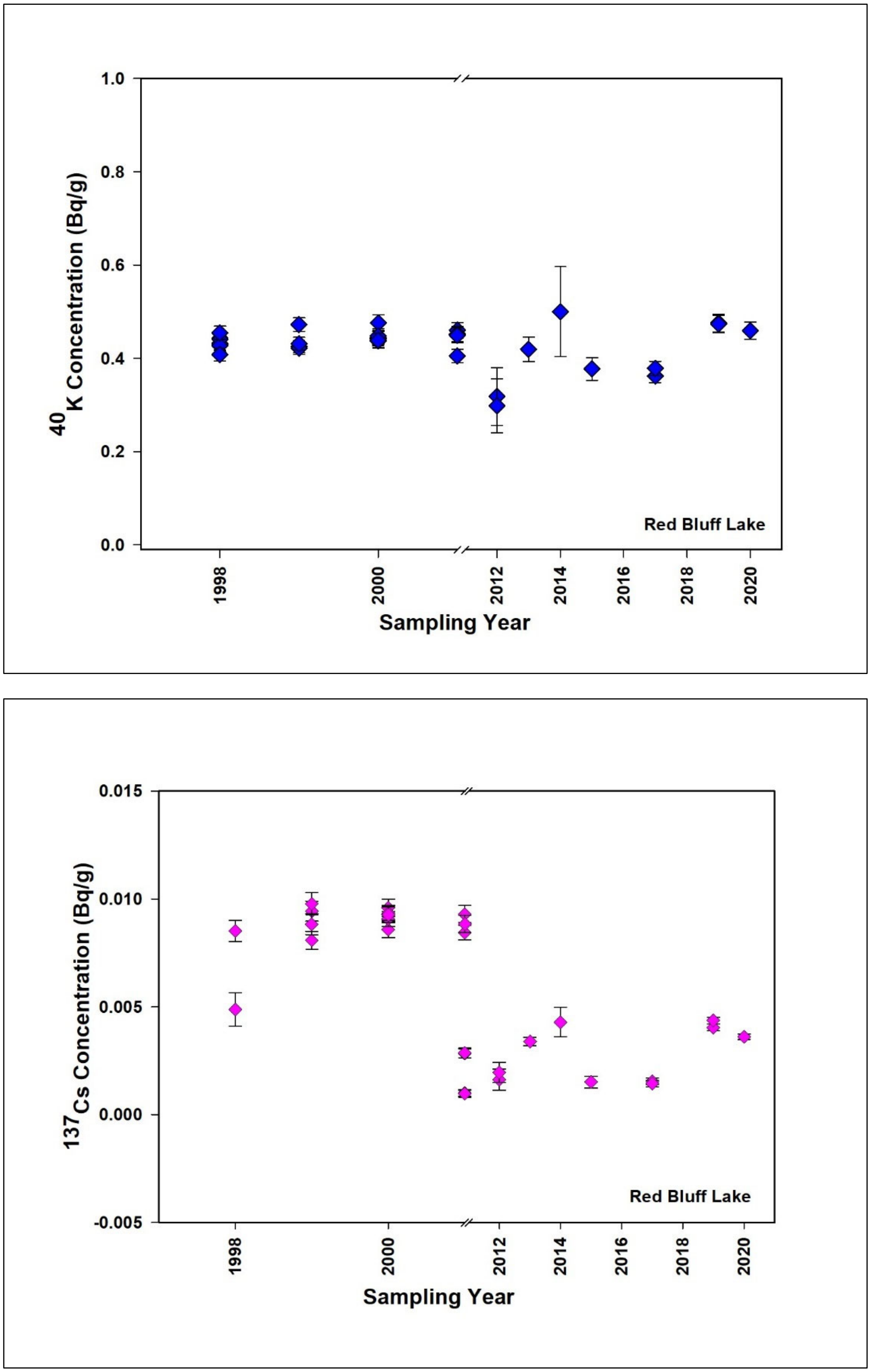


Figure 7.8. Historical Concentration of ^{137}Cs and ^{40}K in Sediment Samples in Three Regional Reservoirs

7.3.4 Strontium Concentrations in Sediments

The beta-radiation-emitting ^{90}Sr radionuclide was detected in one sample of Red Bluff sediment only. The measured concentration was 845 Bq/kg.

7.4 Conclusion

This chapter summarizes the results of the sediment-monitoring program for the calendar year 2020. The $^{239+240}Pu$ was detected in all sediment samples, whereas ^{241}Am was only detected in one sample and ^{238}Pu was not detected in any of the sediment samples in 2020. The concentration of $^{239+240}Pu$ varied in the range of 0.066 to 0.165 mBq/g. Isotopes of uranium were also detected in all sediment samples. Although the sediment concentrations of uranium isotopes were variable between reservoirs, the isotopic ratios were very similar between Lake Carlsbad and Red Bluff Lake. The Lakes appeared to be slightly enriched in ^{234}U compared to ^{238}U, with the activity ratios ranging from 1.53 to 1.62. Present results, as well as the results of previous analyses of sediment samples in the area were consistent for each source across sampling periods. The beta-radiation-emitting ^{90}Sr radionuclide was detected in one sample of Red Bluff sediment only. The measured concentration was 845 Bq/kg. There is no apparent difference between the concentration of the radionuclides collected before and after WIPP started receiving TRU waste. The monitoring results indicate that there is no evidence of increase in sediment radionuclide concentrations that can be attributed to the normal operations of the WIPP.

CHAPTER 8 - IN VIVO MONITORING

The *in vivo* (or direct) radio-bioassay is a measurement of the human body to determine the amount of radioactive material in the body. CEMRC's Internal Dosimetry (ID) Laboratory has been performing *in-vivo* radio-bioassay measurements for radiological and radiation control workers. Additionally, CEMRC's ID Laboratory provides free radio-bioassay service to the public residing within a 100-mile radius of the WIPP site through a program called "Lie Down and Be Counted" (LDBC) since 1997. The LDBC program is the most public aspect of CEMRC and is open to adult residents and children aged 13 and older living within a 100-mile radius of the WIPP site. The purpose of the LDBC program was to establish a baseline of "normal" or "background" radiation present in adults living in the region of the WIPP prior to the emplacement of radioactive waste in the WIPP. Further, once disposal operations began at the WIPP, the LDBC program allows for the continued monitoring of public citizens to determine if WIPP-related disposal activities have any observable impact on area residents' health. Concerned citizens are encouraged to have the *In vivo* radio-bioassay to see what radiation might exist in their lungs and whole body. The data collected prior to the operation of the WIPP TRU waste management serves as a baseline for comparisons with periodic follow-up measurements that are slated to continue through the operational phase of the WIPP.

The LDBC program uses a state-of-the-art lung and whole-body counting system that can measure the body's burden of radioactive elements at extremely low levels. The CEMRC ID laboratory has unique capabilities to detect internal deposited radionuclides in the body. The procedure is non-intrusive; participants are asked to follow a small number of steps before lying down on a test bed inside of a counting room for 30 minutes, allowing for measurements to be taken. Participants will then go over their results with a CEMRC scientist. Each participant contributes to scientific research conducted by the center. Since 1997, whole-body counting has been performed at CEMRC.

The current scope of work requires CEMRC's ID laboratory to perform whole-body measurements for the Department of Energy-Carlsbad Field Office (DOE-CBFO), DOE contractors, radiological and radiation workers, and the public residing within a 100-mile radius of the WIPP site. In the event of an incident or accidental release, *in vivo* measurements will be performed for DOE clients and contractor staff within the first two days after the event. In the event of a scheduling conflict, the DOE and contractor staff's *in vivo* measurements will receive priority over non-DOE clients and members of the public. The results of *in vivo* measurements for members of the public will be reported in an aggregated form and all necessary precautions will be taken to ensure confidentiality and to avoid the release of individualized data. Unexpected positive results from any *in vivo* measurement will trigger an automatic recount. Details of the *in vivo* counting facility, bioassay methodologies, and demographic characteristics counting method are described in the following sections. This chapter provides an overview of the ongoing public radio-bioassay measurements through December 31, 2020.

8.1 *In vivo* Counting Facility

The *in-vivo* counting facility consists of a large, shielded counting chamber made from pre-1945 cast iron to limit the background radiation and an instrument control workstation in the adjacent room. Radio-bioassay operations are performed from the instrument control workstation. The operations room is also equipped with a video display terminal and intercom that are used to monitor subjects during the measurement. The counting chamber as shown in Figure 8.1 is equipped with high purity *germanium detector* arrays designed specifically for *lung* and *whole-body counting, an* oxygen monitor, a video camera, emergency backup lights, and a voice-activated intercom for the subjects to communicate with the operator at any time during the counting process. The counting facility is also equipped with a music system to help participants relax during counting. Four lung detectors are located on top of the bed and are positioned close to the counting subject's chest and four whole-body detectors are also located under the bed. The whole-body detectors face the torso and upper leg parts of the body. CEMRC's ID laboratory has met the requirements and recommendations of the DOE Implementation Guide for Internal Dosimetry Programs (10 CRF 835) and the American National Standards Institute Performance Criteria for Radio-bioassay (ANSI/HPS N13.30) (1996, 2011) and continues to meet the most current criteria for radio-bioassay measurements.

Figure 8.1. The Whole-Body Counting Facility at CEMRC

8.2 Minimum Detectable Activity

The minimum detectable activity or MDA is an *a priori* value used to evaluate the laboratory's ability to detect a radionuclide in a person. The MDA is defined as the amount of a radionuclide that, if present, would be detected 95% of the time under the routine operation of a facility. The MDA is used to measure the efficacy of a facility and should not be used to decide if a specific radio-bioassay has or has not detected activity within a person (ANSI/HPS N13.30, 1996). To determine whether activity has been detected in a particular person, the parameter L_C (decision Level) is used. The L_C represents the 95th percentile of a null distribution resulting from the differences of repeated, pair-wise background measurements. An individual result is assumed to be statistically greater than background if it is greater than the L_C. It is important to note that the use of this criterion will result in a statistically inherent 5% false positive error rate (5% of all measurements will be determined to be positive when there is no true activity in the person). Details of MDA and L_C calculations can be found elsewhere (CEMRC, 1998; ANSI/HPS N13.30, 1996; Webb and Kirchner, 2000).

The details of energy and efficiency calibration of the lung and whole-body counting detectors are discussed in greater detail in a previous CEMRC Report (CEMRC, 2017). The lung detector efficiency varies with the person's chest wall thickness (CWT). Average MDA (nCi) with one standard deviation and percent variation for lung and whole-body detector systems are provided in Appendix G, Tables G.1 and G.2, respectively. One complicating factor in the measurement of low-energy photon emissions from the lung is the absorption of photons in the tissue overlying the lung – adipose (fat), muscle, cartilage, and bone. The thickness of these tissues and, consequently, the attenuation can vary significantly from one individual to the next. This is particularly important for the detection of the 17 keV plutonium X-rays. At this energy, 6 mm of muscle can attenuate half of the transmitted X-rays. In the early days of lung counting, height/weight relationships had been used to estimate the CWT, but these were crude and could easily lead to errors of a factor of 2 or more (CDC, 2006, page 27). For routine *in vivo* radio-bioassay measurements where no lung activity is expected, CEMRC ID uses an empirically derived prediction algorithm to estimate chest wall thickness, using easily measurable physical parameters, namely height and weight of the subject (RB-TBM-016, 2020). This prediction algorithm is based on a composite of the works by Fry et al (1980), Garg (1977), and Dean (1973) and is also chosen by CDC (CDC, 2006, page 30). In cases where a precise measurement of chest wall thickness is critical (e.g., when an intake of an insoluble radionuclide is probable or suspected) CEMRC has an established ultrasonic procedure that could be used in-lieu of the prediction algorithm. Ultrasonic measurements of the chest yield both thickness and composition. The arrangement for ultrasonic measurement is the responsibility of the participant.

A routine radio-bioassay program should be able to detect intakes within a year that will deliver a Committed Effective Dose of 100 mrem. If this performance objective cannot be met, then a performance shortfall is said to exist. The current version of CEMRC's Lung and Whole-body Counting technical manual (RB-TBM-016, 2020) provides a detailed comparison of lung and whole-body detector system's MDAs with an annual limit of intakes.

8.3 Volunteer Participation in the LDBC Program (1997 to 2020)

Between July 21, 1997, and March 26, 1999 (a period referred to as the "pre-operational" phase), the CEMRC ID laboratory had counted 366 public volunteers. This group of 366 measurements constituted the pre-operational baseline to which subsequent results are compared. WIPP became operational on March 27, 1999. Counts performed after the WIPP became operational are referred to as the “operational” phase monitoring. Between March 27, 1999, and December 31, 2020, the CEMRC ID laboratory had counted 1205 public volunteers. These measurements include baseline count (individuals counted for the first time), routine count (counting of previously measured participants, counts performed on individuals at least after two years following the baseline count), and recounts (repeat counts to confirm a positive result). The total number of public volunteers who have participated in the LDBC program between July 21, 1997, and December 31, 2020, are shown in Figure 8.2.

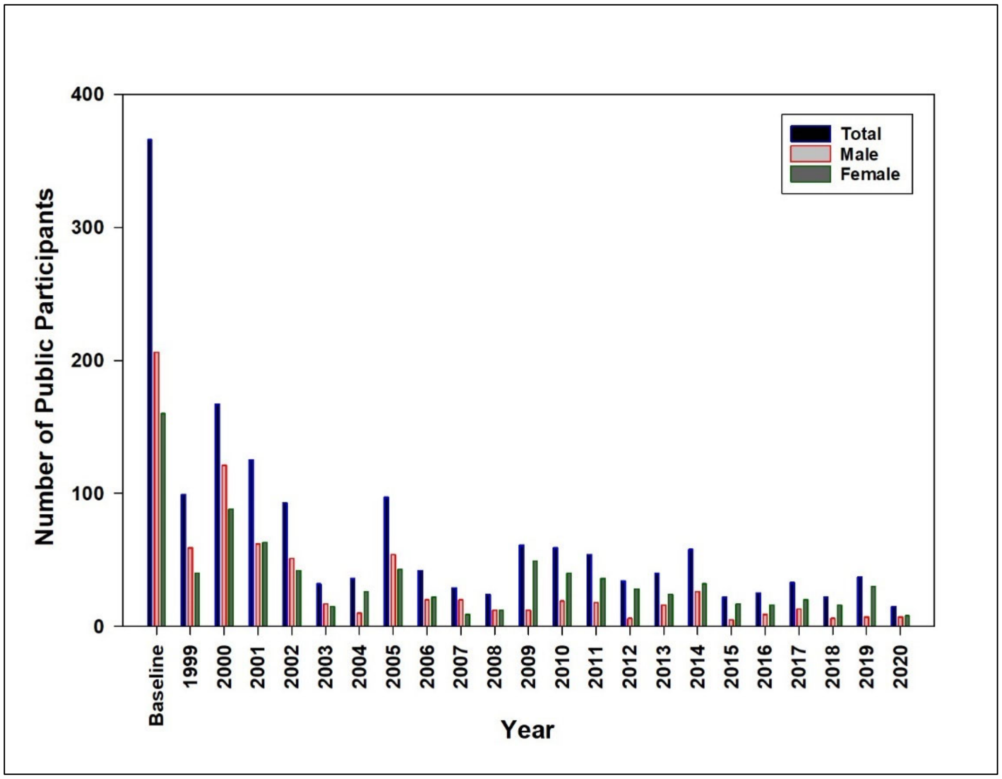


Figure 8.2. Number of LDBC Public Participants from 1997-2020

In addition to the LDBC public counts, the CEMRC ID laboratory also provides *in vivo* radio-bioassay service to Waste Control Specialists (Andrews, TX), Los Alamos National Laboratory, Carlsbad Office, WIPP laboratories (located at CEMRC) and Nuclear Waste Partnership personnel. The total number of radio-bioassay measurements performed through December 2020 is 5709, which includes baseline (in this context baseline means the first time counted at CEMRC), routine, recounts, exit, potential intake, and any other special counts on radiological workers.

8.4 Demographic Characteristics

Public volunteers participating in the LDBC project are asked to complete a questionnaire to gather a demographic profile of the participants, such as age, gender, ethnicity, occupation, foreign travel, wild game consumption, smoking habits, and any nuclear medicine procedures. Appendix G, Table G.3 compares the LDBC demographic characteristics between the baseline and operational phase date. An increase of voluntary participation by Hispanics from 13.4% to 23.7% can be seen during the period between 1999 and 2020. According to the U.S. census, the percentage of the Hispanic population nationwide for this same time period increased from 12.5% to 18.5% and from 42.1% to 49.3% in the State of New Mexico. In addition, it is important to note that if the presence of a radionuclide is dependent on a subclass of interest (i.e., gender, ethnicity, etc.), valid population estimates can still be made by correcting for the proportion of under- or over-sampling for the particular subclass. Variations observed for the remainder of the demographic characteristics are also listed in Appendix G, Table G.3.

8.5 Results and Discussion

8.5.1 LDBC Results Greater Than the Decision Limits (L_C)

The LDBC results greater than the decision limits (LC) for the baseline and operational measurements for the period 1997-2020 are listed in Appendix G, Table F.4. Results listed in Appendix G, Table G.4 are for the participants counted only once. For the baseline measurements (N = 366), the percentage of results greater than L_C were consistent with a 5% random false-positive error rate, at the 95% confidence level (1% to 9%), for all radionuclides except ^{232}Th via the decay of ^{212}Pb, ^{235}U/^{226}Ra, ^{60}Co, ^{137}Cs, ^{40}K, ^{54}Mn, and ^{232}Th via the decay of ^{228}Ac. As discussed in the 1998 report, five of these radionuclides [^{232}Th via ^{212}Pb, ^{60}Co, ^{40}K, ^{54}Mn (^{228}Ac interference), and ^{232}Th (via ^{228}Ac)] are part of the shield-room background and positive detection is expected at low frequency. The ^{40}K is a naturally occurring isotope of an essential biological element, so detection in all individuals is expected. ^{137}Cs and ^{235}U/^{226}Ra are not components of the shielded room background and were observed at frequencies greater than the 95% confidence interval for the false-positive error rate, discussed in more detail below.

For the operational measurement (N = 1201), the percentage of results greater than L_C were consistent with the baseline at a 95% confidence level (margin of error), except for ^{60}Co and ^{232}Th (via ^{228}Ac). For these radionuclides, the percentage of results greater than L_C decreased relative to the baseline. This would be expected for ^{60}Co, given that it has a relatively short half-life (5.2 years) and the content of ^{60}Co within the shield has decreased via decay by approximately 80% since the baseline phase of monitoring. The differences in ^{232}Th (via ^{228}Ac) results between the baseline and operational monitoring phase were also observed in 2001 and 2002 and are likely due to the replacement of aluminum (tends to contain Th and U) in some of the detector cryostat components with those manufactured from low radiation background steel.

The percentage of results greater than L_C for ^{235}U/^{226}Ra (11% for the baseline) is significantly higher than the distribution-free confidence interval for a 5% random false-positive error rate. These data are not nearly as compelling as those for ^{137}Cs, but the large sample size of the current cohort tends to support the observed pattern. ^{235}U and ^{226}Ra cannot be identified separately by individual gamma energies by the current operating system. The activity result is reported together for ^{235}U and ^{226}Ra using the 186 keV gamma ray. Currently, MDA activities of ^{235}U and ^{226}Ra are calculated using their respective abundances for the 186 keV gamma ray. During the 2019-2020 upgrade testing of the facility, the feasibility of identification of ^{235}U by 185.72 keV gamma ray (57% abundance) and ^{226}Ra by 186.21 keV gamma ray (3.64% abundance) was considered; implementation is pending until the system is upgraded to APEX In vivo operating system possibly by the end of 2022. If software resolution of the 185.7 keV and 186.2 keV gamma peaks which are only 0.5 keV apart becomes possible then the 95% confidence level of determining ^{235}U and ^{226}Ra will be re-evaluated.

The ^{40}K results have been positive for all participants counted both before and after WIPP became operational. The ^{40}K body burden ranges from 551 to 5559 Bq per person with an overall mean (±SE) of 2386 (± 21) Bq per person. The ^{40}K content in the body of an adult person with body mass 70 kg ranges from 4,000 to 5,000 Bq (ICPR Publication 23, 1975). Figure 8.3 shows the number of LDBC participants with ^{40}K values greater than L_C. Such results are expected because ^{40}K is an essential biological element contained primarily in muscle. The amount of potassium in the body is proportionate to the muscle mass, which depends on sex, age, and physical activity level. Muscle mass also depends on human ethnicity, height, and body mass (Silva 2010, He et al., 2003). The ^{40}K average value per person for males was significantly greater than that of females because in general, males tend to have larger body sizes and greater muscle content than females. These results are consistent with findings previously reported in CEMRC reports and elsewhere (Webb and Kirchner, 2000). The mean ^{40}K value (± SE) for males was 3016 (± 25) Bq per person, which was significantly greater than that of females, which was 1843 (± 16) Bq per person. This was expected since, in general, males tend to have larger body sizes and greater muscle content than females. Figure 8.4 shows the ^{40}K activities in the LDBC participants through December 2020.

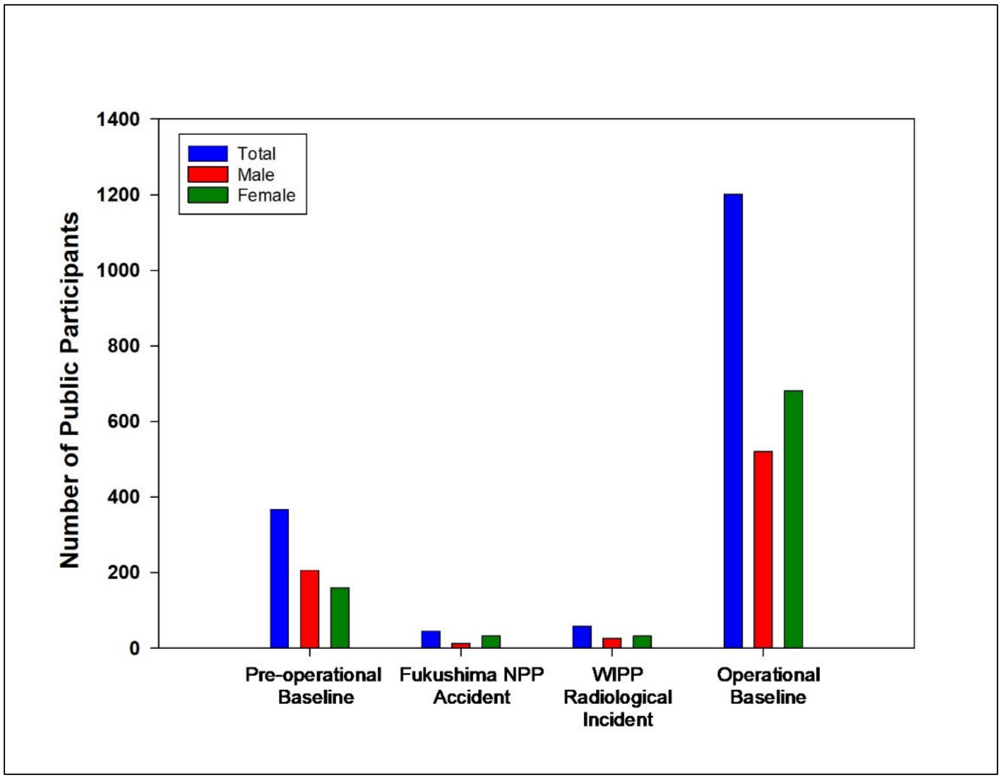


Figure 8.3. Number of Participants with ^{40}K with Results Greater Than L_c during 1997-2020

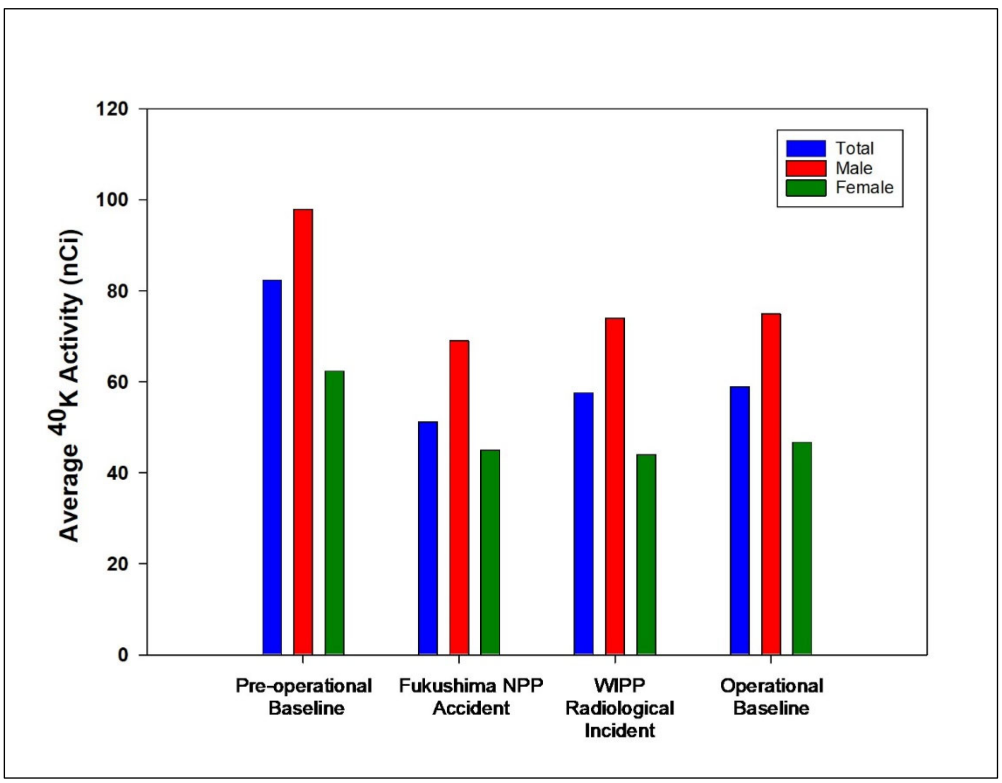


Figure 8.4. Average ^{40}K Activity (nCi) Among LDBC Participants During 1997-2020

Detectable ^{137}Cs is present in about 28% (95% confidence level) for baseline, and 16.6% operational monitoring counts of citizens living in the Carlsbad area as shown in Figure 8.5 and Table F.4. These results are consistent with findings previously reported in CEMRC reports and elsewhere (Webb and Kirchner, 2000). Detectable ^{137}Cs body burdens ranged from 5 to 128 Bq per person with an overall mean (± SE) of 10 (± 1) Bq per person. The mean ^{137}Cs body burden for males (± SE), was 11 (± 1) Bq per person, which was significantly greater than that of females, which was 10 (± 1) Bq per person (Figure 8.6). As previously reported (CERMC Reports; Webb and Kirchner, 2000) the presence of ^{137}Cs was independent of ethnicity, age, radiation work history, consumption of wild game, nuclear medical treatments, and European travel. However, the occurrence of detectable ^{137}Cs was associated with gender where males had a higher prevalence (65%) of ^{137}Cs relative to females (35%).

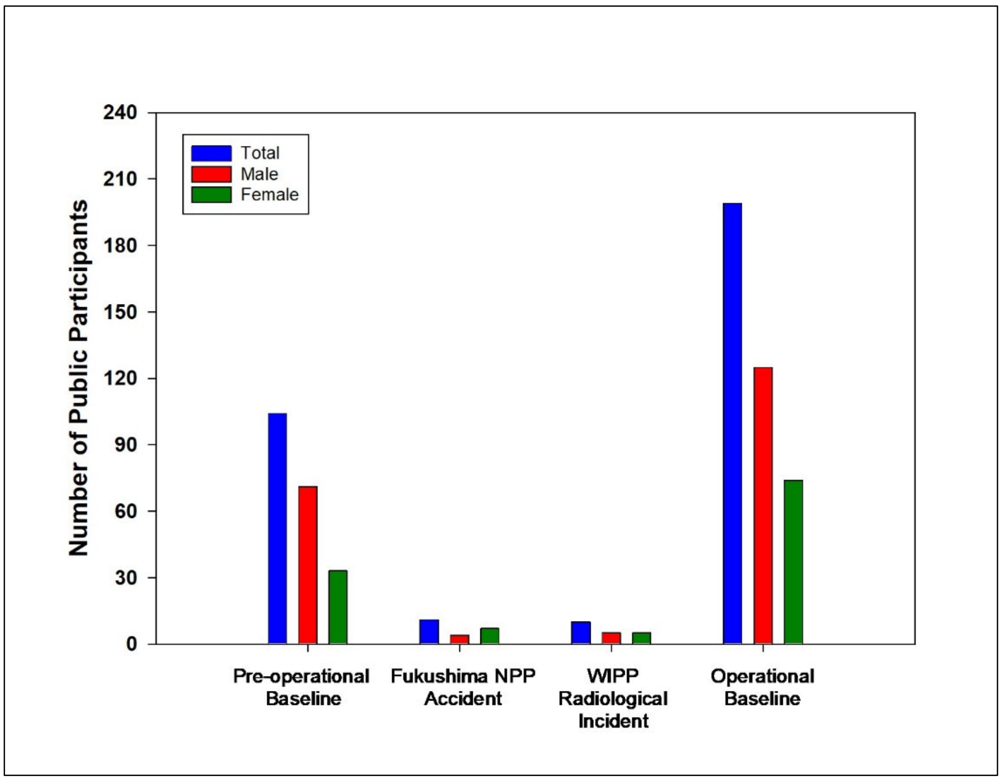


Figure 8.5. Number of Participants with ^{137}Cs with Results Greater Than L_c during 1997-2020

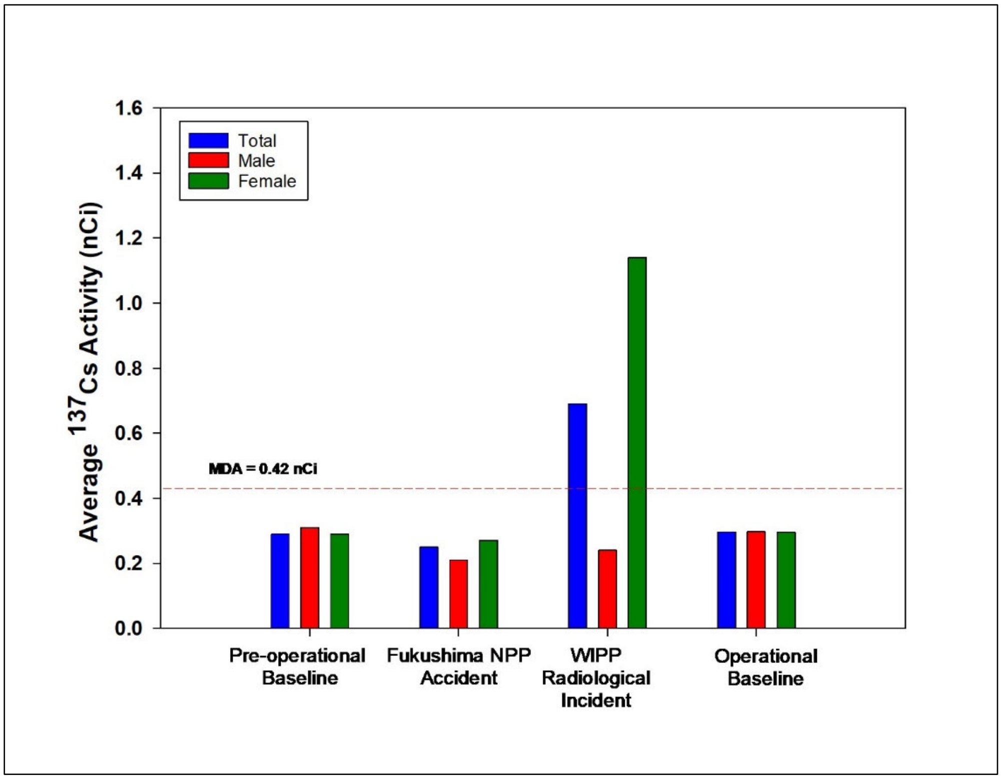


Figure 8.6. Average ^{137}Cs Activity (nCi) Among LDBC Participants During 1997-2020

Furthermore, the presence of ^{137}Cs was associated with smoking. Smokers had a higher prevalence of detectable ^{137}Cs (29.7%) as compared to non-smokers (24.1%) (CEMRC Report, 2005/2006). The association with gender is likely related to the tendency for a larger muscle mass in males than in females, as supported by the ^{40}K results. The association of ^{137}Cs with smoking could be related to the presence of fallout ^{137}Cs in tobacco, a decreased pulmonary clearing capability in smokers, or other as of yet unidentified factors.

Plutonium and americium isotopes, the main component of the WIPP's waste, were also monitored among the public. Lung counting is the primary method for determining intakes of Pu isotopes and ^{241}Am. The lung burdens of plutonium isotopes and ^{241}Am in public participants were measured using the 17 keV X-ray line for plutonium isotopes and the 59.5 keV gamma line for ^{241}Am. Efficiency, and therefore the sensitivity level, varies for every count due to the effects of chest wall thickness (CWT) on the attenuation of the 17 keV x-rays and the 59.5 keV gamma ray. A typical low energy gamma spectrum of the lung counter, of public count and background are shown in Figure 8.7. CWT is estimated by mass to height ratios for routine counting. However, the use of ultrasound for CWT measurement is recommended for special or positive counts. For lung counts, increases in chest wall thickness can increase the individual's MDA. In its more than 20 years of *in vivo* monitoring, CEMRC has never detected Pu isotopes or ^{241}Am in any public volunteers.

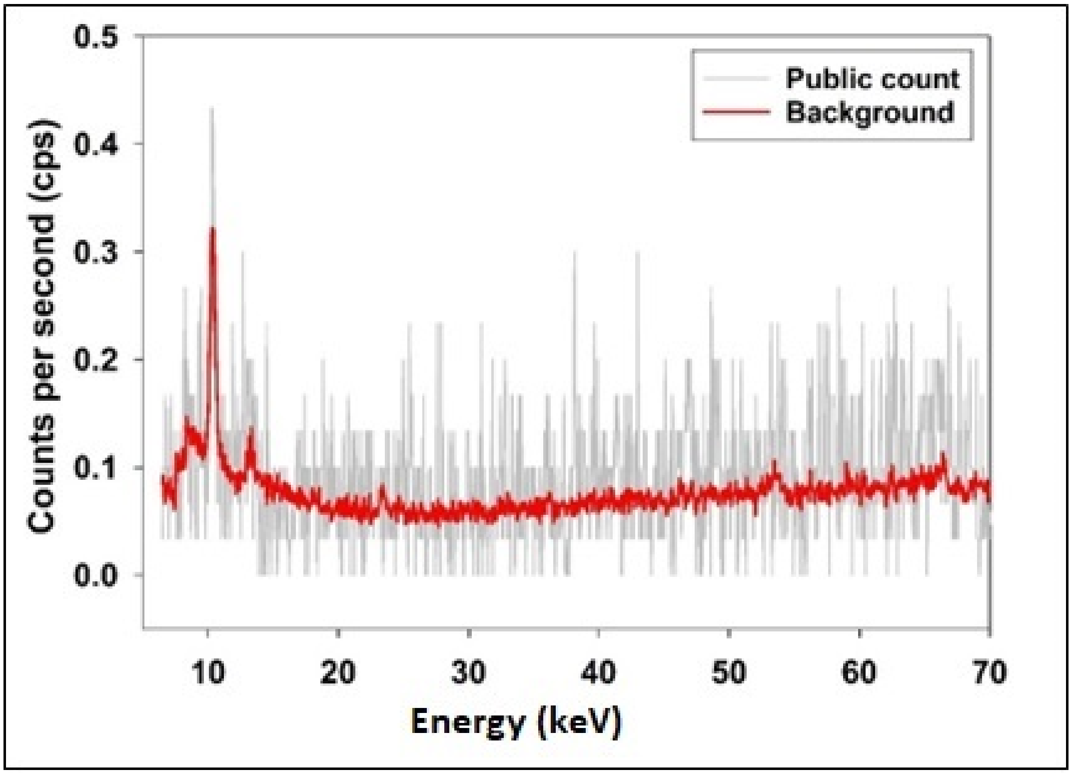


Figure 8.7. Typical 17 keV (Pu isotopes) and ^{241}Am (59.5 keV) Low Lung Gamma Spectra of Public Volunteers

For most radio-bioassay results, a two-step process is used to decide whether the analyte is present. In the first step, a statistical decision level (L_C) is used to determine if the counts in an energy region of a sample spectrum are significantly greater than in the same region in a background spectrum. This process is discussed in the CEMRC Report 1998. The second step of the process involves a review of the spectrum by a technical expert to confirm the first step's conclusion. For example, the application of a decision level (L_C) to a low lung count spectrum may lead to the conclusion that no ^{241}Am is present. In contrast, a ^{241}Am photopeak may be visible to the technical person. In such cases, the technical expert may decide to overrule the initial decision and declare that ^{241}Am is present. At CEMRC, the *in vivo* bioassay program attempts to perform measurements with 95% confidence level and therefore there will be a false positive rate of 5%, meaning 5% of all measurements will be determined to be positive when there is no actual activity in the person. These results, particularly the absence of detectable plutonium and americium levels, suggest that there has been no impact from the WIPP's operations.

8.6 Conclusion

CEMRC's ID has been satisfactorily conducting the LDBC program since its inception in 1997. Comparisons of radiological activities measured between the pre-operational and operational groups revealed no significant differences, thereby indicating that waste disposal activities at the WIPP showed no measurable radiological impact on local residents' health. Furthermore, the absence of detectable levels of plutonium and americium suggests that there has been no impact from the WIPP operations.

Resident participation from communities other than Carlsbad, NM, has not been significant, partly because of the time and distance involved. Resident participation from Carlsbad has also been declining steadily since 2006. The main reason for this decline has been overwhelming public trust and support for the WIPP project. Local acceptance of the WIPP is due partly to its robust safety record and comprehensive environmental monitoring program. Despite its recent shortcomings, there is not a great degree of concern among the local and surrounding communities about their health and safety because of WIPP's operation. Even though there was not a substantial increase in the number of citizens who take advantage of the LDBC program, the mere availability of such a service and their direct participation in CEMRC's whole-body counting program provides transparency which is key to maintaining public trust and confidence.

However, in recent years, there has been increased awareness and interest among students participating in the Early College Initiative in Carlsbad. Additionally, the ID group has also communicated with oil and gas field companies informing them about the capabilities of CEMRC's Lung and Whole Body in vivo radiobioassay facility to monitor radiation exposure of oil and gas field workers as a part of its outreach activities. The ID group also routinely interacts with the public residing in towns other than Carlsbad, informing them about the LDBC program.

CHAPTER 9 - NON-RADIOLOGICAL MONITORING

Non-radiological monitoring is a vital part of the WIPP-EM program because the activities in WIPP may generate both radioactive and hazardous (non-radioactive) materials. The focus of the Environmental Chemistry (EC) group at CEMRC is to monitor the hazardous impact on the environment on, and around, the WIPP site by analyzing various sample types including airborne effluent, air particulate, drinking water, and surface water. The current scope of work requires non-radiological studies for a variety of metals, inorganic anion constituents, and inorganic cation constituents, as well as characterizing some common indicator parameters of local water sources. Current methods utilized by the EC group at CEMRC for non-radiochemical analyses performed on each sample type are provided in Appendix H, Table H.1. In 2020, CEMRC's non-radiological monitoring program included effluent monitoring at the FAS Stations A and B, airborne particulate monitoring surrounding the WIPP site, and annual sampling of local drinking water and surface water sources.

CEMRC has been sampling and analyzing WIPP exhaust air for non-radiological constituents since December 1998. Before the 2014 event, only Station A was used for exhaust air compliance monitoring purposes. After the 2014 event, non-radiological analyses of WIPP exhaust air were halted because all the filters collected were analyzed for radiological constituents to support the evaluation of the event. CEMRC resumed non-radiochemical analyses of exhaust air in 2015 for both Station A and Station B filters.

CEMRC has also been sampling and analyzing ambient air (i.e., aerosol samples) surrounding the WIPP site since 1999. However, in 2005, the sampling process changed. CEMRC resumed reporting results for ambient air in 2020.

In addition to air monitoring, CEMRC has also been sampling and analyzing non-radiological constituents in drinking water from six community supplies and three regional surface water reservoirs since 1997. In this chapter, non-radiological analysis results for WIPP exhaust air, drinking water, and surface water are provided for the year 2020.

9.1 Non-Radiological Monitoring of Airborne Effluent

9.1.1 Sample Collection

As described in Chapter 2, particulates in the exhaust air are collected on 47 mm diameter membrane filters (Versapor™ membrane filter, PALL Corporation, Port Washington, NY, USA) with the use of a cylindrical shrouded probe, commonly referred to as a fixed air sampler or FAS. Typically, two sets of filters are collected from both Station A and Station B: a primary set and a secondary (backup) set. Before the 2014 accidental release event, the primary set of filters was used for the analyses of both radiological and non-radiological constituents, while the backup set of filters was archived. After the 2014 event, the primary set of filters is used for radiochemical analyses, while the backup set is used for non-radiological analyses. Occasionally, both the primary and backup filter sets are needed for immediate radiochemical analyses. In such instances, non-radiological analyses are not performed on this sample type.

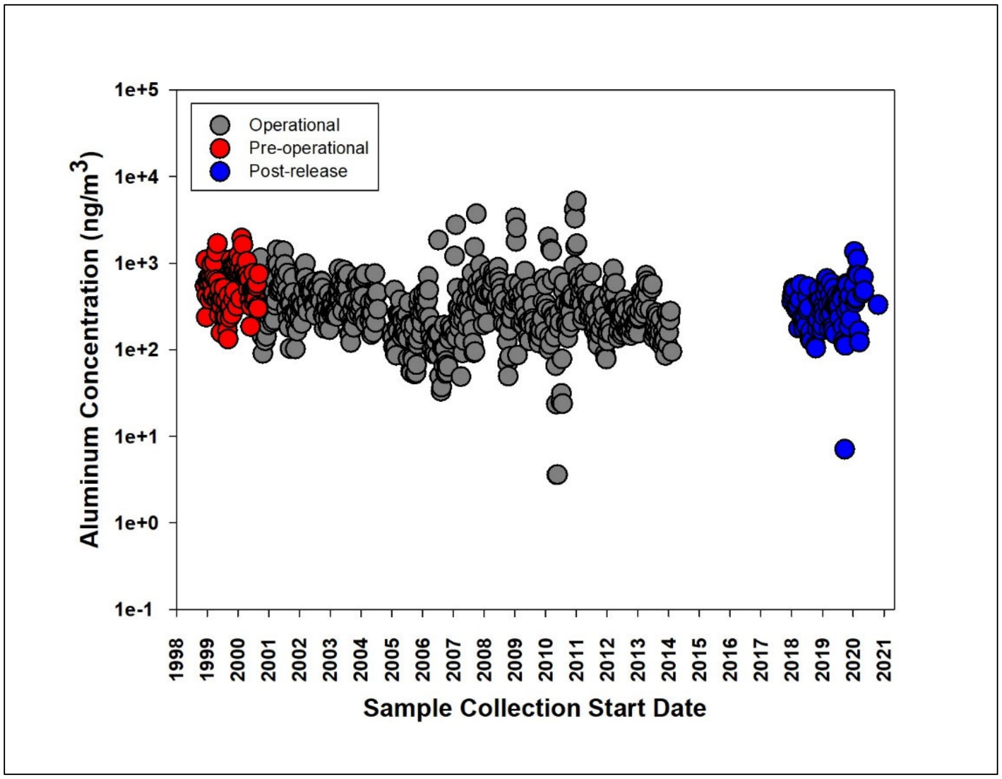
9.1.2 Sample Preparation and Analysis

The backup filters for non-radiological analyses are digested in a strong acid mixture with the use of a CEM MARS Xpress™ or CEM MARS 6™ microwave unit (Charlotte, NC, USA). Individual FAS filters are placed in separate Teflon vessels and digested at 195 ˚C within an acid matrix consisting of nitric, hydrochloric, and hydrofluoric acids. A blank filter and Certified Reference Material (CRM) filter are also digested simultaneously with these FAS filters using the same method for quality control (QC) purposes. Acids used for digestions are either purchased as "trace metal" grade as denoted by the manufacturer or purified in-house with a Milestone Inc. (Shelton, CT, USA) sub-boiling quartz distillation apparatus. After digestion, individual FAS filter solutions are combined into a weekly (or monthly) composite and the composite is analyzed, together with the blank filter and CRM filter, for selected metals by Perkin Elmer Inductively Coupled Plasma-Mass Spectrometers (ICP-MS). Metal concentrations of FAS filters from Station A and Station B are reported as the mass of metal divided by the volume of air (ng/m^3).

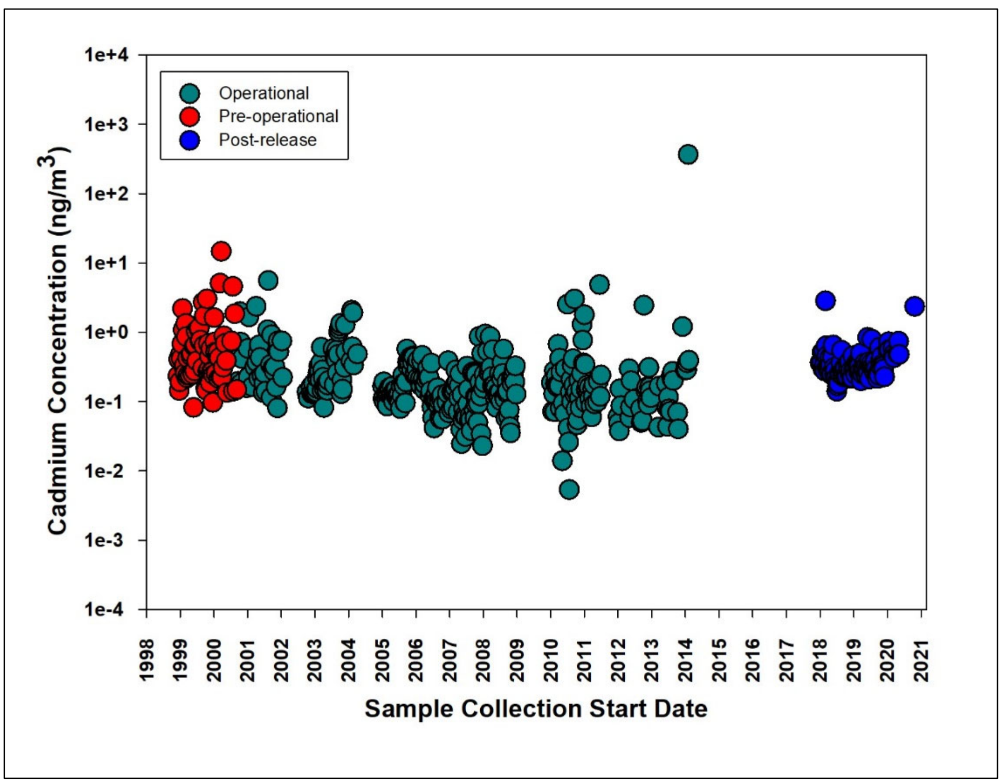
9.1.3 Metal Concentrations at Station A

Time-series plots for selected trace metals are shown in Figure 9.1 from 1998 to 2021. Aluminum (Al), cadmium (Cd), magnesium (Mg), and lead (Pb) are regularly detected at Station A. The concentrations of these trace metals are in the range of 0.22-2.08 ng/m^3 for Cd, 0.49-446.43 ng/m^3 for Pb, 62.31-3401.68 ng/m^3 for Al, and 505.16-101492.56 ng/m^3 for Mg. Thorium (Th), silicon (Si) and uranium (U) are only occasionally measured for the 2020 sampling period. Values for Si, Th, and U are reported in Appendix H, Table H.2. While variability between weekly composite results is common, long–term monitoring data show that there are no differences between the baseline, operational, and post-release data.

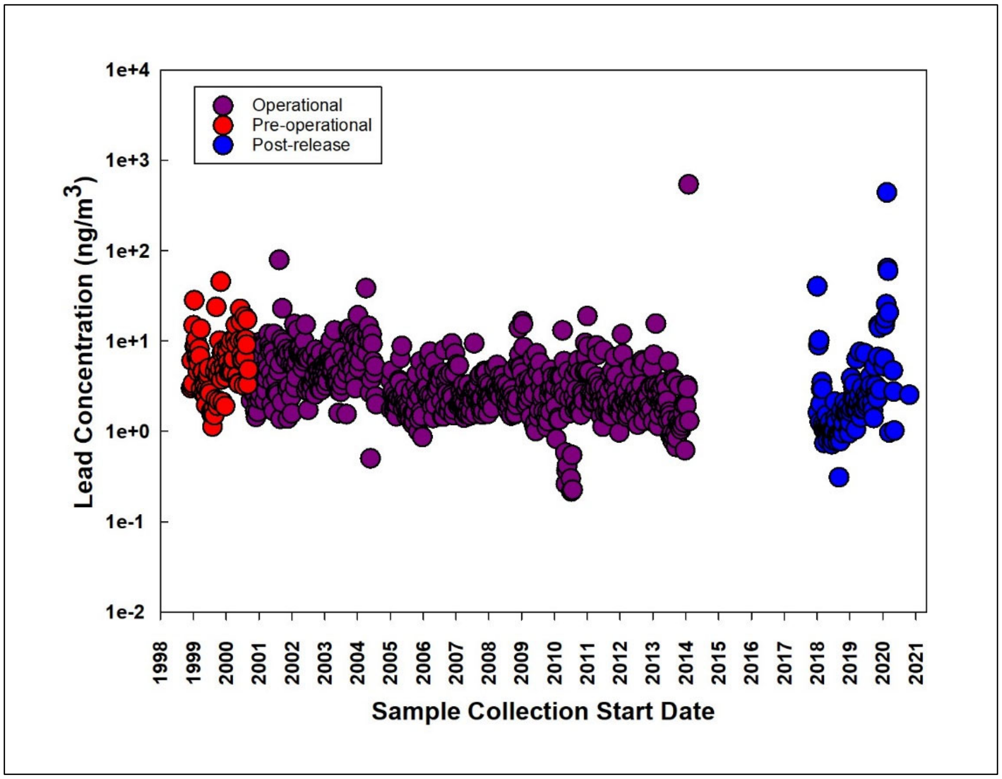
Aluminum concentrations are of particular interest because of the relationship observed between Al concentrations in ambient air and the $^{239+240}Pu$ and ^{241}Am activities (Arimoto et al., 2002 and 2005). Windblown dust is the main source for Al and many other elements (e.g., Fe, Mn, Sc, and the rare earth elements), as well as representing a source for U and some other naturally occurring radionuclides (Arimoto et al., 2005; Kirchner et.al., 2002). Special attention was also paid to magnesium as it is the primary component in the MgO backfill material that is the only engineered barrier at WIPP. Metal concentrations of FAS filter weekly composites from Station A in 2020 are provided in Appendix H, Table H.2.



Operational
Pre-operational
Post-release
Aluminum Concentration (ng/m3)
1e+5
1e+4
1e+3
1e+2
1e+1
1e+0
1e-1
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Sample Collection Start Date



Operational
Pre-operational
Post-release
Cadmium Concentration (ng/m3)
1e+4
1e+3
1e+2
1e+1
1e+0
1e-1
1e-2
1e-3
1e-4
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Sample Collection Start Date



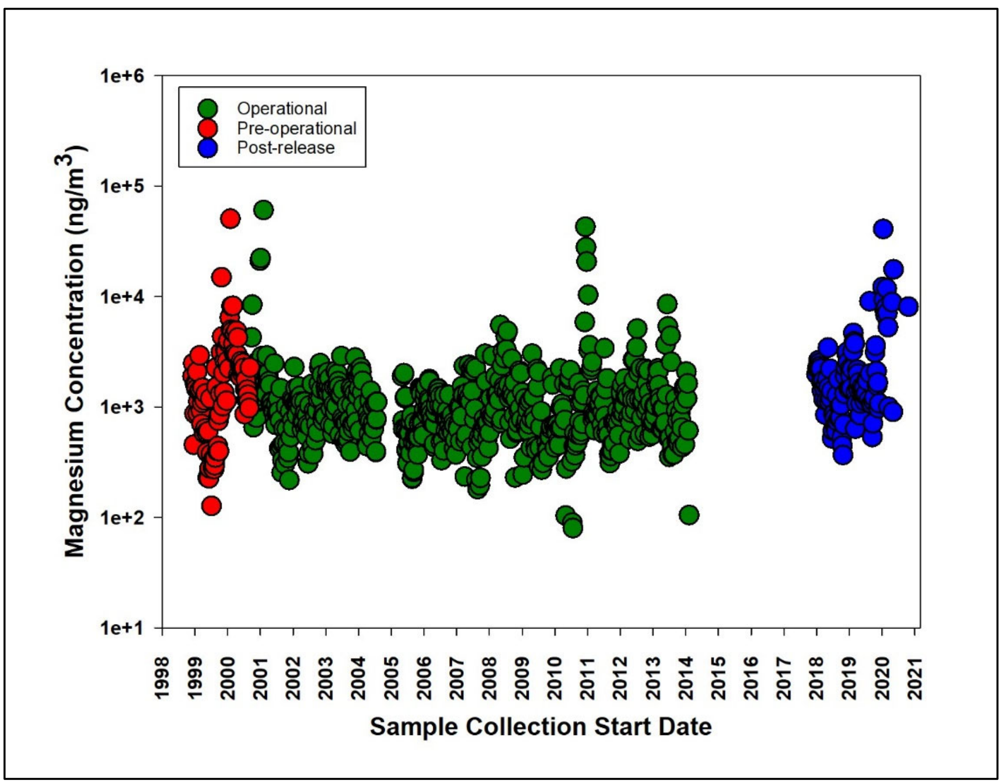
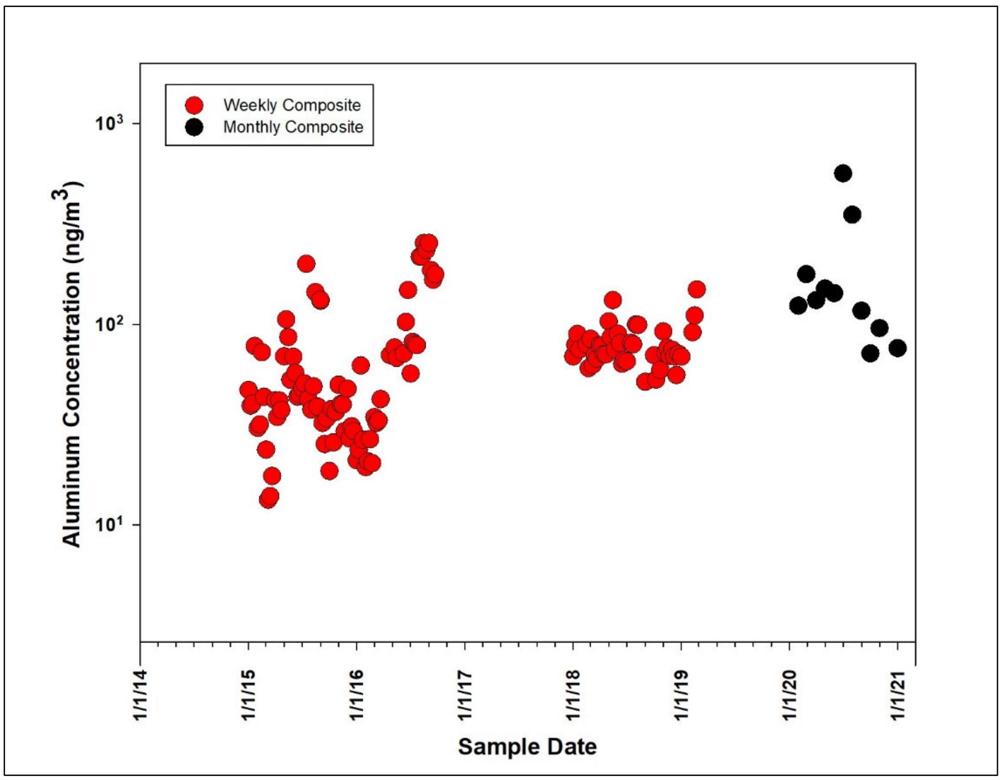
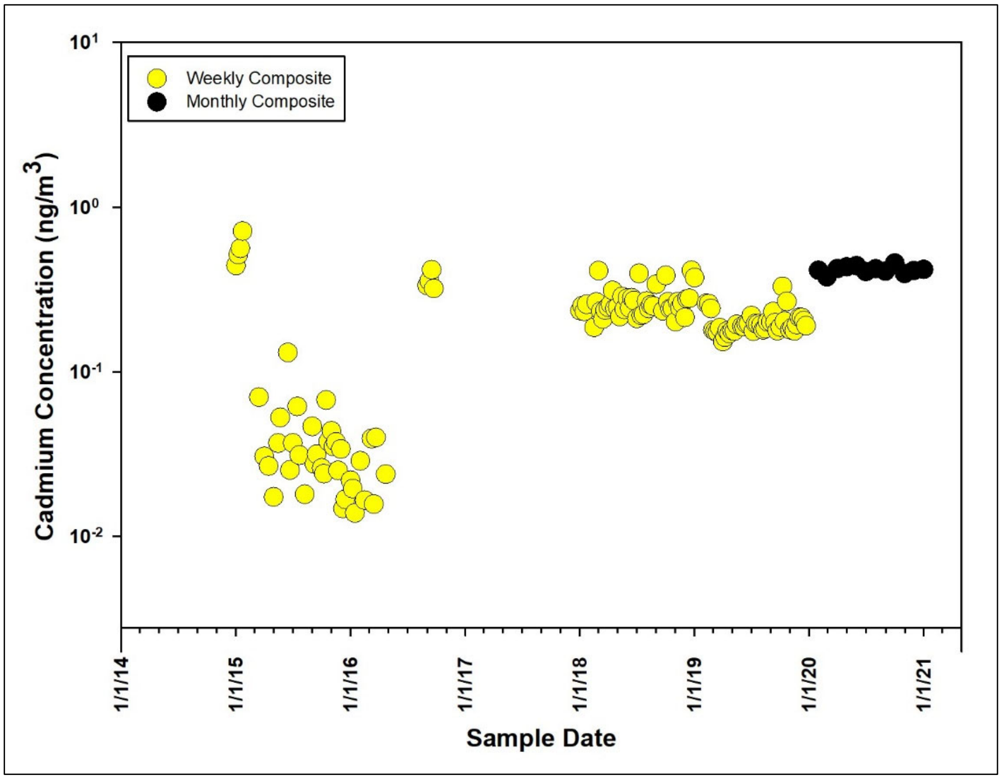


Figure 9.1. Historical Concentrations of Selected Metals at Station A

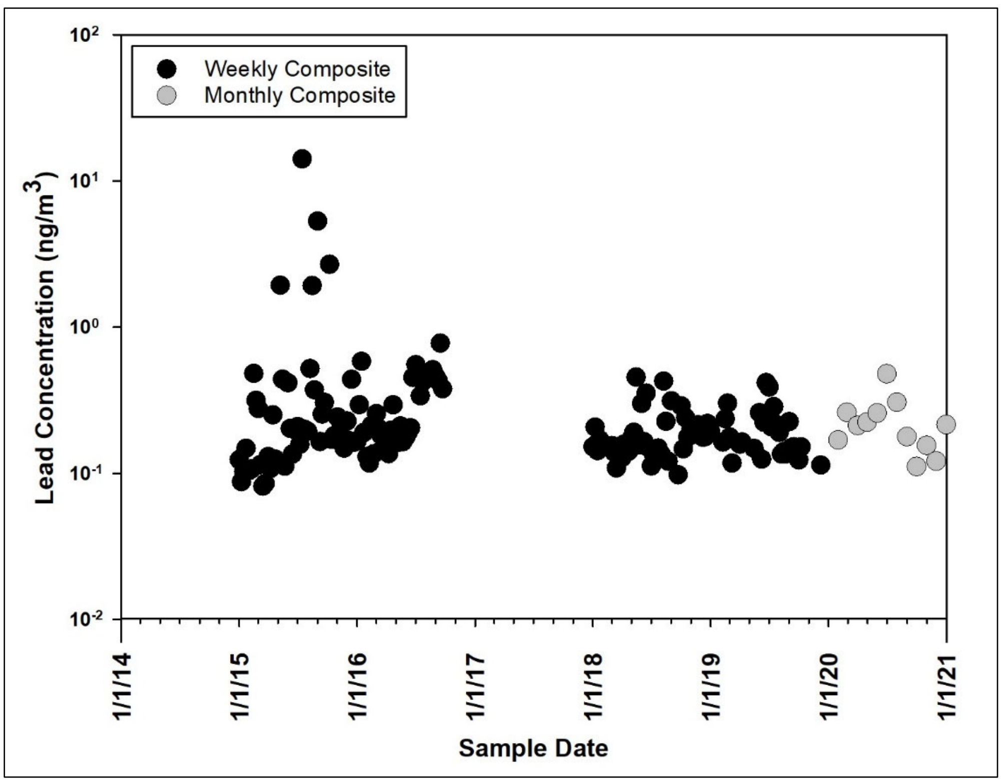
9.1.4 Metal Concentrations at Station B

Non-radiochemical analyses for Station B exhaust filters began in 2015. Time-series plots for weekly composites of Al, Mg, Cd, and Pb are detected regularly at Station B since 2015. In 2020, CEMRC switched from reporting the analysis results for weekly composites of Station B samples to monthly composites. However, Mg concentrations in all monthly composites of 2020 Station B samples are below the MDC, because the requirement of additional analyses starting with year 2020 reporting led to reduced sample volume for individual analyses and consequently higher MDC values. Results of selected metals for January 2020 monthly composites (Appendix H, Table H.3) are compared to the weekly composites from prior years in Figure 9.2. Values below detection limits are not shown in Figure 9.2, leading to an apparent scarcity of data, especially noticeable in 2017. It is noteworthy that the concentrations of most elements detected at Station B are much lower than at Station A, which is expected, given that station B collects effluent air after HEPA filtration.





Weekly Composite
Monthly Composite
Cadmium Concentration (ng/m3)
Sample Date
1/1/14
1/1/15
1/1/16
1/1/17
1/1/18
1/1/19
1/1/20
1/1/21



Weekly Composite
Monthly Composite
Lead Concentration (ng/m3)
Sample Date
1/1/14
1/1/15
1/1/16
1/1/17
1/1/18
1/1/19
1/1/20
1/1/21

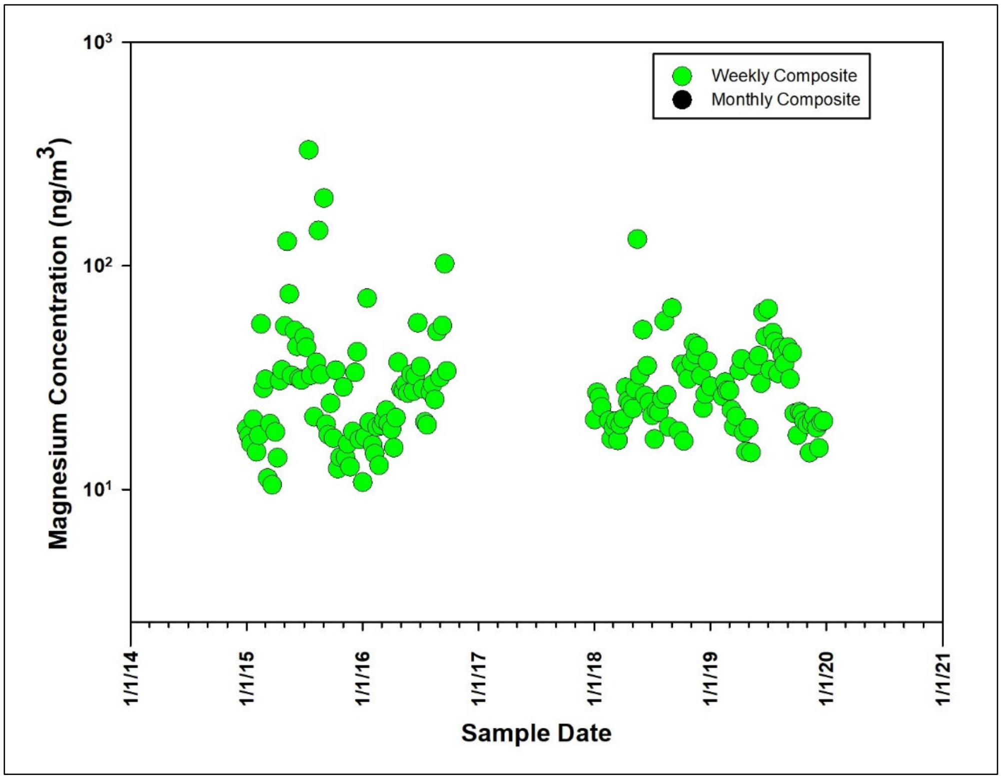


Figure 9.2. Historical Concentrations of Selected Metals at Station B

9.2 Non-Radiological Monitoring of Airborne Particulates

9.2.1 Sample Collection

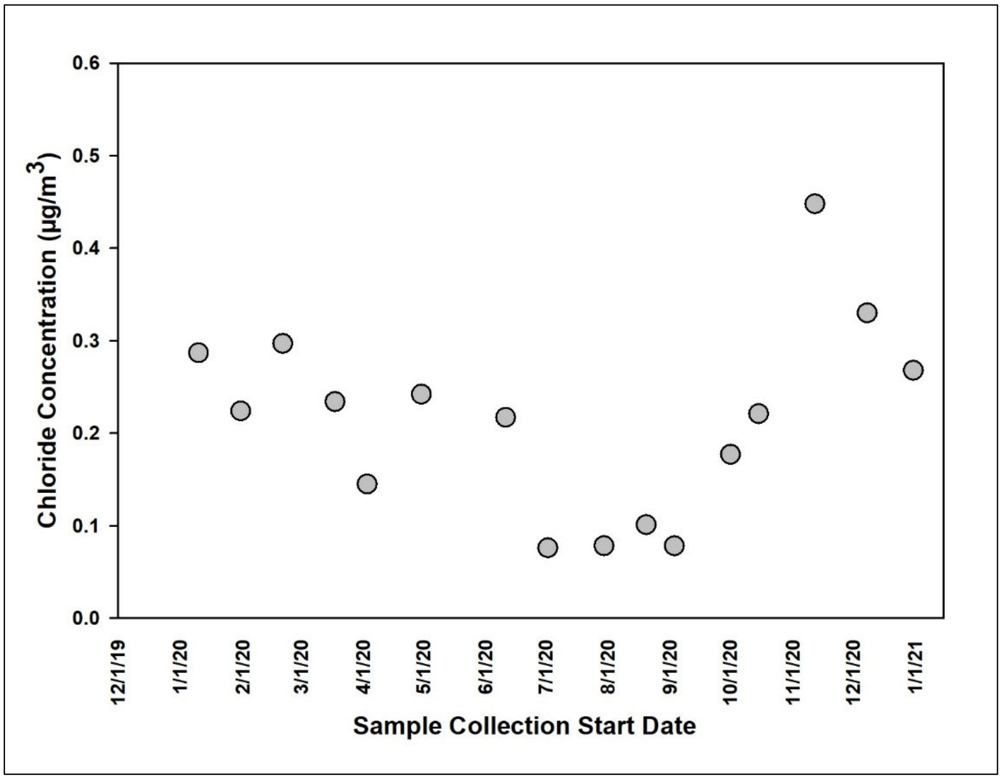
Airborne particulates in the air surrounding the WIPP site are collected on cellulose-based, Whatman 41 filters (GE Healthcare Life Sciences) in a similar way to the glass fiber filters collected above ground for radiochemical analyses. The Whatman 41 filters are only used for non-radiochemical analyses at the following two locations: Near Field and Cactus Flats.

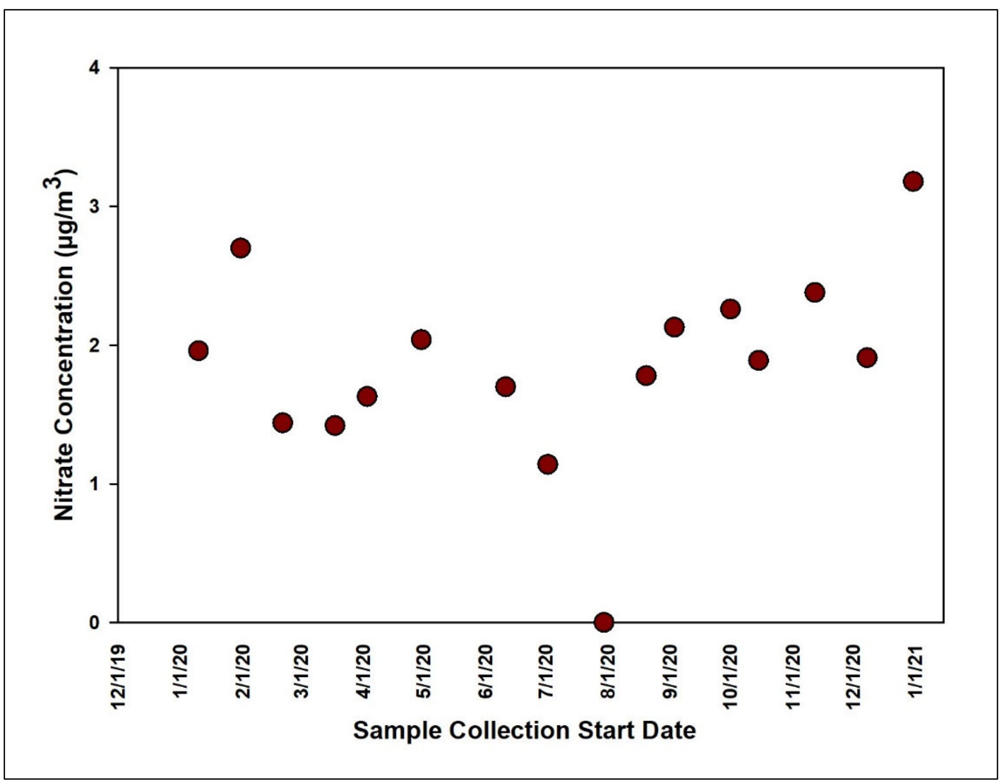
9.2.2 Sample Preparation and Analysis

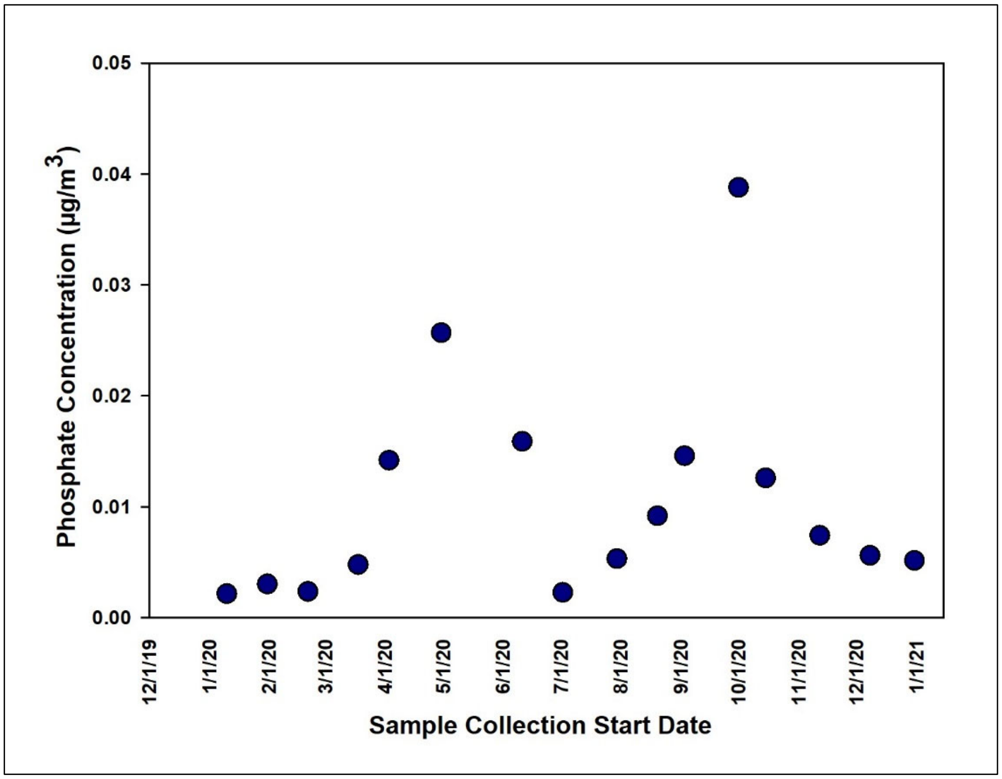
A water extraction using 40 mL ultrapure water is performed at room temperature on a ¼-sheet of each Whatman 41 filter sample. The extracted solution is filtered prior to analysis by Ion Chromatography (IC) for inorganic anions and cations. Blanks and spiked blanks are also extracted in this same manner for quality control purposes. All samples are filtered prior to analysis by Ion Chromatography (IC). Current methods utilized by CEMRC for non-radiochemical analyses performed on each sample type are summarized in Appendix H, Table H.1.

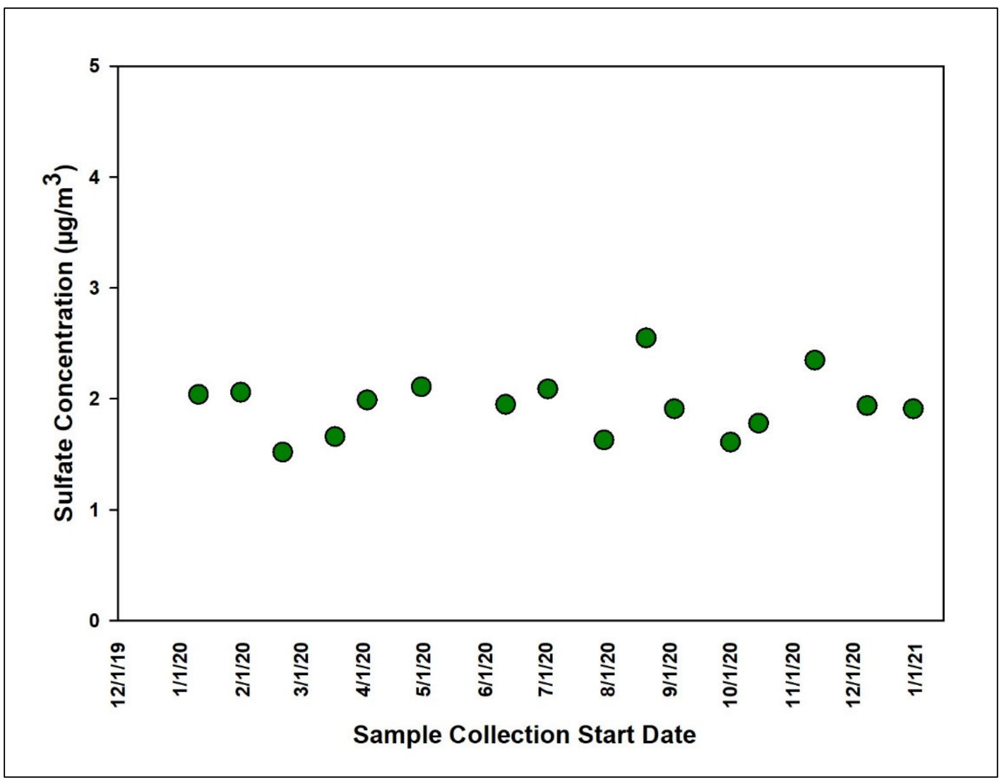
9.2.3 Anion and Cation Concentrations Measured at Near Field

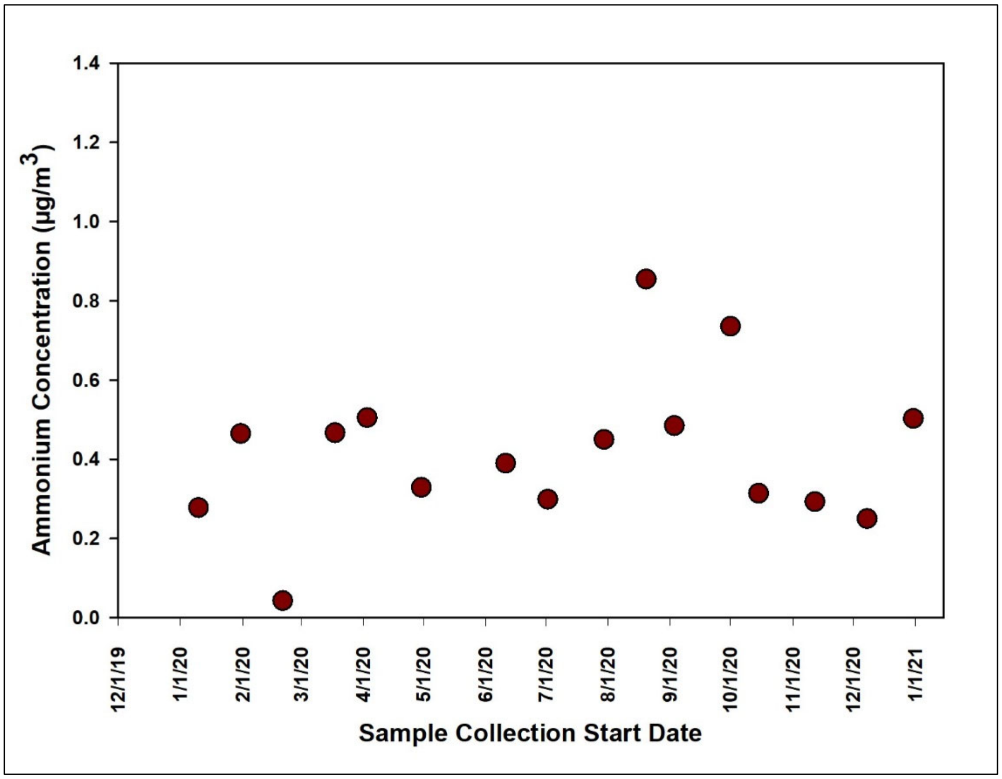
Time-series plots for selected inorganic anions and cations are shown in Figure 9.3 for 2020 samples collected at Near Field. Chloride, nitrate, phosphate, sulfate, ammonium, calcium, potassium, magnesium, and sodium are all regularly detected above the MDC at the Near Field location. Detailed concentrations are reported in Appendix H, Tables H.4 and H.5.

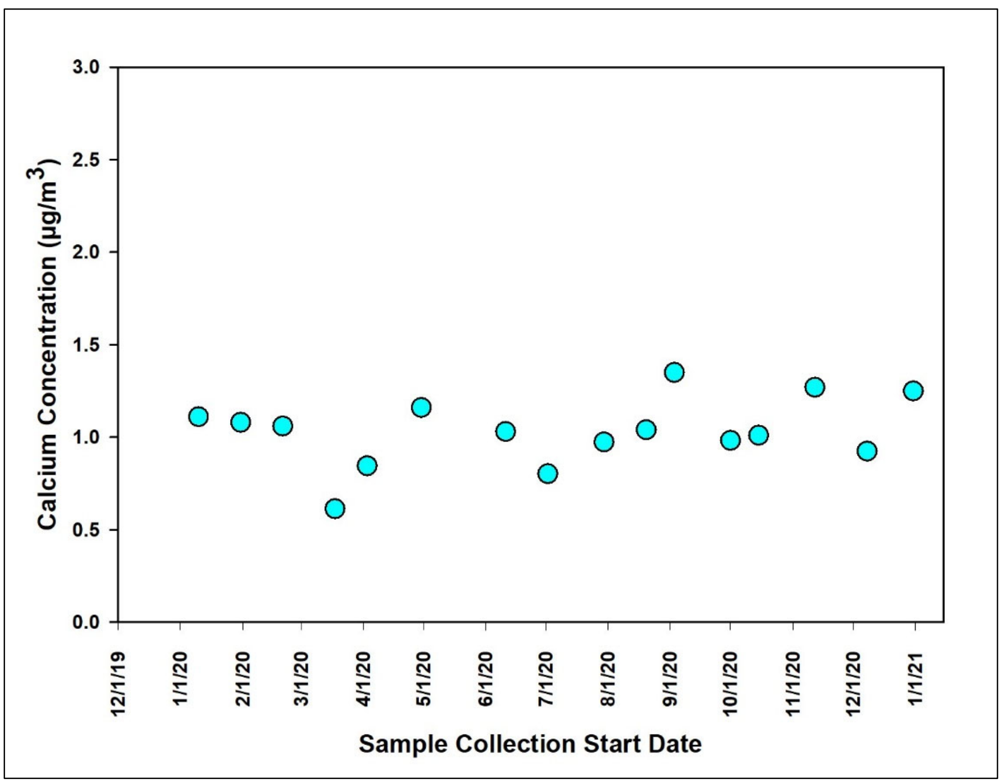


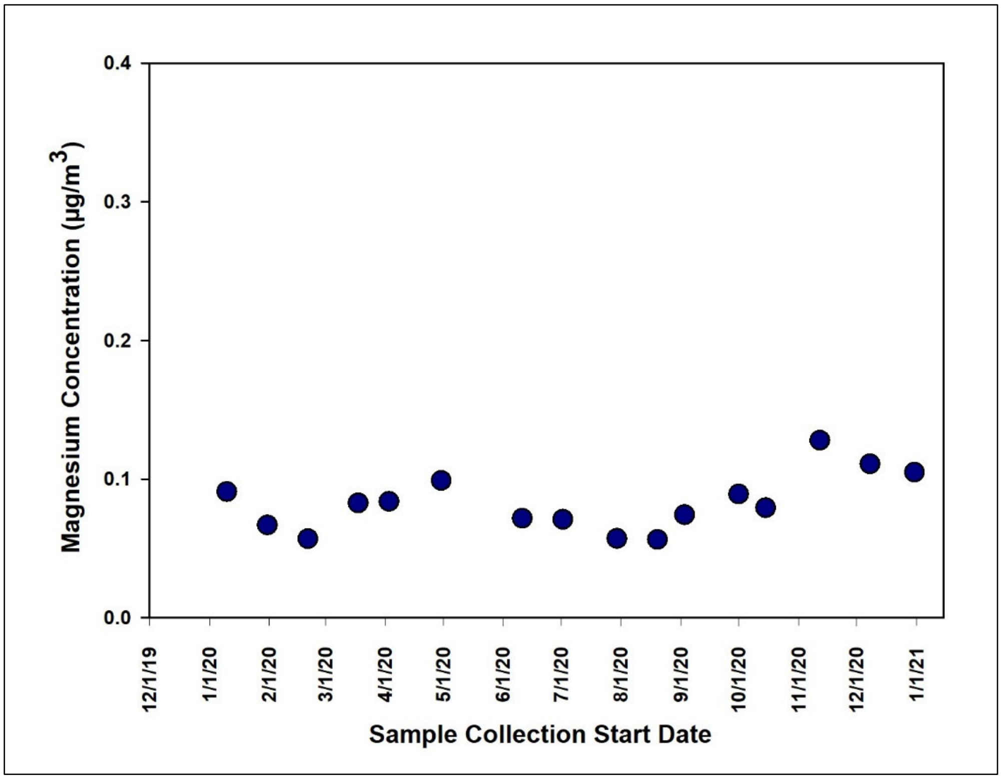



Phosphate Concentration (μg/m3)
0.05
0.04
0.03
0.02
0.01
0.00
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
Sample Collection Start Date

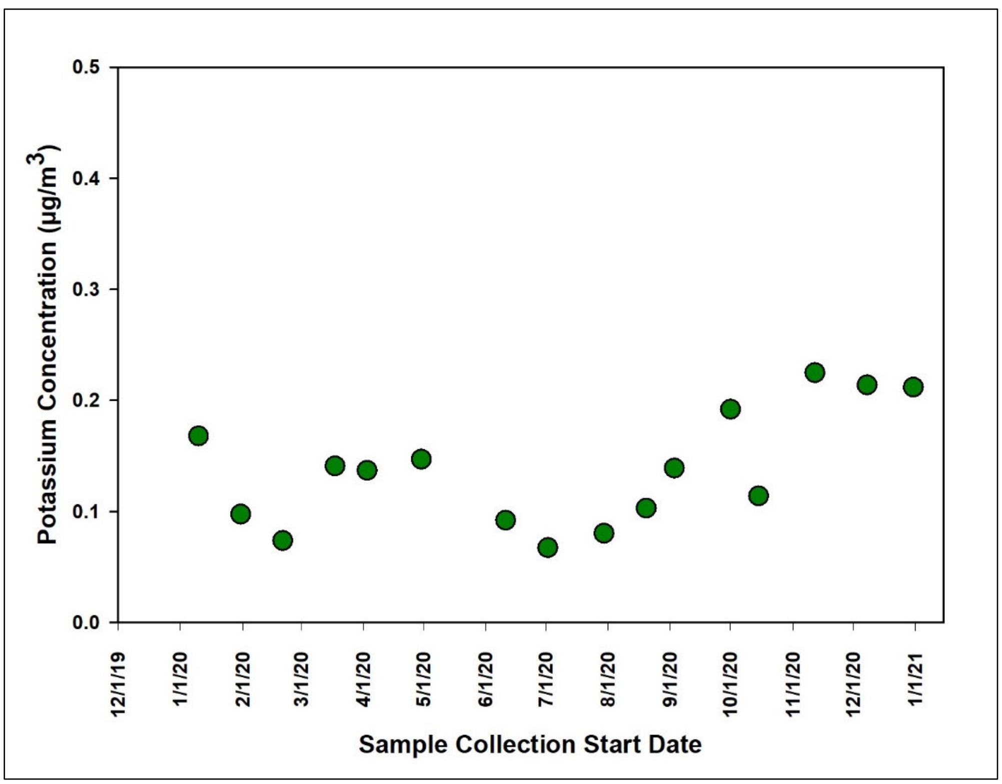

Sulfate Concentration (μg/m3)
5
4
3
2
1
0
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
Sample Collection Start Date


Ammonium Concentration (µg/m3)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
Sample Collection Start Date


Calcium Concentration (µg/m3)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
Sample Collection Start Date



0.4
0.3
0.2
0.1
0.0
Magnesium Concentration (µg/m3)
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
Sample Collection Start Date



0.5
0.4
0.3
0.2
0.1
0.0
Potassium Concentration (µg/m3)
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
Sample Collection Start Date

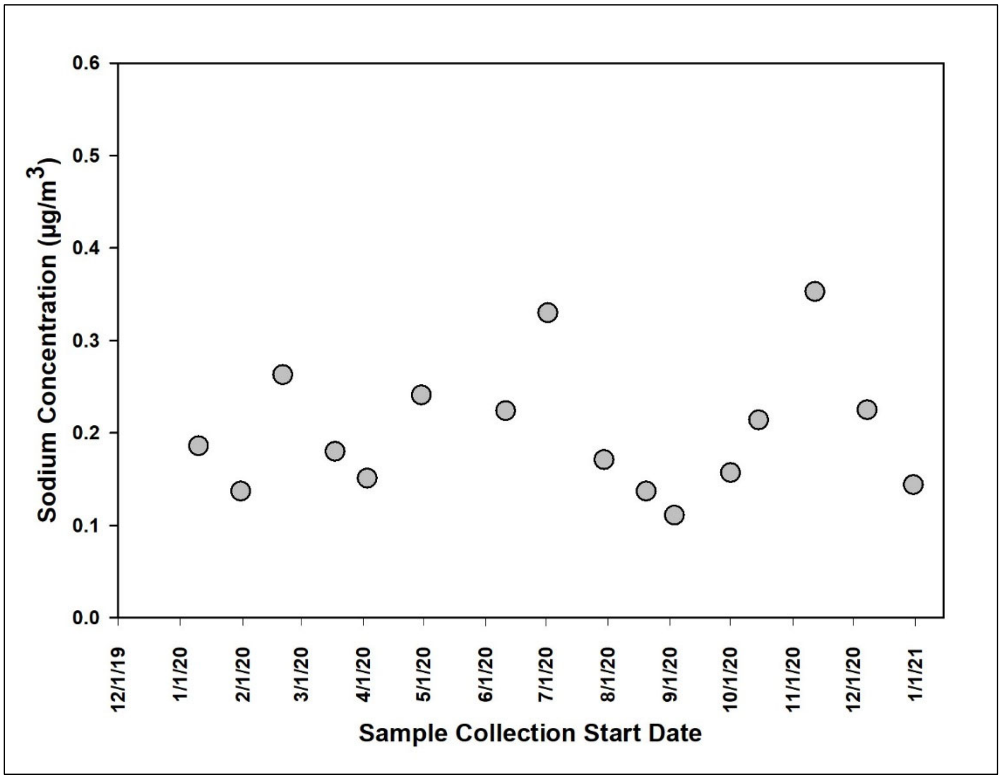
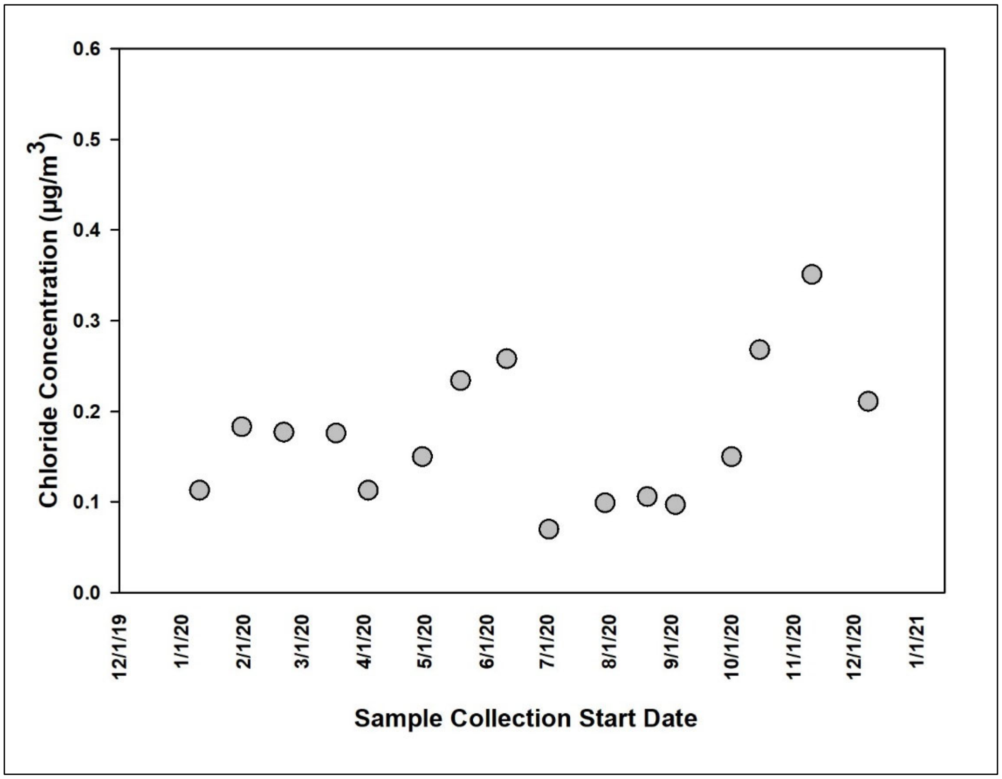


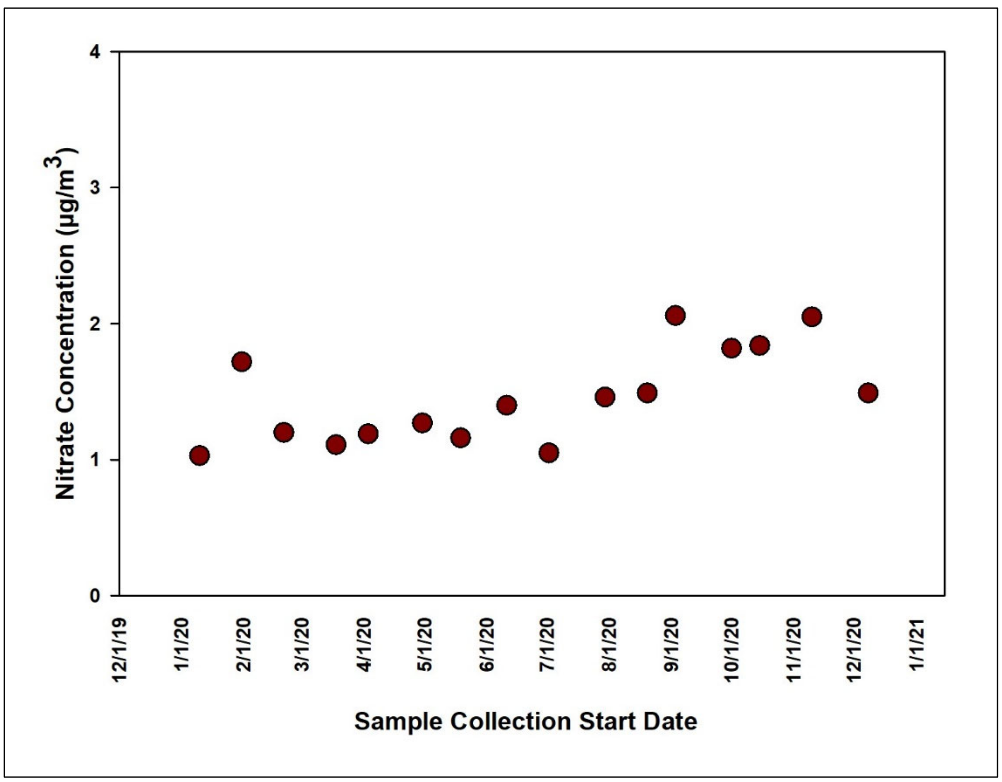
Figure 9.3. Historical Concentrations of Anions and Cations at Near Field

9.2.4 Anion and Cation Concentrations Measured at Cactus Flats

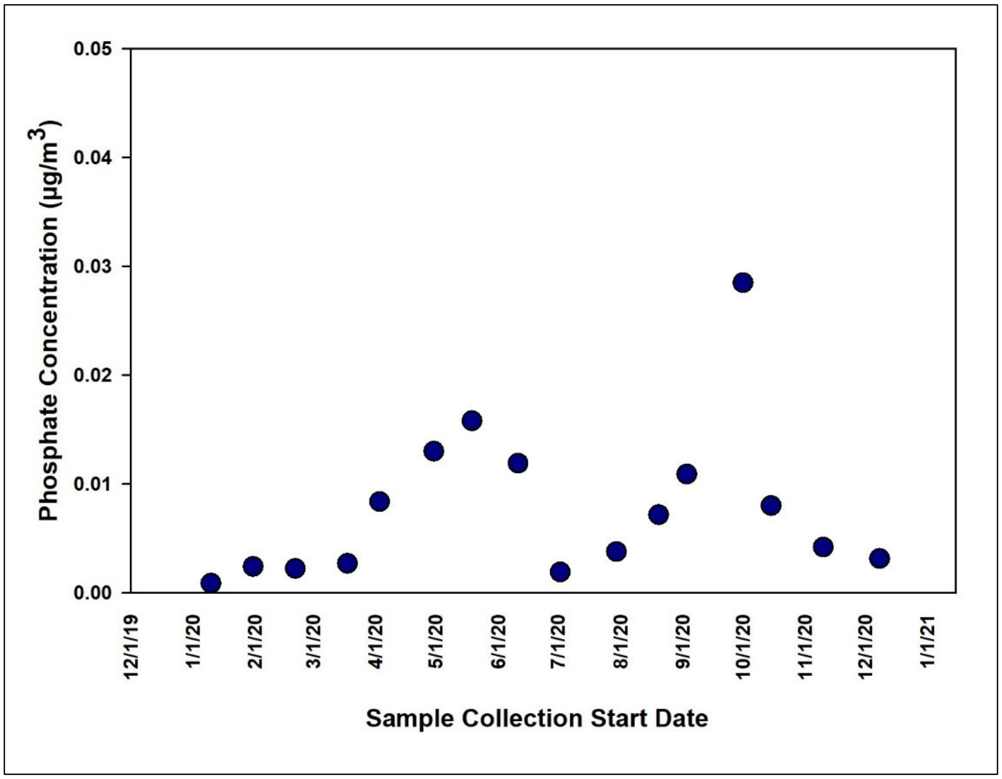
Time-series plots for selected inorganic anions and cations are shown in Figure 9.4 for 2020 samples collected at Cactus Flats. Chloride, nitrate, phosphate, sulfate, ammonium, calcium, potassium, magnesium, and sodium are all regularly detected above the MDC at the Cactus Flats location. Detailed concentrations are reported in Appendix H, Table H.6 and H.7.



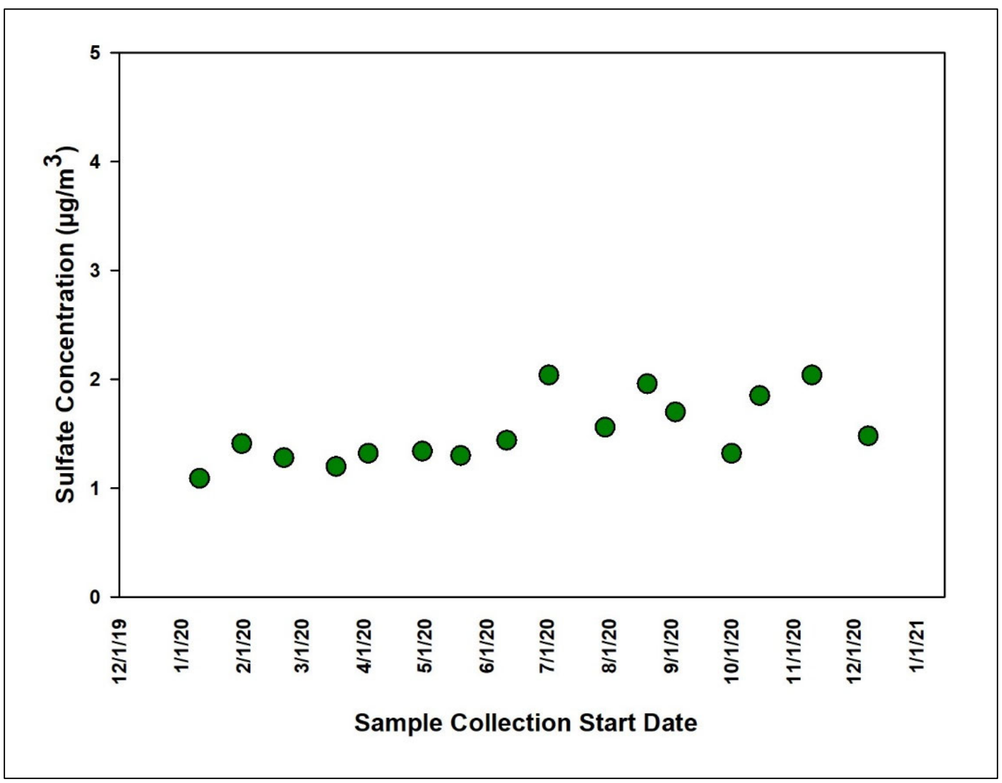
Chloride Concentration (µg/m3)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
Sample Collection Start Date



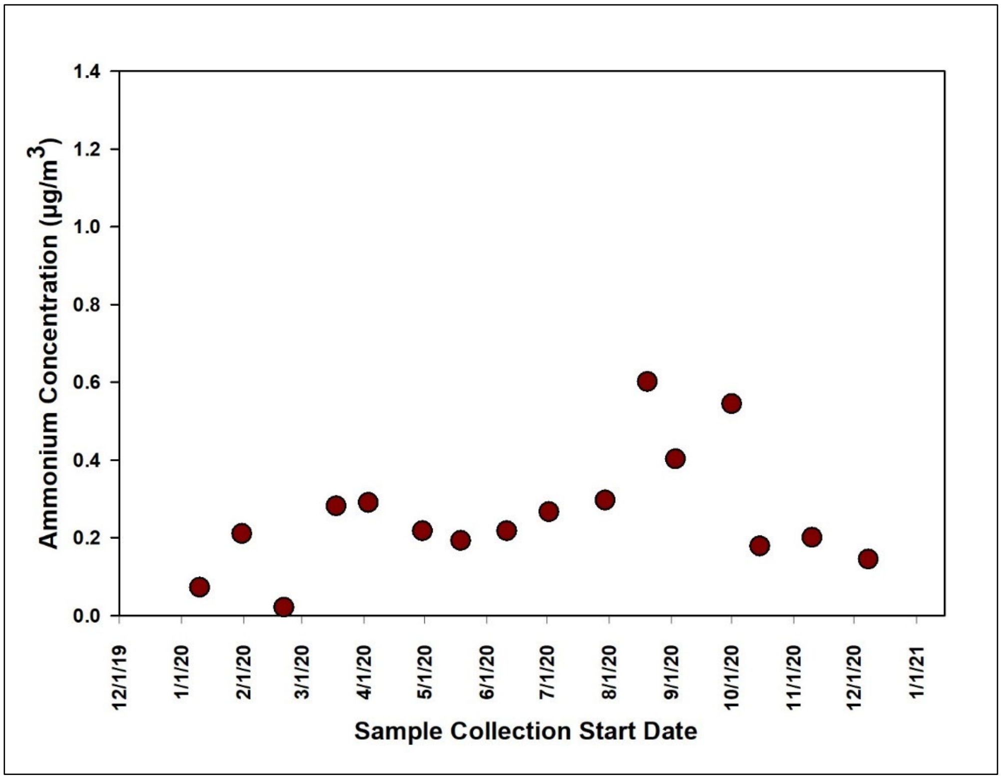
Nitrate Concentration (µg/m3)
4
3
2
1
0
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
Sample Collection Start Date



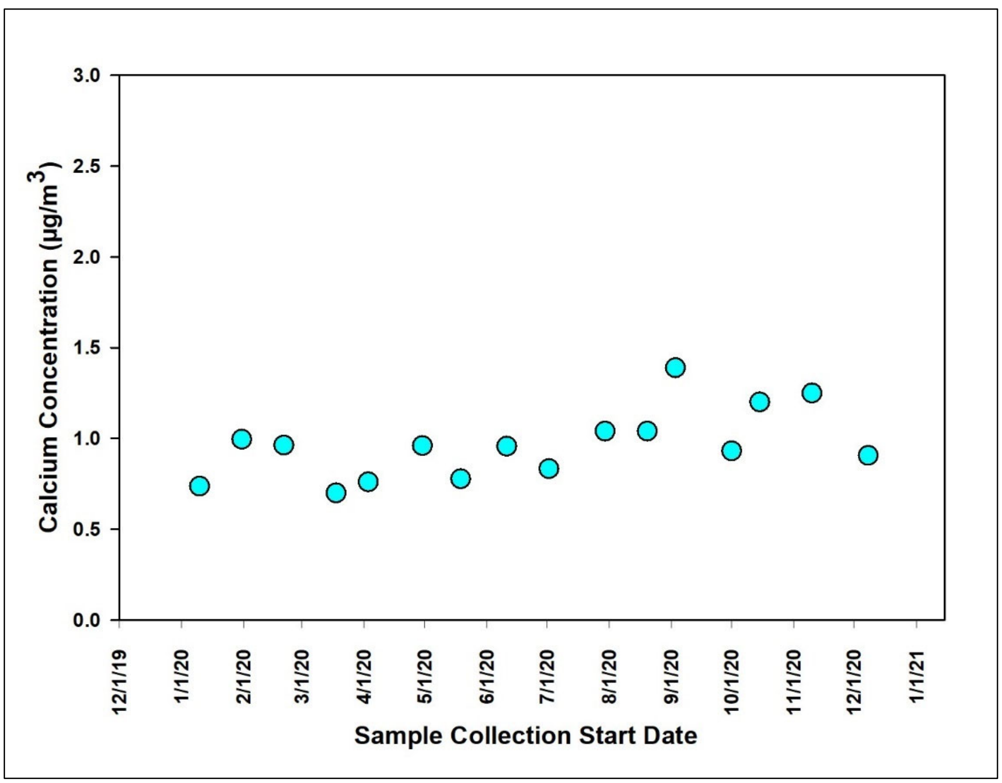
Phosphate Concentration (µg/m3)
0.05
0.04
0.03
0.02
0.01
0.00
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
Sample Collection Start Date



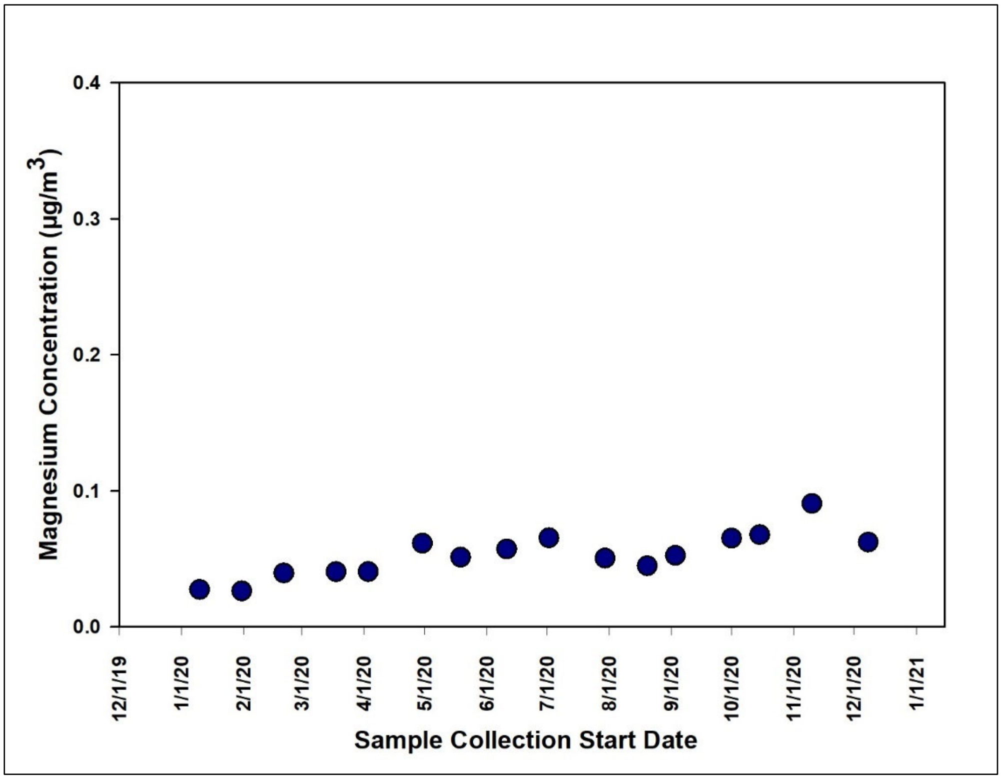
Sulfate Concentration (µg/m3)
5
4
3
2
1
0
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
Sample Collection Start Date



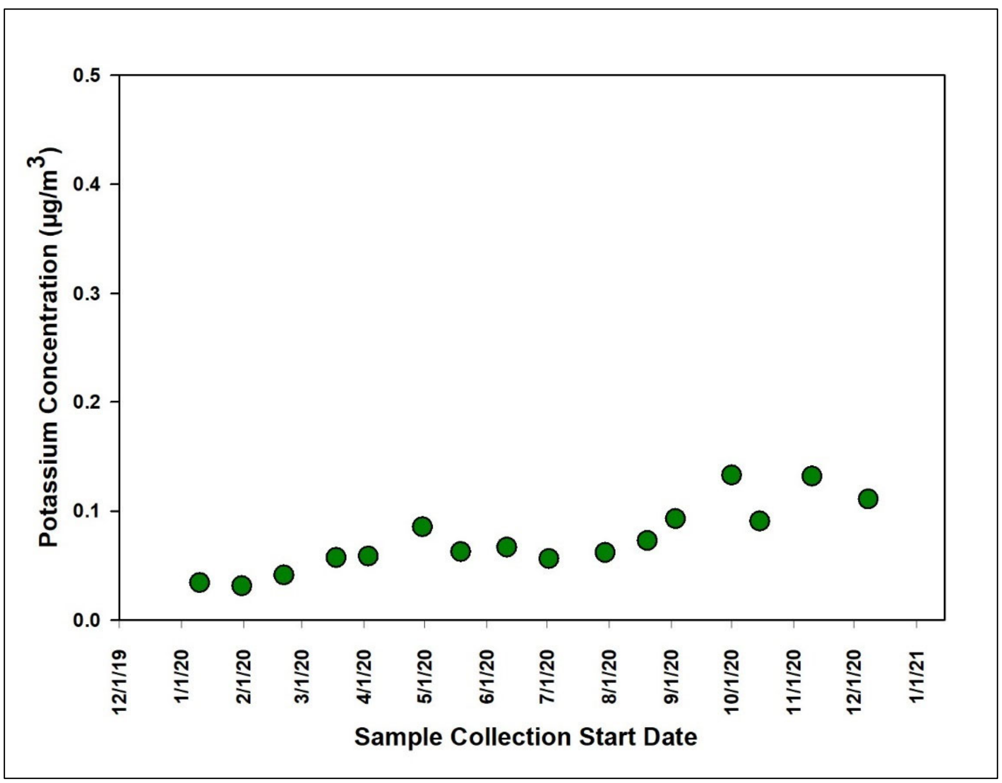
Ammonium Concentration (µg/m3)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
Sample Collection Start Date



Calcium Concentration (µg/m3)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
Sample Collection Start Date



Magnesium Concentration (µg/m3)
0.4
0.3
0.2
0.1
0.0
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
Sample Collection Start Date



Potassium Concentration (µg/m3)
0.5
0.4
0.3
0.2
0.1
0.0
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
Sample Collection Start Date

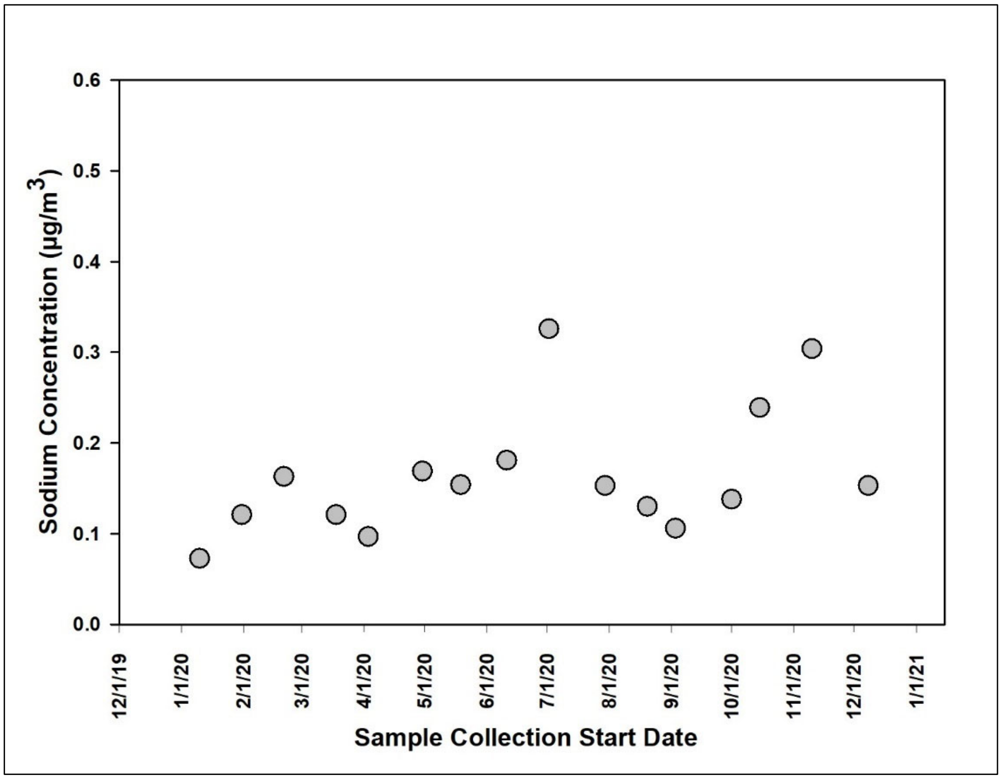


Figure 9.4. Historical Concentrations of Anions and Cations at Cactus Flats

9.3 Non-Radiological Monitoring of Drinking Water

9.3.1 Sample Collection

In 2020, drinking water samples for non-radiological analyses were collected from six community water supplies of Carlsbad, Loving, Otis, Hobbs, Malaga, and Double Eagle. Details regarding the sampling locations and procedure for drinking water sample collection are described in Chapter 6.

9.3.2 Sample Preparation and Analysis

Once the water samples are received at the CEMRC facility, three aliquots are removed immediately for non-radiochemical analyses: (1) 1 L for inorganic analysis, (2) 500 mL for mercury analysis, and (3) 1 L for metal analysis. Each 1 L aliquot removed for inorganic analysis is split in two parts. The first 1 L sub-sample is immediately refrigerated and analyzed for inorganic anions within 48 hours of collection. No preservatives are added to this sample. The other part of the 1 L inorganic sub-sample is preserved with a dilute nitric acid solution for inorganic cation analysis. Due to the high salinity of these drinking water samples, both types of inorganic analyses (anions and cations) require further dilution prior to analysis using ultrapure water. For metal analysis, each aliquot is preserved with nitric acid during collection. Because of the high salinity, drinking water samples are also diluted using the same nitric acid prior to analysis.

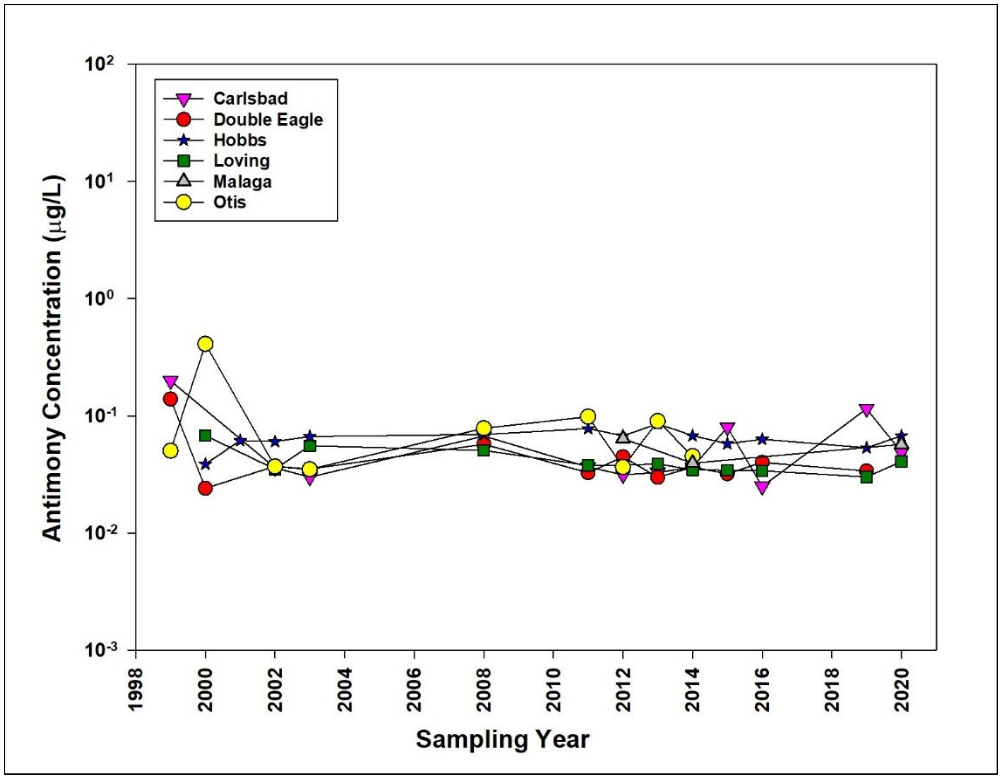
For mercury analysis, each sample is collected in a 500 mL glass container and preserved with bromo-monochloride immediately upon arrival at CEMRC. Sample dilution is not performed for mercury analysis of water samples because mercury is rarely detected above background values. It should be noted that mercury analysis is performed separately from other metals in drinking water samples because of the specific requirements for sample preservation.

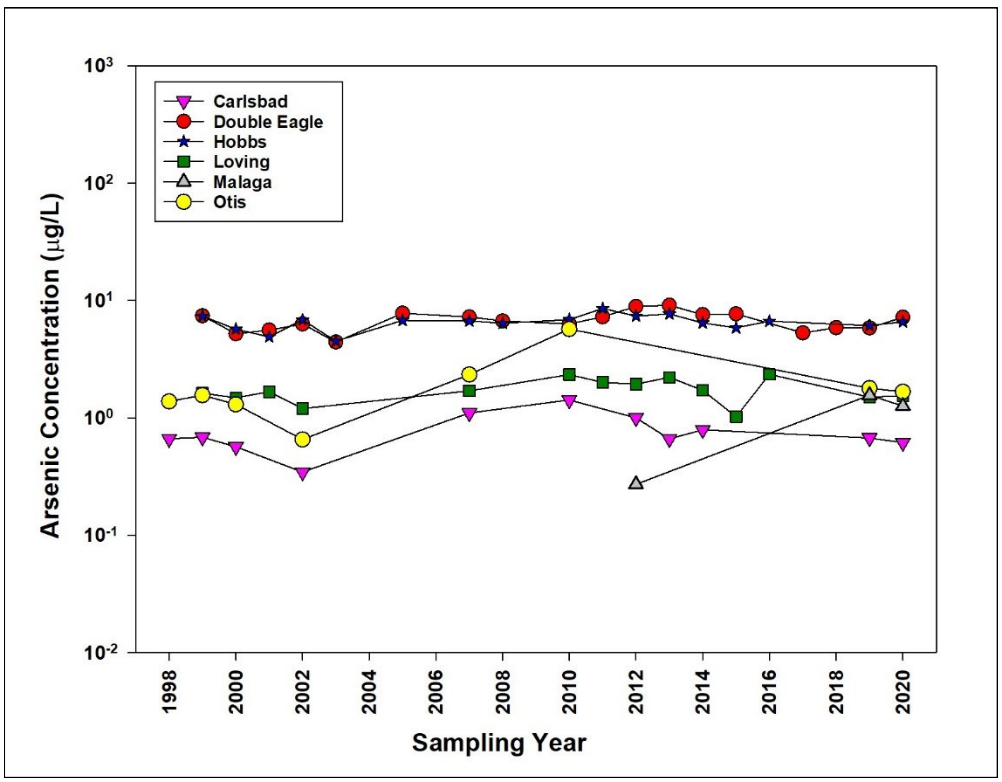
Metal analyses are performed using an ICP-MS, while inorganic cations and anions analyses are performed using an IC. Current methods utilized by CEMRC for non-radiochemical analyses performed on each sample type and their detection limits are summarized in Appendix H, Table H.1.

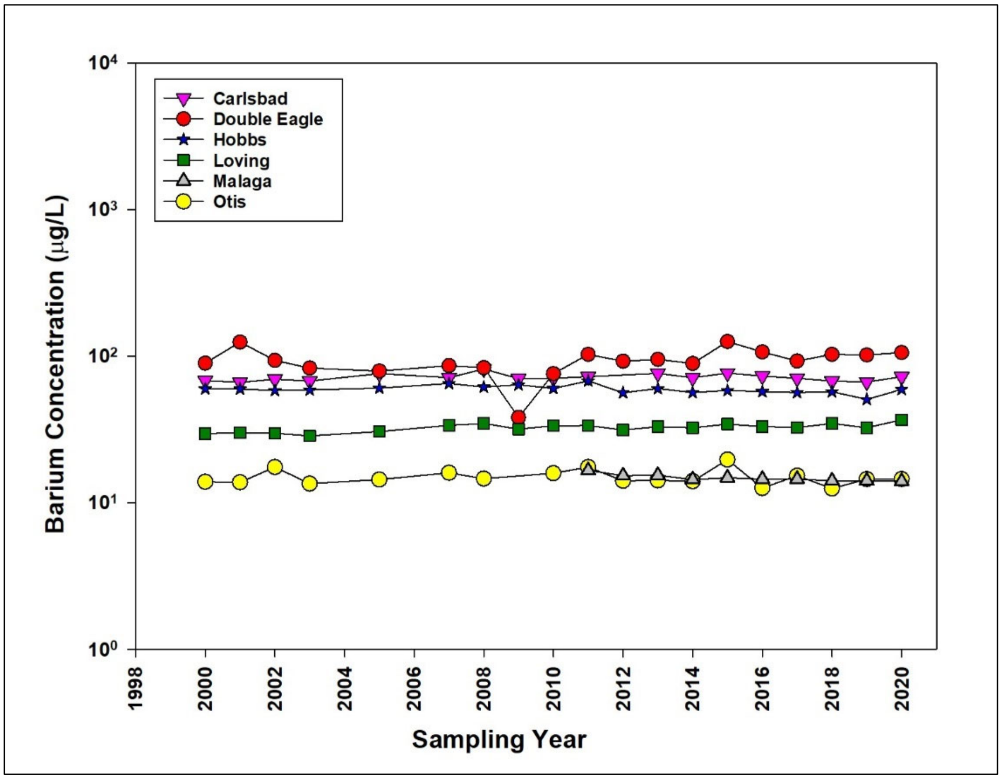
The 2020 trace metal and inorganic anion and cation concentrations measured in drinking water samples are reported in µg/L, which is calculated as the element mass in micrograms (µg) divided by volume of the drinking water in liters (L).

9.3.3 Metal Concentrations in Drinking Water

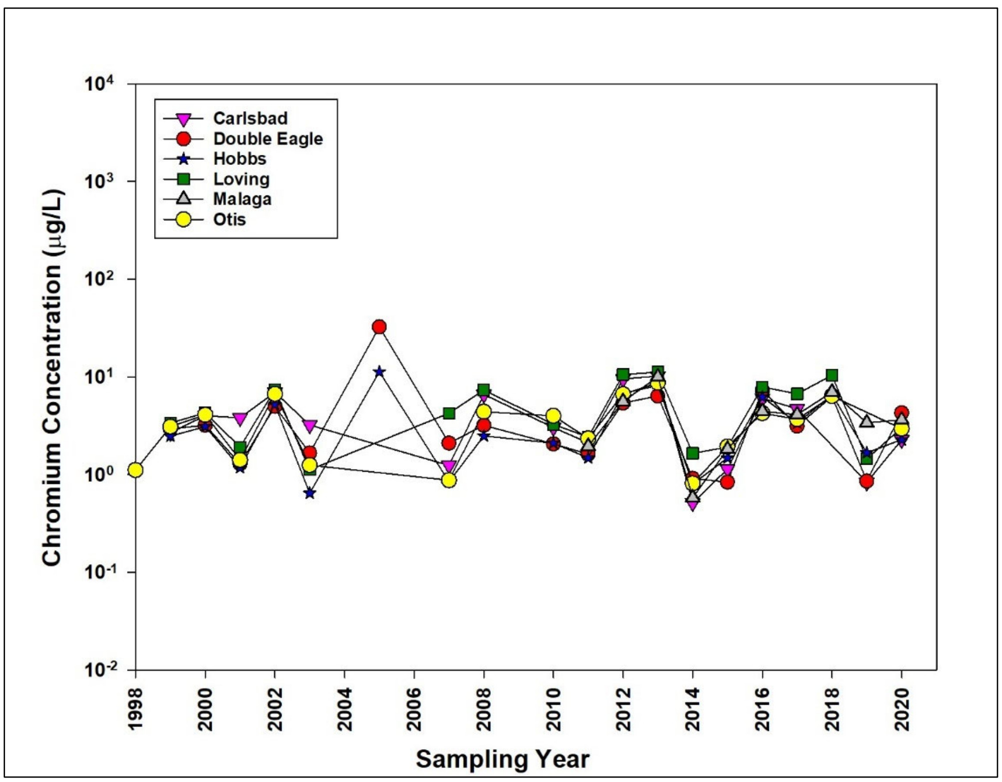
The following elemental constituents are commonly found above the MDC in the drinking water samples collected from the areas surrounding the WIPP site: arsenic (As), barium (Ba), chromium (Cr), copper (Cu), lead (Pb), and antimony (Sb). Figure 9.5 illustrates the historical concentrations of these selected metals from six regional drinking water locations. Minerals are a natural part of all water sources. The quantity of inorganic materials in drinking water is controlled primarily by local geology and topography, but it can also be influenced by urban storm water runoff, industrial or domestic wastewater discharge, oil and gas production, mining, or farming. (NRC, 1980). In 2020, Pb was detected in drinking water samples at the level of 0.12 – 2.94 µg/L, which is lower than the EPA action level of 15 µg/L set for Pb. Mercury was not detected in any drinking water sources, while arsenic was detected in the range of 0.62 – 7.20 µg/L, which is also below the EPA action level of 10 µg/L set for arsenic (US-EPA, 2018).


Carlsbad
Double Eagle
Hobbs
Loving
Malaga
Otis
Antimony Concentration (µg/L)
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Sampling Year

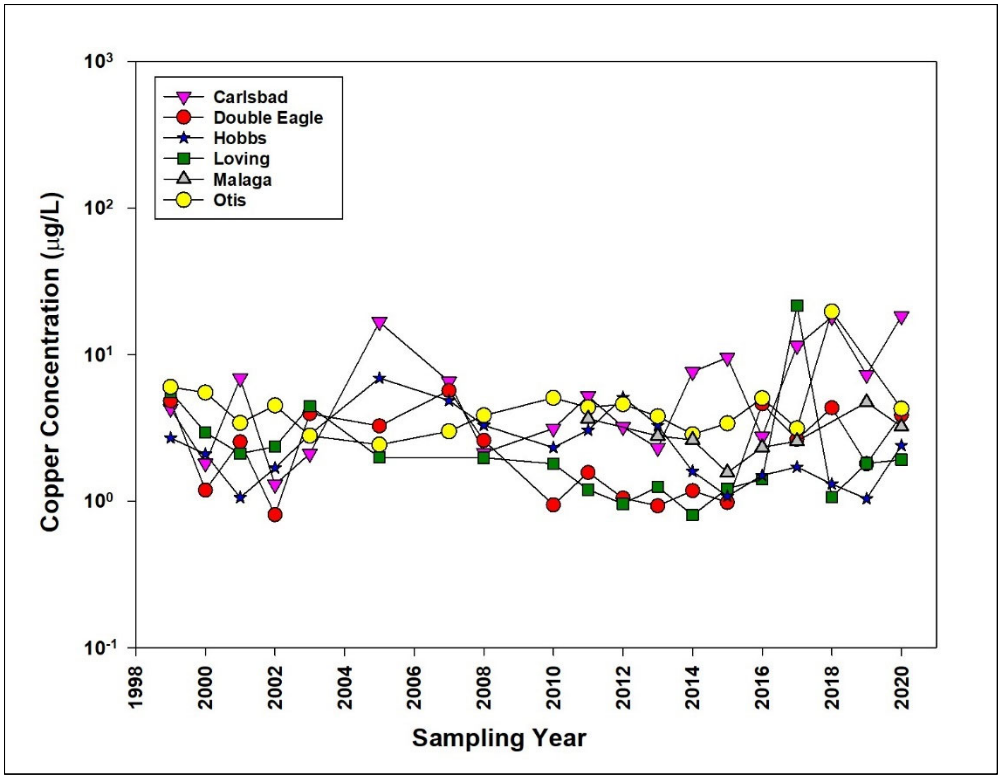

Carlsbad
Double Eagle
Hobbs
Loving
Malaga
Otis
Arsenic Concentration (µg/L)
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Sampling Year



Carlsbad
Double Eagle
Hobbs
Loving
Malaga
Otis
Barium Concentration (μg/L)
Sampling Year



Carlsbad
Double Eagle
Hobbs
Loving
Malaga
Otis
Chromium Concentration (μg/L)
Sampling Year



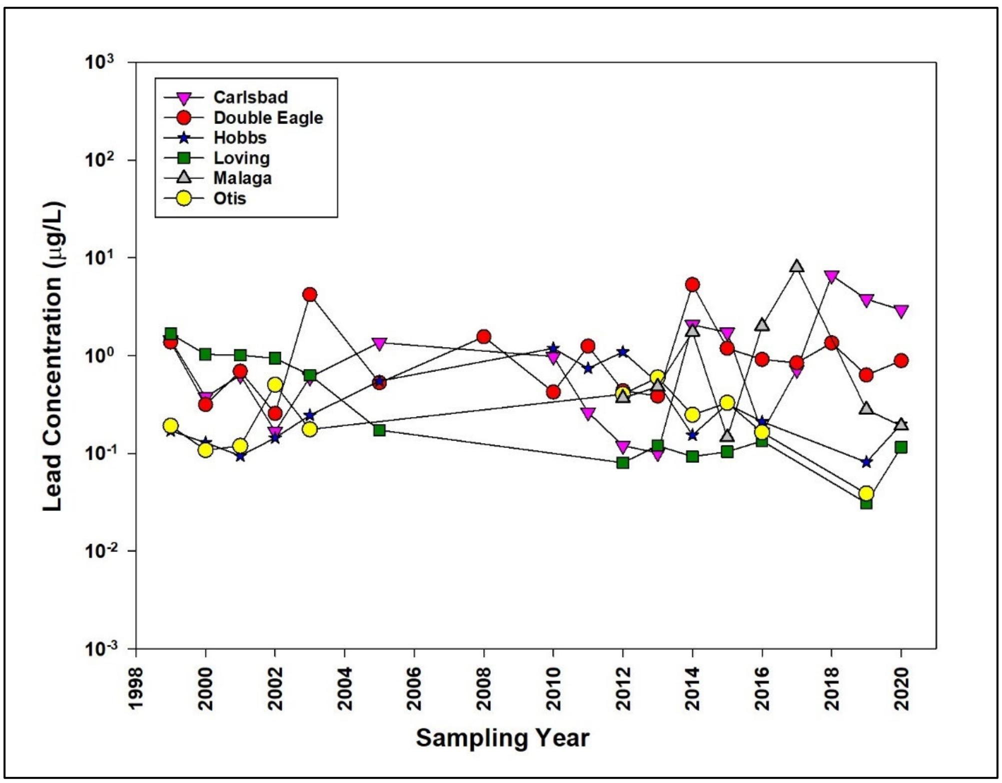
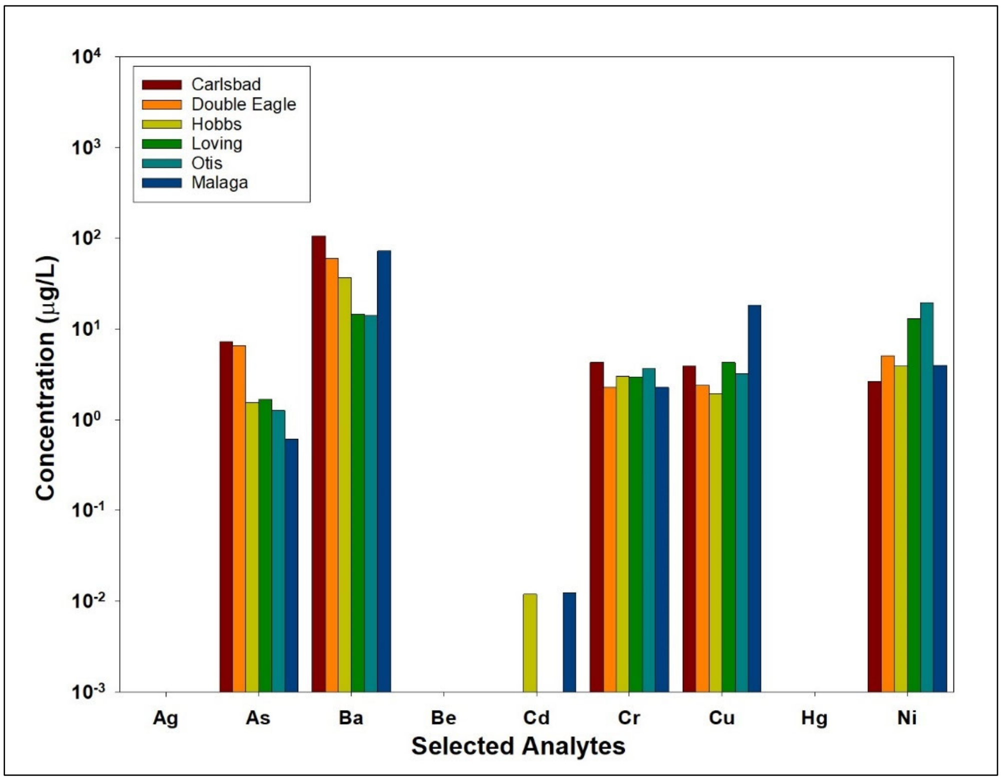


Figure 9.5. Historical Concentrations of Selected Metals in Drinking Water

To monitor the concentration variation of metals over time, metal concentrations of drinking water samples collected in 2020 were compared to those from previous years (see Appendix H, Tables H.6 through H.11). The maximum concentrations measured for these metals are as follows: 7.20 µg/L for As, 106 µg/L for Ba, 4.28 µg/L for Cr, 3.88 µg/L for Cu, and 2.94 µg/L for Pb. Present results as well as the results of previous analyses of drinking water were consistent for each source across sampling periods and were found to be below levels specified under SDWA (Safe Drinking Water Act) (US-EPA, 2018). Furthermore, the 2020 CEMRC results for drinking water from the Carlsbad (Sheep Draw) and WIPP (Double Eagle) locations generally agree with the measurements for the same elements monitored by the City of Carlsbad every year (CCR-2020). Figure 9.6 compares the different locations for the 2020 sampling period.



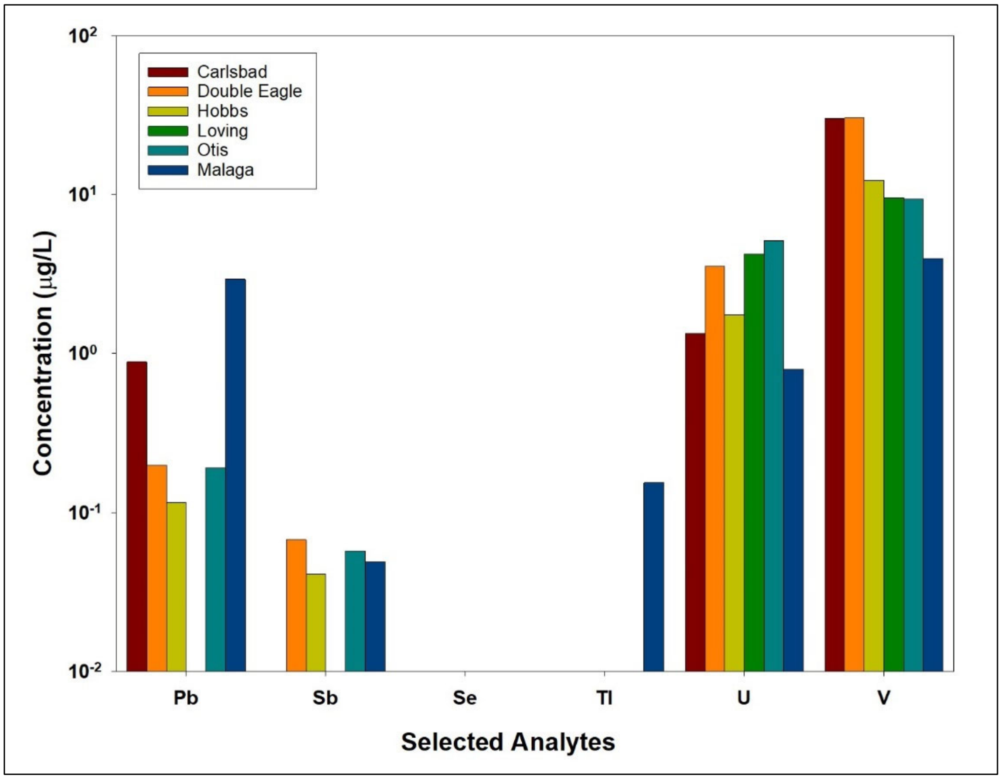


Figure 9.6. Location Comparison of Selected Metals in 2020 Drinking Water

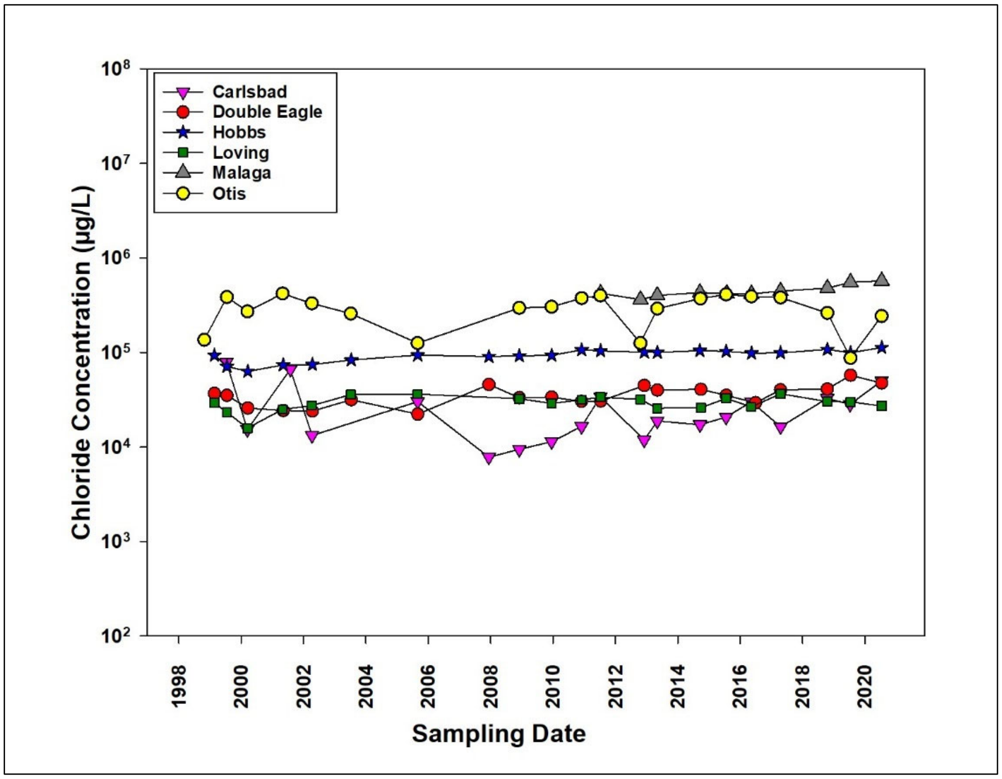
9.3.4 Concentrations of Inorganic Anions in Drinking Water

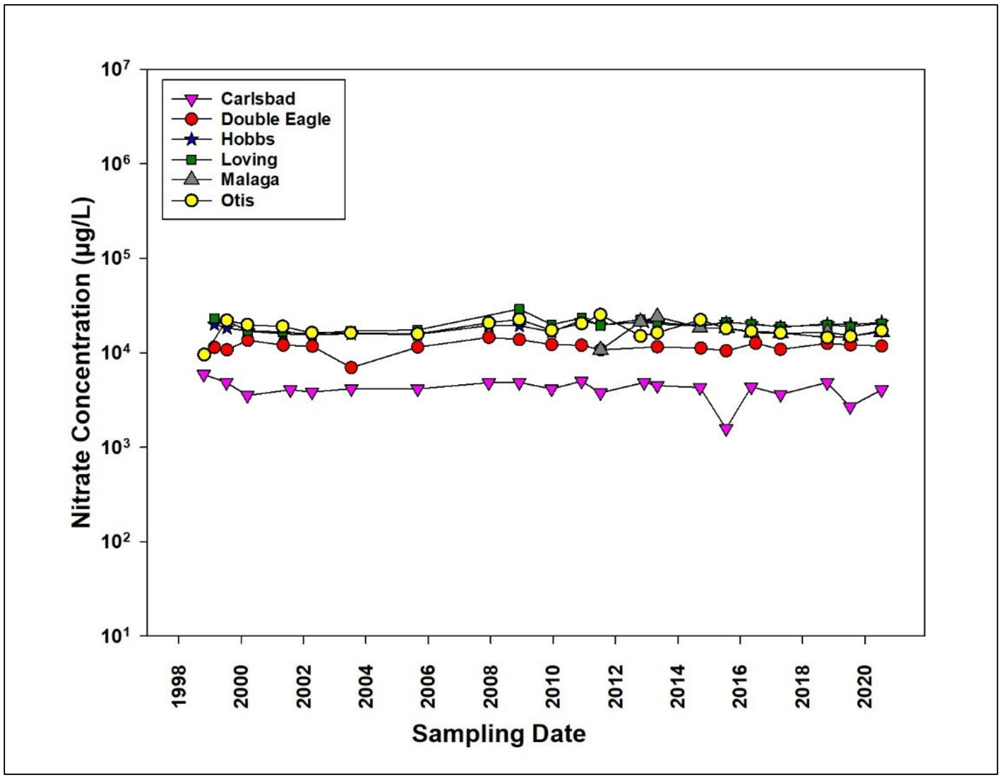
Inorganic anion concentrations measured in regional drinking water samples are listed in Appendix H, Table H.12. Of the seven inorganic anions that are monitored, only chloride, fluoride, nitrate, and sulfate are detected regularly above the MDC. Chloride is always below the EPA secondary standard of 250 mg/L (US-EPA, 2018) for Carlsbad, Double Eagle, Hobbs, and Loving since 1998. However, chloride is frequently detected above the EPA secondary standard (US-EPA-2018) for Malaga drinking water. In fact, all analyses thus far from the Malaga site are above the EPA secondary standard; chloride is measured at the highest level of 572 mg/L in 2020 since the sampling began. Since no pre-operational baseline data are available in the Malaga site for comparison, these high concentrations cannot be directly attributed to the WIPP operations. It should be noted that secondary EPA regulations are also not enforceable.

In 2020, all reported fluoride concentrations are below the EPA limit of 4 mg/L (US-EPA, 2018). All reported nitrate concentrations are also below the EPA limit (44.2 mg/L for the nitrate ion) (US-EPAS, 2018). Loving, Otis, Malaga, and Hobbs water typically have higher nitrate concentrations than Double Eagle and Carlsbad. According to the EPA, common sources of nitrogen in the form of nitrites and nitrates are fertilizer runoff, leaching from septic tanks and sewage, and from erosion of natural deposits.

Sulfate is detected below the EPA secondary standard for the Carlsbad, Double Eagle, Hobbs, and Loving locations, but is routinely detected above the EPA secondary standard of

250 mg/L (US-EPA, 2018) in Malaga and Otis water. It is noteworthy that CEMRC has been detecting high levels of sulfate in Otis water since monitoring began in 1998. Therefore, the high sulfate concentrations in Otis water cannot be a result of the WIPP-related activities. There are no pre-operational baseline data available for the Malaga site. It should be noted that secondary EPA standards are not enforceable. Furthermore, the EPA does not list any potential health effects from long-term exposure to sulfate. Figure 9.7 shows the historical variations of common anions in regional drinking water samples.





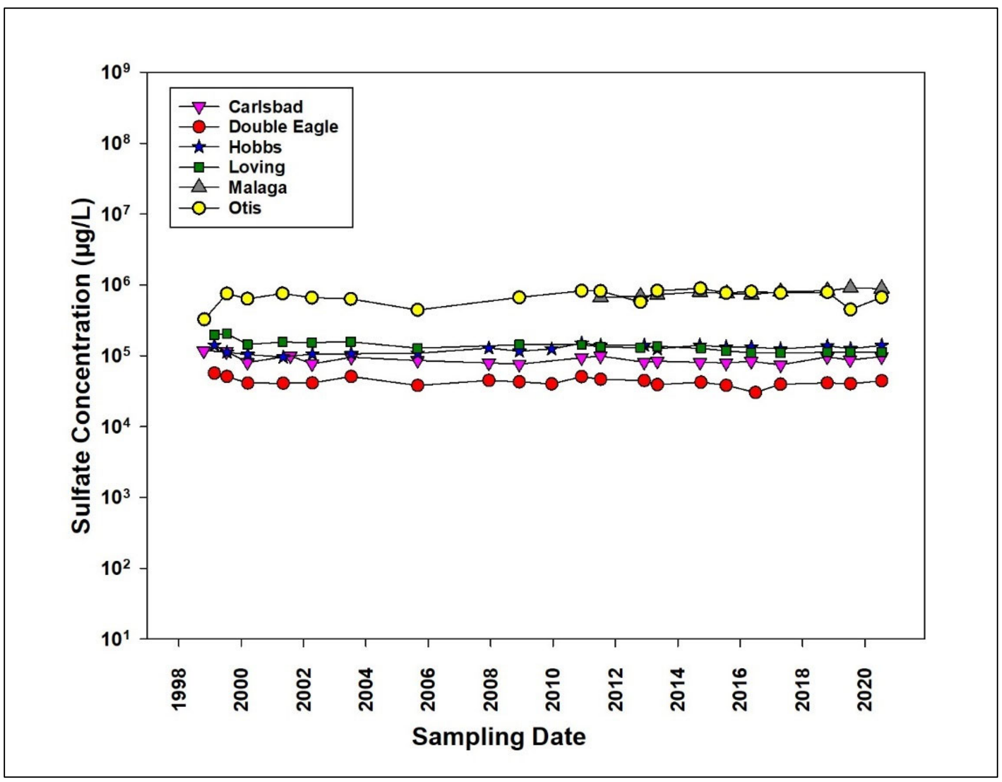
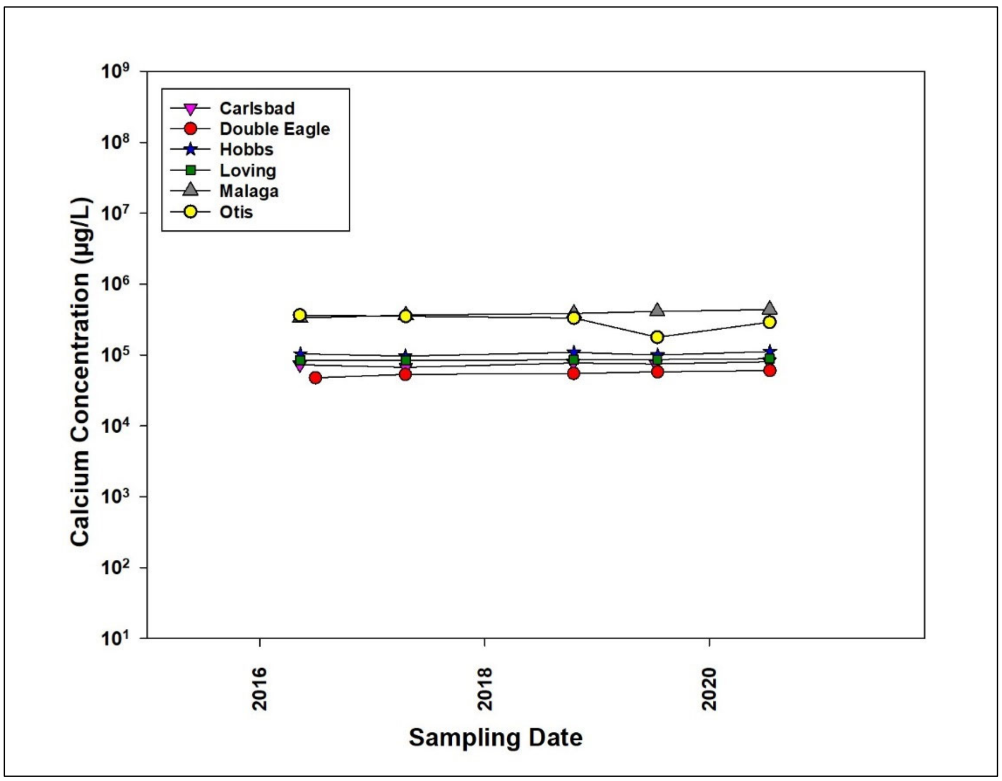
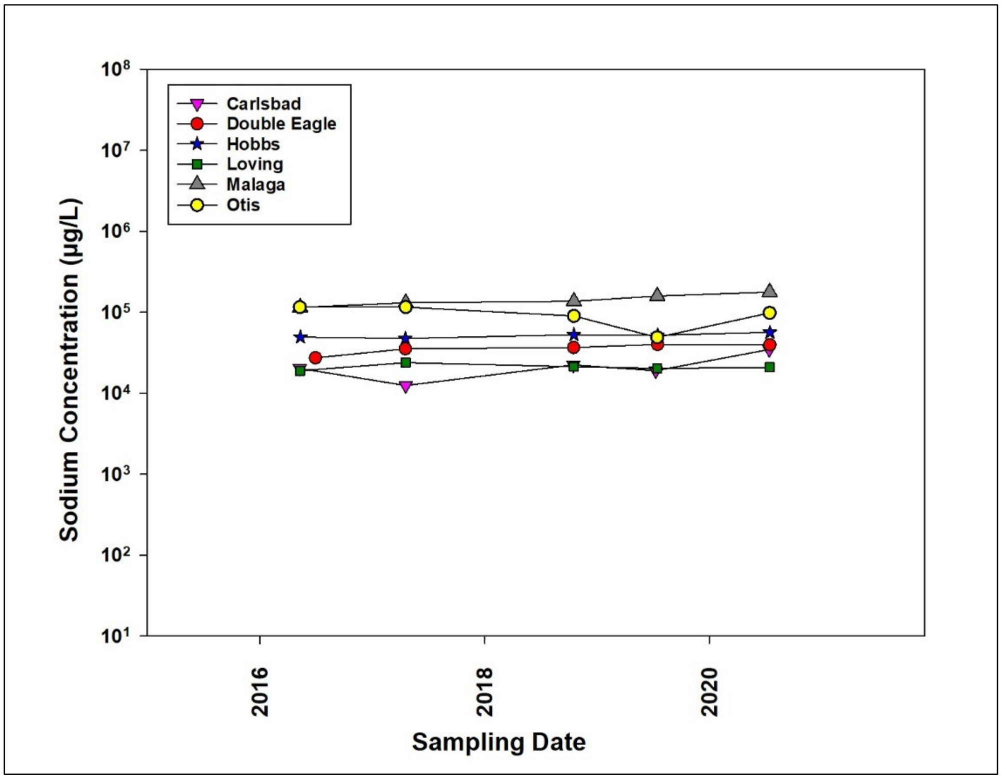


Figure 9.7. Historical Concentrations of Select Anions in Drinking Water

9.3.5 Concentrations of Inorganic Cations in Drinking Water

The 2020 concentrations of inorganic cations measured in drinking water are provided in Appendix H, Table H.13. The corresponding concentrations of these cations measured previously are also listed for comparison. Only concentrations for calcium (Ca), magnesium (Mg), and sodium (Na) are consistently measured above the MDC since cation analysis began in 2016. As illustrated in Figure 9.8, the past 5 years show very consistent measurements in all drinking water sampling locations. Potassium is only occasionally detected above the MDC for all sampling locations. In 2020, potassium was detected above the MDC only at the Double Eagle location (3.96 mg/L). Lithium is only measured above the MDC in Double Eagle PRV4 in 2016 and in 2019. Thus far, ammonium is the only inorganic cation that has never been detected above the MDC at any of the drinking water sampling locations surrounding the WIPP site. Currently, none of the six inorganic cations are monitored by EPA and measured concentrations of these cations are consistent for the 2016-2020 period.





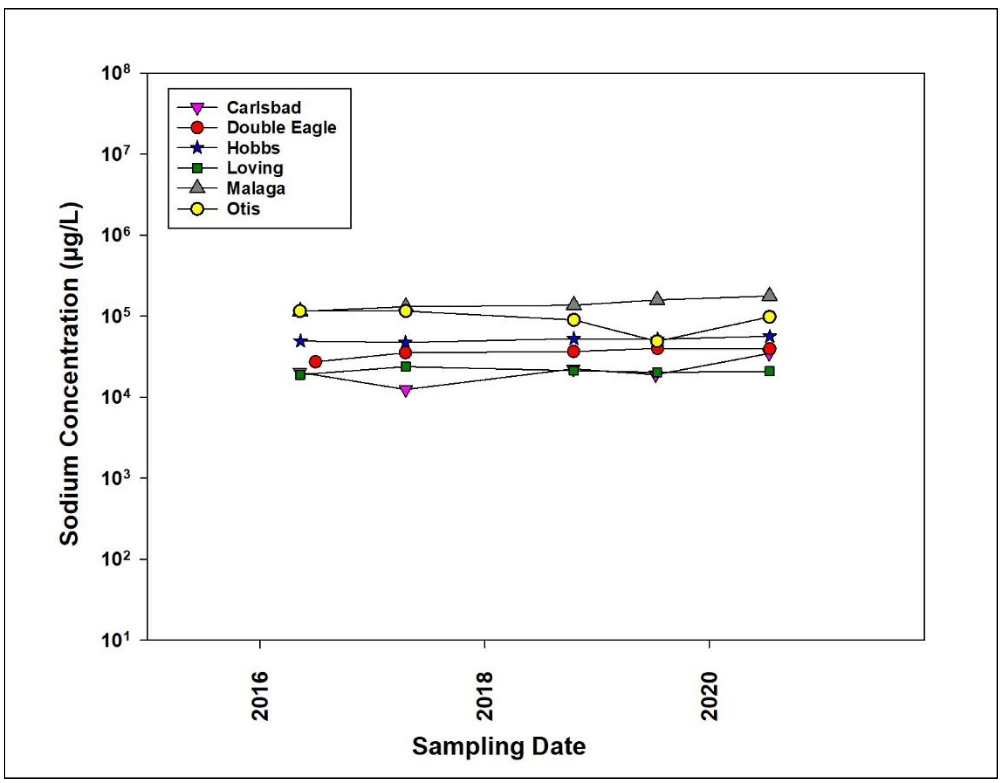


Figure 9.8. Historical Concentrations of Select Cations in Drinking Water

9.3.6 Additional Analyses Performed on Drinking Water

To characterize the drinking water more comprehensively, several additional types of non-radiological analyses were performed this year, including specific gravity, pH, conductance, total organic carbon, total dissolved solids, and total suspended solids. Results of these analyses are provided in Appendix H, Tables H.14-H.18.

9.4 Non-Radiological Monitoring of Surface Water

9.4.1 Sample Collection

In 2020, surface water samples for non-radiological analyses were collected from three regional surface water reservoirs situated on the Pecos River. These locations include Lake Carlsbad, Brantley Lake, and Red Bluff Lake.

9.4.2 Sample Preparation and Analysis

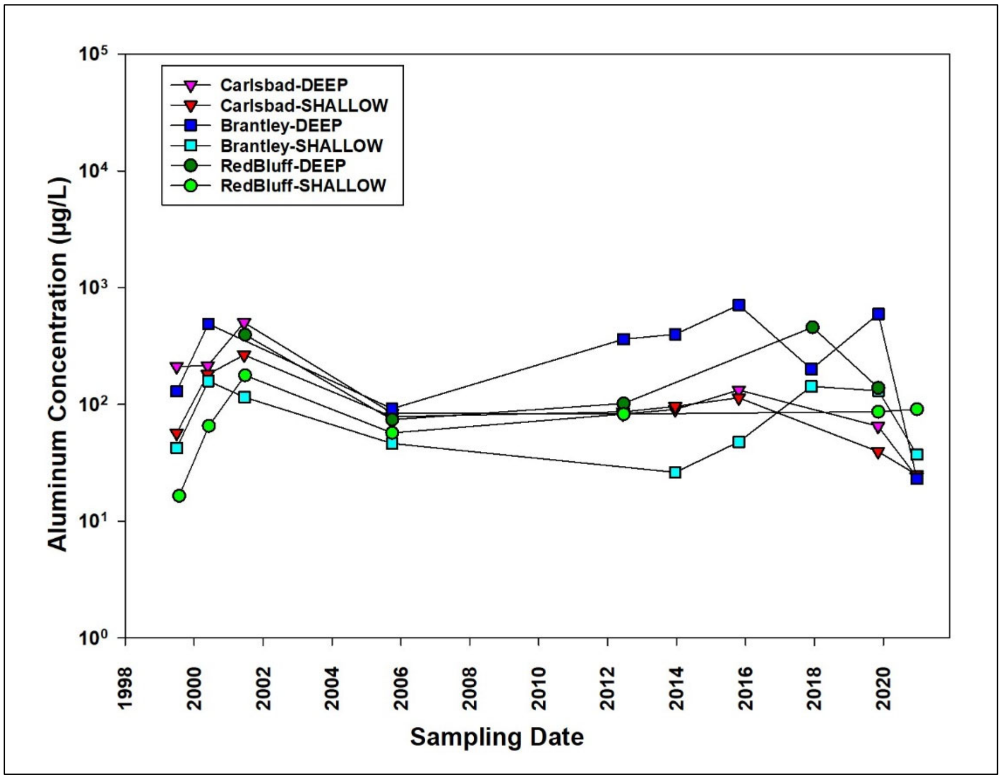
Once the surface water samples are received at the CEMRC facility, samples are divided into the same aliquots as drinking water: (1) 1 L for inorganic constituent analysis, (2) 500 mL for mercury analysis and (3) 1L for elemental analyses. Surface water samples are preserved and analyzed in the same manner as drinking water samples except that all surface water samples are filtered prior to analysis because of the high particulate content.

The 2020 trace metal and inorganic anion/cation concentrations measured in drinking water samples are reported in µg/L for all results. The concentration is calculated as the concentration in mass (micrograms) divided by volume of the drinking water in liters (L).

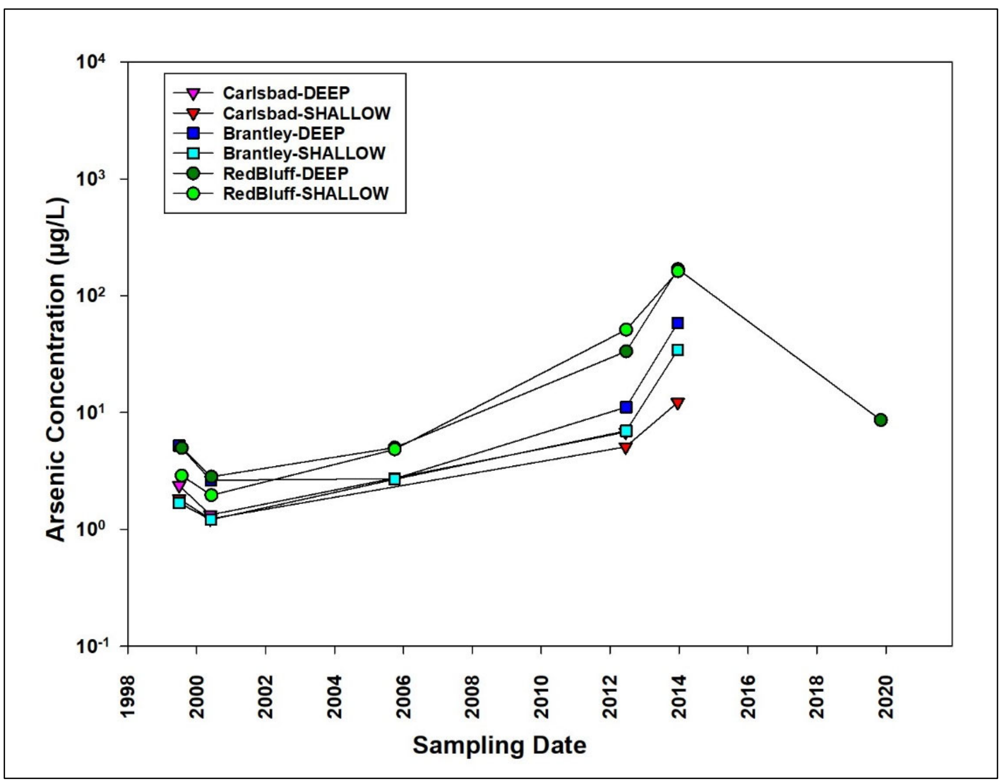
9.4.3 Metal Concentrations in Surface Water

Aluminum (Al), barium (Ba), iron (Fe), and nickel (Ni) are some metals commonly found above the MDC in the surface water samples collected from the areas surrounding the WIPP site. Figure 9.9 illustrates the historical concentrations of these select metals at the three regional surface water locations from both deep and shallow collection areas. In 2020, lead (Pb) and arsenic (As) concentrations in surface water were all below the MDC. It should be noted that arsenic As concentrations have only been detected at one location (Red Bluff in 2019) since 2014. Metals are a natural part of all water sources. The amount of non-radiochemical materials in surface water is determined primarily by local geology and topography, but it can be influenced by urban storm water runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming.

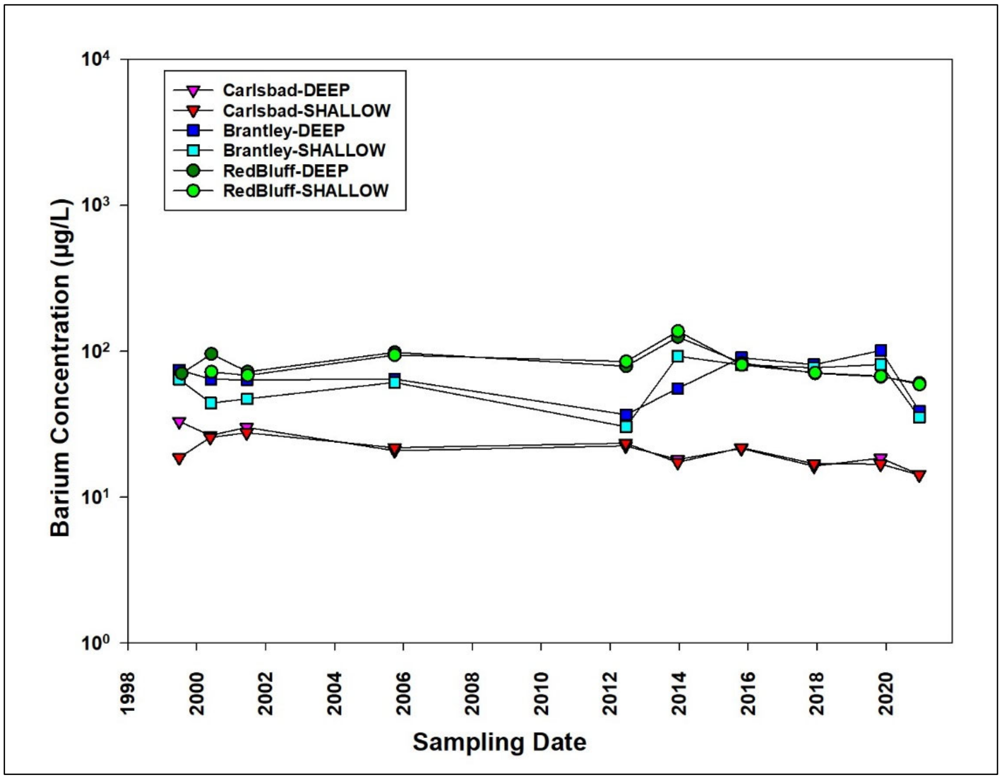
Mercury was not detected in any surface water sources in 2020. However, mercury (Hg) was detected in Lake Carlsbad at the level of 0.028 µg/L and in Brantley Lake at the level of 0.18µg/L in 2001. Mercury was also detected at the level of 0.42 µg/L in Brantley Lake and 0.21 µg/L in Red Bluff Lake in 2012. Another detection of mercury occurred in 2017 in Lake Carlsbad at the level of 0.03 µg/L. All these concentrations were well below the EPA recommended limit of 0.77 µg/L in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect.



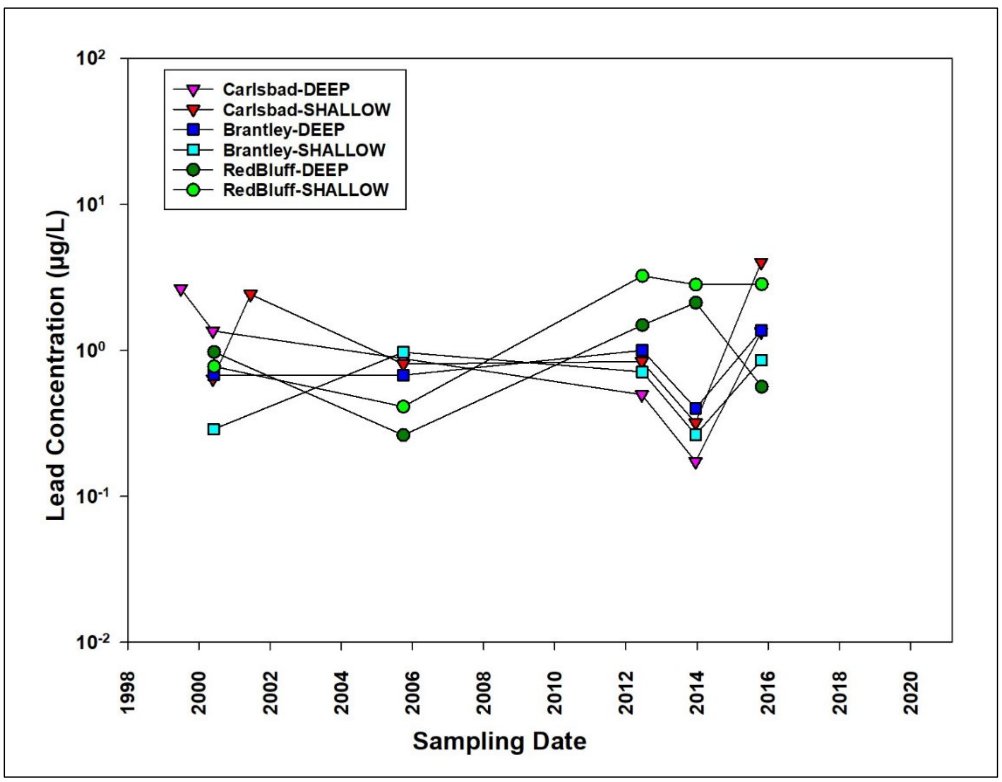
Carlsbad-DEEP
Carlsbad-SHALLOW
Brantley-DEEP
Brantley-SHALLOW
RedBluff-DEEP
RedBluff-SHALLOW
Aluminum Concentration (µg/L)
Sampling Date



Carlsbad-DEEP
Carlsbad-SHALLOW
Brantley-DEEP
Brantley-SHALLOW
RedBluff-DEEP
RedBluff-SHALLOW
Arsenic Concentration (µg/L)
Sampling Date



Carlsbad-DEEP
Carlsbad-SHALLOW
Brantley-DEEP
Brantley-SHALLOW
RedBluff-DEEP
RedBluff-SHALLOW
Barium Concentration (µg/L)
Sampling Date



Carlsbad-DEEP
Carlsbad-SHALLOW
Brantley-DEEP
Brantley-SHALLOW
RedBluff-DEEP
RedBluff-SHALLOW
Lead Concentration (µg/L)
Sampling Date

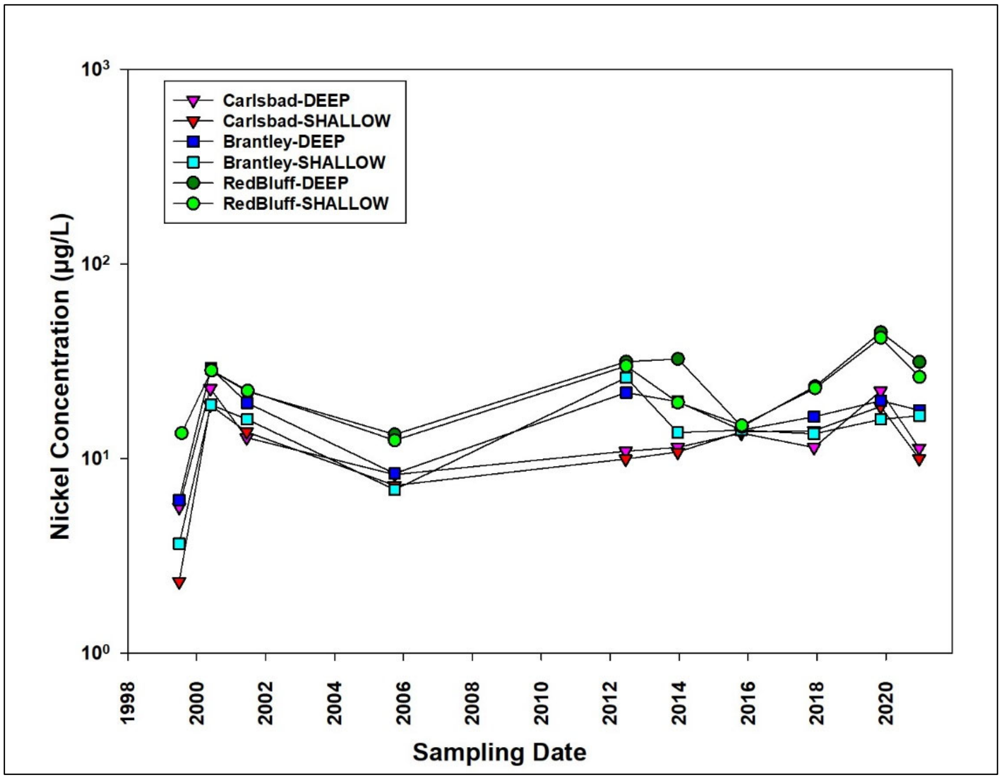
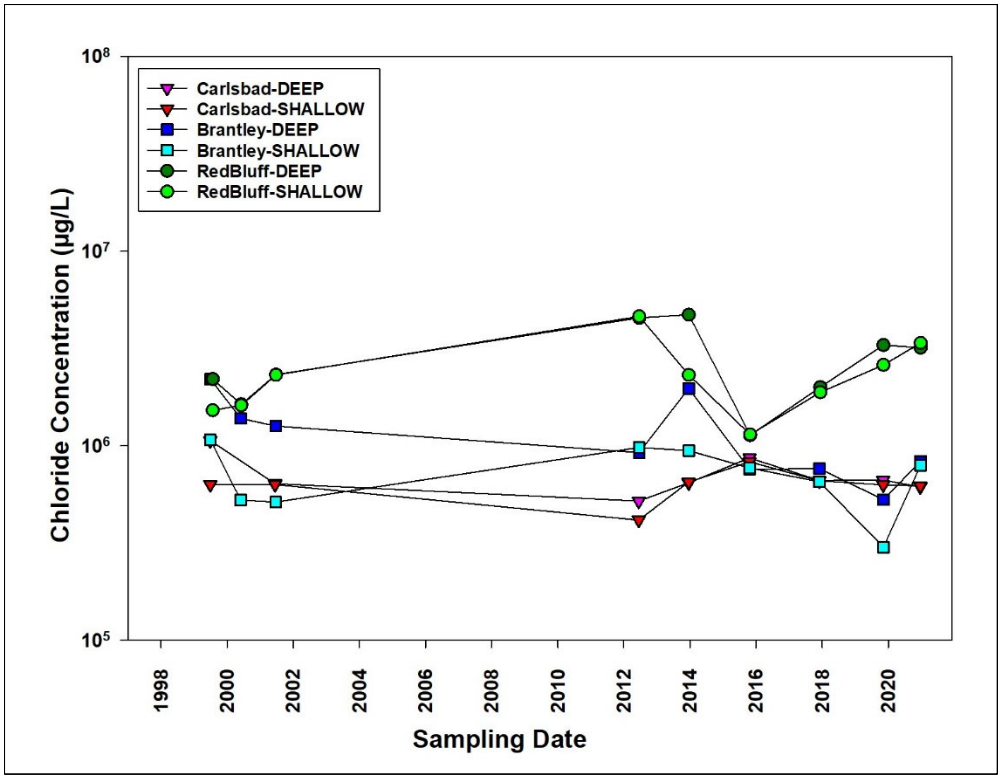


Figure 9.9. Historical Concentrations of Select Metals in Surface Water

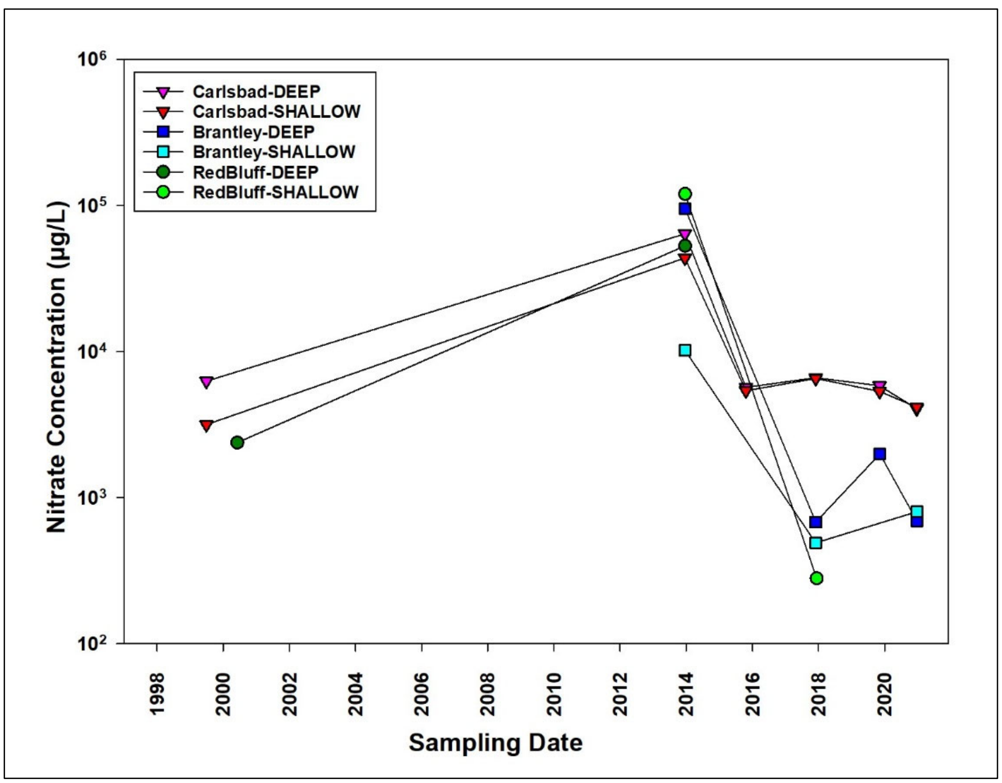
To evaluate trends in concentrations over time, the concentration data for surface water samples collected in 2020 were compared with the previous year's data as shown in Appendix H, Tables H.19 through H.21. The maximum concentrations measured for some of these metals are as follows: 8.61 µg/L for As, 169 µg/L for Ba, and 711 µg/L for Al. Present results as well as the results of previous analyses of surface water were consistent for each source across sampling periods.

9.4.4 Concentrations of Inorganic Anions in Surface Water

Inorganic anion concentrations measured in regional surface water samples are listed in Appendix H, Table H.22. The corresponding concentration ranges of these anions measured previously are also listed for comparison. Of the seven inorganic anions that are monitored, chloride, fluoride, nitrate, and sulfate have been detected regularly above the MDC. The only inorganic anion monitored by the EPA is chloride. The chloride levels in all three regional reservoirs are often above the EPA recommendation of 860 mg/L (EPA, 1988). In 2020, only Red Bluff was detected above the limit with a range of 3,190 mg/L (deep level) to 3,370 mg/L (shallow level). Figure 9.10 shows the historical variations of common anions in regional surface water samples.



Carlsbad-DEEP
Carlsbad-SHALLOW
Brantley-DEEP
Brantley-SHALLOW
RedBluff-DEEP
RedBluff-SHALLOW
Chloride Concentration (µg/L)
Sampling Date



Carlsbad-DEEP
Carlsbad-SHALLOW
Brantley-DEEP
Brantley-SHALLOW
RedBluff-DEEP
RedBluff-SHALLOW
Nitrate Concentration (µg/L)
Sampling Date

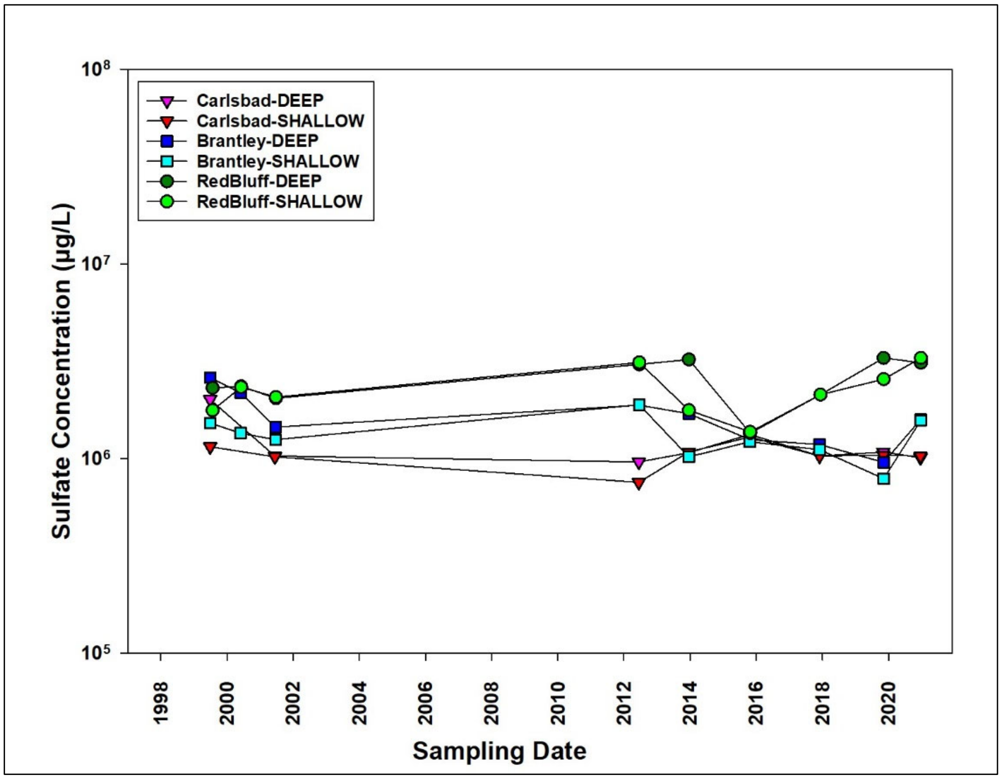
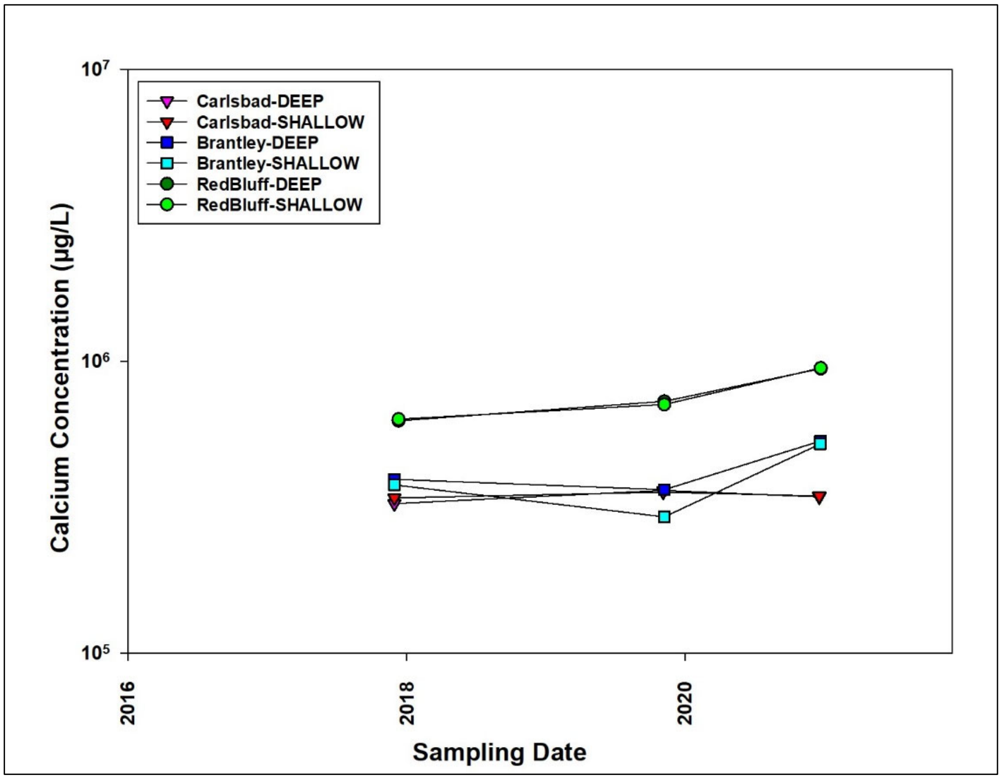


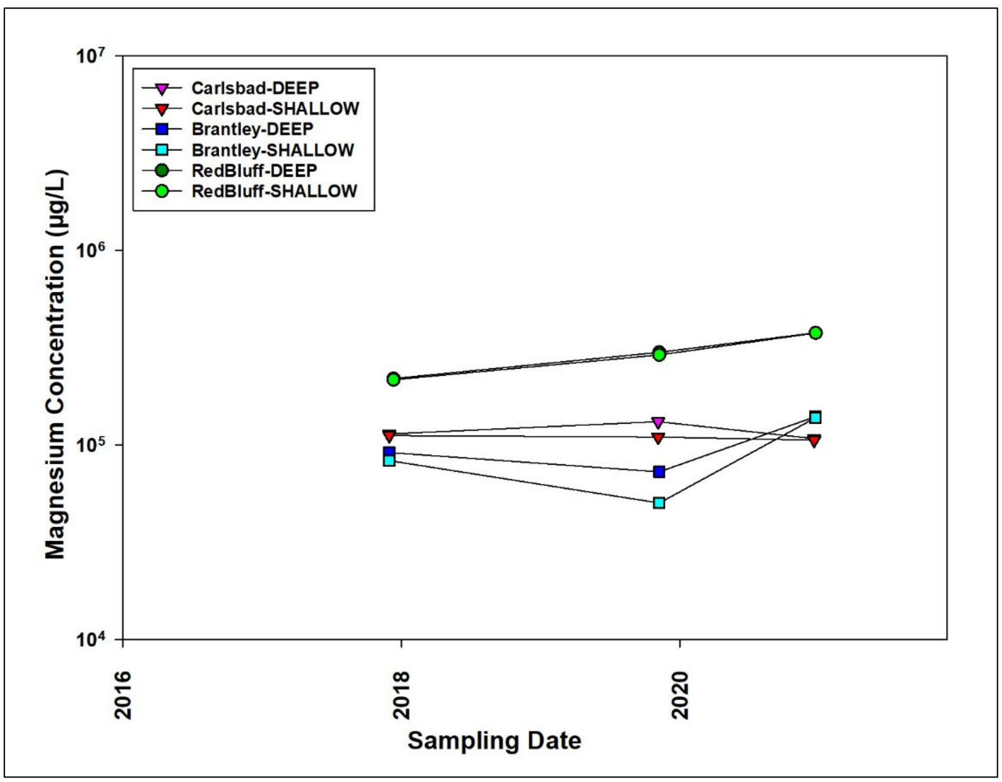
Figure 9.10. Historical Concentrations of Select Anions in Surface Water

9.4.5 Concentrations of Inorganic Cations in Surface Water

The 2020 concentrations of inorganic cations measured in three surface water reservoirs are summarized in Appendix H, Table H.23. The corresponding concentration ranges of these cations measured previously are also listed for comparison. Only concentrations for calcium (Ca), magnesium (Mg), and sodium (Na) have consistently been detected since cation analysis began in 2017. As illustrated in Figure 9.11, all three of these cations have shown consistent measurements in all surface water sampling locations. Potassium is only occasionally detected. In 2020, potassium was detected in Lake Carlsbad at 5.06 mg/L (deep level only) and Red Bluff at 45.4 mg/L (shallow level) and 41.3 mg/L (deep level). Thus far, ammonium is the only inorganic cation that has never been detected above the MDC in any of the regional surface water reservoirs surrounding the WIPP site. Currently, none of the six inorganic cations are monitored by the EPA. It is important to note that inorganic cation analyses in surface water began in 2017.



Calcium Concentration (µg/L)
10^7
10^6
10^5
Carlsbad-DEEP
Carlsbad-SHALLOW
Brantley-DEEP
Brantley-SHALLOW
RedBluff-DEEP
RedBluff-SHALLOW
2016
2018
2020
Sampling Date



Magnesium Concentration (µg/L)
10^7
10^6
10^5
10^4
Carlsbad-DEEP
Carlsbad-SHALLOW
Brantley-DEEP
Brantley-SHALLOW
RedBluff-DEEP
RedBluff-SHALLOW
2016
2018
2020
Sampling Date

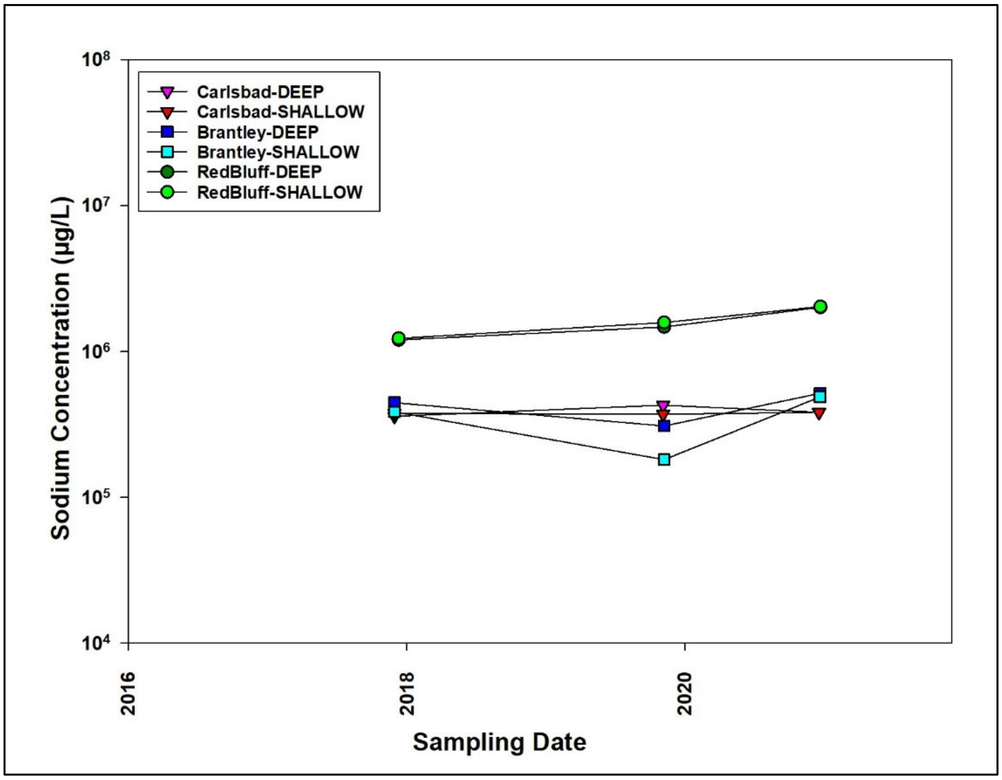


Figure 9.11. Historical Concentrations of Select Cations in Surface Water

9.4.6 Additional Analyses Performed on Surface Water

Several new types of non-radiological water quality parameters were added to surface water analyses in 2020, namely, specific gravity, pH, conductivity, total organic carbon, total dissolved solids, and total suspended solids. Results of these analyses are summarized in Appendix H, Tables H.26 - H.28.

9.5 Conclusion

This chapter presents the monitoring results of a variety of environmental media including effluent air, airborne particulates, drinking water, and surface water for the calendar year 2020. For this monitoring period, the concentrations of Al, Cd, and Pb were detected above the MDC at both the monitoring stations (A and B), and within the range of previously measured results at these sampling locations.

This is the first time that anion and cation concentrations are reported for airborne particulates collected around the WIPP site. Some variation over the two years (2019-2020) of data presented is observed.

In drinking water, barium (Ba), chromium (Cr), copper (Cu), and lead (Pb) were detected above the MDC. They are comparable with the previous values measured at these sampling locations and are all below the EPA action levels. No noticeable changes in the 2020 elemental or inorganic levels are observed which could be attributed to activities at the WIPP site.

Aluminum (Al), barium (Ba), iron (Fe), and nickel (Ni) are some metals commonly measured above the MDC in regional surface water samples collected from the areas surrounding the WIPP site. Their concentrations are within the range of previously measured results at these sampling locations. No noticeable changes in the 2020 elemental or inorganic levels are observed which could be attributed to activities at the WIPP site.

CHAPTER 10 - VOLATILE ORGANIC COMPOUND MONITORING

The WIPP Hazardous Waste Facility Permit (HWFP), Attachment N, mandates the monitoring of volatile organic compound (VOC) emissions from mixed waste that may be entrained in the exhaust air from the WIPP underground hazardous waste disposal units (HWDUs). The purpose of the VOC monitoring is to verify that regulated VOCs emitted by the waste are within the concentration limits specified by the HWFP. The program is designed to determine VOC concentrations attributed to open and closed panels. Currently, ten target VOCs selected for monitoring were determined to represent approximately 99% of the risk due to air emissions. These target compounds are 1,1-dichloroethylene, methylene chloride, chloroform, 1,1,1-trichloroethane, carbon tetrachloride, 1,2-dichloroethane, toluene, chlorobenzene, 1,1,2,2-tetrachloroethane, and trichloroethylene. In 2014, trichloroethylene was added to the analyte list in compliance with the NMED Administrative Order. These ten compounds and their method reporting limits for different types of samples are summarized in Appendix I, Table I.1. Compounds consistently detected in ambient air samples in the underground may be added to the list of compounds of interest.

Repository VOC monitoring was implemented in November 1999 and disposal room VOC monitoring was implemented in November 2006. CEMRC first began analyzing samples for the Confirmatory VOCs Monitoring Plan in April 2004. Originally, the samples were collected from only two stations in the WIPP underground for each filled disposal room, referred to as Repository VOC monitoring. Since 2006, each room actively receiving waste is also sampled at the exhaust side of the room, referred to as disposal room VOC monitoring. The requirements for disposal room VOC monitoring include the addition of sampling locations within active underground hazardous waste disposal units. Disposal room sampling terminates upon initiation of panel closure activities.

Before the 2014 fire and radiation release events, repository VOC sampling for target compounds was performed biweekly at two ambient air monitoring stations, VOC-A, located downstream from HWDU panel 1 in Drift E300, and VOC-B, located upstream from the active panel. As waste is placed in new panels, VOC-B will be relocated to ensure that it samples underground air before it passes the waste panels. Target compounds found in VOC-B represent background concentrations found in the underground. The VOC concentrations measured at this location are VOCs entering the mine through the air intake shaft and VOCs contributed by facility operations upstream of the waste panels. Differences measured between the two stations represent any VOC contributions from the waste panels. After the February 2014 fire event, the waste panels sampling locations for repository VOC monitoring have been changed from Stations VOC-A and VOC-B in the underground to new Stations VOC-C and VOC-D on the surface. Surface VOC sampling has been underway since February 2014.

Disposal room VOC sampling activity was suspended following the 2014 salt truck fire and radiation release event in the WIPP underground. The disposal room VOC monitoring for

Panel 7 (current active waste disposal panel) was activated on December 19, 2016. Details of the sample collection and analyses are described in the following sections.

10.1 Sample Collection

The surface VOC samples were collected twice weekly from two air-sampling locations. These stations are located at the following locations: (1) Station VOC-C, located at the west side of Building 489, and (2) Station VOC-D, at the groundwater pad WQSP-4 for measuring background VOCs. Disposal room VOC samples were collected biweekly from Panel 7, the current active disposal panel. Sample location data are identified by the source panel number, room number, and intake (I) or exhaust (E) function. For example, Panel 7 Room 6 exhaust location is coded P7R6E. Samples were collected by NWP LLC, personnel using a commercially available portable passive air canister and delivered for analysis to CEMRC in weekly batches. For the 2020 monitoring period, a total of 225 surface VOC samples and 256 disposal room VOC samples were collected.

10.2 Sample Preparation and Analysis

Regular VOC samples were analyzed using an Agilent 6890/5975 gas chromatography-mass spectrometry (GC-MS) system interface with an Entech 7100 pre-concentrator, while low-level VOC analyses were primarily analyzed using an Agilent 7820/5977 GCMS interface with Entech 7200/7016D pre-concentrator/auto-sampler system. Analytical procedures employed for the analyses were based on the concepts contained in Compendium Method TO-15 *Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially–Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)"* (1999).

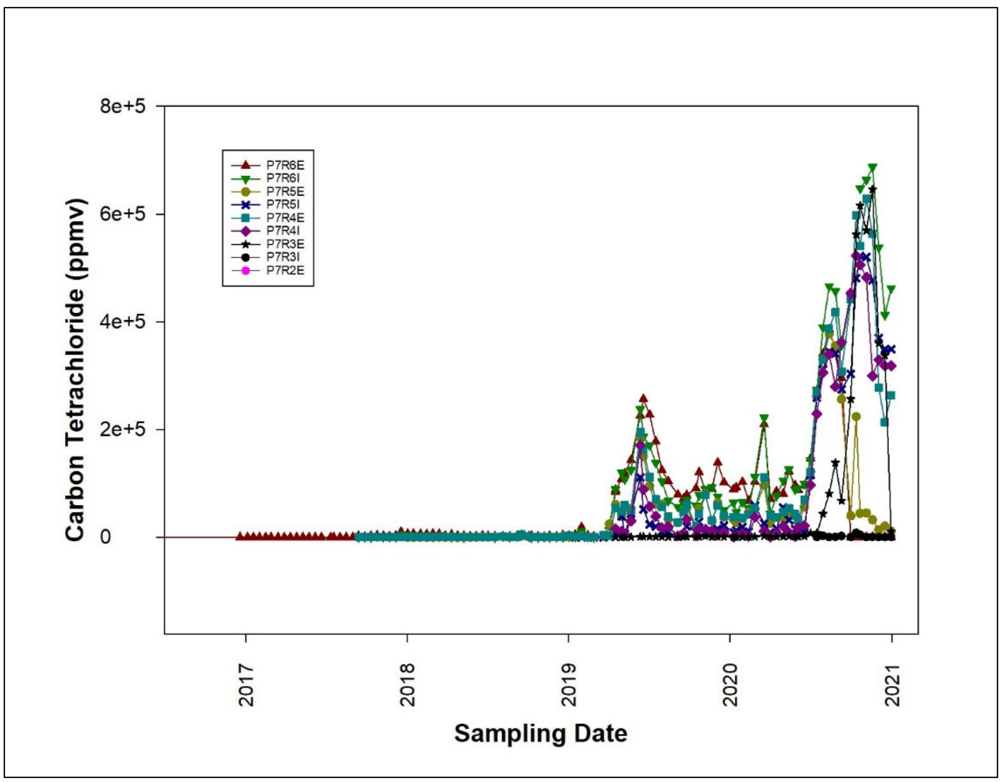
For analysis, a known volume of air sampled from the canister was directed to a pre-concentrator. The pre-concentrator captures VOCs and removes most of the water vapor and bulk gases such as oxygen, nitrogen, and carbon dioxide from the sample prior to introducing the target VOCs to the GC-MS. The VOC screening results were used to determine pre-analysis dilutions required for analysis using Entech 4600 Dynamic Diluter. Canisters were cleaned after sample analysis using the Entech 3100 Canister Cleaning system. All cleaned canisters were analyzed to assure the desired level of cleanliness has been achieved.

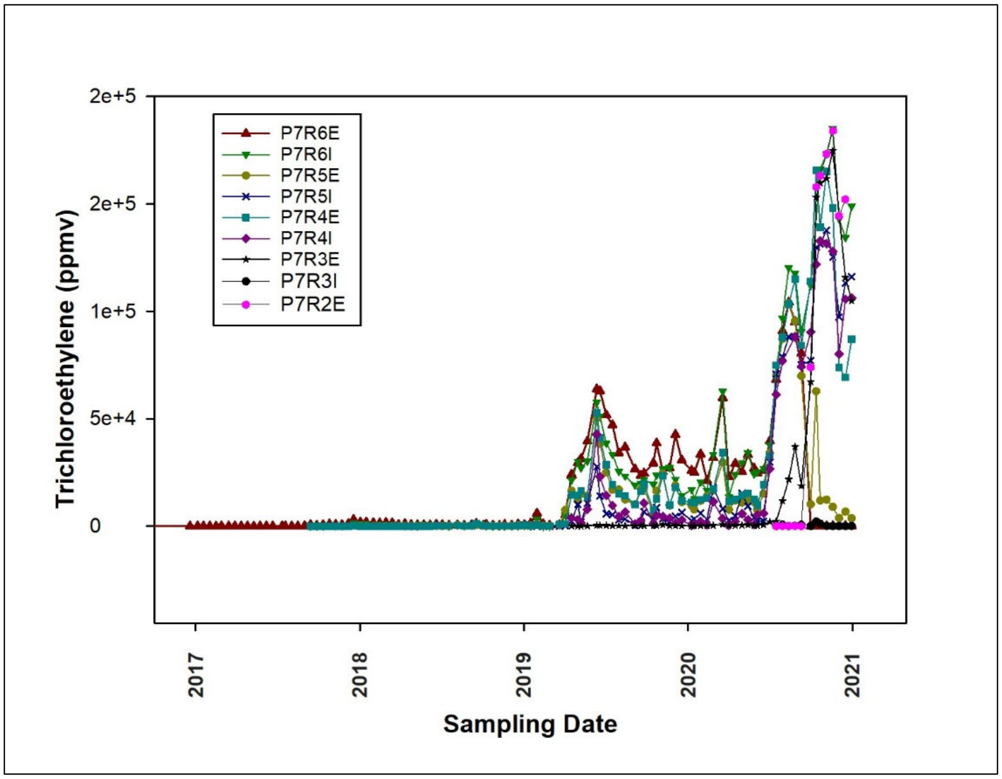
10.3 Results and Discussion

The concentrations of VOCs are reported here either in parts per billion by volume (ppbv) or parts per million by volume (ppmv). Table I.1 lists the maximum MRLs for the ten target compounds for undiluted samples. Due to the samples being diluted in the laboratory, the laboratory MRL for diluted samples is a factor of the lowest calibration level and the dilution factor. For disposal room VOC samples, the laboratory MRL varies for each sample based on the dilution factor (which is calculated based on the estimated concentration for the sample). In comparison, all surface VOC samples have a dilution factor of 2, so for example, the laboratory MRL for SIM mode analysis is 0.1 ppbv (where the lowest calibration level is 0.05 ppbv).

10.3.1 Disposal Room VOC Monitoring Results

Samples were collected from nine rooms in Panel 7 (P7R6E, P7R6I, P7R5E, P7R5I, P7R4E, P7R4I, P7R3E, P7R3I, and P7R2E) in 2020. Maximum sample results for the disposal room VOCs are summarized in Appendix I, Table I.2. Three target VOC compounds, carbon tetrachloride, 1,1,1-trichloroethylene, and trichloroethylene were detected above the laboratory MRL in all nine locations. The variations of carbon tetrachloride, trichloroethylene, and 1,1,1-trichloroethane in the disposal room VOC samples for the year 2020 are shown in Figure 10.1. The maximum concentrations were 687.24 ppmv for carbon tetrachloride, 242.76 ppmv for 1,1,1-tetrachloroethane, and 185.02 ppmv for trichloroethylene. Chloroform was also detected above the laboratory MRL almost regularly and the maximum concentration was 20.73 ppmv. Concentrations of other target VOC compounds, such as methylene chloride, chlorobenzene, 1,1,2,2-tetrachloroethane, and toluene were detected at concentrations less than the method reporting limit, while concentrations of 1,2-dichloroethane and 1,1,-dichloroethylene were either below the method detection limit or not detected. The levels detected were continuously below the 50% action level as listed in Appendix I, Table I.3.





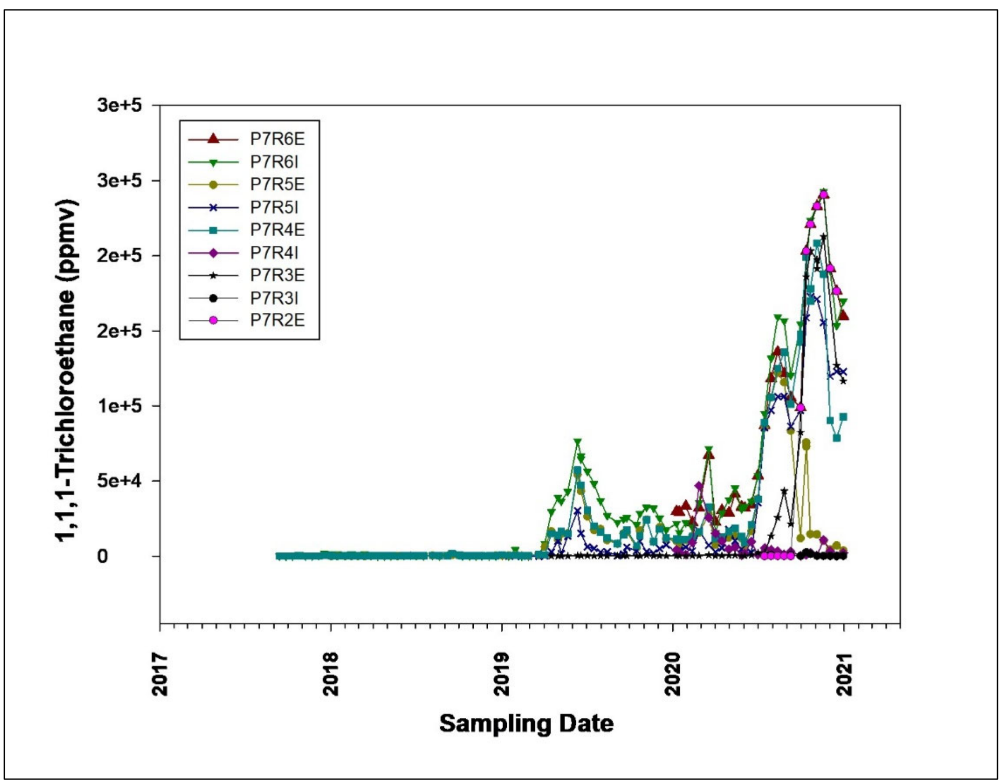
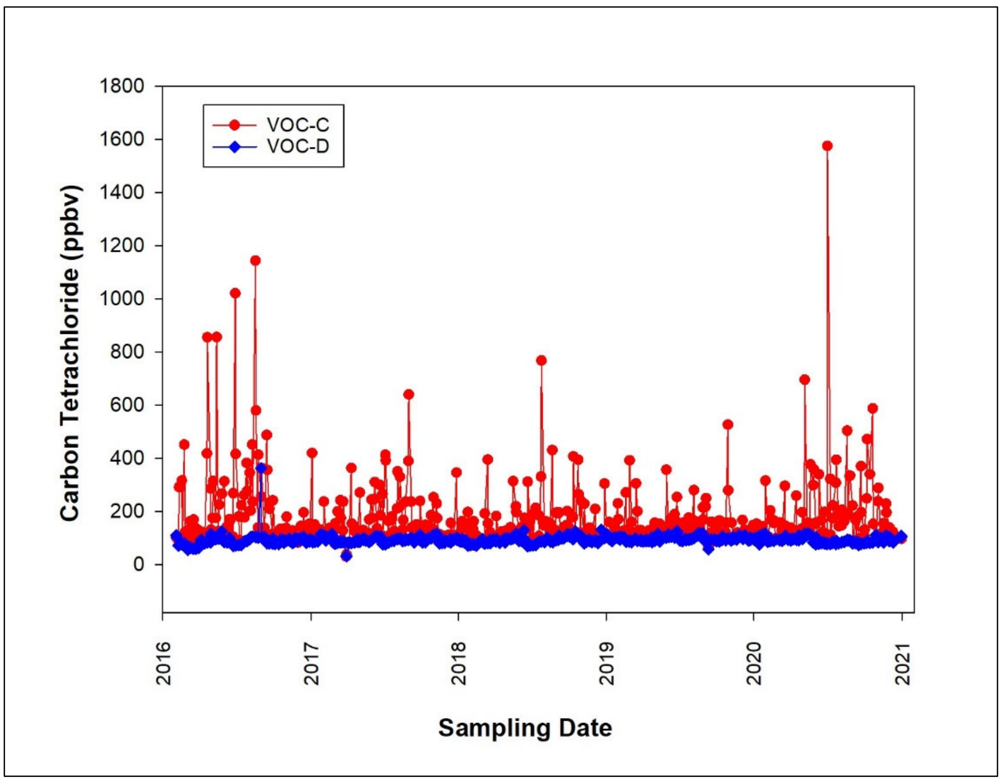
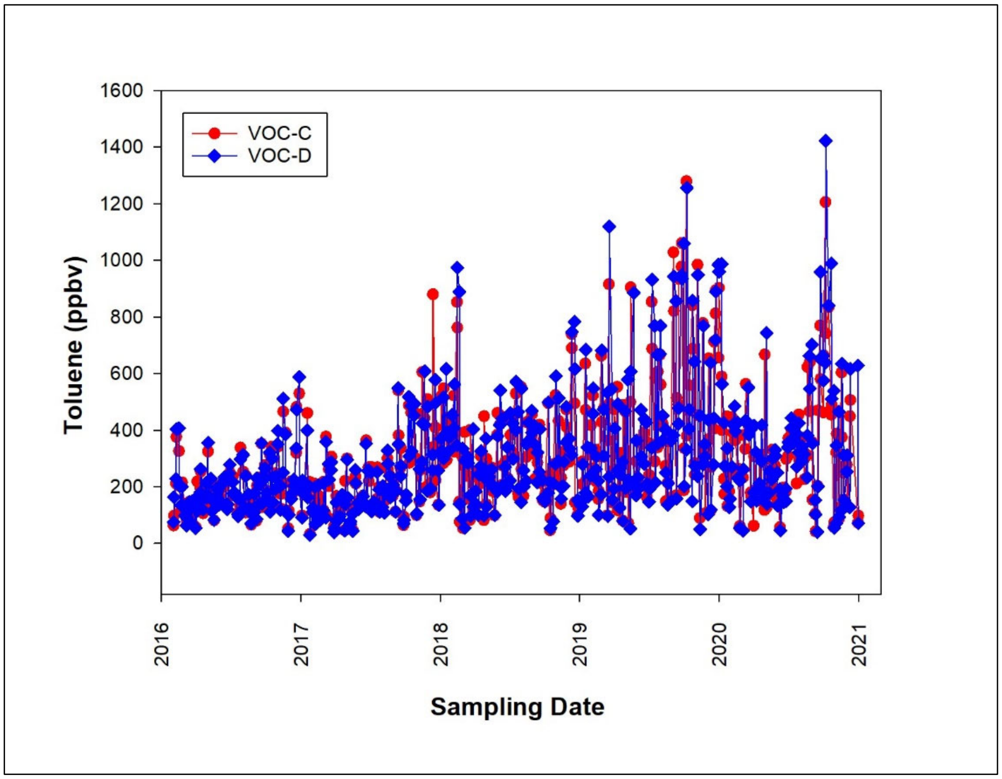


Figure 10.1. Concentrations of Some Target VOC Compounds in Disposal Room VOC Samples

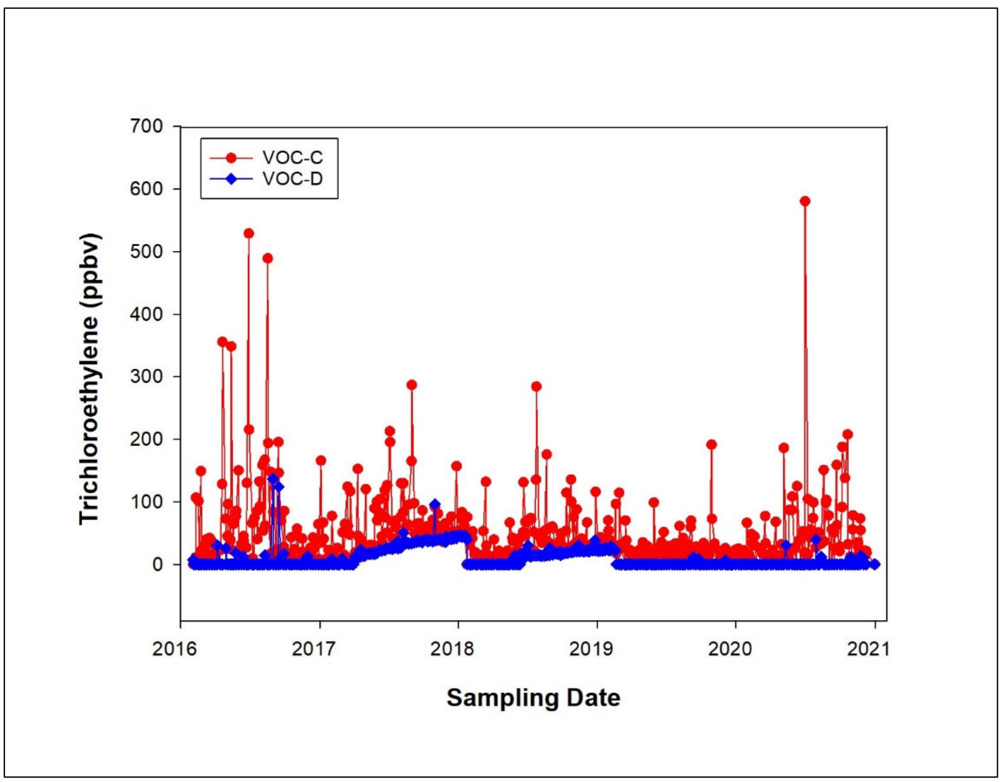
10.3.2 Surface VOC Monitoring Results

The concentration ranges of the target VOC compounds at sampling stations VOC-C and VOC-D are listed in Appendix I, Table I.4. Carbon tetrachloride and toluene were mostly detected above the laboratory MRL (0.1 ppbv) with very few instances below it at VOC-C sampling location. Trichloroethylene and 1,1,1-trichloroethane were detected above the MRL only a couple of times, whereas methylene chloride was detected above the MRL occasionally with values mostly below the MRL at VOC-C location. All other compounds were below the laboratory MRL or were not detected at VOC-C location. Comparatively at VOC-D sampling station, toluene was the only compound detected mostly above the MRL regularly, whereas carbon tetrachloride concentration was typically around the MRL. Typically, concentrations of toluene and methylene chloride are mostly similar at VOC-C and VOC-D locations. All other compounds at VOC-D location were either not detected or below the MRL. The concentrations of carbon tetrachloride, trichloroethylene, toluene, and methylene chloride for VOC-C and VOC-D sampling stations are shown in Figure 10.2.





VOC-C
VOC-D
Toluene (ppbv)
Sampling Date



VOC-C
VOC-D
Trichloroethylene (ppbv)
Sampling Date

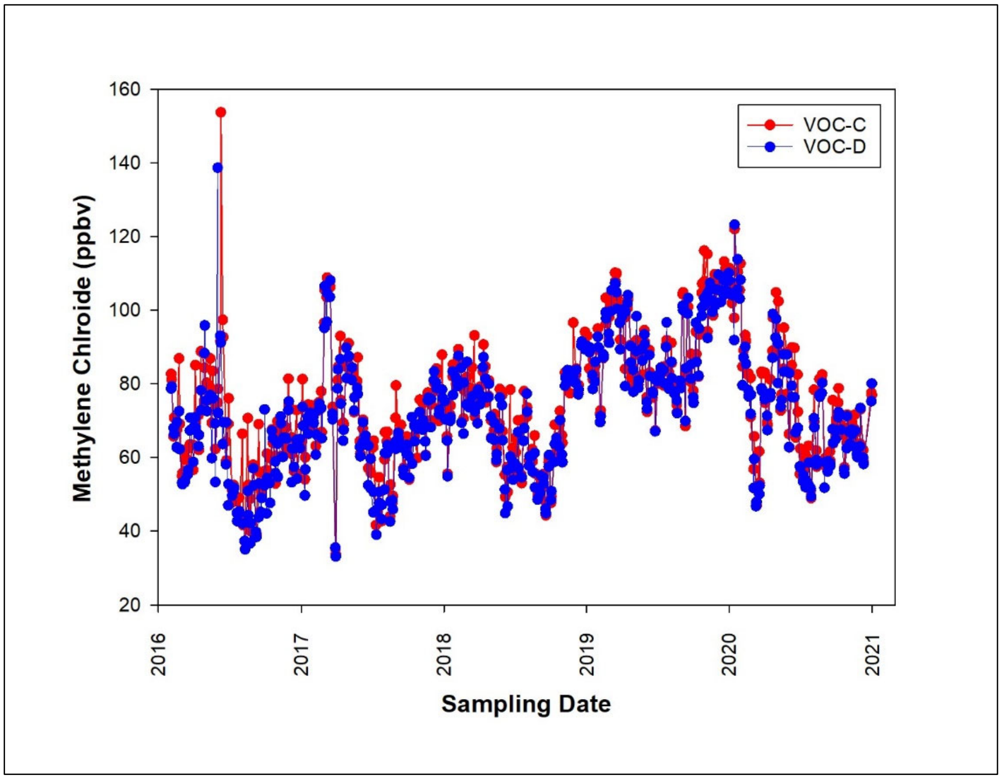


Figure 10.2. Concentrations of Some Target VOC Compounds in Surface VOC Samples

The maximum concentrations of target compounds detected above the MRL at VOC-C were 1.58 ppbv for carbon tetrachloride, 0.58 ppbv for trichloroethylene, 0.53 ppbv for 1,1,1-trichloroethane, 0.12 ppbv for methylene chloride, and 1.21 for toluene. The maximum detected value for carbon tetrachloride was 0.12 ppbv, methylene chloride was 0.12 ppbv, and toluene was 1.42 ppb at VOC-D.

CEMRC does not assess the health risks to the public and workers from the release of VOCs from the Repository and/or VOC in the Repository air. However, the risks evaluation studies conducted by the NWP, LLC indicate that risk to the non-waste surface workers continues to be below action levels. Studies also reported that cancer risk and Hazard Index from the release of VOC were an order of magnitude below an action level (ASER Report-2020, DOE/WIPP-20-3621 and DOE/WIPP-21-3628).

10.4 Conclusion

This chapter summarizes the results of the VOC monitoring program for the calendar year 2020. For disposal room VOC monitoring, 256, and for surface VOC monitoring, 225 samples were collected during 2020. Carbon tetrachloride and toluene were most regularly detected above the MRL at VOC-C sampling location. Three of the ten target compounds were regularly detected above the MRL for disposal room samples. The levels measured in 2020 were below the 50% action level as specified in Module IV of the HWFP. The VOC monitoring results indicate that risk to the non-waste surface workers continues to be below action levels.

There is no evidence of increases in VOCs in the region that could be attributed to releases from WIPP.

The more detailed results of the 2020 VOC monitoring program are reported in the Semi-Annual Volatile Organic Compound Data Summary Report (DOE/WIPP-20-3621 and DOE/WIPP-21-3628).

CHAPTER 11 - LOW BACKGROUND RADIATION EXPERIMENTS

11.1 Introduction

The Low Background Radiation Experiment (LBRE) is a radiation biology project carried out in the WIPP underground and New Mexico State University. The research progress made in 2020 has centered on two of our proposed objectives: 1. To develop a mechanistic and molecular-based understanding of single-celled prokaryotes and multicellular eukaryotes' response to low-level radiation. 2. To document cellular and organismal response to varying the quantity and quality of different low-level radiation sources.

This chapter summarizes the data obtained from experiments carried out in the underground at WIPP during the 2020 summer and a publication centering on our nematode work (Van Voorhies et al. 2020). During 2020 testing, the radiation response of WIPP microbes has been isolated and characterized by Julie Swanson, a member of the Los Alamos National Laboratory Carlsbad Office (LANL-CO) actinide chemistry team. The main goal of the summer's work was to test the hypothesis that bacteria differentially respond to varying qualities of radiation. Throughout the LBRE project, it has documented the ability of bacteria to respond to the deprivation of normal levels of radiation, distinguishing between vanishingly low levels of radiation. For example, between 70 nGy/hr (representing background radiation from KCl) and 1 nGy/hr (sub-normal levels of radiation underground in a steel vault at WIPP.

The purpose of the LBRE program is to document the biological effects of varying the type of source of radiation, that is varying the quality of radiation. To date, results have reported a significant biological response to very low levels of radiation and these experiments have varied the quantity of radiation exposure: 0.9 nGy/hr up to 70 nGy/hr from a single source of radiation (gamma from ^{40}K, as documented in Castillo et al. 2015, 2017, 2018). The program will continue to demonstrate the biological response to varying quantities of radiation. Still, a new experimental approach has been proposed in the current granting period: given the identical amounts of low-level radiation, can organisms distinguish between different radiation qualities?

To test this, part of GB Smith's sabbatical in 2019 was to collect and ship two volcanic sources of natural terrestrial radiation, Roman *Tufo* and Roman *Pozzolana*. These volcanic materials have been mined around Rome and used for building materials for thousands of years. The tufo has been used for building blocks and the pozzolana has been used as cement. These materials have been analyzed for radioisotopes by our colleagues in Rome at the *Istituto Superiore di Sanita* (ISS, the equivalent of the U.S. NIH). They have measured tufo to contain at least 8 gamma emitters representing the thorium chain (62%), the uranium chain (23%) and ^{40}K (15%) (Nuccetelli and Balzan, 2000). We have proposed that these materials may provide a more realistic background source for our LBRE experiments.

Figure 11.1. Roman volcanic tuff (“Tufo”) has been used as a building material for 1000’s of years throughout Italy (1A)

Blocks of Tufo were purchased in October 2019, sent to NMSU and ca. 15 kg of it has been pulverized and deployed underground at WIPP to irradiate cells with a more diverse energy spectrum of sources compared to our irradiator made from KCl. The KCl irradiator is shown in an incubator at WIPP, with cells grown inside the irradiator (1B).

We now are in a position to test if, given the same quantities of radiation, bacteria are able to discern and respond to varying qualities of radiation. This was accomplished by deploying two new sources of radiation that were obtained during Smith’s sabbatical trip to Italy in 2019. Using these two volcanic sources of radiation, volcanic tuff (*tufo*) and volcanic cementacious pozzolan (*pozzolana*) in comparison with KCl, data are presented on the bacterial response from these alternate natural sources of radiation.

This year, the team published the first RNA transcriptome response to below background radiation from a multi-cellular organism (Van Voorhies et al. 2020, https://www.frontiersin.org/articles/10.3389/fpubh.2020.581796/full). This publication expands our work using single-celled bacteria into a multicellular organism (the *Caenorhabditis elegans* nematode) which shares more than 80% of its genes with human, (Lai et al. 2000, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC310876/). As a shorthand representation of this work, Figure 11.1 shows a diagram drawn for a talk given at a Low Radiation Biology conference at Italy’s Gran Sasso lab (Smith, 2019, https://agenda.infn.it/event/19116/). We are addressing one of the long-term goals of the LBRE project, and that is to identify how low levels of radiation are perceived and processed into behavioral output, Figure 11.2.

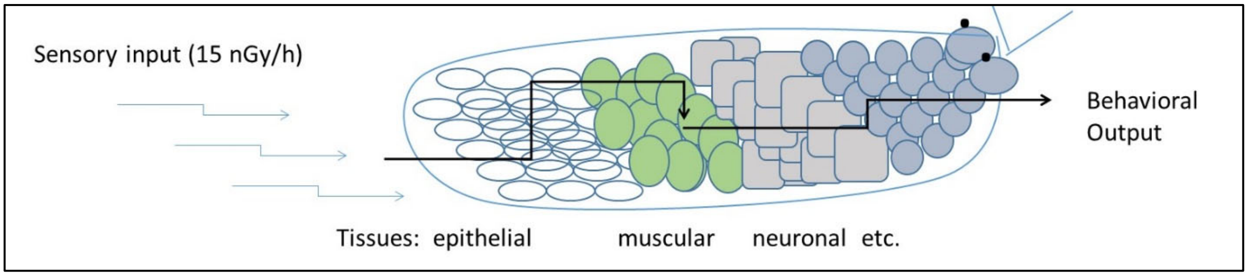


Figure 11.2. In a multicellular organism, is low radiation signal transmitted across tissues to give a behavior output?

11.2 Experimental Approach

11.2.1 Radiation Quality Experiments

In our "add-back" controls in which we expose cells to natural sources of radiation like KCl, we have aimed for a gamma dose rate of 100 nGy/hr based on the U.S. Nuclear Regulatory Commission (NRC) estimate of natural background exposure being 310 mrem/yr (= 354 nGy/hr), and a UK study (Kendall et al. 2013) reporting the proportion of natural background radiation that came from gamma exposure as approximately 95 nGy/hr. The biological response to these two volcanic sources of natural radiation were compared to our current source that uses 12 kg of KCl (ca. 5 µCi). These "volcanic irradiators," with six panels of source surrounding test organisms, were tested this summer underground at WIPP.

Between 10 and 14 kg of the KCl, Tufo and Pozzolana were distributed among 6 panels used to construct three irradiator boxes. Details on the construction and exact dose rates of these irradiators will be discussed in future reports, but we were able to measure the dose rates of the irradiators constructed and deployed in 2020: KCl (ca. 108 nGy/hr), pozzolana (ca. 100 nGy/hr) and tufo (ca. 236 nGy/hr). We ran the highest number of biological replicates in the summer of 2020 since the LBRE project started, replicating an experiment up to 12 times in order to document what we expected to be the subtle effects of varying different qualities of radiation sources. We were able to do this by overlapping experiments at WIPP, by beginning experiments on consecutive days and "doubling up" the use of the space in the vault at WIPP. At varying timepoints, we sampled for cell growth by agar plate counts (viable cell number), and by culture optical density by spectroscopy. RNA was sampled and purified for transcriptome analyses (in process).

This spring, we have designed and built new irradiators to contain between 8-12 kg of these materials to expose cells underground at WIPP to these natural sources of radiation to mimic normal levels of background radiation. Using an ion chamber, we have measured the pozzolana irradiator to provide a dose rate of 106 nGy/hr.

11.2.2 WIPP Isolates

Two halophilic microbes previously isolated from WIPP halite and WIPP groundwater samples were obtained from LANL's Dr. Swanson. One of the WIPP isolates belongs to the Archaea domain (Halobacterium noricense, isolated from WIPP groundwater) and the other isolate belongs to the Bacteria domain (Chromohalobacter salexigens, isolated from WIPP halite). Both were grown at NMSU in the presence of either C. salexigens or H. noricense, and because the two isolates have slower growth rates than bacteria we have used in the past, pilot studies at NMSU were carried out to plan the experiments and sampling regimes at WIPP. During growth at WIPP, we continually monitored for the cultures' purity, and if any cultures were found to be contaminated, as occurred on two occasions, those replicates were eliminated from the analyses.

11.2.3 Nematodes

A group of 300 worms (Caenorhabditis elegans) were incubated in the absence of natural levels of radiation in the 15-cm thick steel vault located at the LBRE laboratory at the north end of the WIPP mine. In parallel, another 300 nematodes were incubated underground in the presence of 2 kg of KCl to mimic natural background levels as reported in previous publications (e.g., Castillo et al 2018). Phenotypic measurements of body length and growth rate and egg-laying rate were taken during the first 72 hours of growth and then RNA was extracted and purified in preparation for transcriptome analysis of differentially expressed genes. Offspring from this 1st incubation were continued to be fed over the next 8 months underground at WIPP and another set of phenotypic measurements and RNA extractions were performed.

11.3 Results and Discussion

11.3.1 WIPP Isolates

In spite of the technical challenges of culturing slow-growing halophiles underground at WIPP, we were able to obtain growth data from two pure cultures representative of the microbes living in the current conditions of the WIPP underground. To acquire the data shown below, a considerable amount of "back-shift" work was required in order to catch the timepoints shown in the graphs below. The halophiles were grown under three conditions, one representing the absence of normal levels of radiation (grown shielded in the pre-World War II vault, ca. 1 nGy/hr), and the two others were grown in irradiators containing natural radiation sources (KCl at ca. 108 nGy/hr or volcanic *tufo* at ca. 236 ngy/hr). *Chromohalobacter* was the faster growing of the two WIPP isolates and it showed a non-significant growth inhibition at the "medium-level" radiation treatment (108 nGy/hr) compared to the low (1 nGy/hr) and high (236 nGy/hr). The slower growing *Halobacterium* was unaffected by the three levels of radiation (Figure 11.3). These growth data are important in terms of long-term WIPP objectives, in that the data demonstrate that the growth of these representative WIPP microbes is not affected by radiation rate differences of more than 100-fold.

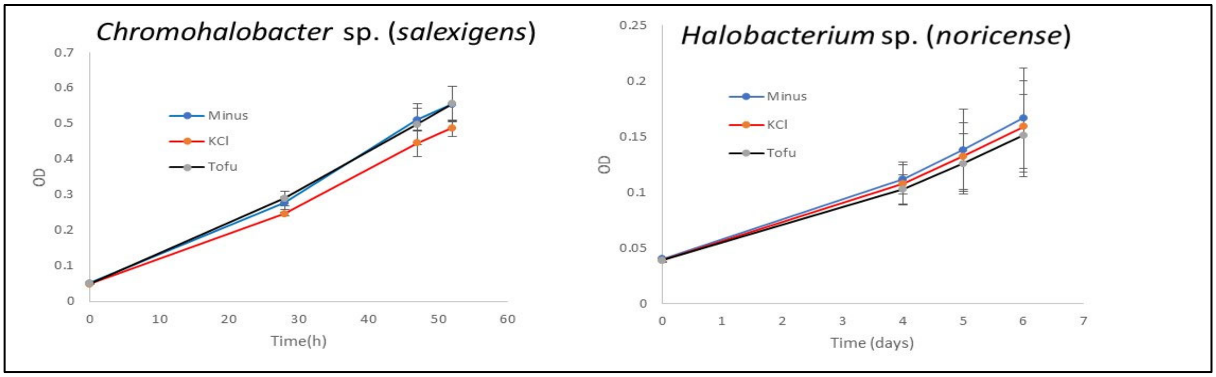


Figure 11.3. WIPP halophilic bacteria isolated and characterized by LANL's Dr. Julie Swanson) were grown underground at WIPP in August of 2020 in the presence of background levels of radiation (KCl or Tufo) and in the absence of background radiation (Minus)

11.3.2 Nematodes

We have analyzed the transcriptome response of the multicellular Caenorhabditis elegans nematode to below background radiation during two experiments carried out underground at the WIPP mine (van Voorhies et al. publication in Frontiers in Public Health, May 2020). Consistent with our previous publications on the bacterial response to sub-background radiation (Smith et al. 2011; Castillo et al. 2015, 2017, 2018), nematodes rapidly (within 72 hours of being brought underground) mounted a physiological response to below-background radiation (15.6 nGy/hr) versus our KCl-supplemented background control (67.4 nGy/hr). In our analyses of the transcriptome, more than 100 genes were significantly regulated as defined by being more than 2-fold up- or down-regulated and which have a False Discovery Rate (FDR) < 0.05. Figure 11.4 is a "Volcano Plot" showing the number of genes that meet these criteria compared to control cells grown at background levels of radiation.

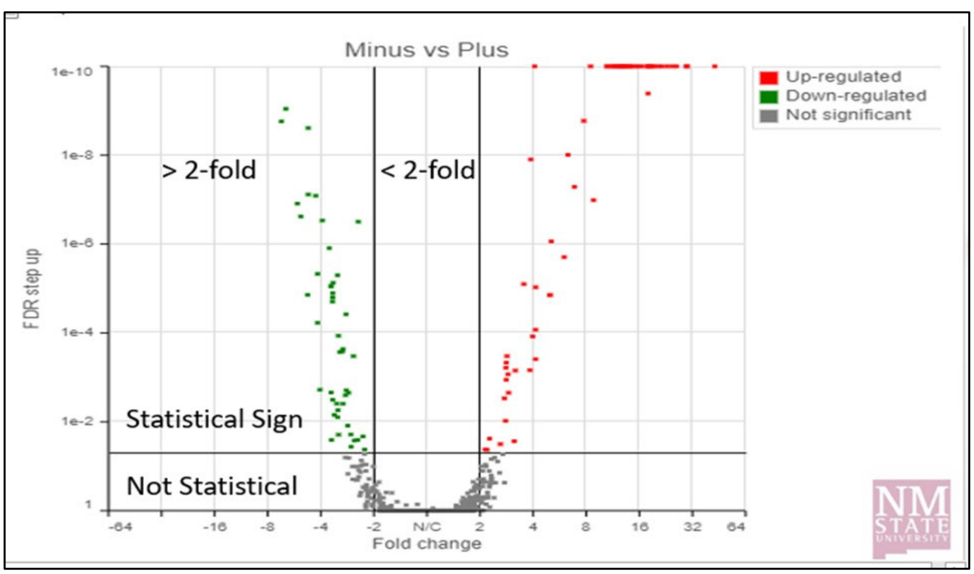


Figure 11.4. C. elegans genes expressed due to incubation in the absence of normal levels of radiation (the "Minus" treatment) while grown shielded in a 48-ton pre-World War II steel vault at WIPP

Interestingly, 49.5 % of the genes that were significantly up-regulated belonged to the major sperm protein group (Figures 11.5 and 11.6, below). Consistent with this sexual reproduction transcriptome response, the phenotype was also affected: nematode egg-laying rate was significantly stimulated (p= 0.04) after 8 months incubation underground. Whether this stimulation of egg-laying rate in the absence of normal levels of radiation is a stress response or not remains the subject of 2021 experiments we plan to carry out with the mosquito, *Aedes egypti*. In any case, these results with the *C. elegans* nematode demonstrating a significant phenotypic and genotypic response in a multicellular organism to minute differences in radiation fields (i.e., a difference of ~50 nGy/hr) continues to challenge the paradigm in Radiation Biology that organisms are oblivious to these levels of radiation.

To verify that the nematode transcriptome response was real, we performed a real-time PCR validation study (Figure 10.5). All major sperm protein (msp) genes that were found to be up-regulated by transcriptome analysis (by RNA Seq), were also more than 2-fold up-regulated by rt PCR analysis, and 3 of 3 down-regulated genes were consistent between the two approaches. These results are interesting for at least two reasons: 1. As in single celled prokaryotes, a multicellular eukaryotic organism is now also shown to be rapidly responsive to these minute differences in radiation levels; 2. The increase in egg-laying rate in the absence can be interpreted in two ways. Either the nematodes are healthier and more fecund in the absence of normal levels of radiation, or the increase in egg-laying rate is a stress response to ensure eggs for the next generation. Both these possibilities are discussed in the Van Voorhies et al. paper and await further experimentation at WIPP.

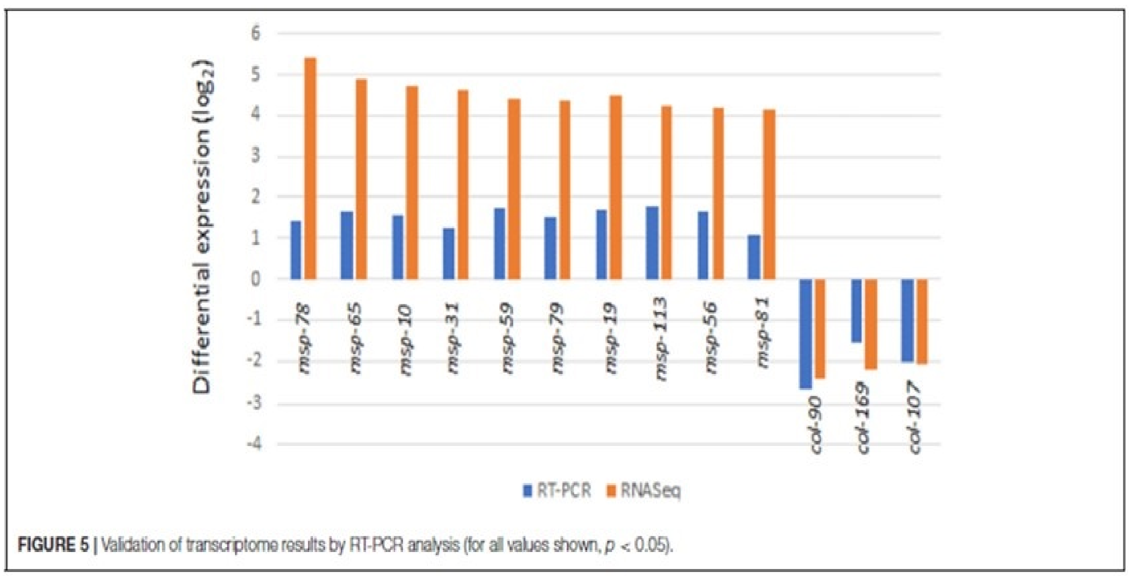


Figure 11.5. (Fig. 5 in Van Voorhies et al. 2020). Real-time PCR validation of Transcriptome (RNA-Seq) data. All 13 genes tested yielded the same results between the two approaches.

The transcriptome data were analyzed by CLC genomics a commercial transcriptome analysis program that was purchased on the LBRE grant. In an effort to ensure that the observation that all major sperm proteins that were differentially expressed were all up-regulated, two other transcriptome analysis “pipeline” programs were used to analyze the libraries generated. All three programs were in agreement with each other. With one exception (msp45 analyzed by CLC Genomic), all three programs showed these genes to be significantly upregulated (Figure 11.6).

Gene	Partek	CLC genomic	DNA Star
msp-78	42.9	33.9	25.5
msp-65	29.5	39.6	40.9
msp-10	26	22.2	21.7
msp-31	24.5	ND	19.8
msp-19	22.9	16.2	22.6
msp-59	21.4	26.4	16.1
msp-79	20.5	18.7	13.9
msp-113	18.8	18.2	15.3
msp-56	18.2	29. 1	19.4
msp-81	17.9	19.6	16.7
msp-77	17.8	30. 1	24.3
msp-53	16.6	32.6	21.3
msp-40	15.8	25.4	20.1
msp-49	15.2	24.2	20.2
msp-152	14.0	20.2	23.9
msp-57	13.9	25.0	17.9
msp-36	13.1	23.8	17.4
msp-55	13.0	18.5	14.7
msp-51	12.8	14.7	12.9
msp-76	11.8	15.0	12.7
msp-45	11.7	- 29. 1	17.3
msp-3	11.4	20.2	17.3
msp-33	10.6	16.5	10.7
msp-142	10.5	28.4	22.0
msp-4	8.5	23.8	17.9
msp-50	6.9	19.7	16.7

Fold-change values are from the ratio of treatment vs. control. ND not detected.

Figure 11.6. Analysis of all the major sperm protein (msp) genes that were upregulated by three different transcriptome software analyses programs

11.4 Conclusions

Irradiators have now been built from three natural sources of radiation, KCl, volcanic tuff and volcanic pozzolan. These irradiators will now allow us to, for the 1st time in below background radiation research, directly test the hypothesis that organisms’ “radiation sensors” differentially respond to varying qualities of radiation. These irradiators will be used in the LBRE project to obtain data on this topic that no one else carrying out biological experiments in the subsurface is able to do.

For the first time, microorganisms that have been isolated from WIPP have been grown in-situ underground at WIPP. Growth kinetics of two representative isolates indicate that at least the halophiles at WIPP are not affected by radiation differences of more than 100-fold.

Regarding the growth of the 1st multicellular organism grown at WIPP, within 72 hours of being incubated underground in the steel vault, the *C. elegans* nematode developed a significant biological response to the lack of radiation treatment. At the time of publication (Oct. 2020), this was the first time anywhere that a significant genetic level response to abnormally low levels of radiation has been documented in a multicellular organism. These results confirm similar results we have observed previously in bacteria, thus increasing the applications of results we have documented with bacteria to multicellular organisms. We plan to continue to add other multi-cellular organisms, for example the mosquito *Aedes egypti*.

CHAPTER 12 - QUALITY ASSURANCE

12.1 General Analytical Quality Assurance

Quality assurance and quality control practices encompass all aspects of CEMRC's WIPP Environmental Monitoring Programs (WIPP-EM). The development and implementation of an independent health and environmental monitoring program has been CEMRC's primary activity. The multi-layered components of the CEMRC Quality Assurance (QA) Program ensure that all analytical data reported in this report are reliable and of high quality and that, all environmental monitoring data meet quality assurance and quality control objectives.

CEMRC is subject to the policies, procedures, and guidelines adopted by NMSU, as well as state and federal laws and regulations that govern the operation of the University and radiological facilities. The management of CEMRC is committed to conducting a well-defined quality assurance program, incorporating good professional practices, and focusing on the quality of its testing and calibration in research and service to sponsors. CEMRC's technical programmatic areas in 2020 included: Environmental Chemistry, Organic Chemistry, Radiochemistry, Field Programs, and Internal Dosimetry. Since its inception, CEMRC's WIPP-EM program has been conducted as a scientific investigation, meaning that it operates without any compliance, regulatory, or oversight responsibilities. As such, there are no specific requirements for reporting data other than following good scientific practices.

12.1.1 Quality Assurance/Quality Control for Field Sampling

Samples for CEMRC's WIPP-EM Programs are collected by personnel trained following approved procedures. Established sampling locations are accurately identified and documented to ensure the continuity of data. Field duplicate samples are used to assess sampling and measurement precision. Logbooks are maintained by technical staff in field operations to record locations and other specifics of the sample collection, and data on instrument identifications, performance, calibration, and maintenance. Data generated from field sampling equipment are error checked by using routine cross-checks, control charts, and graphical summaries. Most data collected in written form are also entered in electronic files and electronic copies are crossed checked against the original data forms. All electronic files are backed up daily.

Calibration and maintenance of equipment and analytical instruments are carried out on predetermined schedules coinciding with the manufacturer's specifications or modified to special project needs. Calibrations are either carried out by equipment vendors or by CEMRC personnel using certified calibration standards.

12.2 Quality Assurance/Quality Control for Radiochemistry

Quality control in the analytical laboratories is maintained through tracking and verification of analytical instrument performance, through the use of American Chemical Society (ACS) certified reagents, through the use of National Institute of Standards and Technology (NIST) traceable radionuclide solutions, and through verification testing of radionuclide concentrations for tracers not purchased directly from NIST or Eckert & Ziegler Analytics Inc. When making laboratory solutions, volumes and lot numbers of stock chemicals are recorded. Prior to weighing radionuclide tracers and samples, the balance being used is checked using NIST traceable weights.

Control checks are performed on all nuclear counting instrumentation each day or prior to counting a new sample. The type of instrument and methods used for performance checks were as follows: for the Protean 9604 gas-flow α/β proportional counter used for the FAS program, efficiency control charting is performed using ^{239}Pu and ^{90}Sr check sources along with ensuring that α/β cross-talk was within limits. Sixty-minute background counts are recorded daily. Two blanks per week for the WIPP Effluent air sampling program are counted for 20 hours and are used as a background history for calculating results.

Routine background determinations are made on the HPGe detector systems by counting blank samples; the data are used to blank correct the sample concentrations.

For the alpha spectrometer, efficiency, resolution, and centroid control charting are performed using Eckert and Ziegler Analytics check sources regularly. Before each sample count, pulser checks are performed to ensure acceptable detector resolution and centroid. Blanks counted for five days are used as a background history for calculating results. Analytical data are verified and validated as required by project-specific quality objectives before being used to support decision-making.

CEMRC also participates in the two national performance evaluation programs, NIST Radiochemistry Inter-Comparison Program (NIST-RIP) and the DOE-Mixed-Analyte Performance Evaluation Program (MAPEP) for soil, air filter, and water analysis. The proficiency tests help ensure the accuracy of analytical results reported to DOE and other stakeholders while also providing an efficient means for laboratories to demonstrate analytical proficiency. Under these programs, CEMRC analyzed blind check samples, and the analysis results are compared with the official results measured by the MAPEP and NRIP laboratories. CEMRC radio-analytical program analyzes MAPEP- air filter, water, soil, gross alpha/beta on air filters & water and unknown sample matrix and NIST-NRIP - glass fiber filters, soil, and acidified water samples. Isotopes of interest in these performance evolution programs are $^{233/234}$U, ^{238}U, ^{238}Pu, $^{239+240}$Pu, and ^{241}Am, ^{244}Cm, and gamma emitters. The analyses are carried out using CEMRC's actinide separation procedures and were treated as a regular sample set to test regular performance. CEMRC's results are consistently close to the known value. MAPEP and NIST-NRIP results are presented in this annual report. Based on the number of A (Acceptable) ratings earned by CEMRC for the analysis of performance evaluation samples, the laboratory provided accurate and reliable radionuclide analysis data for WIPP environmental samples. In addition, for each sample set, reagent blank and tracer spikes are also carried through the entire separation and counting process for recovery determination and quality control. The NIST and MAPEP performance evaluation results are listed in Appendix J, Tables J.1 through J.5. In 2020, CEMRC did not receive NIST-RIP samples and thus, no analyses report has been reported.

12.3 Quality Assurance/Quality Control for Organic Chemistry

To ensure that all procedures, processes, and deliverables are maintained and followed, two layers of assessments and audits are performed every year. A VOCs Confirmatory Monitoring Audit conducted by NWP, as part of their routine yearly program audits in compliance with contract requirements, was performed in October 2019. Additionally, CEMRC internal QA audit was conducted on the organic chemistry group in August 2018. Both audits passed and were conducted in compliance with CEMRC's QAP.

CEMRC's organic chemistry laboratory also participated in the National Air Toxics Trends Station (NATTS) proficiency test for VOC analysis twice in 2020. For the NATTS first quarter test, 1,1,2,2-tetrachloroethane, 1,2-dichloroethane, carbon tetrachloride, chloroform, methylene chloride, and trichloroethylene each met the acceptance criterion of ± 30 percent of the nominal spike value. Methylene chloride was detected above the acceptance criteria when referencing the nominal spike value but was well within acceptance criteria when compared to the referee and other NATTS laboratories; as a result, no corrective action was taken. For the NATTS third quarter test, 1,1,2,2-tetrachloroethane, 1,2-dichloroethane, carbon tetrachloride, chloroform, methylene chloride, and trichloroethylene each met the acceptance criteria.

12.4 Quality Assurance/Quality Control for Environmental Chemistry

The analytical methods employed for inorganic analyses in the environmental chemistry program at CEMRC are based, when applicable, on various standard procedures (EPA/600/4-79-020, 1983; EPA/SW-846, 1997); American Public Health Association, 1981). For some matrix/analyte combinations, appropriate external standard procedures do not exist. For those cases, specialized procedures have been developed to meet the need of the WIPP-EM.

Inorganic analyses were performed using Perkin Elmer Inductively Coupled Plasma Mass Spectrometry (ICP-MS), while inorganic cations and anions were measured using Ion Chromatography (IC). For ICP-MS, triplicate readings are performed on each sample, with the average result reported. Instrument performance checks shown in Appendix J, Table J.6 are run daily; the instrument is calibrated before every sample analysis. The calibration range depends on the type of sample being analyzed.

The Ion Chromatography (IC) instrument is calibrated for inorganic cation concentrations ranging from 0.25 to 10 ppm. Currently, CEMRC procedures for IC analysis only require calibrating the IC instrument once a month, but calibration checks are performed during every sample analysis as routine quality assurance.

For both ICP-MS and IC analyses, a variety of quality control samples (including blanks, spiked blanks, duplicates, and spiked samples) are prepared and run alongside every set of WIPP-EM samples during analysis. Certified reference materials are also analyzed with every sample batch. Once a year, CEMRC participates in several blind proficiency test (PT) studies coordinated by the Environmental Resource Associates (ERA). All of the reported results were within the acceptable ranges as set forth by ERA for metals, inorganic anions, and cations. The results of the blind test are shown in Appendix J, Tables J.7 through J.9.

12.5 Quality Assurance/Quality Control for Internal Dosimetry

The *in vivo* bioassay program at CEMRC participates in the Department of Energy's *In- Vivo* Laboratory Accreditation Program (DOELAP) via Nuclear Waste Partnership LLC of WIPP and is currently accredited as a service laboratory to perform the following direct bioassays.

Direct radiobioassay DOELAP categories are.

- Transuranic elements via L x-rays of ^{238}Pu
- ^{241}Am in lung
- ^{234}Th in lung
- ^{235}U in lung
- Fission and activation products in the lung include ^{54}Mn, ^{57}Co, ^{58}Co, and ^{60}Co
- Fission and activation products in the total body include ^{134}Cs and ^{137}Cs

Under DOELAP, the *in vivo* bioassay program is subject to the performance and quality assurance requirements specified in the Department of Energy Laboratory Accreditation Program for Radiobioassay (DOE-STD-1112-98) and Performance Criteria for Radiobioassay (ANSI-N13.30). A DOELAP testing cycle was completed in 2018 that included counting phantoms representative of each of the categories listed above.

To evaluate system performance, quality control data were routinely performed throughout the year to verify that the lung and whole-body counting system was operating as it was at the time the system was calibrated. Quality control parameters that track both overall system performance and individual detector performance were measured. Quality control parameters tracked to evaluate individual detector performance, included.

- Net peak area, peak centroid, and peak resolution (FWHM) across the energy range of the spectrum,
- Detector background

Quality control parameters tracked to assess overall system performance included the following:

- Mean weighted activity of a standard source
- Summed detector background

Efficiency calibration verification using NIST-traceable standards and phantoms.

In addition, CEMRC's Internal Dosimetry program has participated in the DOE Radiological and Environmental Sciences Laboratory (*RESL*) quarterly blind testing of Bottle Manikin Absorber (BOMAB) phantom for ^{54}Mn, ^{60}Co, and $^{134,\,137}$Cs and Torso for ^{238}Pu, ^{241}Am, ^{235}U,

^{238}U, $^{57,60}Co$, ^{54}Mn activities deposited in the body. These bottle phantom/Torso were counted on the whole-body counting system and the measured activities were reported back to RESL to compare against the known activities. CEMRC has consistently passed all performance criteria for the tests.

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APPENDIX A - RADIONUCLIDE CONCENTRATIONS AND SPECIFIC ACTIVITIES AT STATIONS A AND B

Actinide concentrations and specific activities at Stations A and B

Uranium concentrations and specific activities at Stations A and B

Gamma radionuclide concentrations and specific activities at Stations A and B

Strontium concentrations and specific activities at Stations A and B

Table A.1. Activity concentrations of ^{241}Am (Bq/m^3) at Station A

Sample Date	^{241}Am Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
January 2020				
1st week	1.49E-05	4.10E-06	2.66E-06	Detected
2nd week	5.53E-05	1.00E-05	2.19E-06	Detected
3rd week	1.01E-03	1.34E-04	2.41E-06	Detected
4th week	6.69E-05	1.07E-05	2.06E-06	Detected
February 2020				
1st week	6.37E-05	1.11E-05	1.95E-06	Detected
2nd week	1.97E-05	4.99E-06	2.06E-06	Detected
3rd week	5.54E-05	1.03E-05	3.22E-06	Detected
4th week	9.97E-05	1.61E-05	2.04E-06	Detected
March 2020				
1st week	2.64E-05	5.95E-06	2.17E-06	Detected
2nd week	1.27E-05	7.00E-06	7.12E-06	Detected
3rd week	3.29E-06	2.02E-06	2.28E-06	Detected
4th week	2.21E-05	4.70E-06	1.31E-06	Detected
April 2020				
1st week	1.29E-05	3.88E-06	2.05E-06	Detected
2nd week	3.31E-05	6.76E-06	1.55E-06	Detected
3rd week	1.54E-05	4.10E-06	1.84E-06	Detected
4th week	1.82E-04	2.67E-05	1.22E-06	Detected
May 2020				
1st week	3.36E-05	7.54E-06	2.43E-06	Detected
2nd week	7.59E-05	1.26E-05	1.26E-06	Detected
3rd week	1.76E-06	1.51E-06	2.33E-06	Not Detected
4th week	1.09E-04	1.60E-05	1.25E-06	Detected
June 2020				
1st week	2.57E-05	5.82E-06	2.28E-06	Detected
2nd week	5.86E-05	1.22E-05	2.11E-06	Detected
3rd week	3.04E-05	6.50E-06	2.55E-06	Detected
4th week	2.09E-05	4.67E-06	1.90E-06	Detected

Table A.1. Activity concentrations of ^{241}Am (Bq/m^3) at Station A (continued)

Sample Date	^{241}Am Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
July 2020				
1st week	2.09E-05	5.26E-06	2.47E-06	Detected
2nd week	9.87E-06	3.70E-06	4.38E-06	Detected
3rd week	3.84E-05	8.02E-06	2.39E-06	Detected
4th week	5.12E-04	7.34E-05	1.19E-06	Detected
August 2020				
1st week	6.76E-05	1.28E-05	2.31E-06	Detected
2nd week	6.88E-05	1.22E-05	2.24E-06	Detected
3rd week	2.91E-05	6.66E-06	2.20E-06	Detected
4th week	5.52E-05	1.12E-05	1.90E-06	Detected
September 2020				
1st week	3.09E-05	6.62E-06	1.08E-06	Detected
2nd week	4.97E-05	1.05E-05	2.33E-06	Detected
3rd week	1.86E-05	4.78E-06	2.19E-06	Detected
4th week	6.71E-06	2.62E-06	1.85E-06	Detected
October 2020				
1st week	4.07E-06	2.47E-06	2.64E-06	Detected
2nd week	1.94E-05	4.86E-06	2.32E-06	Detected
3rd week	3.20E-05	7.59E-06	2.63E-06	Detected
4th week	9.43E-06	2.83E-06	1.50E-06	Detected
November 2020				
1st week	7.56E-05	1.30E-05	2.55E-06	Detected
2nd week	1.72E-05	4.81E-06	2.65E-06	Detected
3rd week	2.19E-05	5.30E-06	1.18E-06	Detected
4th week	1.04E-05	3.31E-06	2.02E-06	Detected
December 2020				
1st week	1.52E-05	4.11E-06	1.97E-06	Detected
2nd week	1.09E-05	3.35E-06	1.91E-06	Detected
3rd week	8.41E-06	3.04E-06	1.82E-06	Detected
4th week	1.28E-05	3.62E-06	1.81E-06	Detected

Table A.2. Activity concentrations of $^{239+240}Pu$ (Bq/m^3) at Station A

Sample Date	$^{239+240}Pu$ Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
January 2020				
1st week	2.07E-06	1.47E-06	1.88E-06	Detected
2nd week	3.72E-06	1.90E-06	1.57E-06	Detected
3rd week	1.09E-04	1.64E-05	2.32E-06	Detected
4th week	7.53E-06	2.46E-06	1.00E-06	Detected
February 2020				
1st week	7.01E-06	2.68E-06	1.98E-06	Detected
2nd week	3.37E-06	1.92E-06	1.88E-06	Detected
3rd week	9.99E-06	3.12E-06	1.35E-06	Detected
4th week	9.34E-06	2.95E-06	1.59E-06	Detected
March 2020				
1st week	3.90E-06	2.13E-06	2.18E-06	Detected
2nd week	1.39E-07	1.50E-06	5.05E-06	Not detected
3rd week	-5.39E-07	6.85E-07	3.11E-06	Not detected
4th week	2.80E-06	1.40E-06	9.43E-07	Detected
April 2020				
1st week	1.52E-06	1.27E-06	1.88E-06	Not detected
2nd week	5.32E-06	2.43E-06	1.89E-06	Detected
3rd week	1.17E-06	1.08E-06	1.44E-06	Not detected
4th week	1.78E-05	4.14E-06	1.40E-06	Detected
May 2020				
1st week	4.98E-06	2.39E-06	2.24E-06	Detected
2nd week	1.31E-05	3.81E-06	1.85E-06	Detected
3rd week	2.04E-07	7.63E-07	2.11E-06	Not detected
4th week	1.70E-05	3.93E-06	1.42E-06	Detected
June 2020				
1st week	1.57E-06	1.23E-06	1.42E-06	Detected
2nd week	6.95E-06	2.88E-06	2.15E-06	Detected
3rd week	2.89E-06	1.84E-06	2.56E-06	Detected
4th week	1.65E-06	1.26E-06	1.92E-06	Not Detected

Table A.2. Activity concentrations $^{239+240}Pu$ (Bq/m^3) at Station A (continued)

Sample Date	$^{239+240}Pu$ Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
July 2020				
1st week	3.57E-06	1.96E-06	2.21E-06	Detected
2nd week	1.44E-06	1.29E-06	1.77E-06	Not detected
3rd week	6.84E-06	2.54E-06	1.49E-06	Detected
4th week	7.95E-05	1.23E-06	1.93E-06	Detected
August 2020				
1st week	8.62E-06	3.11E-06	1.87E-06	Detected
2nd week	7.45E-06	2.75E-06	1.88E-06	Detected
3rd week	6.79E-06	2.82E-06	2.10E-06	Detected
4th week	4.85E-06	1.90E-06	1.26E-06	Detected
September 2020				
1st week	6.84E-06	2.57E-06	1.07E-06	Detected
2nd week	3.39E-06	1.88E-06	1.82E-06	Detected
3rd week	1.12E-06	1.08E-06	1.57E-06	Not detected
4th week	8.88E-07	8.66E-07	1.29E-06	Not detected
October 2020				
1st week	1.41E-06	1.67E-06	3.26E-06	Not detected
2nd week	4.09E-06	2.12E-06	1.89E-06	Detected
3rd week	5.44E-06	2.34E-06	1.96E-06	Detected
4th week	1.71E-06	1.07E-06	7.90E-07	Detected
November 2020				
1st week	7.91E-06	2.94E-06	2.10E-06	Detected
2nd week	2.94E-06	1.64E-06	1.06E-06	Detected
3rd week	2.20E-06	1.68E-06	2.43E-06	Not detected
4th week	1.97E-06	1.19E-06	1.17E-06	Detected
December 2020				
1st week	1.68E-06	1.35E-06	1.70E-06	Not detected
2nd week	7.37E-07	9.44E-07	1.67E-06	Not detected
3rd week	5.87E-07	9.37E-07	1.97E-06	Not detected
4th week	1.59E-06	1.11E-06	1.35E-06	Detected

Table A.3. Activity concentrations of ^{238}Pu (Bq/m^3) at Station A

Sample Date	^{238}Pu Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
January 2020				
1st week	7.67E-06	2.80E-06	1.88E-06	Detected
2nd week	1.21E-05	3.63E-06	2.15E-06	Detected
3rd week	1.32E-05	3.75E-06	2.64E-06	Detected
4th week	1.15E-05	3.17E-06	1.12E-06	Detected
February 2020				
1st week	1.16E-05	3.53E-06	1.79E-06	Detected
2nd week	6.69E-06	2.74E-06	2.00E-06	Detected
3rd week	1.39E-05	3.82E-06	2.14E-06	Detected
4th week	9.88E-06	3.08E-06	2.03E-06	Detected
March 2020				
1st week	5.64E-06	2.56E-05	2.18E-06	Detected
2nd week	4.87E-06	4.31E-06	6.90E-06	Not detected
3rd week	2.37E-06	2.03E-06	3.54E-06	Not detected
4th week	1.20E-05	3.15E-06	1.06E-06	Detected
April 2020				
1st week	1.05E-05	3.25E-06	1.71E-06	Detected
2nd week	7.94E-06	3.01E-06	2.01E-06	Detected
3rd week	1.07E-05	3.40E-06	2.29E-06	Detected
4th week	1.24E-05	3.33E-06	1.79E-06	Detected
May 2020				
1st week	1.39E-05	4.10E-06	1.91E-06	Detected
2nd week	1.76E-05	4.50E-06	1.11E-06	Detected
3rd week	9.89E-06	3.50E-06	2.62E-06	Detected
4th week	1.29E-05	3.32E-06	1.42E-06	Detected
June 2020				
1st week	8.46E-06	2.95E-06	2.18E-06	Detected
2nd week	1.68E-05	4.64E-06	1.54E-06	Detected
3rd week	1.71E-05	4.50E-06	2.49E-06	Detected
4th week	1.34E-05	3.53E-06	1.98E-06	Detected

Table A.3. Activity concentrations of ^{238}Pu (Bq/m^3) at Station A (continued)

Sample Date	^{238}Pu Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
July 2020				
1st week	1.93E-05	4.85E-06	2.37E-06	Detected
2nd week	1.08E-05	3.87E-06	4.49E-06	Detected
3rd week	2.18E-05	5.03E-06	2.04E-06	Detected
4th week	1.93E-05	4.33E-06	1.22E-06	Detected
August 2020				
1st week	2.75E-05	6.19E-06	1.99E-06	Detected
2nd week	3.83E-05	7.44E-06	2.13E-06	Detected
3rd week	2.29E-05	5.66E-06	2.32E-06	Detected
4th week	1.78E-05	4.05E-06	1.26E-06	Detected
September 2020				
1st week	1.75E-05	4.50E-06	2.28E-06	Detected
2nd week	2.44E-05	5.61E-06	1.55E-06	Detected
3rd week	1.08E-05	3.39E-06	2.14E-06	Detected
4th week	2.18E-05	4.75E-06	1.63E-06	Detected
October 2020				
1st week	1.39E-05	4.43E-06	2.81E-06	Detected
2nd week	2.64E-05	6.03E-06	1.44E-06	Detected
3rd week	2.85E-05	6.06E-06	1.67E-06	Detected
4th week	1.96E-05	4.28E-06	1.05E-06	Detected
November 2020				
1st week	1.95E-05	4.97E-06	2.72E-06	Detected
2nd week	9.55E-06	3.16E-06	2.19E-06	Detected
3rd week	1.32E-05	4.08E-06	2.82E-06	Detected
4th week	1.20E-05	3.17E-06	1.54E-06	Detected
December 2020				
1st week	1.89E-05	4.86E-06	1.94E-06	Detected
2nd week	1.19E-05	3.64E-06	1.15E-06	Detected
3rd week	8.54E-06	3.10E-06	2.67E-06	Detected
4th week	1.64E-05	3.90E-06	1.61E-06	Detected

Table A.4. Specific activity of ^{241}Am (Bq/g) at Station A

Sample Date	^{241}Am Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
January 2020				
1st week	2.74E-02	7.57E-03	4.91E-03	Detected
2nd week	1.60E-01	2.90E-02	6.31E-03	Detected
3rd week	1.61E+00	2.14E-01	3.85E-03	Detected
4th week	2.34E-01	3.76E-02	7.22E-03	Detected
February 2020				
1st week	2.70E-01	4.69E-02	8.27E-03	Detected
2nd week	1.22E-01	3.09E-02	1.27E-02	Detected
3rd week	2.98E-01	5.55E-02	1.73E-02	Detected
4th week	3.75E-01	6.04E-02	7.67E-03	Detected
March 2020				
1st week	1.98E-01	4.46E-02	1.63E-02	Detected
2nd week	2.55E-01	1.40E-01	1.43E-01	Detected
3rd week	3.46E-02	2.13E-02	2.40E-02	Detected
4th week	1.61E-01	3.42E-02	9.52E-03	Detected
April 2020				
1st week	1.54E-01	4.65E-02	2.46E-02	Detected
2nd week	4.70E-01	9.61E-02	2.20E-02	Detected
3rd week	1.21E-01	3.24E-02	1.46E-02	Detected
4th week	1.34E+00	1.97E-01	9.01E-03	Detected
May 2020				
1st week	3.72E-01	8.35E-02	2.70E-02	Detected
2nd week	5.28E-01	8.79E-02	8.78E-03	Detected
3rd week	1.89E-02	1.62E-02	2.50E-02	Not Detected
4th week	1.68E+00	2.47E-01	1.92E-02	Detected
June 2020				
1st week	6.47E-01	1.46E-01	5.74E-02	Detected
2nd week	1.06E+00	2.21E-01	3.83E-02	Detected
3rd week	7.74E-01	1.66E-01	6.50E-02	Detected
4th week	3.35E-01	7.48E-02	3.05E-02	Detected

Table A.4. Specific activity of ^{241}Am (Bq/g) at Station A (continued)

Sample Date	^{241}Am Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
July 2020				
1st week	5.04E-01	1.27E-01	5.96E-02	Detected
2nd week	1.64E-01	6.17E-02	7.29E-02	Detected
3rd week	4.50E-01	9.39E-02	2.80E-02	Detected
4th week	5.59E+00	8.02E-01	1.30E-02	Detected
August 2020				
1st week	9.84E-01	1.86E-01	3.36E-02	Detected
2nd week	1.48E+00	2.62E-01	4.80E-02	Detected
3rd week	6.92E-01	1.58E-01	5.22E-02	Detected
4th week	2.19E+00	4.46E-01	7.53E-02	Detected
September 2020				
1st week	5.05E-01	1.08E-01	1.76E-02	Detected
2nd week	5.36E-01	1.13E-01	2.52E-02	Detected
3rd week	1.72E-01	4.42E-02	2.02E-02	Detected
4th week	5.80E-02	2.26E-02	1.60E-02	Detected
October 2020				
1st week	4.09E-02	2.48E-02	2.65E-02	Detected
2nd week	7.92E-02	1.98E-02	9.47E-03	Detected
3rd week	2.03E-01	4.81E-02	1.67E-02	Detected
4th week	1.45E-01	4.35E-02	2.31E-02	Detected
November 2020				
1st week	8.45E-01	1.46E-01	2.85E-02	Detected
2nd week	3.56E-01	9.95E-02	5.47E-02	Detected
3rd week	5.13E-01	1.24E-01	2.76E-02	Detected
4th week	4.61E-01	1.47E-01	8.95E-02	Detected
December 2020				
1st week	2.17E-01	5.87E-02	2.81E-02	Detected
2nd week	1.49E-01	4.55E-02	2.59E-02	Detected
3rd week	1.44E-01	5.19E-02	3.12E-02	Detected
4th week	5.30E-01	1.50E-01	7.53E-02	Detected

Table A.5. Specific activity of $^{239+240}Pu$ (Bq/g) at Station A

Sample Date	$^{239+240}Pu$ Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
January 2020				
1st week	3.82E-03	2.71E-03	3.47E-03	Detected
2nd week	1.07E-02	5.48E-03	4.54E-03	Detected
3rd week	1.74E-01	2.61E-02	3.70E-03	Detected
4th week	2.64E-02	8.61E-03	3.50E-03	Detected
February 2020				
1st week	2.97E-02	1.14E-02	8.38E-03	Detected
2nd week	2.09E-02	1.19E-02	1.16E-02	Detected
3rd week	5.38E-02	1.68E-02	7.25E-03	Detected
4th week	3.51E-02	1.11E-02	5.97E-03	Detected
March 2020				
1st week	2.92E-02	1.60E-02	1.64E-02	Detected
2nd week	2.78E-03	3.00E-02	1.01E-01	Not detected
3rd week	-5.68E-03	7.22E-03	3.27E-02	Not detected
4th week	2.04E-02	1.02E-02	6.87E-03	Detected
April 2020				
1st week	1.83E-02	1.53E-02	2.26E-02	Not detected
2nd week	7.57E-02	3.45E-02	2.68E-02	Detected
3rd week	9.21E-03	8.52E-03	1.14E-02	Not detected
4th week	1.32E-01	3.05E-02	1.03E-02	Detected
May 2020				
1st week	5.51E-02	2.64E-02	2.48E-02	Detected
2nd week	9.11E-02	2.65E-02	1.28E-02	Detected
3rd week	2.19E-03	8.20E-03	2.27E-02	Not detected
4th week	2.61E-01	6.05E-02	2.18E-02	Detected
June 2020				
1st week	3.96E-02	3.08E-02	3.56E-02	Detected
2nd week	1.26E-01	5.22E-02	3.90E-02	Detected
3rd week	7.36E-02	4.70E-02	6.53E-02	Detected
4th week	2.65E-02	2.02E-02	3.08E-02	Not detected

Table A.5. Specific activity of $^{239+240}Pu$ (Bq/g) at Station A (continued)

Sample Date	$^{239+240}Pu$ Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
July 2020				
1st week	8.62E-02	4.74E-02	5.34E-02	Detected
2nd week	2.41E-02	2.14E-02	2.95E-02	Not detected
3rd week	8.01E-02	2.98E-02	1.75E-02	Detected
4th week	8.68E-01	1.34E-02	2.11E-02	Detected
August 2020				
1st week	1.26E-01	4.53E-02	2.72E-02	Detected
2nd week	1.60E-01	5.90E-02	4.03E-02	Detected
3rd week	1.61E-01	6.71E-02	4.99E-02	Detected
4th week	1.93E-01	7.56E-02	5.01E-02	Detected
September 2020				
1st week	1.12E-01	4.20E-02	1.75E-02	Detected
2nd week	3.66E-02	2.03E-02	1.97E-02	Detected
3rd week	1.04E-02	9.99E-03	1.45E-02	Not detected
4th week	7.68E-03	7.49E-03	1.11E-02	Not detected
October 2020				
1st week	1.42E-02	1.68E-02	3.27E-02	Not detected
2nd week	1.67E-02	8.63E-03	7.70E-03	Detected
3rd week	3.45E-02	1.48E-02	1.24E-02	Detected
4th week	2.63E-02	1.65E-02	1.22E-02	Detected
November 2020				
1st week	8.84E-02	3.29E-02	2.35E-02	Detected
2nd week	6.08E-02	3.38E-02	2.20E-02	Detected
3rd week	5.16E-02	3.93E-02	5.68E-02	Not detected
4th week	8.71E-02	5.29E-02	5.19E-02	Detected
December 2020				
1st week	2.40E-02	1.93E-02	2.42E-02	Not detected
2nd week	1.00E-02	1.28E-02	2.27E-02	Not detected
3rd week	1.00E-02	1.60E-02	3.37E-02	Not detected
4th week	6.61E-02	4.60E-02	5.60E-02	Detected

Table A.6. Specific activity of ^{238}Pu (Bq/g) at Station A

Sample Date	^{238}Pu Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
January 2020				
1st week	1.42E-02	5.16E-03	3.47E-03	Detected
2nd week	3.50E-02	1.05E-02	6.19E-03	Detected
3rd week	2.11E-02	5.98E-03	4.21E-03	Detected
4th week	4.04E-02	1.11E-02	3.93E-03	Detected
February 2020				
1st week	4.93E-02	1.49E-02	7.59E-03	Detected
2nd week	4.14E-02	1.69E-02	1.23E-02	Detected
3rd week	7.47E-02	2.06E-02	1.15E-02	Detected
4th week	3.71E-02	1.16E-02	7.63E-03	Detected
March 2020				
1st week	4.23E-02	1.92E-01	1.64E-02	Detected
2nd week	9.75E-02	8.62E-02	1.38E-01	Not Detected
3rd week	2.50E-02	2.14E-02	3.73E-02	Not detected
4th week	8.73E-02	2.30E-02	7.71E-03	Detected
April 2020				
1st week	1.25E-01	3.89E-02	2.05E-02	Detected
2nd week	1.13E-01	4.28E-02	2.85E-02	Detected
3rd week	8.46E-02	2.69E-02	1.81E-02	Detected
4th week	9.15E-02	2.45E-02	1.32E-02	Detected
May 2020				
1st week	1.54E-01	4.54E-02	2.11E-02	Detected
2nd week	1.22E-01	3.13E-02	7.73E-03	Detected
3rd week	1.06E-01	3.76E-02	2.81E-02	Detected
4th week	1.99E-01	5.12E-02	2.18E-02	Detected
June 2020				
1st week	2.13E-01	7.42E-02	5.49E-02	Detected
2nd week	3.04E-01	8.41E-02	2.79E-02	Detected
3rd week	4.37E-01	1.15E-01	6.36E-02	Detected
4th week	2.15E-01	5.66E-02	3.16E-02	Detected

Table A.6. Specific activity of ^{238}Pu (Bq/g) at Station A (continued)

Sample Date	^{238}Pu Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
July 2020				
1st week	4.67E-01	1.17E-01	5.71E-02	Detected
2nd week	1.81E-01	6.45E-02	7.48E-02	Detected
3rd week	2.55E-01	5.89E-02	2.39E-02	Detected
4th week	2.11E-01	4.73E-02	1.33E-02	Detected
August 2020				
1st week	4.00E-01	9.01E-02	2.89E-02	Detected
2nd week	8.22E-01	1.60E-01	4.58E-02	Detected
3rd week	5.44E-01	1.34E-01	5.51E-02	Detected
4th week	7.06E-01	1.61E-01	5.01E-02	Detected
September 2020				
1st week	2.86E-01	7.35E-02	3.72E-02	Detected
2nd week	2.63E-01	6.05E-02	1.67E-02	Detected
3rd week	9.98E-02	3.14E-02	1.98E-02	Detected
4th week	1.89E-01	4.11E-02	1.41E-02	Detected
October 2020				
1st week	1.39E-01	4.45E-02	2.81E-02	Detected
2nd week	1.08E-01	2.46E-02	5.85E-03	Detected
3rd week	1.80E-01	3.84E-02	1.06E-02	Detected
4th week	3.01E-01	6.58E-02	1.62E-02	Detected
November 2020				
1st week	2.18E-01	5.56E-02	3.04E-02	Detected
2nd week	1.97E-01	6.54E-02	4.52E-02	Detected
3rd week	3.10E-01	9.54E-02	6.61E-02	Detected
4th week	5.30E-01	1.41E-01	6.82E-02	Detected
December 2020				
1st week	2.69E-01	6.93E-02	2.76E-02	Detected
2nd week	1.62E-01	4.95E-02	1.56E-02	Detected
3rd week	1.46E-01	5.30E-02	4.56E-02	Detected
4th week	6.82E-01	1.62E-01	6.69E-02	Detected

Table A.7. Monthly activity concentrations of U isotopes at Station A

Radionuclide	Sample Date	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{234}U	January	1.89E-06	6.14E-07	6.82E-07	Detected
	February	6.31E-07	2.71E-07	3.82E-07	Detected
	March	4.24E-07	3.03E-07	5.90E-07	Not detected
	April	5.38E-07	2.82E-07	4.94E-07	Detected
	May	2.12E-07	2.56E-07	5.68E-07	Not detected
	June	4.21E-07	2.14E-07	2.86E-07	Detected
	July	3.49E-07	2.08E-07	3.46E-07	Detected
	August	2.81E-07	1.96E-07	3.55E-07	Not detected
	September	6.22E-08	2.23E-07	5.47E-07	Not detected
	October	5.78E-07	2.77E-07	4.67E-07	Detected
	November	2.55E-07	2.69E-07	5.85E-07	Not detected
	December	2.88E-07	1.72E-07	2.57E-07	Detected
^{235}U	January	-4.47E-08	1.42E-07	4.21E-07	Not detected
	February	6.64E-08	1.47E-07	3.52E-07	Not detected
	March	1.10E-07	1.75E-07	3.89E-07	Not detected
	April	-3.28E-08	1.57E-07	4.49E-07	Not detected
	May	1.96E-07	1.70E-07	3.07E-07	Not detected
	June	1.48E-07	1.58E-07	3.00E-07	Not detected
	July	-1.08E-14	1.57E-07	4.27E-07	Not detected
	August	1.06E-07	1.51E-07	3.28E-07	Not detected
	September	2.04E-07	1.92E-07	3.60E-07	Not detected
	October	3.36E-08	1.66E-07	4.24E-07	Not detected
	November	1.35E-07	1.43E-07	2.70E-07	Not detected
	December	8.84E-08	1.27E-07	2.70E-07	Not detected

Table A.7. Monthly activity concentrations of U isotopes at Station A (continued)

Radionuclide	Sample Date	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{238}U	January	7.40E-07	2.79E-07	3.63E-07	Detected
	February	5.29E-07	2.65E-07	4.31E-07	Detected
	March	2.00E-07	3.18E-07	7.31E-07	Not detected
	April	2.93E-07	2.60E-07	5.44E-07	Not detected
	May	7.04E-08	2.54E-07	6.15E-07	Not detected
	June	2.78E-07	2.07E-07	3.80E-07	Not detected
	July	3.29E-07	2.10E-07	3.68E-07	Not detected
	August	1.69E-07	1.88E-07	4.01E-07	Not detected
	September	1.44E-07	2.89E-07	6.78E-07	Not detected
	October	2.24E-07	2.38E-07	5.14E-07	Not detected
	November	-1.09E-07	2.35E-07	6.34E-07	Not detected
	December	1.60E-07	1.66E-07	3.42E-07	Not detected

Table A.8. Specific activity of U isotopes at Station A

Radionuclide	Sample Date	Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{234}U	January	4.34E-01	1.41E-03	1.57E-03	Detected
	February	2.94E-03	1.26E-03	1.78E-03	Detected
	March	3.59E-03	2.56E-03	4.99E-03	Not detected
	April	5.08E-03	2.66E-03	4.66E-03	Detected
	May	2.24E-03	2.70E-03	6.00E-03	Not detected
	June	8.47E-03	4.30E-03	5.75E-03	Detected
	July	4.88E-03	2.91E-03	4.83E-03	Detected
	August	6.42E-03	4.49E-03	8.13E-03	Not detected
	September	6.49E-04	2.33E-03	5.71E-03	Not Detected
	October	4.29E-03	2.06E-03	3.47E-03	Detected
	November	5.21E-03	5.49E-03	1.19E-02	Not detected
	December	5.40E-03	3.23E-03	4.82E-03	Detected
^{235}U	January	-1.03E-04	3.26E-04	9.69E-04	Not detected
	February	3.10E-04	6.87E-04	1.64E-03	Not detected
	March	9.32E-04	1.48E-03	3.28E-03	Not detected
	April	-3.09E-04	1.48E-03	4.24E-03	Not detected
	May	2.07E-03	1.80E-03	3.25E-03	Not detected
	June	2.98E-03	3.18E-03	6.04E-03	Not detected
	July	-1.51E-10	2.19E-03	5.96E-03	Not detected
	August	2.44E-03	3.46E-03	7.50E-03	Not detected
	September	2.13E-03	2.01E-03	3.76E-03	Not detected
	October	2.50E-04	1.24E-03	3.15E-03	Not detected
	November	2.75E-03	2.92E-03	5.51E-03	Not detected
	December	1.66E-03	2.38E-03	5.06E-03	Not detected

Table A.8. Specific activity of U isotopes at Station A (continued)

Radionuclide	Sample Date	Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{238}U	January	1.70E-03	6.43E-04	8.36E-04	Detected
	February	2.47E-03	1.24E-03	2.01E-03	Detected
	March	1.69E-03	2.69E-03	6.17E-03	Not detected
	April	2.76E-03	2.45E-03	5.13E-03	Not detected
	May	7.43E-04	2.68E-03	6.49E-03	Not Detected
	June	5.60E-03	4.16E-03	7.65E-03	Not detected
	July	4.60E-03	2.93E-03	5.14E-03	Not detected
	August	3.87E-03	4.31E-03	9.18E-03	Not detected
	September	1.51E-03	3.02E-03	7.07E-03	Not detected
	October	1.67E-03	1.77E-03	3.82E-03	Not detected
	November	-2.22E-03	4.80E-03	1.29E-02	Not detected
	December	3.00E-03	3.12E-03	6.40E-03	Not detected

Table A.9. Activity concentrations of ^{137}Cs (Bq/m^3) at Station A

Sample Date	^{137}Cs Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
January 2020				
1st week	7.77E-05	3.48E-05	1.13E-04	Not detected
2nd week	-9.39E-05	4.00E-05	1.41E-04	Not detected
3rd week	3.52E-05	4.03E-05	1.34E-04	Not detected
4th week	-3.16E-05	3.18E-05	1.09E-04	Not detected
February 2020				
1st week	4.51E-05	3.31E-05	1.09E-04	Not detected
2nd week	1.37E-05	4.10E-05	1.38E-04	Not detected
3rd week	1.44E-04	4.61E-05	1.48E-04	Not detected
4th week	4.91E-06	3.22E-01	1.10E-04	Not detected
March 2020				
1st week	-5.02E-05	3.08E-05	1.10E-04	Not detected
2nd week	1.50E-04	1.16E-04	3.86E-04	Not detected
3rd week	-8.10E-05	4.55E-05	1.58E-04	Not detected
4th week	-2.07E-05	2.82E-05	9.76E-05	Not detected
April 2020				
1st week	-8.50E-05	3.98E-05	1.39E-04	Not detected
2nd week	-6.46E-06	3.47E-05	1.19E-04	Not detected
3rd week	-2.97E-05	3.16E-05	1.11E-04	Not detected
4th week	4.09E-05	2.83E-05	9.35E-05	Not detected
May 2020				
1st week	5.96E-05	4.52E-05	1.50E-04	Not detected
2nd week	5.97E-05	4.44E-05	1.47E-04	Not detected
3rd week	8.70E-05	3.92E-05	1.27E-04	Not detected
4th week	1.23E-05	2.17E-05	7.34E-05	Not detected
June 2020				
1st week	3.10E-05	3.58E-05	1.20E-04	Not detected
2nd week	7.80E-05	4.67E-05	1.53E-04	Not detected
3rd week	-1.16E-04	4.85E-05	1.69E-04	Not detected
4th week	3.57E-05	3.07E-05	1.02E-04	Not detected

Table A.9. Activity concentrations of ^{137}Cs (Bq/m^3) at Station A (continued)

Sample Date	^{137}Cs Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
July 2020				
1st week	7.35E-05	3.92E-05	1.28E-04	Not detected
2nd week	1.05E-04	4.79E-05	1.56E-04	Not detected
3rd week	1.77E-05	5.34E-05	1.79E-04	Not detected
4th week	4.21E-05	2.74E-05	9.03E-05	Not detected
August 2020				
1st week	6.32E-05	3.82E-05	1.25E-04	Not detected
2nd week	2.38E-04	4.68E-04	1.59E-03	Not detected
3rd week	-7.40E-05	4.28E-04	1.47E-03	Not detected
4th week	1.28E-04	3.16E-04	1.07E-03	Not detected
September 2020				
1st week	6.69E-05	3.98E-05	1.31E-04	Not detected
2nd week	6.46E-05	3.90E-05	1.28E-04	Not detected
3rd week	-1.29E-04	4.32E-05	1.52E-04	Not detected
4th week	-6.80E-05	3.41E-05	1.19E-04	Not detected
October 2020				
1st week	-9.76E-05	4.30E-05	1.50E-04	Not detected
2nd week	8.96E-05	4.03E-05	1.31E-04	Not detected
3rd week	5.99E-05	4.21E-05	1.39E-04	Not detected
4th week	-5.60E-05	3.27E-05	1.13E-04	Not detected
November 2020				
1st week	-3.45E-05	4.74E-05	1.61E-04	Not detected
2nd week	4.17E-05	4.54E-05	1.51E-04	Not detected
3rd week	-3.70E-06	3.11E-05	1.07E-04	Not detected
4th week	-7.48E-05	3.15E-05	1.11E-04	Not detected
December 2020				
1st week	1.15E-04	4.84E-05	1.57E-04	Not detected
2nd week	2.67E-05	3.62E-05	1.22E-04	Not detected
3rd week	5.20E-05	3.86E-05	1.28E-04	Not detected
4th week	1.07E-04	3.36E-05	1.08E-04	Not detected

Table A.10. Activity concentrations ^{40}K (Bq/m^3) at Station A

Sample Date	^{40}K Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
January 2020				
1st week	-7.91E-04	5.30E-04	1.87E-03	Not detected
2nd week	4.36E-04	4.71E-04	1.57E-03	Not detected
3rd week	-4.53E-05	5.69E-04	1.94E-03	Not detected
4th week	4.61E-04	3.62E-04	1.20E-03	Not detected
February 2020				
1st week	3.80E-04	5.68E-04	1.91E-03	Not detected
2nd week	-8.24E-05	5.78E-04	1.97E-03	Not detected
3rd week	-3.80E-04	5.41E-04	1.87E-03	Not detected
4th week	-1.13E-04	4.33E-04	1.50E-03	Not detected
March 2020				
1st week	-3.99E-04	4.93E-04	1.72E-03	Not detected
2nd week	-2.88E-03	1.83E-03	6.46E-03	Not detected
3rd week	2.63E-04	5.00E-04	1.69E-03	Not detected
4th week	-1.80E-04	3.36E-04	1.17E-03	Not detected
April 2020				
1st week	-3.27E-05	4.81E-04	1.64E-03	Not detected
2nd week	-3.85E-04	5.38E-04	1.86E-03	Not detected
3rd week	3.70E-04	5.34E-04	1.80E-03	Not detected
4th week	-3.23E-04	4.10E-04	1.42E-03	Not detected
May 2020				
1st week	-7.64E-04	5.30E-04	1.86E-03	Not detected
2nd week	9.90E-05	4.71E-04	1.61E-03	Not detected
3rd week	-2.19E-04	5.70E-04	1.95E-03	Not detected
4th week	5.42E-04	3.57E-04	1.18E-03	Not detected
June 2020				
1st week	-6.67E-04	5.31E-04	1.86E-03	Not detected
2nd week	2.46E-04	6.39E-04	2.17E-03	Not detected
3rd week	4.13E-04	4.42E-04	1.48E-03	Not detected
4th week	8.67E-05	4.72E-04	1.60E-03	Not detected

Table A.10. Activity concentrations ^{40}K (Bq/m^3) at Station A (continued)

Sample Date	^{40}K Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
July 2020				
1st week	9.46E-04	5.88E-04	1.93E-03	Not detected
2nd week	-9.08E-04	4.93E-04	1.76E-03	Not detected
3rd week	4.45E-05	4.46E-04	1.52E-03	Not detected
4th week	2.61E-04	4.17E-04	1.40E-03	Not detected
August 2020				
1st week	-1.75E-04	5.94E-04	2.03E-03	Not detected
2nd week	2.38E-04	4.68E-04	1.59E-03	Not detected
3rd week	-7.40E-05	4.28E-04	1.47E-03	Not detected
4th week	1.28E-04	3.16E-04	1.07E-03	Not detected
September 2020				
1st week	-2.72E-04	5.51E-04	1.90E-03	Not detected
2nd week	6.32E-04	4.92E-04	1.63E-03	Not detected
3rd week	1.55E-04	4.45E-04	1.51E-03	Not detected
4th week	-1.67E-04	4.43E-04	1.52E-03	Not detected
October 2020				
1st week	-5.00E-05	4.27E-04	1.46E-03	Not detected
2nd week	-9.26E-04	5.44E-04	1.92E-03	Not detected
3rd week	2.09E-04	5.30E-04	1.80E-03	Not detected
4th week	4.89E-04	3.29E-04	1.09E-03	Not detected
November 2020				
1st week	1.62E-04	4.42E-04	1.50E-03	Not detected
2nd week	-2.33E-04	5.61E-04	1.93E-03	Not detected
3rd week	5.52E-05	4.50E-04	1.55E-03	Not detected
4th week	4.38E-04	4.33E-04	1.44E-03	Not detected
December 2020				
1st week	-3.48E-04	5.42E-04	1.87E-03	Not detected
2nd week	2.03E-04	4.58E-04	1.56E-03	Not detected
3rd week	-1.99E-04	6.17E-04	2.11E-03	Not detected
4th week	2.00E-05	3.17E-04	1.09E-03	Not detected

Table A.11. Activity concentrations of ^{60}Co (Bq/m^3) at Station A

Sample Date	^{60}Co Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
January 2020				
1st week	1.11E-05	3.74E-05	1.28E-04	Not detected
2nd week	2.98E-05	2.71E-05	9.09E-05	Not detected
3rd week	5.43E-05	3.52E-05	1.16E-04	Not detected
4th week	4.31E-05	2.46E-05	8.05E-05	Not detected
February 2020				
1st week	5.82E-05	3.49E-05	1.14E-04	Not detected
2nd week	2.99E-05	3.41E-05	1.15E-04	Not detected
3rd week	7.95E-05	3.35E-05	1.07E-04	Not detected
4th week	8.48E-06	2.92E-05	1.01E-04	Not detected
March 2020				
1st week	5.52E-05	3.56E-05	1.17E-04	Not detected
2nd week	2.34E-04	1.28E-04	4.19E-04	Not detected
3rd week	8.72E-05	4.37E-05	1.42E-04	Not detected
4th week	5.55E-05	2.45E-05	7.86E-05	Not detected
April 2020				
1st week	1.94E-05	3.15E-05	1.07E-04	Not detected
2nd week	1.69E-05	3.22E-05	1.10E-04	Not detected
3rd week	-5.92E-05	-5.92E-05	3.64E-05	Not detected
4th week	2.13E-05	2.49E-05	8.41E-05	Not detected
May 2020				
1st week	-1.82E-05	3.19E-05	1.13E-04	Not detected
2nd week	1.08E-05	3.29E-05	1.13E-04	Not detected
3rd week	4.05E-05	4.31E-05	1.44E-04	Not detected
4th week	1.79E-05	2.16E-05	7.33E-05	Not detected
June 2020				
1st week	6.64E-05	4.44E-05	1.47E-04	Not detected
2nd week	4.41E-05	4.37E-05	1.47E-04	Not detected
3rd week	3.62E-05	2.92E-05	9.71E-05	Not detected
4th week	-4.44E-06	2.49E-05	8.66E-05	Not detected

Table A.11. Activity concentrations of ^{60}Co (Bq/m^3) at Station A (continued)

Sample Date	^{60}Co Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
July 2020				
1st week	1.09E-05	3.24E-05	1.11E-04	Not detected
2nd week	-3.50E-05	3.35E-05	1.20E-04	Not detected
3rd week	-5.57E-06	2.80E-05	9.77E-05	Not detected
4th week	1.66E-05	2.69E-05	9.11E-05	Not detected
August 2020				
1st week	3.77E-05	3.25E-05	1.08E-04	Not detected
2nd week	-8.02E-06	3.14E-05	1.10E-04	Not detected
3rd week	4.74E-05	2.82E-05	9.25E-05	Not detected
4th week	6.99E-07	1.80E-05	6.25E-05	Not detected
September 2020				
1st week	4.60E-05	4.30E-05	1.43E-04	Not detected
2nd week	2.32E-05	3.68E-05	1.25E-04	Not detected
3rd week	2.67E-05	2.67E-05	8.96E-05	Not detected
4th week	1.47E-05	3.01E-05	1.02E-04	Not detected
October 2020				
1st week	3.89E-05	2.63E-05	8.68E-05	Not detected
2nd week	4.36E-05	3.23E-05	1.07E-04	Not detected
3rd week	-5.05E-05	3.19E-05	1.17E-04	Not detected
4th week	2.59E-05	2.06E-05	6.86E-05	Not detected
November 2020				
1st week	3.32E-06	2.59E-05	8.99E-05	Not detected
2nd week	7.01E-05	3.24E-05	1.05E-04	Not detected
3rd week	3.08E-05	3.18E-05	1.07E-04	Not detected
4th week	3.85E-05	2.34E-05	7.69E-05	Not detected
December 2020				
1st week	-4.48E-05	3.30E-05	1.19E-04	Not detected
2nd week	-3.01E-05	2.97E-05	1.08E-04	Not detected
3rd week	7.78E-05	3.42E-05	1.10E-04	Not detected
4th week	1.06E-06	2.08E-05	7.25E-05	Not detected

Table A.12. Specific activity of ^{137}Cs (Bq/g) at Station A

Sample Date	^{137}Cs Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
January 2020				
1st week	1.43E-01	6.43E-02	2.09E-01	Not detected
2nd week	-2.71E-01	1.15E-01	4.06E-01	Not detected
3rd week	5.61E-02	6.42E-02	2.14E-01	Not detected
4th week	-1.11E-01	1.11E-01	3.81E-01	Not detected
February 2020				
1st week	1.91E-01	1.40E-01	4.63E-01	Not detected
2nd week	8.45E-02	2.54E-01	8.56E-01	Not detected
3rd week	7.77E-01	2.48E-01	7.96E-01	Not detected
4th week	1.85E-02	1.21E+03	4.12E-01	Not detected
March 2020				
1st week	-3.77E-01	2.31E-01	8.27E-01	Not detected
2nd week	3.00E+00	2.33E+00	7.72E+00	Not detected
3rd week	-8.53E-01	4.79E-01	1.66E+00	Not detected
4th week	-1.51E-01	2.06E-01	7.11E-01	Not detected
April 2020				
1st week	-1.02E+00	4.78E-01	1.67E+00	Not detected
2nd week	-9.19E-02	4.94E-01	1.69E+00	Not detected
3rd week	-2.35E-01	2.50E-01	8.77E-01	Not detected
4th week	3.01E-01	2.09E-01	6.89E-01	Not detected
May 2020				
1st week	6.59E-01	5.01E-01	1.66E+00	Not detected
2nd week	4.15E-01	3.09E-01	1.02E+00	Not detected
3rd week	9.35E-01	4.21E-01	1.37E+00	Not detected
4th week	1.90E-01	3.35E-01	1.13E+00	Not detected
June 2020				
1st week	7.79E-01	9.00E-01	3.01E+00	Not detected
2nd week	1.42E+00	8.48E-01	2.78E+00	Not detected
3rd week	-2.96E+00	1.24E+00	4.30E+00	Not detected
4th week	5.72E-01	4.92E-01	1.63E+00	Not detected

Table A.12. Specific activity of ^{137}Cs (Bq/g) at Station A (continued)

Sample Date	^{137}Cs Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
July 2020				
1st week	1.77E+00	9.46E-01	3.10E+00	Not detected
2nd week	1.74E+00	7.98E-01	2.60E+00	Not detected
3rd week	2.07E-01	6.26E-01	2.09E+00	Not detected
4th week	4.59E-01	2.99E-01	9.86E-01	Not detected
August 2020				
1st week	9.20E-01	5.56E-01	1.83E+00	Not detected
2nd week	5.10E+00	1.00E+01	3.41E+01	Not detected
3rd week	-1.76E+00	1.02E+01	3.49E+01	Not detected
4th week	5.06E+00	1.25E+01	4.24E+01	Not detected
September 2020				
1st week	1.09E+00	6.49E-01	2.13E+00	Not detected
2nd week	6.98E-01	4.21E-01	1.38E+00	Not detected
3rd week	-1.20E+00	4.00E-01	1.41E+00	Not detected
4th week	-5.87E-01	2.95E-01	1.02E+00	Not Detected
October 2020				
1st week	-9.79E-01	4.32E-01	1.51E+00	Not detected
2nd week	3.65E-01	1.64E-01	5.34E-01	Not detected
3rd week	3.79E-01	2.67E-01	8.82E-01	Not detected
4th week	-8.60E-01	5.02E-01	1.73E+00	Not detected
November 2020				
1st week	-3.85E-01	5.30E-01	1.80E+00	Not detected
2nd week	8.61E-01	9.39E-01	3.12E+00	Not detected
3rd week	-8.66E-02	7.28E-01	2.51E+00	Not detected
4th week	-3.32E+00	1.40E+00	4.91E+00	Not detected
December 2020				
1st week	1.65E+00	6.91E-01	2.25E+00	Not detected
2nd week	3.63E-01	4.93E-01	1.65E+00	Not detected
3rd week	8.88E-01	6.61E-01	2.18E+00	Not detected
4th week	4.42E+00	1.40E+00	4.46E+00	Not detected

Table A.13. Specific activity of ^{40}K (Bq/g) at Station A

Sample Date	^{40}K Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
January 2020				
1st week	-1.46E+00	9.79E-01	3.44E+00	Not detected
2nd week	1.26E+00	1.36E+00	4.54E+00	Not detected
3rd week	-7.22E-02	9.06E-01	3.09E+00	Not detected
4th week	1.61E+00	1.27E+00	4.20E+00	Not detected
February 2020				
1st week	1.61E+00	2.41E+00	8.07E+00	Not detected
2nd week	-5.10E-01	3.57E+00	1.22E+01	Not detected
3rd week	-2.05E+00	2.91E+00	1.01E+01	Not detected
4th week	-4.23E-01	1.63E+00	5.62E+00	Not detected
March 2020				
1st week	-3.00E+00	3.70E+00	1.29E+01	Not detected
2nd week	-5.77E+01	3.67E+01	1.29E+02	Not detected
3rd week	2.77E+00	5.27E+00	1.78E+01	Not detected
4th week	-1.31E+00	2.45E+00	8.54E+00	Not detected
April 2020				
1st week	-3.92E-01	5.77E+00	1.97E+01	Not detected
2nd week	-5.47E+00	7.64E+00	2.64E+01	Not detected
3rd week	2.92E+00	4.22E+00	1.42E+01	Not detected
4th week	-2.38E+00	3.02E+00	1.05E+01	Not detected
May 2020				
1st week	-8.46E+00	5.87E+00	2.06E+01	Not detected
2nd week	6.88E-01	3.27E+00	1.12E+01	Not detected
3rd week	-2.35E+00	6.12E+00	2.10E+01	Not detected
4th week	8.36E+00	5.50E+00	1.81E+01	Not detected
June 2020				
1st week	-1.68E+01	1.33E+01	4.67E+01	Not detected
2nd week	4.46E+00	1.16E+01	3.94E+01	Not detected
3rd week	1.05E+01	1.13E+01	3.77E+01	Not detected
4th week	1.39E+00	7.55E+00	2.56E+01	Not detected

Table A.13. Specific activity of ^{40}K (Bq/g) at Station A (continued)

Sample Date	^{40}K Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
July 2020				
1st week	2.28E+01	1.42E+01	4.67E+01	Not detected
2nd week	-1.51E+01	8.21E+00	2.94E+01	Not detected
3rd week	5.22E-01	5.23E+00	1.78E+01	Not detected
4th week	2.85E+00	4.55E+00	1.53E+01	Not detected
August 2020				
1st week	-2.55E+00	8.65E+00	2.95E+01	Not detected
2nd week	5.10E+00	1.00E+01	3.41E+01	Not detected
3rd week	-1.76E+00	1.02E+01	3.49E+01	Not detected
4th week	5.06E+00	1.25E+01	4.24E+01	Not detected
September 2020				
1st week	-4.44E+00	8.99E+00	3.09E+01	Not detected
2nd week	6.82E+00	5.31E+00	1.76E+01	Not detected
3rd week	1.43E+00	4.11E+00	1.39E+01	Not detected
4th week	-1.44E+00	3.83E+00	1.31E+01	Not detected
October 2020				
1st week	-5.02E-01	4.28E+00	1.47E+01	Not detected
2nd week	-3.77E+00	2.21E+00	7.81E+00	Not detected
3rd week	1.32E+00	3.36E+00	1.14E+01	Not detected
4th week	7.51E+00	5.06E+00	1.67E+01	Not detected
November 2020				
1st week	1.81E+00	4.94E+00	1.67E+01	Not detected
2nd week	-4.82E+00	1.16E+01	3.98E+01	Not detected
3rd week	1.29E+00	1.05E+01	3.62E+01	Not detected
4th week	1.94E+01	1.92E+01	6.38E+01	Not detected
December 2020				
1st week	-4.97E+00	7.74E+00	2.67E+01	Not detected
2nd week	2.76E+00	6.23E+00	2.12E+01	Not detected
3rd week	-3.40E+00	1.06E+01	3.60E+01	Not detected
4th week	8.31E-01	1.32E+01	4.52E+01	Not detected

Table A.14. Specific activity of ^{60}Co (Bq/g) at Station A

Sample Date	^{60}Co Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
January 2020				
1st week	2.04E-02	6.90E-02	2.36E-01	Not detected
2nd week	8.60E-02	7.83E-02	2.62E-01	Not detected
3rd week	8.66E-02	5.61E-02	1.85E-01	Not detected
4th week	1.51E-01	8.60E-02	2.82E-01	Not detected
February 2020				
1st week	2.47E-01	1.48E-01	4.85E-01	Not detected
2nd week	1.85E-01	2.11E-01	7.10E-01	Not detected
3rd week	4.28E-01	1.80E-01	5.78E-01	Not detected
4th week	3.19E-02	1.10E-01	3.78E-01	Not detected
March 2020				
1st week	4.14E-01	2.67E-01	8.80E-01	Not detected
2nd week	4.68E+00	2.57E+00	8.39E+00	Not detected
3rd week	9.19E-01	4.60E-01	1.50E+00	Not detected
4th week	4.04E-01	1.79E-01	5.73E-01	Not detected
April 2020				
1st week	2.33E-01	3.78E-01	1.28E+00	Not detected
2nd week	2.40E-01	4.57E-01	1.56E+00	Not detected
3rd week	-4.67E-01	-4.67E-01	2.87E-01	Not detected
4th week	1.57E-01	1.84E-01	6.20E-01	Not detected
May 2020				
1st week	-2.01E-01	3.54E-01	1.25E+00	Not detected
2nd week	7.50E-02	2.29E-01	7.88E-01	Not detected
3rd week	4.35E-01	4.63E-01	1.55E+00	Not detected
4th week	2.76E-01	3.33E-01	1.13E+00	Not detected
June 2020				
1st week	1.67E+00	1.12E+00	3.69E+00	Not detected
2nd week	8.01E-01	7.94E-01	2.66E+00	Not detected
3rd week	9.22E-01	7.44E-01	2.48E+00	Not detected
4th week	-7.11E-02	3.98E-01	1.39E+00	Not detected

Table A.14. Specific activity of ^{60}Co (Bq/g) at Station A (continued)

Sample Date	^{60}Co Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
July 2020				
1st week	2.63E-01	7.81E-01	2.68E+00	Not detected
2nd week	-5.82E-01	5.58E-01	2.00E+00	Not detected
3rd week	-6.53E-02	3.28E-01	1.15E+00	Not detected
4th week	1.81E-01	2.94E-01	9.94E-01	Not detected
August 2020				
1st week	5.49E-01	4.73E-01	1.58E+00	Not detected
2nd week	-1.72E-01	6.73E-01	2.37E+00	Not detected
3rd week	1.13E+00	6.70E-01	2.20E+00	Not detected
4th week	2.78E-02	7.14E-01	2.48E+00	Not detected
September 2020				
1st week	7.51E-01	7.01E-01	2.34E+00	Not detected
2nd week	2.50E-01	3.97E-01	1.35E+00	Not detected
3rd week	2.47E-01	2.47E-01	8.29E-01	Not detected
4th week	1.27E-01	2.60E-01	8.82E-01	Not detected
October 2020				
1st week	3.91E-01	2.64E-01	8.71E-01	Not detected
2nd week	1.78E-01	1.32E-01	4.37E-01	Not detected
3rd week	-3.20E-01	2.02E-01	7.41E-01	Not detected
4th week	3.98E-01	3.17E-01	1.05E+00	Not detected
November 2020				
1st week	3.72E-02	2.90E-01	1.01E+00	Not detected
2nd week	1.45E+00	6.71E-01	2.16E+00	Not detected
3rd week	7.21E-01	7.45E-01	2.51E+00	Not detected
4th week	1.71E+00	1.04E+00	3.41E+00	Not detected
December 2020				
1st week	-6.40E-01	4.71E-01	1.70E+00	Not detected
2nd week	-4.10E-01	4.04E-01	1.46E+00	Not detected
3rd week	1.33E+00	5.85E-01	1.88E+00	Not detected
4th week	4.38E-02	8.62E-01	3.01E+00	Not detected

Table A.15. Activity concentrations of ^{241}Am (Bq/m^3) at Station B

Radionuclide	Sample Date	^{241}Am Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{241}Am	January	4.77E-07	3.22E-07	3.93E-07	Detected
	February	1.87E-06	6.73E-07	4.88E-07	Detected
	March	1.88E-06	7.37E-07	7.31E-07	Detected
	April	4.00E-07	3.08E-07	3.91E-07	Detected
	May	1.61E-06	5.87E-07	3.85E-07	Detected
	June	3.81E-06	1.05E-06	4.86E-07	Detected
	July	2.64E-06	8.25E-07	5.14E-07	Detected
	August	1.30E-06	5.50E-07	4.98E-07	Detected
	September	1.83E-06	6.83E-07	2.79E-07	Detected
	October	2.24E-06	7.36E-07	4.73E-07	Detected
	November	3.00E-06	1.04E-06	6.79E-07	Detected
	December	1.92E-06	6.69E-07	4.47E-07	Detected

Table A.16. Activity concentrations of $^{239+240}Pu$ (Bq/m^3) at Station B

Radionuclide	Sample Date	$^{239+240}Pu$ Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
$^{239+240}Pu$	January	1.72E-07	1.99E-07	3.53E-07	Not detected
	February	1.67E-07	2.09E-07	3.05E-07	Not detected
	March	2.28E-07	2.56E-07	4.19E-07	Not detected
	April	8.22E-08	1.49E-07	3.05E-07	Not detected
	May	2.33E-07	2.25E-07	3.26E-07	Not detected
	June	3.33E-07	3.81E-07	6.21E-07	Not detected
	July	2.91E-07	2.97E-07	4.76E-07	Not detected
	August	-9.72E-08	1.23E-07	5.60E-07	Not detected
	September	3.50E-07	4.77E-07	9.42E-07	Not detected
	October	7.28E-07	5.47E-07	6.45E-07	Detected
	November	3.36E-08	1.17E-07	3.32E-07	Not Detected
	December	-7.16E-08	2.31E-07	8.26E-07	Not detected

Table A.17. Activity concentrations of ^{238}Pu (Bq/m^3) at Station B

Radionuclide	Sample Date	^{238}Pu Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{238}Pu	January	-9.57E-08	1.14E-07	4.75E-07	Not detected
	February	0.00E+00	1.62E-07	5.18E-07	Not detected
	March	9.11E-08	1.65E-07	3.38E-07	Not detected
	April	-3.08E-08	1.09E-07	3.42E-07	Not detected
	May	-8.98E-08	1.07E-07	4.45E-07	Not detected
	June	-2.38E-08	1.35E-07	5.20E-07	Not detected
	July	5.13E-08	2.58E-07	7.47E-07	Not detected
	August	-1.55E-07	1.33E-07	6.39E-07	Not detected
	September	-1.85E-07	2.41E-07	9.82E-07	Not detected
	October	0.00E+00	2.75E-07	8.80E-07	Not detected
	November	-2.24E-08	1.17E-07	3.32E-07	Not detected
	December	2.00E-07	2.51E-07	3.57E-07	Not detected

Table A.18. Specific activity of ^{241}Am (Bq/g) at Station B

Radionuclide	Sample Date	^{241}Am Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{241}Am	January	1.30E-01	8.77E-02	1.07E-01	Detected
	February	3.67E-01	1.32E-01	9.58E-02	Detected
	March	3.97E-01	1.56E-01	1.55E-01	Detected
	April	4.54E-02	3.50E-02	4.43E-02	Detected
	May	1.57E-01	5.71E-02	3.75E-02	Detected
	June	7.14E-01	1.96E-01	9.10E-02	Detected
	July	3.54E-01	1.11E-01	6.88E-02	Detected
	August	4.33E-01	1.83E-01	1.66E-01	Detected
	September	6.32E-01	2.36E-01	9.62E-02	Detected
	October	5.36E-01	1.76E-01	1.13E-01	Detected
	November	6.59E-01	2.30E-01	1.49E-01	Detected
	December	7.15E-01	2.49E-01	1.66E-01	Detected

Table A.19. Specific activity of $^{239+240}Pu$ (Bq/g) at Station B

Radionuclide	Sample Date	$^{239+240}Pu$ Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
$^{239+240}Pu$	January	4.24E-02	5.43E-02	9.64E-02	Not Detected
	February	3.64E-02	4.11E-02	5.99E-02	Not Detected
	March	4.81E-02	5.42E-02	8.86E-02	Not Detected
	April	9.33E-03	1.69E-02	3.46E-02	Not Detected
	May	2.27E-02	2.19E-02	3.17E-02	Not Detected
	June	5.94E-02	7.14E-02	1.16E-01	Not Detected
	July	4.09E-02	3.98E-02	6.39E-02	Not Detected
	August	-3.24E-02	4.11E-02	1.87E-01	Not Detected
	September	1.21E-01	1.65E-01	3.25E-01	Not Detected
	October	1.74E-01	1.31E-01	1.54E-01	Detected
	November	-1.63E-02	2.56E-02	7.32E-02	Not Detected
	December	1.21E-02	8.60E-02	3.08E-01	Not Detected

Table A.20. Specific activity of ^{238}Pu (Bq/g) at Station B

Radionuclide	Sample Date	^{238}Pu Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{238}Pu	January	-2.61E-02	3.10E-02	1.29E-01	Not Detected
	February	0.00E+00	3.18E-02	1.02E-01	Not Detected
	March	1.93E-02	3.48E-02	7.14E-02	Not Detected
	April	-3.50E-03	1.23E-02	3.88E-02	Not Detected
	May	-8.74E-03	1.04E-02	4.33E-02	Not Detected
	June	-4.46E-03	2.52E-02	9.74E-02	Not Detected
	July	6.87E-03	3.46E-02	1.00E-01	Not Detected
	August	-5.18E-02	4.44E-02	2.13E-01	Not Detected
	September	-6.38E-02	8.32E-02	3.39E-01	Not Detected
	October	0.00E+00	6.58E-02	2.11E-01	Not Detected
	November	-4.93E-03	2.56E-02	7.32E-02	Not Detected
	December	7.45E-02	9.35E-02	1.33E-01	Not Detected

Table A.21. Activity concentrations of U isotopes at Station B

Radionuclide	Sample Date	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{234}U	January	5.62E-14	3.44E-07	8.80E-07	Not Detected
	February	3.38E-07	5.03E-07	1.14E-06	Not Detected
	March	3.32E-07	4.85E-07	1.10E-06	Not Detected
	April	3.36E-08	2.60E-07	6.76E-07	Not Detected
	May	2.61E-07	3.21E-07	6.97E-07	Not Detected
	June	3.07E-07	3.00E-07	5.95E-07	Not Detected
	July	-1.85E-07	2.81E-07	8.50E-07	Not Detected
	August	2.35E-07	2.36E-07	4.65E-07	Not Detected
	September	-4.45E-14	3.96E-07	1.05E-06	Not Detected
	October	-7.89E-08	3.53E-07	9.68E-07	Not Detected
	November	6.54E-08	2.99E-07	7.53E-07	Not Detected
	December	6.33E-08	3.35E-07	8.36E-07	Not Detected
^{235}U	January	3.15E-07	4.69E-07	1.06E-06	Not Detected
	February	1.19E-07	2.06E-07	4.39E-07	Not Detected
	March	6.14E-07	4.39E-07	7.23E-07	Not Detected
	April	8.30E-08	2.03E-07	4.98E-07	Not Detected
	May	8.08E-08	1.61E-07	3.75E-07	Not Detected
	June	-1.01E-14	2.06E-07	5.94E-07	Not Detected
	July	1.30E-07	2.95E-07	7.07E-07	Not Detected
	August	3.62E-08	1.25E-07	3.36E-07	Not Detected
	September	-1.15E-07	2.82E-07	9.13E-07	Not Detected
	October	4.87E-08	3.51E-07	9.16E-07	Not Detected
	November	-2.09E-09	2.13E-07	6.14E-07	Not Detected
	December	-1.56E-07	2.71E-07	8.32E-07	Not Detected

Table A.21. Activity concentrations of U isotopes at Station B (continued)

Radionuclide	Sample Date	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{238}U	January	-2.34E-07	3.23E-07	9.21E-07	Not Detected
	February	-2.40E-07	5.19E-07	1.43E-06	Not Detected
	March	-2.05E-07	4.30E-07	1.20E-06	Not Detected
	April	-3.34E-08	2.91E-07	7.87E-07	Not Detected
	May	-2.28E-07	2.53E-07	8.00E-07	Not Detected
	June	6.80E-08	2.89E-07	7.25E-07	Not Detected
	July	3.17E-08	2.78E-07	7.24E-07	Not Detected
	August	-5.84E-08	2.19E-07	6.23E-07	Not Detected
	September	-2.32E-07	4.47E-07	1.27E-06	Not Detected
	October	-1.18E-07	3.24E-07	9.24E-07	Not Detected
	November	-3.23E-07	3.67E-07	1.08E-06	Not Detected
	December	-3.15E-08	2.75E-07	7.41E-07	Not Detected

Table A.22. Specific activity of U isotopes at Station B

Radionuclide	Sample Date	Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{234}U	January	1.53E-08	9.36E-02	2.40E-01	Not Detected
	February	6.65E-02	9.89E-02	2.23E-01	Not Detected
	March	7.01E-02	1.03E-01	2.32E-01	Not Detected
	April	3.81E-03	2.95E-02	7.67E-02	Not Detected
	May	2.54E-02	3.12E-02	6.78E-02	Not Detected
	June	5.76E-02	5.62E-02	1.11E-01	Not Detected
	July	-2.47E-02	3.76E-02	1.14E-01	Not Detected
	August	7.82E-02	7.87E-02	1.55E-01	Not Detected
	September	-1.53E-08	1.37E-01	3.61E-01	Not Detected
	October	-1.89E-02	8.45E-02	2.32E-01	Not Detected
	November	1.44E-02	6.58E-02	1.66E-01	Not Detected
	December	2.36E-02	1.25E-01	3.11E-01	Not Detected

Table A.22. Specific activity of U isotopes at Station B (continued)

Radionuclide	Sample Date	Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{235}U	January	8.59E-02	1.28E-01	2.88E-01	Not Detected
	February	2.35E-02	4.04E-02	8.62E-02	Not Detected
	March	1.30E-01	9.28E-02	1.53E-01	Not Detected
	April	9.42E-03	2.30E-02	5.65E-02	Not Detected
	May	7.86E-03	1.57E-02	3.64E-02	Not Detected
	June	-1.88E-09	3.87E-02	1.11E-01	Not Detected
	July	1.74E-02	3.95E-02	9.47E-02	Not Detected
	August	1.21E-02	4.18E-02	1.12E-01	Not Detected
	September	-3.97E-02	9.73E-02	3.15E-01	Not Detected
	October	1.17E-02	8.40E-02	2.19E-01	Not Detected
	November	-4.60E-04	4.69E-02	1.35E-01	Not Detected
	December	-5.81E-02	1.01E-01	3.10E-01	Not Detected
^{238}U	January	-6.39E-02	8.80E-02	2.51E-01	Not Detected
	February	-4.71E-02	1.02E-01	2.82E-01	Not Detected
	March	-4.34E-02	9.08E-02	2.54E-01	Not Detected
	April	-3.79E-03	3.31E-02	8.93E-02	Not Detected
	May	-2.21E-02	2.46E-02	7.78E-02	Not Detected
	June	1.27E-02	5.41E-02	1.36E-01	Not Detected
	July	4.24E-03	3.72E-02	9.70E-02	Not Detected
	August	-1.95E-02	7.29E-02	2.07E-01	Not Detected
	September	-8.01E-02	1.54E-01	4.38E-01	Not Detected
	October	-2.82E-02	7.76E-02	2.21E-01	Not Detected
	November	-7.12E-02	8.09E-02	2.37E-01	Not Detected
	December	-1.17E-02	1.02E-01	2.76E-01	Not Detected

Table A.23. Activity concentrations of ^{137}Cs (Bq/m^3) at Station B

Radionuclide	Sample Date	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{137}Cs	January	-1.11E-05	9.91E-06	3.40E-05	Not detected
	February	-3.62E-08	7.83E-06	2.67E-05	Not detected
	March	-5.49E-07	9.52E-06	3.24E-05	Not detected
	April	-2.53E-05	1.05E-05	3.67E-05	Not detected
	May	-1.33E-05	1.13E-05	3.85E-05	Not detected
	June	1.78E-05	1.18E-05	3.88E-05	Not detected
	July	-1.83E-05	9.70E-06	3.37E-05	Not detected
	August	-1.78E-05	1.01E-05	3.50E-05	Not detected
	September	-3.59E-05	1.27E-05	4.42E-05	Not detected
	October	-3.12E-05	9.21E-06	3.28E-05	Not detected
	November	1.60E-05	8.39E-06	2.74E-05	Not detected
	December	-3.06E-05	1.15E-05	3.99E-05	Not detected

Table A.24. Activity concentrations of ^{40}K (Bq/m^3) at Station B

Radionuclide	Sample Date	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{40}K	January	-4.17E-05	9.81E-05	3.38E-04	Not detected
	February	-4.36E-05	1.44E-04	4.93E-04	Not detected
	March	-4.25E-05	1.48E-04	5.07E-04	Not detected
	April	7.90E-05	1.14E-04	3.83E-04	Not detected
	May	4.86E-05	1.11E-04	3.74E-04	Not detected
	June	-3.15E-04	1.09E-04	4.03E-04	Not detected
	July	-3.48E-05	1.02E-04	3.51E-04	Not detected
	August	-2.95E-05	1.01E-04	3.47E-04	Not detected
	September	1.18E-04	1.12E-04	3.74E-04	Not detected
	October	4.76E-05	9.97E-05	3.37E-04	Not detected
	November	-4.08E-05	1.36E-04	4.65E-04	Not detected
	December	1.13E-05	1.08E-04	3.67E-04	Not detected

Table A.25. Activity concentrations of ^{60}Co (Bq/m^3) at Station B

Radionuclide	Sample Date	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{60}Co	January	4.50E-06	8.30E-06	2.81E-05	Not detected
	February	-7.70E-06	7.49E-06	2.69E-05	Not detected
	March	-3.15E-06	9.28E-06	3.24E-05	Not detected
	April	4.07E-05	1.04E-05	3.25E-05	Detected
	May	2.30E-06	6.33E-06	2.17E-05	Not detected
	June	3.46E-06	7.63E-06	2.62E-05	Not detected
	July	-3.23E-06	5.79E-06	2.05E-05	Not detected
	August	2.21E-05	6.86E-06	2.14E-05	Detected
	September	-4.90E-06	7.11E-06	2.50E-05	Not detected
	October	2.25E-06	6.44E-06	2.21E-05	Not detected
	November	4.59E-06	7.62E-06	2.59E-05	Not detected
	December	3.06E-06	8.18E-06	2.78E-05	Not detected

Table A.26. Monthly specific activity of ^{137}Cs (Bq/g) in Station B (post-HEPA) filters in 2020

Radionuclide	Sample Date	Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{137}Cs	January	-3.02E+00	2.70E+00	9.28E+00	Not detected
	February	-7.12E-03	1.54E+00	5.25E+00	Not detected
	March	-1.16E-01	2.01E+00	6.85E+00	Not detected
	April	-2.87E+00	1.19E+00	4.16E+00	Not detected
	May	-1.29E+00	1.10E+00	3.74E+00	Not detected
	June	3.34E+00	2.21E+00	7.27E+00	Not detected
	July	-2.45E+00	1.30E+00	4.52E+00	Not detected
	August	-5.92E+00	3.37E+00	1.17E+01	Not detected
	September	-1.24E+01	4.39E+00	1.52E+01	Not detected
	October	-7.48E+00	2.20E+00	7.85E+00	Not detected
	November	3.52E+00	1.85E+00	6.04E+00	Not detected
	December	-1.14E+01	4.27E+00	1.49E+01	Not detected

Table A.27. Specific activity of ^{40}K (Bq/g) at Station B

Radionuclide	Sample Date	Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{40}K	January	-1.14E+01	2.67E+01	9.22E+01	Not detected
	February	-8.58E+00	2.84E+01	9.69E+01	Not detected
	March	-8.98E+00	3.13E+01	1.07E+02	Not detected
	April	8.96E+00	1.30E+01	4.35E+01	Not detected
	May	4.73E+00	1.08E+01	3.64E+01	Not detected
	June	-5.90E+01	2.03E+01	7.55E+01	Not detected
	July	-4.66E+00	1.37E+01	4.71E+01	Not detected
	August	-9.83E+00	3.36E+01	1.16E+02	Not detected
	September	4.07E+01	3.87E+01	1.29E+02	Not detected
	October	1.14E+01	2.39E+01	8.06E+01	Not detected
	November	-8.98E+00	3.00E+01	1.02E+02	Not detected
	December	4.21E+00	4.02E+01	1.37E+02	Not detected

Table A.28. Specific activity of ^{60}Co (Bq/g) at Station B

Radionuclide	Sample Date	Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{60}Co	January	1.23E+00	2.26E+00	7.65E+00	Not detected
	February	-1.51E+00	1.47E+00	5.29E+00	Not detected
	March	-6.66E-01	1.96E+00	6.86E+00	Not detected
	April	4.62E+00	1.18E+00	3.69E+00	Detected
	May	2.23E-01	6.16E-01	2.11E+00	Not detected
	June	6.49E-01	1.43E+00	4.91E+00	Not detected
	July	-4.33E-01	7.76E-01	2.75E+00	Not detected
	August	7.37E+00	2.29E+00	7.12E+00	Detected
	September	-1.69E+00	2.45E+00	8.63E+00	Not detected
	October	5.38E-01	1.54E+00	5.29E+00	Not detected
	November	1.01E+00	1.68E+00	5.70E+00	Not detected
	December	1.14E+00	3.04E+00	1.03E+01	Not detected

Table A.29. Activity concentrations of ^{90}Sr (Bq/m^3) at Station A

Sample Date	^{90}Sr Activity Bq/m^3	Unc. (2-sig) Bq/m^3	MDC Bq/m^3	Status
January 2020				
1st week	6.89E-03	7.29E-04	1.31E-02	Not detected
2nd week	6.95E-03	7.57E-04	1.32E-02	Not detected
3rd week	6.92E-03	7.50E-04	1.31E-02	Not detected
4th week	5.21E-03	5.33E-04	9.14E-03	Not detected
February 2020				
1st week	6.06E-03	6.87E-04	1.31E-02	Not detected
2nd week	7.25E-03	7.61E-04	1.32E-02	Not detected
3rd week	7.41E-03	7.66E-04	1.30E-02	Not detected
4th week	6.28E-03	6.66E-04	1.05E-02	Not detected
March 2020				
1st week	6.81E-03	7.18E-04	1.18E-02	Not detected
2nd week	2.39E-02	2.58E-03	4.14E-02	Not detected
3rd week	6.84E-03	7.58E-04	1.29E-02	Not detected
4th week	4.57E-03	4.93E-04	8.61E-03	Not detected
April 2020				
1st week	8.28E-03	8.06E-04	1.20E-02	Not detected
2nd week	7.04E-03	7.46E-04	1.17E-02	Not detected
3rd week	8.61E-03	8.24E-04	1.20E-02	Not detected
4th week	5.54E-03	5.93E-04	9.23E-03	Not detected
May 2020				
1st week	7.19E-03	7.53E-04	1.20E-02	Not detected
2nd week	8.33E-03	8.13E-04	1.20E-02	Not detected
3rd week	5.72E-03	6.65E-04	1.16E-02	Not detected
4th week	4.23E-03	4.77E-04	8.19E-03	Not detected
June 2020				
1st week	7.74E-03	7.80E-04	1.18E-02	Not detected
2nd week	1.07E-02	1.04E-03	1.52E-02	Not detected
3rd week	9.58E-03	8.87E-04	1.17E-02	Not detected
4th week	5.59E-03	5.82E-04	9.16E-03	Not detected

Table A.29. Activity concentrations of ^{90}Sr (Bq/m^3) at Station A (continued)

Sample Date	^{90}Sr Activity Bq/m^3	Unc. (2-sig) Bq/m^3	MDC Bq/m^3	Status
July 2020				
1st week	6.31E-03	6.77E-04	1.17E-02	Not detected
2nd week	9.57E-03	9.03E-04	1.17E-02	Not detected
3rd week	8.82E-03	8.54E-04	1.17E-02	Not detected
4th week	6.06E-03	5.81E-04	8.33E-03	Not detected
August 2020				
1st week	7.40E-03	7.65E-04	1.17E-02	Not detected
2nd week	-	-	-	-
3rd week	-	-	-	-
4th week	-	-	-	-
September 2020				
1st week	-	-	-	-
2nd week	7.14E-03	7.31E-04	1.23E-02	Not detected
3rd week	7.44E-03	7.50E-04	1.23E-02	Not detected
4th week	5.39E-03	5.80E-04	9.65E-03	Not detected
October 2020				
1st week	6.84E-03	7.20E-04	1.22E-02	Not detected
2nd week	6.89E-03	7.26E-04	1.23E-02	Not detected
3rd week	6.29E-03	6.99E-04	1.22E-02	Not detected
4th week	5.42E-03	5.41E-04	8.67E-03	Not detected
November 2020				
1st week	9.55E-03	8.66E-04	1.22E-02	Not detected
2nd week	6.89E-03	7.27E-04	1.23E-02	Not detected
3rd week	7.41E-03	7.68E-04	1.23E-02	Not detected
4th week	5.81E-03	5.88E-04	9.63E-03	Not detected
December 2020				
1st week	7.05E-03	7.14E-04	1.12E-02	Not detected
2nd week	6.07E-03	6.78E-04	1.13E-02	Not detected
3rd week	7.44E-03	7.61E-04	1.13E-02	Not detected
4th week	4.20E-03	4.67E-04	7.84E-03	Not detected

Table A.30. Activity concentrations of ^{90}Sr (Bq/m^3) at Station A

Sample Date	^{90}Sr Activity Bq/g	Unc. (2-sig) Bq/g	MDC Bq/g	Status
January 2020				
1st week	1.27E+01	1.35E+00	2.41E+01	Not detected
2nd week	2.01E+01	2.18E+00	3.80E+01	Not detected
3rd week	1.10E+01	1.20E+00	2.09E+01	Not detected
4th week	1.82E+01	1.86E+00	3.20E+01	Not detected
February 2020				
1st week	2.57E+01	2.91E+00	5.53E+01	Not detected
2nd week	4.49E+01	4.71E+00	8.18E+01	Not detected
3rd week	3.99E+01	4.12E+00	7.00E+01	Not detected
4th week	2.36E+01	2.50E+00	3.94E+01	Not detected
March 2020				
1st week	5.11E+01	5.38E+00	8.86E+01	Not detected
2nd week	4.78E+02	5.16E+01	8.29E+02	Not detected
3rd week	7.21E+01	7.98E+00	1.36E+02	Not detected
4th week	3.33E+01	3.59E+00	6.27E+01	Not detected
April 2020				
1st week	9.93E+01	9.68E+00	1.43E+02	Not detected
2nd week	1.00E+02	1.06E+01	1.67E+02	Not detected
3rd week	6.80E+01	6.51E+00	9.50E+01	Not detected
4th week	4.08E+01	4.37E+00	6.80E+01	Not detected
May 2020				
1st week	7.96E+01	8.34E+00	1.33E+02	Not detected
2nd week	5.80E+01	5.66E+00	8.37E+01	Not detected
3rd week	6.14E+01	7.15E+00	1.25E+02	Not detected
4th week	6.51E+01	7.35E+00	1.26E+02	Not detected
June 2020				
1st week	1.94E+02	1.96E+01	2.96E+02	Not detected
2nd week	1.94E+02	1.90E+01	2.75E+02	Not detected
3rd week	2.44E+02	2.26E+01	2.97E+02	Not detected
4th week	8.95E+01	9.32E+00	1.47E+02	Not detected

Table A.30. Specific activity of ^{90}Sr (Bq/g) at Station A (continued)

Sample Date	^{90}Sr Activity Bq/g	Unc. (2-sig) Bq/g	MDC Bq/g	Status
July 2020				
1st week	1.52E+02	1.63E+01	2.82E+02	Not detected
2nd week	1.59E+02	1.50E+01	1.94E+02	Not detected
3rd week	1.03E+02	1.00E+01	1.38E+02	Not detected
4th week	6.61E+01	6.34E+00	9.09E+01	Not detected
August 2020				
1st week	1.08E+02	1.11E+01	1.70E+02	Not detected
2nd week	-	-	-	-
3rd week	-	-	-	-
4th week	-	-	-	-
September 2020				
1st week	-	-	-	-
2nd week	7.70E+01	7.90E+00	1.33E+02	Not detected
3rd week	6.88E+01	6.93E+00	1.14E+02	Not detected
4th week	4.66E+01	5.01E+00	8.34E+01	Not detected
October 2020				
1st week	6.86E+01	7.23E+00	1.23E+02	Not detected
2nd week	2.81E+01	2.96E+00	5.02E+01	Not detected
3rd week	3.99E+01	4.43E+00	7.75E+01	Not detected
4th week	8.34E+01	8.32E+00	1.33E+02	Not detected
November 2020				
1st week	1.07E+02	9.68E+00	1.37E+02	Not detected
2nd week	1.42E+02	1.50E+01	2.55E+02	Not detected
3rd week	1.74E+02	1.80E+01	2.88E+02	Not detected
4th week	2.58E+02	2.60E+01	4.27E+02	Not detected
December 2020				
1st week	1.01E+02	1.02E+01	1.59E+02	Not detected
2nd week	8.25E+01	9.22E+00	1.54E+02	Not detected
3rd week	1.27E+02	1.30E+01	1.94E+02	Not detected
4th week	1.74E+02	1.94E+01	3.25E+02	Not detected

Table A.31. Activity concentrations of ^{90}Sr (Bq/m^3) at Station B

Radionuclide	Sample Date	^{90}Sr Activity Bq/m^3	Unc.(2-sig) Bq/m^3	MDC Bq/m^3	Status
^{90}Sr	January	1.80E-03	1.83E-04	2.91E-03	Not detected
	February	1.73E-03	1.80E-04	3.12E-03	Not detected
	March	1.65E-03	1.81E-04	3.52E-03	Not detected
	April	1.54E-03	1.64E-04	3.01E-03	Not detected
	May	1.42E-03	1.57E-04	2.90E-03	Not detected
	June	1.96E-03	1.92E-04	3.18E-03	Not detected
	July	1.61E-03	1.66E-04	2.91E-03	Not detected
	August	1.80E-03	1.79E-04	2.91E-03	Not detected
	September	1.92E-03	1.90E-04	3.04E-03	Not detected
	October	1.55E-03	1.66E-04	2.94E-03	Not detected
	November	1.41E-03	1.61E-04	3.04E-03	Not detected
	December	1.55E-03	1.67E-04	2.94E-03	Not detected

Table A.32. Specific activity of ^{90}Sr (Bq/g) at Station B

Radionuclide	Sample Date	^{90}Sr Activity Bq/g	Unc.(2-sig) Bq/g	MDC Bq/g	Status
^{90}Sr	January	4.90E+02	4.98E+01	7.93E+02	Not detected
	February	3.40E+02	3.53E+01	6.14E+02	Not detected
	March	3.49E+02	3.82E+01	7.45E+02	Not detected
	April	1.75E+02	1.86E+01	3.41E+02	Not detected
	May	1.39E+02	1.53E+01	2.83E+02	Not detected
	June	3.68E+02	3.60E+01	5.95E+02	Not detected
	July	2.16E+02	2.22E+01	3.90E+02	Not detected
	August	6.00E+02	5.96E+01	9.70E+02	Not detected
	September	6.63E+02	6.57E+01	1.05E+03	Not detected
	October	3.71E+02	3.98E+01	7.04E+02	Not detected
	November	3.10E+02	3.54E+01	6.68E+02	Not detected
	December	5.77E+02	6.20E+01	1.09E+03	Not detected

APPENDIX B - AIRBORNE PARTICULATE MONITORING

Actinide concentrations and specific activities at six monitoring stations around WIPP

Uranium concentrations and specific activities at six monitoring stations around WIPP

Gamma radionuclide concentrations and specific activities at six monitoring stations around WIPP

Strontium concentrations and specific activities at six monitoring stations around WIPP

Table B.1. Activity concentrations of $^{239+240}Pu$ at Onsite station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
$^{239+240}Pu$	Jan. 10 – Jan. 31	-5.04E-09	1.01E-08	2.96E-08	Not detected
	Jan. 31 – Feb. 21	-4.06E-09	8.14E-09	2.39E-08	Not detected
	Feb. 21 – Mar. 18	1.83E-09	7.34E-09	1.84E-08	Not detected
	Mar. 18 – Apr. 3	7.44E-09	1.08E-08	2.36E-08	Not detected
	Apr. 3 – Apr. 30	1.33E-08	9.01E-09	1.44E-08	Not detected
	Apr. 30 – May. 19	1.27E-08	1.21E-08	2.49E-08	Not detected
	May 19 – Jun. 11	2.18E-08	1.18E-08	1.73E-08	Detected
	Jun. 11 – Jul. 2	-1.71E-09	1.50E-08	4.03E-08	Not detected
	Jul. 2 – Jul. 30	0.00E+00	1.31E-08	3.50E-08	Not detected
	Jul. 30 – Aug. 20	6.74E-09	1.18E-08	2.71E-08	Not detected
	Aug. 20 – Sep. 3	7.49E-09	1.08E-08	2.38E-08	Not detected
	Sep. 3 – Oct. 1	2.58E-08	1.17E-08	1.61E-08	Detected
	Oct. 1 – Oct. 15	3.64E-08	2.88E-08	5.54E-08	Not detected
	Oct. 15 – Nov. 10	2.61E-08	1.08E-08	1.23E-08	Detected
	Nov. 10 – Dec. 8	1.84E-09	1.52E-08	3.92E-08	Not detected
	Dec. 8 – Dec. 31	3.49E-08	1.74E-08	2.70E-08	Detected
	Dec. 31 – Jan. 14	4.92E-09	8.54E-09	1.95E-08	Not detected

Table B.2. Activity concentrations of ^{241}Am at Onsite station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc.(2σ) Bq/m^3	MDC Bq/m^3	Status
^{241}Am	Jan. 10 – Jan. 31	1.32E-07	2.67E-08	1.75E-08	Detected
	Jan. 31 – Feb. 21	8.46E-09	8.34E-09	1.70E-08	Not detected
	Feb. 21 – Mar. 18	1.82E-08	1.02E-08	1.59E-08	Detected
	Mar. 18 – Apr. 3	1.01E-08	1.04E-08	2.16E-08	Not detected
	Apr. 3 – Apr. 30	1.54E-08	1.17E-08	2.35E-08	Not detected
	Apr. 30 – May. 19	4.14E-08	1.45E-08	8.24E-09	Detected
	May 19 – Jun. 11	1.66E-08	8.99E-09	1.38E-08	Detected
	Jun. 11 – Jul. 2	2.22E-08	1.28E-08	2.09E-08	Detected
	Jul. 2 – Jul. 30	8.04E-09	9.70E-09	2.13E-08	Not detected
	Jul. 30 – Aug. 20	1.35E-08	1.50E-08	3.23E-08	Not detected
	Aug. 20 – Sep. 3	4.45E-09	1.15E-08	2.79E-08	Not detected
	Sep. 3 – Oct. 1	1.99E-08	1.27E-08	2.39E-08	Not detected
	Oct. 1 – Oct. 15	7.41E-09	1.22E-08	2.79E-08	Not detected
	Oct. 15 – Nov. 10	1.61E-08	1.02E-08	1.81E-08	Not detected
	Nov. 10 – Dec. 8	1.71E-08	1.01E-08	1.72E-08	Not detected
	Dec. 8 – Dec. 31	2.33E-08	1.23E-08	2.13E-08	Detected
	Dec. 31 – Jan. 14	1.85E-08	1.25E-08	2.30E-08	Not detected

Table B.3. Activity concentrations of ^{238}Pu at Onsite station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{238}Pu	Jan. 10 – Jan. 31	-1.26E-08	9.53E-09	3.21E-08	Not detected
	Jan. 31 – Feb. 21	-9.15E-09	7.93E-09	2.59E-08	Not detected
	Feb. 21 – Mar. 18	-3.67E-09	5.81E-09	1.84E-08	Not detected
	Mar. 18 – Apr. 3	-8.93E-09	9.46E-09	3.17E-08	Not detected
	Apr. 3 – Apr. 30	-2.04E-09	5.77E-09	1.78E-08	Not detected
	Apr. 30 – May. 19	-5.30E-09	9.25E-09	2.70E-08	Not detected
	May 19 – Jun. 11	1.09E-09	9.98E-09	2.56E-08	Not detected
	Jun. 11 – Jul. 2	-1.54E-08	1.34E-08	4.37E-08	Not detected
	Jul. 2 – Jul. 30	-4.92E-09	9.87E-09	3.09E-08	Not detected
	Jul. 30 – Aug. 20	-5.39E-09	8.54E-09	2.71E-08	Not detected
	Aug. 20 – Sep. 3	-1.20E-08	1.05E-08	3.52E-08	Not detected
	Sep. 3 – Oct. 1	2.77E-09	6.66E-09	1.61E-08	Not detected
	Oct. 1 – Oct. 15	-1.56E-08	1.81E-08	5.84E-08	Not detected
	Oct. 15 – Nov. 10	-1.74E-09	6.03E-09	1.75E-08	Not detected
	Nov. 10 – Dec. 8	-3.68E-09	1.16E-08	3.46E-08	Not detected
	Dec. 8 – Dec. 31	-6.70E-09	8.08E-09	2.70E-08	Not detected
	Dec. 31 – Jan. 14	-4.92E-09	9.85E-09	2.89E-08	Not detected

Table B.4. Activity concentrations of $^{239+240}Pu$ at Near Field station

Radionuclide	Sample Date 2020	Activity Bq/m³	Unc. (2σ) Bq/m³	MDC Bq/m³	Status
$^{239+240}Pu$	Jan. 10 – Jan. 31	1.62E-08	8.81E-09	7.94E-09	Detected
	Jan. 31 – Feb. 21	7.00E-09	5.71E-09	7.37E-09	Not detected
	Feb. 21 – Mar. 18	1.05E-08	7.90E-09	1.39E-08	Not detected
	Mar. 18 – Apr. 3	6.08E-09	9.44E-09	2.12E-08	Not detected
	Apr. 3 – Apr. 30	1.11E-08	7.92E-09	1.21E-08	Not detected
	Apr. 30 – May. 19	2.05E-08	1.05E-08	1.48E-08	Detected
	May 19 – Jun. 11	5.05E-08	1.54E-08	1.61E-08	Detected
	Jun. 11 – Jul. 2	1.25E-08	8.92E-09	1.53E-08	Not detected
	Jul. 2 – Jul. 30	9.15E-09	7.39E-09	1.29E-08	Not detected
	Jul. 30 – Aug. 20	8.83E-09	8.45E-09	1.59E-08	Not detected
	Aug. 20 – Sep. 3	-9.80E-09	1.35E-08	3.94E-08	Not detected
	Sep. 3 – Oct. 1	1.35E-08	9.10E-09	1.56E-08	Not detected
	Oct. 1 – Oct. 15	NR	NR	NR	
	Oct. 15 – Nov. 10	3.18E-08	1.23E-08	1.32E-08	Detected
	Nov. 10 – Dec. 8	2.78E-08	1.32E-08	1.52E-08	Detected
	Dec. 8 – Dec. 31	3.48E-08	1.41E-08	1.58E-08	Detected
	Dec. 31 – Jan. 14	6.24E-09	9.90E-09	2.20E-08	Not detected

NR = Not reported

Table B.5. Activity concentrations of ^{241}Am at Near Field station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{241}Am	Jan. 10 – Jan. 31	1.02E-08	9.68E-09	2.00E-08	Not detected
	Jan. 31 – Feb. 21	8.19E-09	9.08E-09	1.94E-08	Not detected
	Feb. 21 – Mar. 18	-1.76E-09	9.44E-09	2.97E-08	Not detected
	Mar. 18 – Apr. 3	1.84E-08	9.16E-09	7.54E-09	Detected
	Apr. 3 – Apr. 30	5.30E-09	7.63E-09	1.68E-08	Not detected
	Apr. 30 – May. 19	1.18E-08	7.99E-09	1.33E-08	Not detected
	May 19 – Jun. 11	7.06E-09	7.88E-09	1.67E-08	Not detected
	Jun. 11 – Jul. 2	8.94E-09	9.67E-09	2.07E-08	Not detected
	Jul. 2 – Jul. 30	1.52E-07	2.84E-08	1.95E-08	Detected
	Jul. 30 – Aug. 20	2.56E-09	8.54E-09	2.09E-08	Not detected
	Aug. 20 – Sep. 3	8.20E-09	1.16E-08	2.61E-08	Not detected
	Sep. 3 – Oct. 1	1.84E-08	1.09E-08	1.96E-08	Not detected
	Oct. 1 – Oct. 15	2.30E-08	1.61E-08	3.08E-08	Not detected
	Oct. 15 – Nov. 10	1.67E-08	1.07E-08	1.96E-08	Not detected
	Nov. 10 – Dec. 8	1.25E-08	1.05E-08	2.09E-08	Not detected
	Dec. 8 – Dec. 31	2.63E-08	1.15E-08	1.53E-08	Detected
	Dec. 31 – Jan. 14	9.78E-09	1.13E-08	2.44E-08	Not detected

Table B.6. Activity concentrations of ^{238}Pu at Near Field station

Radionuclide	Sample Date 2020	Activity Bq/m³	Unc. (2σ) Bq/m3	MDC Bq/m³	Status
^{238}Pu	Jan. 10 – Jan. 31	-1.17E-08	3.23E-08	7.97E-08	Not detected
	Jan. 31 – Feb. 21	-1.48E-08	2.98E-08	7.39E-08	Not detected
	Feb. 21 – Mar. 18	-6.12E-09	6.34E-09	2.06E-08	Not detected
	Mar. 18 – Apr. 3	-7.29E-09	8.46E-09	2.73E-08	Not detected
	Apr. 3 – Apr. 30	-4.04E-09	7.57E-09	2.27E-08	Not detected
	Apr. 30 – May. 19	-6.53E-09	6.77E-09	2.19E-08	Not detected
	May 19 – Jun. 11	5.13E-09	6.87E-09	1.49E-08	Not detected
	Jun. 11 – Jul. 2	-8.66E-09	6.45E-09	2.26E-08	Not detected
	Jul. 2 – Jul. 30	-2.75E-09	6.08E-09	1.84E-08	Not detected
	Jul. 30 – Aug. 20	-6.91E-09	6.68E-09	2.33E-08	Not detected
	Aug. 20 – Sep. 3	-1.13E-09	8.79E-09	2.42E-08	Not detected
	Sep. 3 – Oct. 1	-5.08E-08	5.92E-08	1.90E-07	Not detected
	Oct. 1 – Oct. 15	NR	NR	NR	
	Oct. 15 – Nov. 10	0.00E+00	7.00E-09	1.88E-08	Not detected
	Nov. 10 – Dec. 8	1.26E-09	5.65E-09	1.52E-08	Not detected
	Dec. 8 – Dec. 31	-1.12E-09	6.74E-09	1.95E-08	Not detected
	Dec. 31 – Jan. 14	-4.68E-09	1.04E-08	3.14E-08	Not detected

NR = Not reported

Table B.7. Activity concentrations of $^{239+240}Pu$ at Cactus Flats station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
$^{239+240}Pu$	Jan. 10 – Jan. 31	4.51E-09	7.82E-09	1.79E-08	Not detected
	Jan. 31 – Feb. 21	2.07E-09	6.54E-09	1.64E-08	Not detected
	Feb. 21 – Mar. 18	1.09E-08	1.18E-08	2.56E-08	Not detected
	Mar. 18 – Apr. 3	9.10E-09	8.39E-09	1.60E-08	Not detected
	Apr. 3 – Apr. 30	3.26E-09	4.36E-09	9.45E-09	Not detected
	Apr. 30 – May. 19	2.35E-08	1.17E-08	1.76E-08	Detected
	May 19 – Jun. 11	2.30E-08	1.21E-08	1.93E-08	Detected
	Jun. 11 – Jul. 2	1.60E-08	1.12E-08	2.00E-08	Not detected
	Jul. 2 – Jul. 30	6.60E-09	4.28E-09	6.65E-09	Not detected
	Jul. 30 – Aug. 20	6.78E-09	1.18E-08	2.73E-08	Not detected
	Aug. 20 – Sep. 3	1.35E-08	1.18E-08	2.02E-08	Not detected
	Sep. 3 – Oct. 1	1.38E-08	5.33E-09	4.13E-09	Detected
	Oct. 1 – Oct. 15	2.69E-08	1.26E-08	1.58E-08	Detected
	Oct. 15 – Nov. 10	2.84E-08	1.41E-08	2.24E-08	Detected
	Nov. 10 – Dec. 8	3.54E-08	1.71E-08	2.17E-08	Detected
	Dec. 8 – Dec. 31	2.76E-08	1.44E-08	1.94E-08	Detected
	Dec. 31 – Jan. 14	1.02E-08	1.78E-08	4.11E-08	Not detected

Table B.8. Activity concentrations of ^{241}Am at Cactus Flats station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{241}Am	Jan. 10 – Jan. 31	6.69E-09	1.19E-08	2.75E-08	Not detected
	Jan. 31 – Feb. 21	1.60E-09	1.06E-08	2.63E-08	Not detected
	Feb. 21 – Mar. 18	1.54E-08	9.85E-09	1.72E-08	Not detected
	Mar. 18 – Apr. 3	1.54E-08	1.04E-08	1.74E-08	Not detected
	Apr. 3 – Apr. 30	5.48E-09	4.33E-09	8.35E-09	Not detected
	Apr. 30 – May. 19	1.93E-08	1.08E-08	1.73E-08	Detected
	May 19 – Jun. 11	1.78E-08	7.81E-09	5.69E-09	Detected
	Jun. 11 – Jul. 2	9.89E-09	7.81E-09	1.44E-08	Not detected
	Jul. 2 – Jul. 30	-8.06E-10	5.47E-09	1.41E-08	Not detected
	Jul. 30 – Aug. 20	4.49E-09	6.98E-09	1.56E-08	Not detected
	Aug. 20 – Sep. 3	7.96E-09	8.49E-09	1.73E-08	Not detected
	Sep. 3 – Oct. 1	-1.29E-09	5.76E-09	1.50E-08	Not detected
	Oct. 1 – Oct. 15	1.33E-08	9.95E-09	1.79E-08	Not detected
	Oct. 15 – Nov. 10	2.21E-08	9.15E-09	6.26E-09	Detected
	Nov. 10 – Dec. 8	7.02E-09	9.65E-09	2.15E-08	Not detected
	Dec. 8 – Dec. 31	1.51E-08	1.15E-08	2.16E-08	Not detected
	Dec. 31 – Jan. 14	1.60E-08	1.42E-08	2.83E-08	Not detected

Table B.9. Activity concentrations of ^{238}Pu in the filter samples collected from Cactus Flats station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{238}Pu	Jan. 10 – Jan. 31	-7.89E-09	8.17E-09	2.65E-08	Not detected
	Jan. 31 – Feb. 21	-4.13E-09	8.28E-09	2.43E-08	Not detected
	Feb. 21 – Mar. 18	-9.08E-09	1.03E-08	2.98E-08	Not detected
	Mar. 18 – Apr. 3	-2.02E-09	8.58E-09	2.38E-08	Not detected
	Apr. 3 – Apr. 30	5.43E-10	2.87E-09	7.66E-09	Not detected
	Apr. 30 – May. 19	1.88E-09	6.50E-09	1.63E-08	Not detected
	May 19 – Jun. 11	-9.58E-10	7.90E-09	2.15E-08	Not detected
	Jun. 11 – Jul. 2	5.33E-09	8.27E-09	1.85E-08	Not detected
	Jul. 2 – Jul. 30	-2.83E-09	4.01E-09	1.20E-08	Not detected
	Jul. 30 – Aug. 20	-1.36E-08	1.04E-08	3.18E-08	Not detected
	Aug. 20 – Sep. 3	-1.35E-08	1.08E-08	3.78E-08	Not detected
	Sep. 3 – Oct. 1	1.78E-09	2.00E-09	3.28E-09	Not detected
	Oct. 1 – Oct. 15	-5.61E-09	9.80E-09	2.86E-08	Not detected
	Oct. 15 – Nov. 10	-5.26E-09	7.61E-09	2.36E-08	Not detected
	Nov. 10 – Dec. 8	-1.54E-08	1.17E-08	3.92E-08	Not detected
	Dec. 8 – Dec. 31	-5.53E-09	6.80E-09	2.41E-08	Not detected
	Dec. 31 – Jan. 14	2.92E-09	5.84E-09	1.35E-08	Not detected

Table B.10. Activity concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from Loving station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{241}Am	Jan. 10 – Jan. 31	1.16E-07	2.36E-08	1.39E-08	Detected
	Jan. 31 – Feb. 21	4.75E-09	6.35E-09	1.38E-08	Not detected
	Feb. 21 – Mar. 18	8.50E-09	1.02E-08	2.22E-08	Not detected
	Mar. 18 – Apr. 3	-1.02E-09	1.31E-08	3.36E-08	Not detected
	Apr. 3 – Apr. 30	1.95E-08	1.28E-08	2.49E-08	Not detected
	Apr. 30 – May. 19	1.65E-08	9.84E-09	1.59E-08	Detected
	May 19 – Jun. 11	1.68E-08	8.81E-09	1.27E-08	Detected
	Jun. 11 – Jul. 2	1.26E-08	1.13E-08	2.28E-08	Not detected
	Jul. 2 – Jul. 30	2.45E-09	6.24E-09	1.48E-08	Not detected
	Jul. 30 – Aug. 20	8.94E-09	8.81E-09	1.82E-08	Not detected
	Aug. 20 – Sep. 3	9.30E-09	1.12E-08	2.43E-08	Not detected
	Sep. 3 – Oct. 1	-1.60E-09	1.13E-08	2.89E-08	Not detected
	Oct. 1 – Oct. 15	3.69E-08	1.82E-08	2.36E-08	Detected
	Oct. 15 – Nov. 10	2.45E-08	1.06E-08	1.34E-08	Detected
	Nov. 10 – Dec. 8	2.74E-08	1.04E-08	7.96E-09	Detected
	Dec. 8 – Dec. 31	1.71E-08	9.21E-09	1.35E-08	Detected
	Dec. 31 – Jan. 14	1.07E-09	9.38E-09	2.42E-08	Not detected
$^{239+240}$Pu	Jan. 10 – Jan. 31	2.42E-09	9.07E-09	2.28E-08	Not detected
	Jan. 31 – Feb. 21	2.90E-09	7.51E-09	1.82E-08	Not detected
	Feb. 21 – Mar. 18	1.21E-08	8.16E-09	1.21E-08	Not detected
	Mar. 18 – Apr. 3	7.60E-09	8.53E-09	1.79E-08	Not detected
	Apr. 3 – Apr. 30	1.55E-08	1.30E-08	2.45E-08	Not detected
	Apr. 30 – May. 19	1.39E-08	1.01E-08	1.87E-08	Not detected
	May 19 – Jun. 11	2.37E-08	1.53E-08	2.58E-08	Not detected
	Jun. 11 – Jul. 2	1.37E-08	1.11E-08	2.12E-08	Not detected
	Jul. 2 – Jul. 30	7.81E-09	6.31E-09	1.10E-08	Not detected
	Jul. 30 – Aug. 20	1.38E-08	7.83E-09	1.03E-08	Detected
	Aug. 20 – Sep. 3	2.08E-09	1.38E-08	3.63E-08	Not detected
	Sep. 3 – Oct. 1	2.26E-08	1.05E-08	1.18E-08	Detected
	Oct. 1 – Oct. 15	3.50E-08	3.59E-08	7.32E-08	Not detected
	Oct. 15 – Nov. 10	3.35E-08	1.25E-08	1.40E-08	Detected
	Nov. 10 – Dec. 8	3.70E-08	1.81E-08	2.68E-08	Detected
	Dec. 8 – Dec. 31	1.86E-08	1.26E-08	2.16E-08	Not detected

Table B.10. Activity concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from Loving station (continued)

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
$^{239+240}$Pu	Dec. 31 – Jan. 14	1.26E-08	1.09E-08	1.97E-08	Not detected
^{238}Pu	Jan. 10 – Jan. 31	-3.63E-09	6.42E-09	2.11E-08	Not detected
	Jan. 31 – Feb. 21	0.00E+00	6.12E-09	1.69E-08	Not detected
	Feb. 21 – Mar. 18	1.11E-08	8.39E-09	1.42E-08	Not detected
	Mar. 18 – Apr. 3	-3.80E-09	4.67E-09	1.65E-08	Not detected
	Apr. 3 – Apr. 30	0.00E+00	7.96E-09	2.23E-08	Not detected
	Apr. 30 – May. 19	-7.42E-09	5.92E-09	2.08E-08	Not detected
	May 19 – Jun. 11	0.00E+00	7.25E-09	2.09E-08	Not detected
	Jun. 11 – Jul. 2	-3.16E-09	8.18E-09	2.37E-08	Not detected
	Jul. 2 – Jul. 30	-3.91E-09	4.71E-09	1.57E-08	Not detected
	Jul. 30 – Aug. 20	8.60E-10	4.55E-09	1.21E-08	Not detected
	Aug. 20 – Sep. 3	-2.08E-09	9.32E-09	2.94E-08	Not detected
	Sep. 3 – Oct. 1	1.97E-09	6.23E-09	1.56E-08	Not detected
	Oct. 1 – Oct. 15	-2.33E-08	3.31E-08	9.92E-08	Not detected
	Oct. 15 – Nov. 10	-8.82E-10	7.69E-09	2.07E-08	Not detected
	Nov. 10 – Dec. 8	-1.28E-08	1.11E-08	3.63E-08	Not detected
	Dec. 8 – Dec. 31	4.96E-09	7.84E-09	1.74E-08	Not detected
	Dec. 31 – Jan. 14	-1.40E-09	1.01E-08	2.81E-08	Not detected

Table B.11. Activity concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from Carlsbad station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{241}Am	Jan. 10 – Jan. 31	8.88E-09	9.52E-09	1.98E-08	Not detected
	Jan. 31 – Feb. 21	6.38E-09	8.38E-09	1.83E-08	Not detected
	Feb. 21 – Mar. 18	4.12E-09	9.19E-09	2.18E-08	Not detected
	Mar. 18 – Apr. 3	9.22E-09	8.30E-09	1.60E-08	Not detected
	Apr. 3 – Apr. 30	5.39E-09	7.08E-09	1.55E-08	Not detected
	Apr. 30 – May. 19	5.90E-09	6.12E-09	1.19E-08	Not detected
	May 19 – Jun. 11	8.76E-09	7.98E-09	1.60E-08	Not detected
	Jun. 11 – Jul. 2	9.61E-09	1.06E-08	2.26E-08	Not detected
	Jul. 2 – Jul. 30	1.36E-08	1.00E-08	1.91E-08	Not detected
	Jul. 30 – Aug. 20	1.10E-08	7.87E-09	1.35E-08	Not detected
	Aug. 20 – Sep. 3	1.28E-08	1.10E-08	2.15E-08	Not detected
	Sep. 3 – Oct. 1	1.19E-08	9.22E-09	1.78E-08	Not detected
	Oct. 1 – Oct. 15	2.97E-08	1.72E-08	3.03E-08	Not detected
	Oct. 15 – Nov. 10	2.26E-08	1.10E-08	1.68E-08	Detected
	Nov. 10 – Dec. 8	1.33E-08	9.53E-09	1.77E-08	Not detected
	Dec. 8 – Dec. 31	1.81E-08	9.53E-09	1.44E-08	Detected
	Dec. 31 – Jan. 14	5.05E-09	1.13E-08	2.67E-08	Not detected
$^{239+240}$Pu	Jan. 10 – Jan. 31	8.12E-09	1.63E-08	3.81E-08	Not detected
	Jan. 31 – Feb. 21	4.14E-09	1.21E-08	2.92E-08	Not detected
	Feb. 21 – Mar. 18	3.90E-09	8.72E-09	2.08E-08	Not detected
	Mar. 18 – Apr. 3	5.77E-09	7.68E-09	1.63E-08	Not detected
	Apr. 3 – Apr. 30	6.60E-09	6.99E-09	1.32E-08	Not detected
	Apr. 30 – May. 19	1.11E-08	8.73E-09	1.61E-08	Not detected
	May 19 – Jun. 11	2.18E-08	1.45E-08	2.87E-09	Detected
	Jun. 11 – Jul. 2	2.08E-08	1.20E-08	1.91E-08	Detected
	Jul. 2 – Jul. 30	9.63E-09	7.79E-09	1.29E-08	Not detected
	Jul. 30 – Aug. 20	1.44E-08	9.87E-09	1.81E-08	Not detected
	Aug. 20 – Sep. 3	1.94E-08	1.85E-08	3.91E-08	Not detected
	Sep. 3 – Oct. 1	1.84E-08	1.40E-08	2.64E-08	Not detected
	Oct. 1 – Oct. 15	5.58E-08	1.99E-08	1.97E-08	Detected
	Oct. 15 – Nov. 10	1.59E-08	1.52E-08	3.20E-08	Not detected
	Nov. 10 – Dec. 8	2.40E-08	1.49E-08	2.25E-08	Detected
	Dec. 8 – Dec. 31	1.61E-08	1.14E-08	2.00E-08	Not detected

Table B.11. Activity concentrations of ^{241}Am, $^{239+240}Pu$, and ^{238}Pu in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2020	Activity Bq/m³	Unc. (2σ) Bq/m³	MDC Bq/m³	Status
$^{239+240}Pu$	Dec. 31 – Jan. 14	1.37E-09	9.90E-09	2.58E-08	Not detected
^{238}Pu	Jan. 10 – Jan. 31	1.35E-09	8.12E-09	2.15E-08	Not detected
	Jan. 31 – Feb. 21	3.11E-09	6.88E-09	1.64E-08	Not detected
	Feb. 21 – Mar. 18	-9.74E-10	6.46E-09	1.83E-08	Not detected
	Mar. 18 – Apr. 3	-9.24E-09	9.29E-09	2.94E-08	Not detected
	Apr. 3 – Apr. 30	-9.89E-09	8.59E-09	2.80E-08	Not detected
	Apr. 30 – May. 19	0.00E+00	4.52E-09	1.30E-08	Not detected
	May 19 – Jun. 11	-5.13E-09	1.03E-08	3.01E-08	Not detected
	Jun. 11 – Jul. 2	4.38E-09	6.94E-09	1.54E-08	Not detected
	Jul. 2 – Jul. 30	1.07E-09	5.67E-09	1.51E-08	Not detected
	Jul. 30 – Aug. 20	-5.09E-09	4.52E-09	1.60E-08	Not detected
	Aug. 20 – Sep. 3	2.77E-09	5.55E-09	1.29E-08	Not detected
	Sep. 3 – Oct. 1	-3.93E-09	8.71E-09	2.64E-08	Not detected
	Oct. 1 – Oct. 15	1.40E-09	9.26E-09	2.43E-08	Not detected
	Oct. 15 – Nov. 10	7.95E-09	6.87E-09	1.06E-08	Not detected
	Nov. 10 – Dec. 8	1.60E-09	1.06E-08	2.78E-08	Not detected
	Dec. 8 – Dec. 31	-2.30E-09	5.64E-09	1.82E-08	Not detected
	Dec. 31 – Jan. 14	-8.24E-09	8.73E-09	2.93E-08	Not detected

Table B.12. Activity concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from East Tower station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{241}Am	Jan. 10 – Jan. 31	2.37E-08	3.14E-08	6.96E-08	Not detected
	Jan. 31 – Feb. 21	-1.06E-09	9.25E-09	2.49E-08	Not detected
	Feb. 21 – Mar. 18	9.77E-09	2.03E-08	4.79E-08	Not detected
	Mar. 18 – Apr. 3	3.21E-08	2.17E-08	4.27E-08	Not detected
	Apr. 3 – Apr. 30	-3.62E-09	1.17E-08	3.10E-08	Not detected
	Apr. 30 – May. 19	2.00E-08	1.24E-08	2.24E-08	Not detected
	May 19 – Jun. 11	1.14E-08	9.55E-09	1.91E-08	Not detected
	Jun. 11 – Jul. 2	2.03E-08	1.07E-08	1.74E-08	Detected
	Jul. 2 – Jul. 30	1.13E-08	9.41E-09	1.85E-08	Not detected
	Jul. 30 – Aug. 20	7.38E-09	9.17E-09	2.01E-08	Not detected
	Aug. 20 – Sep. 3	1.54E-08	1.21E-08	2.34E-08	Not detected
	Sep. 3 – Oct. 1	2.13E-08	1.15E-08	1.89E-08	Detected
	Oct. 1 – Oct. 15	1.35E-09	1.24E-08	3.18E-08	Not detected
	Oct. 15 – Nov. 10	3.27E-09	1.11E-08	2.69E-08	Not detected
	Nov. 10 – Dec. 8	2.53E-08	1.17E-08	1.79E-08	Detected
	Dec. 8 – Dec. 31	9.27E-09	1.06E-08	2.30E-08	Not detected
	Dec. 31 – Jan. 14	7.13E-09	1.02E-08	2.28E-08	Not detected
$^{239+240}$Pu	Jan. 10 – Jan. 31	0.00E+00	2.45E-08	6.57E-08	Not detected
	Jan. 31 – Feb. 21	7.33E-09	9.62E-09	2.10E-08	Not detected
	Feb. 21 – Mar. 18	7.73E-09	1.03E-08	2.24E-08	Not detected
	Mar. 18 – Apr. 3	1.91E-08	1.80E-08	3.59E-08	Not detected
	Apr. 3 – Apr. 30	1.27E-08	8.01E-09	9.80E-09	Detected
	Apr. 30 – May. 19	9.76E-09	1.05E-08	2.18E-08	Not detected
	May 19 – Jun. 11	3.45E-08	1.36E-08	1.75E-08	Detected
	Jun. 11 – Jul. 2	1.56E-08	1.19E-08	2.24E-08	Not detected
	Jul. 2 – Jul. 30	1.62E-08	1.01E-08	1.60E-08	Detected
	Jul. 30 – Aug. 20	1.45E-08	9.00E-09	1.49E-08	Not detected
	Aug. 20 – Sep. 3	1.77E-08	1.44E-08	2.25E-08	Not detected
	Sep. 3 – Oct. 1	5.74E-08	1.72E-08	1.57E-08	Detected
	Oct. 1 – Oct. 15	3.88E-08	2.40E-08	3.33E-08	Detected
	Oct. 15 – Nov. 10	1.02E-08	1.14E-08	2.39E-08	Not detected
	Nov. 10 – Dec. 8	2.74E-08	1.48E-08	2.04E-08	Detected
	Dec. 8 – Dec. 31	2.03E-08	1.21E-08	1.90E-08	Detected

Table B.12. Activity concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from East Tower station (continued)

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
$^{239+240}$Pu	Dec. 31 – Jan. 14	3.75E-09	9.02E-09	2.18E-08	Not detected
^{238}Pu	Jan. 10 – Jan. 31	-9.80E-09	2.70E-08	7.68E-08	Not detected
	Jan. 31 – Feb. 21	-4.19E-09	8.39E-09	2.46E-08	Not detected
	Feb. 21 – Mar. 18	-1.03E-08	8.22E-09	2.89E-08	Not detected
	Mar. 18 – Apr. 3	-1.91E-08	1.44E-08	4.87E-08	Not detected
	Apr. 3 – Apr. 30	-4.22E-09	8.96E-09	2.59E-08	Not detected
	Apr. 30 – May. 19	-5.42E-09	8.42E-09	2.55E-08	Not detected
	May 19 – Jun. 11	-6.52E-09	5.63E-09	1.99E-08	Not detected
	Jun. 11 – Jul. 2	-6.70E-09	8.38E-09	2.62E-08	Not detected
	Jul. 2 – Jul. 30	-3.03E-09	8.35E-09	2.38E-08	Not detected
	Jul. 30 – Aug. 20	-4.26E-09	6.17E-09	1.91E-08	Not detected
	Aug. 20 – Sep. 3	-1.42E-08	1.40E-08	4.69E-08	Not detected
	Sep. 3 – Oct. 1	-2.97E-09	8.16E-09	2.33E-08	Not detected
	Oct. 1 – Oct. 15	-1.11E-08	2.08E-08	6.22E-08	Not detected
	Oct. 15 – Nov. 10	-8.90E-09	7.69E-09	2.71E-08	Not detected
	Nov. 10 – Dec. 8	-2.89E-09	8.17E-09	2.51E-08	Not detected
	Dec. 8 – Dec. 31	-1.07E-08	1.05E-08	3.27E-08	Not detected
	Dec. 31 – Jan. 14	-3.75E-09	6.63E-09	2.18E-08	Not detected

Table B.13. Specific activity of ^{241}Am in the filter samples collected from Onsite station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc.(2σ) Bq/g	MDC Bq/g	Status
^{241}Am	Jan. 10 – Jan. 31	2.95E-03	5.95E-04	3.90E-04	Detected
	Jan. 31 – Feb. 21	3.12E-04	3.08E-04	6.28E-04	Not detected
	Feb. 21 – Mar. 18	2.97E-04	1.66E-04	2.59E-04	Detected
	Mar. 18 – Apr. 3	1.55E-04	1.58E-04	3.29E-04	Not detected
	Apr. 3 – Apr. 30	1.96E-04	1.49E-04	3.00E-04	Not detected
	Apr. 30 – May. 19	3.63E-04	1.27E-04	7.21E-05	Detected
	May 19 – Jun. 11	1.77E-04	9.57E-05	1.47E-04	Detected
	Jun. 11 – Jul. 2	2.47E-04	1.42E-04	2.32E-04	Detected
	Jul. 2 – Jul. 30	1.12E-04	1.34E-04	2.95E-04	Not detected
	Jul. 30 – Aug. 20	2.65E-04	2.95E-04	6.37E-04	Not detected
	Aug. 20 – Sep. 3	7.04E-05	1.82E-04	4.42E-04	Not detected
	Sep. 3 – Oct. 1	2.31E-04	1.48E-04	2.77E-04	Not detected
	Oct. 1 – Oct. 15	8.26E-05	1.37E-04	3.11E-04	Not detected
	Oct. 15 – Nov. 10	1.94E-04	1.22E-04	2.17E-04	Not detected
	Nov. 10 – Dec. 8	2.10E-04	1.24E-04	2.11E-04	Not detected
	Dec. 8 – Dec. 31	2.96E-04	1.56E-04	2.70E-04	Detected
	Dec. 31 – Jan. 14	5.60E-04	3.78E-04	6.98E-04	Not detected

Table B.14. Specific activity of $^{239+240}Pu$ in the filter samples collected from Onsite station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
$^{239+240}Pu$	Jan. 10 – Jan. 31	-1.13E-04	2.25E-04	6.61E-04	Not detected
	Jan. 31 – Feb. 21	-1.50E-04	3.01E-04	8.82E-04	Not detected
	Feb. 21 – Mar. 18	2.99E-05	1.20E-04	3.01E-04	Not detected
	Mar. 18 – Apr. 3	1.14E-04	1.64E-04	3.60E-04	Not detected
	Apr. 3 – Apr. 30	1.69E-04	1.15E-04	1.84E-04	Not detected
	Apr. 30 – May. 19	1.11E-04	1.06E-04	2.18E-04	Not detected
	May 19 – Jun. 11	2.32E-04	1.25E-04	1.84E-04	Detected
	Jun. 11 – Jul. 2	-1.91E-05	1.66E-04	4.48E-04	Not detected
	Jul. 2 – Jul. 30	0.00E+00	1.82E-04	4.85E-04	Not detected
	Jul. 30 – Aug. 20	1.33E-04	2.32E-04	5.34E-04	Not detected
	Aug. 20 – Sep. 3	1.19E-04	1.72E-04	3.76E-04	Not detected
	Sep. 3 – Oct. 1	3.00E-04	1.36E-04	1.86E-04	Detected
	Oct. 1 – Oct. 15	4.06E-04	3.21E-04	6.19E-04	Not detected
	Oct. 15 – Nov. 10	3.13E-04	1.30E-04	1.47E-04	Detected
	Nov. 10 – Dec. 8	2.26E-05	1.86E-04	4.81E-04	Not detected
	Dec. 8 – Dec. 31	4.42E-04	2.21E-04	3.42E-04	Detected
	Dec. 31 – Jan. 14	1.49E-04	2.59E-04	5.92E-04	Not detected

Table B.15. Specific activity of ^{238}Pu in the filter samples collected from Onsite station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{238}Pu	Jan. 10 – Jan. 31	-2.81E-04	2.13E-04	7.17E-04	Not detected
	Jan. 31 – Feb. 21	-3.38E-04	2.93E-04	9.56E-04	Not detected
	Feb. 21 – Mar. 18	-5.98E-05	9.48E-05	3.01E-04	Not detected
	Mar. 18 – Apr. 3	-1.36E-04	1.44E-04	4.84E-04	Not detected
	Apr. 3 – Apr. 30	-2.61E-05	7.38E-05	2.27E-04	Not detected
	Apr. 30 – May. 19	-4.64E-05	8.10E-05	2.36E-04	Not detected
	May 19 – Jun. 11	1.16E-05	1.06E-04	2.72E-04	Not detected
	Jun. 11 – Jul. 2	-1.71E-04	1.49E-04	4.86E-04	Not detected
	Jul. 2 – Jul. 30	-6.83E-05	1.37E-04	4.28E-04	Not detected
	Jul. 30 – Aug. 20	-1.06E-04	1.68E-04	5.34E-04	Not detected
	Aug. 20 – Sep. 3	-1.90E-04	1.66E-04	5.57E-04	Not detected
	Sep. 3 – Oct. 1	3.21E-05	7.72E-05	1.86E-04	Not detected
	Oct. 1 – Oct. 15	-1.74E-04	2.02E-04	6.51E-04	Not detected
	Oct. 15 – Nov. 10	-2.09E-05	7.24E-05	2.10E-04	Not detected
	Nov. 10 – Dec. 8	-4.51E-05	1.43E-04	4.25E-04	Not detected
	Dec. 8 – Dec. 31	-8.51E-05	1.03E-04	3.42E-04	Not detected
	Dec. 31 – Jan. 14	-1.49E-04	2.99E-04	8.78E-04	Not detected

Table B.16. Specific activity of ^{241}Am in the filter samples collected from Near Field station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{241}Am	Jan. 10 – Jan. 31	2.64E-04	2.50E-04	5.17E-04	Not detected
	Jan. 31 – Feb. 21	2.85E-04	3.16E-04	6.75E-04	Not detected
	Feb. 21 – Mar. 18	-5.05E-05	2.72E-04	8.55E-04	Not detected
	Mar. 18 – Apr. 3	4.79E-04	2.38E-04	1.96E-04	Detected
	Apr. 3 – Apr. 30	1.03E-04	1.48E-04	3.26E-04	Not detected
	Apr. 30 – May. 19	2.05E-04	1.39E-04	2.33E-04	Not detected
	May 19 – Jun. 11	1.15E-04	1.29E-04	2.73E-04	Not detected
	Jun. 11 – Jul. 2	1.55E-04	1.67E-04	3.59E-04	Not detected
	Jul. 2 – Jul. 30	2.38E-03	4.47E-04	3.06E-04	Detected
	Jul. 30 – Aug. 20	5.45E-05	1.82E-04	4.46E-04	Not detected
	Aug. 20 – Sep. 3	1.82E-04	2.58E-04	5.79E-04	Not detected
	Sep. 3 – Oct. 1	2.63E-04	1.56E-04	2.80E-04	Not detected
	Oct. 1 – Oct. 15	2.71E-04	1.90E-04	3.64E-04	Not detected
	Oct. 15 – Nov. 10	2.96E-04	1.90E-04	3.48E-04	Not detected
	Nov. 10 – Dec. 8	1.75E-04	1.47E-04	2.95E-04	Not detected
	Dec. 8 – Dec. 31	3.47E-04	1.51E-04	2.01E-04	Detected
	Dec. 31 – Jan. 14	3.33E-04	3.87E-04	8.31E-04	Not detected

Table B.17. Specific activity of $^{239+240}Pu$ at Near Field station

Radionuclides	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
$^{239+240}Pu$	Jan. 10 – Jan. 31	4.19E-04	2.28E-04	2.05E-04	Detected
	Jan. 31 – Feb. 21	2.44E-04	1.99E-04	2.56E-04	Not detected
	Feb. 21 – Mar. 18	3.02E-04	2.27E-04	3.99E-04	Not detected
	Mar. 18 – Apr. 3	1.58E-04	2.45E-04	5.50E-04	Not detected
	Apr. 3 – Apr. 30	2.15E-04	1.53E-04	2.35E-04	Not detected
	Apr. 30 – May. 19	3.58E-04	1.83E-04	2.58E-04	Detected
	May 19 – Jun. 11	8.25E-04	2.52E-04	2.63E-04	Detected
	Jun. 11 – Jul. 2	2.17E-04	1.54E-04	2.64E-04	Not detected
	Jul. 2 – Jul. 30	1.44E-04	1.16E-04	2.03E-04	Not detected
	Jul. 30 – Aug. 20	1.88E-04	1.80E-04	3.38E-04	Not detected
	Aug. 20 – Sep. 3	-2.17E-04	2.98E-04	8.74E-04	Not detected
	Sep. 3 – Oct. 1	1.93E-04	1.30E-04	2.24E-04	Not detected
	Oct. 1 – Oct. 15	NR	NR	NR	
	Oct. 15 – Nov. 10	5.64E-04	2.19E-04	2.34E-04	Detected
	Nov. 10 – Dec. 8	3.91E-04	1.86E-04	2.13E-04	Detected
	Dec. 8 – Dec. 31	4.58E-04	1.86E-04	2.08E-04	Detected
	Dec. 31 – Jan. 14	2.13E-04	3.37E-04	7.50E-04	Not detected

NR = Not reported

Table B.18. Specific activity of ^{238}Pu at Near Field station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{238}Pu	Jan. 10 – Jan. 31	-3.02E-04	8.35E-04	2.06E-03	Not detected
	Jan. 31 – Feb. 21	-5.16E-04	1.04E-03	2.57E-03	Not detected
	Feb. 21 – Mar. 18	-1.76E-04	1.82E-04	5.92E-04	Not detected
	Mar. 18 – Apr. 3	-1.89E-04	2.20E-04	7.09E-04	Not detected
	Apr. 3 – Apr. 30	-7.82E-05	1.47E-04	4.39E-04	Not detected
	Apr. 30 – May. 19	-1.14E-04	1.18E-04	3.83E-04	Not detected
	May 19 – Jun. 11	8.39E-05	1.12E-04	2.44E-04	Not detected
	Jun. 11 – Jul. 2	-1.50E-04	1.12E-04	3.92E-04	Not detected
	Jul. 2 – Jul. 30	-4.32E-05	9.56E-05	2.89E-04	Not detected
	Jul. 30 – Aug. 20	-1.47E-04	1.42E-04	4.96E-04	Not detected
	Aug. 20 – Sep. 3	-2.51E-05	1.95E-04	5.36E-04	Not detected
	Sep. 3 – Oct. 1	-7.27E-04	8.48E-04	2.72E-03	Not detected
	Oct. 1 – Oct. 15	NR	NR	NR	
	Oct. 15 – Nov. 10	0.00E+00	1.24E-04	3.34E-04	Not detected
	Nov. 10 – Dec. 8	1.78E-05	7.95E-05	2.13E-04	Not detected
	Dec. 8 – Dec. 31	-1.48E-05	8.87E-05	2.57E-04	Not detected
	Dec. 31 – Jan. 14	-1.60E-04	3.53E-04	1.07E-03	Not detected

NR = Not reported

Table B.19. Specific activity of ^{241}Am at Cactus Flats station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{241}**Am**	Jan. 10 – Jan. 31	1.68E-04	2.97E-04	6.88E-04	Not detected
	Jan. 31 – Feb. 21	6.69E-05	4.44E-04	1.10E-03	Not detected
	Feb. 21 – Mar. 18	4.22E-04	2.69E-04	4.71E-04	Not detected
	Mar. 18 – Apr. 3	4.72E-04	3.21E-04	5.35E-04	Not detected
	Apr. 3 – Apr. 30	2.34E-04	1.85E-04	3.56E-04	Not detected
	Apr. 30 – May. 19	3.93E-04	2.19E-04	3.52E-04	Detected
	May 19 – Jun. 11	3.48E-04	1.53E-04	1.11E-04	Detected
	Jun. 11 – Jul. 2	2.25E-04	1.77E-04	3.26E-04	Not detected
	Jul. 2 – Jul. 30	-3.70E-05	2.51E-04	6.46E-04	Not detected
	Jul. 30 – Aug. 20	9.86E-05	1.53E-04	3.43E-04	Not detected
	Aug. 20 – Sep. 3	2.49E-04	2.66E-04	5.43E-04	Not detected
	Sep. 3 – Oct. 1	-3.77E-05	1.69E-04	4.39E-04	Not detected
	Oct. 1 – Oct. 15	2.10E-04	1.57E-04	2.82E-04	Not detected
	Oct. 15 – Nov. 10	3.19E-04	1.32E-04	9.02E-05	Detected
	Nov. 10 – Dec. 8	8.08E-05	1.11E-04	2.48E-04	Not detected
	Dec. 8 – Dec. 31	1.94E-04	1.48E-04	2.79E-04	Not detected
	Dec. 31 – Jan. 14	3.74E-04	3.32E-04	6.64E-04	Not detected

Table B.20. Specific activity of $^{239+240}Pu$ at Cactus Flats station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
$^{239+240}Pu$	Jan. 10 – Jan. 31	1.13E-04	1.96E-04	4.48E-04	Not detected
	Jan. 31 – Feb. 21	8.64E-05	2.74E-04	6.86E-04	Not detected
	Feb. 21 – Mar. 18	2.98E-04	3.23E-04	6.99E-04	Not detected
	Mar. 18 – Apr. 3	2.80E-04	2.58E-04	4.93E-04	Not detected
	Apr. 3 – Apr. 30	1.39E-04	1.86E-04	4.03E-04	Not detected
	Apr. 30 – May. 19	4.77E-04	2.38E-04	3.59E-04	Detected
	May 19 – Jun. 11	4.50E-04	2.36E-04	3.77E-04	Detected
	Jun. 11 – Jul. 2	3.63E-04	2.54E-04	4.55E-04	Not detected
	Jul. 2 – Jul. 30	3.03E-04	1.96E-04	3.05E-04	Not detected
	Jul. 30 – Aug. 20	1.49E-04	2.59E-04	6.00E-04	Not detected
	Aug. 20 – Sep. 3	4.23E-04	3.69E-04	6.35E-04	Not detected
	Sep. 3 – Oct. 1	4.05E-04	1.56E-04	1.21E-04	Detected
	Oct. 1 – Oct. 15	4.24E-04	1.99E-04	2.49E-04	Detected
	Oct. 15 – Nov. 10	4.10E-04	2.04E-04	3.23E-04	Detected
	Nov. 10 – Dec. 8	4.07E-04	1.96E-04	2.50E-04	Detected
	Dec. 8 – Dec. 31	3.56E-04	1.86E-04	2.50E-04	Detected
	Dec. 31 – Jan. 14	2.39E-04	4.17E-04	9.63E-04	Not detected

Table B.21. Specific activity of ^{238}Pu at Cactus Flats station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{238}Pu	Jan. 10 – Jan. 31	-1.98E-04	2.05E-04	6.63E-04	Not detected
	Jan. 31 – Feb. 21	-1.73E-04	3.46E-04	1.02E-03	Not detected
	Feb. 21 – Mar. 18	-2.48E-04	2.82E-04	8.14E-04	Not detected
	Mar. 18 – Apr. 3	-6.22E-05	2.64E-04	7.31E-04	Not detected
	Apr. 3 – Apr. 30	2.32E-05	1.23E-04	3.27E-04	Not detected
	Apr. 30 – May. 19	3.82E-05	1.32E-04	3.33E-04	Not detected
	May 19 – Jun. 11	-1.88E-05	1.55E-04	4.21E-04	Not detected
	Jun. 11 – Jul. 2	1.21E-04	1.88E-04	4.21E-04	Not detected
	Jul. 2 – Jul. 30	-1.30E-04	1.84E-04	5.52E-04	Not detected
	Jul. 30 – Aug. 20	-2.98E-04	2.27E-04	6.99E-04	Not detected
	Aug. 20 – Sep. 3	-4.23E-04	3.37E-04	1.19E-03	Not detected
	Sep. 3 – Oct. 1	5.22E-05	5.87E-05	9.61E-05	Not detected
	Oct. 1 – Oct. 15	-8.84E-05	1.55E-04	4.51E-04	Not detected
	Oct. 15 – Nov. 10	-7.59E-05	1.10E-04	3.41E-04	Not detected
	Nov. 10 – Dec. 8	-1.77E-04	1.34E-04	4.51E-04	Not detected
	Dec. 8 – Dec. 31	-7.13E-05	8.75E-05	3.10E-04	Not detected
	Dec. 31 – Jan. 14	6.84E-05	1.37E-04	3.18E-04	Not detected

Table B.22. Specific activity of ^{241}Am, $^{239+240}Pu$, and ^{238}Pu in the filter samples collected from Loving station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{241}Am	Jan. 10 – Jan. 31	2.24E-03	4.53E-04	2.67E-04	Detected
	Jan. 31 – Feb. 21	1.28E-04	1.71E-04	3.72E-04	Not detected
	Feb. 21 – Mar. 18	1.78E-04	2.14E-04	4.65E-04	Not detected
	Mar. 18 – Apr. 3	-1.75E-05	2.24E-04	5.74E-04	Not detected
	Apr. 3 – Apr. 30	2.62E-04	1.72E-04	3.34E-04	Not detected
	Apr. 30 – May. 19	2.07E-04	1.24E-04	2.00E-04	Detected
	May 19 – Jun. 11	2.16E-04	1.13E-04	1.63E-04	Detected
	Jun. 11 – Jul. 2	1.74E-04	1.55E-04	3.15E-04	Not detected
	Jul. 2 – Jul. 30	5.87E-05	1.49E-04	3.54E-04	Not detected
	Jul. 30 – Aug. 20	1.34E-04	1.32E-04	2.74E-04	Not detected
	Aug. 20 – Sep. 3	1.35E-04	1.63E-04	3.53E-04	Not detected
	Sep. 3 – Oct. 1	-1.53E-05	1.08E-04	2.76E-04	Not detected
	Oct. 1 – Oct. 15	3.18E-04	1.57E-04	2.04E-04	Detected
	Oct. 15 – Nov. 10	2.61E-04	1.13E-04	1.43E-04	Detected
	Nov. 10 – Dec. 8	2.93E-04	1.11E-04	8.52E-05	Detected
	Dec. 8 – Dec. 31	1.68E-04	9.07E-05	1.33E-04	Detected
	Dec. 31 – Jan. 14	2.85E-05	2.49E-04	6.42E-04	Not detected
$^{239+240}Pu$	Jan. 10 – Jan. 31	4.65E-05	1.74E-04	4.38E-04	Not detected
	Jan. 31 – Feb. 21	7.83E-05	2.02E-04	4.91E-04	Not detected
	Feb. 21 – Mar. 18	2.53E-04	1.71E-04	2.53E-04	Not detected
	Mar. 18 – Apr. 3	1.30E-04	1.46E-04	3.05E-04	Not detected
	Apr. 3 – Apr. 30	2.08E-04	1.75E-04	3.29E-04	Not detected
	Apr. 30 – May. 19	1.75E-04	1.27E-04	2.35E-04	Not detected
	May 19 – Jun. 11	3.05E-04	1.97E-04	3.32E-04	Not detected
	Jun. 11 – Jul. 2	1.89E-04	1.53E-04	2.93E-04	Not detected
	Jul. 2 – Jul. 30	1.87E-04	1.51E-04	2.63E-04	Not detected
	Jul. 30 – Aug. 20	2.06E-04	1.18E-04	1.55E-04	Detected
	Aug. 20 – Sep. 3	3.03E-05	2.01E-04	5.28E-04	Not detected
	Sep. 3 – Oct. 1	2.16E-04	1.01E-04	1.13E-04	Detected
	Oct. 1 – Oct. 15	3.02E-04	3.10E-04	6.31E-04	Not detected
	Oct. 15 – Nov. 10	3.57E-04	1.33E-04	1.49E-04	Detected
	Nov. 10 – Dec. 8	3.96E-04	1.93E-04	2.87E-04	Detected
	Dec. 8 – Dec. 31	1.83E-04	1.24E-04	2.13E-04	Not detected

Table B.22. Specific activity of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from Loving station (continued)

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
$^{239+240}$Pu	Dec. 31 – Jan. 14	3.34E-04	2.90E-04	5.23E-04	Not detected
^{238}Pu	Jan. 10 – Jan. 31	-6.98E-05	1.23E-04	4.05E-04	Not detected
	Jan. 31 – Feb. 21	0.00E+00	1.65E-04	4.55E-04	Not detected
	Feb. 21 – Mar. 18	2.32E-04	1.76E-04	2.97E-04	Not detected
	Mar. 18 – Apr. 3	-6.48E-05	7.97E-05	2.82E-04	Not detected
	Apr. 3 – Apr. 30	0.00E+00	1.07E-04	2.99E-04	Not detected
	Apr. 30 – May. 19	-9.33E-05	7.45E-05	2.62E-04	Not detected
	May 19 – Jun. 11	0.00E+00	9.33E-05	2.69E-04	Not detected
	Jun. 11 – Jul. 2	-4.37E-05	1.13E-04	3.27E-04	Not detected
	Jul. 2 – Jul. 30	-9.34E-05	1.13E-04	3.76E-04	Not detected
	Jul. 30 – Aug. 20	1.29E-05	6.83E-05	1.82E-04	Not detected
	Aug. 20 – Sep. 3	-3.03E-05	1.35E-04	4.27E-04	Not detected
	Sep. 3 – Oct. 1	1.88E-05	5.95E-05	1.49E-04	Not detected
	Oct. 1 – Oct. 15	-2.01E-04	2.86E-04	8.55E-04	Not detected
	Oct. 15 – Nov. 10	-9.40E-06	8.19E-05	2.21E-04	Not detected
	Nov. 10 – Dec. 8	-1.37E-04	1.19E-04	3.89E-04	Not detected
	Dec. 8 – Dec. 31	4.89E-05	7.72E-05	1.72E-04	Not detected
	Dec. 31 – Jan. 14	-3.71E-05	2.68E-04	7.46E-04	Not detected

Table B.23. Specific activity of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from Carlsbad station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{241}Am	Jan. 10 – Jan. 31	3.21E-04	3.44E-04	7.18E-04	Not detected
	Jan. 31 – Feb. 21	2.50E-04	3.29E-04	7.19E-04	Not detected
	Feb. 21 – Mar. 18	1.21E-04	2.69E-04	6.37E-04	Not detected
	Mar. 18 – Apr. 3	2.96E-04	2.67E-04	5.16E-04	Not detected
	Apr. 3 – Apr. 30	1.05E-04	1.37E-04	3.01E-04	Not detected
	Apr. 30 – May. 19	1.07E-04	1.11E-04	2.16E-04	Not detected
	May 19 – Jun. 11	1.32E-04	1.20E-04	2.41E-04	Not detected
	Jun. 11 – Jul. 2	1.58E-04	1.74E-04	3.71E-04	Not detected
	Jul. 2 – Jul. 30	1.83E-04	1.35E-04	2.56E-04	Not detected
	Jul. 30 – Aug. 20	1.79E-04	1.28E-04	2.18E-04	Not detected
	Aug. 20 – Sep. 3	2.39E-04	2.05E-04	4.01E-04	Not detected
	Sep. 3 – Oct. 1	1.45E-04	1.12E-04	2.17E-04	Not detected
	Oct. 1 – Oct. 15	2.90E-04	1.68E-04	2.96E-04	Not detected
	Oct. 15 – Nov. 10	2.89E-04	1.40E-04	2.15E-04	Detected
	Nov. 10 – Dec. 8	2.00E-04	1.43E-04	2.66E-04	Not detected
	Dec. 8 – Dec. 31	2.46E-04	1.29E-04	1.95E-04	Detected
	Dec. 31 – Jan. 14	2.41E-04	5.37E-04	1.27E-03	Not detected
$^{239+240}$Pu	Jan. 10 – Jan. 31	2.94E-04	5.88E-04	1.38E-03	Not detected
	Jan. 31 – Feb. 21	1.63E-04	4.74E-04	1.15E-03	Not detected
	Feb. 21 – Mar. 18	1.14E-04	2.55E-04	6.07E-04	Not detected
	Mar. 18 – Apr. 3	1.86E-04	2.47E-04	5.24E-04	Not detected
	Apr. 3 – Apr. 30	1.28E-04	1.36E-04	2.56E-04	Not detected
	Apr. 30 – May. 19	2.01E-04	1.59E-04	2.92E-04	Not detected
	May 19 – Jun. 11	3.28E-04	2.18E-04	4.31E-05	Detected
	Jun. 11 – Jul. 2	3.41E-04	1.97E-04	3.13E-04	Detected
	Jul. 2 – Jul. 30	1.29E-04	1.05E-04	1.73E-04	Not detected
	Jul. 30 – Aug. 20	2.34E-04	1.60E-04	2.93E-04	Not detected
	Aug. 20 – Sep. 3	3.62E-04	3.45E-04	7.28E-04	Not detected
	Sep. 3 – Oct. 1	2.23E-04	1.70E-04	3.20E-04	Not detected
	Oct. 1 – Oct. 15	5.46E-04	1.94E-04	1.92E-04	Detected
	Oct. 15 – Nov. 10	2.03E-04	1.94E-04	4.09E-04	Not detected
	Nov. 10 – Dec. 8	3.60E-04	2.24E-04	3.38E-04	Detected
	Dec. 8 – Dec. 31	2.18E-04	1.54E-04	2.71E-04	Not detected

Table B.23. Specific activity of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
$^{239+240}$Pu	Dec. 31 – Jan. 14	6.55E-05	4.72E-04	1.23E-03	Not detected
^{238}Pu	Jan. 10 – Jan. 31	4.89E-05	2.94E-04	7.77E-04	Not detected
	Jan. 31 – Feb. 21	1.22E-04	2.70E-04	6.45E-04	Not detected
	Feb. 21 – Mar. 18	-2.85E-05	1.89E-04	5.36E-04	Not detected
	Mar. 18 – Apr. 3	-2.97E-04	2.99E-04	9.47E-04	Not detected
	Apr. 3 – Apr. 30	-1.92E-04	1.67E-04	5.44E-04	Not detected
	Apr. 30 – May. 19	0.00E+00	8.21E-05	2.36E-04	Not detected
	May 19 – Jun. 11	-7.71E-05	1.54E-04	4.53E-04	Not detected
	Jun. 11 – Jul. 2	7.18E-05	1.14E-04	2.53E-04	Not detected
	Jul. 2 – Jul. 30	1.44E-05	7.60E-05	2.03E-04	Not detected
	Jul. 30 – Aug. 20	-8.25E-05	7.33E-05	2.59E-04	Not detected
	Aug. 20 – Sep. 3	5.17E-05	1.04E-04	2.40E-04	Not detected
	Sep. 3 – Oct. 1	-4.78E-05	1.06E-04	3.20E-04	Not detected
	Oct. 1 – Oct. 15	1.36E-05	9.05E-05	2.38E-04	Not detected
	Oct. 15 – Nov. 10	1.02E-04	8.78E-05	1.35E-04	Not detected
	Nov. 10 – Dec. 8	2.40E-05	1.59E-04	4.18E-04	Not detected
	Dec. 8 – Dec. 31	-3.12E-05	7.64E-05	2.47E-04	Not detected
	Dec. 31 – Jan. 14	-3.93E-04	4.16E-04	1.39E-03	Not detected

Table B.24. Specific activity of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu in the filter samples collected from East Tower station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{241}Am	Jan. 10 – Jan. 31	3.72E-04	4.93E-04	1.09E-03	Not detected
	Jan. 31 – Feb. 21	-3.32E-05	2.90E-04	7.81E-04	Not detected
	Feb. 21 – Mar. 18	2.06E-04	4.29E-04	1.01E-03	Not detected
	Mar. 18 – Apr. 3	5.65E-04	3.82E-04	7.51E-04	Not detected
	Apr. 3 – Apr. 30	-8.18E-05	2.65E-04	7.01E-04	Not detected
	Apr. 30 – May. 19	3.52E-04	2.18E-04	3.94E-04	Not detected
	May 19 – Jun. 11	1.61E-04	1.35E-04	2.70E-04	Not detected
	Jun. 11 – Jul. 2	3.30E-04	1.73E-04	2.82E-04	Detected
	Jul. 2 – Jul. 30	1.86E-04	1.56E-04	3.05E-04	Not detected
	Jul. 30 – Aug. 20	1.45E-04	1.80E-04	3.94E-04	Not detected
	Aug. 20 – Sep. 3	2.98E-04	2.35E-04	4.53E-04	Not detected
	Sep. 3 – Oct. 1	2.68E-04	1.44E-04	2.38E-04	Detected
	Oct. 1 – Oct. 15	1.47E-05	1.34E-04	3.45E-04	Not detected
	Oct. 15 – Nov. 10	4.38E-05	1.49E-04	3.60E-04	Not detected
	Nov. 10 – Dec. 8	3.30E-04	1.53E-04	2.34E-04	Detected
	Dec. 8 – Dec. 31	1.15E-04	1.32E-04	2.86E-04	Not detected
	Dec. 31 – Jan. 14	2.48E-04	3.55E-04	7.94E-04	Not detected
$^{239+240}$Pu	Jan. 10 – Jan. 31	0.00E+00	3.84E-04	1.03E-03	Not detected
	Jan. 31 – Feb. 21	2.29E-04	3.01E-04	6.59E-04	Not detected
	Feb. 21 – Mar. 18	1.63E-04	2.18E-04	4.73E-04	Not detected
	Mar. 18 – Apr. 3	3.36E-04	3.17E-04	6.32E-04	Not detected
	Apr. 3 – Apr. 30	2.86E-04	1.81E-04	2.22E-04	Detected
	Apr. 30 – May. 19	1.72E-04	1.84E-04	3.84E-04	Not detected
	May 19 – Jun. 11	4.88E-04	1.92E-04	2.48E-04	Detected
	Jun. 11 – Jul. 2	2.53E-04	1.94E-04	3.64E-04	Not detected
	Jul. 2 – Jul. 30	2.67E-04	1.66E-04	2.65E-04	Detected
	Jul. 30 – Aug. 20	2.84E-04	1.76E-04	2.91E-04	Not detected
	Aug. 20 – Sep. 3	3.44E-04	2.78E-04	4.37E-04	Not detected
	Sep. 3 – Oct. 1	7.21E-04	2.17E-04	1.97E-04	Detected
	Oct. 1 – Oct. 15	4.22E-04	2.60E-04	3.62E-04	Detected
	Oct. 15 – Nov. 10	1.36E-04	1.53E-04	3.20E-04	Not detected
	Nov. 10 – Dec. 8	3.58E-04	1.93E-04	2.66E-04	Detected
	Dec. 8 – Dec. 31	2.53E-04	1.51E-04	2.36E-04	Detected

Table B.24. Specific activity of ^{241}Am, $^{239+240}Pu$, and ^{238}Pu in the filter samples collected from East Tower station (continued)

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
$^{239+240}Pu$	Dec. 31 – Jan. 14	1.30E-04	3.14E-04	7.57E-04	Not detected
^{238}Pu	Jan. 10 – Jan. 31	-1.54E-04	4.23E-04	1.20E-03	Not detected
	Jan. 31 – Feb. 21	-1.31E-04	2.63E-04	7.70E-04	Not detected
	Feb. 21 – Mar. 18	-2.17E-04	1.74E-04	6.10E-04	Not detected
	Mar. 18 – Apr. 3	-3.36E-04	2.54E-04	8.57E-04	Not detected
	Apr. 3 – Apr. 30	-9.54E-05	2.03E-04	5.85E-04	Not detected
	Apr. 30 – May. 19	-9.54E-05	1.48E-04	4.49E-04	Not detected
	May 19 – Jun. 11	-9.24E-05	7.98E-05	2.81E-04	Not detected
	Jun. 11 – Jul. 2	-1.09E-04	1.36E-04	4.25E-04	Not detected
	Jul. 2 – Jul. 30	-5.01E-05	1.38E-04	3.93E-04	Not detected
	Jul. 30 – Aug. 20	-8.35E-05	1.21E-04	3.75E-04	Not detected
	Aug. 20 – Sep. 3	-2.74E-04	2.72E-04	9.09E-04	Not detected
	Sep. 3 – Oct. 1	-3.73E-05	1.03E-04	2.92E-04	Not detected
	Oct. 1 – Oct. 15	-1.20E-04	2.26E-04	6.76E-04	Not detected
	Oct. 15 – Nov. 10	-1.19E-04	1.03E-04	3.62E-04	Not detected
	Nov. 10 – Dec. 8	-3.77E-05	1.07E-04	3.28E-04	Not detected
	Dec. 8 – Dec. 31	-1.34E-04	1.30E-04	4.07E-04	Not detected
	Dec. 31 – Jan. 14	-1.30E-04	2.30E-04	7.57E-04	Not detected

Table B.25. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Onsite station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{234}U	Jan. 10 – Jan. 31	1.10E-06	1.84E-07	2.46E-08	Detected
	Jan. 31 – Feb. 21	6.00E-07	1.47E-07	5.01E-08	Detected
	Feb. 21 – Mar. 18	1.75E-06	2.63E-07	2.88E-08	Detected
	Mar. 18 – Apr. 3	1.88E-06	3.11E-07	5.45E-08	Detected
	Apr. 3 – Apr. 30	1.76E-06	2.60E-07	2.42E-08	Detected
	Apr. 30 – May. 19	3.14E-06	4.16E-07	2.15E-08	Detected
	May 19 – Jun. 11	2.60E-06	3.51E-07	2.85E-08	Detected
	Jun. 11 – Jul. 2	2.38E-06	3.36E-07	3.32E-08	Detected
	Jul. 2 – Jul. 30	1.88E-06	2.75E-07	2.20E-08	Detected
	Jul. 30 – Aug. 20	1.54E-06	2.82E-07	5.61E-08	Detected
	Aug. 20 – Sep. 3	1.65E-06	2.88E-07	4.89E-08	Detected
	Sep. 3 – Oct. 1	2.20E-06	3.09E-07	2.08E-08	Detected
	Oct. 1 – Oct. 15	2.63E-06	4.02E-07	3.93E-08	Detected
	Oct. 15 – Nov. 10	2.51E-06	3.61E-07	3.02E-08	Detected
	Nov. 10 – Dec. 8	2.75E-06	3.90E-07	3.06E-08	Detected
	Dec. 8 – Dec. 31	2.56E-06	3.41E-07	2.61E-08	Detected
	Dec. 31 – Jan. 14	1.41E-06	2.41E-07	3.85E-08	Detected
^{235}U	Jan. 10 – Jan. 31	3.22E-08	2.09E-08	2.90E-08	Detected
	Jan. 31 – Feb. 21	5.46E-08	2.86E-08	2.92E-08	Detected
	Feb. 21 – Mar. 18	8.22E-08	3.04E-08	3.39E-08	Detected
	Mar. 18 – Apr. 3	6.95E-08	3.55E-08	3.59E-08	Detected
	Apr. 3 – Apr. 30	9.51E-08	2.91E-08	2.11E-08	Detected
	Apr. 30 – May. 19	1.14E-07	3.29E-08	2.24E-08	Detected
	May 19 – Jun. 11	1.15E-07	3.15E-08	1.87E-08	Detected
	Jun. 11 – Jul. 2	9.28E-08	3.07E-08	2.19E-08	Detected
	Jul. 2 – Jul. 30	8.88E-08	2.92E-08	2.28E-08	Detected
	Jul. 30 – Aug. 20	4.38E-08	3.21E-08	3.69E-08	Detected
	Aug. 20 – Sep. 3	7.38E-08	3.53E-08	3.22E-08	Detected
	Sep. 3 – Oct. 1	1.08E-07	3.11E-08	2.16E-08	Detected
	Oct. 1 – Oct. 15	1.39E-07	4.82E-08	4.08E-08	Detected
	Oct. 15 – Nov. 10	9.85E-08	3.64E-08	3.72E-08	Detected
	Nov. 10 – Dec. 8	1.24E-07	4.05E-08	3.77E-08	Detected
	Dec. 8 – Dec. 31	2.45E-07	4.56E-08	1.61E-08	Detected

Table B.25. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Onsite station (continued)

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{235}U	Dec. 31 – Jan. 14	7.11E-08	2.92E-08	2.09E-08	Detected
^{238}U	Jan. 10 – Jan. 31	1.04E-06	1.79E-07	2.22E-08	Detected
	Jan. 31 – Feb. 21	5.23E-07	1.38E-07	5.25E-08	Detected
	Feb. 21 – Mar. 18	1.56E-06	2.42E-07	2.60E-08	Detected
	Mar. 18 – Apr. 3	1.80E-06	3.01E-07	3.86E-08	Detected
	Apr. 3 – Apr. 30	1.62E-06	2.45E-07	2.94E-08	Detected
	Apr. 30 – May. 19	2.87E-06	3.87E-07	2.56E-08	Detected
	May 19 – Jun. 11	2.16E-06	3.04E-07	2.02E-08	Detected
	Jun. 11 – Jul. 2	2.23E-06	3.19E-07	2.36E-08	Detected
	Jul. 2 – Jul. 30	1.62E-06	2.48E-07	2.61E-08	Detected
	Jul. 30 – Aug. 20	1.30E-06	2.54E-07	3.98E-08	Detected
	Aug. 20 – Sep. 3	1.69E-06	2.93E-07	3.47E-08	Detected
	Sep. 3 – Oct. 1	2.10E-06	2.98E-07	2.47E-08	Detected
	Oct. 1 – Oct. 15	2.60E-06	3.99E-07	4.66E-08	Detected
	Oct. 15 – Nov. 10	2.47E-06	3.57E-07	3.21E-08	Detected
	Nov. 10 – Dec. 8	2.58E-06	3.71E-07	3.26E-08	Detected
	Dec. 8 – Dec. 31	2.29E-06	3.13E-07	3.09E-08	Detected
	Dec. 31 – Jan. 14	1.23E-06	2.21E-07	4.90E-08	Detected

Table B.26. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Near Field station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{234}U	Jan. 10 – Jan. 31	1.14E-06	1.89E-07	7.88E-09	Detected
	Jan. 31 – Feb. 21	6.74E-07	1.57E-07	3.60E-08	Detected
	Feb. 21 – Mar. 18	1.18E-06	2.00E-07	8.67E-09	Detected
	Mar. 18 – Apr. 3	1.40E-06	2.35E-07	2.77E-08	Detected
	Apr. 3 – Apr. 30	1.71E-06	2.54E-07	2.04E-08	Detected
	Apr. 30 – May. 19	1.84E-06	2.71E-07	2.86E-08	Detected
	May 19 – Jun. 11	2.03E-06	2.91E-07	2.32E-08	Detected
	Jun. 11 – Jul. 2	1.89E-06	2.73E-07	2.13E-08	Detected
	Jul. 2 – Jul. 30	2.04E-06	2.92E-07	2.85E-08	Detected
	Jul. 30 – Aug. 20	1.37E-06	2.32E-07	3.19E-08	Detected
	Aug. 20 – Sep. 3	1.24E-06	2.23E-07	2.98E-08	Detected
	Sep. 3 – Oct. 1	1.95E-06	2.77E-07	2.47E-08	Detected
	Oct. 1 – Oct. 15	2.75E-06	4.16E-07	5.25E-08	Detected
	Oct. 15 – Nov. 10	1.90E-06	2.96E-07	5.36E-08	Detected
	Nov. 10 – Dec. 8	2.40E-06	3.42E-07	2.77E-08	Detected
	Dec. 8 – Dec. 31	2.79E-06	3.67E-07	2.83E-08	Detected
	Dec. 31 – Jan. 14	1.27E-06	2.50E-07	3.90E-08	Detected
^{235}U	Jan. 10 – Jan. 31	3.87E-08	1.93E-08	9.72E-09	Detected
	Jan. 31 – Feb. 21	2.65E-08	2.32E-08	2.65E-08	Not detected
	Feb. 21 – Mar. 18	6.22E-08	2.42E-08	1.07E-08	Detected
	Mar. 18 – Apr. 3	9.11E-08	3.14E-08	1.58E-08	Detected
	Apr. 3 – Apr. 30	6.60E-08	2.49E-08	2.12E-08	Detected
	Apr. 30 – May. 19	7.59E-08	2.72E-08	2.41E-08	Detected
	May 19 – Jun. 11	1.29E-07	3.39E-08	1.32E-08	Detected
	Jun. 11 – Jul. 2	7.18E-08	2.47E-08	1.21E-08	Detected
	Jul. 2 – Jul. 30	8.81E-08	2.88E-08	2.40E-08	Detected
	Jul. 30 – Aug. 20	7.57E-08	3.03E-08	1.82E-08	Detected
	Aug. 20 – Sep. 3	7.26E-08	2.97E-08	1.70E-08	Detected
	Sep. 3 – Oct. 1	7.95E-08	2.58E-08	2.08E-08	Detected
	Oct. 1 – Oct. 15	1.24E-07	4.66E-08	4.43E-08	Detected
	Oct. 15 – Nov. 10	1.16E-07	3.80E-08	2.47E-08	Detected
	Nov. 10 – Dec. 8	1.82E-07	4.49E-08	2.55E-08	Detected
	Dec. 8 – Dec. 31	9.70E-08	2.74E-08	1.12E-08	Detected

Table B.26. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Near Field station (continued)

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{235}U	Dec. 31 – Jan. 14	3.62E-08	3.21E-08	4.38E-08	Not detected
^{238}U	Jan. 10 – Jan. 31	9.00E-07	1.68E-07	7.85E-08	Detected
	Jan. 31 – Feb. 21	6.78E-07	1.58E-07	4.19E-08	Detected
	Feb. 21 – Mar. 18	9.36E-07	1.77E-07	8.64E-08	Detected
	Mar. 18 – Apr. 3	1.20E-06	2.14E-07	3.23E-08	Detected
	Apr. 3 – Apr. 30	1.42E-06	2.22E-07	2.42E-08	Detected
	Apr. 30 – May. 19	1.56E-06	2.40E-07	3.67E-08	Detected
	May 19 – Jun. 11	1.85E-06	2.72E-07	2.70E-08	Detected
	Jun. 11 – Jul. 2	1.63E-06	2.45E-07	2.48E-08	Detected
	Jul. 2 – Jul. 30	1.77E-06	2.63E-07	3.65E-08	Detected
	Jul. 30 – Aug. 20	1.24E-06	2.17E-07	3.71E-08	Detected
	Aug. 20 – Sep. 3	1.18E-06	2.17E-07	3.47E-08	Detected
	Sep. 3 – Oct. 1	1.81E-06	2.61E-07	3.17E-08	Detected
	Oct. 1 – Oct. 15	2.60E-06	4.01E-07	6.74E-08	Detected
	Oct. 15 – Nov. 10	1.76E-06	2.80E-07	5.80E-08	Detected
	Nov. 10 – Dec. 8	2.31E-06	3.32E-07	3.13E-08	Detected
	Dec. 8 – Dec. 31	2.38E-06	3.23E-07	2.90E-08	Detected
	Dec. 31 – Jan. 14	1.27E-06	2.50E-07	5.00E-08	Detected

Table B.27. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Cactus Flats station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{234}U	Jan. 10 – Jan. 31	1.07E-06	1.84E-07	3.03E-08	Detected
	Jan. 31 – Feb. 21	7.11E-07	1.53E-07	2.99E-08	Detected
	Feb. 21 – Mar. 18	1.26E-06	2.08E-07	3.07E-08	Detected
	Mar. 18 – Apr. 3	1.16E-06	2.22E-07	5.55E-08	Detected
	Apr. 3 – Apr. 30	6.62E-07	1.12E-07	1.85E-08	Detected
	Apr. 30 – May. 19	1.53E-06	2.34E-07	2.10E-08	Detected
	May 19 – Jun. 11	1.64E-06	2.48E-07	3.29E-08	Detected
	Jun. 11 – Jul. 2	1.61E-06	2.44E-07	3.24E-08	Detected
	Jul. 2 – Jul. 30	6.58E-07	1.06E-07	1.11E-08	Detected
	Jul. 30 – Aug. 20	1.43E-06	2.41E-07	4.80E-08	Detected
	Aug. 20 – Sep. 3	9.89E-07	1.94E-07	4.19E-08	Detected
	Sep. 3 – Oct. 1	8.56E-07	1.29E-07	1.19E-08	Detected
	Oct. 1 – Oct. 15	2.09E-06	3.31E-07	3.89E-08	Detected
	Oct. 15 – Nov. 10	2.14E-06	3.14E-07	2.85E-08	Detected
	Nov. 10 – Dec. 8	2.81E-06	3.97E-07	4.26E-08	Detected
	Dec. 8 – Dec. 31	2.51E-06	3.47E-07	2.54E-08	Detected
	Dec. 31 – Jan. 14	1.64E-06	2.98E-07	3.48E-08	Detected
^{235}U	Jan. 10 – Jan. 31	4.59E-08	2.24E-08	2.25E-08	Detected
	Jan. 31 – Feb. 21	4.19E-08	2.27E-08	1.61E-08	Detected
	Feb. 21 – Mar. 18	5.96E-08	2.48E-08	2.27E-08	Detected
	Mar. 18 – Apr. 3	5.74E-08	3.23E-08	3.74E-08	Detected
	Apr. 3 – Apr. 30	3.74E-08	1.53E-08	1.56E-08	Detected
	Apr. 30 – May. 19	7.59E-08	2.51E-08	1.20E-08	Detected
	May 19 – Jun. 11	8.14E-08	2.77E-08	2.22E-08	Detected
	Jun. 11 – Jul. 2	5.24E-08	2.32E-08	2.19E-08	Detected
	Jul. 2 – Jul. 30	3.20E-08	1.20E-08	6.34E-09	Detected
	Jul. 30 – Aug. 20	4.32E-08	2.69E-08	3.24E-08	Detected
	Aug. 20 – Sep. 3	5.12E-08	2.71E-08	2.83E-08	Detected
	Sep. 3 – Oct. 1	4.43E-08	1.42E-08	6.75E-09	Detected
	Oct. 1 – Oct. 15	1.20E-07	4.16E-08	2.21E-08	Detected
	Oct. 15 – Nov. 10	8.82E-08	3.20E-08	2.63E-08	Detected
	Nov. 10 – Dec. 8	1.71E-07	4.59E-08	2.80E-08	Detected
	Dec. 8 – Dec. 31	1.12E-07	3.19E-08	1.68E-08	Detected

Table B.27. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Cactus Flats station (continued)

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{235}U	Dec. 31 – Jan. 14	9.26E-08	4.05E-08	2.51E-08	Detected
^{238}U	Jan. 10 – Jan. 31	9.83E-07	1.76E-07	5.18E-08	Detected
	Jan. 31 – Feb. 21	6.89E-07	1.50E-07	3.42E-08	Detected
	Feb. 21 – Mar. 18	9.94E-07	1.79E-07	5.25E-08	Detected
	Mar. 18 – Apr. 3	1.06E-06	2.11E-07	5.83E-08	Detected
	Apr. 3 – Apr. 30	6.39E-07	1.09E-07	2.38E-08	Detected
	Apr. 30 – May. 19	1.40E-06	2.19E-07	2.22E-08	Detected
	May 19 – Jun. 11	1.49E-06	2.32E-07	3.24E-08	Detected
	Jun. 11 – Jul. 2	1.44E-06	2.26E-07	3.41E-08	Detected
	Jul. 2 – Jul. 30	6.26E-07	1.02E-07	1.17E-08	Detected
	Jul. 30 – Aug. 20	1.39E-06	2.36E-07	5.04E-08	Detected
	Aug. 20 – Sep. 3	7.89E-07	1.72E-07	4.40E-08	Detected
	Sep. 3 – Oct. 1	7.86E-07	1.21E-07	1.25E-08	Detected
	Oct. 1 – Oct. 15	1.83E-06	3.01E-07	4.10E-08	Detected
	Oct. 15 – Nov. 10	1.98E-06	2.97E-07	3.22E-08	Detected
	Nov. 10 – Dec. 8	2.76E-06	3.91E-07	5.27E-08	Detected
	Dec. 8 – Dec. 31	2.50E-06	3.46E-07	1.97E-08	Detected
	Dec. 31 – Jan. 14	1.58E-06	4.05E-08	2.51E-08	Detected

Table B.28. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Loving station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{234}U	Jan. 10 – Jan. 31	1.24E-06	2.01E-07	3.05E-08	Detected
	Jan. 31 – Feb. 21	9.41E-07	1.81E-07	3.34E-08	Detected
	Feb. 21 – Mar. 18	1.36E-06	2.20E-07	3.46E-08	Detected
	Mar. 18 – Apr. 3	1.62E-06	2.76E-07	4.42E-08	Detected
	Apr. 3 – Apr. 30	1.95E-06	2.78E-07	2.04E-08	Detected
	Apr. 30 – May. 19	2.36E-06	3.26E-07	2.96E-08	Detected
	May 19 – Jun. 11	2.18E-06	3.11E-07	2.78E-08	Detected
	Jun. 11 – Jul. 2	2.19E-06	3.03E-07	2.22E-08	Detected
	Jul. 2 – Jul. 30	1.18E-06	1.61E-07	1.36E-08	Detected
	Jul. 30 – Aug. 20	1.91E-06	2.91E-07	3.38E-08	Detected
	Aug. 20 – Sep. 3	1.70E-06	2.76E-07	3.46E-08	Detected
	Sep. 3 – Oct. 1	2.64E-06	3.69E-07	3.74E-08	Detected
	Oct. 1 – Oct. 15	3.28E-06	4.69E-07	5.18E-08	Detected
	Oct. 15 – Nov. 10	2.77E-06	3.96E-07	4.60E-08	Detected
	Nov. 10 – Dec. 8	2.76E-06	3.97E-07	4.78E-08	Detected
	Dec. 8 – Dec. 31	3.13E-06	4.02E-07	2.14E-08	Detected
	Dec. 31 – Jan. 14	1.43E-06	2.41E-07	3.06E-08	Detected
^{235}U	Jan. 10 – Jan. 31	5.67E-08	2.38E-08	2.33E-08	Detected
	Jan. 31 – Feb. 21	3.66E-08	2.36E-08	2.59E-08	Detected
	Feb. 21 – Mar. 18	6.72E-08	2.70E-08	2.63E-08	Detected
	Mar. 18 – Apr. 3	5.97E-08	3.34E-08	3.86E-08	Detected
	Apr. 3 – Apr. 30	7.44E-08	2.46E-08	1.16E-08	Detected
	Apr. 30 – May. 19	9.97E-08	3.02E-08	2.19E-08	Detected
	May 19 – Jun. 11	1.26E-07	3.53E-08	2.42E-08	Detected
	Jun. 11 – Jul. 2	6.82E-08	2.42E-08	1.94E-08	Detected
	Jul. 2 – Jul. 30	4.81E-08	1.43E-08	1.01E-08	Detected
	Jul. 30 – Aug. 20	9.51E-08	3.40E-08	2.95E-08	Detected
	Aug. 20 – Sep. 3	7.09E-08	3.14E-08	3.01E-08	Detected
	Sep. 3 – Oct. 1	1.16E-07	3.60E-08	2.77E-08	Detected
	Oct. 1 – Oct. 15	1.60E-07	4.99E-08	3.83E-08	Detected
	Oct. 15 – Nov. 10	1.60E-07	4.60E-08	3.03E-08	Detected
	Nov. 10 – Dec. 8	1.14E-07	4.12E-08	4.34E-08	Detected
	Dec. 8 – Dec. 31	1.35E-07	3.26E-08	2.26E-08	Detected

Table B.28. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Loving station (continued)

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{235}U	Dec. 31 – Jan. 14	6.82E-08	2.91E-08	2.67E-08	Detected
^{238}U	Jan. 10 – Jan. 31	1.26E-06	2.04E-07	3.04E-08	Detected
	Jan. 31 – Feb. 21	9.37E-07	1.80E-07	3.48E-08	Detected
	Feb. 21 – Mar. 18	1.20E-06	2.03E-07	3.44E-08	Detected
	Mar. 18 – Apr. 3	1.57E-06	2.71E-07	5.36E-08	Detected
	Apr. 3 – Apr. 30	1.80E-06	2.61E-07	2.15E-08	Detected
	Apr. 30 – May. 19	2.16E-06	3.05E-07	2.85E-08	Detected
	May 19 – Jun. 11	1.99E-06	2.91E-07	3.37E-08	Detected
	Jun. 11 – Jul. 2	1.79E-06	2.60E-07	2.69E-08	Detected
	Jul. 2 – Jul. 30	9.68E-07	1.39E-07	1.31E-08	Detected
	Jul. 30 – Aug. 20	1.80E-06	2.78E-07	4.10E-08	Detected
	Aug. 20 – Sep. 3	1.73E-06	2.80E-07	4.19E-08	Detected
	Sep. 3 – Oct. 1	2.49E-06	3.52E-07	3.59E-08	Detected
	Oct. 1 – Oct. 15	3.04E-06	4.43E-07	4.97E-08	Detected
	Oct. 15 – Nov. 10	2.53E-06	3.69E-07	5.69E-08	Detected
	Nov. 10 – Dec. 8	2.63E-06	3.83E-07	5.26E-08	Detected
	Dec. 8 – Dec. 31	2.72E-06	3.58E-07	2.22E-08	Detected
	Dec. 31 – Jan. 14	1.31E-06	2.28E-07	3.71E-08	Detected

Table B.29. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Carlsbad station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{234}U	Jan. 10 – Jan. 31	7.70E-07	1.59E-07	4.21E-08	Detected
	Jan. 31 – Feb. 21	6.98E-07	1.55E-07	3.64E-08	Detected
	Feb. 21 – Mar. 18	9.65E-07	1.75E-07	3.39E-08	Detected
	Mar. 18 – Apr. 3	1.12E-06	2.13E-07	5.77E-08	Detected
	Apr. 3 – Apr. 30	1.43E-06	2.24E-07	2.84E-08	Detected
	Apr. 30 – May. 19	1.79E-06	2.57E-07	2.51E-08	Detected
	May 19 – Jun. 11	2.03E-06	2.93E-07	3.93E-08	Detected
	Jun. 11 – Jul. 2	1.89E-06	2.82E-07	4.26E-08	Detected
	Jul. 2 – Jul. 30	2.31E-06	3.15E-07	2.72E-08	Detected
	Jul. 30 – Aug. 20	1.70E-06	2.56E-07	3.81E-08	Detected
	Aug. 20 – Sep. 3	1.25E-06	2.27E-07	4.84E-08	Detected
	Sep. 3 – Oct. 1	2.01E-06	2.90E-07	3.30E-08	Detected
	Oct. 1 – Oct. 15	3.04E-06	4.55E-07	5.95E-07	Detected
	Oct. 15 – Nov. 10	2.47E-06	3.45E-07	3.41E-08	Detected
	Nov. 10 – Dec. 8	2.25E-06	3.25E-07	4.39E-08	Detected
	Dec. 8 – Dec. 31	2.70E-06	3.60E-07	2.04E-08	Detected
	Dec. 31 – Jan. 14	9.27E-07	1.92E-07	4.51E-08	Detected
^{235}U	Jan. 10 – Jan. 31	4.06E-08	2.34E-08	2.15E-08	Detected
	Jan. 31 – Feb. 21	3.14E-08	2.24E-08	2.30E-08	Detected
	Feb. 21 – Mar. 18	5.00E-08	2.26E-08	1.73E-08	Detected
	Mar. 18 – Apr. 3	3.77E-08	2.52E-08	2.01E-08	Detected
	Apr. 3 – Apr. 30	5.87E-08	2.37E-08	2.10E-08	Detected
	Apr. 30 – May. 19	8.29E-08	2.49E-08	1.55E-08	Detected
	May 19 – Jun. 11	1.01E-07	3.04E-08	1.37E-08	Detected
	Jun. 11 – Jul. 2	8.19E-08	2.86E-08	1.49E-08	Detected
	Jul. 2 – Jul. 30	1.30E-07	3.21E-08	1.68E-08	Detected
	Jul. 30 – Aug. 20	7.95E-08	2.69E-08	1.33E-08	Detected
	Aug. 20 – Sep. 3	3.81E-08	2.39E-08	1.69E-08	Detected
	Sep. 3 – Oct. 1	9.62E-08	3.00E-08	2.03E-08	Detected
	Oct. 1 – Oct. 15	1.78E-07	5.43E-08	3.67E-08	Detected
	Oct. 15 – Nov. 10	1.17E-07	3.53E-08	3.10E-08	Detected
	Nov. 10 – Dec. 8	1.06E-07	3.34E-08	2.03E-08	Detected
	Dec. 8 – Dec. 31	1.13E-07	3.05E-08	1.76E-08	Detected

Table B.29. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{235}U	Dec. 31 – Jan. 14	4.36E-08	2.85E-08	3.72E-08	Detected
^{238}U	Jan. 10 – Jan. 31	7.03E-07	1.52E-07	4.31E-08	Detected
	Jan. 31 – Feb. 21	6.49E-07	1.49E-07	4.07E-08	Detected
	Feb. 21 – Mar. 18	9.39E-07	1.72E-07	3.47E-08	Detected
	Mar. 18 – Apr. 3	1.09E-06	2.10E-07	5.49E-08	Detected
	Apr. 3 – Apr. 30	1.29E-06	2.08E-07	2.18E-08	Detected
	Apr. 30 – May. 19	1.71E-06	2.49E-07	2.98E-08	Detected
	May 19 – Jun. 11	1.86E-06	2.75E-07	3.74E-08	Detected
	Jun. 11 – Jul. 2	1.70E-06	2.60E-07	4.05E-08	Detected
	Jul. 2 – Jul. 30	2.02E-06	2.85E-07	3.22E-08	Detected
	Jul. 30 – Aug. 20	1.51E-06	2.35E-07	3.63E-08	Detected
	Aug. 20 – Sep. 3	1.20E-06	2.22E-07	4.61E-08	Detected
	Sep. 3 – Oct. 1	1.88E-06	2.77E-07	3.91E-08	Detected
	Oct. 1 – Oct. 15	2.96E-06	4.46E-07	7.06E-08	Detected
	Oct. 15 – Nov. 10	2.15E-06	3.09E-07	3.75E-08	Detected
	Nov. 10 – Dec. 8	2.10E-06	9.53E-09	1.77E-08	Detected
	Dec. 8 – Dec. 31	2.47E-06	9.53E-09	1.44E-08	Detected
	Dec. 31 – Jan. 14	9.66E-07	1.13E-08	2.67E-08	Detected

Table B.30. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from East Tower station

Radionuclide	Sample Date 2020	Activity Bq/m³	Unc. (2σ) Bq/m³	MDC Bq/m³	Status
^{234}U	Jan. 10 – Jan. 31	2.08E-06	4.69E-07	8.91E-08	Detected
	Jan. 31 – Feb. 21	7.93E-07	1.71E-07	4.23E-08	Detected
	Feb. 21 – Mar. 18	1.59E-06	2.65E-07	2.93E-08	Detected
	Mar. 18 – Apr. 3	1.98E-06	3.62E-07	6.42E-08	Detected
	Apr. 3 – Apr. 30	1.41E-06	2.26E-07	2.98E-08	Detected
	Apr. 30 – May. 19	1.62E-06	2.49E-07	3.18E-08	Detected
	May 19 – Jun. 11	2.08E-06	2.96E-07	2.35E-08	Detected
	Jun. 11 – Jul. 2	2.06E-06	2.99E-07	2.69E-08	Detected
	Jul. 2 – Jul. 30	1.74E-06	2.61E-07	3.36E-08	Detected
	Jul. 30 – Aug. 20	1.46E-06	2.31E-07	2.64E-08	Detected
	Aug. 20 – Sep. 3	1.46E-06	2.54E-07	3.37E-08	Detected
	Sep. 3 – Oct. 1	2.07E-06	2.99E-07	3.24E-04	Not detected
	Oct. 1 – Oct. 15	2.70E-06	4.11E-07	6.00E-08	Detected
	Oct. 15 – Nov. 10	2.43E-06	3.56E-07	2.45E-08	Detected
	Nov. 10 – Dec. 8	2.56E-06	3.82E-07	2.81E-08	Detected
	Dec. 8 – Dec. 31	2.68E-06	3.57E-07	1.42E-08	Detected
	Dec. 31 – Jan. 14	1.33E-06	2.43E-07	2.60E-08	Detected
^{235}U	Jan. 10 – Jan. 31	1.35E-07	7.04E-08	4.55E-08	Detected
	Jan. 31 – Feb. 21	2.55E-08	2.38E-08	3.25E-08	Not detected
	Feb. 21 – Mar. 18	7.18E-08	3.27E-08	3.30E-08	Detected
	Mar. 18 – Apr. 3	6.94E-09	3.20E-08	5.24E-08	Not detected
	Apr. 3 – Apr. 30	4.89E-08	2.22E-08	1.84E-08	Detected
	Apr. 30 – May. 19	9.89E-08	2.93E-08	1.26E-08	Detected
	May 19 – Jun. 11	7.44E-08	2.61E-08	1.92E-08	Detected
	Jun. 11 – Jul. 2	8.99E-08	3.01E-08	2.19E-08	Detected
	Jul. 2 – Jul. 30	1.21E-07	3.28E-08	1.33E-08	Detected
	Jul. 30 – Aug. 20	6.34E-08	2.58E-08	2.15E-08	Detected
	Aug. 20 – Sep. 3	6.40E-08	3.04E-08	2.75E-08	Detected
	Sep. 3 – Oct. 1	8.83E-08	2.98E-08	2.40E-08	Detected
	Oct. 1 – Oct. 15	1.43E-07	4.72E-08	2.37E-08	Detected
	Oct. 15 – Nov. 10	9.69E-08	3.56E-08	2.58E-08	Detected
	Nov. 10 – Dec. 8	9.24E-08	3.73E-08	2.95E-08	Detected
	Dec. 8 – Dec. 31	1.16E-07	3.14E-08	2.34E-08	Detected

Table B.30. Activity concentrations of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from East Tower station (continued)

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{235}U	Dec. 31 – Jan. 14	3.98E-08	3.04E-08	4.28E-08	Not detected
^{238}U	Jan. 10 – Jan. 31	1.95E-06	4.55E-07	9.29E-08	Detected
	Jan. 31 – Feb. 21	7.93E-07	1.71E-07	4.79E-08	Detected
	Feb. 21 – Mar. 18	1.20E-06	2.21E-07	3.76E-08	Detected
	Mar. 18 – Apr. 3	1.68E-06	3.30E-07	7.93E-08	Detected
	Apr. 3 – Apr. 30	1.32E-06	2.17E-07	3.53E-08	Detected
	Apr. 30 – May. 19	1.60E-06	2.47E-07	3.26E-08	Detected
	May 19 – Jun. 11	1.87E-06	2.73E-07	2.90E-08	Detected
	Jun. 11 – Jul. 2	1.78E-06	2.69E-07	3.32E-08	Detected
	Jul. 2 – Jul. 30	1.69E-06	2.55E-07	3.44E-08	Detected
	Jul. 30 – Aug. 20	1.39E-06	2.24E-07	3.25E-08	Detected
	Aug. 20 – Sep. 3	1.26E-06	2.32E-07	4.16E-08	Detected
	Sep. 3 – Oct. 1	2.02E-06	2.92E-07	2.45E-08	Detected
	Oct. 1 – Oct. 15	2.65E-06	4.05E-07	6.14E-08	Detected
	Oct. 15 – Nov. 10	2.39E-06	3.52E-07	3.26E-08	Detected
	Nov. 10 – Dec. 8	2.36E-06	3.58E-07	3.74E-08	Detected
	Dec. 8 – Dec. 31	2.31E-06	3.17E-07	2.14E-08	Detected
	Dec. 31 – Jan. 14	1.21E-06	2.30E-07	3.45E-08	Detected

Table B.31. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Onsite station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{234}U	Jan. 10 – Jan. 31	2.45E-02	4.11E-03	5.50E-04	Detected
	Jan. 31 – Feb. 21	2.22E-02	5.43E-03	1.85E-03	Detected
	Feb. 21 – Mar. 18	2.86E-02	4.30E-03	4.70E-04	Detected
	Mar. 18 – Apr. 3	2.86E-02	4.75E-03	8.32E-04	Detected
	Apr. 3 – Apr. 30	2.25E-02	3.32E-03	3.09E-04	Detected
	Apr. 30 – May. 19	2.75E-02	3.64E-03	1.89E-04	Detected
	May 19 – Jun. 11	2.76E-02	3.74E-03	3.03E-04	Detected
	Jun. 11 – Jul. 2	2.65E-02	3.74E-03	3.69E-04	Detected
	Jul. 2 – Jul. 30	2.60E-02	3.81E-03	3.04E-04	Detected
	Jul. 30 – Aug. 20	3.04E-02	5.55E-03	1.11E-03	Detected
	Aug. 20 – Sep. 3	2.60E-02	4.56E-03	7.74E-04	Detected
	Sep. 3 – Oct. 1	2.56E-02	3.58E-03	2.41E-04	Detected
	Oct. 1 – Oct. 15	2.94E-02	4.48E-03	4.38E-04	Detected
	Oct. 15 – Nov. 10	3.01E-02	4.34E-03	3.62E-04	Detected
	Nov. 10 – Dec. 8	3.37E-02	4.78E-03	3.75E-04	Detected
	Dec. 8 – Dec. 31	3.24E-02	4.32E-03	3.31E-04	Detected
	Dec. 31 – Jan. 14	4.28E-02	7.30E-03	1.17E-03	Detected
^{235}U	Jan. 10 – Jan. 31	7.19E-04	4.65E-04	6.47E-04	Detected
	Jan. 31 – Feb. 21	2.02E-03	1.05E-03	1.08E-03	Detected
	Feb. 21 – Mar. 18	1.34E-03	4.96E-04	5.53E-04	Detected
	Mar. 18 – Apr. 3	1.06E-03	5.42E-04	5.48E-04	Detected
	Apr. 3 – Apr. 30	1.22E-03	3.71E-04	2.70E-04	Detected
	Apr. 30 – May. 19	1.00E-03	2.88E-04	1.96E-04	Detected
	May 19 – Jun. 11	1.22E-03	3.35E-04	1.99E-04	Detected
	Jun. 11 – Jul. 2	1.03E-03	3.41E-04	2.43E-04	Detected
	Jul. 2 – Jul. 30	1.23E-03	4.05E-04	3.16E-04	Detected
	Jul. 30 – Aug. 20	8.64E-04	6.33E-04	7.28E-04	Detected
	Aug. 20 – Sep. 3	1.17E-03	5.58E-04	5.09E-04	Detected
	Sep. 3 – Oct. 1	1.25E-03	3.61E-04	2.51E-04	Detected
	Oct. 1 – Oct. 15	1.55E-03	5.38E-04	4.56E-04	Detected
	Oct. 15 – Nov. 10	1.18E-03	4.38E-04	4.47E-04	Detected
	Nov. 10 – Dec. 8	1.53E-03	4.97E-04	4.63E-04	Detected
	Dec. 8 – Dec. 31	3.11E-03	5.78E-04	2.04E-04	Detected

Table B.31. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) at Onsite station (continued)

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
	Dec. 31 – Jan. 14	2.16E-03	8.87E-04	6.34E-04	Detected
^{238}U	Jan. 10 – Jan. 31	2.33E-02	3.99E-03	4.96E-04	Detected
	Jan. 31 – Feb. 21	1.93E-02	5.10E-03	1.94E-03	Detected
	Feb. 21 – Mar. 18	2.54E-02	3.95E-03	4.24E-04	Detected
	Mar. 18 – Apr. 3	2.74E-02	4.60E-03	5.90E-04	Detected
	Apr. 3 – Apr. 30	2.07E-02	3.13E-03	3.75E-04	Detected
	Apr. 30 – May. 19	2.51E-02	3.39E-03	2.24E-04	Detected
	May 19 – Jun. 11	2.30E-02	3.23E-03	2.15E-04	Detected
	Jun. 11 – Jul. 2	2.47E-02	3.54E-03	2.62E-04	Detected
	Jul. 2 – Jul. 30	2.25E-02	3.43E-03	3.61E-04	Detected
	Jul. 30 – Aug. 20	2.57E-02	5.01E-03	7.84E-04	Detected
	Aug. 20 – Sep. 3	2.68E-02	4.64E-03	5.49E-04	Detected
	Sep. 3 – Oct. 1	2.43E-02	3.45E-03	2.87E-04	Detected
	Oct. 1 – Oct. 15	2.91E-02	4.45E-03	5.20E-04	Detected
	Oct. 15 – Nov. 10	2.97E-02	4.29E-03	3.85E-04	Detected
	Nov. 10 – Dec. 8	3.17E-02	4.55E-03	3.99E-04	Detected
	Dec. 8 – Dec. 31	2.91E-02	3.97E-03	3.92E-04	Detected
	Dec. 31 – Jan. 14	3.73E-02	6.71E-03	1.49E-03	Detected

Table B.32. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Near Field station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{234}U	Jan. 10 – Jan. 31	2.94E-02	4.90E-03	2.04E-04	Detected
	Jan. 31 – Feb. 21	2.34E-02	5.47E-03	1.25E-03	Detected
	Feb. 21 – Mar. 18	3.39E-02	5.75E-03	2.50E-04	Detected
	Mar. 18 – Apr. 3	3.63E-02	6.12E-03	7.21E-04	Detected
	Apr. 3 – Apr. 30	3.31E-02	4.92E-03	3.94E-04	Detected
	Apr. 30 – May. 19	3.21E-02	4.72E-03	4.99E-04	Detected
	May 19 – Jun. 11	3.32E-02	4.76E-03	3.80E-04	Detected
	Jun. 11 – Jul. 2	3.27E-02	4.73E-03	3.68E-04	Detected
	Jul. 2 – Jul. 30	3.21E-02	4.58E-03	4.47E-04	Detected
	Jul. 30 – Aug. 20	2.92E-02	4.94E-03	6.79E-04	Detected
	Aug. 20 – Sep. 3	2.74E-02	4.94E-03	6.60E-04	Detected
	Sep. 3 – Oct. 1	2.80E-02	3.96E-03	3.54E-04	Detected
	Oct. 1 – Oct. 15	3.24E-02	4.92E-03	6.20E-04	Detected
	Oct. 15 – Nov. 10	3.37E-02	5.25E-03	9.50E-04	Detected
	Nov. 10 – Dec. 8	3.38E-02	4.81E-03	3.90E-04	Detected
	Dec. 8 – Dec. 31	3.67E-02	4.84E-03	3.73E-04	Detected
	Dec. 31 – Jan. 14	4.33E-02	8.52E-03	1.33E-03	Detected
^{235}U	Jan. 10 – Jan. 31	1.00E-03	4.98E-04	2.52E-04	Detected
	Jan. 31 – Feb. 21	9.21E-04	8.07E-04	9.22E-04	Not detected
	Feb. 21 – Mar. 18	1.79E-03	6.97E-04	3.08E-04	Detected
	Mar. 18 – Apr. 3	2.37E-03	8.16E-04	4.10E-04	Detected
	Apr. 3 – Apr. 30	1.28E-03	4.82E-04	4.10E-04	Detected
	Apr. 30 – May. 19	1.32E-03	4.74E-04	4.21E-04	Detected
	May 19 – Jun. 11	2.11E-03	5.55E-04	2.16E-04	Detected
	Jun. 11 – Jul. 2	1.24E-03	4.27E-04	2.10E-04	Detected
	Jul. 2 – Jul. 30	1.38E-03	4.52E-04	3.77E-04	Detected
	Jul. 30 – Aug. 20	1.61E-03	6.45E-04	3.87E-04	Detected
	Aug. 20 – Sep. 3	1.61E-03	6.58E-04	3.76E-04	Detected
	Sep. 3 – Oct. 1	1.14E-03	3.69E-04	2.98E-04	Detected
	Oct. 1 – Oct. 15	1.46E-03	5.50E-04	5.23E-04	Detected
	Oct. 15 – Nov. 10	2.05E-03	6.75E-04	4.38E-04	Detected
	Nov. 10 – Dec. 8	2.57E-03	6.32E-04	3.60E-04	Detected
	Dec. 8 – Dec. 31	1.28E-03	3.61E-04	1.47E-04	Detected

Table B.32. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Near Field station (continued)

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
	Dec. 31 – Jan. 14	1.23E-03	1.09E-03	1.49E-03	Not detected
^{238}U	Jan. 10 – Jan. 31	2.33E-02	4.33E-03	2.03E-03	Detected
	Jan. 31 – Feb. 21	2.36E-02	5.49E-03	1.46E-03	Detected
	Feb. 21 – Mar. 18	2.70E-02	5.08E-03	2.49E-03	Detected
	Mar. 18 – Apr. 3	3.13E-02	5.57E-03	8.39E-04	Detected
	Apr. 3 – Apr. 30	2.74E-02	4.31E-03	4.68E-04	Detected
	Apr. 30 – May. 19	2.72E-02	4.19E-03	6.41E-04	Detected
	May 19 – Jun. 11	3.03E-02	4.45E-03	4.42E-04	Detected
	Jun. 11 – Jul. 2	2.82E-02	4.24E-03	4.29E-04	Detected
	Jul. 2 – Jul. 30	2.79E-02	4.13E-03	5.74E-04	Detected
	Jul. 30 – Aug. 20	2.64E-02	4.62E-03	7.90E-04	Detected
	Aug. 20 – Sep. 3	2.61E-02	4.81E-03	7.68E-04	Detected
	Sep. 3 – Oct. 1	2.59E-02	3.74E-03	4.54E-04	Detected
	Oct. 1 – Oct. 15	3.07E-02	4.73E-03	7.96E-04	Detected
	Oct. 15 – Nov. 10	3.12E-02	4.96E-03	1.03E-03	Detected
	Nov. 10 – Dec. 8	3.26E-02	4.68E-03	4.40E-04	Detected
	Dec. 8 – Dec. 31	3.13E-02	4.26E-03	3.81E-04	Detected
	Dec. 31 – Jan. 14	4.33E-02	8.53E-03	1.70E-03	Detected

Table B.33. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Cactus Flats station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{234}U	Jan. 10 – Jan. 31	2.68E-02	4.61E-03	7.59E-04	Detected
	Jan. 31 – Feb. 21	2.97E-02	6.38E-03	1.25E-03	Detected
	Feb. 21 – Mar. 18	3.45E-02	5.67E-03	8.39E-04	Detected
	Mar. 18 – Apr. 3	3.57E-02	6.82E-03	1.71E-03	Detected
	Apr. 3 – Apr. 30	2.83E-02	4.76E-03	7.91E-04	Detected
	Apr. 30 – May. 19	3.12E-02	4.76E-03	4.28E-04	Detected
	May 19 – Jun. 11	3.21E-02	4.86E-03	6.44E-04	Detected
	Jun. 11 – Jul. 2	3.65E-02	5.54E-03	7.36E-04	Detected
	Jul. 2 – Jul. 30	3.02E-02	4.86E-03	5.11E-04	Detected
	Jul. 30 – Aug. 20	3.14E-02	5.29E-03	1.05E-03	Detected
	Aug. 20 – Sep. 3	3.10E-02	6.08E-03	1.31E-03	Detected
	Sep. 3 – Oct. 1	2.51E-02	3.77E-03	3.48E-04	Detected
	Oct. 1 – Oct. 15	3.29E-02	5.21E-03	6.12E-04	Detected
	Oct. 15 – Nov. 10	3.08E-02	4.53E-03	4.11E-04	Detected
	Nov. 10 – Dec. 8	3.23E-02	4.56E-03	4.90E-04	Detected
	Dec. 8 – Dec. 31	3.23E-02	4.47E-03	3.27E-04	Detected
	Dec. 31 – Jan. 14	3.84E-02	6.98E-03	8.16E-04	Detected
^{235}U	Jan. 10 – Jan. 31	1.15E-03	5.61E-04	5.62E-04	Detected
	Jan. 31 – Feb. 21	1.75E-03	9.52E-04	6.72E-04	Detected
	Feb. 21 – Mar. 18	1.63E-03	6.77E-04	6.21E-04	Detected
	Mar. 18 – Apr. 3	1.77E-03	9.94E-04	1.15E-03	Detected
	Apr. 3 – Apr. 30	1.60E-03	6.55E-04	6.67E-04	Detected
	Apr. 30 – May. 19	1.54E-03	5.12E-04	2.44E-04	Detected
	May 19 – Jun. 11	1.59E-03	5.43E-04	4.34E-04	Detected
	Jun. 11 – Jul. 2	1.19E-03	5.26E-04	4.96E-04	Detected
	Jul. 2 – Jul. 30	1.47E-03	5.49E-04	2.91E-04	Detected
	Jul. 30 – Aug. 20	9.49E-04	5.90E-04	7.11E-04	Detected
	Aug. 20 – Sep. 3	1.61E-03	8.50E-04	8.86E-04	Detected
	Sep. 3 – Oct. 1	1.30E-03	4.17E-04	1.98E-04	Detected
	Oct. 1 – Oct. 15	1.89E-03	6.56E-04	3.49E-04	Detected
	Oct. 15 – Nov. 10	1.27E-03	4.62E-04	3.79E-04	Detected
	Nov. 10 – Dec. 8	1.96E-03	5.27E-04	3.22E-04	Detected
	Dec. 8 – Dec. 31	1.44E-03	4.11E-04	2.16E-04	Detected

Table B.33. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Cactus Flats station (continued)

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{235}U	Dec. 31 – Jan. 14	2.17E-03	9.48E-04	5.89E-04	Detected
^{238}U	Jan. 10 – Jan. 31	2.46E-02	4.40E-03	1.30E-03	Detected
	Jan. 31 – Feb. 21	2.88E-02	6.28E-03	1.43E-03	Detected
	Feb. 21 – Mar. 18	2.72E-02	4.89E-03	1.43E-03	Detected
	Mar. 18 – Apr. 3	3.28E-02	6.49E-03	1.79E-03	Detected
	Apr. 3 – Apr. 30	2.73E-02	4.66E-03	1.02E-03	Detected
	Apr. 30 – May. 19	2.85E-02	4.47E-03	4.51E-04	Detected
	May 19 – Jun. 11	2.91E-02	4.54E-03	6.35E-04	Detected
	Jun. 11 – Jul. 2	3.26E-02	5.12E-03	7.73E-04	Detected
	Jul. 2 – Jul. 30	2.87E-02	4.70E-03	5.39E-04	Detected
	Jul. 30 – Aug. 20	3.05E-02	5.19E-03	1.11E-03	Detected
	Aug. 20 – Sep. 3	2.47E-02	5.40E-03	1.38E-03	Detected
	Sep. 3 – Oct. 1	2.30E-02	3.55E-03	3.67E-04	Detected
	Oct. 1 – Oct. 15	2.88E-02	4.75E-03	6.46E-04	Detected
	Oct. 15 – Nov. 10	2.86E-02	4.28E-03	4.64E-04	Detected
	Nov. 10 – Dec. 8	3.18E-02	4.50E-03	6.06E-04	Detected
	Dec. 8 – Dec. 31	3.22E-02	4.46E-03	2.53E-04	Detected
	Dec. 31 – Jan. 14	3.69E-02	9.48E-04	5.89E-04	Detected

Table B.34. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Loving station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{234}U	Jan. 10 – Jan. 31	2.38E-02	3.87E-03	5.86E-04	Detected
	Jan. 31 – Feb. 21	2.54E-02	4.87E-03	9.00E-04	Detected
	Feb. 21 – Mar. 18	2.84E-02	4.60E-03	7.23E-04	Detected
	Mar. 18 – Apr. 3	2.76E-02	4.71E-03	7.55E-04	Detected
	Apr. 3 – Apr. 30	2.61E-02	3.73E-03	2.74E-04	Detected
	Apr. 30 – May. 19	2.96E-02	4.10E-03	3.73E-04	Detected
	May 19 – Jun. 11	2.80E-02	4.00E-03	3.58E-04	Detected
	Jun. 11 – Jul. 2	3.02E-02	4.19E-03	3.07E-04	Detected
	Jul. 2 – Jul. 30	2.81E-02	3.85E-03	3.26E-04	Detected
	Jul. 30 – Aug. 20	2.87E-02	4.37E-03	5.08E-04	Detected
	Aug. 20 – Sep. 3	2.47E-02	4.01E-03	5.02E-04	Detected
	Sep. 3 – Oct. 1	2.53E-02	3.53E-03	3.58E-04	Detected
	Oct. 1 – Oct. 15	2.82E-02	4.05E-03	4.46E-04	Detected
	Oct. 15 – Nov. 10	2.95E-02	4.22E-03	4.90E-04	Detected
	Nov. 10 – Dec. 8	2.95E-02	4.25E-03	5.11E-04	Detected
	Dec. 8 – Dec. 31	3.09E-02	3.96E-03	2.11E-04	Detected
	Dec. 31 – Jan. 14	3.80E-02	6.40E-03	8.13E-04	Detected
^{235}U	Jan. 10 – Jan. 31	1.09E-03	4.56E-04	4.47E-04	Detected
	Jan. 31 – Feb. 21	9.88E-04	6.35E-04	6.98E-04	Detected
	Feb. 21 – Mar. 18	1.41E-03	5.65E-04	5.52E-04	Detected
	Mar. 18 – Apr. 3	1.02E-03	5.69E-04	6.59E-04	Detected
	Apr. 3 – Apr. 30	9.98E-04	3.30E-04	1.56E-04	Detected
	Apr. 30 – May. 19	1.25E-03	3.80E-04	2.76E-04	Detected
	May 19 – Jun. 11	1.62E-03	4.55E-04	3.12E-04	Detected
	Jun. 11 – Jul. 2	9.42E-04	3.34E-04	2.67E-04	Detected
	Jul. 2 – Jul. 30	1.15E-03	3.42E-04	2.41E-04	Detected
	Jul. 30 – Aug. 20	1.43E-03	5.10E-04	4.43E-04	Detected
	Aug. 20 – Sep. 3	1.03E-03	4.56E-04	4.38E-04	Detected
	Sep. 3 – Oct. 1	1.11E-03	3.44E-04	2.65E-04	Detected
	Oct. 1 – Oct. 15	1.38E-03	4.30E-04	3.30E-04	Detected
	Oct. 15 – Nov. 10	1.71E-03	4.90E-04	3.23E-04	Detected
	Nov. 10 – Dec. 8	1.22E-03	4.41E-04	4.65E-04	Detected
	Dec. 8 – Dec. 31	1.33E-03	3.21E-04	2.23E-04	Detected

Table B.34. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Loving station (continued)

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{235}U	Dec. 31 – Jan. 14	1.81E-03	7.73E-04	7.09E-04	Detected
^{238}U	Jan. 10 – Jan. 31	2.42E-02	3.91E-03	5.84E-04	Detected
	Jan. 31 – Feb. 21	2.53E-02	4.86E-03	9.39E-04	Detected
	Feb. 21 – Mar. 18	2.52E-02	4.25E-03	7.20E-04	Detected
	Mar. 18 – Apr. 3	2.68E-02	4.62E-03	9.16E-04	Detected
	Apr. 3 – Apr. 30	2.41E-02	3.51E-03	2.89E-04	Detected
	Apr. 30 – May. 19	2.71E-02	3.83E-03	3.58E-04	Detected
	May 19 – Jun. 11	2.56E-02	3.74E-03	4.34E-04	Detected
	Jun. 11 – Jul. 2	2.47E-02	3.59E-03	3.72E-04	Detected
	Jul. 2 – Jul. 30	2.31E-02	3.31E-03	3.13E-04	Detected
	Jul. 30 – Aug. 20	2.70E-02	4.17E-03	6.15E-04	Detected
	Aug. 20 – Sep. 3	2.52E-02	4.07E-03	6.09E-04	Detected
	Sep. 3 – Oct. 1	2.38E-02	3.36E-03	3.44E-04	Detected
	Oct. 1 – Oct. 15	2.62E-02	3.82E-03	4.29E-04	Detected
	Oct. 15 – Nov. 10	2.69E-02	3.94E-03	6.07E-04	Detected
	Nov. 10 – Dec. 8	2.82E-02	4.10E-03	5.63E-04	Detected
	Dec. 8 – Dec. 31	2.68E-02	3.53E-03	2.19E-04	Detected
	Dec. 31 – Jan. 14	3.48E-02	6.06E-03	9.86E-04	Detected

Table B.35. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Carlsbad station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{234}U	Jan. 10 – Jan. 31	2.78E-02	5.75E-03	1.52E-03	Detected
	Jan. 31 – Feb. 21	2.74E-02	6.07E-03	1.43E-03	Detected
	Feb. 21 – Mar. 18	2.82E-02	5.12E-03	9.92E-04	Detected
	Mar. 18 – Apr. 3	3.59E-02	6.86E-03	1.86E-03	Detected
	Apr. 3 – Apr. 30	2.78E-02	4.34E-03	5.51E-04	Detected
	Apr. 30 – May. 19	3.25E-02	4.68E-03	4.56E-04	Detected
	May 19 – Jun. 11	3.05E-02	4.41E-03	5.92E-04	Detected
	Jun. 11 – Jul. 2	3.10E-02	4.62E-03	6.99E-04	Detected
	Jul. 2 – Jul. 30	3.10E-02	4.23E-03	3.65E-04	Detected
	Jul. 30 – Aug. 20	2.76E-02	4.16E-03	6.18E-04	Detected
	Aug. 20 – Sep. 3	2.32E-02	4.23E-03	9.03E-04	Detected
	Sep. 3 – Oct. 1	2.44E-02	3.53E-03	4.00E-04	Detected
	Oct. 1 – Oct. 15	2.97E-02	4.44E-03	5.82E-03	Detected
	Oct. 15 – Nov. 10	3.16E-02	4.41E-03	4.36E-04	Detected
	Nov. 10 – Dec. 8	3.38E-02	4.88E-03	6.59E-04	Detected
	Dec. 8 – Dec. 31	3.66E-02	4.87E-03	2.76E-04	Detected
	Dec. 31 – Jan. 14	4.42E-02	9.15E-03	2.15E-03	Detected
^{235}U	Jan. 10 – Jan. 31	1.47E-03	8.46E-04	7.78E-04	Detected
	Jan. 31 – Feb. 21	1.23E-03	8.80E-04	9.00E-04	Detected
	Feb. 21 – Mar. 18	1.46E-03	6.61E-04	5.06E-04	Detected
	Mar. 18 – Apr. 3	1.21E-03	8.09E-04	6.48E-04	Detected
	Apr. 3 – Apr. 30	1.14E-03	4.60E-04	4.08E-04	Detected
	Apr. 30 – May. 19	1.51E-03	4.53E-04	2.82E-04	Detected
	May 19 – Jun. 11	1.51E-03	4.57E-04	2.06E-04	Detected
	Jun. 11 – Jul. 2	1.34E-03	4.70E-04	2.44E-04	Detected
	Jul. 2 – Jul. 30	1.75E-03	4.31E-04	2.25E-04	Detected
	Jul. 30 – Aug. 20	1.29E-03	4.36E-04	2.15E-04	Detected
	Aug. 20 – Sep. 3	7.11E-04	4.45E-04	3.15E-04	Detected
	Sep. 3 – Oct. 1	1.17E-03	3.65E-04	2.47E-04	Detected
	Oct. 1 – Oct. 15	1.74E-03	5.31E-04	3.59E-04	Detected
	Oct. 15 – Nov. 10	1.50E-03	4.51E-04	3.96E-04	Detected
	Nov. 10 – Dec. 8	1.59E-03	5.01E-04	3.04E-04	Detected
	Dec. 8 – Dec. 31	1.53E-03	4.13E-04	2.39E-04	Detected

Table B.35. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
	Dec. 31 – Jan. 14	2.08E-03	1.36E-03	1.77E-03	Detected
^{238}U	Jan. 10 – Jan. 31	2.54E-02	5.49E-03	1.56E-03	Detected
	Jan. 31 – Feb. 21	2.55E-02	5.86E-03	1.60E-03	Detected
	Feb. 21 – Mar. 18	2.75E-02	5.04E-03	1.01E-03	Detected
	Mar. 18 – Apr. 3	3.50E-02	6.75E-03	1.77E-03	Detected
	Apr. 3 – Apr. 30	2.51E-02	4.05E-03	4.23E-04	Detected
	Apr. 30 – May. 19	3.11E-02	4.53E-03	5.41E-04	Detected
	May 19 – Jun. 11	2.79E-02	4.13E-03	5.63E-04	Detected
	Jun. 11 – Jul. 2	2.78E-02	4.27E-03	6.65E-04	Detected
	Jul. 2 – Jul. 30	2.71E-02	3.82E-03	4.33E-04	Detected
	Jul. 30 – Aug. 20	2.45E-02	3.81E-03	5.88E-04	Detected
	Aug. 20 – Sep. 3	2.24E-02	4.14E-03	8.59E-04	Detected
	Sep. 3 – Oct. 1	2.29E-02	3.36E-03	4.75E-04	Detected
	Oct. 1 – Oct. 15	2.89E-02	4.36E-03	6.90E-04	Detected
	Oct. 15 – Nov. 10	2.75E-02	3.95E-03	4.80E-04	Detected
	Nov. 10 – Dec. 8	3.15E-02	1.43E-04	2.66E-04	Detected
	Dec. 8 – Dec. 31	3.35E-02	1.29E-04	1.95E-04	Detected
	Dec. 31 – Jan. 14	4.61E-02	5.37E-04	1.27E-03	Detected

Table B.36. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from East Tower station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{234}U	Jan. 10 – Jan. 31	3.26E-02	7.35E-03	1.40E-03	Detected
	Jan. 31 – Feb. 21	2.48E-02	5.35E-03	1.32E-03	Detected
	Feb. 21 – Mar. 18	3.37E-02	5.60E-03	6.19E-04	Detected
	Mar. 18 – Apr. 3	3.48E-02	6.38E-03	1.13E-03	Detected
	Apr. 3 – Apr. 30	3.18E-02	5.11E-03	6.73E-04	Detected
	Apr. 30 – May. 19	2.86E-02	4.38E-03	5.60E-04	Detected
	May 19 – Jun. 11	2.95E-02	4.19E-03	3.32E-04	Detected
	Jun. 11 – Jul. 2	3.34E-02	4.85E-03	4.36E-04	Detected
	Jul. 2 – Jul. 30	2.88E-02	4.31E-03	5.55E-04	Detected
	Jul. 30 – Aug. 20	2.85E-02	4.53E-03	5.16E-04	Detected
	Aug. 20 – Sep. 3	2.84E-02	4.92E-03	6.53E-04	Detected
	Sep. 3 – Oct. 1	2.60E-02	3.75E-03	4.07E+00	Not detected
	Oct. 1 – Oct. 15	2.93E-02	4.46E-03	6.52E-04	Detected
	Oct. 15 – Nov. 10	3.25E-02	4.77E-03	3.28E-04	Detected
	Nov. 10 – Dec. 8	3.35E-02	4.98E-03	3.67E-04	Detected
	Dec. 8 – Dec. 31	3.34E-02	4.44E-03	1.77E-04	Detected
	Dec. 31 – Jan. 14	4.62E-02	8.46E-03	9.03E-04	Detected
^{235}U	Jan. 10 – Jan. 31	2.12E-03	1.10E-03	7.14E-04	Detected
	Jan. 31 – Feb. 21	7.99E-04	7.45E-04	1.02E-03	Not detected
	Feb. 21 – Mar. 18	1.52E-03	6.90E-04	6.96E-04	Detected
	Mar. 18 – Apr. 3	1.22E-04	5.62E-04	9.23E-04	Not detected
	Apr. 3 – Apr. 30	1.11E-03	5.02E-04	4.16E-04	Detected
	Apr. 30 – May. 19	1.74E-03	5.16E-04	2.21E-04	Detected
	May 19 – Jun. 11	1.05E-03	3.69E-04	2.71E-04	Detected
	Jun. 11 – Jul. 2	1.46E-03	4.89E-04	3.56E-04	Detected
	Jul. 2 – Jul. 30	2.00E-03	5.42E-04	2.19E-04	Detected
	Jul. 30 – Aug. 20	1.24E-03	5.06E-04	4.22E-04	Detected
	Aug. 20 – Sep. 3	1.24E-03	5.90E-04	5.33E-04	Detected
	Sep. 3 – Oct. 1	1.11E-03	3.75E-04	3.01E-04	Detected
	Oct. 1 – Oct. 15	1.55E-03	5.13E-04	2.57E-04	Detected
	Oct. 15 – Nov. 10	1.30E-03	4.77E-04	3.45E-04	Detected
	Nov. 10 – Dec. 8	1.21E-03	4.87E-04	3.86E-04	Detected

Table B.36. Specific activity of U isotopes (^{234}U, ^{235}U, and ^{238}U) in the filter samples collected from East Tower station (continued)

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{235}U	Dec. 8 – Dec. 31	1.44E-03	3.91E-04	2.91E-04	Detected
	Dec. 31 – Jan. 14	1.39E-03	1.06E-03	1.49E-03	Not detected
^{238}U	Jan. 10 – Jan. 31	3.06E-02	7.13E-03	1.46E-03	Detected
	Jan. 31 – Feb. 21	2.48E-02	5.36E-03	1.50E-03	Detected
	Feb. 21 – Mar. 18	2.53E-02	4.66E-03	7.94E-04	Detected
	Mar. 18 – Apr. 3	2.96E-02	5.80E-03	1.40E-03	Detected
	Apr. 3 – Apr. 30	2.98E-02	4.90E-03	7.99E-04	Detected
	Apr. 30 – May. 19	2.82E-02	4.35E-03	5.73E-04	Detected
	May 19 – Jun. 11	2.66E-02	3.87E-03	4.11E-04	Detected
	Jun. 11 – Jul. 2	2.89E-02	4.36E-03	5.38E-04	Detected
	Jul. 2 – Jul. 30	2.79E-02	4.21E-03	5.68E-04	Detected
	Jul. 30 – Aug. 20	2.71E-02	4.38E-03	6.37E-04	Detected
	Aug. 20 – Sep. 3	2.45E-02	4.49E-03	8.06E-04	Detected
	Sep. 3 – Oct. 1	2.53E-02	3.67E-03	3.08E-04	Detected
	Oct. 1 – Oct. 15	2.87E-02	4.40E-03	6.67E-04	Detected
	Oct. 15 – Nov. 10	3.20E-02	4.72E-03	4.37E-04	Detected
	Nov. 10 – Dec. 8	3.08E-02	4.67E-03	4.88E-04	Detected
	Dec. 8 – Dec. 31	2.87E-02	3.94E-03	2.66E-04	Detected
	Dec. 31 – Jan. 14	4.20E-02	8.00E-03	1.20E-03	Detected

Table B.37. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Onsite station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{137}Cs	Jan. 10 – Jan. 31	-6.05E-07	3.99E-07	1.35E-06	Not detected
	Jan. 31 – Feb. 21	1.23E-06	3.49E-07	1.13E-06	Detected
	Feb. 21 – Mar. 18	1.88E-07	2.80E-07	9.31E-07	Not detected
	Mar. 18 – Apr. 3	4.40E-07	4.31E-07	1.43E-06	Not detected
	Apr. 3 – Apr. 30	1.48E-07	2.67E-07	8.92E-07	Not detected
	Apr. 30 – May. 19	-4.57E-07	4.65E-07	1.56E-06	Not detected
	May 19 – Jun. 11	8.12E-07	3.51E-07	1.14E-06	Not detected
	Jun. 11 – Jul. 2	1.02E-06	4.49E-07	1.47E-06	Not detected
	Jul. 2 – Jul. 30	1.06E-06	3.69E-07	1.20E-06	Not detected
	Jul. 30 – Aug. 20	1.53E-06	5.45E-07	1.77E-06	Not detected
	Aug. 20 – Sep. 3	2.58E-06	6.42E-07	2.07E-06	Detected
	Sep. 3 – Oct. 1	-4.05E-07	3.82E-07	1.29E-06	Not detected
	Oct. 1 – Oct. 15	1.78E-06	5.62E-07	1.82E-06	Not detected
	Oct. 15 – Nov. 10	1.89E-06	4.40E-07	1.41E-06	Detected
	Nov. 10 – Dec. 8	5.00E-07	2.79E-07	9.14E-07	Not detected
	Dec. 8 – Dec. 31	1.01E-06	4.32E-07	1.41E-06	Not detected
	Dec. 31 – Jan. 14	1.31E-06	5.42E-07	1.77E-06	Not detected
^{60}Co	Jan. 10 – Jan. 31	4.59E-07	2.15E-07	6.99E-07	Not detected
	Jan. 31 – Feb. 21	5.78E-07	2.80E-07	9.12E-07	Not detected
	Feb. 21 – Mar. 18	2.23E-07	2.65E-07	8.86E-07	Not detected
	Mar. 18 – Apr. 3	2.35E-08	3.18E-07	1.08E-06	Not detected
	Apr. 3 – Apr. 30	7.58E-07	2.60E-07	8.32E-07	Not detected
	Apr. 30 – May. 19	-7.87E-08	1.16E-06	3.97E-06	Not detected
	May 19 – Jun. 11	-1.54E-07	2.28E-07	7.94E-07	Not detected
	Jun. 11 – Jul. 2	-5.26E-08	2.42E-07	8.36E-07	Not detected
	Jul. 2 – Jul. 30	-9.96E-09	3.12E-07	1.06E-06	Not detected
	Jul. 30 – Aug. 20	5.45E-08	4.12E-07	1.39E-06	Not detected
	Aug. 20 – Sep. 3	2.60E-07	3.95E-07	1.32E-06	Not detected
	Sep. 3 – Oct. 1	2.13E-07	2.41E-07	8.05E-07	Not detected
	Oct. 1 – Oct. 15	-4.26E-07	3.37E-07	1.18E-06	Not detected
	Oct. 15 – Nov. 10	4.03E-07	2.43E-07	8.00E-07	Not detected
	Nov. 10 – Dec. 8	-3.18E-07	2.97E-07	1.03E-06	Not detected

Table B.37. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Onsite station (continued)

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{60}Co	Dec. 8 – Dec. 31	5.42E-07	3.48E-07	1.15E-06	Not detected
	Dec. 31 – Jan. 14	4.29E-07	3.03E-07	1.00E-06	Not detected
^{40}K	Jan. 10 – Jan. 31	4.41E-05	5.26E-06	1.59E-05	Detected
	Jan. 31 – Feb. 21	2.52E-05	6.08E-06	1.94E-05	Detected
	Feb. 21 – Mar. 18	3.94E-05	6.16E-06	1.91E-05	Detected
	Mar. 18 – Apr. 3	4.43E-05	6.90E-06	2.12E-05	Detected
	Apr. 3 – Apr. 30	1.68E-05	6.11E-06	1.99E-05	Not detected
	Apr. 30 – May. 19	6.66E-05	6.23E-06	1.82E-05	Detected
	May 19 – Jun. 11	-2.21E-07	5.68E-06	1.90E-05	Not detected
	Jun. 11 – Jul. 2	3.53E-05	6.13E-06	1.91E-05	Detected
	Jul. 2 – Jul. 30	2.29E-05	5.83E-06	1.87E-05	Detected
	Jul. 30 – Aug. 20	5.37E-05	8.64E-06	2.69E-05	Detected
	Aug. 20 – Sep. 3	6.70E-05	9.71E-06	3.00E-05	Detected
	Sep. 3 – Oct. 1	5.03E-05	5.29E-06	1.57E-05	Detected
	Oct. 1 – Oct. 15	7.52E-05	9.03E-06	2.74E-05	Detected
	Oct. 15 – Nov. 10	5.82E-05	6.38E-06	1.91E-05	Detected
	Nov. 10 – Dec. 8	7.37E-05	5.73E-06	1.56E-05	Detected
	Dec. 8 – Dec. 31	7.35E-05	6.49E-06	1.88E-05	Detected
	Dec. 31 – Jan. 14	2.91E-05	7.45E-06	2.39E-05	Detected

Table B.38. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Near Field station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{137}Cs	Jan. 10 – Jan. 31	-3.36E-07	6.75E-07	2.28E-06	Not detected
	Jan. 31 – Feb. 21	5.46E-07	3.41E-07	1.12E-06	Not detected
	Feb. 21 – Mar. 18	4.04E-07	7.70E-07	2.57E-06	Not detected
	Mar. 18 – Apr. 3	2.04E-07	9.25E-07	3.09E-06	Not detected
	Apr. 3 – Apr. 30	7.11E-07	3.84E-07	1.26E-06	Not detected
	Apr. 30 – May. 19	-1.62E-07	8.64E-07	2.90E-06	Not detected
	May 19 – Jun. 11	8.86E-07	7.36E-07	2.43E-06	Not detected
	Jun. 11 – Jul. 2	-6.99E-07	6.50E-07	2.22E-06	Not detected
	Jul. 2 – Jul. 30	4.20E-07	3.12E-07	1.03E-06	Not detected
	Jul. 30 – Aug. 20	-5.52E-05	7.77E-07	2.62E-06	Not detected
	Aug. 20 – Sep. 3	1.06E-06	4.43E-07	1.44E-06	Not detected
	Sep. 3 – Oct. 1	-5.83E-07	7.33E-07	2.48E-06	Not detected
	Oct. 1 – Oct. 15	1.05E-06	4.49E-07	1.46E-06	Not detected
	Oct. 15 – Nov. 10	6.31E-07	3.08E-07	1.01E-06	Not detected
	Nov. 10 – Dec. 8	-4.25E-07	7.30E-07	2.47E-06	Not detected
	Dec. 8 – Dec. 31	8.96E-07	3.35E-07	1.09E-06	Not detected
	Dec. 31 – Jan. 14	1.41E-06	5.83E-07	1.90E-06	Not detected
^{60}Co	Jan. 10 – Jan. 31	-5.37E-07	4.56E-07	1.62E-06	Not detected
	Jan. 31 – Feb. 21	1.24E-07	2.46E-07	8.30E-07	Not detected
	Feb. 21 – Mar. 18	3.31E-07	4.91E-07	1.66E-06	Not detected
	Mar. 18 – Apr. 3	4.01E-07	5.74E-07	1.94E-06	Not detected
	Apr. 3 – Apr. 30	1.33E-07	2.62E-07	8.82E-07	Not detected
	Apr. 30 – May. 19	3.89E-07	4.91E-07	1.65E-06	Not detected
	May 19 – Jun. 11	7.57E-07	4.66E-07	1.53E-06	Not detected
	Jun. 11 – Jul. 2	-4.52E-07	4.68E-07	1.65E-06	Not detected
	Jul. 2 – Jul. 30	2.51E-07	2.97E-07	9.93E-07	Not detected
	Jul. 30 – Aug. 20	4.81E-07	4.61E-07	1.54E-06	Not detected
	Aug. 20 – Sep. 3	9.11E-08	4.18E-07	1.41E-06	Not detected
	Sep. 3 – Oct. 1	-6.33E-08	4.82E-07	1.66E-06	Not detected
	Oct. 1 – Oct. 15	1.26E-06	5.35E-07	1.74E-06	Not detected
	Oct. 15 – Nov. 10	4.03E-07	2.42E-07	7.96E-07	Not detected
	Nov. 10 – Dec. 8	2.47E-07	4.74E-07	1.61E-06	Not detected
	Dec. 8 – Dec. 31	-6.63E-08	3.02E-07	1.03E-06	Not detected

Table B.38. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Near Field station (continued)

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{60}Co	Dec. 31 – Jan. 14	4.62E-07	3.26E-07	1.08E-06	Not detected
^{40}K	Jan. 10 – Jan. 31	4.08E-05	7.37E-06	2.21E-05	Detected
	Jan. 31 – Feb. 21	2.99E-05	6.45E-06	2.05E-05	Detected
	Feb. 21 – Mar. 18	3.34E-05	7.58E-06	2.34E-05	Detected
	Mar. 18 – Apr. 3	3.82E-05	7.81E-06	2.36E-05	Detected
	Apr. 3 – Apr. 30	4.69E-05	5.85E-06	1.76E-05	Detected
	Apr. 30 – May. 19	4.65E-05	7.53E-06	2.22E-05	Detected
	May 19 – Jun. 11	3.57E-05	5.94E-06	1.71E-05	Detected
	Jun. 11 – Jul. 2	2.91E-05	6.10E-06	1.83E-05	Detected
	Jul. 2 – Jul. 30	3.82E-05	5.58E-06	1.70E-05	Detected
	Jul. 30 – Aug. 20	3.39E-05	7.13E-06	2.18E-05	Detected
	Aug. 20 – Sep. 3	4.90E-05	6.41E-06	1.91E-05	Detected
	Sep. 3 – Oct. 1	4.29E-05	7.12E-06	2.10E-05	Detected
	Oct. 1 – Oct. 15	7.68E-05	8.67E-06	2.56E-05	Detected
	Oct. 15 – Nov. 10	5.47E-05	5.44E-06	1.56E-05	Detected
	Nov. 10 – Dec. 8	5.36E-05	7.45E-06	2.13E-05	Detected
	Dec. 8 – Dec. 31	8.09E-05	5.81E-06	1.54E-05	Detected
	Dec. 31 – Jan. 14	3.12E-05	6.91E-06	2.18E-05	Detected

Table B.39. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Cactus Flats station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{137}Cs	Jan. 10 – Jan. 31	1.35E-07	4.38E-07	1.46E-06	Not detected
	Jan. 31 – Feb. 21	3.18E-07	2.96E-07	9.82E-07	Not detected
	Feb. 21 – Mar. 18	2.19E-07	2.41E-07	8.04E-07	Not detected
	Mar. 18 – Apr. 3	5.11E-07	3.75E-07	1.24E-06	Not detected
	Apr. 3 – Apr. 30	2.31E-07	3.61E-07	1.20E-06	Not detected
	Apr. 30 – May. 19	9.74E-07	3.05E-07	9.85E-07	Not detected
	May 19 – Jun. 11	5.70E-07	3.70E-07	1.22E-06	Not detected
	Jun. 11 – Jul. 2	1.57E-06	3.17E-07	9.98E-07	Detected
	Jul. 2 – Jul. 30	-4.03E-07	3.54E-07	1.20E-06	Not detected
	Jul. 30 – Aug. 20	7.35E-07	3.35E-07	1.09E-06	Not detected
	Aug. 20 – Sep. 3	-2.51E-07	9.22E-07	3.10E-06	Not detected
	Sep. 3 – Oct. 1	3.07E-07	1.63E-07	5.34E-07	Not detected
	Oct. 1 – Oct. 15	1.91E-06	4.05E-07	1.28E-06	Detected
	Oct. 15 – Nov. 10	8.65E-07	8.42E-07	2.79E-06	Not detected
	Nov. 10 – Dec. 8	1.43E-07	7.07E-07	2.37E-06	Not detected
	Dec. 8 – Dec. 31	-2.12E-07	9.21E-07	3.09E-06	Not detected
	Dec. 31 – Jan. 14	-6.95E-07	1.06E-06	3.59E-06	Not detected
^{60}Co	Jan. 10 – Jan. 31	-8.44E-07	1.04E-06	1.82E-06	Not detected
	Jan. 31 – Feb. 21	2.84E-07	2.51E-07	8.35E-07	Not detected
	Feb. 21 – Mar. 18	-1.46E-07	2.65E-07	9.12E-07	Not detected
	Mar. 18 – Apr. 3	7.25E-08	2.79E-07	9.46E-07	Not detected
	Apr. 3 – Apr. 30	4.88E-07	2.41E-07	7.84E-07	Not detected
	Apr. 30 – May. 19	4.36E-07	3.34E-07	1.11E-06	Not detected
	May 19 – Jun. 11	8.71E-07	3.73E-07	1.21E-06	Not detected
	Jun. 11 – Jul. 2	8.27E-07	3.30E-07	1.07E-06	Not detected
	Jul. 2 – Jul. 30	-8.92E-08	2.26E-07	7.86E-07	Not detected
	Jul. 30 – Aug. 20	2.02E-07	2.33E-07	7.80E-07	Not detected
	Aug. 20 – Sep. 3	-2.11E-08	6.07E-07	2.09E-06	Not detected
	Sep. 3 – Oct. 1	-9.05E-07	4.77E-07	1.71E-06	Not detected
	Oct. 1 – Oct. 15	1.80E-07	4.53E-07	1.52E-06	Not detected
	Oct. 15 – Nov. 10	-4.13E-08	5.05E-07	1.73E-06	Not detected
	Nov. 10 – Dec. 8	4.80E-07	5.19E-07	1.74E-06	Not detected
	Dec. 8 – Dec. 31	2.44E-07	5.43E-07	1.84E-06	Not detected

Table B.39. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Cactus Flats station (continued)

Radionuclide	Sample Date 2020	Activity Bq/m3	Unc. (2σ) Bq/m3	MDC Bq/m3	Status
	Dec. 31 – Jan. 14	1.23E-06	9.00E-07	2.98E-06	Not detected
^{40}K	Jan. 10 – Jan. 31	3.24E-05	4.91E-06	1.51E-05	Detected
	Jan. 31 – Feb. 21	3.53E-05	5.50E-06	1.69E-05	Detected
	Feb. 21 – Mar. 18	3.49E-05	5.64E-06	1.74E-05	Detected
	Mar. 18 – Apr. 3	3.16E-05	6.83E-06	2.17E-05	Detected
	Apr. 3 – Apr. 30	9.46E-06	2.89E-06	9.08E-06	Detected
	Apr. 30 – May. 19	4.09E-05	6.22E-06	1.93E-05	Detected
	May 19 – Jun. 11	5.61E-05	6.36E-06	1.91E-05	Detected
	Jun. 11 – Jul. 2	3.82E-05	6.09E-06	1.90E-05	Detected
	Jul. 2 – Jul. 30	1.07E-05	3.00E-06	9.35E-06	Detected
	Jul. 30 – Aug. 20	4.03E-05	5.08E-06	1.51E-05	Detected
	Aug. 20 – Sep. 3	3.12E-05	8.24E-06	2.57E-05	Detected
	Sep. 3 – Oct. 1	2.84E-05	3.11E-06	9.28E-06	Detected
	Oct. 1 – Oct. 15	5.80E-05	7.64E-06	2.33E-05	Detected
	Oct. 15 – Nov. 10	5.52E-05	8.00E-06	2.33E-05	Detected
	Nov. 10 – Dec. 8	7.61E-05	8.36E-06	2.31E-05	Detected
	Dec. 8 – Dec. 31	4.84E-05	8.18E-06	2.42E-05	Detected
	Dec. 31 – Jan. 14	2.95E-05	9.89E-06	3.14E-05	Not detected

Table B.40. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Loving station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{137}Cs	Jan. 10 – Jan. 31	-8.78E-07	3.49E-07	1.20E-06	Not detected
	Jan. 31 – Feb. 21	-1.73E-08	7.45E-07	2.50E-06	Not detected
	Feb. 21 – Mar. 18	8.46E-07	2.57E-07	8.24E-07	Detected
	Mar. 18 – Apr. 3	1.35E-06	9.97E-07	3.29E-06	Not detected
	Apr. 3 – Apr. 30	7.02E-07	3.35E-07	1.10E-06	Not detected
	Apr. 30 – May. 19	1.10E-06	3.66E-07	1.18E-06	Not detected
	May 19 – Jun. 11	7.82E-07	3.97E-07	1.30E-06	Not detected
	Jun. 11 – Jul. 2	1.20E-06	4.52E-07	1.47E-06	Not detected
	Jul. 2 – Jul. 30	-2.59E-07	1.89E-07	6.37E-07	Not detected
	Jul. 30 – Aug. 20	-7.62E-07	3.93E-07	1.33E-06	Not detected
	Aug. 20 – Sep. 3	-1.24E-06	9.92E-07	3.37E-06	Not detected
	Sep. 3 – Oct. 1	6.44E-07	3.37E-07	1.10E-06	Not detected
	Oct. 1 – Oct. 15	8.17E-07	4.21E-07	1.38E-06	Not detected
	Oct. 15 – Nov. 10	-6.72E-07	4.14E-07	1.40E-06	Not detected
	Nov. 10 – Dec. 8	1.09E-06	3.44E-07	1.11E-06	Not detected
	Dec. 8 – Dec. 31	3.26E-08	4.20E-07	1.40E-06	Not detected
	Dec. 31 – Jan. 14	6.33E-07	3.43E-07	1.13E-06	Not detected
^{60}Co	Jan. 10 – Jan. 31	2.02E-07	2.02E-07	6.75E-07	Not detected
	Jan. 31 – Feb. 21	-1.29E-07	4.69E-07	1.62E-06	Not detected
	Feb. 21 – Mar. 18	2.24E-07	2.36E-07	7.88E-07	Not detected
	Mar. 18 – Apr. 3	-6.19E-08	5.55E-07	1.91E-06	Not detected
	Apr. 3 – Apr. 30	5.93E-07	3.20E-07	1.05E-06	Not detected
	Apr. 30 – May. 19	4.83E-08	2.63E-07	8.92E-07	Not detected
	May 19 – Jun. 11	-7.51E-09	2.31E-07	7.93E-07	Not detected
	Jun. 11 – Jul. 2	-4.08E-07	2.22E-07	7.95E-07	Not detected
	Jul. 2 – Jul. 30	1.20E-07	9.51E-08	3.16E-07	Not detected
	Jul. 30 – Aug. 20	-5.00E-09	2.72E-07	9.19E-07	Not detected
	Aug. 20 – Sep. 3	1.33E-06	6.08E-07	1.97E-06	Not detected
	Sep. 3 – Oct. 1	8.62E-08	2.70E-07	9.15E-07	Not detected
	Oct. 1 – Oct. 15	4.81E-07	4.00E-07	1.33E-06	Not detected
	Oct. 15 – Nov. 10	2.47E-07	2.95E-07	9.82E-07	Not detected
	Nov. 10 – Dec. 8	-1.05E-07	2.23E-07	7.74E-07	Not detected
	Dec. 8 – Dec. 31	-1.88E-07	2.29E-07	7.93E-07	Not detected

Table B.40. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Loving station (continued)

Radionuclide	Sample Date 2020	Activity Bq/m³	Unc. (2σ) Bq/m³	MDC Bq/m³	Status
	Dec. 31 – Jan. 14	-4.08E-07	5.92E-07	2.07E-06	Not detected
^{40}K	Jan. 10 – Jan. 31	4.08E-05	5.19E-06	1.58E-05	Detected
	Jan. 31 – Feb. 21	2.43E-05	6.92E-06	2.18E-05	Detected
	Feb. 21 – Mar. 18	3.85E-05	6.61E-06	2.08E-05	Detected
	Mar. 18 – Apr. 3	5.96E-05	8.69E-06	2.52E-05	Detected
	Apr. 3 – Apr. 30	5.24E-05	6.37E-06	1.93E-05	Detected
	Apr. 30 – May. 19	6.39E-05	5.66E-06	1.59E-05	Detected
	May 19 – Jun. 11	-5.37E-06	5.55E-06	1.88E-05	Not detected
	Jun. 11 – Jul. 2	2.95E-05	5.11E-06	1.58E-05	Detected
	Jul. 2 – Jul. 30	2.21E-05	2.61E-06	7.84E-06	Detected
	Jul. 30 – Aug. 20	4.36E-05	5.24E-06	1.58E-05	Detected
	Aug. 20 – Sep. 3	5.14E-05	9.15E-06	2.73E-05	Detected
	Sep. 3 – Oct. 1	6.31E-05	5.50E-06	1.53E-05	Detected
	Oct. 1 – Oct. 15	7.69E-05	7.99E-06	2.32E-05	Detected
	Oct. 15 – Nov. 10	6.45E-05	5.53E-06	1.58E-05	Detected
	Nov. 10 – Dec. 8	7.19E-05	5.70E-06	1.56E-05	Detected
	Dec. 8 – Dec. 31	8.29E-05	5.90E-06	1.63E-05	Detected
	Dec. 31 – Jan. 14	3.87E-05	7.52E-06	2.37E-05	Detected

Table B.41. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Carlsbad station

Radionuclide	Sample Date 2020	Activity Bq/m³	Unc. (2σ) Bq/m³	MDC Bq/m³	Status
^{137}Cs	Jan. 10 – Jan. 31	5.28E-07	7.57E-07	2.52E-06	Not detected
	Jan. 31 – Feb. 21	-8.30E-07	3.88E-07	1.32E-06	Not detected
	Feb. 21 – Mar. 18	-1.13E-08	8.73E-07	2.92E-06	Not detected
	Mar. 18 – Apr. 3	-8.62E-07	2.00E-06	3.35E-06	Not detected
	Apr. 3 – Apr. 30	3.98E-07	3.97E-07	1.32E-06	Not detected
	Apr. 30 – May. 19	-3.69E-07	3.95E-07	1.33E-06	Not detected
	May 19 – Jun. 11	6.95E-07	8.12E-07	2.69E-06	Not detected
	Jun. 11 – Jul. 2	5.45E-07	7.77E-07	2.58E-06	Not detected
	Jul. 2 – Jul. 30	8.32E-07	7.85E-07	2.60E-06	Not detected
	Jul. 30 – Aug. 20	8.10E-07	3.27E-07	1.06E-06	Not detected
	Aug. 20 – Sep. 3	8.62E-07	4.44E-07	1.46E-06	Not detected
	Sep. 3 – Oct. 1	1.08E-06	7.75E-07	2.56E-06	Not detected
	Oct. 1 – Oct. 15	9.27E-07	1.32E-06	4.39E-06	Not detected
	Oct. 15 – Nov. 10	1.46E-06	4.12E-07	1.33E-06	Detected
	Nov. 10 – Dec. 8	-3.41E-07	7.57E-07	2.55E-06	Not detected
	Dec. 8 – Dec. 31	4.03E-07	7.40E-07	2.47E-06	Not detected
	Dec. 31 – Jan. 14	1.70E-08	2.91E-07	9.86E-07	Not detected
^{60}Co	Jan. 10 – Jan. 31	6.33E-07	4.64E-07	1.54E-06	Not detected
	Jan. 31 – Feb. 21	-1.31E-07	1.91E-07	6.63E-07	Not detected
	Feb. 21 – Mar. 18	2.21E-07	5.41E-07	1.83E-06	Not detected
	Mar. 18 – Apr. 3	-3.86E-07	1.22E-06	2.10E-06	Not detected
	Apr. 3 – Apr. 30	1.67E-07	2.28E-07	7.66E-07	Not detected
	Apr. 30 – May. 19	5.13E-07	2.59E-07	8.46E-07	Not detected
	May 19 – Jun. 11	1.01E-06	5.18E-07	1.69E-06	Not detected
	Jun. 11 – Jul. 2	1.17E-06	4.89E-07	1.57E-06	Not detected
	Jul. 2 – Jul. 30	6.62E-07	4.69E-07	1.55E-06	Not detected
	Jul. 30 – Aug. 20	5.32E-07	3.39E-07	1.12E-06	Not detected
	Aug. 20 – Sep. 3	-3.97E-08	3.21E-07	1.10E-06	Not detected
	Sep. 3 – Oct. 1	2.04E-07	4.70E-07	1.60E-06	Not detected
	Oct. 1 – Oct. 15	2.64E-06	1.01E-06	3.24E-06	Not detected
	Oct. 15 – Nov. 10	1.63E-07	3.38E-07	1.13E-06	Not detected
	Nov. 10 – Dec. 8	9.11E-07	5.87E-07	1.93E-06	Not detected
	Dec. 8 – Dec. 31	-3.91E-08	5.08E-07	1.74E-06	Not detected

Table B.41. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{60}Co	Dec. 31 – Jan. 14	1.44E-07	2.80E-07	9.47E-07	Not detected
^{40}K	Jan. 10 – Jan. 31	3.46E-05	6.96E-06	2.11E-05	Detected
	Jan. 31 – Feb. 21	1.98E-05	4.39E-06	1.39E-05	Detected
	Feb. 21 – Mar. 18	5.46E-05	7.51E-06	2.15E-05	Detected
	Mar. 18 – Apr. 3	2.79E-05	1.15E-05	1.83E-05	Detected
	Apr. 3 – Apr. 30	2.78E-05	5.41E-06	1.69E-05	Detected
	Apr. 30 – May. 19	4.82E-05	5.53E-06	1.66E-05	Detected
	May 19 – Jun. 11	5.59E-05	8.07E-06	2.36E-05	Detected
	Jun. 11 – Jul. 2	3.85E-05	7.80E-06	2.39E-05	Detected
	Jul. 2 – Jul. 30	5.26E-05	7.76E-06	2.26E-05	Detected
	Jul. 30 – Aug. 20	4.02E-05	6.11E-06	1.89E-05	Detected
	Aug. 20 – Sep. 3	5.80E-05	7.95E-06	2.44E-05	Detected
	Sep. 3 – Oct. 1	4.71E-05	7.74E-06	2.30E-05	Detected
	Oct. 1 – Oct. 15	1.08E-04	1.30E-05	3.66E-05	Detected
	Oct. 15 – Nov. 10	6.24E-05	6.40E-06	1.90E-05	Detected
	Nov. 10 – Dec. 8	6.79E-05	8.74E-06	2.52E-05	Detected
	Dec. 8 – Dec. 31	6.99E-05	8.12E-06	2.26E-05	Detected
	Dec. 31 – Jan. 14	8.72E-05	1.01E-05	2.83E-05	Detected

Table B.42. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from East Tower station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{137}Cs	Jan. 10 – Jan. 31	2.99E-07	1.07E-06	3.59E-06	Not detected
	Jan. 31 – Feb. 21	-1.11E-06	7.02E-07	2.41E-06	Not detected
	Feb. 21 – Mar. 18	2.56E-07	3.15E-07	1.05E-06	Not detected
	Mar. 18 – Apr. 3	3.33E-06	1.33E-06	2.16E-06	Detected
	Apr. 3 – Apr. 30	-1.44E-06	8.09E-07	2.77E-06	Not detected
	Apr. 30 – May. 19	5.89E-07	8.26E-07	2.75E-06	Not detected
	May 19 – Jun. 11	-1.95E-07	4.21E-07	1.41E-06	Not detected
	Jun. 11 – Jul. 2	-5.66E-07	3.99E-07	1.35E-06	Not detected
	Jul. 2 – Jul. 30	9.26E-07	3.66E-07	1.19E-06	Not detected
	Jul. 30 – Aug. 20	-3.74E-07	8.37E-07	2.81E-06	Not detected
	Aug. 20 – Sep. 3	5.79E-07	1.20E-06	4.00E-06	Not detected
	Sep. 3 – Oct. 1	-4.99E-07	3.65E-07	1.23E-06	Not detected
	Oct. 1 – Oct. 15	-6.43E-07	5.34E-07	1.80E-06	Not detected
	Oct. 15 – Nov. 10	6.36E-07	2.78E-06	1.14E-05	Not detected
	Nov. 10 – Dec. 8	1.14E-06	8.38E-07	2.76E-06	Not detected
	Dec. 8 – Dec. 31	-5.04E-07	4.25E-07	1.43E-06	Not detected
	Dec. 31 – Jan. 14	-6.59E-07	5.20E-07	1.75E-06	Not detected
^{60}Co	Jan. 10 – Jan. 31	8.41E-07	9.98E-07	3.34E-06	Not detected
	Jan. 31 – Feb. 21	7.47E-07	5.35E-07	1.77E-06	Not detected
	Feb. 21 – Mar. 18	4.53E-07	2.66E-07	8.72E-07	Not detected
	Mar. 18 – Apr. 3	1.76E-06	1.06E-06	1.74E-06	Detected
	Apr. 3 – Apr. 30	5.75E-07	6.51E-07	2.18E-06	Not detected
	Apr. 30 – May. 19	2.39E-07	5.23E-07	1.77E-06	Not detected
	May 19 – Jun. 11	1.98E-07	2.17E-07	7.25E-07	Not detected
	Jun. 11 – Jul. 2	2.57E-07	1.94E-07	6.43E-07	Not detected
	Jul. 2 – Jul. 30	-1.82E-08	2.20E-07	7.58E-07	Not detected
	Jul. 30 – Aug. 20	1.41E-07	4.82E-07	1.64E-06	Not detected
	Aug. 20 – Sep. 3	4.29E-07	8.58E-07	2.89E-06	Not detected
	Sep. 3 – Oct. 1	-1.15E-07	2.41E-07	8.26E-07	Not detected
	Oct. 1 – Oct. 15	-3.53E-09	3.08E-07	1.05E-06	Not detected
	Oct. 15 – Nov. 10	1.74E-06	3.05E-06	1.24E-05	Not detected
	Nov. 10 – Dec. 8	-5.77E-07	4.75E-07	1.68E-06	Not detected

Table B.42. Activity concentrations of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from East Tower Station (continued)

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc. (2σ) Bq/m^3	MDC Bq/m^3	Status
^{60}Co	Dec. 8 – Dec. 31	8.69E-08	2.45E-07	8.24E-07	Not detected
	Dec. 31 – Jan. 14	-5.20E-07	3.69E-07	1.27E-06	Not detected
^{40}K	Jan. 10 – Jan. 31	1.26E-04	1.90E-05	5.79E-05	Detected
	Jan. 31 – Feb. 21	2.68E-05	7.08E-06	2.21E-05	Detected
	Feb. 21 – Mar. 18	4.30E-05	7.19E-06	2.24E-05	Detected
	Mar. 18 – Apr. 3	5.63E-05	1.98E-05	3.20E-05	Detected
	Apr. 3 – Apr. 30	4.11E-05	7.92E-06	2.38E-05	Detected
	Apr. 30 – May. 19	4.00E-05	7.72E-06	2.33E-05	Detected
	May 19 – Jun. 11	3.54E-05	5.25E-06	1.62E-05	Detected
	Jun. 11 – Jul. 2	3.92E-05	4.96E-06	1.50E-05	Detected
	Jul. 2 – Jul. 30	4.71E-05	5.26E-06	1.54E-05	Detected
	Jul. 30 – Aug. 20	3.91E-05	6.70E-06	1.97E-05	Detected
	Aug. 20 – Sep. 3	1.31E-04	1.37E-05	3.85E-05	Detected
	Sep. 3 – Oct. 1	4.82E-05	5.22E-06	1.55E-05	Detected
	Oct. 1 – Oct. 15	6.46E-05	7.79E-06	2.35E-05	Detected
	Oct. 15 – Nov. 10	-2.63E-05	3.97E-05	1.88E-04	Not detected
	Nov. 10 – Dec. 8	6.42E-05	8.08E-06	2.29E-05	Detected
	Dec. 8 – Dec. 31	7.65E-05	5.80E-06	1.62E-05	Detected
	Dec. 31 – Jan. 14	2.49E-05	6.09E-06	1.94E-05	Detected

Table B.43. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Onsite station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{137}Cs	Jan. 10 – Jan. 31	-1.35E-02	8.91E-03	3.01E-02	Not detected
	Jan. 31 – Feb. 21	4.55E-02	1.29E-02	4.15E-02	Detected
	Feb. 21 – Mar. 18	3.06E-03	4.56E-03	1.52E-02	Not detected
	Mar. 18 – Apr. 3	6.72E-03	6.59E-03	2.18E-02	Not detected
	Apr. 3 – Apr. 30	1.89E-03	3.41E-03	1.14E-02	Not detected
	Apr. 30 – May. 19	-4.00E-03	4.07E-03	1.37E-02	Not detected
	May 19 – Jun. 11	8.64E-03	3.73E-03	1.22E-02	Not detected
	Jun. 11 – Jul. 2	1.14E-02	4.99E-03	1.63E-02	Not detected
	Jul. 2 – Jul. 30	1.47E-02	5.12E-03	1.66E-02	Not detected
	Jul. 30 – Aug. 20	3.02E-02	1.08E-02	3.49E-02	Not detected
	Aug. 20 – Sep. 3	4.08E-02	1.02E-02	3.27E-02	Detected
	Sep. 3 – Oct. 1	-4.69E-03	4.43E-03	1.49E-02	Not detected
	Oct. 1 – Oct. 15	1.98E-02	6.27E-03	2.03E-02	Not detected
	Oct. 15 – Nov. 10	2.27E-02	5.29E-03	1.70E-02	Detected
	Nov. 10 – Dec. 8	6.13E-03	3.42E-03	1.12E-02	Not detected
	Dec. 8 – Dec. 31	1.28E-02	5.49E-03	1.79E-02	Not detected
	Dec. 31 – Jan. 14	3.98E-02	1.65E-02	5.37E-02	Not detected
^{60}Co	Jan. 10 – Jan. 31	1.03E-02	4.80E-03	1.56E-02	Not detected
	Jan. 31 – Feb. 21	2.14E-02	1.03E-02	3.37E-02	Not detected
	Feb. 21 – Mar. 18	3.64E-03	4.33E-03	1.45E-02	Not detected
	Mar. 18 – Apr. 3	3.60E-04	4.85E-03	1.65E-02	Not detected
	Apr. 3 – Apr. 30	9.68E-03	3.33E-03	1.06E-02	Not detected
	Apr. 30 – May. 19	-6.88E-04	1.02E-02	3.48E-02	Not detected
	May 19 – Jun. 11	-1.63E-03	2.43E-03	8.45E-03	Not detected
	Jun. 11 – Jul. 2	-5.84E-04	2.69E-03	9.28E-03	Not detected
	Jul. 2 – Jul. 30	-1.38E-04	4.32E-03	1.46E-02	Not detected
	Jul. 30 – Aug. 20	1.08E-03	8.12E-03	2.75E-02	Not detected
	Aug. 20 – Sep. 3	4.12E-03	6.25E-03	2.10E-02	Not detected
	Sep. 3 – Oct. 1	2.47E-03	2.80E-03	9.34E-03	Not detected
	Oct. 1 – Oct. 15	-4.75E-03	3.76E-03	1.32E-02	Not detected
	Oct. 15 – Nov. 10	4.84E-03	2.92E-03	9.60E-03	Not detected
	Nov. 10 – Dec. 8	-3.90E-03	3.64E-03	1.26E-02	Not detected

Table B.43. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Onsite station (continued)

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{60}Co	Dec. 8 – Dec. 31	6.88E-03	4.42E-03	1.45E-02	Not detected
	Dec. 31 – Jan. 14	1.30E-02	9.20E-03	3.04E-02	Not detected
^{40}K	Jan. 10 – Jan. 31	9.84E-01	1.17E-01	3.54E-01	Detected
	Jan. 31 – Feb. 21	9.31E-01	2.24E-01	7.18E-01	Detected
	Feb. 21 – Mar. 18	6.43E-01	1.00E-01	3.12E-01	Detected
	Mar. 18 – Apr. 3	6.77E-01	1.05E-01	3.24E-01	Detected
	Apr. 3 – Apr. 30	2.14E-01	7.81E-02	2.54E-01	Not detected
	Apr. 30 – May. 19	5.82E-01	5.46E-02	1.59E-01	Detected
	May 19 – Jun. 11	-2.36E-03	6.04E-02	2.03E-01	Not detected
	Jun. 11 – Jul. 2	3.92E-01	6.82E-02	2.12E-01	Detected
	Jul. 2 – Jul. 30	3.17E-01	8.08E-02	2.59E-01	Detected
	Jul. 30 – Aug. 20	1.06E+00	1.70E-01	5.29E-01	Detected
	Aug. 20 – Sep. 3	1.06E+00	1.54E-01	4.75E-01	Detected
	Sep. 3 – Oct. 1	5.84E-01	6.14E-02	1.82E-01	Detected
	Oct. 1 – Oct. 15	8.39E-01	1.01E-01	3.05E-01	Detected
	Oct. 15 – Nov. 10	6.98E-01	7.66E-02	2.30E-01	Detected
	Nov. 10 – Dec. 8	9.04E-01	7.03E-02	1.91E-01	Detected
	Dec. 8 – Dec. 31	9.32E-01	8.23E-02	2.38E-01	Detected
	Dec. 31 – Jan. 14	8.83E-01	2.26E-01	7.24E-01	Detected

Table B.44. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Near Field station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{137}Cs	Jan. 10 – Jan. 31	-8.70E-03	1.75E-02	5.91E-02	Not detected
	Jan. 31 – Feb. 21	1.90E-02	1.19E-02	3.91E-02	Not detected
	Feb. 21 – Mar. 18	1.16E-02	2.22E-02	7.39E-02	Not detected
	Mar. 18 – Apr. 3	5.30E-03	2.40E-02	8.03E-02	Not detected
	Apr. 3 – Apr. 30	1.38E-02	7.43E-03	2.44E-02	Not detected
	Apr. 30 – May. 19	-2.82E-03	1.51E-02	5.05E-02	Not detected
	May 19 – Jun. 11	1.45E-02	1.20E-02	3.98E-02	Not detected
	Jun. 11 – Jul. 2	-1.21E-02	1.13E-02	3.84E-02	Not detected
	Jul. 2 – Jul. 30	6.61E-03	4.90E-03	1.62E-02	Not detected
	Jul. 30 – Aug. 20	-1.18E+00	1.65E-02	5.58E-02	Not detected
	Aug. 20 – Sep. 3	2.36E-02	9.81E-03	3.20E-02	Not detected
	Sep. 3 – Oct. 1	-8.35E-03	1.05E-02	3.55E-02	Not detected
	Oct. 1 – Oct. 15	1.24E-02	5.30E-03	1.73E-02	Not detected
	Oct. 15 – Nov. 10	1.12E-02	5.47E-03	1.79E-02	Not detected
	Nov. 10 – Dec. 8	-5.99E-03	1.03E-02	3.47E-02	Not detected
	Dec. 8 – Dec. 31	1.18E-02	4.41E-03	1.43E-02	Not detected
	Dec. 31 – Jan. 14	4.81E-02	1.99E-02	6.49E-02	Not detected
^{60}Co	Jan. 10 – Jan. 31	-1.39E-02	1.18E-02	4.19E-02	Not detected
	Jan. 31 – Feb. 21	4.30E-03	8.57E-03	2.89E-02	Not detected
	Feb. 21 – Mar. 18	9.53E-03	1.41E-02	4.77E-02	Not detected
	Mar. 18 – Apr. 3	1.04E-02	1.49E-02	5.03E-02	Not detected
	Apr. 3 – Apr. 30	2.58E-03	5.07E-03	1.71E-02	Not detected
	Apr. 30 – May. 19	6.79E-03	8.57E-03	2.88E-02	Not detected
	May 19 – Jun. 11	1.24E-02	7.62E-03	2.51E-02	Not detected
	Jun. 11 – Jul. 2	-7.83E-03	8.10E-03	2.86E-02	Not detected
	Jul. 2 – Jul. 30	3.94E-03	4.67E-03	1.56E-02	Not detected
	Jul. 30 – Aug. 20	1.02E-02	9.82E-03	3.28E-02	Not detected
	Aug. 20 – Sep. 3	2.02E-03	9.25E-03	3.12E-02	Not detected
	Sep. 3 – Oct. 1	-9.06E-04	6.91E-03	2.38E-02	Not detected
	Oct. 1 – Oct. 15	1.49E-02	6.32E-03	2.05E-02	Not detected
	Oct. 15 – Nov. 10	7.14E-03	4.30E-03	1.41E-02	Not detected
	Nov. 10 – Dec. 8	3.48E-03	6.67E-03	2.26E-02	Not detected

Table B.44. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Near Field station (continued)

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{60}Co	Dec. 8 – Dec. 31	-8.73E-04	3.97E-03	1.35E-02	Not detected
	Dec. 31 – Jan. 14	1.57E-02	1.11E-02	3.67E-02	Not detected
^{40}K	Jan. 10 – Jan. 31	1.06E+00	1.91E-01	5.72E-01	Detected
	Jan. 31 – Feb. 21	1.04E+00	2.25E-01	7.15E-01	Detected
	Feb. 21 – Mar. 18	9.62E-01	2.18E-01	6.74E-01	Detected
	Mar. 18 – Apr. 3	9.93E-01	2.03E-01	6.12E-01	Detected
	Apr. 3 – Apr. 30	9.08E-01	1.13E-01	3.41E-01	Detected
	Apr. 30 – May. 19	8.11E-01	1.31E-01	3.87E-01	Detected
	May 19 – Jun. 11	5.84E-01	9.70E-02	2.79E-01	Detected
	Jun. 11 – Jul. 2	5.04E-01	1.06E-01	3.18E-01	Detected
	Jul. 2 – Jul. 30	6.01E-01	8.76E-02	2.67E-01	Detected
	Jul. 30 – Aug. 20	7.22E-01	1.52E-01	4.63E-01	Detected
	Aug. 20 – Sep. 3	1.09E+00	1.42E-01	4.24E-01	Detected
	Sep. 3 – Oct. 1	6.15E-01	1.02E-01	3.00E-01	Detected
	Oct. 1 – Oct. 15	9.07E-01	1.02E-01	3.02E-01	Detected
	Oct. 15 – Nov. 10	9.71E-01	9.65E-02	2.77E-01	Detected
	Nov. 10 – Dec. 8	7.55E-01	1.05E-01	3.00E-01	Detected
	Dec. 8 – Dec. 31	1.06E+00	7.66E-02	2.03E-01	Detected
	Dec. 31 – Jan. 14	1.06E+00	2.35E-01	7.42E-01	Detected

Table B.45. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Cactus Flats station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{137}Cs	Jan. 10 – Jan. 31	3.38E-03	1.10E-02	3.65E-02	Not detected
	Jan. 31 – Feb. 21	1.33E-02	1.24E-02	4.11E-02	Not detected
	Feb. 21 – Mar. 18	5.98E-03	6.59E-03	2.19E-02	Not detected
	Mar. 18 – Apr. 3	1.57E-02	1.15E-02	3.80E-02	Not detected
	Apr. 3 – Apr. 30	9.85E-03	1.54E-02	5.12E-02	Not detected
	Apr. 30 – May. 19	1.98E-02	6.22E-03	2.01E-02	Not detected
	May 19 – Jun. 11	1.12E-02	7.25E-03	2.39E-02	Not detected
	Jun. 11 – Jul. 2	3.57E-02	7.18E-03	2.26E-02	Detected
	Jul. 2 – Jul. 30	-1.85E-02	1.62E-02	5.52E-02	Not detected
	Jul. 30 – Aug. 20	1.61E-02	7.35E-03	2.40E-02	Not detected
	Aug. 20 – Sep. 3	-7.88E-03	2.89E-02	9.72E-02	Not detected
	Sep. 3 – Oct. 1	8.99E-03	4.78E-03	1.57E-02	Not detected
	Oct. 1 – Oct. 15	3.01E-02	6.38E-03	2.02E-02	Detected
	Oct. 15 – Nov. 10	1.25E-02	1.21E-02	4.02E-02	Not detected
	Nov. 10 – Dec. 8	1.65E-03	8.13E-03	2.72E-02	Not detected
	Dec. 8 – Dec. 31	-2.72E-03	1.19E-02	3.98E-02	Not detected
	Dec. 31 – Jan. 14	-1.63E-02	2.49E-02	8.43E-02	Not detected
^{60}Co	Jan. 10 – Jan. 31	-2.11E-02	2.59E-02	4.56E-02	Not detected
	Jan. 31 – Feb. 21	1.19E-02	1.05E-02	3.49E-02	Not detected
	Feb. 21 – Mar. 18	-3.97E-03	7.22E-03	2.49E-02	Not detected
	Mar. 18 – Apr. 3	2.23E-03	8.59E-03	2.91E-02	Not detected
	Apr. 3 – Apr. 30	2.08E-02	1.03E-02	3.35E-02	Not detected
	Apr. 30 – May. 19	8.87E-03	6.81E-03	2.25E-02	Not detected
	May 19 – Jun. 11	1.71E-02	7.31E-03	2.38E-02	Not detected
	Jun. 11 – Jul. 2	1.88E-02	7.49E-03	2.43E-02	Not detected
	Jul. 2 – Jul. 30	-4.09E-03	1.04E-02	3.61E-02	Not detected
	Jul. 30 – Aug. 20	4.44E-03	5.11E-03	1.71E-02	Not detected
	Aug. 20 – Sep. 3	-6.62E-04	1.90E-02	6.53E-02	Not detected
	Sep. 3 – Oct. 1	-2.66E-02	1.40E-02	5.01E-02	Not detected
	Oct. 1 – Oct. 15	2.84E-03	7.15E-03	2.39E-02	Not detected
	Oct. 15 – Nov. 10	-5.96E-04	7.28E-03	2.50E-02	Not detected
	Nov. 10 – Dec. 8	5.52E-03	5.97E-03	2.00E-02	Not detected
	Dec. 8 – Dec. 31	3.14E-03	6.99E-03	2.37E-02	Not detected

Table B.45. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Cactus Flats station (continued)

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{60}Co	Dec. 31 – Jan. 14	2.89E-02	2.11E-02	6.98E-02	Not detected
^{40}K	Jan. 10 – Jan. 31	8.12E-01	1.23E-01	3.79E-01	Detected
	Jan. 31 – Feb. 21	1.48E+00	2.30E-01	7.07E-01	Detected
	Feb. 21 – Mar. 18	9.54E-01	1.54E-01	4.75E-01	Detected
	Mar. 18 – Apr. 3	9.71E-01	2.10E-01	6.67E-01	Detected
	Apr. 3 – Apr. 30	4.04E-01	1.24E-01	3.88E-01	Detected
	Apr. 30 – May. 19	8.34E-01	1.27E-01	3.93E-01	Detected
	May 19 – Jun. 11	1.10E+00	1.25E-01	3.75E-01	Detected
	Jun. 11 – Jul. 2	8.68E-01	1.38E-01	4.30E-01	Detected
	Jul. 2 – Jul. 30	4.93E-01	1.38E-01	4.29E-01	Detected
	Jul. 30 – Aug. 20	8.84E-01	1.11E-01	3.31E-01	Detected
	Aug. 20 – Sep. 3	9.79E-01	2.58E-01	8.05E-01	Detected
	Sep. 3 – Oct. 1	8.33E-01	9.11E-02	2.72E-01	Detected
	Oct. 1 – Oct. 15	9.14E-01	1.20E-01	3.67E-01	Detected
	Oct. 15 – Nov. 10	7.95E-01	1.15E-01	3.37E-01	Detected
	Nov. 10 – Dec. 8	8.75E-01	9.62E-02	2.65E-01	Detected
	Dec. 8 – Dec. 31	6.24E-01	1.05E-01	3.11E-01	Detected
	Dec. 31 – Jan. 14	6.92E-01	2.32E-01	7.36E-01	Not detected

Table B.46. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Loving station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{137}Cs	Jan. 10 – Jan. 31	-1.69E-02	6.71E-03	2.30E-02	Not detected
	Jan. 31 – Feb. 21	-4.67E-04	2.01E-02	6.74E-02	Not detected
	Feb. 21 – Mar. 18	1.77E-02	5.38E-03	1.72E-02	Detected
	Mar. 18 – Apr. 3	2.31E-02	1.70E-02	5.62E-02	Not detected
	Apr. 3 – Apr. 30	9.42E-03	4.49E-03	1.47E-02	Not detected
	Apr. 30 – May. 19	1.39E-02	4.60E-03	1.49E-02	Not detected
	May 19 – Jun. 11	1.01E-02	5.11E-03	1.68E-02	Not detected
	Jun. 11 – Jul. 2	1.66E-02	6.24E-03	2.03E-02	Not detected
	Jul. 2 – Jul. 30	-6.18E-03	4.51E-03	1.52E-02	Not detected
	Jul. 30 – Aug. 20	-1.14E-02	5.90E-03	2.00E-02	Not detected
	Aug. 20 – Sep. 3	-1.81E-02	1.44E-02	4.90E-02	Not detected
	Sep. 3 – Oct. 1	6.15E-03	3.22E-03	1.06E-02	Not detected
	Oct. 1 – Oct. 15	7.04E-03	3.63E-03	1.19E-02	Not detected
	Oct. 15 – Nov. 10	-7.16E-03	4.41E-03	1.49E-02	Not detected
	Nov. 10 – Dec. 8	1.17E-02	3.68E-03	1.19E-02	Not detected
	Dec. 8 – Dec. 31	3.21E-04	4.14E-03	1.38E-02	Not detected
	Dec. 31 – Jan. 14	1.68E-02	9.12E-03	2.99E-02	Not detected
^{60}Co	Jan. 10 – Jan. 31	3.87E-03	3.88E-03	1.30E-02	Not detected
	Jan. 31 – Feb. 21	-3.49E-03	1.26E-02	4.38E-02	Not detected
	Feb. 21 – Mar. 18	4.68E-03	4.93E-03	1.65E-02	Not detected
	Mar. 18 – Apr. 3	-1.06E-03	9.47E-03	3.26E-02	Not detected
	Apr. 3 – Apr. 30	7.95E-03	4.29E-03	1.40E-02	Not detected
	Apr. 30 – May. 19	6.08E-04	3.30E-03	1.12E-02	Not detected
	May 19 – Jun. 11	-9.67E-05	2.98E-03	1.02E-02	Not detected
	Jun. 11 – Jul. 2	-5.64E-03	3.06E-03	1.10E-02	Not detected
	Jul. 2 – Jul. 30	2.86E-03	2.27E-03	7.55E-03	Not detected
	Jul. 30 – Aug. 20	-7.50E-05	4.08E-03	1.38E-02	Not detected
	Aug. 20 – Sep. 3	1.94E-02	8.85E-03	2.86E-02	Not detected
	Sep. 3 – Oct. 1	8.24E-04	2.58E-03	8.74E-03	Not detected
	Oct. 1 – Oct. 15	4.14E-03	3.45E-03	1.14E-02	Not detected
	Oct. 15 – Nov. 10	2.63E-03	3.14E-03	1.05E-02	Not detected
	Nov. 10 – Dec. 8	-1.12E-03	2.39E-03	8.29E-03	Not detected
	Dec. 8 – Dec. 31	-1.86E-03	2.26E-03	7.81E-03	Not detected

Table B.46. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Loving station (continued)

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{60}Co	Dec. 31 – Jan. 14	-1.09E-02	1.57E-02	5.51E-02	Not detected
^{40}K	Jan. 10 – Jan. 31	7.83E-01	9.97E-02	3.03E-01	Detected
	Jan. 31 – Feb. 21	6.56E-01	1.87E-01	5.87E-01	Detected
	Feb. 21 – Mar. 18	8.05E-01	1.38E-01	4.35E-01	Detected
	Mar. 18 – Apr. 3	1.02E+00	1.48E-01	4.30E-01	Detected
	Apr. 3 – Apr. 30	7.04E-01	8.55E-02	2.59E-01	Detected
	Apr. 30 – May. 19	8.03E-01	7.12E-02	2.00E-01	Detected
	May 19 – Jun. 11	-6.91E-02	7.15E-02	2.42E-01	Not detected
	Jun. 11 – Jul. 2	4.08E-01	7.05E-02	2.18E-01	Detected
	Jul. 2 – Jul. 30	5.28E-01	6.23E-02	1.87E-01	Detected
	Jul. 30 – Aug. 20	6.54E-01	7.86E-02	2.37E-01	Detected
	Aug. 20 – Sep. 3	7.47E-01	1.33E-01	3.98E-01	Detected
	Sep. 3 – Oct. 1	6.03E-01	5.26E-02	1.47E-01	Detected
	Oct. 1 – Oct. 15	6.63E-01	6.89E-02	2.00E-01	Detected
	Oct. 15 – Nov. 10	6.87E-01	5.89E-02	1.69E-01	Detected
	Nov. 10 – Dec. 8	7.69E-01	6.10E-02	1.66E-01	Detected
	Dec. 8 – Dec. 31	8.17E-01	5.81E-02	1.61E-01	Detected
	Dec. 31 – Jan. 14	1.03E+00	2.00E-01	6.31E-01	Detected

Table B.47. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Carlsbad station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{137}Cs	Jan. 10 – Jan. 31	1.91E-02	2.74E-02	9.10E-02	Not detected
	Jan. 31 – Feb. 21	-3.25E-02	1.52E-02	5.18E-02	Not detected
	Feb. 21 – Mar. 18	-3.31E-04	2.55E-02	8.54E-02	Not detected
	Mar. 18 – Apr. 3	-2.77E-02	6.42E-02	1.08E-01	Not detected
	Apr. 3 – Apr. 30	7.72E-03	7.71E-03	2.55E-02	Not detected
	Apr. 30 – May. 19	-6.71E-03	7.18E-03	2.42E-02	Not detected
	May 19 – Jun. 11	1.05E-02	1.22E-02	4.05E-02	Not detected
	Jun. 11 – Jul. 2	8.94E-03	1.27E-02	4.24E-02	Not detected
	Jul. 2 – Jul. 30	1.12E-02	1.05E-02	3.49E-02	Not detected
	Jul. 30 – Aug. 20	1.31E-02	5.30E-03	1.72E-02	Not detected
	Aug. 20 – Sep. 3	1.61E-02	8.28E-03	2.71E-02	Not detected
	Sep. 3 – Oct. 1	1.31E-02	9.41E-03	3.10E-02	Not detected
	Oct. 1 – Oct. 15	9.06E-03	1.29E-02	4.29E-02	Not detected
	Oct. 15 – Nov. 10	1.86E-02	5.27E-03	1.70E-02	Detected
	Nov. 10 – Dec. 8	-5.12E-03	1.14E-02	3.83E-02	Not detected
	Dec. 8 – Dec. 31	5.45E-03	1.00E-02	3.34E-02	Not detected
	Dec. 31 – Jan. 14	8.10E-04	1.39E-02	4.70E-02	Not detected
^{60}Co	Jan. 10 – Jan. 31	2.29E-02	1.68E-02	5.56E-02	Not detected
	Jan. 31 – Feb. 21	-5.15E-03	7.49E-03	2.60E-02	Not detected
	Feb. 21 – Mar. 18	6.47E-03	1.58E-02	5.36E-02	Not detected
	Mar. 18 – Apr. 3	-1.24E-02	3.91E-02	6.76E-02	Not detected
	Apr. 3 – Apr. 30	3.24E-03	4.42E-03	1.49E-02	Not detected
	Apr. 30 – May. 19	9.33E-03	4.71E-03	1.54E-02	Not detected
	May 19 – Jun. 11	1.51E-02	7.79E-03	2.54E-02	Not detected
	Jun. 11 – Jul. 2	1.92E-02	8.03E-03	2.58E-02	Not detected
	Jul. 2 – Jul. 30	8.88E-03	6.29E-03	2.08E-02	Not detected
	Jul. 30 – Aug. 20	8.63E-03	5.49E-03	1.81E-02	Not detected
	Aug. 20 – Sep. 3	-7.40E-04	5.99E-03	2.05E-02	Not detected
	Sep. 3 – Oct. 1	2.47E-03	5.71E-03	1.94E-02	Not detected
	Oct. 1 – Oct. 15	2.58E-02	9.84E-03	3.17E-02	Not detected
	Oct. 15 – Nov. 10	2.09E-03	4.32E-03	1.45E-02	Not detected
	Nov. 10 – Dec. 8	1.37E-02	8.81E-03	2.90E-02	Not detected
	Dec. 8 – Dec. 31	-5.30E-04	6.87E-03	2.36E-02	Not detected

Table B.47. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from Carlsbad station (continued)

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{60}Co	Dec. 31 – Jan. 14	6.85E-03	1.33E-02	4.51E-02	Not detected
^{40}K	Jan. 10 – Jan. 31	1.25E+00	2.52E-01	7.62E-01	Detected
	Jan. 31 – Feb. 21	7.78E-01	1.72E-01	5.44E-01	Detected
	Feb. 21 – Mar. 18	1.60E+00	2.20E-01	6.28E-01	Detected
	Mar. 18 – Apr. 3	8.97E-01	3.68E-01	5.90E-01	Detected
	Apr. 3 – Apr. 30	5.40E-01	1.05E-01	3.29E-01	Detected
	Apr. 30 – May. 19	8.77E-01	1.01E-01	3.02E-01	Detected
	May 19 – Jun. 11	8.41E-01	1.21E-01	3.54E-01	Detected
	Jun. 11 – Jul. 2	6.31E-01	1.28E-01	3.92E-01	Detected
	Jul. 2 – Jul. 30	7.06E-01	1.04E-01	3.04E-01	Detected
	Jul. 30 – Aug. 20	6.51E-01	9.90E-02	3.07E-01	Detected
	Aug. 20 – Sep. 3	1.08E+00	1.48E-01	4.54E-01	Detected
	Sep. 3 – Oct. 1	5.73E-01	9.40E-02	2.79E-01	Detected
	Oct. 1 – Oct. 15	1.06E+00	1.28E-01	3.58E-01	Detected
	Oct. 15 – Nov. 10	7.98E-01	8.18E-02	2.43E-01	Detected
	Nov. 10 – Dec. 8	1.02E+00	1.31E-01	3.79E-01	Detected
	Dec. 8 – Dec. 31	9.46E-01	1.10E-01	3.06E-01	Detected
	Dec. 31 – Jan. 14	1.78E+00	3.07E-01	9.47E-01	Detected

Table B.48. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from East Tower station

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{137}Cs	Jan. 10 – Jan. 31	4.69E-03	1.68E-02	5.63E-02	Not detected
	Jan. 31 – Feb. 21	-3.49E-02	2.20E-02	7.55E-02	Not detected
	Feb. 21 – Mar. 18	5.39E-03	6.65E-03	2.21E-02	Not detected
	Mar. 18 – Apr. 3	5.87E-02	2.34E-02	3.81E-02	Detected
	Apr. 3 – Apr. 30	-3.25E-02	1.83E-02	6.27E-02	Not detected
	Apr. 30 – May. 19	1.04E-02	1.45E-02	4.84E-02	Not detected
	May 19 – Jun. 11	-2.76E-03	5.97E-03	2.00E-02	Not detected
	Jun. 11 – Jul. 2	-9.18E-03	6.47E-03	2.18E-02	Not detected
	Jul. 2 – Jul. 30	1.53E-02	6.04E-03	1.97E-02	Not detected
	Jul. 30 – Aug. 20	-7.32E-03	1.64E-02	5.51E-02	Not detected
	Aug. 20 – Sep. 3	1.12E-02	2.33E-02	7.76E-02	Not detected
	Sep. 3 – Oct. 1	-6.27E-03	4.58E-03	1.55E-02	Not detected
	Oct. 1 – Oct. 15	-6.99E-03	5.80E-03	1.96E-02	Not detected
	Oct. 15 – Nov. 10	8.51E-03	3.72E-02	1.52E-01	Not detected
	Nov. 10 – Dec. 8	1.49E-02	1.09E-02	3.61E-02	Not detected
	Dec. 8 – Dec. 31	-6.27E-03	5.29E-03	1.78E-02	Not detected
	Dec. 31 – Jan. 14	-2.29E-02	1.81E-02	6.10E-02	Not detected
^{60}Co	Jan. 10 – Jan. 31	1.32E-02	1.57E-02	5.24E-02	Not detected
	Jan. 31 – Feb. 21	2.34E-02	1.68E-02	5.54E-02	Not detected
	Feb. 21 – Mar. 18	9.55E-03	5.61E-03	1.84E-02	Not detected
	Mar. 18 – Apr. 3	3.11E-02	1.87E-02	3.07E-02	Detected
	Apr. 3 – Apr. 30	1.30E-02	1.47E-02	4.93E-02	Not detected
	Apr. 30 – May. 19	4.20E-03	9.20E-03	3.12E-02	Not detected
	May 19 – Jun. 11	2.80E-03	3.07E-03	1.03E-02	Not detected
	Jun. 11 – Jul. 2	4.17E-03	3.15E-03	1.04E-02	Not detected
	Jul. 2 – Jul. 30	-3.00E-04	3.64E-03	1.25E-02	Not detected
	Jul. 30 – Aug. 20	2.76E-03	9.43E-03	3.22E-02	Not detected
	Aug. 20 – Sep. 3	8.31E-03	1.66E-02	5.60E-02	Not detected
	Sep. 3 – Oct. 1	-1.45E-03	3.03E-03	1.04E-02	Not detected
	Oct. 1 – Oct. 15	-3.83E-05	3.34E-03	1.14E-02	Not detected
	Oct. 15 – Nov. 10	2.32E-02	4.08E-02	1.66E-01	Not detected
	Nov. 10 – Dec. 8	-7.53E-03	6.20E-03	2.20E-02	Not detected
	Dec. 8 – Dec. 31	1.08E-03	3.04E-03	1.03E-02	Not detected

Table B.48. Specific activity of gamma emitting isotopes (^{137}Cs, ^{60}Co, and ^{40}K) in the filter samples collected from East Tower station (continued)

Radionuclide	Sample Date 2020	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{60}Co	Dec. 31 – Jan. 14	-1.81E-02	1.28E-02	4.42E-02	Not detected
^{40}K	Jan. 10 – Jan. 31	1.98E+00	2.98E-01	9.08E-01	Detected
	Jan. 31 – Feb. 21	8.39E-01	2.22E-01	6.91E-01	Detected
	Feb. 21 – Mar. 18	9.07E-01	1.52E-01	4.74E-01	Detected
	Mar. 18 – Apr. 3	9.91E-01	3.48E-01	5.64E-01	Detected
	Apr. 3 – Apr. 30	9.28E-01	1.79E-01	5.38E-01	Detected
	Apr. 30 – May. 19	7.04E-01	1.36E-01	4.09E-01	Detected
	May 19 – Jun. 11	5.01E-01	7.44E-02	2.30E-01	Detected
	Jun. 11 – Jul. 2	6.36E-01	8.04E-02	2.43E-01	Detected
	Jul. 2 – Jul. 30	7.78E-01	8.70E-02	2.54E-01	Detected
	Jul. 30 – Aug. 20	7.66E-01	1.31E-01	3.86E-01	Detected
	Aug. 20 – Sep. 3	2.55E+00	2.65E-01	7.47E-01	Detected
	Sep. 3 – Oct. 1	6.05E-01	6.56E-02	1.95E-01	Detected
	Oct. 1 – Oct. 15	7.01E-01	8.46E-02	2.55E-01	Detected
	Oct. 15 – Nov. 10	-3.53E-01	5.32E-01	2.51E+00	Not detected
	Nov. 10 – Dec. 8	8.38E-01	1.05E-01	2.99E-01	Detected
	Dec. 8 – Dec. 31	9.52E-01	7.21E-02	2.02E-01	Detected
	Dec. 31 – Jan. 14	8.66E-01	2.12E-01	6.76E-01	Detected

Table B.49. Activity concentrations of ^{90}Sr (Bq/m^3) at Onsite station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc.(2-sig) Bq/m^3	MDC Bq/m^3	Status
^{90}Sr	Jan. 10 – Jan. 31	2.05E-04	1.82E-05	2.47E-04	Not detected
	Jan. 31 – Feb. 21	5.87E-04	3.45E-05	2.47E-04	Detected
	Feb. 21 – Mar. 18	1.44E-04	1.49E-05	2.43E-04	Not detected
	Mar. 18 – Apr. 3	-	-	-	-
	Apr. 3 – Apr. 30	1.72E-04	1.64E-05	2.54E-04	Not detected
	Apr. 30 – May. 19	2.03E-04	1.91E-05	2.69E-04	Not detected
	May 19 – Jun. 11	1.72E-04	1.64E-05	2.47E-04	Not detected
	Jun. 11 – Jul. 2	1.77E-04	1.72E-05	2.51E-04	Not detected
	Jul. 2 – Jul. 30	1.49E-04	1.52E-05	2.54E-04	Not detected
	Jul. 30 – Aug. 20	2.82E-04	2.55E-05	3.70E-04	Not detected
	Aug. 20 – Sep. 3	-	-	-	-
	Sep. 3 – Oct. 1	1.61E-04	1.61E-05	2.39E-04	Not detected
	Oct. 1 – Oct. 15	-	-	-	-
	Oct. 15 – Nov. 10	1.49E-04	1.84E-05	2.31E-04	Not detected
	Nov. 10 – Dec. 8	1.49E-04	1.54E-05	2.39E-04	Not detected
	Dec. 8 – Dec. 31	1.44E-04	1.49E-05	2.39E-04	Not detected
	Dec. 31 – Jan. 14	1.68E-04	1.83E-05	2.98E-04	Not detected

Table B.50. Specific activity of ^{90}Sr (Bq/g) at Onsite station

Radionuclide	Sample Date 2020	^{90}Sr Activity Bq/g	Unc.(2-sig) Bq/g	MDC Bq/g	Status
^{90}Sr	Jan. 10 – Jan. 31	4.57E+00	4.06E-01	5.51E+00	Not detected
	Jan. 31 – Feb. 21	2.17E+01	1.27E+00	9.11E+00	Detected
	Feb. 21 – Mar. 18	2.35E+00	2.43E-01	3.96E+00	Not detected
	Mar. 18 – Apr. 3	-	-	-	-
	Apr. 3 – Apr. 30	2.19E+00	2.10E-01	3.25E+00	Not detected
	Apr. 30 – May. 19	1.78E+00	1.67E-01	2.36E+00	Not detected
	May 19 – Jun. 11	1.83E+00	1.74E-01	2.63E+00	Not detected
	Jun. 11 – Jul. 2	1.97E+00	1.91E-01	2.79E+00	Not detected
	Jul. 2 – Jul. 30	2.07E+00	2.11E-01	3.52E+00	Not detected
	Jul. 30 – Aug. 20	5.55E+00	5.03E-01	7.29E+00	Not detected
	Aug. 20 – Sep. 3	-	-	-	-
	Sep. 3 – Oct. 1	1.86E+00	1.87E-01	2.77E+00	Not detected
	Oct. 1 – Oct. 15	-	-	-	-
	Oct. 15 – Nov. 10	1.79E+00	2.21E-01	2.77E+00	Not detected
	Nov. 10 – Dec. 8	1.83E+00	1.89E-01	2.93E+00	Not detected
	Dec. 8 – Dec. 31	1.83E+00	1.90E-01	3.03E+00	Not detected
	Dec. 31 – Jan. 14	5.10E+00	5.57E-01	9.03E+00	Not detected

Table B.51. Activity concentrations of ^{90}Sr (Bq/m^3) at Near Field station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc.(2-sig) Bq/m^3	MDC Bq/m^3	Status
^{90}Sr	Jan. 10 – Jan. 31	1.77E-04	1.70E-05	2.47E-04	Not detected
	Jan. 31 – Feb. 21	2.82E-04	2.22E-05	2.47E-04	Detected
	Feb. 21 – Mar. 18	1.77E-04	1.68E-05	2.43E-04	Not detected
	Mar. 18 – Apr. 3	2.50E-04	2.24E-05	2.89E-04	Not detected
	Apr. 3 – Apr. 30	-	-	-	-
	Apr. 30 – May. 19	1.98E-04	1.81E-05	2.52E-04	Not detected
	May 19 – Jun. 11	1.83E-04	1.72E-05	2.35E-04	Not detected
	Jun. 11 – Jul. 2	1.66E-04	1.62E-05	2.35E-04	Not detected
	Jul. 2 – Jul. 30	1.38E-05	1.35E-06	0.00E+00	Detected
	Jul. 30 – Aug. 20	1.66E-04	1.65E-05	2.54E-04	Not detected
	Aug. 20 – Sep. 3	-	-	-	-
	Sep. 3 – Oct. 1	1.44E-04	1.50E-05	2.31E-04	Not detected
	Oct. 1 – Oct. 15	-	-	-	-
	Oct. 15 – Nov. 10	1.55E-04	1.54E-05	2.31E-04	Not detected
	Nov. 10 – Dec. 8	1.61E-04	1.61E-05	2.39E-04	Not detected
	Dec. 8 – Dec. 31	-	-	-	-
	Dec. 31 – Jan. 14	2.04E-04	2.05E-05	3.20E-04	Not detected

Table B.52. Specific activity of ^{90}Sr (Bq/g) at Near Field station

Radionuclide	Sample Date 2020	^{90}Sr Activity Bq/g	Unc.(2-sig) Bq/g	MDC Bq/g	Status
^{90}Sr	Jan. 10 – Jan. 31	4.58E+00	4.39E-01	6.38E+00	Not detected
	Jan. 31 – Feb. 21	9.82E+00	7.74E-01	8.58E+00	Detected
	Feb. 21 – Mar. 18	5.10E+00	4.84E-01	6.99E+00	Not detected
	Mar. 18 – Apr. 3	6.50E+00	5.82E-01	7.51E+00	Not detected
	Apr. 3 – Apr. 30	-	-	-	-
	Apr. 30 – May. 19	3.45E+00	3.15E-01	4.39E+00	Not detected
	May 19 – Jun. 11	2.98E+00	2.81E-01	3.84E+00	Not detected
	Jun. 11 – Jul. 2	2.88E+00	2.80E-01	4.07E+00	Not detected
	Jul. 2 – Jul. 30	2.17E-01	2.12E-02	0.00E+00	Detected
	Jul. 30 – Aug. 20	3.54E+00	3.51E-01	5.41E+00	Not detected
	Aug. 20 – Sep. 3	-	-	-	-
	Sep. 3 – Oct. 1	2.06E+00	2.14E-01	3.31E+00	Not detected
	Oct. 1 – Oct. 15	-	-	-	-
	Oct. 15 – Nov. 10	2.75E+00	2.73E-01	4.10E+00	Not detected
	Nov. 10 – Dec. 8	2.26E+00	2.26E-01	3.36E+00	Not detected
	Dec. 8 – Dec. 31	-	-	-	-
	Dec. 31 – Jan. 14	6.94E+00	7.00E-01	1.09E+01	Not detected

Table B.53. Activity concentrations of ^{90}Sr (Bq/m^3) at Cactus Flats station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc.(2-sig) Bq/m^3	MDC Bq/m^3	Status
^{90}Sr	Jan. 10 – Jan. 31	3.99E-04	2.77E-05	2.47E-04	Detected
	Jan. 31 – Feb. 21	2.21E-04	1.88E-05	2.47E-04	Not detected
	Feb. 21 – Mar. 18	1.49E-04	1.52E-05	2.43E-04	Not detected
	Mar. 18 – Apr. 3	2.08E-04	1.91E-05	2.76E-04	Not detected
	Apr. 3 – Apr. 30	9.13E-05	8.47E-06	1.23E-04	Not detected
	Apr. 30 – May. 19	1.61E-04	1.57E-05	2.47E-04	Not detected
	May 19 – Jun. 11	1.83E-04	1.70E-05	2.35E-04	Not detected
	Jun. 11 – Jul. 2	1.61E-04	1.57E-05	2.35E-04	Not detected
	Jul. 2 – Jul. 30	8.30E-05	8.09E-06	1.27E-04	Not detected
	Jul. 30 – Aug. 20	1.44E-04	1.48E-05	2.54E-04	Not detected
	Aug. 20 – Sep. 3	1.84E-04	1.86E-05	2.94E-04	Not detected
	Sep. 3 – Oct. 1	8.58E-05	8.44E-06	1.15E-04	Not detected
	Oct. 1 – Oct. 15	1.95E-04	1.94E-05	2.90E-04	Not detected
	Oct. 15 – Nov. 10	1.66E-04	1.63E-05	2.31E-04	Not detected
	Nov. 10 – Dec. 8	1.72E-04	1.64E-05	2.39E-04	Not detected
	Dec. 8 – Dec. 31	-	-	-	-
	Dec. 31 – Jan. 14	2.34E-04	2.35E-05	3.68E-04	Not detected

Table B.54. Specific activity of ^{90}Sr (Bq/g) at Cactus Flats station

Radionuclide	Sample Date 2020	^{90}Sr Activity Bq/g	Unc.(2-sig) Bq/g	MDC Bq/g	Status
^{90}Sr	Jan. 10 – Jan. 31	9.98E+00	6.94E-01	6.18E+00	Detected
	Jan. 31 – Feb. 21	9.26E+00	7.85E-01	1.03E+01	Not detected
	Feb. 21 – Mar. 18	4.08E+00	4.15E-01	6.63E+00	Not detected
	Mar. 18 – Apr. 3	6.39E+00	5.88E-01	8.50E+00	Not detected
	Apr. 3 – Apr. 30	3.90E+00	3.61E-01	5.27E+00	Not detected
	Apr. 30 – May. 19	3.27E+00	3.19E-01	5.02E+00	Not detected
	May 19 – Jun. 11	3.58E+00	3.32E-01	4.60E+00	Not detected
	Jun. 11 – Jul. 2	3.64E+00	3.56E-01	5.33E+00	Not detected
	Jul. 2 – Jul. 30	3.81E+00	3.71E-01	5.83E+00	Not detected
	Jul. 30 – Aug. 20	3.16E+00	3.24E-01	5.58E+00	Not detected
	Aug. 20 – Sep. 3	5.77E+00	5.82E-01	9.22E+00	Not detected
	Sep. 3 – Oct. 1	2.52E+00	2.48E-01	3.39E+00	Not detected
	Oct. 1 – Oct. 15	3.07E+00	3.05E-01	4.58E+00	Not detected
	Oct. 15 – Nov. 10	2.39E+00	2.35E-01	3.33E+00	Not detected
	Nov. 10 – Dec. 8	1.97E+00	1.89E-01	2.75E+00	Not detected
	Dec. 8 – Dec. 31	-	-	-	-
	Dec. 31 – Jan. 14	5.48E+00	5.50E-01	8.62E+00	Not detected

Table B.55. Activity concentrations of ^{90}Sr (Bq/m^3) at Loving station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc.(2-sig) Bq/m^3	MDC Bq/m^3	Status
^{90}Sr	Jan. 10 – Jan. 31	1.66E-04	1.64E-05	2.47E-04	Not detected
	Jan. 31 – Feb. 21	2.05E-04	1.85E-05	2.47E-04	Not detected
	Feb. 21 – Mar. 18	1.49E-04	1.51E-05	2.43E-04	Not detected
	Mar. 18 – Apr. 3	1.78E-04	1.75E-05	2.80E-04	Not detected
	Apr. 3 – Apr. 30	1.61E-04	1.56E-05	2.47E-04	Not detected
	Apr. 30 – May. 19	1.88E-04	1.75E-05	2.47E-04	Not detected
	May 19 – Jun. 11	1.55E-04	1.56E-05	2.35E-04	Not detected
	Jun. 11 – Jul. 2	1.77E-04	1.67E-05	2.35E-04	Not detected
	Jul. 2 – Jul. 30	-	-	-	-
	Jul. 30 – Aug. 20	1.72E-04	1.62E-05	2.54E-04	Not detected
	Aug. 20 – Sep. 3	1.68E-04	1.85E-05	3.01E-04	Not detected
	Sep. 3 – Oct. 1	1.55E-04	1.56E-05	2.31E-04	Not detected
	Oct. 1 – Oct. 15	-	-	-	-
	Oct. 15 – Nov. 10	1.44E-04	1.48E-05	2.31E-04	Not detected
	Nov. 10 – Dec. 8	1.72E-04	1.63E-05	2.39E-04	Not detected
	Dec. 8 – Dec. 31	1.44E-04	1.49E-05	2.39E-04	Not detected
	Dec. 31 – Jan. 14	1.68E-04	1.83E-05	2.98E-04	Not detected

Table B.56. Specific activity of ^{90}Sr (Bq/g) at Loving station

Radionuclide	Sample Date 2020	^{90}Sr Activity Bq/g	Unc.(2-sig) Bq/g	MDC Bq/g	Status
^{90}Sr	Jan. 10 – Jan. 31	3.19E+00	3.15E-01	4.74E+00	Not detected
	Jan. 31 – Feb. 21	5.52E+00	4.99E-01	6.65E+00	Not detected
	Feb. 21 – Mar. 18	3.13E+00	3.16E-01	5.08E+00	Not detected
	Mar. 18 – Apr. 3	3.05E+00	2.98E-01	4.77E+00	Not detected
	Apr. 3 – Apr. 30	2.15E+00	2.10E-01	3.31E+00	Not detected
	Apr. 30 – May. 19	2.37E+00	2.20E-01	3.10E+00	Not detected
	May 19 – Jun. 11	2.00E+00	2.01E-01	3.03E+00	Not detected
	Jun. 11 – Jul. 2	2.45E+00	2.31E-01	3.25E+00	Not detected
	Jul. 2 – Jul. 30	-	-	-	-
	Jul. 30 – Aug. 20	2.58E+00	2.43E-01	3.81E+00	Not detected
	Aug. 20 – Sep. 3	2.44E+00	2.69E-01	4.38E+00	Not detected
	Sep. 3 – Oct. 1	1.48E+00	1.49E-01	2.21E+00	Not detected
	Oct. 1 – Oct. 15	-	-	-	-
	Oct. 15 – Nov. 10	1.53E+00	1.58E-01	2.46E+00	Not detected
	Nov. 10 – Dec. 8	1.84E+00	1.75E-01	2.56E+00	Not detected
	Dec. 8 – Dec. 31	1.83E+00	1.90E-01	3.03E+00	Not detected
	Dec. 31 – Jan. 14	5.10E+00	5.57E-01	9.03E+00	Not detected

Table B.57. Activity concentrations of ^{90}Sr (Bq/m^3) at Carlsbad station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc.(2-sig) Bq/m^3	MDC Bq/m^3	Status
^{90}Sr	Jan. 10 – Jan. 31	2.05E-04	1.87E-05	2.47E-04	Not detected
	Jan. 31 – Feb. 21	1.66E-04	1.59E-05	2.47E-04	Not detected
	Feb. 21 – Mar. 18	1.83E-04	1.70E-05	2.43E-04	Not detected
	Mar. 18 – Apr. 3	1.77E-04	1.76E-05	2.77E-04	Not detected
	Apr. 3 – Apr. 30	3.21E-04	2.34E-05	2.47E-04	Detected
	Apr. 30 – May. 19	1.87E-04	1.73E-05	2.52E-04	Not detected
	May 19 – Jun. 11	1.66E-04	1.62E-05	2.35E-04	Not detected
	Jun. 11 – Jul. 2	1.77E-04	1.71E-05	2.35E-04	Not detected
	Jul. 2 – Jul. 30	-	-	-	-
	Jul. 30 – Aug. 20	1.88E-04	1.72E-05	2.54E-04	Not detected
	Aug. 20 – Sep. 3	-	-	-	-
	Sep. 3 – Oct. 1	1.77E-04	1.68E-05	2.31E-04	Not detected
	Oct. 1 – Oct. 15	2.78E-04	2.63E-05	3.74E-04	Not detected
	Oct. 15 – Nov. 10	1.66E-04	1.63E-05	2.35E-04	Not detected
	Nov. 10 – Dec. 8	1.55E-04	1.55E-05	2.39E-04	Not detected
	Dec. 8 – Dec. 31	-	-	-	-
	Dec. 31 – Jan. 14	1.93E-04	1.93E-05	3.17E-04	Not detected

Table B.58. Specific activity of ^{90}Sr (Bq/g) at Carlsbad station

Radionuclide	Sample Date 2020	^{90}Sr Activity Bq/g	Unc.(2-sig) Bq/g	MDC Bq/g	Status
^{90}Sr	Jan. 10 – Jan. 31	7.41E+00	6.77E-01	8.92E+00	Not detected
	Jan. 31 – Feb. 21	6.51E+00	6.23E-01	9.68E+00	Not detected
	Feb. 21 – Mar. 18	5.34E+00	4.98E-01	7.11E+00	Not detected
	Mar. 18 – Apr. 3	5.69E+00	5.66E-01	8.91E+00	Not detected
	Apr. 3 – Apr. 30	6.23E+00	4.55E-01	4.79E+00	Detected
	Apr. 30 – May. 19	3.40E+00	3.14E-01	4.59E+00	Not detected
	May 19 – Jun. 11	2.50E+00	2.43E-01	3.53E+00	Not detected
	Jun. 11 – Jul. 2	2.91E+00	2.80E-01	3.86E+00	Not detected
	Jul. 2 – Jul. 30	-	-	-	-
	Jul. 30 – Aug. 20	3.05E+00	2.79E-01	4.12E+00	Not detected
	Aug. 20 – Sep. 3	-	-	-	-
	Sep. 3 – Oct. 1	2.15E+00	2.04E-01	2.81E+00	Not detected
	Oct. 1 – Oct. 15	2.71E+00	2.57E-01	3.65E+00	Not detected
	Oct. 15 – Nov. 10	2.12E+00	2.08E-01	3.00E+00	Not detected
	Nov. 10 – Dec. 8	2.33E+00	2.32E-01	3.59E+00	Not detected
	Dec. 8 – Dec. 31	-	-	-	-
	Dec. 31 – Jan. 14	9.22E+00	9.21E-01	1.51E+01	Not detected

Table B.59. Activity concentrations of ^{90}Sr (Bq/m^3) at East Tower station

Radionuclide	Sample Date 2020	Activity Bq/m^3	Unc.(2-sig) Bq/m^3	MDC Bq/m^3	Status
^{90}Sr	Jan. 10 – Jan. 31	6.66E-04	6.15E-05	9.00E-04	Not detected
	Jan. 31 – Feb. 21	2.72E-04	2.25E-05	2.64E-04	Detected
	Feb. 21 – Mar. 18	-	-	-	-
	Mar. 18 – Apr. 3	2.93E-04	2.83E-05	4.15E-04	Not detected
	Apr. 3 – Apr. 30	1.98E-04	1.90E-05	2.85E-04	Not detected
	Apr. 30 – May. 19	1.76E-04	1.71E-05	2.70E-04	Not detected
	May 19 – Jun. 11	1.61E-04	1.55E-05	2.35E-04	Not detected
	Jun. 11 – Jul. 2	1.66E-04	1.61E-05	2.43E-04	Not detected
	Jul. 2 – Jul. 30	-	-	-	-
	Jul. 30 – Aug. 20	1.77E-04	1.68E-05	2.54E-04	Not detected
	Aug. 20 – Sep. 3	1.93E-04	2.03E-05	3.20E-04	Not detected
	Sep. 3 – Oct. 1	1.55E-04	1.57E-05	2.31E-04	Not detected
	Oct. 1 – Oct. 15	-	-	-	-
	Oct. 15 – Nov. 10	1.61E-04	1.60E-05	2.35E-04	Not detected
	Nov. 10 – Dec. 8	2.55E-04	2.09E-05	2.39E-04	Detected
	Dec. 8 – Dec. 31	-	-	-	-
	Dec. 31 – Jan. 14	2.06E-04	2.04E-05	3.26E-04	Not detected

Table B.60. Specific activity of ^{90}Sr (Bq/g) at East Tower station

Radionuclide	Sample Date 2020	^{90}Sr Activity Bq/g	Unc.(2-sig) Bq/g	MDC Bq/g	Status
^{90}Sr	Jan. 10 – Jan. 31	1.05E+01	9.65E-01	1.41E+01	Not detected
	Jan. 31 – Feb. 21	8.52E+00	7.05E-01	8.26E+00	Detected
	Feb. 21 – Mar. 18	-	-	-	-
	Mar. 18 – Apr. 3	5.15E+00	4.98E-01	7.29E+00	Not detected
	Apr. 3 – Apr. 30	4.47E+00	4.29E-01	6.43E+00	Not detected
	Apr. 30 – May. 19	3.10E+00	3.01E-01	4.76E+00	Not detected
	May 19 – Jun. 11	2.27E+00	2.20E-01	3.33E+00	Not detected
	Jun. 11 – Jul. 2	2.69E+00	2.62E-01	3.94E+00	Not detected
	Jul. 2 – Jul. 30	-	-	-	-
	Jul. 30 – Aug. 20	3.47E+00	3.29E-01	4.98E+00	Not detected
	Aug. 20 – Sep. 3	3.74E+00	3.94E-01	6.20E+00	Not detected
	Sep. 3 – Oct. 1	1.95E+00	1.98E-01	2.90E+00	Not detected
	Oct. 1 – Oct. 15	-	-	-	-
	Oct. 15 – Nov. 10	2.15E+00	2.14E-01	3.15E+00	Not detected
	Nov. 10 – Dec. 8	3.32E+00	2.73E-01	3.12E+00	Detected
	Dec. 8 – Dec. 31	-	-	-	-
	Dec. 31 – Jan. 14	7.16E+00	7.11E-01	1.13E+01	Not detected

APPENDIX C - RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES

Actinide concentrations in soil samples

Uranium concentrations in soil samples

Gamma radionuclide concentrations in soil samples

Strontium concentrations in soil samples

Table C.1. Activity concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu (Bq/kg) in soil samples collected from Near Field in the vicinity of the WIPP site

Radionuclide	Grid Node	Sampling Date	Activity Bq/kg	Unc. (2s) Bq/kg	MDC Bq/kg	Status
^{241}Am	A-1	6/18/2020	2.08E-02	2.55E-02	5.53E-02	Not detected
	A-2	7/2/2020	6.26E-02	2.64E-02	1.84E-02	Detected
	A-3	9/9/2020	-2.64E-03	2.05E-02	5.63E-02	Not detected
	A-4	9/9/2020	5.12E-02	2.68E-02	4.29E-02	Detected
	A-5	9/14/2020	1.33E-02	2.26E-02	5.21E-02	Not detected
	A-6	9/14/2020	-1.62E-02	2.74E-02	7.58E-02	Not detected
	A-7	7/2/2020	3.57E-02	2.47E-02	4.48E-02	Not detected
	A-8	9/14/2020	4.82E-02	3.84E-02	7.55E-02	Not detected
	A-5-Dup	9/14/2020	0.00E+00	4.18E-02	1.09E-01	Not detected
	B-1	6/22/2020	5.42E-02	2.77E-02	4.11E-02	Detected
	B-2	6/22/2020	3.47E-02	1.94E-02	2.15E-02	Detected
	B-3	9/9/2020	5.87E-02	3.33E-02	5.72E-02	Detected
	B-4	9/9/2020	2.79E-02	2.97E-02	6.26E-02	Not detected
	B-5	9/14/2020	4.14E-02	2.80E-02	4.81E-02	Not detected
	B-6	9/14/2020	9.56E-02	3.44E-02	4.43E-02	Detected
	B-7	9/14/2020	1.46E-01	3.96E-02	1.63E-02	Detected
	B-8	6/18/2020	5.88E-02	2.71E-02	3.59E-02	Detected
	B-4-Dup	9/9/2020	3.42E-01	6.95E-02	4.62E-02	Detected
$^{239+240}$Pu	A-1	6/18/2020	4.72E-02	3.14E-02	5.83E-02	Not detected
	A-2	7/2/2020	5.21E-02	2.81E-02	4.13E-02	Detected
	A-3	9/9/2020	4.47E-02	2.76E-02	4.67E-02	Not detected
	A-4	9/9/2020	8.28E-02	3.27E-02	4.38E-02	Detected
	A-5	9/14/2020	2.66E-02	2.10E-02	3.85E-02	Not detected
	A-6	9/14/2020	2.80E-02	2.56E-02	5.12E-02	Not detected
	A-7	7/2/2020	5.81E-02	3.93E-02	6.74E-02	Not detected
	A-8	9/14/2020	8.70E-02	4.18E-02	6.93E-02	Detected
	A-5-Dup	9/14/2020	5.04E-02	2.49E-02	3.23E-02	Detected
	B-1	6/22/2020	1.65E-01	4.66E-02	3.62E-02	Detected
	B-2	6/22/2020	4.80E-02	2.59E-02	3.80E-02	Detected
	B-3	9/9/2020	1.13E-01	3.98E-02	4.92E-02	Detected
	B-4	9/9/2020	6.54E-02	3.10E-02	4.38E-02	Detected

Table C.1. Activity concentrations of ^{241}Am, $^{239+240}Pu$, and ^{238}Pu (Bq/kg) in soil samples collected from Near Field in the vicinity of the WIPP site (continued)

Radionuclide	Grid Node	Sampling Date	Activity Bq/kg	Unc. (2s) Bq/kg	MDC Bq/kg	Status
$^{239+240}Pu$	B-5	9/14/2020	4.41E-02	3.67E-02	7.70E-02	Not detected
	B-6	9/14/2020	7.84E-02	3.70E-02	6.01E-02	Detected
	B-7	9/14/2020	1.38E-01	4.47E-02	4.38E-02	Detected
	B-8	6/18/2020	6.24E-02	3.36E-02	5.54E-02	Detected
	B-4-Dup	9/9/2020	8.31E-02	3.95E-02	5.97E-02	Detected
^{238}Pu	A-1	6/18/2020	-1.99E-02	2.00E-02	6.33E-02	Not detected
	A-2	7/2/2020	-1.82E-02	1.89E-02	6.12E-02	Not detected
	A-3	9/9/2020	-7.45E-03	1.32E-02	4.32E-02	Not detected
	A-4	9/9/2020	-1.31E-02	1.52E-02	4.89E-02	Not detected
	A-5	9/14/2020	-6.64E-03	8.88E-03	3.12E-02	Not detected
	A-6	9/14/2020	-2.04E-02	1.78E-02	5.98E-02	Not detected
	A-7	7/2/2020	-3.87E-03	2.57E-02	7.29E-02	Not detected
	A-8	9/14/2020	8.15E-03	2.11E-02	5.12E-02	Not detected
	A-5-Dup	9/14/2020	-6.88E-03	1.38E-02	4.31E-02	Not detected
	B-1	6/22/2020	1.29E-02	2.13E-02	4.84E-02	Not detected
	B-2	6/22/2020	4.80E-03	2.04E-02	5.11E-02	Not detected
	B-3	9/9/2020	-2.94E-02	2.61E-02	7.86E-02	Not detected
	B-4	9/9/2020	-7.55E-03	2.41E-02	6.65E-02	Not detected
	B-5	9/14/2020	-1.76E-02	2.26E-02	6.57E-02	Not detected
	B-6	9/14/2020	-1.47E-02	2.09E-02	6.25E-02	Not detected
	B-7	9/14/2020	-3.29E-09	1.35E-02	3.89E-02	Not detected
	B-8	6/18/2020	-1.04E-02	1.95E-02	5.84E-02	Not detected
	B-4-Dup	9/9/2020	-2.97E-02	2.67E-02	8.37E-02	Not detected

Table C.2. Activity concentrations of ^{234}U, ^{235}U, and ^{238}U (Bq/kg) in soil samples collected from Near Field in the vicinity of the WIPP site

Radionuclide	Grid Node	Sampling Date	Activity Bq/kg	Unc. (2s) Bq/kg	MDC Bq/kg	Status
^{234}U	A-1	6/18/2020	5.76E+00	6.70E-01	6.89E-02	Detected
	A-2	7/2/2020	4.82E+00	5.77E-01	5.86E-02	Detected
	A-3	9/9/2020	4.29E+00	5.54E-01	1.21E-01	Detected
	A-4	9/9/2020	5.58E+00	6.61E-01	6.27E-02	Detected
	A-5	9/14/2020	5.03E+00	5.79E-01	6.98E-02	Detected
	A-6	9/14/2020	5.77E+00	7.03E-01	7.43E-02	Detected
	A-7	7/2/2020	5.84E+00	8.17E-01	1.28E-01	Detected
	A-8	9/14/2020	6.63E+00	9.35E-01	2.26E-01	Detected
	A-5-Dup	9/14/2020	5.22E+00	7.03E-01	9.07E-02	Detected
	B-1	6/22/2020	6.36E+00	8.32E-01	1.19E-01	Detected
	B-2	6/22/2020	6.35E+00	8.08E-01	1.35E-01	Detected
	B-3	9/9/2020	6.62E+00	8.90E-01	1.91E-01	Detected
	B-4	9/9/2020	7.69E+00	8.65E-01	4.27E-02	Detected
	B-5	9/14/2020	5.35E+00	6.18E-01	4.68E-02	Detected
	B-6	9/14/2020	5.50E+00	6.37E-01	6.45E-02	Detected
	B-7	9/14/2020	7.79E+00	9.52E-01	1.18E-01	Detected
	B-8	6/18/2020	5.94E+00	7.72E-01	7.45E-02	Detected
	B-4-Dup	9/9/2020	6.07E+00	6.99E-01	3.71E-02	Detected
^{235}U	A-1	6/18/2020	2.41E-01	6.35E-02	4.54E-02	Detected
	A-2	7/2/2020	2.55E-01	6.75E-02	3.34E-02	Detected
	A-3	9/9/2020	2.18E-01	7.69E-02	7.50E-02	Detected
	A-4	9/9/2020	2.83E-01	7.23E-02	5.47E-02	Detected
	A-5	9/14/2020	2.52E-01	5.85E-02	2.43E-02	Detected
	A-6	9/14/2020	2.67E-01	7.69E-02	6.07E-02	Detected
	A-7	7/2/2020	3.08E-01	1.23E-01	1.44E-01	Detected
	A-8	9/14/2020	4.91E-01	1.52E-01	8.93E-02	Detected
	A-5-Dup	9/14/2020	3.46E-01	1.09E-01	6.55E-02	Detected
	B-1	6/22/2020	2.92E-01	1.05E-01	1.03E-01	Detected
	B-2	6/22/2020	3.14E-01	9.80E-02	8.36E-02	Detected
	B-3	9/9/2020	4.30E-01	1.31E-01	7.54E-02	Detected
	B-4	9/9/2020	3.48E-01	7.52E-02	5.27E-02	Detected

Table C.2. Activity concentrations of ^{234}U, ^{235}U, and ^{238}U (Bq/kg) in soil samples collected from Near Field in the vicinity of the WIPP site (continued)

Radionuclide	Grid Node	Sampling Date	Activity Bq/kg	Unc. (2s) Bq/kg	MDC Bq/kg	Status
^{235}U	B-5	9/14/2020	3.25E-01	7.25E-02	4.31E-02	Detected
	B-6	9/14/2020	3.25E-01	7.32E-02	4.24E-02	Detected
	B-7	9/14/2020	3.02E-01	9.65E-02	1.07E-01	Detected
	B-8	6/18/2020	2.41E-01	9.54E-02	1.23E-01	Detected
	B-4-Dup	9/9/2020	2.93E-01	7.02E-02	3.90E-02	Detected
^{238}U	A-1	6/18/2020	6.16E+00	7.13E-01	4.89E-02	Detected
	A-2	7/2/2020	5.23E+00	6.21E-01	6.82E-02	Detected
	A-3	9/9/2020	4.60E+00	5.90E-01	1.44E-01	Detected
	A-4	9/9/2020	5.84E+00	6.90E-01	7.60E-02	Detected
	A-5	9/14/2020	5.51E+00	6.30E-01	6.64E-02	Detected
	A-6	9/14/2020	5.93E+00	7.20E-01	9.18E-02	Detected
	A-7	7/2/2020	5.99E+00	8.36E-01	1.64E-01	Detected
	A-8	9/14/2020	7.45E+00	1.04E+00	2.32E-01	Detected
	A-5-Dup	9/14/2020	5.53E+00	7.39E-01	1.21E-01	Detected
	B-1	6/22/2020	6.98E+00	9.06E-01	1.85E-01	Detected
	B-2	6/22/2020	6.56E+00	8.34E-01	1.61E-01	Detected
	B-3	9/9/2020	7.38E+00	9.81E-01	1.95E-01	Detected
	B-4	9/9/2020	8.09E+00	9.07E-01	4.55E-02	Detected
	B-5	9/14/2020	5.57E+00	6.40E-01	5.28E-02	Detected
	B-6	9/14/2020	5.79E+00	6.68E-01	7.98E-02	Detected
	B-7	9/14/2020	8.59E+00	1.04E+00	1.30E-01	Detected
	B-8	6/18/2020	5.91E+00	7.69E-01	1.12E-01	Detected
	B-4-Dup	9/9/2020	6.30E+00	7.25E-01	4.93E-02	Detected

Table C.3. Activity concentrations of ^{137}Cs, ^{40}K, and ^{60}Co (Bq/kg) in soil samples collected from Near Field in the vicinity of the WIPP site

Radionuclide	Grid Node	Sampling Date	Activity Bq/kg	Unc. (2s) Bq/kg	MDC Bq/kg	Status
^{137}Cs	A-1	6/18/2020	8.98E-01	5.93E-02	1.40E-01	Detected
	A-2	7/2/2020	1.56E+00	6.66E-02	1.57E-01	Detected
	A-3	9/9/2020	7.95E-01	5.19E-02	1.46E-01	Detected
	A-4	9/9/2020	1.67E+00	8.36E-02	1.40E-01	Detected
	A-5	9/14/2020	1.23E+00	5.97E-02	1.49E-01	Detected
	A-6	9/14/2020	5.02E-01	5.13E-02	1.56E-01	Detected
	A-7	7/2/2020	1.43E+00	7.77E-02	1.51E-01	Detected
	A-8	9/14/2020	2.28E+00	8.38E-02	1.83E-01	Detected
	A-5-Dup	9/14/2020	1.14E+00	6.04E-02	1.63E-01	Detected
	B-1	6/22/2020	2.72E+00	8.69E-02	1.70E-01	Detected
	B-2	6/22/2020	1.37E+00	7.43E-02	1.44E-01	Detected
	B-3	9/9/2020	3.50E+00	1.06E-01	1.84E-01	Detected
	B-4	9/9/2020	1.61E+00	8.32E-02	1.49E-01	Detected
	B-5	9/14/2020	1.96E+00	7.36E-02	1.65E-01	Detected
	B-6	9/14/2020	1.52E+00	6.78E-02	1.66E-01	Detected
	B-7	9/14/2020	3.13E+00	1.39E-01	1.73E-01	Detected
	B-8	6/18/2020	1.42E+00	6.62E-02	1.65E-01	Detected
	B-4-Dup	9/9/2020	2.77E+00	8.83E-02	1.72E-01	Detected
^{40}K	A-1	6/18/2020	1.66E+02	1.51E+01	1.79E+00	Detected
	A-2	7/2/2020	1.78E+02	7.06E+00	1.76E+00	Detected
	A-3	9/9/2020	1.50E+02	6.05E+00	1.47E+00	Detected
	A-4	9/9/2020	1.61E+02	1.46E+01	1.80E+00	Detected
	A-5	9/14/2020	1.80E+02	7.15E+00	1.74E+00	Detected
	A-6	9/14/2020	1.87E+02	7.47E+00	1.51E+00	Detected
	A-7	7/2/2020	2.10E+02	1.91E+01	1.86E+00	Detected
	A-8	9/14/2020	2.45E+02	9.69E+00	2.00E+00	Detected
	A-5-Dup	9/14/2020	1.66E+02	6.67E+00	1.46E+00	Detected
	B-1	6/22/2020	2.21E+02	8.83E+00	1.61E+00	Detected
	B-2	6/22/2020	2.11E+02	1.92E+01	1.89E+00	Detected
	B-3	9/9/2020	2.17E+02	8.58E+00	1.89E+00	Detected
	B-4	9/9/2020	2.29E+02	2.08E+01	2.07E+00	Detected

Table C.3. Activity concentrations of ^{137}Cs, ^{40}K, and ^{60}Co (Bq/kg) in soil samples collected from Near Field in the vicinity of the WIPP site (continued)

Radionuclide	Grid Node	Sampling Date	Activity Bq/kg	Unc. (2s) Bq/kg	MDC Bq/kg	Status
^{40}K	B-5	9/14/2020	1.58E+02	6.37E+00	1.64E+00	Detected
	B-6	9/14/2020	1.55E+02	6.19E+00	1.75E+00	Detected
	B-7	9/14/2020	2.55E+02	2.32E+01	1.97E+00	Detected
	B-8	6/18/2020	2.00E+02	7.93E+00	1.76E+00	Detected
	B-4-Dup	9/9/2020	1.99E+02	7.98E+00	1.67E+00	Detected
^{60}Co	A-1	6/18/2020	3.82E-02	3.39E-02	1.12E-01	Not Detected
	A-2	7/2/2020	8.88E-04	2.96E-02	9.98E-02	Not Detected
	A-3	9/9/2020	2.58E-02	2.62E-02	8.70E-02	Not Detected
	A-4	9/9/2020	-8.36E-04	3.21E-02	1.08E-01	Not Detected
	A-5	9/14/2020	8.50E-03	6.09E-02	2.03E-01	Not Detected
	A-6	9/14/2020	1.31E-02	2.99E-02	9.97E-02	Not Detected
	A-7	7/2/2020	8.01E-03	3.47E-02	1.16E-01	Not Detected
	A-8	9/14/2020	-6.44E-02	6.38E-02	2.14E-01	Not Detected
	A-5-Dup	9/14/2020	3.90E-02	3.18E-02	1.05E-01	Not Detected
	B-1	6/22/2020	-1.13E-02	3.17E-02	1.07E-01	Not Detected
	B-2	6/22/2020	1.62E-02	4.41E-02	1.47E-01	Not Detected
	B-3	9/9/2020	1.18E-02	4.81E-02	1.61E-01	Not Detected
	B-4	9/9/2020	1.26E-02	3.97E-02	1.32E-01	Not Detected
	B-5	9/14/2020	4.31E-02	2.85E-02	9.39E-02	Not Detected
	B-6	9/14/2020	-1.64E-02	2.87E-02	9.78E-02	Not Detected
	B-7	9/14/2020	-3.04E-02	3.79E-02	1.28E-01	Not Detected
	B-8	6/18/2020	5.23E-02	3.54E-02	1.16E-01	Not Detected
	B-4-Dup	9/9/2020	1.72E-02	3.90E-02	1.30E-01	Not Detected

Table C.4. Activity concentration of ^{90}Sr (Bq/kg) in soil samples collected from Near Field in the vicinity of the WIPP site

Radionuclide	Grid Node	Sample Date 2020	^{90}Sr Activity Bq/kg	Unc.(2-sig) Bq/kg	MDC Bq/kg	Status
^{90}Sr	A-1	6/18/2020	4.07E+02	3.82E+01	4.88E+02	Not detected
	A-2	7/2/2020	4.14E+02	3.83E+01	4.70E+02	Not detected
	A-3	9/9/2020	3.51E+02	3.35E+01	4.57E+02	Not detected
	A-4	9/9/2020	4.25E+02	3.96E+01	4.83E+02	Not detected
	A-5	9/14/2020	3.70E+02	3.62E+01	4.96E+02	Not detected
	A-6	9/14/2020	4.09E+02	3.81E+01	4.90E+02	Not detected
	A-7	7/2/2020	4.17E+02	4.00E+01	4.86E+02	Not detected
	A-8	9/14/2020	4.22E+02	3.95E+01	4.92E+02	Not detected
	A-5-Dup	9/14/2020	4.21E+02	4.05E+01	4.91E+02	Not detected
	B-1	6/22/2020	3.47E+02	3.53E+01	4.93E+02	Not detected
	B-2	6/22/2020	4.44E+02	3.98E+01	4.66E+02	Not detected
	B-3	9/9/2020	3.65E+02	3.45E+01	4.62E+02	Not detected
	B-4	9/9/2020	3.62E+02	3.49E+01	4.57E+02	Not detected
	B-5	9/14/2020	3.91E+02	3.70E+01	4.67E+02	Not detected
	B-6	9/14/2020	3.83E+02	3.60E+01	4.45E+02	Not detected
	B-7	9/14/2020	4.46E+02	3.94E+01	4.68E+02	Not detected
	B-8	6/18/2020	4.20E+02	3.88E+01	4.87E+02	Not detected
	B-4-Dup	9/9/2020	4.26E+02	3.91E+01	4.70E+02	Not detected

APPENDIX D - RADIONUCLIDE CONCENTRATIONS IN SURFACE WATER

Actinide concentrations in surface water

Uranium concentrations in surface water

Gamma radionuclide concentrations in surface water

Strontium concentrations in surface water

Table D.1. ^{241}Am, $^{239+240}$Pu and ^{238}Pu concentrations in surface water

Radionuclide	Location	Activity Bq/L	Unc (2-sig) (Bq/L)	MDC (Bq/L)	Status
^{241}Am	Lake Carlsbad (Shallow)	6.93E-05	1.21E-04	2.79E-04	Not detected
	Lake Carlsbad (Deep)	1.04E-04	1.55E-04	3.50E-04	Not detected
	Brantley Lake (Shallow)	-1.52E-04	2.04E-04	6.23E-04	Not detected
	Brantley Lake (Deep)	3.48E-04	2.59E-04	3.59E-04	Not detected
	Brantley Lake (Shallow)-Dup	4.94E-05	1.51E-04	3.69E-04	Not detected
	Brantley Lake (Deep)-Dup	-1.41E-04	1.01E-04	3.41E-04	Not detected
	Red Bluff (Shallow)	3.52E-05	1.49E-04	3.75E-04	Not detected
	Red Bluff (Deep)	8.03E-05	1.51E-04	3.50E-04	Not detected
	Trip Blank	9.47E-05	1.30E-04	2.88E-04	Not detected
$^{239+240}$Pu	Lake Carlsbad (Shallow)	-5.54E-05	9.98E-05	2.79E-04	Not detected
	Lake Carlsbad (Deep)	-1.33E-05	7.03E-05	2.11E-04	Not detected
	Brantley Lake (Shallow)	-1.44E-04	1.70E-04	5.07E-04	Not detected
	Brantley Lake (Deep)	1.64E-05	7.34E-05	1.97E-04	Not detected
	Brantley Lake (Shallow)-Dup	-1.44E-05	1.12E-04	3.07E-04	Not detected
	Brantley Lake (Deep)-Dup	3.18E-05	7.79E-05	1.91E-04	Not detected
	Red Bluff (Shallow)	4.41E-05	8.83E-05	2.07E-04	Not detected
	Red Bluff (Deep)	-3.06E-05	9.68E-05	2.88E-04	Not detected
	Trip Blank	0.00E+00	7.21E-05	2.08E-04	Not detected

Table D.1. ^{241}Am, $^{239+240}$Pu and ^{238}Pu concentrations in surface water (continued)

Radionuclide	Location	Activity Bq/L	Unc (2-sig) (Bq/L)	MDC (Bq/L)	Status
^{238}Pu	Lake Carlsbad (Shallow)	-1.39E-05	1.00E-04	2.79E-04	Not detected
	Lake Carlsbad (Deep)	-1.06E-04	9.27E-05	3.12E-04	Not detected
	Brantley Lake (Shallow)	-3.24E-04	1.80E-04	5.91E-04	Not detected
	Brantley Lake (Deep)	1.64E-05	8.69E-05	2.31E-04	Not detected
	Brantley Lake (Shallow)-Dup	-4.33E-05	8.67E-05	2.71E-04	Not detected
	Brantley Lake (Deep)-Dup	1.59E-05	7.10E-05	1.91E-04	Not detected
	Red Bluff (Shallow)	-1.03E-04	1.22E-04	3.74E-04	Not detected
	Red Bluff (Deep)	-1.38E-04	1.20E-04	3.90E-04	Not detected
	Trip Blank	-4.42E-05	7.81E-05	2.56E-04	Not detected

Table D.2. Uranium concentrations in surface water

Radionuclide	Location	Activity Bq/L	Unc (2-sig) (Bq/L)	MDC (Bq/L)	Status
^{234}U	Lake Carlsbad (Shallow)	1.05E-01	1.21E-02	3.93E-04	Detected
	Lake Carlsbad (Deep)	1.06E-01	1.24E-02	4.48E-04	Detected
	Brantley Lake (Shallow)	1.27E-01	1.61E-02	1.02E-03	Detected
	Brantley Lake (Deep)	1.26E-01	1.44E-02	5.21E-04	Detected
	Brantley Lake (Shallow)-Dup	1.21E-01	1.44E-02	8.55E-04	Detected
	Brantley Lake (Deep)-Dup	1.29E-01	1.57E-02	4.29E-04	Detected
	Red Bluff (Shallow)	2.86E-01	3.22E-02	3.37E-04	Detected
	Red Bluff (Deep)	3.03E-01	3.47E-02	5.54E-04	Detected
	Trip Blank	1.38E-04	1.47E-04	3.00E-04	Not detected
^{235}U	Lake Carlsbad (Shallow)	2.70E-03	6.34E-04	4.85E-04	Detected
	Lake Carlsbad (Deep)	2.91E-03	6.75E-04	4.13E-04	Detected
	Brantley Lake (Shallow)	2.28E-03	7.52E-04	6.70E-04	Detected
	Brantley Lake (Deep)	2.49E-03	7.15E-03	5.74E-04	Detected
	Brantley Lake (Shallow)-Dup	3.64E-03	7.51E-04	3.95E-04	Detected
	Brantley Lake (Deep)-Dup	3.50E-03	8.43E-04	4.51E-04	Detected
	Red Bluff (Shallow)	6.62E-03	1.09E-03	3.37E-04	Detected
	Red Bluff (Deep)	7.10E-03	1.22E-03	4.61E-04	Detected
	Trip Blank	2.13E-05	1.28E-04	3.37E-04	Not detected

Table D.2. Uranium concentrations in surface water (continued)

Radionuclide	Location	Activity Bq/L	Unc (2-sig) (Bq/L)	MDC (Bq/L)	Status
^{238}U	Lake Carlsbad (Shallow)	4.53E-02	5.44E-03	4.18E-04	Detected
	Lake Carlsbad (Deep)	4.69E-02	5.69E-03	5.05E-04	Detected
	Brantley Lake (Shallow)	6.14E-02	8.08E-03	1.26E-03	Detected
	Brantley Lake (Deep)	6.13E-02	7.15E-03	5.74E-04	Detected
	Brantley Lake (Shallow)-Dup	5.63E-02	6.95E-03	9.26E-04	Detected
	Brantley Lake (Deep)-Dup	6.31E-02	7.89E-03	5.71E-04	Detected
	Red Bluff (Shallow)	1.43E-01	1.62E-02	4.11E-04	Detected
	Red Bluff (Deep)	1.46E-01	1.70E-02	4.71E-04	Detected
	Trip Blank	-1.64E-11	1.46E-04	3.85E-04	Not detected

Table D.3. Gamma emitting radionuclides in surface water

Radionuclide	Location	Activity Bq/L	Unc (2-sig) (Bq/L)	MDC (Bq/L)	Status
^{137}Cs	Lake Carlsbad (Shallow)	-1.27E-02	2.32E-02	7.81E-02	Not detected
	Lake Carlsbad (Deep)	-1.57E-02	1.06E-02	3.64E-02	Not detected
	Brantley Lake (Shallow)	-3.29E-02	1.42E-02	4.83E-02	Not detected
	Brantley Lake (Deep)	4.75E-02	1.51E-02	4.89E-02	Not detected
	Brantley Lake (Shallow)-Dup	1.95E-02	2.37E-02	7.84E-02	Not detected
	Brantley Lake (Deep)-Dup	-9.50E-03	1.58E-02	5.30E-02	Not detected
	Red Bluff (Shallow)	-1.11E-02	1.89E-02	6.39E-02	Not detected
	Red Bluff (Deep)	5.11E-02	2.27E-02	7.40E-02	Not detected
	Trip Blank	-7.96E-03	8.39E-03	2.89E-02	Not detected
^{60}Co	Lake Carlsbad (Shallow)	-2.09E-03	8.53E-03	2.92E-02	Not detected
	Lake Carlsbad (Deep)	6.42E-03	9.66E-03	3.24E-02	Not detected
	Brantley Lake (Shallow)	3.15E-03	1.08E-02	3.63E-02	Not detected
	Brantley Lake (Deep)	-4.67E-03	9.66E-03	3.32E-02	Not detected
	Brantley Lake (Shallow)-Dup	-4.93E-03	1.39E-02	4.78E-02	Not detected
	Brantley Lake (Deep)-Dup	-2.83E-03	8.09E-03	2.77E-02	Not detected
	Red Bluff (Shallow)	-8.59E-03	1.45E-02	5.00E-02	Not detected
	Red Bluff (Deep)	-1.69E-02	1.39E-02	4.87E-02	Not detected
	Trip Blank	6.99E-03	8.16E-03	2.74E-02	Not detected

Table D.3. Gamma emitting radionuclides in surface water (continued)

Radionuclide	Location	Activity Bq/L	Unc (2-sig) (Bq/L)	MDC (Bq/L)	Status
^{40}K	Lake Carlsbad (Shallow)	-1.70E-01	1.65E-01	5.61E-01	Not detected
	Lake Carlsbad (Deep)	-8.38E-02	1.32E-01	4.50E-01	Not detected
	Brantley Lake (Shallow)	5.87E-02	1.81E-01	6.03E-01	Not detected
	Brantley Lake (Deep)	-6.35E-02	1.37E-01	4.64E-01	Not detected
	Brantley Lake (Shallow)-Dup	2.22E-01	1.83E-01	6.06E-01	Not detected
	Brantley Lake (Deep)-Dup	-3.14E-02	1.57E-01	5.28E-01	Not detected
	Red Bluff (Shallow)	5.52E-01	1.97E-01	6.34E-01	Not detected
	Red Bluff (Deep)	9.14E-01	1.96E-01	6.04E-01	Detected
	Trip Blank	-2.22E-01	1.29E-01	4.48E-01	Not detected

Table D.4. ^{90}Sr concentrations in surface water

Radionuclide	Location	Activity Bq/L	Unc (2-sig) (Bq/L)	MDC (Bq/L)	Status
^{90}Sr	Lake Carlsbad (Shallow)	1.36E+01	1.34E+00	2.01E+01	Not detected
	Lake Carlsbad (Deep)	1.40E+01	1.32E+00	2.01E+01	Not detected
	Brantley Lake (Shallow)	1.25E+01	1.24E+00	2.01E+01	Not detected
	Brantley Lake (Deep)	1.29E+01	1.22E+00	2.01E+01	Not detected
	Brantley Lake (Shallow)-Dup	1.32E+01	1.25E+00	2.01E+01	Not detected
	Brantley Lake (Deep)-Dup	1.29E+01	1.25E+00	2.01E+01	Not detected
	Red Bluff (Shallow)	1.44E+01	1.34E+00	2.01E+01	Not detected
	Red Bluff (Deep)	1.21E+01	1.19E+00	2.01E+01	Not detected
	Trip Blank	1.75E+01	1.52E+00	2.01E+01	Not detected

APPENDIX E - RADIONUCLIDE CONCENTRATIONS IN DRINKING WATER

Actinide concentrations in drinking water

Uranium concentrations in drinking water

Gamma radionuclide concentrations in drinking water

Strontium concentrations in drinking water

Table E.1. ^{241}Am, $^{239+240}$Pu, and ^{238}Pu concentrations in drinking water

Radionuclide	Location	Activity Bq/L	Unc (2-sig) (Bq/L)	MDC (Bq/L)	Status
^{241}Am	Carlsbad	1.36E-04	1.40E-04	2.99E-04	Not detected
	Double Eagle	1.15E-04	1.02E-04	1.41E-04	Not detected
	Hobbs	3.56E-05	1.12E-04	2.83E-04	Not detected
	Malaga	-9.76E-05	1.62E-04	4.42E-04	Not detected
	Otis	-1.02E-04	1.86E-04	5.08E-04	Not detected
	Otis-Dup	2.24E-04	1.51E-04	2.79E-04	Not detected
	Loving	1.27E-04	1.33E-04	2.83E-04	Not detected
	Trip Blank	1.17E-04	1.20E-04	2.50E-04	Not detected
$^{239+240}$Pu	Carlsbad	-6.43E-05	7.75E-05	2.59E-04	Not detected
	Double Eagle	-2.39E-05	1.07E-04	3.37E-04	Not detected
	Hobbs	1.73E-05	1.25E-04	3.26E-04	Not detected
	Malaga	8.37E-05	1.01E-04	2.01E-04	Not detected
	Otis	-5.43E-05	1.88E-04	5.10E-04	Not detected
	Otis-Dup	-7.64E-05	1.02E-04	3.26E-04	Not detected
	Loving	3.32E-05	2.00E-04	5.27E-04	Not detected
	Trip Blank	7.50E-05	1.41E-04	3.26E-04	Not detected
^{238}Pu	Carlsbad	-5.14E-05	8.15E-05	2.59E-04	Not detected
	Double Eagle	-2.15E-04	1.87E-04	6.10E-04	Not detected
	Hobbs	-1.56E-04	1.35E-04	4.42E-04	Not detected
	Malaga	5.03E-05	1.01E-04	2.36E-04	Not detected
	Otis	-2.72E-04	1.90E-04	5.95E-04	Not detected
	Otis-Dup	0.00E+00	1.06E-04	2.88E-04	Not detected
	Loving	-2.33E-04	2.41E-04	7.81E-04	Not detected
	Trip Blank	-1.31E-04	1.25E-04	4.21E-04	Not detected

Table E.2. Uranium concentrations in drinking water

Radionuclide	Location	Activity Bq/L	Unc (2-sig) (Bq/L)	MDC (Bq/L)	Status
^{234}U	Carlsbad	2.79E-02	3.28E-03	3.39E-04	Detected
	Double Eagle	4.96E-02	5.69E-03	3.69E-04	Detected
	Hobbs	1.07E-01	1.20E-02	3.82E-04	Detected
	Malaga	1.86E-01	2.04E-02	4.28E-04	Detected
	Otis	1.46E-01	1.64E-02	4.97E-04	Detected
	Otis-Dup	1.44E-01	1.58E-02	4.39E-04	Detected
	Loving	7.43E-02	8.47E-03	1.23E-04	Detected
	Trip Blank	1.53E-04	1.78E-04	3.82E-04	Not detected
^{235}U	Carlsbad	6.77E-04	2.76E-04	4.00E-04	Detected
	Double Eagle	1.02E-03	3.22E-04	1.98E-04	Detected
	Hobbs	3.25E-03	6.55E-04	3.51E-04	Detected
	Malaga	3.32E-03	6.26E-04	3.27E-04	Detected
	Otis	3.50E-03	7.00E-04	3.68E-04	Detected
	Otis-Dup	3.90E-03	6.88E-04	2.24E-04	Detected
	Loving	1.42E-03	3.79E-04	1.52E-04	Detected
	Trip Blank	1.89E-04	1.41E-04	1.95E-04	Not detected
^{238}U	Carlsbad	1.07E-02	1.40E-03	3.06E-04	Detected
	Double Eagle	1.94E-02	2.40E-03	3.46E-04	Detected
	Hobbs	4.55E-02	5.27E-03	4.38E-04	Detected
	Malaga	6.93E-02	7.76E-03	4.27E-04	Detected
	Otis	5.56E-02	6.44E-03	8.49E-04	Detected
	Otis-Dup	5.58E-02	6.29E-03	4.49E-04	Detected
	Loving	2.43E-02	3.01E-03	1.22E-03	Detected
	Trip Blank	-3.39E-05	1.44E-04	3.98E-04	Not detected

Table E.3. Historical concentrations of ^{234}U, ^{235}U, and ^{238}U (Bq/L) in Carlsbad drinking water

Year	^{234}U (Bq/L)	^{235}U (Bq/L)	^{238}U (Bq/L)
1998	3.34E-02	7.52E-04	1.35E-02
1999	2.94E-02	6.99E-04	1.14E-02
2000	2.81E-02	8.12E-04	1.08E-02
2001	3.15E-02	9.68E-04	1.21E-02
2002	3.02E-02	7.97E-04	1.26E-02
2003	2.90E-02	5.52E-04	1.05E-02
2005	2.75E-02	1.54E-03	1.11E-02
2007	NR	NR	NR
2008	7.73E-02	3.09E-03	3.18E-02
2009	2.48E-02	3.57E-04	9.24E-03
2010	2.99E-02	5.64E-04	1.17E-02
2011	2.83E-02	7.83E-03	1.09E-02
2012	9.20E-03	1.85E-04	3.26E-03
2013	2.47E-02	3.80E-04	9.35E-03
2014	2.85E-02	5.83E-04	1.06E-02
2015	2.09E-02	3.39E-04	7.80E-03
2016	3.34E-02	9.90E-04	1.23E-02
2017	3.02E-02	5.41E-04	8.36E-02
2018	2.80E-02	5.87E-04	1.10E-02
2019	1.00E-01	2.35E-03	4.42E-02
2020	2.79E-02	6.77E-04	1.07E-02

Table E.4. Historical concentrations of ^{234}U, ^{235}U, and ^{238}U (Bq/L) in Double Eagle

Year	^{234}U (Bq/L)	^{235}U (Bq/L)	^{238}U(Bq/L)
1998	NR	NR	NR
1999	6.19E-02	1.35E-04	2.32E-02
2000	5.40E-02	1.38E-04	2.19E-02
2001	4.10E-02	1.22E-04	1.74E-02
2002	4.16E-02	1.01E-04	1.77E-02
2003	4.25E-02	8.89E-05	1.61E-02
2005	5.83E-02	1.43E-04	2.48E-02
2007	NR	NR	NR
2008	1.86E-01	4.31E-04	7.94E-02
2009	6.97E-02	7.55E-04	2.89E-02
2010	4.89E-02	1.36E-04	2.01E-02
2011	4.80E-02	8.45E-05	1.86E-02
2012	8.75E-03	3.55E-04	3.22E-03
2013	4.69E-02	4.90E-03	1.81E-02
2014	4.94E-02	6.12E-04	1.85E-02
2015	4.55E-02	9.19E-04	1.57E-02
2016	5.14E-02	1.19E-03	1.96E-02
2017	9.65E-02	2.36E-03	4.13E-02
2018	6.56E-02	1.85E-03	2.54E-02
2019	8.22E-02	1.57E-03	3.20E-02
2020	4.96E-02	1.02E-03	1.94E-02

Table E.5. Historical concentrations of ^{234}U, ^{235}U, and ^{238}U in Hobbs drinking water

Year	^{234}U (Bq/L)	^{235}U (Bq/L)	^{238}U (Bq/L)
1998	NR	NR	NR
1999	8.81E-02	2.46E-03	3.86E-02
2000	9.06E-02	2.34E-03	3.99E-02
2001	7.52E-02	2.59E-03	3.32E-02
2002	9.40E-02	2.37E-03	4.05E-02
2003	1.30E-01	2.51E-03	4.61E-02
2005	9.82E-02	2.68E-03	4.27E-02
2007	NR	NR	NR
2008	2.87E-01	1.18E-02	1.31E-01
2009	8.94E-02	1.99E-03	3.86E-02
2010	1.04E-01	2.23E-03	4.59E-02
2011	1.04E-01	2.60E-03	4.50E-02
2012	1.61E-02	4.31E-04	5.82E-03
2013	9.25E-02	2.18E-03	3.97E-02
2014	9.82E-02	1.89E-03	4.01E-02
2015	9.67E-02	2.17E-03	4.17E-02
2016	1.05E-01	2.48E-03	4.44E-02
2017	4.82E-02	2.37E-03	5.08E-02
2018	9.82E-02	2.54E-03	4.49E-02
2019	9.96E-02	2.30E-03	4.35E-02
2020	1.07E-01	3.25E-03	4.55E-02

Table E.6. Historical concentrations of ^{234}U, ^{235}U, and ^{238}U in Otis drinking water

Year	^{234}U (Bq/L)	^{235}U (Bq/L)	^{238}U (Bq/L)
1998	1.29E-01	2.73E-03	4.67E-02
1999	1.50E-01	2.85E-03	5.30E-02
2000	1.44E-01	2.97E-03	5.16E-02
2001	1.62E-01	3.30E-03	6.01E-02
2002	1.47E-01	3.34E-03	5.34E-02
2003	1.34E-01	2.56E-03	4.81E-02
2005	1.17E-01	2.60E-03	4.36E-02
2007	NR	NR	NR
2008	3.89E-01	1.35E-02	1.53E-01
2009	1.47E-01	3.80E-03	5.35E-02
2010	1.54E-01	2.66E-03	5.41E-02
2011	1.54E-01	1.19E-02	2.39E-01
2012	3.94E-02	1.00E-03	1.39E-02
2013	1.51E-01	3.17E-03	5.45E-02
2014	1.71E-01	3.46E-03	7.24E-02
2015	1.70E-01	2.95E-03	6.61E-02
2016	2.70E-02	1.44E-03	1.13E-02
2017	1.68E-01	2.86E-03	6.59E-02
2018	1.71E-01	3.36E-03	6.54E-02
2019	1.15E-01	2.01E-03	4.02E-02
2020	1.46E-01	3.50E-03	5.56E-02

Table E.7. Historical concentrations of ^{234}U, ^{235}U, and ^{238}U in Loving drinking water

Year	^{234}U (Bq/L)	^{235}U (Bq/L)	^{238}U (Bq/L)
1998	NR	NR	NR
1999	8.15E-02	1.66E-03	2.63E-02
2000	8.38E-02	1.63E-03	2.59E-02
2001	8.05E-02	1.61E-03	2.48E-02
2002	8.82E-02	1.63E-03	2.83E-02
2003	7.91E-02	1.35E-03	2.40E-02
2005	8.13E-02	1.42E-03	2.64E-02
2007	NR	NR	NR
2008	2.56E-01	5.15E-03	7.71E-02
2009	7.42E-02	1.26E-03	2.22E-02
2010	8.00E-02	1.20E-03	2.49E-02
2011	7.50E-02	3.90E-02	2.57E-02
2012	2.53E-02	4.93E-04	7.58E-03
2013	7.17E-02	1.20E-03	2.31E-02
2014	7.57E-02	1.63E-03	2.24E-02
2015	7.42E-02	1.26E-03	2.30E-02
2016	7.05E-02	1.23E-03	2.23E-02
2017	7.48E-02	1.01E-03	2.16E-02
2018	7.31E-02	1.35E-03	2.35E-02
2019	8.18E-02	1.42E-03	2.56E-02
2020	7.43E-02	1.42E-03	2.43E-02

Table E.8. Historical concentrations of ^{234}U, ^{235}U, and ^{238}U (Bq/L) in Malaga drinking water

Year	^{234}U (Bq/L)	^{235}U (Bq/L)	^{238}U (Bq/L)
2011	1.38E-01	2.56E-03	5.34E-02
2012	1.33E-01	1.92E-03	4.83E-02
2013	1.40E-01	3.33E-03	5.46E-02
2014	1.67E-01	4.59E-03	6.19E-02
2015	1.57E-01	4.99E-03	6.07E-02
2016	1.47E-01	2.36E-03	5.43E-02
2017	1.65E-01	3.24E-03	6.24E-02
2018	1.61E-01	3.41E-03	6.01E-02
2019	1.81E-01	4.09E-03	6.67E-02
2020	1.86E-01	3.32E-03	6.93E-02

*Collection started in 2011

Table E.9. Gamma emitting radionuclides in drinking water

Radionuclide	Location	Activity Bq/L	Unc(2-sig) (Bq/L)	MDC (Bq/L)	Status
^{137}Cs	Carlsbad	2.29E-02	1.25E-02	4.09E-02	Not detected
	Double Eagle	-3.27E-02	1.29E-02	4.41E-02	Not detected
	Hobbs	-1.63E-02	1.71E-02	5.75E-02	Not detected
	Malaga	-1.10E-02	1.60E-02	5.36E-02	Not detected
	Otis	-4.18E-04	8.98E-03	3.04E-02	Not detected
	Otis-Dup	-2.94E-02	1.36E-02	4.61E-02	Not detected
	Loving	2.29E-02	1.75E-02	5.76E-02	Not detected
	Trip Blank	1.79E-02	1.36E-02	4.49E-02	Not detected
^{60}Co	Carlsbad	4.55E-03	8.85E-03	2.98E-02	Not detected
	Double Eagle	1.12E-02	1.07E-02	3.57E-02	Not detected
	Hobbs	2.01E-02	1.13E-02	3.72E-02	Not detected
	Malaga	2.37E-02	7.74E-03	2.47E-02	Not detected
	Otis	1.06E-02	1.01E-02	3.35E-02	Not detected
	Otis-Dup	9.70E-03	8.82E-03	2.93E-02	Not detected
	Loving	-1.56E-02	9.09E-03	3.21E-02	Not detected
	Trip Blank	2.04E-02	8.38E-03	2.70E-02	Not detected
^{40}K	Carlsbad	3.49E-01	2.08E-01	6.84E-01	Not detected
	Double Eagle	-1.57E-01	1.39E-01	4.77E-01	Not detected
	Hobbs	-2.30E-02	1.52E-01	5.14E-01	Not detected
	Malaga	4.55E-01	1.74E-01	5.66E-01	Not detected
	Otis	-4.50E-02	1.44E-01	4.84E-01	Not detected
	Otis-Dup	-1.71E-01	1.85E-01	6.24E-01	Not detected
	Loving	-5.37E-02	1.93E-01	6.46E-01	Not detected
	Trip Blank	-6.82E-02	1.77E-01	5.95E-01	Not detected

Table E.10. ^{90}Sr concentration in drinking water

Radionuclide	Location	Activity Bq/L	Unc(2-sig) (Bq/L)	MDC (Bq/L)	Status
^{90}Sr	Carlsbad	1.23E+01	1.16E+00	1.92E+01	Not detected
	Double Eagle	1.42E+01	1.30E+00	1.92E+01	Not detected
	Hobbs	1.34E+01	1.27E+00	1.92E+01	Not detected
	Malaga	1.23E+01	1.22E+00	1.92E+01	Not detected
	Otis	1.38E+01	1.30E+00	1.92E+01	Not detected
	Otis-Dup	1.27E+01	1.21E+00	1.92E+01	Not detected
	Loving	1.38E+01	1.30E+00	1.92E+01	Not detected
	Trip Blank	1.60E+01	1.44E+00	1.92E+01	Not detected

APPENDIX F - RADIONUCLIDE CONCENTRATIONS IN SEDIMENT SAMPLES

Actinide concentrations in sediment samples

Uranium concentrations in sediment samples

Gamma radionuclide concentrations in sediment samples

Strontium concentrations in sediment samples

Table F.1. Activity concentrations of ^{241}Am, $^{239+240}$Pu, and ^{238}Pu (Bq/g) in sediment samples collected from the three reservoirs in the vicinity of the WIPP site

Radionuclide	Location	Sample Date	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{241}Am	Lake Carlsbad	12/18/2020	2.49E-05	3.99E-05	9.10E-05	Not detected
	Brantley	12/21/2020	5.73E-05	4.91E-05	9.60E-05	Not detected
	Red Bluff	12/22/2020	1.09E-04	5.91E-05	9.54E-05	Detected
	Red Bluff, Dup	12/21/2020	8.18E-05	9.86E-05	2.16E-04	Not detected
$^{239+240}$Pu	Lake Carlsbad	12/18/2020	7.17E-05	3.77E-05	6.00E-05	Detected
	Brantley	12/21/2020	1.18E-04	4.92E-05	6.04E-05	Detected
	Red Bluff	12/22/2020	1.65E-04	4.86E-05	3.47E-05	Detected
	Red Bluff, Dup	12/21/2020	6.64E-05	4.58E-05	8.91E-05	Not detected
^{238}Pu	Lake Carlsbad	12/18/2020	-2.99E-06	2.15E-05	6.00E-05	Not detected
	Brantley	12/21/2020	-1.90E-05	2.96E-05	8.95E-05	Not detected
	Red Bluff	12/22/2020	1.74E-05	2.02E-05	4.08E-05	Not detected
	Red Bluff, Dup	12/21/2020	-4.42E-05	3.38E-05	1.04E-04	Not detected

Dup = duplicate

Table F.2. Activity concentrations of ^{234}U, ^{235}U, and ^{238}U (Bq/g) in sediment samples collected from the three reservoirs in the vicinity of the WIPP site

Radionuclide	Location	Sample Date	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{234}U	Lake Carlsbad	12/18/2020	3.78E-02	4.10E-03	3.15E-05	Detected
	Brantley	12/21/2020	4.53E-02	4.97E-03	9.18E-05	Detected
	Red Bluff	12/22/2020	7.34E-02	7.90E-03	5.03E-05	Detected
	Red Bluff, Dup	12/21/2020	4.43E-02	4.82E-03	6.86E-05	Detected
^{235}U	Lake Carlsbad	12/18/2020	1.30E-03	1.85E-04	5.19E-05	Detected
	Brantley	12/21/2020	1.78E-03	2.61E-04	7.46E-05	Detected
	Red Bluff	12/22/2020	2.17E-03	2.81E-04	4.10E-05	Detected
	Red Bluff, Dup	12/21/2020	1.74E-03	2.44E-04	6.49E-05	Detected
^{238}U	Lake Carlsbad	12/18/2020	2.48E-02	2.70E-03	4.19E-05	Detected
	Brantley	12/21/2020	3.57E-02	3.94E-03	8.48E-05	Detected
	Red Bluff	12/22/2020	4.54E-02	4.90E-03	7.20E-05	Detected
	Red Bluff, Dup	12/21/2020	3.53E-02	3.85E-03	6.55E-05	Detected

Dup = duplicate

Table F.3. Activity concentrations of ^{137}Cs, ^{40}K, and ^{60}Co (Bq/g) in sediment samples collected from the three reservoirs in the vicinity of the WIPP site

Radionuclide	Location	Sample Date	Activity Bq/g	Unc. (2σ) Bq/g	MDC Bq/g	Status
^{137}Cs	Lake Carlsbad	12/18/2020	1.71E-03	1.15E-04	2.73E-04	Detected
	Brantley	12/21/2020	3.08E-03	1.59E-04	2.96E-04	Detected
	Red Bluff	12/22/2020	3.61E-03	1.26E-04	2.72E-04	Detected
	Red Bluff Dup	12/21/2020	3.44E-05	7.89E-05	2.62E-04	Not detected
^{40}K	Lake Carlsbad	12/18/2020	2.77E-01	2.53E-02	3.76E-03	Detected
	Brantley	12/21/2020	5.75E-01	5.22E-02	4.18E-03	Detected
	Red Bluff	12/22/2020	4.59E-01	1.83E-02	2.80E-03	Detected
	Red Bluff Dup	12/21/2020	-7.07E-04	5.82E-04	1.99E-03	Not detected
^{60}Co	Lake Carlsbad	12/18/2020	8.01E-07	8.59E-05	2.87E-04	Not detected
	Brantley	12/21/2020	7.42E-06	9.90E-05	3.29E-04	Not detected
	Red Bluff	12/22/2020	3.28E-05	5.40E-05	1.80E-04	Not detected
	Red Bluff Dup	12/21/2020	1.78E-05	9.96E-05	3.31E-04	Not detected

Dup = duplicate

Table F.4. Activity concentrations of ^{90}Sr (Bq/kg) in sediment samples collected from the three reservoirs in the vicinity of the WIPP site

Radionuclide	Location	Sample Date	Activity Bq/kg	Unc. (2-sig) Bq/kg	MDC Bq/kg	Status
^{90}Sr	Lake Carlsbad	12/18/2020	3.59E+02	3.54E+01	4.66E+02	Not detected
	Brantley	12/21/2020	4.65E+02	4.30E+01	4.66E+02	Not detected
	Red Bluff	12/22/2020	8.45E+02	5.58E+01	4.66E+02	Detected
	Red Bluff Dup	12/21/2020	4.12E+02	3.68E+01	4.66E+02	Not detected

APPENDIX G - IN VIVO MONITORING RESULTS

Average MDA of lung detector through December 2020

Average MDA of whole-body counting detector December 2020

Demographic characteristics of the LDBC population through December 2020

LDBC results greater than the decision limits (L_C) through December 2020

Table G.1. Average MDA (nCi) of lung detector as a function of chest wall thickness between 2006 and 2020

Radionuclide	Energy (keV)	MDA (nCi) as a function of Chest Wall Thickness (CWT in cm)													
		1.6 cm		2.22 cm		3.01 cm		3.33 cm		4.18 cm		5.10 cm		6.0 cm	
		Avg	1-Stdev	Avg	1 Stdev	Avg	1 Stdev	Avg	1 Stdev	Avg	1 Stdev	Avg	1 Stdev	Avg	1 Stdev
^{241}Am	59.5	0.18	0.01	0.23	0.01	0.30	0.01	0.34	0.01	0.46	0.02	0.65	0.03	0.90	0.05
^{144}Ce	133.5	0.48	0.01	0.56	0.01	0.71	0.01	0.79	0.01	1.01	0.03	1.33	0.05	1.74	0.08
^{252}Cf	19.2	18.38	0.99	34.97	1.04	83.16	3.25	119	5.26	303	18	836	67	2257	223
^{244}Cm	18.1	16.85	0.65	35.09	1.23	91.61	3.72	136	6.28	383	22	1176	85	3526	311
^{155}Eu	105.3	0.27	0.01	0.336	0.005	0.43	0.01	0.48	0.01	0.64	0.02	0.86	0.04	1.16	0.07
^{237}Np	86.5	0.48	0.02	0.61	0.01	0.80	0.01	0.89	0.02	1.19	0.04	1.64	0.09	2.24	0.16
^{238}Pu	17.1	18.00	0.96	41.60	2.15	120	6	186	9.73	587	34	2036	138	6870	541
^{239}Pu	17.1	44.78	2.38	104	5	299	15	463	24	1461	85	5066	343	17093	1345
^{240}Pu	17.1	17.59	0.94	40.66	2.10	117	6	182	10	574	33	1990	135	6715	529
^{242}Pu	17.1	21.22	1.13	49.05	2.53	142	7	220	11	693	40	2401	163	8101	638
^{226}Ra	186.1	1.72	0.07	1.95	0.03	2.38	0.04	2.60	0.05	3.24	0.08	4.12	0.13	5.20	0.20
^{232}Th via ^{212}Pb	238.6	0.152	0.004	0.179	0.004	0.220	0.004	0.24	0.00	0.30	0.01	0.39	0.01	0.49	0.02
^{232}Th	59.0	33.50	0.94	42.73	0.67	57.03	1.44	64.11	1.90	87.48	3.68	122	6.85	170	12
^{232}Th via ^{228}Th[a]	84.3	4.78	0.21	6.07	0.10	7.97	0.20	8.92	0.27	11.99	0.56	16.52	1.08	22.61	1.91
^{233}U	440.3	0.66	0.02	0.77	0.02	0.93	0.02	1.01	0.03	1.24	0.03	1.56	0.04	1.94	0.06
^{235}U[b]	185.7	0.106	0.004	0.120	0.002	0.147	0.003	0.161	0.003	0.20	0.00	0.25	0.01	0.32	0.01
Nat U via ^{234}Th[c]	63.3	1.58	0.08	2.03	0.05	2.68	0.07	3.01	0.09	4.09	0.16	5.72	0.29	7.92	0.51

[a] Radionuclide used to indicate natural thorium.

[b] Radionuclide used to indicate enriched uranium.

[c] Radionuclide used to indicate natural uranium or depleted uranium.

Table G.2. Average MDA (nCi) of whole-body detector (from 2002 to 2020).

Radionuclide	Energy (keV)	Average MDA (nCi)	1-stdev (nCi)
^{133}Ba	356	0.78	0.04
^{140}Ba	537	1.51	0.08
^{141}Ce	145	1.63	0.14
^{58}Co	811	0.36	0.02
^{60}Co	1333	0.36	0.01
^{51}Cr	320	4.46	0.37
^{134}Cs	604	0.35	0.03
^{137}Cs	662	0.42	0.02
^{152}Eu	344	1.60	0.11
^{154}Eu	1275	0.95	0.04
^{155}Eu	105	3.81	0.34
^{59}Fe	1099	0.67	0.03
^{131}I	365	0.48	0.03
^{133}I	530	0.42	0.03
^{192}Ir	317	0.55	0.05
^{54}Mn	835	0.45	0.01
^{103}Ru	497	0.40	0.03
^{106}Ru	622	3.31	0.03
^{125}Sb	428	1.33	0.03
^{232}Th via ^{228}Ac	911	1.23	0.03
^{88}Y	898	0.37	0.03
^{65}Zn	1116	1.10	0.03
^{95}Zr	757	0.59	0.03

Table G.3. Demographic characteristics of the LDBC population during 1997-2020

Characteristic		Voluntary Participants		2000[a]		2020[b] Estimates	
		Baseline	Operational	NM	US	NM	US
Gender	Male	56.2% (52.2% to 61.9%)[C]	43.4% (40.6% to 46.2%)	49.2%	49.1%	49.5%	49.2%
	Female	43.8% (38.6% to 48.3%)	56.6% (53.8 to 59.4 %)	50.8%	50.9%	50.5%	50.8%
Ethnicity	Hispanic	13.4% (9.5% to 16.3%)	23.8% (21.4% to 26.2%)	42.1%	12.5%	49.3%	18.5%
	All others	86.6% (83.3% to 90.9%)	76.2% (73.8% to 78.6%)	57.9%	87.5%	50.7%	81.5%
Age 65 years or over		16.70%[d]	34.1% (31.4% to 36.8%)	11.7%	12.4%	18.0%	16.5%
Currently or previously classified as a radiation worker		4.0%[d]	9.6% (8.0% to 11.3%)	NA	NA	NA	NA
Consumption of wild game within 3 months prior to count		16.4%[d]	22.3% (20.0% to 24.7%)	NA	NA	NA	NA
Medical treatment other than X-rays using radionuclides		9%[d]	5.7% (4.4% to 7.0%)	NA	NA	NA	NA
European/Japan travel within 2 years prior to the count		4%[d]	4.6% (3.5% to 5.8%)	NA	NA	NA	NA
Current smoker		13.9%[d]	13% (11.1% to 14.9%)	N/A	N/A	14% - 16.4%[e]	14%[f]

a: 2000 Census data for U.S. and NM
https://www2.census.gov/library/publications/2001/dec/2kh00.pdf
https://www.census.gov/prod/2002pubs/c2kprof00-nm.pdf
(retrieved on 9/15/2021)

b: 2020 Census data for U.S. and NM
https://www.census.gov/quickfacts/fact/table/US/PST045219 (retrieved on 9/15/2021)
https://www.census.gov/quickfacts/fact/table/NM/HSD410219 (retrieved on 9/15/2021)

c: Values in parentheses are margin of error (margin of error represents the 95% confidence interval of the observed percentage

d: Margin of error cannot be quoted due to small sample size.

e: % Adult smoking in NM and f: % Adult smoking in U.S.
https://www.cdc.gov/tobacco/data_statistics/fact_sheets/adult_data/cig_smoking/index.htm#nation
(Page last reviewed December 10, 2020, accessed on 9/15/2021)

Table G.4. LDBC results greater than the decision limits (L_C) through December 2020

Radionuclide	*In vivo* count type	Baseline counts (N = 366) % of results ≥ L_C[a]	Operational counts (N = 1201 % of results ≥ L_C[a]
^{241}Am	Lung	5.2 (4.0 to 6.4)	4.2 (3.1 to 5.4)
^{144}Ce	Lung	4.6 (3.5 to 5.7)	4.7 (3.5 to 5.9)
^{252}Cf	Lung	4.1 (3.1 to 5.1)	6 (4.7 to 7.3)
^{244}Cm	Lung	5.7 (4.5 to 7.0)	4.8 (3.6 to 6)
^{155}Eu	Lung	7.1 (5.8 to 8.4)	5.1 (3.8 to 6.3)
^{237}Np	Lung	3.6 (2.6 to 4.5)	3.8 (2.7 to 4.9)
^{210}Pb	Lung	4.4 (3.3 to 5.4)	6.1 (4.7 to 7.4)
Pu-Isotope[c]	Lung	5.7 (4.5 to 7.0)	5.0 (3.8 to 6.2)
^{232}Th via ^{212}Pb[d]	Lung	34.2 (31.7 to 36.6)	31.7 (29.1 to 34.4)
^{232}Th	Lung	4.9 (3.8 to 6.0)	5.5 (4.2 to 6.8)
^{232}Th via ^{228}Th	Lung	4.1 (3.1 to 5.1)	4.7 (3.5 to 5.9)
^{233}U	Lung	5.7 (4.5 to 7.0)	9 (7.4 to 10.6)
^{235}U[e]	Lung	10.7 (9.0 to 12.3)	11.0 (9.2 to 12.8)
^{238}U	Lung	5.2 (4.0 to 6.4)	5.5 (4.2 to 6.8)
^{133}Ba	Whole Body	3.6 (2.6 to 4.5)	3.2 (2.2 to 4.2)
^{140}Ba	Whole Body	5.2 (4.0 to 6.4)	4 (2.9 to 5.1)
^{141}Ce	Whole Body	3.6 (2.6 to 4.5)	4.7 (3.5 to 5.9)
^{58}Co	Whole Body	4.4 (3.3 to 5.4)	3.7 (2.7 to 4.8)
[d] ^{60}Co	Whole Body	54.6 (52.0 to 57.2)	21.6 (19.2 to 23.9)
^{51}Cr	Whole Body	5.7 (4.5 to 7.0)	4.4 (3.3 to 5.6)
^{134}Cs	Whole Body	1.6 (1.0 to 2.3)	2.5 (1.6 to 3.4)
^{137}Cs	Whole Body	28.4 (26.1 to 30.8)	16.6 (14.5 to 18.7)
^{152}Eu	Whole Body	7.4 (6.0 to 8.7)	5.6 (4.3 to 6.9)
^{154}Eu	Whole Body	3.8 (2.8 to 4.8)	3.5 (2.5 to 4.5)
^{155}Eu	Whole Body	3.8 (2.8 to 4.8)	3.3 (2.3 to 4.3)
^{59}Fe	Whole Body	3.8 (2.8 to 4.8)	5.7 (4.4 to 7)
^{131}I	Whole Body	5.2 (4.0 to 6.4)	4.5 (3.3 to 5.7)
^{133}I	Whole Body	3.3 (2.3 to 4.2)	4 (2.9 to 5.1)
^{192}Ir	Whole Body	4.1 (3.1 to 5.1)	4.1 (3 to 5.2)
^{40}K	Whole Body	100.0 (100.0 to 100.0)	100 (100 to 100)
[d] ^{54}Mn	Whole Body	12.3 (10.6 to 14.0)	12.6 (10.7 to 14.4)
^{103}Ru	Whole Body	2.2 (1.4 to 3.0)	1.8 (1.1 to 2.6)
^{106}Ru	Whole Body	4.4 (3.3 to 5.4)	4.4 (3.3 to 5.6)
^{125}Sb	Whole Body	5.2 (4.0 to 6.4)	4.6 (3.4 to 5.8)
^{232}Th via ^{228}Ac	Whole Body	34.7 (32.2 to 37.2)	26.7 (24.2 to 29.2)
^{88}Y	Whole Body	7.7 (6.3 to 9.0)	6.7 (5.3 to 8.1)
^{95}Zr	Whole Body	6.6 (5.3 to 7.9)	3.7 (2.7 to 4.8)

[a] N = number of individuals. Baseline counts include only the initial counts during this baseline period.
[b] Margin of error represents the 95% confidence interval of the observed percentage.
[c] $^{238\text{-}240,\ 242}$Pu isotopes are identified as a group, denoted as Pu-Isotopes by the software.
[d] These radionuclides are present in the shield background, so they are expected to be detected periodically.
[e] ^{235}U and ^{226}Ra both have the same 186 keV gamma ray energy, the software calculates the individual activity using the corresponding yields.

APPENDIX H - NON-RADIOLOGICAL MONITORING

Detection limits of different methods

Weekly composite concentrations of selected metals (ng/m^3) at station A

Monthly composite concentrations of selected metals (ng/m^3) at station B

Concentrations of selected anion concentrations (ng/m^3) in ambient air at Near Field

Concentrations of selected cation concentrations (ng/m^3) in ambient air at Near Field

Concentrations of selected anion concentrations (ng/m^3) in ambient air at Cactus Flats

Concentrations of selected cation concentrations (ng/m^3) in ambient air at Cactus Flats

Summary of metal concentrations in drinking water during 1998 - 2020

Selected anion concentrations in communities drinking water during 1998 – 2020

Selected cation concentrations in communities drinking water during 2016 - 2020

Summaries of other analyses performed on drinking water in 2020

Summary of metal concentrations in surface water during 1999 - 2020

Selected anion concentrations in surface water during 1999 – 2020

Selected cation concentrations in surface water during 2017 - 2020

Summaries of other analyses performed on surface water in 2020

Table H.1. Summary of sample type, analytes, methods, and detection limits used for non-radioactive analyses in 2020

Sample Type	Detection method	Method/ Parameters	Analytes of Interest	Detection Limits* (µg/L)
Drinking Water	ICP-MS	Metals analysis (EPA 200.8)	Over 30 different metals	Varies by element**
Drinking Water	IC	Anions (EPA 300.0)	F^-, Cl^-, Br^-, NO_2^-, NO_3^-, PO_4^{3-}, SO_4^{2-}	1.3 – 11.2
Drinking Water	ICP-MS	Mercury (EPA 200.8)	Hg	0.30
Drinking Water	IC	Cations (ASTM Standard D6919-09)	Li^+, Na^+, K^+, Ca^{2+}, Mg^{2+}, NH_4^+, Mg^{2+}	5.9 - 102
Surface Water	ICP-MS	Metals analysis (EPA 200.8)	Over 30 different metals	Varies by element**
Surface Water	IC	Anions (EPA 300.0)	F^-, Cl^-, Br^-, NO_2^-, NO_3^-, PO_4^{3-}, SO_4^{2-}	1.4- 15.2
Surface Water	ICP-MS	Mercury (EPA 200.8)	Hg	0.34
Surface Water	IC	Cations (ASTM Standard D6919-09)	Li^+, Na^+, K^+, Ca^{2+}, Mg^{2+}, NH_4^+, Mg^{2+}	6.9 - 130
Station A and B filters	ICP-MS	Metals analysis (EPA 200.8)	Al Cd Mg Pb Si Th U	306.7 0.38 36.4 0.34 314.0 0.25 0.11
Whatman 41 filters	IC	Anions (EPA 300.0)	F^-, Cl^-, Br^-, NO_2^-, NO_3^-, PO_4^{3-}, SO_4^{2-}	12.3 – 2032.0

* Detection limits are determined/updated annually.

** Current MDC values for individual metals are included in the results section of this chapter.

Table H.2. Concentrations of selected metals (ng/m³) in weekly composites from Station A

Sample Date	Aluminum ng/m³	Cadmium ng/m³	Lead ng/m³	Magnesium ng/m³	Potassium ng/m³	Silica ng/m³	Thorium ng/m³	Uranium ng/m³
January 2020								
1st week	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2nd week	552.68	0.56	5.28	12215.77	11576.46	N/A	<MDC	0.07
3rd week	3401.68	1.82	15.85	101492.56	94479.67	N/A	0.39	0.36
4th week	1272.64	2.01	54.58	34024.92	30181.05	N/A	<MDC	0.15
February 2020								
1st week	390.07	<MDC	18.10	7484.67	N/A	N/A	<MDC	<MDC
2nd week	400.56	<MDC	N/A	6841.50	N/A	N/A	<MDC	<MDC
3rd week	777.90	<MDC	446.43	8027.50	N/A	N/A	<MDC	<MDC
4th week	1289.92	<MDC	74.24	13630.40	N/A	N/A	<MDC	<MDC
March 2020								
1st week	2546.01	2.08	209.60	24867.34	N/A	32595.71	0.41	0.18
2nd week	166.64	0.48	20.72	5269.70	N/A	630.71	<MDC	<MDC
3rd week	62.31	0.22	0.49	505.16	N/A	238.63	<MDC	<MDC
4th week	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
April 2020								
1st week	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2nd week	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3rd week	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4th week	1034.91	1.13	10.87	20457.98	N/A	3165.01	<MDC	0.08
May 2020								
1st week	694	0.74	2.76	901	N/A	1297	<MDC	0.038
2nd week	482	0.23	1.02	17583	N/A	990	<MDC	0.033
3rd week	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4th week	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
June 2020								
1st week	283	0.52	1.28	497	N/A	1129	<MDC	<MDC
2nd week	700	0.47	1.71	6073	N/A	1906	0.080	0.036
3rd week	1250	1.31	3.26	1780	N/A	2804	<MDC	0.052
4th week	2620	1.99	8.36	2693	N/A	6184	0.24	0.098

Table H.2. Concentrations of selected metals (ng/m^3) in weekly composites from Station A (continued)

Sample Date	Aluminum ng/m^3	Cadmium ng/m^3	Lead ng/m^3	Magnesium ng/m^3	Potassium ng/m^3	Silica ng/m^3	Thorium ng/m^3	Uranium ng/m^3
July 2020								
1st week	741	0.55	3.28	1000	N/A	1620	0.085	0.028
2nd week	432	0.40	1.24	657	N/A	962	0.050	0.021
3rd week	1040	0.54	1.93	880	N/A	2020	0.12	0.038
4th week	445	0.90	2.81	1410	N/A	1210	<MDC	0.028
August 2020								
1st week	309	0.44	1.65	530	N/A	N/A	<MDC	0.019
2nd week	545	0.51	1.16	495	N/A	N/A	0.058	0.024
3rd week	392	0.54	1.34	416	N/A	N/A	0.041	0.022
4th week	356	0.69	1.35	574	N/A	N/A	<MDC	0.020
September 2020								
1st week	430	0.49	1.24	595	N/A	880	0.047	0.023
2nd week	378	0.59	1.33	625	N/A	866	0.041	0.024
3rd week	305	0.54	2.57	663	N/A	643	<MDC	0.021
4th week	79	0.14	0.35	167	N/A	151	<MDC	0.006
October 2020								
1st week	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2nd week	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3rd week	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4th week	332	0.48	2.54	8090	N/A	991	<MDC	0.034
November 2020								
1st week	353	0.48	1.75	8010	N/A	906	0.049	0.038
2nd week	393	0.48	1.63	818	N/A	989	0.056	0.026
3rd week	366	3.57	1.06	650	N/A	958	0.068	0.027
4th week	362	0.45	0.92	551	N/A	906	0.053	0.020
December 2020								
1st week	319	0.51	1.15	6360	N/A	N/A	0.047	0.031
2nd week	516	0.50	2.00	8510	N/A	N/A	0.084	0.042
3rd week	333	0.42	1.41	802	N/A	N/A	0.050	0.026
4th week	846	0.63	2.61	859	N/A	N/A	0.14	0.048

Table H.3. Concentrations of selected metals (ng/m^3) in monthly composites from Station B

Sample Date	Aluminum ng/m^3	Cadmium ng/m^3	Lead ng/m^3	Magnesium ng/m^3	Potassium ng/m^3	Silica ng/m^3	Thorium ng/m^3	Uranium ng/m^3
January	124	0.41	0.17	<MDC	100.67	255	<MDC	<MDC
February	178	0.38	0.26	<MDC	123.3	284	<MDC	<MDC
March	132	0.42	0.21	<MDC	N/A	350	<MDC	<MDC
April	151	0.43	0.22	<MDC	N/A	281	<MDC	<MDC
May	143	0.44	0.26	<MDC	N/A	319	<MDC	<MDC
June	565	0.41	0.48	<MDC	N/A	298	0.043	0.017
July	352	0.42	0.31	<MDC	N/A	208	<MDC	<MDC
August	117	0.41	0.18	<MDC	N/A	268	<MDC	<MDC
September	72	0.46	0.11	<MDC	N/A	<MDC	<MDC	<MDC
October	96	0.40	0.15	<MDC	N/A	254	<MDC	<MDC
November	<MDC	0.41	0.12	<MDC	N/A	<MDC	<MDC	<MDC
December	76	0.42	0.22	<MDC	N/A	236	<MDC	<MDC

Table H.4. Concentrations of anions in ambient air (µg/m^3) at Near Field

Start Date	Chloride	Nitrate	Phosphate	Sulfate
1/10/2020	0.287	1.96	0.00217	2.04
1/31/2020	0.224	2.70	0.00304	2.06
2/21/2020	0.297	1.44	0.00237	1.52
3/18/2020	0.234	1.42	0.00480	1.66
4/3/2020	0.145	1.63	0.0142	1.99
4/30/2020	0.242	2.04	0.0257	2.11
6/11/2020	0.217	1.70	0.0159	1.95
7/2/2020	0.0760	1.14	0.00228	2.09
7/30/2020	0.0783	0.00132	0.00533	1.63
8/20/2020	0.101	1.78	0.00919	2.55
9/3/2020	0.0782	2.13	0.0146	1.91
10/1/2020	0.177	2.26	0.0388	1.61
10/15/2020	0.221	1.89	0.0126	1.78
11/12/2020	0.448	2.38	0.007.43	2.35
12/8/2020	0.330	1.91	0.00562	1.94
12/31/2020	0.268	3.18	0.00516	1.91

Table H.5. Concentrations of cations in ambient air (µg/m^3) at Near Field

Start Date	Ammonium	Calcium	Magnesium	Potassium	Sodium
1/10/2020	0.278	1.11	0.0910	0.168	0.186
1/31/2020	0.465	1.08	0.0669	0.0976	0.137
2/21/2020	0.0431	1.06	0.0570	0.0738	0.263
3/18/2020	0.467	0.613	0.0828	0.141	0.180
4/3/2020	0.505	0.845	0.0839	0.137	0.151
4/30/2020	0.329	1.16	0.0990	0.147	0.241
5/19/20	N/A	N/A	N/A	N/A	N/A
6/11/2020	0.390	1.03	0.0717	0.0921	0.224
7/2/2020	0.299	0.802	0.0709	0.0674	0.330
7/30/2020	0.450	0.974	0.0572	0.0804	0.171
8/20/2020	0.855	1.04	0.0565	0.103	0.137
9/3/2020	0.485	1.35	0.0743	0.139	0.111
10/1/2020	0.736	0.982	0.0892	0.192	0.157
10/15/2020	0.314	1.01	0.0793	0.114	0.214
11/12/2020	0.293	1.27	0.128	0.225	0.353
12/8/2020	0.250	0.924	0.111	0.214	0.225
12/31/2020	0.503	1.25	0.105	0.212	0.144

Table H.6. Concentrations of anions in ambient air (µg/m^3) at Cactus Flats

Start Date	Chloride	Nitrate	Phosphate	Sulfate
1/10/2020	0.113	1.03	0.000874	1.09
1/31/2020	0.183	1.72	0.00241	1.41
2/21/2020	0.177	1.20	0.00223	1.28
3/18/2020	0.176	1.11	0.00270	1.20
4/3/2020	0.113	1.19	0.00837	1.32
4/30/2020	0.150	1.27	0.0130	1.34
5/19/2020	0.234	1.16	0.0158	1.30
6/11/2020	0.258	1.40	0.0119	1.44
7/2/2020	0.0700	1.05	0.00190	2.04
7/30/2020	0.0991	1.46	0.00378	1.56
8/20/2020	0.106	1.49	0.00717	1.96
9/3/2020	0.0971	2.06	0.0109	1.70
10/1/2020	0.150	1.82	0.0285	1.32
10/15/2020	0.268	1.84	0.00801	1.85
11/10/2020	0.351	2.05	0.00419	2.04
12/8/2020	0.211	1.49	0.00315	1.48

Table H.7. Concentrations of cations in ambient air (μg/m^3) at Cactus Flats

Start Date	Ammonium	Calcium	Magnesium	Potassium	Sodium
1/10/2020	0.0725	0.737	0.0275	0.0342	0.0727
1/31/2020	0.211	0.995	0.0264	0.0313	0.121
2/21/2020	0.0213	0.963	0.0396	0.0413	0.163
3/18/2020	0.282	0.699	0.0405	0.0573	0.121
4/3/2020	0.291	0.760	0.0406	0.0586	0.0968
4/30/2020	0.218	0.960	0.0615	0.0855	0.169
5/19/2020	0.193	0.777	0.0512	0.0627	0.154
6/11/2020	0.218	0.957	0.0572	0.0668	0.181
7/2/2020	0.267	0.833	0.0654	0.0563	0.326
7/30/2020	0.297	1.04	0.0505	0.0618	0.153
8/20/2020	0.602	1.04	0.0449	0.0729	0.130
9/3/2020	0.403	1.39	0.0525	0.0929	0.106
10/1/2020	0.545	0.931	0.0652	0.133	0.138
10/15/2020	0.179	1.20	0.0678	0.0908	0.239
11/10/2020	0.201	1.25	0.0907	0.132	0.304
12/8/2020	0.145	0.906	0.0623	0.111	0.153
12/31/20	N/A	N/A	N/A	N/A	N/A

Table H.8. Summary of metal concentrations measured in Carlsbad drinking water from 1998-2020

Metal	2020 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2019 (µg/L)
Ag	<MDC	1.36E-02	0.0175-0.0599
Al	6.70E+00	9.20E-01	1.83-41.1
As	6.15E-01	1.26E-01	0.297-1.42
B	N/A	N/A	28.9-44.4
Ba	7.25E+01	2.80E-01	66.4-81.9
Be	<MDC	1.30E-02	N/A
Ca	7.82E+04	2.02E+02	59000-73600
Cd	1.24E-02	1.00E-02	0.0187-0.0187
Ce	N/A	N/A	0.00581-0.0342
Co	3.70E-01	1.38E-02	0.088-0.341
Cr	2.27E+00	3.80E-01	0.514-10.2
Cu	1.83E+01	4.40E-01	1.3-18.1
Dy	N/A	N/A	0.00356-0.00356
Er	<MDC	2.60E-03	0.00332-0.00338
Eu	2.16E-02	1.22E-02	0.0104-0.028
Fe	4.40E+02	2.80E+01	0.71-652
Ga	N/A	N/A	3.25-3.25
Gd	N/A	N/A	0.00196-0.0622
Hg	<MDC	2.99E-01	0.0226-0.0314
K	1.70E+03	3.94E+01	1020-3560
La	<MDC	1.34E-02	0.00581-0.0442
Li	7.35E+00	1.90E-02	5.14-8.86
Mg	3.44E+04	2.80E+00	27300-34700
Mn	3.08E+00	4.80E-02	0.055-29.3
Mo	N/A	N/A	0.893-1.37
Na	3.44E+04	3.80E-01	8160-45500
Nd	<MDC	2.80E-03	0.0085-0.00935
Ni	3.97E+00	2.40E-02	1.46-3.14
P	7.25E+00	5.00E+00	16.1-49.5
Pb	2.94E+00	1.38E-02	0.101-6.62

Table H.8. Summary of metal concentrations measured in Carlsbad drinking water from 1998-2020 (continued)

Metal	2020 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2019 (µg/L)
Pr	N/A	N/A	0.00193-0.00372
Sb	4.90E-02	1.12E-02	0.025-0.199
Sc	2.05E+00	6.60E-02	1.18-3.03
Se	<MDC	9.40E+00	-0.0883-1.93
Si	7.00E+03	8.89E+02	5350-6870
Sr	4.04E+02	1.54E-01	261-362
Th	<MDC	5.60E-02	0.00632-0.0176
Tl	1.54E-01	8.80E-03	0.0897-1.3
U	7.97E-01	4.40E-02	0.654-1.05
V	3.97E+00	1.20E-01	3.07-6.57
Zn	3.41E+01	5.40E+00	2.13-38.7

Table H.9. Summary of metal concentrations measured in Double Eagle water from 1998-2020

Metal	2020 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2019 (µg/L)
Ag	<MDC	6.80E-02	0.00362-0.178
Al	9.01E+00	4.60E+00	1.93-72.2
As	7.20E+00	6.30E-01	4.48-9.11
B	N/A	N/A	29.8-85.5
Ba	1.06E+02	1.40E+00	38.2-126
Be	<MDC	6.50E-02	0.0363-0.0676
Ca	5.81E+04	2.02E+02	41500-59400
Cd	<MDC	5.00E-02	0.0187-0.0187
Ce	N/A	N/A	0.00363-0.0322
Co	1.69E-01	6.90E-02	0.0573-1.12
Cr	4.28E+00	1.90E+00	0.838-32.5
Cu	3.88E+00	2.20E+00	0.809-5.69
Dy	N/A	N/A	0.0615-0.0615
Er	<MDC	1.30E-02	0.0579-0.0579
Eu	<MDC	6.10E-02	0.0168-0.0932
Fe	5.10E+02	1.40E+02	0.0301-932
Ga	N/A	N/A	4.46-4.46
Gd	N/A	N/A	N/A
Hg	<MDC	2.99E-01	N/A
K	3.83E+03	1.97E+02	2220-29400
La	<MDC	6.70E-02	0.0119-0.075
Li	1.84E+01	9.50E-02	9.97-21.7
Mg	1.18E+04	1.40E+00	8510-12500
Mn	3.55E+00	2.40E-01	0.222-15
Mo	N/A	N/A	1.42-6.7
Na	4.15E+04	1.90E-01	3840-40400
Nd	<MDC	1.40E-02	0.00235-0.0488
Ni	2.66E+00	1.20E-01	0.768-4.03
P	<MDC	2.50E+01	6.38-23.5

Table H.9. Summary of metal concentrations measured in Double Eagle water from 1998-2020 (continued)

Metal	2020 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2019 (µg/L)
Pb	8.87E-01	6.90E-02	0.256-5.32
Pr	N/A	N/A	0.000905-0.000905
Sb	<MDC	5.60E-02	0.0241-0.139
Sc	4.96E+00	3.30E-01	1.4-6.59
Se	<MDC	4.70E+01	-0.0416-5.3
Si	1.95E+04	4.44E+03	7370-18100
Sr	6.40E+02	1.54E-01	50.6-612
Th	<MDC	2.80E-01	0.00207-0.0838
Tl	<MDC	4.40E-02	-0.0123--0.0123
U	1.34E+00	2.20E-01	1.17-2.38
V	3.03E+01	6.00E-01	7.71-40.6
Zn	<MDC	2.70E+01	1.46-12.5

Table H.10. Summary of metal concentrations measured in Hobbs water from 1998-2020

Metal	2020 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2019 (µg/L)
Ag	<MDC	3.40E-02	0.00386-0.104
Al	6.20E+00	2.30E+00	3.03-114
As	6.59E+00	3.15E-01	4.55-8.56
B	N/A	N/A	141-197
Ba	5.94E+01	7.00E-01	50.7-67.9
Be	<MDC	3.25E-02	0.0539-0.0539
Ca	N/A	N/A	76300-110000
Cd	<MDC	2.50E-02	N/A
Ce	N/A	N/A	0.0051-0.0356
Co	5.97E-01	3.45E-02	0.0978-0.361
Cr	2.28E+00	9.50E-01	0.644-11.3
Cu	2.40E+00	1.10E+00	1.04-6.93
Dy	N/A	N/A	0.00418-0.00418
Er	9.60E-03	6.50E-03	N/A
Eu	<MDC	3.05E-02	0.0112-0.0197
Fe	4.95E+02	7.00E+01	36.4-444
Ga	N/A	N/A	2.56-2.56
Gd	N/A	N/A	N/A
Hg	<MDC	2.99E-01	N/A
K	2.84E+03	9.85E+01	2110-25200
La	<MDC	3.35E-02	0.0125-0.0501
Li	3.29E+01	4.75E-02	26.5-38.9
Mg	2.48E+04	2.80E+00	19000-26700
Mn	1.52E+00	1.20E-01	0.379-3.76
Mo	N/A	N/A	2.36-3.31
Na	5.30E+04	3.80E-01	4970-58000
Nd	1.21E-02	7.00E-03	0.00301-0.0144
Ni	5.08E+00	6.00E-02	1.67-4.78
P	<MDC	1.25E+01	17.4-83.1
Pb	1.99E-01	3.45E-02	0.0812-1.19

Table H.10. Summary of metal concentrations measured in Hobbs water from 1998-2020 (continued)

Metal	2020 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2019 (µg/L)
Pr	N/A	N/A	0.00157-0.00188
Sb	6.75E-02	2.80E-02	0.0388-0.0853
Sc	<MDC	3.40E-02	0.00386-0.104
Se	6.82E+00	1.65E-01	3.06-10.5
Si	<MDC	2.35E+01	-0.17-12.3
Sr	2.73E+04	2.22E+03	22000-28600
Th	1.17E+03	1.54E-01	78.9-1220
Tl	<MDC	1.40E-01	0.00229-0.136
U	<MDC	2.20E-02	0.00945-0.0224
V	3.55E+00	1.10E-01	2.9-4.3
Zn	3.04E+01	3.00E-01	30.7-39.9

Table H.11. Summary of metal concentrations measured in Loving drinking water from 1998-2020

Metal	2020 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2019 (µg/L)
Ag	<MDC	1.36E-02	0.00255-0.217
Al	7.32E+00	9.20E-01	1.43-376
As	1.54E+00	1.26E-01	0.789-2.35
B	N/A	N/A	75.5-112
Ba	3.68E+01	2.80E-01	29.6-34.7
Be	<MDC	1.30E-02	0.0935-0.0935
Ca	9.03E+04	2.02E+02	67100-100000
Cd	1.19E-02	1.00E-02	N/A
Ce	N/A	N/A	0.000974-0.253
Co	3.65E-01	1.38E-02	0.0842-0.404
Cr	3.02E+00	3.80E-01	1.12-11.2
Cu	1.92E+00	4.40E-01	0.806-21.6
Dy	N/A	N/A	N/A
Er	3.53E-02	2.60E-03	N/A
Eu	5.57E-02	1.22E-02	0.007-0.043
Fe	4.16E+02	2.80E+01	3.6-312
Ga	N/A	N/A	1.26-1.26
Gd	N/A	N/A	0.00215-0.0432
Hg	<MDC	2.99E-01	N/A
K	2.07E+03	3.94E+01	1690-19800
La	5.19E-02	1.34E-02	0.00666-0.0233
Li	1.79E+01	1.90E-02	15-22.4
Mg	3.78E+04	2.80E+00	30200-42100
Mn	5.14E-02	4.80E-02	0.0143-1.77
Mo	N/A	N/A	1.28-1.72
Na	2.14E+04	3.80E-01	2330-28200
Nd	3.53E-02	2.80E-03	0.00337-0.0393
Ni	3.87E+00	2.40E-02	1.41-3.38
P	1.29E+01	5.00E+00	14.8-73.2
Pb	1.16E-01	1.38E-02	0.0311-1.67

Table H.11. Summary of metal concentrations measured in Loving drinking water from 1998-2020 (continued)

Metal	2020 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2019 (µg/L)
Pr	N/A	N/A	N/A
Sb	4.08E-02	1.12E-02	0.0301-0.184
Sc	3.02E+00	6.60E-02	1.5-4.72
Se	<MDC	9.40E+00	-2.89-1.53
Si	1.06E+04	8.89E+02	8910-10900
Sr	8.34E+02	1.54E-01	76-937
Th	<MDC	5.60E-02	0.00569-0.00738
Tl	<MDC	8.80E-03	0.00224-0.0432
U	1.75E+00	4.40E-02	1.68-2.3
V	1.23E+01	1.20E-01	11.1-16.1
Zn	<MDC	5.40E+00	2.21-53.3

Table H.12. Summary of metal concentrations measured in Otis drinking water from 1998-2020

Metal	2020 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2019 (µg/L)
Ag	<MDC	6.80E-02	0.0263-0.0263
Al	5.41E+00	4.60E+00	2.69-1060
As	1.67E+00	6.30E-01	0.653-2.34
B	N/A	N/A	146-239
Ba	1.45E+01	1.40E+00	12.5-19.7
Be	<MDC	6.50E-02	N/A
Ca	2.83E+05	1.01E+03	171000-360000
Cd	<MDC	5.00E-02	N/A
Ce	N/A	N/A	0.0275-0.0275
Co	1.44E+00	6.90E-02	0.244-0.951
Cr	2.95E+00	1.90E+00	0.812-8.72
Cu	4.28E+00	2.20E+00	2.43-19.7
Dy	N/A	N/A	0.00339-0.117
Er	<MDC	1.30E-02	0.0999-0.0999
Eu	<MDC	6.10E-02	0.00342-0.111
Fe	1.42E+03	1.40E+02	2.87-1070
Ga	N/A	N/A	0.654-0.654
Gd	N/A	N/A	N/A
Hg	<MDC	2.99E-01	0.0323-0.0323
K	3.08E+03	1.97E+02	2410-4010
La	<MDC	6.70E-02	0.00336-0.106
Li	4.17E+01	9.50E-02	30.8-67.9
Mg	8.13E+04	1.40E+01	51600-108000
Mn	<MDC	2.40E-01	0.198-4.91
Mo	N/A	N/A	2.25-5.03
Na	9.98E+04	1.90E+00	48600-197000
Nd	<MDC	1.40E-02	0.0048-0.0905
Ni	1.29E+01	1.20E-01	2.62-21.1
P	<MDC	2.50E+01	45.4-368
Pb	<MDC	6.90E-02	0.0388-0.598

Table H.12. Summary of metal concentrations measured in Otis drinking water from 1998-2020 (continued)

Metal	2020 Concentration (µg/L)	MDC (µg/L)	Concentration range from 1998-2019 (µg/L)
Pr	N/A	N/A	N/A
Sb	<MDC	5.60E-02	0.0366-0.41
Sc	3.16E+00	3.30E-01	0.655-5.35
Se	<MDC	4.70E+01	-0.0243-1.19
Si	1.12E+04	4.44E+03	9290-13900
Sr	3.48E+03	7.70E-01	1850-4970
Th	<MDC	2.80E-01	0.00119-0.116
Tl	<MDC	4.40E-02	-0.0063--0.0063
U	4.22E+00	2.20E-01	2.87-6.1
V	9.57E+00	6.00E-01	7.87-12.9
Zn	<MDC	2.70E+01	1.54-25.2

Table H.13. Summary of metal concentrations measured in Malaga drinking water from 2011-2020

Metal	2020 Concentration (µg/L)	MDC (µg/L)	Concentration range from 2011-2019 (µg/L)
Ag	<MDC	6.80E-02	0.069-0.069
Al	9.26E+00	4.60E+00	2.39-11.6
As	1.26E+00	6.30E-01	1.56-5.44
B	N/A	N/A	N/A
Ba	1.40E+01	1.40E+00	14.1-16.6
Be	<MDC	6.50E-02	0.304-0.304
Ca	4.56E+05	1.01E+03	241000-403000
Cd	<MDC	5.00E-02	N/A
Ce	N/A	N/A	N/A
Co	1.72E+00	6.90E-02	0.339-0.857
Cr	3.63E+00	1.90E+00	0.58-10
Cu	3.23E+00	2.20E+00	1.57-4.73
Dy	N/A	N/A	N/A
Er	6.81E-02	1.30E-02	N/A
Eu	8.40E-02	6.10E-02	N/A
Fe	2.48E+03	1.40E+02	590-2140
Ga	N/A	N/A	N/A
Gd	N/A	N/A	N/A
Hg	<MDC	2.99E-01	N/A
K	4.31E+03	1.97E+02	2570-4310
La	8.77E-02	6.70E-02	N/A
Li	5.37E+01	9.50E-02	37.2-58.7
Mg	1.28E+05	1.40E+01	69800-120000
Mn	3.16E-01	2.40E-01	0.284-1.3
Mo	N/A	N/A	3.23-3.99
Na	1.82E+05	1.90E+00	75300-159000
Nd	6.68E-02	1.40E-02	N/A
Ni	1.96E+01	1.20E-01	5.66-14.6
P	2.58E+01	2.50E+01	56.4-445
Pb	1.91E-01	6.90E-02	0.146-7.98

Table H.13. Summary of metal concentrations measured in Malaga drinking water from 2011-2020 (continued)

Metal	2020 Concentration (µg/L)	MDC (µg/L)	Concentration range from 2011-2019 (µg/L)
Pr	N/A	N/A	N/A
Sb	5.71E-02	5.60E-02	0.0395-0.0638
Sc	3.66E+00	3.30E-01	1.45-2.91
Se	<MDC	4.70E+01	16.5-16.5
Si	1.23E+04	4.44E+03	9120-11100
Sr	5.35E+03	7.70E-01	3710-4570
Th	<MDC	2.80E-01	N/A
Tl	<MDC	4.40E-02	N/A
U	5.16E+00	2.20E-01	4.38-5.61
V	9.40E+00	6.00E-01	8.3-12.9
Zn	<MDC	2.70E+01	15.2-167

Table H.14. Selected anion concentrations in drinking water from 1998-2020

Anion	2020 Concentration (µg/L)	MDC (µg/L)	Concentrations range from 1998-2019 (µg/L)
Carlsbad			
Bromide	<MDC	10.2	22.00-84.00
Chloride	50100	1.1	7830.00-78800.00
Fluoride	354	1.3	123.00-862.00
Nitrate	4060	11.1	1570.00-5910.00
Nitrite	<MDC	3.3	247.00-1340.00
Phosphate	<MDC	11.2	N/A
Sulfate	97200	3.2	74500.00-117000.00
Double Eagle PRV4			
Bromide	271	10.2	94.90-278.00
Chloride	47500	1.1	22300.00-57500.00
Fluoride	767	1.3	440.00-1360.00
Nitrate	11800	11.1	6980.00-14600.00
Nitrite	<MDC	3.3	967.00-967.00
Phosphate	<MDC	11.2	N/A-N/A
Sulfate	44400	3.2	30400.00-56900.00
Hobbs			
Bromide	158	10.2	82.70-394.00
Chloride	113000	5.5	63200.00-108000.00
Fluoride	1210	1.3	491.00-2880.00
Nitrate	21000	11.1	15700.00-22100.00
Nitrite	<MDC	3.3	1390.00-1390.00
Phosphate	<MDC	11.2	N/A
Sulfate	140000	16	104000.00-151000.00
Loving			
Bromide	92	10.2	35.80-115.00
Chloride	27200	1.1	15900.00-36500.00
Fluoride	470	1.3	131.00-2340.00
Nitrate	20600	11.1	15900.00-29100.00
Nitrite	<MDC	3.3	1540.00-1540.00
Phosphate	<MDC	11.2	52.80-52.80
Sulfate	113000	16	110000.00-205000.00

Table H.14. Selected anion concentrations in drinking water from 1998-2020 (continued)

Anion	2020 Concentration (µg/L)	MDC (µg/L)	Concentrations range from 1998-2019 (µg/L)
Malaga (2011-2020)			
Bromide	345	51	240.00-390.00
Chloride	572000	11	363000.00-555000.00
Fluoride	840	6.5	780.00-855.00
Nitrate	16600	55.5	10700.00-24100.00
Nitrite	<MDC	16.5	4010.00-4010.00
Phosphate	<MDC	56	N/A
Sulfate	885000	32	673000.00-910000.00
Otis			
Bromide	51	170	56.70-360.00
Chloride	5.5	243000	87400.00-412000.00
Fluoride	6.5	835	470.00-1530.00
Nitrate	55.5	17200	9590.00-25300.00
Nitrite	16.5	<MDC	1630.00-1630.00
Phosphate	56	<MDC	N/A
Sulfate	32	670000	327000.00-894000.00

Table H.15. Selected cation concentrations in drinking water

Cation	2020 Concentration (µg/L)	MDC (µg/L)	Concentration range in 2016-2019 (µg/L)
Carlsbad			
Ammonium	<MDC	70	N/A
Calcium	80400	460	47700.00-57900.00
Lithium	<MDC	29.5	12.00-95.00
Magnesium	35800	150	9990.00-11700.00
Potassium	<MDC	500	2110.00-3280.00
Sodium	34800	120	27400.00-40200.00
Double Eagle PRV4			
Ammonium	<MDC	28	N/A
Calcium	60600	460	47700.00-57900.00
Lithium	<MDC	11.8	12.00-95.00
Magnesium	11000	60	9990.00-11700.00
Potassium	3460	200	2110.00-3280.00
Sodium	39600	240	27400.00-40200.00
Hobbs			
Ammonium	<MDC	140	N/A
Calcium	112000	920	96900.00-109000.00
Lithium	<MDC	59	N/A
Magnesium	24100	300	22400.00-24300.00
Potassium	<MDC	1000	1280.00-2550.00
Sodium	56700	240	47600.00-52800.00
Loving			
Ammonium	<MDC	70	N/A
Calcium	88900	460	83600.00-86500.00
Lithium	<MDC	29.5	N/A
Magnesium	38100	150	34400.00-34900.00
Potassium	<MDC	500	920.00-1760.00
Sodium	20900	120	19000.00-23900.00
Malaga			
Ammonium	<MDC	280	N/A
Calcium	437000	2300	334000.00-413000.00
Lithium	<MDC	118	N/A

Table H.15. Selected cation concentrations in drinking water (continued)

Cation	2020 Concentration (µg/L)	MDC (µg/L)	Concentration range in 2016-2019 (µg/L)
Malaga			
Magnesium	128000	600	101000.00-116000.00
Potassium	<MDC	2000	2720.00-3540.00
Sodium	178000	480	115000.00-159000.00
Otis			
Ammonium	<MDC	280	N/A
Calcium	291000	2300	178000.00-366000.00
Lithium	<MDC	118	N/A
Magnesium	82100	600	57300.00-88800.00
Potassium	<MDC	2000	2080.00-2080.00
Sodium	98300		

Table H.16. Summary of conductivities measured in drinking water samples for 2020

Location	Conductivity (mS/cm)	Temperature (°C)
Sheep Draw	0.78	26.1
Loving	0.78	25.5
Otis	2.33	25.3
Malaga	3.67	25.6
Double Eagle PRV4	0.59	25.8
Hobbs	1.01	26.1

Table H.17. Summary of pH measurements conducted on drinking water samples for 2020

Location	pH @ 26.5°C
Sheep Draw	8.052
Loving	7.666
Otis	7.636
Malaga	7.552
Double Eagle PRV4	8.037
Hobbs	8.073

Table H.18. Summary of specific gravity measured in drinking water samples for 2020

Location	SG $_{T/4°C}$
Sheep Draw	0.994
Loving	0.991
Otis	0.997
Malaga	0.995
Double PRV4	0.994
Hobbs	0.994

Table H.19. Summary of total dissolved solids (TDS) and total suspended solids (TSS) measured in drinking water samples for 2020

Location	TDS mg/L	TSS* mg/L
Sheep Draw	790	ND
Loving	500	ND
Otis	1705	ND
Malaga	2705	ND
Double Eagle PRV4	320	ND
Hobbs	675	ND

*ND = non-detectable

Table H.20. Summary of total organic carbon (TOC), total inorganic carbon (TIC), and total nitrogen (TN) measured in drinking water samples for 2020

Location	TOC mg/L	TIC mg/L	TN mg/L
Carlsbad	46.28	44.36	0.9847
Loving	47.91	44.09	4.539
Otis	32.51	31.81	4.067
Malaga	29.67	28.18	3.888
Double Eagle (PRV4)	5.814	30.00	2.647
Hobbs	32.14	32.15	4.894

Table H.21. Summary of metal concentrations measured in Lake Carlsbad surface water from 1999-2020

Metal	2020 Shallow Level Concentration (µg/L)	2020 Deep Level Concentration (µg/L)	MDC (µg/L)	Concentration range from 1999-2019 (µg/L)
Ag	1.21	0.533	0.31	N/A
Al	24	25	19	39.50 - 503.00
As	<MDC	<MDC	2.05	5.08 - 12.20
B	N/A	N/A	N/A	197.00 - 225.00
Ba	14.2	14.3	0.6	16.30 - 33.00
Be	<MDC	<MDC	0.25	0.015 - 0.15
Ca	334000	336000	31500	303000.00 - 419000.00
Cd	<MDC	<MDC	0.115	N/A
Ce	<MDC	<MDC	0.14	0.081 - 0.49
Co	1.43	1.41	0.175	0.66 - 5.22
Cr	<MDC	<MDC	8.5	0.30 - 12.40
Cu	<MDC	<MDC	66	2.63 - 11.30
Dy	<MDC	<MDC	0.15	0.0067 - 0.10
Er	<MDC	<MDC	0.027	0.0012 - 0.43
Eu	<MDC	<MDC	0.145	0.0065 - 8.30
Fe	1150	1430	455	76.00 - 3960.00
Gd	<MDC	<MDC	0.11	0.0091 - 0.36
Hg	<MDC	<MDC	0.339	0.0028 - 0.42
K	4510	4790	414	4410.00 - 12400.00
La	<MDC	<MDC	0.115	0.04 - 8.27
Li	35.3	36.4	0.27	39.50 - 77.50
Mg	101000	104000	63	90500.00 - 151000.00
Mn	<MDC	<MDC	6	8.47 - 66.50
Mo	<MDC	<MDC	9.5	2.32 - 12.20
Na	348000	359000	324	317000.00 - 506000.00
Nd	<MDC	<MDC	0.145	0.038 - 6.97
Ni	9.99	11.3	0.8	2.33 - 22.90
P	<MDC	<MDC	154	83.50 - 1390.00

Table H.21. Summary of metal concentrations measured in Lake Carlsbad surface water from 1999-2020 (continued)

Metal	2020 Shallow Level Concentration (µg/L)	2020 Deep Level Concentration (µg/L)	MDC (µg/L)	Concentration range from 1999-2019 (µg/L)
Pb	<MDC	<MDC	2.75	0.17 - 4.01
Pr	<MDC	<MDC	0.155	0.010 - 0.47
Sb	<MDC	<MDC	0.205	N/A
Sc	1.43	1.98	0.5	2.25 - 9.47
Se	<MDC	<MDC	86.5	16.30 - 35.60
Si	7130	8040	3320	6610.00 - 9530.00
Sr	4340	4350	6	4160.00 - 6150.00
Th	<MDC	<MDC	0.7	0.0091 - 10.50
Tl	<MDC	<MDC	0.205	0.12 - 0.25
U	3.3	3.28	0.95	3.56 - 9.17
V	4.96	5.84	2.4	5.05 - 9.31
Zn	N/A	N/A	439	5.93 - 278.00

Table H.22. Summary of metal concentrations measured in Brantley Lake surface water from 1999-2020

Metal	2020 Shallow Level Concentration (µg/L)	2020 Deep Level Concentration (µg/L)	MDC (µg/L)	Concentration range from 1999-2019 (µg/L)
Ag	<MDC	<MDC	0.31	N/A
Al	37.3	23.1	19	26.20 - 711.00
As	<MDC	<MDC	2.05	2.68 - 58.60
B	N/A	N/A	N/A	209.00 - 218.00
Ba	35.2	38.8	0.6	30.30 - 101.00
Be	<MDC	<MDC	0.25	0.0019 - 0.14
Ca	501000	500000	31500	275000.00 - 667000.00
Cd	<MDC	<MDC	0.115	N/A
Ce	<MDC	<MDC	0.14	0.0057 - 0.67
Co	1.89	1.37	0.175	0.73 - 6.76
Cr	<MDC	<MDC	8.5	0.32 - 18.00
Cu	<MDC	<MDC	66	3.10 - 8.07
Dy	<MDC	<MDC	0.15	0.0058 - 0.52
Er	<MDC	<MDC	0.027	0.00035 - 0.40
Eu	<MDC	<MDC	0.145	0.015 - 0.23
Fe	2180	2270	455	53.00 - 2390.00
Gd	<MDC	<MDC	0.11	0.0073 - 0.54
Hg	<MDC	<MDC	0.339	0.18 - 0.18
K	5510	4960	414	4670.00 - 15100.00
La	<MDC	<MDC	0.115	0.034 - 0.64
Li	46.9	46.6	0.27	23.40 - 77.70
Mg	141000	134000	63	51000.00 - 201000.00
Mn	9.93	8.88	6	8.98 - 753.00
Mo	<MDC	<MDC	9.5	2.41 - 5.01
Na	451000	453000	324	187000.00 - 1250000.00
Nd	<MDC	<MDC	0.145	0.033 - 0.53

Table H.22. Summary of metal concentrations measured in Brantley surface water from 1999-2020 (continued)

Metal	2020 Shallow Level Concentration (µg/L)	2020 Deep Level Concentration (µg/L)	MDC (µg/L)	Concentration range from 1999-2019 (µg/L)
Ni	16.6	17.7	0.8	3.65 - 29.10
P	<MDC	<MDC	154	127.00 - 5130.00
Pb	<MDC	<MDC	2.75	0.26 - 1.37
Pr	<MDC	<MDC	0.155	0.011 - 0.64
Sb	<MDC	<MDC	0.205	0.25 - 0.31
Sc	2.23	1.89	0.5	0.93 - 2.89
Se	<MDC	<MDC	86.5	28.20 - 186.00
Si	9370	5680	3320	3010.00 - 8130.00
Sr	7180	7350	24	3930.00 - 10200.00
Th	<MDC	<MDC	0.7	0.02 - 0.41
Tl	<MDC	<MDC	0.205	0.05 - 0.05
U	3.83	3.99	0.95	2.77 - 7.94
V	4.52	3.83	2.4	3.47 - 8.00
Zn	N/A	N/A	439	10.70 - 375.00

Table H.23. Summary of metal concentrations measured in Red Bluff surface water from 1999-2020

Metal	2020 Shallow Level Concentration (μg/L)	2020 Deep Level Concentration (μg/L)	MDC (μg/L)	Concentration range from 1999-2019 (μg/L)
Ag	<MDC	<MDC	1.24	N/A
Al	90.9	<MDC	76	16.50 - 459.00
As	<MDC	<MDC	8.2	4.83 - 169.00
B	N/A	N/A	N/A	372.00 - 376.00
Ba	59.2	60.4	2.4	66.80 - 137.00
Be	<MDC	<MDC	1	0.033 - 0.27
Ca	821000	858000	31500	419000.00 - 899000.00
Cd	<MDC	<MDC	0.46	0.41 - 77.30
Ce	<MDC	<MDC	0.56	0.039 - 4.65
Co	<MDC	<MDC	0.7	0.77 - 6.01
Cr	<MDC	<MDC	34	1.86 - 42.10
Cu	<MDC	<MDC	264	6.73 - 8.87
Dy	<MDC	<MDC	0.6	0.003 - 2.53
Er	<MDC	<MDC	0.108	0.0021 - 2.35
Eu	<MDC	<MDC	0.58	0.024 - 8.58
Fe	2850	4880	1820	33.80 - 5030.00
Gd	<MDC	<MDC	0.44	0.014 - 3.59
Hg	<MDC	<MDC	0.339	0.061 - 0.21
K	32400	35900	1660	16000.00 - 83900.00
La	<MDC	<MDC	0.46	0.035 - 8.45
Li	131	143	1.08	43.00 - 134.00
Mg	334000	351000	252	120000.00 - 410000.00
Mn	<MDC	<MDC	24	37.00 - 297.00
Mo	<MDC	<MDC	38	3.16 - 15.10
Na	1660000	1720000	1620	579000.00 - 2650000.00
Nd	<MDC	<MDC	0.58	0.021 - 7.47
Ni	26.3	31.4	3.2	12.40 - 44.60
P	<MDC	<MDC	616	133.00 - 11600.00
Pb	<MDC	<MDC	11	0.26 - 3.24
Pr	<MDC	<MDC	0.62	0.0071 - 4.01

Table H.23. Summary of metal concentrations measured in Red Bluff surface water from 1999-2020 (continued)

Metal	2020 Shallow Level Concentration (µg/L)	2020 Deep Level Concentration (µg/L)	MDC (µg/L)	Concentration range from 1999-2019 (µg/L)
Sb	<MDC	<MDC	0.82	0.25 - 0.87
Sc	<MDC	2.63	2	0.59 - 4.74
Se	<MDC	<MDC	346	83.70 - 529.00
Si	<MDC	<MDC	13300	5630.00 - 5900.00
Sr	13800	14400	24	5760.00 - 15000.00
Th	<MDC	<MDC	2.8	0.0047 - 12.60
Tl	<MDC	<MDC	0.82	N/A
U	9.76	10.1	3.8	3.28 - 12.30
V	<MDC	<MDC	9.6	2.42 - 20.70
Zn	N/A	N/A	1750	6.21 - 1300.00

Table H.24. Selected anion concentrations in surface water from 1999-2020

Anion	2020 Shallow level Concentration (µg/L)	2020 Deep level Concentration (µg/L)	MDC (µg/L)	Concentrations range from 1999-2019 (µg/L)
Lake Carlsbad				
Bromide	255	255	22.5	360 - 410
Chloride	621,000	614,000	26.0	414,000 – 1,060,000
Fluoride	730	725	7.0	548 – 1,050
Nitrate	4,160	4,060	84.5	3,160 – 6,630
Nitrite	870	840	14.5	3,410 – 64,100
Phosphate	<MDC	<MDC	76.0	N/A
Sulfate	1,030,000	1,010,000	100.0	754,000 – 2,010,000
Brantley Lake				
Bromide	270	270	45.0	260 - 300
Chloride	792,000	831,000	13.0	301,000 – 2,200,000
Fluoride	900	870	14.0	440 – 1,980
Nitrate	800	690	169.0	490 – 95,400
Nitrite	<MDC	<MDC	29.0	1,450 – 120,000
Phosphate	<MDC	<MDC	152.0	N/A
Sulfate	1,570,000	1,590,000	250.0	788,000 – 2,610,000
Red Bluff Lake				
Bromide	1,040	1,060	90.0	880 – 1,340
Chloride	3,370,000	3,190,000	65.0	1,130,000 – 4,710,000
Fluoride	1,160	1,160	28.0	640 – 3,770
Nitrate	<MDC	<MDC	338.0	280 – 120,000
Nitrite	<MDC	<MDC	58.0	7,220 – 248,000
Phosphate	<MDC	<MDC	304.0	N/A
Sulfate	3,290,000	3,110,000	250.0	1,350,000 – 3,290,000

Table H.25. Selected cation concentrations in surface water from 2017-2020

Cation	2020 Shallow level Concentration (µg/L)	2020 Deep level Concentration (µg/L)	MDC (µg/L)	Concentrations range from 2017-2019 (µg/L)
Lake Carlsbad				
Ammonium	<MDC	<MDC	460	N/A
Calcium	345,000	343,000	2,350	325,000 – 361,000
Lithium	<MDC	<MDC	46	N/A
Magnesium	106,000	108,000	240	110,000 – 132,000
Potassium	<MDC	5,060	1,520	8,300 – 13,000
Sodium	382,000	382,000	350	359,000 – 428,000
Brantley Lake				
Ammonium	<MDC	<MDC	460	N/A
Calcium	521,000	533,000	2,350	293,000 – 394,000
Lithium	<MDC	<MDC	46	720 – 1,320
Magnesium	138,000	140,000	240	50,400 – 91,600
Potassium	<MDC	<MDC	1,520	7,200 – 7,420
Sodium	487,000	516,000	350	181,000 – 445,000
Red Bluff				
Ammonium	<MDC	<MDC	1,150	N/A
Calcium	949,000	944,000	9,400	625,000 – 729,000
Lithium	<MDC	<MDC	115	N/A
Magnesium	377,000	378,000	600	217,000 – 300,000
Potassium	45,400	41,300	3,800	20,600 – 40,000
Sodium	2,030,000	2,010,000	1,400	1,200,000 – 1,580,000

Table H.26. Summary of conductivities measured in surface water samples for 2020

Location	Conductivity mS/cm	Temperature (°C)
Lake Carlsbad (Shallow)	3.67	19.2
Lake Carlsbad (Deep)	3.63	19.1
Brantley Lake (Shallow)	4.75	19.0
Brantley Lake (Deep)	5.00	19.1
Red Bluff (Shallow)	12.46	7.70
Red Bluff (Deep)	12.48	8.46

Table H.27. Summary of pH measurements conducted on surface water samples for 2020

Location	pH @ 22.3°C
Lake Carlsbad, shallow	8.071
Lake Carlsbad, deep	8.070
Brantley Lake, shallow	7.889
Brantley Lake, deep	8.011
Red Bluff, shallow	7.244
Red Bluff, deep	7.352

Table H.28. Summary of specific gravity measured in surface water samples for 2020

Location	$SG_{T/4°C}$
Lake Carlsbad, shallow	0.970
Lake Carlsbad, deep	0.968
Brantley Lake, shallow	0.970
Brantley Lake, deep	0.967
Red Bluff, shallow	0.973
Red Bluff, deep	0.976

Table H.29. Summary of total organic carbon (TOC), total inorganic carbon (TIC), and total nitrogen (TN) measured in surface water samples for 2020

Location	TOC	TIC	TN
Lake Carlsbad (shallow)	23.15	30.18	1.149
Lake Carlsbad (deep)	23.77	31.71	1.127
Brantley Lake (shallow)	20.14	24.20	0.634
Brantley Lake (deep)	19.96	23.33	0.653
Red Bluff (shallow)	21.95	16.33	1.350
Red Bluff (deep)	21.58	16.48	1.384

APPENDIX I - VOC COMPOUNDS AND CONCENTRATIONS OF DISPOSAL AND SURFACE RESULTS

Target compounds for WIPP confirmatory VOC

Concentrations of concern for VOC

Disposal room VOC monitoring results for Panel 7

Surface VOC results

Table I.1 Target compounds for WIPP confirmatory VOC monitoring program and the maximum MRLs for undiluted repository and disposal room VOCs

Target Compound	MRL (ppbv) for Repository air VOC in SIM mode	MRL (ppbv) for repository air VOC in SCAN mode	MRL (ppbv) for Disposal Room VOC
1,1-Dichloroethylene	0.1	0.2	500
Carbon tetrachloride	0.1	0.2	500
Methylene chloride	0.1	0.2	500
Chloroform	0.1	0.2	500
1,1,2,2-Tetrachloroethane	0.1	0.2	500
1,1,1-Trichloroethane	0.1	0.2	500
Chlorobenzene	0.1	0.2	500
1,2-Dichloroethane	0.1	0.2	500
Toluene	0.1	0.2	500
Trichloroethylene	0.1	0.2	500

ppbv- Parts per billion by volume
MRL – Maximum Method Reporting Limit for undiluted samples.
SIM- Selected Ion Monitoring

Table I.2. Disposal room VOC monitoring maximum results for Panel 7

Target Compound	P7R6E (ppmv)	P7R6I (ppmv)	P7R5E (ppmv)	P7R5I (ppmv)
Carbon tetrachloride	687.07	687.24	645.78	521.91
Chlorobenzene	U	U	U	U
Chloroform	19.60	20.73	15.75	12.86
1,2-Dichloroethane	U	U	U	U
1,1-Dichloroethylene	U	U	U	U
Methylene chloride	0.79J	0.33J	U	0.02J
1,1,2,2-Tetrachloroethane	0.09J	U	U	U
Toluene	U	U	U	U
1,1,1-Trichloroethane	240.66	242.76	212.75	172.66
Trichloroethylene	183.97	185.02	174.79	137.69

ppmv-Parts per million by volume
U – Not-Detected (ND) or below Method Detection Limit
J – Estimated value, below laboratory Method Reporting Limit

Table I.2. Disposal room VOC monitoring maximum results for Panel 7 (continued)

Target Compound	P7R4E (ppmv)	P7R4I (ppmv)	P7R3E (ppmv)	P7R3I (ppmv)	P7R2E (ppmv)
Carbon tetrachloride	628.11	522.43	223.77	8.05	0.69
Chlorobenzene	U	U	U	U	U
Chloroform	15.22	12.16	5.47	0.16	0.02
1,2-Dichloroethane	U	U	U	U	U
1,1-Dichloroethylene	U	U	U	U	U
Methylene chloride	U	U	0.002J	0.001J	0.002J
1,1,2,2-Tetrachloroethane	U	U	U	0.0004J	0.0003J
Toluene	U	0.001J	0.002J	0.001J	0.002J
1,1,1-Trichloroethane	208.38	170.85	72.96	2.53	0.23
Trichloroethylene	165.60	132.79	62.77	2.11	0.20

ppmv-Parts per million by volume
U – Not-Detected (ND) or below Method Detection Limit
J – Estimated value, below laboratory Method Reporting Limit

Table I.3. Concentrations of concern for VOC, from Module IV of the HWFP (No. NM4890139088-TSDF)

Target Compound	50% Action Level (ppmv)	95% Action Level (ppmv)	Room based Limits (ppmv)
1,1-Dichloroethylene	2,745	5,215	5,490
Carbon tetrachloride	4,813	9,145	9,625
Methylene Chloride	50,000	95,000	100,000
Chloroform	4,965	9,433	9,930
1,1,2,2-Tetrachloroethane	1,480	2,812	2,960
1,1,1-Trichloroethane	16,850	32,015	33,700
Chlorobenzene	6500	12350	13000
1,2-Dichloroethane	1,200	2,280	2,400
Toluene	5,500	10,450	11,000
Trichloroethylene*	24,000	45,600	48,000

*Concentration of concern has not been established

Table I.4. Surface VOC results for stations VOC-C and VOC-D

Target Compounds	VOC-C (ppbv)	VOC-D (ppbv)
Carbon Tetrachloride	0.085J-1.58	0.074J-0.118J
Chlorobenzene	U-0.039J	U-0.013J
Chloroform	U-0.049J	U-0.030J
1,2-Dichloroethane	U-0.039J	U-0.038J
1,1-Dichloroethylene	U	U
Methylene chloride	0.047J-0.122J	0.047J-0.123J
1,1,2,2-Tetrachloroethane	U-0.016J	U-0.009J
Toluene	0.042J-1.21	0.040J-1.42
1,1,1-Trichloroethane	U-0.532	U-0.010J
Trichloroethylene	U-0.581	U-0.040J

ppbv-Parts per billion by volume
U – Not-Detected (ND) or below Method Detection Limit
J – Estimated value, below laboratory Method Reporting Limit

APPENDIX J - RADIOCHEMISTRY INTERCOMPARISON, ICP-MS PERFORMANCE, ENVIRONMENTAL CHEMISTRY PROFICIENCY

NIST radiochemistry intercomparison program test results

MAPEP radiochemistry intercomparison program test results

Daily performance tests for ICP-MS

Environmental chemistry proficiency test results for metal analyses, mercury, inorganic anions, and cations

Table J.1. Radiochemistry MAPEP 2020 inter-comparison results

MAPEP Mixed Analyte Performance Evaluation Program

Department of Energy RESL - 1955 Fremont Ave, MS4149 - Idaho Falls, ID 83415

Laboratory Results For MAPEP-20-GrF43

(CMRC01) Carlsbad Environmental Monitoring and Research Center
1400 University Dr.
Carlsbad, NM 88220

Radiological								Units: (Bq/sample)
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Gross alpha	0.291	0.528	A		-44.9	0.158 - 0.898	0.008	A
Gross beta	0.998	0.915	A		9.1	0.458 - 1.373	0.025	A

Radiological Reference Date: August 1, 2020

Gross Alpha Flags:

A = Result acceptable, Bias <= +/- 70% with a statistically positive result at two standard deviations (Result/Uncertainty > 2, i.e., the range encompassing the result, plus or minus the total uncertainty at two standard deviations, does not include zero).

N = Result not acceptable, Bias > +/- 70% or the reported result is not statistically positive at two standard deviations (Result/Uncertainty <= 2, i.e., the range encompassing the result, plus or minus the total uncertainty at two standard deviations, includes zero).

Gross Beta Flags:

A = Result acceptable, Bias <= +/- 50% with a statistically positive result at two standard deviations (Result/Uncertainty > 2, i.e., the range encompassing the result, plus or minus the total uncertainty at two standard deviations, does not include zero).

N = Result not acceptable, Bias > +/- 50% or the reported result is not statistically positive at two standard deviations (Result/Uncertainty <= 2, i.e., the range encompassing the result, plus or minus the total uncertainty at two standard deviations, includes zero).

Uncertainty Flags:

NOT ACCEPTABLE..........................RP<2%

ACCEPTABLE..................................2%<=RP<=15%

ACCEPTABLE WITH WARNING...........15%<RP<=30%

NOT ACCEPTABLE...........................RP>30%

RP = Relative Precision

Issued 12/11/2020 Printed 12/14/2020

Table J.1. Radiochemistry MAPEP 2020 inter-comparison results (continued)

MAPEP Mixed Analyte Performance Evaluation Program

Department of Energy RESL - 1955 Fremont Ave, MS4149 - Idaho Falls, ID 83415

Laboratory Results For MAPEP-20-GrW43

(CMRC01) Carlsbad Environmental Monitoring and Research Center
1400 University Dr.
Carlsbad, NM 88220

Radiological								Units: (Bq/L)
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Gross alpha	0.930	0.62	A		50.0	0.19 - 1.05	0.192	W
Gross beta	1.069	0.83	A		28.8	0.42 - 1.25	0.261	W

Radiological Reference Date: August 1, 2020

Gross Alpha Flags:

A = Result acceptable, Bias <= +/- 70% with a statistically positive result at two standard deviations (Result/Uncertainty > 2, i.e., the range encompassing the result, plus or minus the total uncertainty at two standard deviations, does not include zero).

N = Result not acceptable, Bias > +/- 70% or the reported result is not statistically positive at two standard deviations (Result/Uncertainty <= 2, i.e., the range encompassing the result, plus or minus the total uncertainty at two standard deviations, includes zero).

Gross Beta Flags:

A = Result acceptable, Bias <= +/- 50% with a statistically positive result at two standard deviations (Result/Uncertainty > 2, i.e., the range encompassing the result, plus or minus the total uncertainty at two standard deviations, does not include zero).

N = Result not acceptable, Bias > +/- 50% or the reported result is not statistically positive at two standard deviations (Result/Uncertainty <= 2, i.e., the range encompassing the result, plus or minus the total uncertainty at two standard deviations, includes zero).

Uncertainty Flags:

NOT ACCEPTABLE..........................RP<2%

ACCEPTABLE..................................2%<=RP<=15%

ACCEPTABLE WITH WARNING...........15%<RP<=30%

NOT ACCEPTABLE..........................RP>30%

RP = Relative Precision

Issued 12/11/2020 Printed 12/14/2020

(continued)

Table J.2. Radiochemistry MAPEP 2020 inter-comparison results for soil

MAPEP Mixed Analyte Performance Evaluation Program

Department of Energy RESL - 1955 Fremont Ave, MS4149 - Idaho Falls, ID 83415

Laboratory Results For MAPEP-20-MaS43

(CMRC01) Carlsbad Environmental Monitoring and Research Center
1400 University Dr.
Carlsbad, NM 88220

Inorganic							Units: (mg/kg)	
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Antimony	NR	53				37 - 69		
Arsenic	NR	16.7				11.7 - 21.7		
Barium	NR	275				193 - 358		
Beryllium	NR	40.5				28.4 - 52.7		
Cadmium	NR	9.71				6.80 - 12.62		
Chromium	NR	109.2				76.4 - 142.0		
Cobalt	NR	109.2				76.4 - 142.0		
Copper	NR	163				114 - 212		
Lead	NR	51.0				35.7 - 66.3		
Mercury	NR	0.630				0.441 - 0.819		
Nickel	NR	238				167 - 309		
Selenium	NR	8.03				5.62 - 10.44		
Silver	NR	84.9				59.4 - 110.4		
Technetium-99	NR					False Positive Test		
Thallium	NR	43.1				30.2 - 56.0		
Uranium-235	NR	0.0343				0.0240 - 0.0446		
Uranium-238	NR	10.3				7.2 - 13.4		
Uranium-Total	NR	10.3				7.2 - 13.4		
Vanadium	NR	153				107 - 199		
Zinc	NR	280				196 - 364		

Radiological							Units: (Bq/kg)	
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	2.02E-01		A			False Positive Test	1.91E-01	
Cesium-134	7.47E+02	710	A		5.2	497 - 923	6.73	N
Cesium-137	9.08E-01		N	(1)		False Positive Test	2.77E-01	
Cobalt-57	1.26E+03	1100	A		14.5	770 - 1430	7.73	A
Cobalt-60	1.07E+03	1000	A		7.0	700 - 1300	2.14	A
Iron-55	NR	577				404 - 750		
Manganese-54	6.99E+02	610	A		14.6	427 - 793	1.44	A
Nickel-63	NR	980				686 - 1274		
Plutonium-238	6.61E+01	57.7	A		14.6	40.4 - 75.0	4.89	A
Plutonium-239/240	8.10E+01	79	A		2.5	55 - 103	5.97	A
Potassium-40	7.20E+02	622	A		15.8	435 - 809	1.47	A
Strontium-90	NR	487				341 - 633		
Technetium-99	NR					False Positive Test		

Issued 12/11/2020 Printed 12/14/2020

Table J.2. Radiochemistry MAPEP 2020 inter-comparison results for soil (continued)

Radiological							Units: (Bq/kg)	
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Uranium-234	4.77E+01	48.1	A		-0.8	33.7 - 62.5	3.66	A
Uranium-238	1.39E+02	128	A		8.6	90 - 166	1.02	A
Zinc-65	5.43E+02	470	A		15.5	329 - 611	1.18	A

Radiological Reference Date: August 1, 2020

Results Flags:

A = Result acceptable Bias <=20%

W = Result acceptable with warning 20% < Bias < 30%

N = Result not acceptable Bias > 30%

RW = Report Warning

NR = Not Reported

Uncertainty Flags:

NOT ACCEPTABLE...........................RP<2%

ACCEPTABLE.................................2%<=RP<=15%

ACCEPTABLE WITH WARNING...........15%<RP<=30%

NOT ACCEPTABLE............................RP>30%

RP = Relative Precision

Notes:

(1) = False Positive

Issued 12/11/2020 Printed 12/14/2020

Table J.3. Radiochemistry MAPEP 2020 inter-comparison results for water

MAPEP Mixed Analyte Performance Evaluation Program

Department of Energy RESL - 1955 Fremont Ave, MS4149 - Idaho Falls, ID 83415

Laboratory Results For MAPEP-20-MaW43

(CMRC01) Carlsbad Environmental Monitoring and Research Center
1400 University Dr.
Carlsbad, NM 88220

Inorganic							Units: (mg/L)	
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Antimony	NR	13.5				9.5 - 17.6		
Arsenic	NR	3.71				2.60 - 4.82		
Barium	NR	0.690				0.483 - 0.897		
Beryllium	NR	2.24				1.57 - 2.91		
Cadmium	NR	0.306				0.214 - 0.398		
Chromium	NR	1.77				1.24 - 2.30		
Cobalt	NR	18.0				12.6 - 23.4		
Copper	NR	19.1				13.4 - 24.8		
Lead	NR	1.88				1.32 - 2.44		
Mercury	NR					False Positive Test		
Nickel	NR	15.2				10.6 - 19.8		
Selenium	NR	0.490				0.343 - 0.637		
Technetium-99	NR	1.48E-5				1.04E-5 - 1.92E-5		
Thallium	NR	4.45				3.12 - 5.79		
Uranium-235	NR	7.6E-4				5.32E-4 - 9.88E-4		
Uranium-238	NR	0.105				0.074 - 0.137		
Uranium-Total	NR	0.105				0.074 - 0.137		
Vanadium	NR	11.6				8.1 - 15.1		
Zinc	NR	18.5				13.0 - 24.1		

Radiological							Units: (Bq/L)	
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	7.74E-01	0.922	A		-16.1	0.645 - 1.199	5.18E-02	A
Cesium-134	1.27E+01	15.2	A		-16.4	10.6 - 19.8	4.39E-01	A
Cesium-137	1.54E+01	14.3	A		7.7	10.0 - 18.6	3.27E-01	A
Cobalt-57	5.03E-01		A			False Positive Test	5.01E-01	
Cobalt-60	1.19E+01	12.2	A		-2.5	8.5 - 15.9	4.43E-01	A
Hydrogen-3	NR	360				252 - 468		
Iron-55	NR	32.9				23.0 - 42.8		
Manganese-54	9.06E-02		A			False Positive Test	1.47E-01	
Nickel-63	NR					False Positive Test		
Plutonium-238	6.88E-01	0.704	A		-2.3	0.493 - 0.915	4.54E-02	A
Plutonium-239/240	7.40E-03	0.0089	A			Sensitivity Evaluation	1.37E-03	
Potassium-40	9.73E-01		A			False Positive Test	5.61	
Radium-226	NR	1.25				0.88 - 1.63		
Strontium-90	NR	11.6				8.1 - 15.1		

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Table J.3. Radiochemistry MAPEP 2020 inter-comparison results for water (continued)

Radiological							Units: (Bq/L)	
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Technetium-99	NR	9.4				6.6 - 12.2		
Uranium-234	1.21E+00	1.26	A		-4.0	0.88 - 1.64	8.37E-02	A
Uranium-238	1.22E+00	1.3	A		-6.2	0.9 - 1.7	8.41E-02	A
Zinc-65	1.82E+01	16.9	A		7.7	11.8 - 22.0	1.22	A

Radiological Reference Date: August 1, 2020

Uncertainty Flags:

NOT ACCEPTABLE...........................RP<2%

ACCEPTABLE..................................2%<=RP<=15%

ACCEPTABLE WITH WARNING...........15%<RP<=30%

NOT ACCEPTABLE............................RP>30%

RP = Relative Precision

Table J.4. Radiochemistry MAPEP 2020 inter-comparison results for filter

MAPEP Mixed Analyte Performance Evaluation Program

Department of Energy RESL - 1955 Fremont Ave, MS4149 - Idaho Falls, ID 83415

Laboratory Results For MAPEP-20-RdF43

(CMRC01) Carlsbad Environmental Monitoring and Research Center
1400 University Dr.
Carlsbad, NM 88220

Inorganic							Units: (ug/sample)	
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Uranium-235	NR	0.102				0.071 - 0.133		
Uranium-238	NR	14.6				10.2 - 19.0		
Uranium-Total	NR	14.7				10.3 - 19.1		

Radiological							Units: (Bq/sample)	
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	1.33E-01	0.134	A		-0.7	0.094 - 0.174	8.71E-03	A
Cesium-134	1.61E+00	1.83	A		-12.0	1.28 - 2.38	1.75E-01	A
Cesium-137	1.12E+00	0.996	A		12.5	0.697 - 1.295	2.96E-02	A
Cobalt-57	3.12E-03		A			False Positive Test	3.32E-02	
Cobalt-60	1.77E+00	1.73	A		2.3	1.21 - 2.25	3.71E-02	A
Manganese-54	1.47E+00	1.40	A		5.0	0.98 - 1.82	3.57E-02	A
Plutonium-238	9.00E-02	0.0867	A		3.8	0.0607 - 0.1127	6.47E-03	A
Plutonium-239/240	1.58E-03	0.0017	A			Sensitivity Evaluation	3.78E-04	
Strontium-90	NR	2.08				1.46 - 2.70		
Uranium-234	1.74E-01	0.175	A		-0.6	0.123 - 0.228	1.22E-02	A
Uranium-238	1.81E-01	0.182	A		-0.5	0.127 - 0.237	1.26E-02	A
Zinc-65	2.23E+00	2.00	A		11.5	1.40 - 2.60	8.54E-02	A

Radiological Reference Date: August 1, 2020

Result Flags:

A = Result acceptable Bias <=20%

W = Result acceptable with warning 20% < Bias < 30%

N = Result not acceptable Bias > 30%

RW = Report Warning

NR = Not Reported

Uncertainty Flags:

NOT ACCEPTABLE............................RP<2%

ACCEPTABLE......................................2%<=RP<=15%

ACCEPTABLE WITH WARNING...........15%<RP<=30%

Issued 12/11/2020 Printed 12/14/2020

Table J.4. Radiochemistry MAPEP 2020 inter-comparison results for filter (continued)

Radiological								Units: (Bq/sample)
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag

NOT ACCEPTABLE............................RP>30%

Issued 12/11/2020 Printed 12/14/2020

Table J.5. Radiochemistry MAPEP 2020 inter-comparison results for unknown sample

MAPEP Mixed Analyte Performance Evaluation Program

Department of Energy RESL - 1955 Fremont Ave, MS4149 - Idaho Falls, ID 83415

Laboratory Results For MAPEP-20-XrM43

(CMRC01) Carlsbad Environmental Monitoring and Research Center
1400 University Dr.
Carlsbad, NM 88220

Radiological			Units: (Bq/sample)	
Sample ID	Nuclide	Known Activity	Experimental Activity	Bias (%)
MAPEP-20-XrM43	Am-241	0.0477 +/- 0.0012	4.60E-02 +/- 3.46E-03	-3.6
MAPEP-20-XrM43	Cs-134	0.159 +/- 0.004	1.73E-01 +/- 3.25E-02	8.8
MAPEP-20-XrM43	Cs-137	1.118 +/- 0.018	1.52E+00 +/- 7.92E-02	36.0
MAPEP-20-XrM43	Co-57	0.0144 +/- 0.0003	1.88E-02 +/- 2.57E-02	30.6
MAPEP-20-XrM43	Co-60	0.504 +/- 0.016	6.20E-01 +/- 4.32E-02	23.0
MAPEP-20-XrM43	Cm-244	0.0543 +/- 0.0007	4.68E-02 +/- 3.52E-03	-13.8
MAPEP-20-XrM43	Mn-54	0.0177 +/- 0.0004	1.56E-02 +/- 2.13E-02	-11.9
MAPEP-20-XrM43	Pu-238	0.0587 +/- 0.0012	5.66E-02 +/- 4.57E-03	-3.6
MAPEP-20-XrM43	Pu-239	0.0483 +/- 0.0012	4.73E-02 +/- 3.92E-03	-2.1
MAPEP-20-XrM43	K-40		3.47E+00 +/- 5.03E-01	
MAPEP-20-XrM43	Sr-90	0.657 +/- 0.015		
MAPEP-20-XrM43	Tc-99	0.694 +/- 0.015		
MAPEP-20-XrM43	U-234	0.00804 +/- 0.00017	8.64E-03 +/- 1.35E-03	7.5
MAPEP-20-XrM43	U-235		1.08E-03 +/- 4.92E-04	
MAPEP-20-XrM43	U-238	0.0610 +/- 0.0012	5.90E-02 +/- 5.66E-03	-3.3
MAPEP-20-XrM43	Zn-65	0.00399 +/- 0.00009	2.22E-02 +/- 2.43E-02	

Radiological Reference Date: August 1, 2020

Issued 12/11/2020 Printed 12/14/2020

Table J.6. Daily performance tests (ICP-MS, NexION)

	Acceptable Ranges	07/23/2020			12/31/2020		
	Criteria for Net Intensity Mean of 5 replicate readings	Measured Intensity Mean	RSD	Performance Evaluation	Measured Mean Intensity	RSD	Performance Evaluation
Be	>3,500	6,379.4	1.9	Acceptable	12,543.3	2.2	Acceptable
In	>500,000	80,907.3	2.2	Acceptable	194,264.7	1.6	Acceptable
U	>40,000	66,721.2	1.0	Acceptable	108,528.8	1.4	Acceptable
CeO	≤3%	2.2%	N/A	Acceptable	2.6%	N/A	Acceptable
Ce++	≤3%	1.9%	N/A	Acceptable	2.4%	N/A	Acceptable
Bkgd	≤10	0.067	N/A	Acceptable	0.20	N/A	Acceptable

RSD = Relative Standard Deviation

Table J.7. Environmental chemistry proficiency test results for metal analyses

ERA
A Waters Company

WS-284 Final Evaluation Report

Adrienne Chancellor
Associate Research Scientist
New Mexico State University
1400 University Dr
CEMRC
Carlsbad, NM 88220-3575
(575) 234-5525

EPA ID: Not Reported
ERA Customer Number: N215603
Report Issued: 04/20/20
Study Dates: 03/02/20 - 04/16/20

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
WS Metals (cat# 590, lot# S284-697)												
1000	Aluminum	µg/L	645.19	654	556 - 752	Acceptable	EPA 200.8 5.4 1994	4/14/2020	-0.365	661	43.3	
1005	Antimony	µg/L	7.80	8.65	6.06 - 11.2	Acceptable	EPA 200.8 5.4 1994	4/14/2020	-0.909	8.29	0.544	
1010	Arsenic	µg/L	10.25	9.07	6.35 - 11.8	Acceptable	EPA 200.8 5.4 1994	4/14/2020	1.59	8.98	0.801	
1015	Barium	µg/L	2106.82	2200	1870 - 2530	Acceptable	EPA 200.8 5.4 1994	4/14/2020	-0.311	2150	128	
1020	Beryllium	µg/L	4.32	4.13	3.51 - 4.75	Acceptable	EPA 200.8 5.4 1994	4/14/2020	0.201	4.27	0.255	
1025	Boron	µg/L		1880	1600 - 2160	Not Reported				1840	153	
1030	Cadmium	µg/L	20.55	21.6	17.3 - 25.9	Acceptable	EPA 200.8 5.4 1994	4/14/2020	-0.441	21.1	1.25	
1040	Chromium	µg/L	78.76	80.8	68.7 - 92.9	Acceptable	EPA 200.8 5.4 1994	4/14/2020	-0.122	79.2	3.96	
1055	Copper	µg/L	639.74	651	586 - 716	Acceptable	EPA 200.8 5.4 1994	4/14/2020	-0.0458	642	43.4	
1070	Iron	µg/L	755.61	816	694 - 938	Acceptable	EPA 200.8 5.4 1994	4/14/2020	-1.45	809	37.1	
1075	Lead	µg/L	68.99	69.3	48.5 - 90.1	Acceptable	EPA 200.8 5.4 1994	4/14/2020	0.349	67.4	4.57	
1090	Manganese	µg/L	91.59	94.6	80.4 - 109	Acceptable	EPA 200.8 5.4 1994	4/14/2020	-0.737	95.5	5.32	
1100	Molybdenum	µg/L	63.82	71.7	60.9 - 82.5	Acceptable	EPA 200.8 5.4 1994	4/14/2020	-1.21	68.2	3.63	
1105	Nickel	µg/L	150.09	152	129 - 175	Acceptable	EPA 200.8 5.4 1994	4/14/2020	-0.0127	150	8.17	
1140	Selenium	µg/L	40.48	41.2	33.0 - 49.4	Acceptable	EPA 200.8 5.4 1994	4/14/2020	-0.345	41.3	2.27	
1150	Silver	µg/L	32.23	34.6	24.2 - 45.0	Acceptable	EPA 200.8 5.4 1994	4/14/2020	-0.763	34.3	2.71	
1165	Thallium	µg/L	7.63	7.87	5.51 - 10.2	Acceptable	EPA 200.8 5.4 1994	4/14/2020	-0.0824	7.67	0.535	
1185	Vanadium	µg/L	55.16	56.9	48.4 - 65.4	Acceptable	EPA 200.8 5.4 1994	4/14/2020	-0.0284	55.2	1.81	
1190	Zinc	µg/L	928.39	933	793 - 1070	Acceptable	EPA 200.8 5.4 1994	4/14/2020	0.0104	928	46.6	

This report is scored by the criteria in the 2016 TNI Standard, Volume 3, instead of by the criteria in the 2009 TNI Standard to which the Proficiency Testing Provider is accredited. This is a planned change and is endorsed by the TNI Proficiency Testing Program Executive Committee for transition to the 2016 TNI Standard.

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Table J.8. Environmental chemistry proficiency test results for mercury and inorganic anions

ERA

A Waters Company

WS-283 Final Evaluation Report

Adrienne Chancellor
Associate Research Scientist
New Mexico State University
1400 University Dr
CEMRC
Carlsbad, NM 88220-3575
(575) 234-5525

EPA ID: Not Reported
ERA Customer Number: N215603
Report Issued: 03/23/20
Study Dates: 02/03/20 - 03/19/20

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
WS Inorganics (cat# 591, lot# S283-698)												
1505	Alkalinity as CaCO3	mg/L		86.4	77.8 - 95.0	Not Reported				86.0	2.83	
1575	Chloride	mg/L	115.7	116	98.6 - 133	Acceptable	EPA 300.0 2.1 1993	2/25/2020	0.508	114	4.28	
1610	Conductivity at 25°C	µmhos/cm		946	851 - 1040	Not Reported				942	19.8	
1730	Fluoride	mg/L	7.3	7.55	6.80 - 8.30	Acceptable	EPA 300.0 2.1 1993	2/25/2020	-0.281	7.38	0.277	
1820	Nitrate + Nitrite as N	mg/L		3.43	2.92 - 3.94	Not Reported				3.35	0.165	
1810	Nitrate as N	mg/L	3.3	3.43	3.09 - 3.77	Acceptable	EPA 300.0 2.1 1993	2/25/2020	-0.335	3.35	0.144	
1125	Potassium	mg/L		25.1	21.3 - 28.9	Not Reported				25.1	1.50	
2000	Sulfate	mg/L	146.2	150	128 - 172	Acceptable	EPA 300.0 2.1 1993	2/25/2020	-0.313	148	6.39	
1955	Total Dissolved Solids at 180°C	mg/L		631	505 - 757	Not Reported				629	25.5	

Table J.9. Environmental chemistry proficiency test results for hardness (cations)

ERA

A Waters Company

WS-282 Final Evaluation Report

Adrienne Chancellor
Associate Research Scientist
New Mexico State University
1400 University Dr
CEMRC
Carlsbad, NM 88220-3575
(575) 234-5525

EPA ID: Not Reported
ERA Customer Number: N215603
Report Issued: 02/24/20
Study Dates: 01/06/20 - 02/20/20

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
WS Hardness (cat# 555, lot# S282-693)												
1035	Calcium	mg/L	52.5	52.2	44.4 - 60.0	Acceptable	ASTM D6919-09 2009	1/16/2020	0.414	51.6	2.12	
1085	Magnesium	mg/L	14.5	14.6	12.4 - 16.8	Acceptable	ASTM D6919-09 2009	1/16/2020	-0.104	14.6	0.664	
1155	Sodium	mg/L	36.6	36.6	31.1 - 42.1	Acceptable	ASTM D6919-09 2009	1/16/2020	0.0825	36.5	1.42	
1550	Calcium Hardness as CaCO3	mg/L		130	110 - 150	Not Reported				130	5.06	
1755	Total Hardness as CaCO3	mg/L		190	162 - 218	Not Reported				188	6.95	

This report is scored by the criteria in the 2016 TNI Standard, Volume 3, instead of by the criteria in the 2009 TNI Standard to which the Proficiency Testing Provider is accredited. This is a planned change and is endorsed by the TNI Proficiency Testing Program Executive Committee for transition to the 2016 TNI Standard.

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Study # : WS-282