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Radiological Impact of 2022 Operations at the Savannah River Site

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September 2023

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EXECUTIVE SUMMARY

This report presents the environmental dose assessment methods and the estimated potential doses to the public from 2022 Savannah River Site (SRS) air and liquid radioactive releases. Also documented are potential doses from special-case exposure scenarios, such as the consumption of wildlife or goat milk.

Dose to the Offsite Representative Person

The 2022 dose to the offsite representative person from SRS liquid releases was 0.17 mrem and from SRS air releases it was 0.016 mrem. To show compliance with the U. S. Department of Energy (DOE) all pathway dose standard of 100 mrem/yr, SRS conservatively adds these two doses for a total representative person dose of 0.18 mrem which is 0.18% of the DOE standard.

Sportsman Doses

Onsite Hunter: SRS conducts annual hunts to control onsite deer and feral hog populations. The estimated dose from consuming harvested deer or hog meat is determined for every onsite hunter. During 2022, the maximum potential dose an onsite hunter received was 8.76 mrem, or 8.76% of DOE's 100 mrem/yr all-pathway dose standard.

Creek Mouth Fisherman: SRS estimated the maximum potential dose from fish consumption at 0.57 mrem from catfish collected at the mouth of Lower Three Runs. This dose is 0.57% of the DOE standard. SRS bases this hypothetical dose on the low probability scenario that, during 2022, a fisherman consumed 24 kg (53 lbs) of catfish caught exclusively from the mouth of Lower Three Runs.

Release of Material Containing Residual Radioactivity

SRS did not release any real property (land or buildings) in 2022. SRS unconditionally released a total of 13,488 items of personal property (such as tools) from radiological areas in 2022. Most of these items did not leave the Site. However, all of these items required no additional radiological controls post-survey as they met DOE Order 458.1 release criteria.

Radiation Dose to Aquatic and Terrestrial Biota

SRS conducts screening evaluations of plant and animal doses for aquatic and terrestrial ecosystems. For 2022, all SRS aquatic system locations passed the initial (Level 1) screenings and no further assessments were required at those locations.

For the land-based systems evaluation, SRS performed initial screenings using concentration data from the five onsite radiological soil sampling locations. Typically, SRS collects and analyzes only one soil sample per year from each location. For 2022, all land-based locations passed their initial (Level 1) pathway screenings.

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LIST OF ABBREVIATIONS

ALARA	As Low as Reasonably Achievable
BCG	Biota Concentration Guide
BJWSA	Beaufort-Jasper Water and Sewer Authority
BLLDF	Barnwell Low-Level Disposal Facility
COS	Center of Site
DOE	U. S. Department of Energy
EPA	U. S. Environmental Protection Agency
FGR	Federal Guidance Report
GDNR	Georgia Department of Natural Resources
ICRP	International Commission on Radiological Protection
MCL	Maximum Contaminant Levels
MEI	Maximally Exposed Individual
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NRC	Nuclear Regulatory Commission
RM	River Mile
SCDHEC	South Carolina Department of Health and Environmental Control
SRNL	Savannah River National Laboratory
SRS	Savannah River Site
TRL	Three Rivers Landfill
USGS	U. S. Geological Survey
VEGP	Georgia Power Company's Vogtle Electric Generating Plant

Introduction

This report presents environmental dose assessment methods and the estimated potential doses to the public from 2022 Savannah River Site (SRS) atmospheric and liquid radioactive releases. It also documents potential doses from special-case exposure scenarios, such as the consumption of wildlife and/or goat milk. Unless noted, the generic term "dose," as used in this report, includes both the committed effective dose (50-year committed dose) from internal deposition of radionuclides and the effective dose attributable to sources external to the body. Using the effective dose allows doses from different types of radiation and to different parts of the body to be expressed on the same basis.

Humans, plants, and animals potentially receive radiation doses from natural and man-made occurrences. The average annual "background" dose for all people living in the United States is 625 mrem. This includes an average background dose of 311 mrem from naturally occurring radionuclides (found in our bodies and in the earth) and from cosmic radiation. Man-made sources include medical procedures (300 mrem), consumer products (13 mrem), and industrial and occupational exposures (less than 1 mrem) (NCRP 2009).

The U.S. Department of Energy (DOE) has established dose limits to the public, so that DOE operations will not contribute significantly to this average annual exposure. DOE Order 458.1 (DOE 2020) establishes 100 mrem/yr (1 mSv/yr) as the annual dose limit to a member of the public. As shown in Figure 1-1, radiation exposure primarily occurs through the following pathways:

- Inhalation,
- Ingestion,
- Skin absorption, and
- Direct (external) exposure to radionuclides in soil, air, and water.

1.0 Dose Assessment Methods

DOE Order 458.1 states that compliance with the DOE annual dose limit of 100 mrem (1 mSv), for a member of the public, may be demonstrated by calculating dose to the maximally exposed individual (MEI) or to a representative person. Prior to 2012, SRS used the MEI concept for dose compliance which is based on adult dose coefficients and adult male usage parameters. Beginning in 2012, SRS now uses the representative person concept for dose compliance.

1.1 Representative Person

DOE Order 458.1 defines the representative person as an individual receiving a dose that is representative of the more highly exposed individuals in the population. This term is equivalent to and replaces the "average member of the critical group." However, in the *International Commission on Radiological Protection* (ICRP) *Report 101* (ICRP 2006), the definition is extended to include the average value for the more highly exposed group or the 95th percentile of appropriate national or regional data. At SRS, the representative person who is at the 95th percentile of national usage data is now used as a replacement for the MEI. SRS believes the representative person concept is superior to the MEI concept for dose calculations because it includes all members of the population receiving dose as opposed to only adult males (as is the case for the MEI concept).

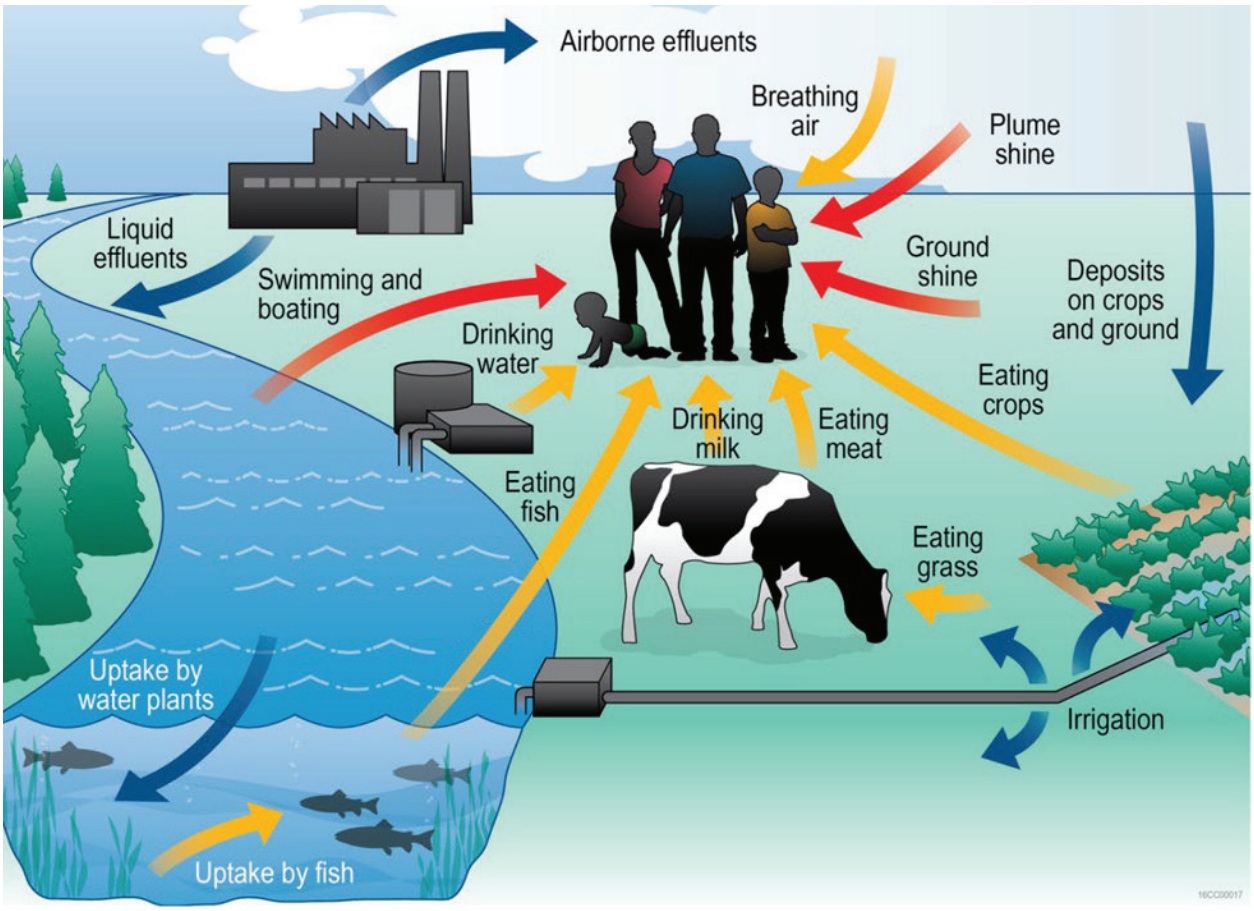


Figure 1-1. Exposure Pathways to Humans from Atmospheric and Liquid Effluents

The representative person dose is based on a reference person using exposure parameters (at the 95th percentile of national and regional data) developed specifically for SRS. The reference person is a hypothetical person with average physical and physiological characteristics— including factors such as age and gender—used internationally to standardize radiation dose calculations. The reference person is weighted, based on sex and age, and this weighting is based on the six age groups documented in ICRP Report 89 (ICRP 2002): infant (0 years), 1 year, 5 years, 10 years, 15 years, and adult. The Environmental Protection Agency (EPA) (2011) proportioned the various age- and gender-specific intake rates to correspond with these respective age groupings. The SRS-specific reference person usage parameters were developed using methods described in Stone and Jannik (2013) and are provided in Table 1-1. The applicable national and regional data used are from the EPA *Exposure Factors Handbook (Final Report)* (EPA 2011) and recently updated chapters (EPA 2018, 2019). SRS also developed reference usage parameters at the 50th percentile to calculate dose to a "typical" person for determining collective (population) doses.

The Land and Water Use Characteristics and Human Health Input Parameters for use in Environmental Dosimetry and Risk Assessments at the Savannah River Site (Stagich 2021) documents all other applicable land- and water- use parameters used in the dose calculations. These parameters include local characteristics of food production, river recreational activities, and other human usage parameters required in the SRS dosimetry models. In addition, SRS documents the preferred elemental bioaccumulation and transfer factors to be used in human health exposure calculations in this land and water report. Data Table A-1 and Data Table A-2 provide a summary of the site-specific input parameters that are the most important to the dose calculations for the liquid and airborne pathways, respectively.

Table 1-1. SRS Representative and Typical Person Usage Parameters

	Unit	Representative Person	Typical Person
Air	m^3/y	6,400	5,000[a]
Water	L/y	920	330[b]
Meat	kg/y	90	35[c]
Leafy Vegetables	kg/y	25	9
Other Produce	kg/y	305	95
Milk/Dairy	L/y	270	73
Freshwater Fish	kg/y	24	3.7
Saltwater Invertebrate	kg/y	N/A	1.5

a. 1 cubic meter = 1.3 cubic yards
b. 1 liter = 1.06 quarts
c. 1 kilogram = 2.2 pounds

In 2017, SRS made two major changes in the locations of the representative person:

1) For the liquid pathway, the representative person was moved from river mile (RM) 118.8 (near US Hwy 301 bridge) to RM 141.5, which is slightly downriver from the Steel Creek mouth. The historical location at RM 118.8 is downriver of all SRS streams. However, SRS radiological releases into Lower Three Runs are 1) from legacy contamination and not current operations and 2) have remained small for many years. Moving the representative person to near Steel Creek is more conservative because it accounts for less dilution and gives a better indication of the potential dose from fish.
2) For the air pathway, in addition to the offsite representative person living near the Site boundary, SRS also calculated potential dose for an adult worker at the Three Rivers Landfill (TRL) located near B Area. Three Rivers Landfill is located on SRS, but it is accessed directly from public South Carolina Hwy 125 outside of the Site's security perimeter in Aiken County. The workers at Three Rivers Landfill are not Site employees and are now considered members of the public to comply with DOE Order 458.1 and with National Emissions Standards for Hazardous Pollutants Compliance (NESHAP) regulations (EPA 2006). Figure 1-2 shows the SRS representative locations.

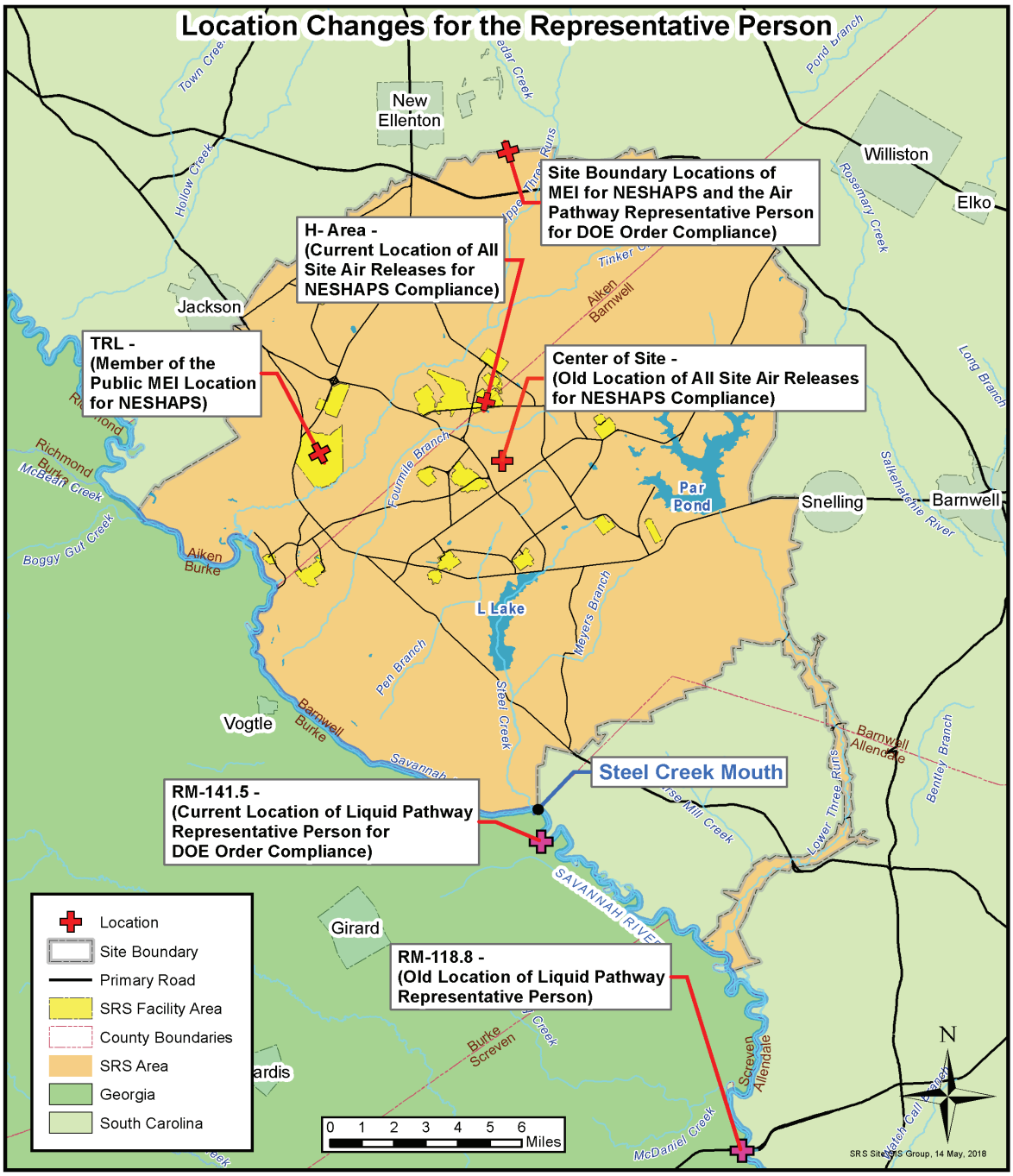


Figure 1-2. Locations of the SRS Representative Persons for Air and Liquid Releases and the MEI Locations for NESHAPS

1.2 Dose Models

SRS calculates the potential offsite doses from SRS effluent releases of radioactive materials (air and liquid) for the following scenarios for DOE public dose compliance:

- Representative person living at the SRS boundary
- Industrial worker at the Three Rivers Landfill located on SRS (near B Area)
- Population living within a 50-mile (80-kilometer [km]) radius of SRS's H-Area

To demonstrate compliance with the DOE Order 458.1 all-pathway dose standard of 100 mrem per year, SRS conservatively combines the air pathway and liquid pathway dose estimates, even though the two doses are calculated for hypothetical individuals residing at different geographic locations (Figure 1-2).

For SRS dose calculations, unspecified alpha releases were treated as plutonium-239, and unspecified beta releases as strontium-90. These radionuclides have the highest dose factors of the alpha- and beta-emitters, respectively, commonly measured in SRS waste streams.

SRS has assessed the potential effects of routine radioactive releases annually since operations began and, since 1972, has published annual offsite dose estimates in Site environmental reports made available to the public. For all routine environmental dose calculations performed since 1978, SRS has used environmental transport models based on the Nuclear Regulatory Commission (NRC) developed codes (NRC 1977). The NRC-based transport models use DOE accepted methods, consider all significant exposure pathways, and permit detailed analysis of the effects of routine operations.

For showing compliance with DOE Order 458.1 at SRS, the MAXDOSE-SR and POPDOSE-SR codes are used for air releases (representative person and population, respectively) and LADTAP XL© is used for liquid releases. The *SRS Environmental Dose Assessment Manual* (SRNL 2023) describes these models.

To demonstrate compliance with EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations (EPA 2006), SRS calculated the MEI and collective doses using 1) the CAP88 PC version 4.1.0.2 computer code, 2) the 2022 airborne-release source term (Data Table A-23), and 3) site-specific input parameters (Data Table A-24). The EPA requires the use of the MEI concept and does not allow use of the representative person concept at this time. The SRS MEI locations for NESHAPS are shown in Figure 1-2.

The EPA hard codes most of the input parameters in the CAP88 PC program, and they cannot be changed without EPA approval. SRS uses the version of CAP88-PC (v.4.1.0.2) that became available from EPA in January 2020 (Stagich 2020). CAP88-PC v.4.1.0.2 includes improvements to the user interface and system capabilities. Additionally, EPA updated the radionuclide physical data, dose factors, risk factors and decay chain information from the DCFPAK Version 2.2. to the DCFPAK 3.02, both provided by Oak Ridge National Laboratory (Eckerman and Leggett 2013).

CAP88-PC allows up to six different stack heights per release. For the stack height inputs at SRS, the reference heights related to operational stack heights in the tritium production facilities located in H Area were used; 0m, 15m, 21m, 31m, 56m, 59m. If there were emissions from other areas on site at a stack height not in the six previously listed, the stack height was defaulted to the shorter stack height, as shorter stack heights produce a higher estimated dose (Minter et al. 2018).

1.3 Dose Coefficients

From 1988 through 2009, SRS used the internal and external dose conversion factors provided in DOE (1988). In 2010, the internal dose conversion factors were updated to use the dose factors from ICRP Publication 72 (ICRP 1996), and the external dose conversion factors were updated to the dose factors provided in *Federal Guidance Report 12* (FGR) (EPA 1993). In 2012, SRS changed to the reference person concept and started using the (gender- and age-averaged) ingestion and inhalation dose coefficients documented in *DOE Derived Concentration Technical Standard*, DOE-STD-1196-2011 (DOE 2011). In 2019, SRS started using the external dose factors from FGR 15 (EPA 2019). FGR 15 is a revision to FGR 12 that incorporates age-specific external dose coefficients. SRS used the age-specific values to develop "reference person" external dose coefficients in a method similar to that documented in DOE (2011). The SRS report *Updated External Exposure Dose Coefficients,* SRNL-L3200-2020-00014 (Laird and Jannik 2020) documents the external dose coefficients used.

For 2022, the dose to a representative person is based on: 1) the SRS-specific reference person usage parameters at the 95th percentile of appropriate national or regional data based on Stone and Jannik (2013), 2) the reference person (gender- and age-averaged) ingestion and inhalation dose coefficients documented in *DOE Derived Concentration Technical Standard*, DOE-STD-1196-2021 (DOE 2021), and 3) the external dose coefficients derived from *Federal Guidance Report 15* (EPA 2019).

1.4 Meteorological Database

SRS calculated the potential offsite doses from radiological releases to the air with quality-assured meteorological data for A-Area, K-Area (for combined releases from C-Area, K-Area, and L-Area), and H-Area (for combined releases from all other areas) for DOE compliance. To show compliance with NESHAP regulations (EPA 2006), only the H-Area meteorological database was used in the calculations, because the EPA-required dosimetry code (CAP88 PC version 4.1.0.2) is limited to a single release location.

The current five-year meteorological datasets used in dose calculations cover the period 2014 through 2018 (Bell 2020). These datasets differ from previous five-year datasets in that they now 1) estimate atmospheric stability using the standard deviation of the vertical wind velocity and 2) use an updated surface roughness factor for SRS. Data Table A-3 shows the 2014-2018 meteorological database for H-Area. Figure 1-3 is the H-Area wind rose for 2014-2018, with the directions shown being those toward which the wind blows. As shown, the wind blows towards the East-Northeast the highest percentage of time (about 10%).

1.5 Population Database and Distribution

SRS calculates the collective (population) doses from air releases for the population within a 50-mile radius of H-Area, which is the location of most of the Site's radiological releases. Based on the U.S. Census Bureau's 2020 data, the population within a 50-mile radius of H-Area is 838,833 people. This translates to an average population density of about 107 people per square mile outside the SRS boundary, with the largest concentration in the Augusta metropolitan area. Data Table A-4 show the population distribution around H-Area.

SRS also calculates the collective doses resulting from SRS liquid releases for the populations served by the City of Savannah Industrial and Domestic Water Supply Plant (City of Savannah I&D), near Port Wentworth, Georgia, and for the Beaufort-Jasper Water and Sewer Authority's (BJWSA) Chelsea and Purrysburg Water Treatment Plants, both near Beaufort, South Carolina. According to the treatment plant operators, the population served by the City of Savannah I&D facility during 2022 was 37,637 people while the BJWSA Chelsea facility served 107,000 people and the BJWSA Purrysburg facility served 83,000 people. The total population dose resulting from routine SRS liquid releases is the sum of five contributing categories: 1) BJWSA water consumers, 2) City of Savannah I&D water consumers, 3) consumption of fish and invertebrates of Savannah River origin, 4) recreational activities on the Savannah River, and 5) irrigation of foodstuffs using river water near River Mile (RM) 141.5 (Down river near the Steel Creek mouth).

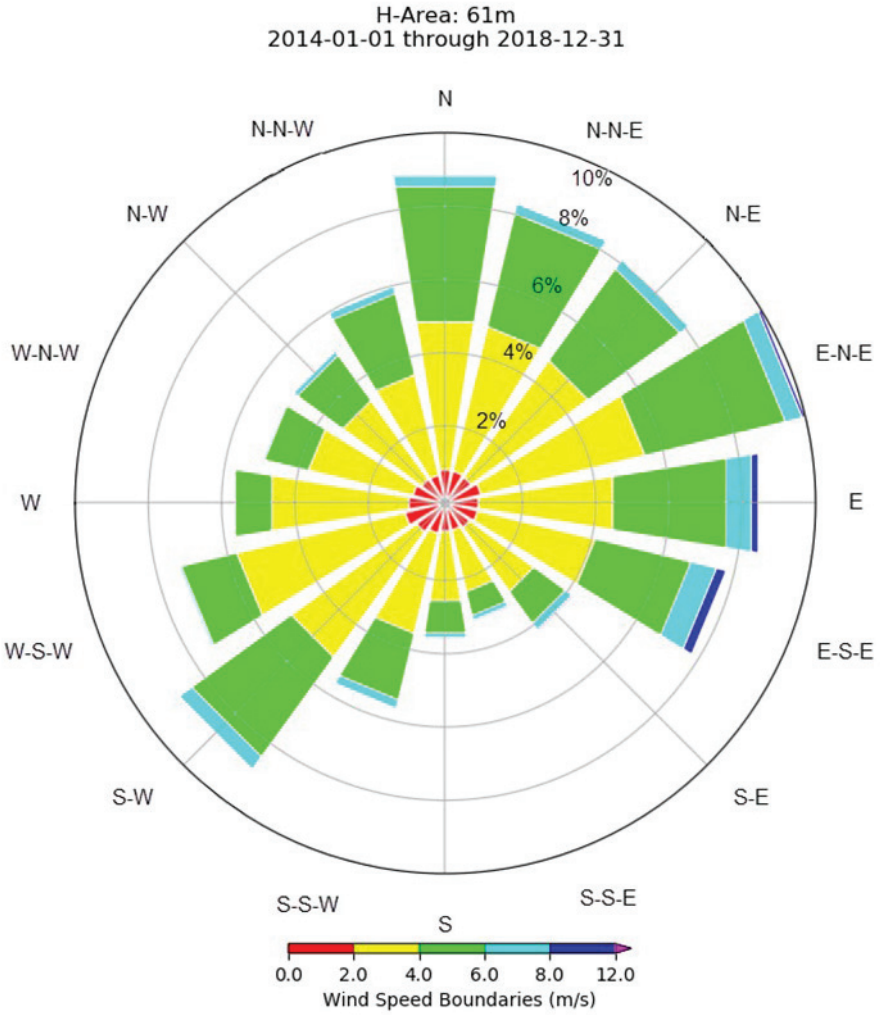


Figure 1-3. 2014-2018 Wind Rose for H-Area (Direction is toward which the wind blows)

1.6 Savannah River Flow Rate Data

SRS determines the Savannah River annual average flow rates using the recorded water elevation at a U.S. Geological Survey (USGS) gauging station #02197500, near RM 118.8. Data Table A-5 provides river flow rates measured at this location from 1954 through 2022. Figure 1-4 shows that the average river flow rate for these years is about 10,013 cubic feet per second (cfs). Apart from 2020, there has been a downward trend in these data, with an average measured flow rate of 9,321 cfs during the past 10 years.

The SRS liquid dose calculations typically do not use these data. Instead, SRS uses an "effective" flow rate based on 1) the measured annual release of tritium and 2) the annual average tritium concentrations measured from RM 141.5 and from the downriver water treatment plants. Data Table A-6 provides the effective river flow rate calculations.

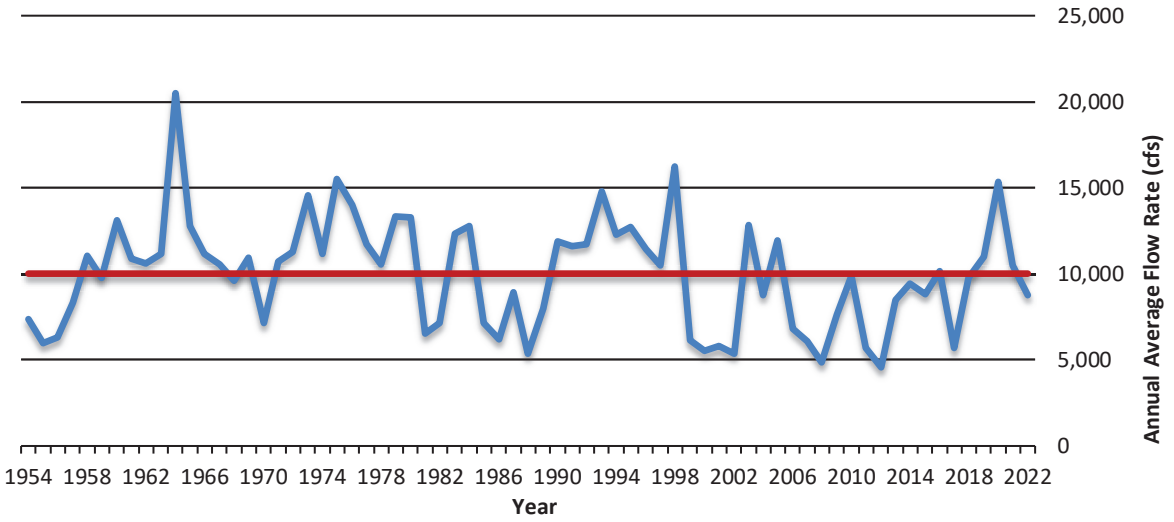


Figure 1-4. Savannah River Annual Average Flow Rates at River Mile 118.8

The effective flow rates used in the dose calculations are usually more conservative (that is, lead to higher dose estimates) than the measured flow rates because it accounts for less dilution. However, if SRS calculates an effective flow that is more than the measured value at RM 118.8, then the measured value is used.

For 2022, SRS used an effective Savannah River flow rate of 7,230 cfs in the dose calculations. The 2022 effective flow rate is 14% less than the 2021 effective flow rate of 8,456 cfs. This estimated flow rate (based on actual measured tritium concentrations in the river) is more conservative than the 2022 USGS measured flow rate (at RM 118.8) of 8,773 cfs.

2.0 Dose Calculation Results

2.1 Liquid Pathway Doses

No known large-scale uses of Savannah River water downstream of SRS exist for agricultural irrigation purposes. However, the potential for agricultural irrigation does exist, especially for individual garden use. Therefore, the totals for the SRS representative person and collective dose include doses from the irrigation pathway.

2.1.1 Liquid Release Source Terms

Table 2-1 shows, by radionuclide, the 2022 radioactive liquid release quantities used as the source term in SRS dose calculations and Data Table A-7 shows these liquid releases by Site stream. Data Table A-8 provides a five-year history of SRS liquid radioactive releases.

Tritium accounts for more than 99% of the total amount of radioactivity the Site released to the Savannah River. In 2022, SRS released a total of 348 curies of tritium to the river, a 28% decrease from the 2021 amount of 483 curies.

In 2022, the Georgia Power Company's Vogtle Electric Generating Plant (VEGP) released 1,430 curies of tritium to the Savannah River and 13.2 curies migrated from the Barnwell Low-Level Disposal Facility (BLLDF) for an overall total of 1,556 curies of tritium (SRS plus VEGP plus BLLDF). This is a 19% decrease from the combined total of 1,918 curies in 2021.

2.1.2 Radionuclide Concentrations in Savannah River Water, Drinking Water, and Fish

At several locations along the Savannah River, SRS measures the tritium concentrations in the river water and cesium-137 in fish. SRS uses these measurements to make dose determinations. The amounts of all other radionuclides released from SRS are so small that their concentration in the Savannah River usually cannot be detected using conventional analytical techniques. SRS calculates concentrations in the river based on the annual release amounts and river flow rates using the LADTAP XL code, version 2022 (Peyton and Stagich 2022).

2.1.2.1 Radionuclide Concentrations in River Water and Treated Drinking Water

Table 2-1 shows the measured tritium concentrations in the Savannah River near RM 141.5 and at the BJWSA Purrysburg Water Treatment Facility, which is representative of the BJWSA Chelsea and the City of Savannah I&D water treatment plants. These downriver tritium concentrations include tritium releases from SRS, VEGP, and BLLDF. Table 2-1 also provides the calculated concentrations for the other released radionuclides and a comparison of these concentrations to the Safe Drinking Water Act, 40 CFR 141 (EPA 2000) maximum contaminant level (MCL) for each radionuclide.

In 2022, the 12-month average tritium concentration measured in Savannah River water near RM 141.5 was 241 picocuries per liter (pCi/L). This reflects a 5% decrease from the 254 pCi/L measured in 2021. SRS attributes this decrease to the 19% decrease in the combined (SRS plus VEGP plus BLLDF) total of tritium released to the Savannah River in 2022.

Table 2-1 indicates that all individual radionuclide concentrations at the three downriver community drinking water systems, as well as at RM 141.5, were below the EPA MCLs. Because SRS releases more than one radionuclide, the sum-of-the-fractions of the reported concentration of each radionuclide divided by its corresponding MCL must not exceed 1.0. As Data Table A-9 shows, the sum-of-the-fractions for the water treatment plants (determined at the BJWSA Purrysburg plant) was 0.0130, which is below the 1.0 sum-of-the-fractions requirement.

2.1.2.2 Radionuclide Concentrations in Fish

At SRS, an important dose pathway for the representative person is from the consumption of fish. Fish exhibit a high degree of bioaccumulation for certain elements. For cesium (including radioactive isotopes of cesium, such as cesium-137), the bioaccumulation factor for Savannah River fish is 3,000, meaning that the concentration of cesium in fish flesh is about 3,000 times the concentration of cesium found in the water in which the fish live (Carlton et al. 1994).

Because of this high bioaccumulation factor, SRS can detect cesium-137 more easily in fish flesh than in river water. Therefore, when conservative to do so, SRS will base the fish pathway dose from cesium-137 directly on the analysis of the fish collected near RM 141.5, the assumed location of the hypothetical representative person. As shown in Data Table A-10, the 2022 cesium-137 release value of 0.191 Ci is based on analysis of fish in the river.

Table 2-1. 2022 Radioactive Liquid Releases and 12-Month Average Downriver Radionuclide Concentrations Compared to the EPA's Drinking Water Maximum Contaminant Levels (MCL)

Nuclide	Curies Released	12-Month Average Concentration (pCi/L)		
		Below SRS[a]	at BJWSA Purrysburg Plant[b]	EPA MCL[c]
H-3[d]	1.56E+03	2.41E+02	1.65E+02	2.00E+04
C-14	7.09E-03	1.10E-03	7.51E-04	2.00E+03
Sr-90	1.63E-02	2.52E-03	1.72E-03	8.00E+00
Tc-99	1.22E-02	1.89E-03	1.29E-03	9.00E+02
I-129	1.30E-02	2.02E-03	1.38E-03	1.00E+00
Cs-137	1.91E-01	2.95E-02	2.02E-02	2.00E+02
Eu-154	6.35E-02	9.83E-03	6.73E-03	6.00E+01
U-234	6.35E-02	9.83E-03	6.73E-03	1.03E+01
U-235	3.73E-03	5.78E-04	3.96E-04	4.67E-01
U-238	7.20E-02	1.11E-02	7.63E-03	1.00E+01
Np-237	9.07E-05	1.40E-05	9.61E-06	1.50E+01
Pu-238	2.53E-04	3.92E-05	2.68E-05	1.50E+01
Pu-239	2.72E-05	4.21E-06	2.88E-06	1.50E+01
Am-241	2.60E-05	4.02E-06	2.76E-06	1.50E+01
Cm-244	1.02E-05	1.58E-06	1.08E-06	1.50E+01
Alpha	1.04E-02	1.61E-03	1.10E-03	1.50E+01
Beta	4.39E-02	6.79E-03	4.65E-03	8.00E+00

a. Near Savannah River Mile 141.5, downriver of SRS
b. Beaufort-Jasper Water and Sewer Authority, drinking water at the Purrysburg Plant
c. MCLs for uranium based on radioisotope specific activity X 30 µg/L X isotopic abundance
d. The tritium concentrations and source term are based on actual measurements of the Savannah River water at the various locations. They include contributions from VEGP and Barnwell Low-Level Disposal Facility. All other radionuclide concentrations are calculated based on the effective or measured river flow rate.

2.1.2.3 Dose to the Representative Person

Data Table A-11 shows the 2022 dose to the representative person from all liquid pathways, including irrigation, was estimated at 0.17 mrem (0.0017 mSv), which is a 39% decrease from the 0.28 mrem dose in 2021. Table 2-2 shows that this total dose is 0.17% of the all-pathway public dose standard of 100 mrem/yr (1 mSv/yr).

Table 2-2. Potential Dose to the Representative Person from SRS Liquid Releases in 2022

	Committed Dose (mrem)	Applicable Standard (mrem)	Percent of Standard (%)
Near Site Boundary (All Liquid Pathways)			
All Liquid Pathways Except Irrigation	0.12		
Irrigation Pathways	0.048		
Total Liquid Pathways	0.17	100[a]	0.17

a. All-pathway dose standard: 100 mrem/yr (DOE Order 458.1)

About 28% of the 2022 all liquid pathways total dose to the representative person resulted from the irrigation pathway (Data Table A-11). This pathway is based on the ingestion of meat, milk, and vegetables that have been exposed to irrigation water from the Savannah River. The fish consumption pathway, based on concentrations in fish from Steel Creek, accounted for 64% and the drinking water pathway accounted

for 6%. Figure 2-1 shows, cesium-137 (70%), nonvolatile beta (6%), uranium-234 (5%) and uranium-238 (5%) were the major contributors to the total dose. Data Table A-12 provides a five-year history of SRS liquid pathway doses.

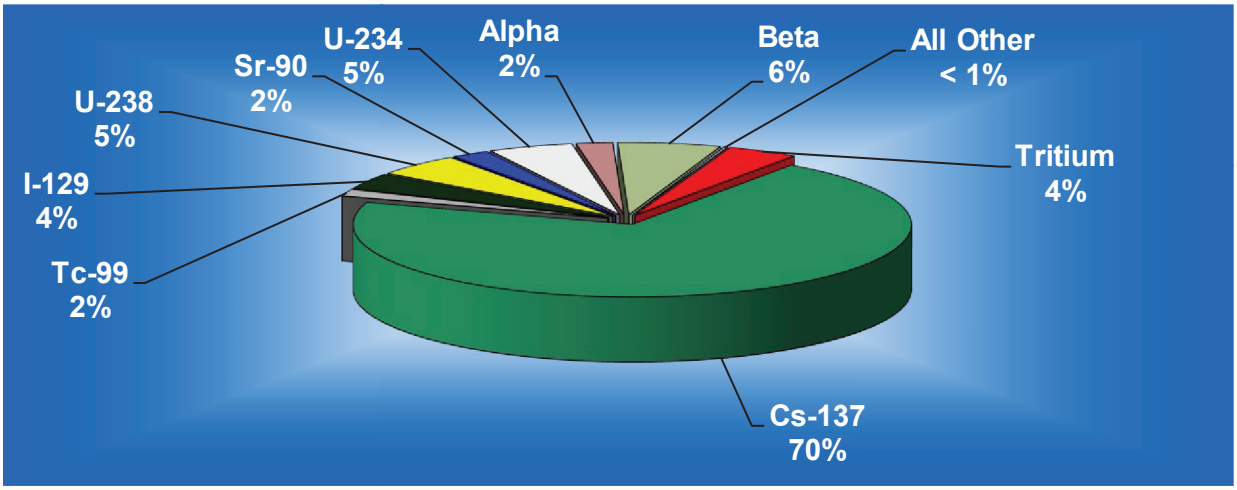


Figure 2-1. Radionuclide Contributions to the 2022 SRS Representative Person Total Liquid Pathway Dose of 0.17 mrem (0.0017 mSv)

2.1.2.4 Drinking Water Pathway Dose

People living downriver of SRS may receive some dose by consuming drinking water that contains radioactive releases from the Site and from VEGP and BLLDF. In 2022, SRS estimated the maximum potential drinking water dose from all sources to be 0.024 mrem (0.00024 mSv). Tritium in downriver drinking water represented the highest percentage of the dose (about 71%) to customers of the three downriver water treatment plants.

Data Table A-13 shows the 2022 SRS-only releases were responsible for a maximum potential drinking water dose of 0.011 mrem (0.00011 mSv). This dose is 10% more than the 2021 dose of 0.010 mrem (0.00010 mSv). SRS attributes this increase to increases in cesium-137, strontium-90, uranium-234, and uranium-238 liquid releases during 2022. DOE and EPA do not have a specific regulatory drinking water dose standard, but the EPA MCLs, defined in 40 CFR 141 (EPA 2000), assume a potential dose of 4 mrem/yr for beta and gamma emitters. The 2022 maximum drinking water dose of 0.011 mrem is well below this value.

2.1.2.5 Collective (Population) Dose

SRS calculates the collective drinking water consumption dose for the separate population groups that the BJWSA and City of Savannah I&D water treatment plants serve (Data Table A-14).

Calculations of collective doses from agricultural irrigation assume that 1,000 acres of land are used for each of the major food types grown in the SRS area (vegetables, milk, and meat) with the population within 50 miles of SRS consuming all the food produced on these 1,000-acre parcels. Historically, SRS limited the food consumption pathway dose to the smaller of 1) the total foodstuffs actually produced in the SRS 50-mile radius or 2) the total foodstuffs produced on the 1,000-acre parcels (based on regional productivity rates) (Stagich 2021). The total amount of foodstuff produced in the SRS area (which is difficult to determine because of under reporting by small farms and individual gardens) has typically been less than the amount produced on 1,000-acre parcels. Beginning in 2016, SRS now conservatively uses only the amount produced on the 1,000-acre irrigated parcels for collective dose estimates.

In 2022, the collective dose from all liquid pathways was 2.0 person-rem (0.020 person-Sv) (Data Table A-15). Person-rem is calculated as the dose to a "typical" person multiplied by the number of people exposed. This is a 39% decrease from the comparable 2021 collective dose of 3.3 person-rem (0.033 person-Sv). DOE Order 458.1 requires that a collective dose be calculated and reported, but there is not a separate collective dose standard for comparison.

2.2 Air Pathway Doses

2.2.1 Atmospheric Source Terms

Data Table A-16 documents the 2022 SRS radiological air releases by Site area. Data Table A-17 provides a five-year history of SRS atmospheric releases, and it shows that tritium oxide releases, which account for a majority of the offsite doses, decreased about 14% from 2021 to 2022. Estimates of unmonitored diffuse and fugitive sources were included in the atmospheric source term, as required for demonstrating compliance with EPA regulations.

2.2.2 Atmospheric Concentrations

For dose determinations, SRS uses calculated radionuclide concentrations from standard modeling of measured effluent releases instead of measured concentrations in the air surveillance samples. This is because most radionuclides SRS released in 2022 were not detected (using conventional analytical methods) in the air samples collected at the Site perimeter and offsite locations. The exception to this is tritium oxide, which can be measured at the site perimeter locations. Therefore, to confirm the dose models, SRS compares the measured concentrations of tritium oxide with the calculated concentrations from CAP88 PC and MAXDOSE. In Data Table A-18, this comparison showed that in 2022 the dose models used at SRS were about 2 times more conservative than the measured tritium oxide concentrations.

2.2.3 Dose to the Representative Person

As shown in Data Table A-19a, the 2022 estimated dose from air releases to the representative person was 0.016 mrem (0.00016 mSv), 0.16% of the DOE Order 458.1 air pathway standard of 10 mrem per year.

Table 2-3 compares the representative person dose with the DOE standard. The 2022 dose was about 6% less than the 2021 dose of 0.017 mrem (0.00017 mSv). SRS attributes most of this decrease to the decrease in tritium oxide releases during 2022.

In 2017, SRS began to calculate the potential dose for an adult worker at the Three Rivers Landfill near B Area. As shown in Figure 1-2, Three Rivers Landfill is located on SRS, but it is accessed directly from public Hwy 125 outside of the Site's security perimeter. The workers at Three Rivers Landfill are not Site employees and are now considered members of the public to comply with DOE Order 458.1.

For this assessment, SRS assumed that an adult person worked at Three Rivers Landfill for 2000 hours during the year (8 hours/day, 5 days/week, 50 weeks/year). SRS also assumed that this worker was only exposed from the inhalation and external-exposure pathways. No locally grown food consumption was considered at this industrial location.

For 2022, SRS calculated a potential dose to a Three Rivers Landfill worker of 0.011 mrem (0.00011 mSv). This dose is less than the representative person dose of 0.016 mrem that was reported for DOE Order 458.1 compliance. Data Table A-19b shows the results of these calculations.

Table 2-3. Potential Doses to the Representative Person and to the NESHAP MEI from SRS Atmospheric Releases in 2022 and Comparison to the Applicable Dose Standard

	MAXDOSE-SR Site Boundary DOE 458.1	CAP88-PC (EPA NESHAP) Site Boundary	CAP88-PC (EPA NESHAP) TRL Worker
Calculated dose (mrem)	0.016	0.029	0.031
Applicable Standard (mrem)	10[a]	10[b]	10[a]
Percent of Standard (%)	0.16	0.29	0.31

a. DOE: DOE Order 458.1
b. EPA: (NESHAP) 40 CFR 61, Subpart H

As shown in Figure 2-2, tritium oxide releases accounted for nearly 71% of the dose to the representative person. Iodine-129 contributed 14% to the dose while krypton-85 and cesium-137 contributed 4% and 7%, respectively. Strontium-90 contributed about 2% with Plutonium-239 contributing 1% to the dose. No other individual radionuclide accounted for more than 1% of the representative person dose. Data Table A-19a shows that the major pathways through which a representative person received radioactivity from atmospheric releases were vegetable consumption (35%), inhalation (32%), and cow milk consumption (21%). As shown in Data Table A-20 and in Figure 2-3, the due north sector (0.0162 mrem) of the Site was slightly higher than the north-northwest sector (0.0153 mrem) making it the location of the highest dose to the representative person.

Because of the potential in the SRS vicinity for the consumption of goat milk, additional calculations of the dose to the representative person were performed substituting goat milk for the customary cow milk pathway. As shown in Data Table A-21, SRS estimated that the potential dose to the representative person using the goat milk pathway is 0.018 mrem (0.00018 mSv). SRS provides this dose for reference only.

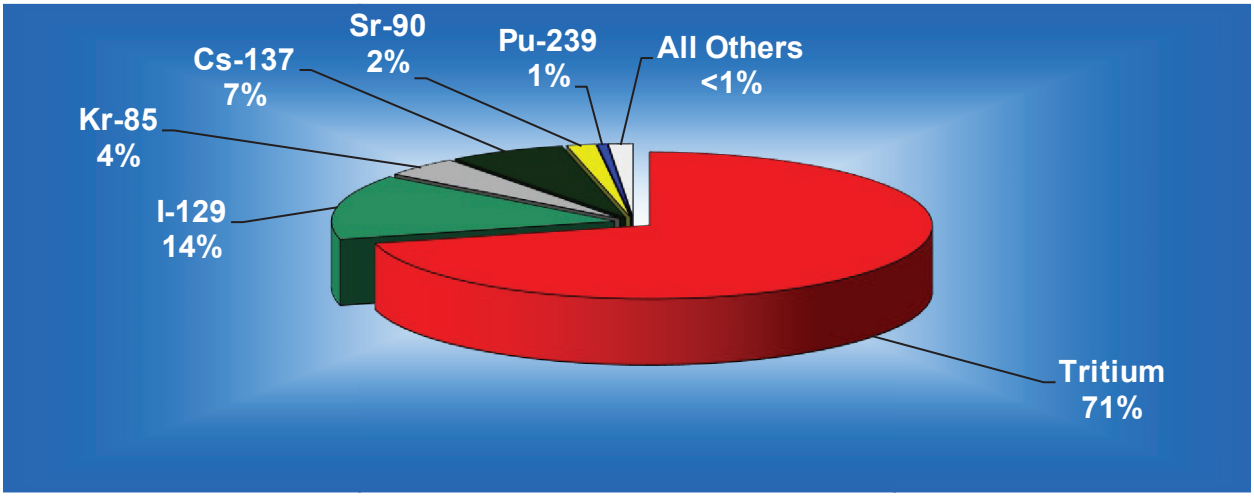


Figure 2-2. Radionuclide Contributions to the 2022 SRS Air Pathway Dose of 0.016 mrem (0.00016 mSv)

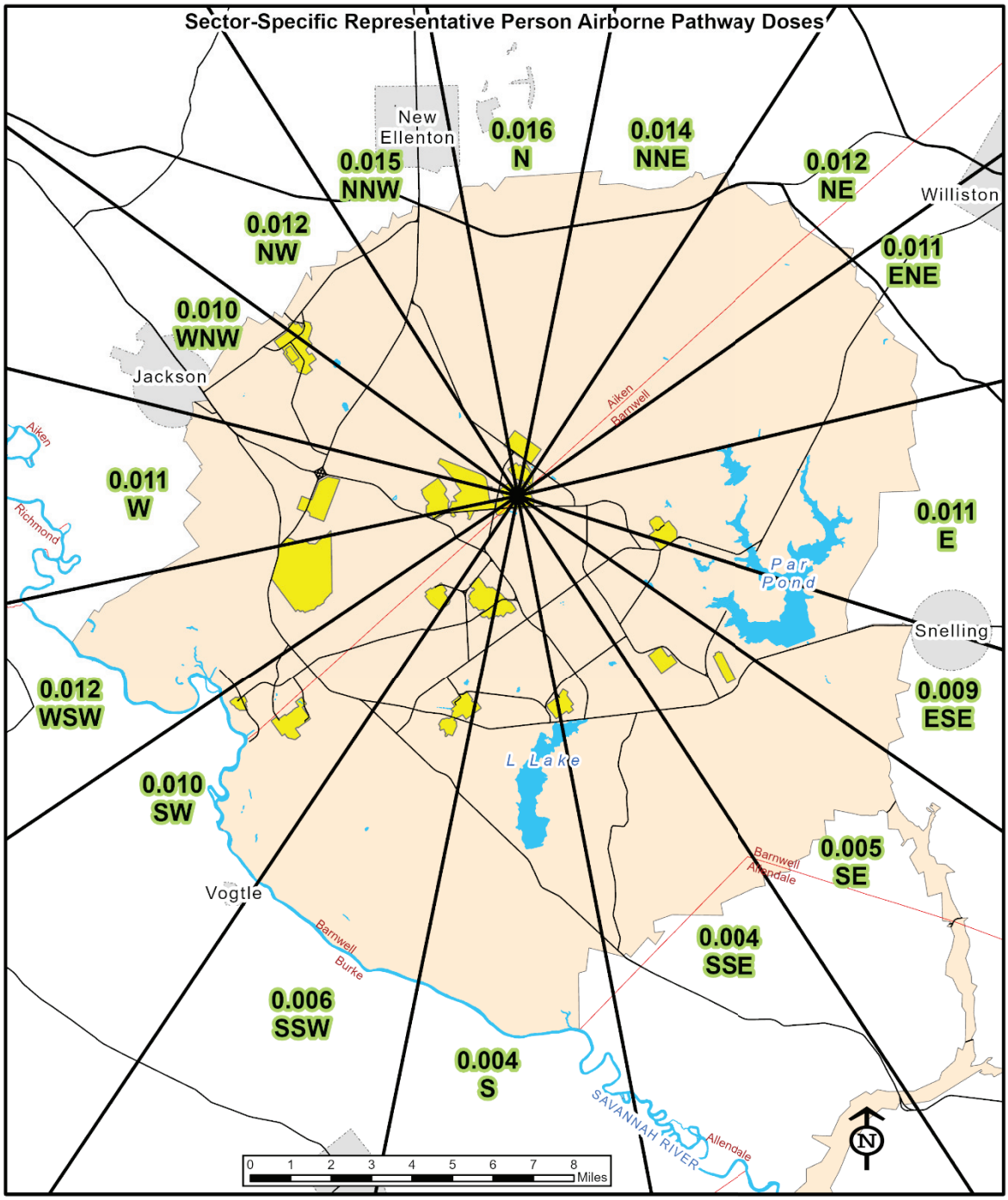


Figure 2-3. Sector-specific Representative Person Site Boundary Doses

2.2.4 Collective (Population) Dose

SRS calculates the air-pathway collective dose for the entire (838,833 people) population living within 50 miles of SRS's H-Area. Data Table A-4 shows the population distribution around H-Area.

In 2022, SRS estimated the air-pathway collective dose at 0.74 person-rem (0.0074 person-Sv), which is less than 0.01% of the annual collective dose from natural sources of radiation (about 234,000 person-rem).

Data Table A-22 shows the 2022 air-pathway collective doses by radionuclide and pathway. Tritium oxide releases accounted for 72% of the collective dose.

2.2.5 National Emission Standards for Hazardous Air Pollutants (NESHAP) Compliance

2.2.5.1 Maximally Exposed Individual Dose

To demonstrate compliance with NESHAP regulations (EPA 2006), SRS calculated MEI and collective doses using 1) CAP88 PC version 4.1.0.2 computer code, 2) the 2022 air-release source term shown in Data Table A-23, and 3) Site-specific input parameters shown in Data Table A-24. The EPA requires the use of the MEI concept and does not allow use of the representative person concept. The EPA specifies most of the input parameters in the CAP88 PC program; they cannot be changed without specific EPA approval.

For 2022, SRS used CAP88 PC (version 4.1.0.2, dated January 2020) to demonstrate compliance with the EPA's 10 mrem/yr (0.1 mSv/yr) public dose standard for airborne emissions from DOE sites. For 2022, the Site boundary MEI dose (Data Table A-25a) was estimated at 0.0292 mrem (0.000292 mSv), or 0.29% of the 10-mrem/yr EPA standard, as shown in Table 2-3.

SRS estimated the MEI dose for the Three Rivers Landfill worker (Data Table A-25b) to be 0.0307 mrem (0.000307 mSv). For 2022, SRS reported the slightly higher TRL worker dose of 0.0307 mrem for NESHAP compliance. This dose is 0.31% of the 10-mrem/yr EPA standard, as Table 2-3 shows.

Data Table A-25a shows tritium oxide releases accounted for about 42% of the MEI dose and elemental tritium accounted for 20%. The CAP88 PC model very conservatively treats elemental tritium the same as tritium oxide. The 2022 NESHAP compliance dose (TRL dose) was about 54% more than the 2021 dose of 0.0199 mrem (0.000199 mSv). NESHAP regulations require separate dose reporting from diffuse and fugitive releases. Data Table A-26a shows the MEI dose for the TRL worker from diffuse and fugitive releases was about 0.00164 mrem (0.0000164 mSv). The diffuse and fugitive releases account for about 5% of the total 2022 MEI dose. Data Table A-26b provides the MEI dose and the TRL Worker location from diffuse and fugitive releases.

2.2.5.2 Collective Dose

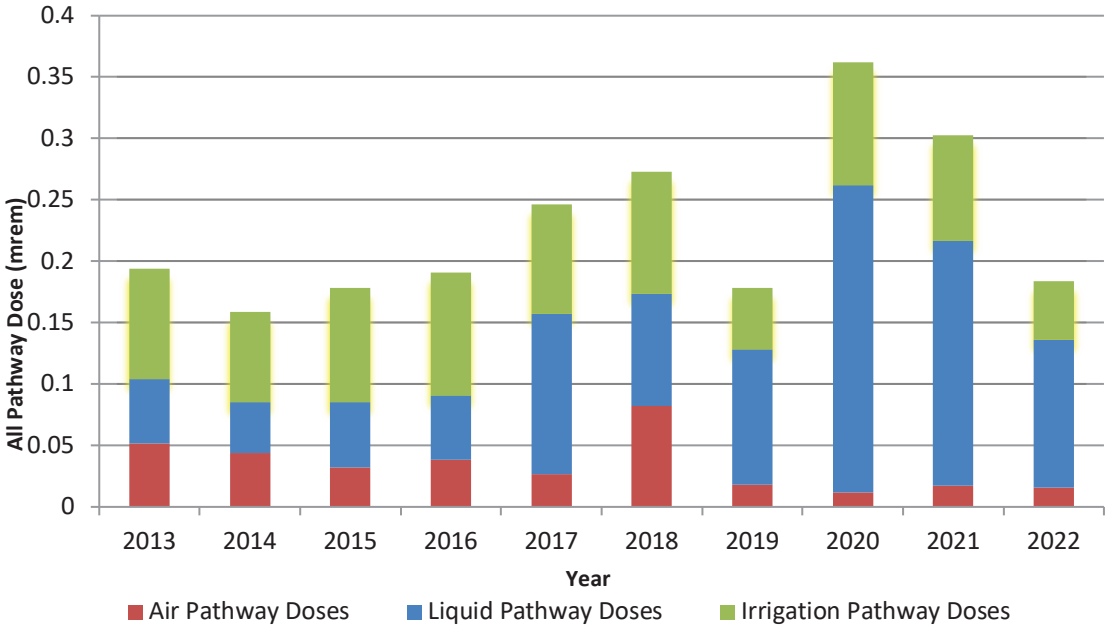
The CAP88 PC-determined collective (population) dose for 2022 was estimated at 2.5 person-rem (0.025 person-Sv), which is 32% more than the 2021 collective dose of 1.9 person-rem (0.019 person-Sv). Tritium releases accounted for 72% of the NESHAP collective dose.

For the population dose (Data Table A-28), the CAP88 PC version 4.1.0.2 estimates a higher dose compared to POPDOSE-SR, mainly because 1) it assumes the general population has the same inhalation and consumption rates as the MEI, and 2) it assumes a one-to-one ratio between tritium oxide in air and tritium oxide in plant leaves (whereas POPDOSE-SR assumes a 50% ratio).

2.3 All-Pathway Dose

As stated in DOE Order 458.1, the all-pathway dose standard is 100 mrem/yr. SRS ensures a conservative estimate by combining the representative person airborne pathway and liquid pathway dose estimates, even though the two estimated doses are for hypothetical individuals residing at different geographic locations (Figure 1-2).

For 2022, the potential representative person all-pathway dose was 0.18 mrem (0.0018 mSv), calculated as 0.016 mrem from air pathways plus 0.17 mrem from liquid pathways. The all-pathway dose is 0.18% of the 100 mrem/yr (1 mSv/yr) DOE dose standard. The 2022 all-pathway dose is about 39% less than the 2021 total dose of 0.30 mrem (0.0030 mSv). Data Table A-12 provides a five-year history of the SRS all-pathway doses. Figure 2-4 shows a 10-year history of SRS's all-pathway (airborne, liquid, and irrigation pathways) doses to the MEI/representative person.



1. Beginning in 2011, the irrigation pathway dose is included in the liquid pathway dose. Previous years do not include the irrigation pathway dose.
2. Beginning in 2012, SRS began using the representative person dose instead of the MEI dose.

Figure 2-4. Ten-Year History of SRS Maximum Potential All-Pathway Dose

2.4 Sportsman Dose

DOE Order 458.1 specifies radiation dose standards for individual members of the public. The dose standard of 100 mrem/yr includes the dose a person receives from routine DOE operations through all exposure pathways. Additionally, SRS considers and quantifies unique exposure pathways that are not included in the standard calculations of the doses to the representative person. This is because they apply to unlikely scenarios, such as eating fish caught only from the mouths of SRS streams ("creek-mouth fish"), or to special scenarios, such as onsite volunteer hunters.

In addition to deer, hog, fish, and turkey consumption, SRS considered the following exposure pathways for an offsite hunter and an offsite fisherman on Creek Plantation, a privately-owned portion of the Savannah River Swamp.

- External exposure to contaminated soil,
- Incidental ingestion of contaminated soil, and
- Incidental inhalation of renewed suspension of contaminated soil.

2.4.1 Onsite Hunter Dose

2.4.1.1 Deer and Hog Consumption Pathway

SRS holds annual hunts for the public to control the Site's deer and wild pig populations and to reduce animal-vehicle accidents. The estimated dose from consuming harvested deer or hog meat is determined for every onsite hunter. During 2022, the maximum potential dose an onsite hunter received was 8.76 mrem (0.0876 mSv), or 8.76% of DOE's 100 mrem/yr dose standard (Table 2-4). This dose is for an actual hunter who harvested one animal (one deer) during the 2022 hunts (Data Table A-29). For the hunter-dose calculation, SRS conservatively assumes that the hunter individually consumed the entire edible portion of these animals, about 23 kilograms (kg) (50 lbs).

2.4.1.2 Turkey Consumption Pathway

SRS typically hosts a special turkey hunt during April for hunters with mobility impairments. Hunters harvested 8 turkeys in 2022. SRS measured all the turkeys for cesium-137. Since none of them measured above background, SRS did not assign a dose to these hunters.

2.4.2 Hypothetical Offsite Hunter Doses

2.4.2.1 Deer and Hog Consumption Pathway

The deer and hog consumption pathways considered were for hypothetical offsite individuals whose entire intake of meat (81 kg) during the year was either deer or hog meat. SRS assumes these individuals harvested deer or hogs that had resided on SRS during the year and then moved offsite prior to hunting season.

Based on these unlikely assumptions and on the measured average concentration of cesium-137 in all deer (1.25 pCi/g) and hogs (1.29 pCi/g) harvested from SRS during 2022, the potential maximum doses from this pathway were estimated at 3.06 mrem (0.0306 mSv) for the offsite deer hunter and 3.22 mrem (0.0322 mSv) for the offsite hog hunter. Data Table A-29 documents these dose calculations.

Beginning in 2013, a background cesium-137 concentration of 0.5 pCi/g is subtracted from the onsite average concentrations, before calculating the offsite hunter doses. The 0.5 pCi/g background concentration is based on the median value determined by South Carolina Department of Health and Environmental Control (SCDHEC) for South Carolina deer, from 2008 through 2012 (SCDHEC 2013).

2.4.2.2 Savannah River Swamp Hunter Soil Exposure Pathway

SRS estimated the potential dose to a recreational hunter exposed to SRS legacy contamination on the privately-owned Creek Plantation. SRS assumes that this recreational sportsman hunted for 120 hours during the year (8 hours per day for 15 days) at the location of maximum radionuclide contamination. Table 2-4 shows the offsite hog consumption pathway 3.22 mrem, and the Savannah River swamp hunter soil exposure pathway 1.86 mrem were conservatively added together to obtain a total offsite hunter dose of 5.08 mrem (0.0508 mSv). This potential dose is 5.1% of the DOE 100 mrem/yr all-pathway dose standard.

2.4.3 Hypothetical Offsite Fisherman Dose and Risk

2.4.3.1 Creek-Mouth Fish Consumption Pathway

For 2022, SRS analyzed four species of fish (panfish, catfish, flathead catfish, and bass) taken from the mouths of four SRS streams. Using these concentrations, SRS estimated the maximum potential dose from fish consumption at 0.565 mrem (0.00565 mSv) from catfish collected at the mouth of Lower Three Runs. SRS bases this hypothetical dose on the low-probability scenario that, during 2022, a fisherman consumed 24 kg (53 lbs) of catfish caught exclusively from the mouth of Lower Three Runs. All this potential dose was from cesium-137. Data Table A-30a and Data Table A-30b, respectively, show the measured concentrations and resulting doses for each location and species combination.

2.4.3.2 Savannah River Swamp Fisherman Soil Exposure Pathway

Using the RESRAD code (Yu et al. 2001), SRS calculated the potential dose to a recreational fisherman exposed to SRS legacy contamination in Savannah River Swamp soil on the privately-owned Creek Plantation. SRS assumes that this recreational sportsman fished on the South Carolina bank of the Savannah River, near the mouth of Steel Creek, for 250 hours during the year.

Using the radionuclide concentrations measured in soil at this location, SRS estimated the potential dose to a fisherman from a combination of 1) external exposure to the contaminated soil, 2) incidental ingestion of the soil, and 3) incidental inhalation of renewed suspension soil to be 2.08 mrem (0.00208 mSv).

Table 2-4 shows how SRS conservatively combined the maximum Steel Creek fish consumption dose (0.57 mrem) and the Savannah River Swamp fisherman soil exposure pathway (2.08 mrem) to obtain a total offsite fisherman dose of 2.65 mrem (0.0265 mSv). This potential dose is 2.7% of the DOE 100 mrem/yr all-pathway dose standard.

2.4.3.3 Potential Risk from Consumption of SRS Creek-Mouth Fish

During 1991 and 1992, in response to a U.S. House of Representatives Appropriations Committee request for a plan to evaluate risk to the public from fish collected from the Savannah River, SRS developed a fish monitoring plan in conjunction with the EPA, the Georgia Department of Natural Resources (GDNR), and SCDHEC. This plan ensures SRS assesses the radiological risk from the consumption of Savannah River fish and requires that SRS present a summary of the results in the SRS Annual Site Environmental Report.

Table 2-4. 2022 Representative Person All-Pathways and Sportsman Doses Compared to the DOE All-Pathways Dose Standard

	Committed Dose (mrem)	Applicable Standard (mrem)[a]	Percent of Standard (%)
Representative Person Dose			
All-Pathways (Liquid Plus Airborne Pathways)	0.18	100	0.18
Sportsman Dose			
Onsite Hunter	8.76	100	8.76
Creek-Mouth Fisherman[b]	0.57	100	0.57
Savannah River Swamp Hunter			
Offsite Hog Consumption	3.22		
Offsite Deer Consumption	3.06		
Soil Exposure[c]	1.86		
Total Offsite Hunter Dose (Hog + Soil Exposure)	5.08	100	5.08
Savannah River Swamp Fisherman			
Steel Creek Fish Consumption	0.57		
Soil Exposure[d]	2.08		
Total Offsite Fisherman Dose (Fish + Soil Exposure)	2.65	100	2.65

a. All-pathway dose standard; 100 mrem/yr (DOE Order 458.1)
b. In 2022, the maximum dose to a hypothetical fisherman resulted from the consumption of catfish from the mouth of Lower Three Runs
c. Includes the dose from a combination of external exposure to and incidental ingestion and inhalation of the worst-case Savannah River swamp soil
d. Includes the dose from a combination of external exposure and incidental ingestion and inhalation of Savannah River swamp soil near the mouth of Steel Creek

2.4.3.4 Risk Comparison

For 2022, SRS compared the maximum potential radiation doses and lifetime fatal and nonfatal cancer risks (from the consumption of SRS creek-mouth fish for 1-year, 30-year, and 50-year exposure durations) to the radiation risks associated with the DOE Order 458.1 all-pathway dose standard of 100 mrem/yr (1.0 mSv/yr) in Table 2-5. SRS estimated the potential risks using the cancer morbidity risk coefficients from Federal Guidance Report No. 13 (EPA 1999). The assumed maximum fish consumption rate is 24 kg per year (Table 1-1).

In 2022, the maximum dose and risk to a hypothetical fisherman resulted from the consumption of catfish from the mouth of Lower Three Runs (Data Table A-30b and Data Table A-30c). Figure 2-5 shows the history (1994-2022) of the annual potential radiation doses from consumption of Savannah River fish. Over the past ten years, there are no apparent trends in these data. This is because of the relatively large variability in the radionuclide concentrations measured in fish from the same location, due to differences in the following:

- Size of the fish collected each year,
- Mobility and location within the stream mouth from which they are collected,
- Time of year they are collected,
- Amount of radionuclides in the stream water and sediments in which they live that are chemically and physically available to the fish,
- Water quality at each SRS stream mouth, caused by annual changes in stream flow rates (turbulence) and water chemistry.

Table 2-5. Potential Lifetime Risks from the Consumption of Savannah River Fish Compared to Dose Standards

	Committed Dose (mrem)	Potential Risk[(a)]
2022 Savannah River Fish		
1-Year Exposure	0.57	4.3E-07
30-Year Exposure	16.9	1.3E-05
50-Year Exposure	28.2	2.2E-05
Dose Standard		
100 mrem/yr All Pathway		
1-Year Exposure	100	7.3E-05
30-Year Exposure	3,000	2.2E-03
50-Year Exposure	5,000	3.7E-03

a. All radiological risk factors are based on observed and documented health effects to actual people who have received high doses (more than 10,000 mrem) of radiation, such as the Japanese atomic bomb survivors. Radiological risks at low doses (less than 10,000 mrem) are theoretical and are estimated by extrapolating the observed health effects at high doses to the low-dose region by using a linear, no-threshold model. However, cancer and other health effects have not been observed consistently at low radiation doses because the health risks either do not exist or are so low that they are undetectable by current scientific methods.

As indicated in Table 2-5, the 50-year maximum potential lifetime risk from consumption of SRS creek-mouth fish was 2.2E-05, well below the 50-year risk (3.7E-03) associated with the 100 mrem/yr dose standard.

If a potential lifetime risk is less than 1.0E-06 (i.e., one additional case of cancer over that expected in a group of 1,000,000 people), the risk is considered minimal and the corresponding contaminant concentrations are considered negligible. If a calculated risk is more than 1.0E-04 (one additional case of cancer in a population of 10,000), some form of corrective action or remediation may be required. However, if a calculated risk falls between 1.0E-04 and 1.0E-06 (the case with the maximum potential lifetime risks from the consumption of Savannah River fish), then the risk may be deemed acceptable, if it is kept 'as low as reasonably achievable' (ALARA). At SRS, an environmental ALARA program (3Q 18.5) is in place, to ensure that the potential doses and risks from Site radioactive liquid effluents (and, therefore, from consumption of Savannah River fish) are kept ALARA (SRS 2015).

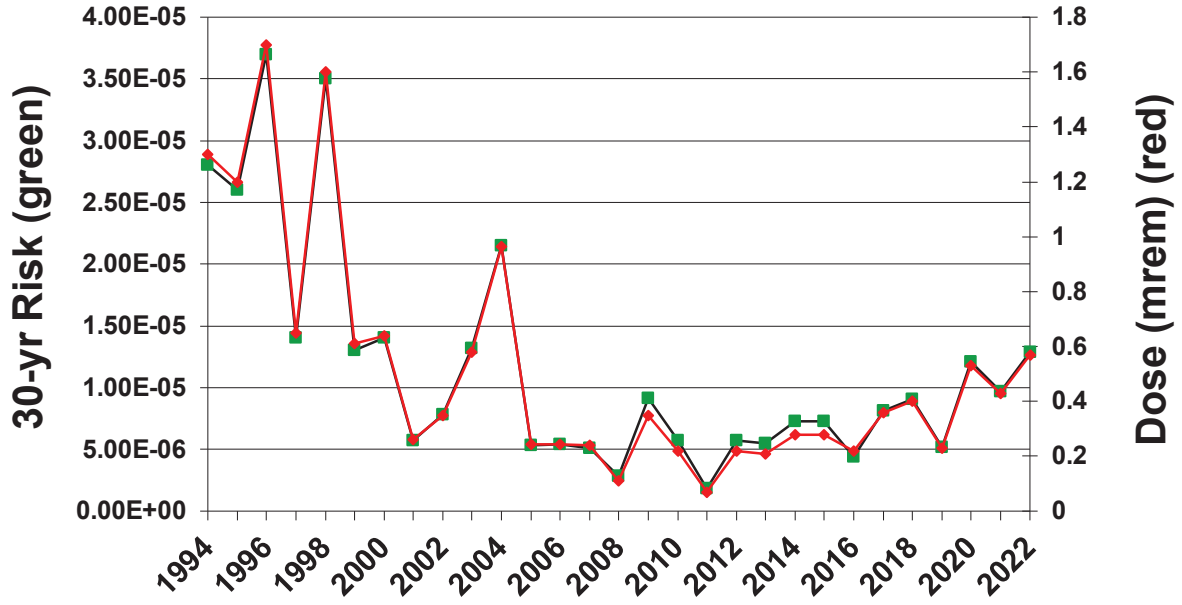


Figure 2-5. History of SRS Maximum Potential Fisherman Doses and 30-y Projected Risks

3.0 Release of Material Containing Residual Radioactivity

DOE Order 458.1 establishes authorized surface contamination limits, which, in turn, allow SRS to release personal and real property unconditionally. This order defines personal property as, "*property of any kind, except for real property" and defines real property as "land and anything permanently affixed to the land such as buildings, fences and those things attached to the buildings, such as light fixtures, plumbing and heating fixtures, or other such items, that would be personal property if not attached.*" SRS handles unconditional release of real property on a case-by-case basis, which requires specific approval from DOE. SRS did not release any real property in 2022, so the following discussion is associated with release of personal property from SRS. DOE Order 458.1 specifies that SRS must prepare and submit an annual summary of cleared property to the Field Element Manager (i.e., DOE-SR Manager).

3.1 Property Release Methodology

Through the use of procedures, SRS governs the unconditional release of equipment and material. Following a radiological survey, SRS can unconditionally release an item if it meets specific documented limits. For items meeting unconditional release criteria, SRS generates a form and electronically attaches it to the applicable radiological survey, via the Site's Visual Survey Data System. To determine the amount of material and equipment released from SRS facilities in 2022, SRS subsequently compiled these electronic forms and coordinated a site-wide review. These measures ensure that radiological releases of material from SRS are consistent with the requirements of DOE Order 458.1.

In 2022, SRS unconditionally released a total of 13,488 items of personal property from radiological areas. Most of these items did not leave the Site. Therefore, all of these items required no additional radiological controls, post-survey, as they met DOE Order 458.1 release criteria. The DOE Order 458.1 allows using DOE Order 5400.5 derived supplemental limits for unconditional release of equipment and materials.

In 2003, DOE approved an SRS request to use supplemental limits for releasing material from the Site, with no further DOE controls. These supplemental release limits, provided in Data Table A-31, are dose-based. These limits are such, that if any member of the public received any exposure, it would be less than 1 mrem/yr. The supplemental limits include both surface and volume concentration criteria. The surface

criteria are very similar to those used in previous years. The volume criteria allow SRS the option to dispose of potentially volume-contaminated material in Three Rivers Landfill, an onsite sanitary waste facility. In 2022, SRS did not release any material from the Site using the supplemental release limits volume concentration criteria.

4.0 Radiation Dose to Aquatic and Terrestrial Biota

DOE Order 458.1 requires that SRS conduct Site operations in a manner that protects the local biota from adverse effects due to radiation and radioactive material releases. To demonstrate compliance with this requirement, SRS uses the approved DOE Standard, DOE-STD-1153-2019, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2019).

The biota dose rate limits specified in this standard are:

- Aquatic animals 1.0 rad/day (0.01 gray/day),
- Riparian animals 0.1 rad/day (0.001 gray/day),
- Terrestrial plants 1.0 rad/day (0.01 gray/day), and
- Terrestrial animals 0.1 rad/day (0.001 gray/day).

4.1 DOE Biota Concentration Guides

SRS evaluates biota doses for aquatic and terrestrial systems using the RESRAD Biota model (version 1.8) (DOE 2004), which directly implements the DOE (2019) guidance.

For aquatic systems (aquatic and riparian animals), the RESRAD Biota model performs a combined water-plus-sediment evaluation. SRS performed initial screenings in 2022 using maximum (for Level 1) radionuclide concentration data from the 14 SRS environmental monitoring stream and sediment sampling locations that are co-located. These screenings determine the biota concentration guide (BCG) sum-of-the-fractions for each of the 14 assessed aquatic systems. A sum-of-the-fractions less than 1.0 indicates the sampling site has passed its initial pathway screening. This means that the biota dose rate limits were not exceeded, and that no further assessments are needed.

Data Table A-32 presents the results of the 2022 biota dose assessment. For 2022, all SRS aquatic system locations passed the initial (Level 1) pathway screenings, and no further assessments were required.

To evaluate the terrestrial systems (terrestrial plants and animals), SRS performed initial screenings using concentration data from the five onsite radiological soil sampling locations. Typically, SRS collects and analyzes only one soil sample per year from each location. For 2022, all terrestrial locations passed their initial (Level 1) pathway screenings (Data Table A-32).

5.0 References

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Appendix A

Data Table A-1. Parameters Used for Liquid Pathway Calculations

Table A-1, Parameters Used for Liquid Pathway Dose Calculations

Reference and Typical Person Consumption and Usage Rates

(Note: Values developed by Savannah River National Laboratory for SRS in Stone and Jannik, 2013)

Pathway	Reference Person 95th percentile	Typical Person 50th percentile	Units
Fish consumption	24	3.7	kg/y
Marine invertebrates	Not applicable	1.5	kg/y
Boating	44	3,110,000	h/y (person-h/y)
Swimming	14	295,000	h/y (person-h/y)
Shoreline recreation	20	822,000	h/y (person-h/y)
Water consumption	920	330	L/y
Population Served by Downriver Water Treatment Plants			
Beaufort-Jasper Purrysburg Plant		83,000	persons
Beaufort-Jasper Chelsea Plant		107,000	persons
City of Savannah Industrial & Domestic Water Supply [(a)]		37,637	persons
50-mile Population			
H-Area - 2020 US Census		838,833	persons

Site-Specific Parameters Used in Liquid Dose Calculations	Value	Units
Savannah River *effective* flow rate at RM 141.5 for 2022 [(b)]	7,230	ft^3/s
River dilution in estuary	3	
Transport Time		
Recreation	1	d
Drinking Water	1.5	d
Fish	2	d
Treatment Plant Drinking Water	4	d
Sport Fish	10	d
Commercial Fish	13	d
Salt Water Invertebrate	13	d
Edible aquatic food harvest		
Fish - sport	8,220	person-kg/y
Fish - commercial	57,000	person-kg/y
Invertebrates - salt water	380,000	person-kg/y
Shoreline width factor	0.2	
Fish bioaccumulation factor for cesium	3,000	

a) Based on production value (http://savannahwaterquality.com/reports/2020/i-and-d) and ratio of total production to population served for Chelsea & Purrysburg

a) The effective river flow rate was based on tritium concentration measurements.

The 2022 measured river flow rate was 8,773 cfs. See Data Table 6-6 for details.

Parameters Used for Liquid Pathway Dose Calculations

Irrigation Parameter Values:

Parameter	Value	Units	Comments
50Mile Total Vegetable Production:	7122412	kg/yr	**5.30E+06***
50Mile Total Leafy Veg Production:	1780603	kg/yr	**1.40E+06***
Irrigated land area:	1000	acres	
Pop dose determined by:	area		POP or AREA
River transit time:	2	d	
Irrigation rate:	3.6	L/sq.m/d	102 L/sq.m/mo
Weathering removal constant:	0.0495	1/d	14 d half-life
Crop exposure time:	70	d	
Grass exposure time:	30	d	
Vegetable crop yield:	2.2	kg/sq.m	
Pasture grass yield:	0.7	kg/sq.m	
Milk production yield:	0.34	L/sq.m	
Meat production yield:	0.01	kd/sq.m	
Surface density of soil:	240	kg/sq.m	
Pasture grass hold-up time:	0	d	
Veg transport time (individual):	1	d	d
Veg transport time (population):	6	d	d
Milk transport time:	3	d	d
Meat transport time:	6	d	d
Fraction of fodder from irrigated field:	1.00		
Cattle consumption rate of fodder:	36	kg/d	beef
	52	kg/d	milk
Fraction of water from Savannah River:	1.00		
Cattle consumption rate of water:	28	L/d	beef
	50	L/d	milk
Individual consumption rates:	305	kg/yr	veg
	25	kg/yr	leafy
	90	kg/yr	meat
	270	L/yr	milk
Population consumption rates:	95	kg/yr	veg
	9	kg/yr	leafy
	35	kg/yr	meat
	73	L/yr	milk
Fractional retention on leaves:	0.25		all nuclides

Data Table A-2. Site-Specific Parameters Used for Airborne Pathway Dose

Data Table A-2, Site-Specific Parameters Used for Airborne Pathway Doses using MAXDOSE and POPDOSE

Pathway	Reference Person 95th Percentile (Individual)	SRS MEI Pre-2012 Adult Individual	Percent Change	Typical Person 50th Percentile (Population)	SRS Population Pre-2012 Average Adult	Percent Change
Fruits, vegetables, and grains (kg/yr)	305	276	↑ 10.5%	95	163	↓ 41.7%
Leafy vegetables (kg/yr)	25	43	↓ 41.9%	9	21	↓ 57.1%
Milk (L/yr)	270	230	↑ 17.4%	73	120	↓ 39.2%
Meat (beef) (kg/yr)	90	81	↑ 11.1%	35	43	↓ 18.6%
Inhalation (m^3/yr)	6,400	8,000	↓ 20.0%	5,000	5,548	↓ 9.9%
50-mile Population						
H-Area - 2020 US Census (persons)	838,833					

Release Locations for Representative Person Dose				
	Reactors	**F & H**	**SRNL**	**Diffuse and Fugitive**
Release height, m	40	61	31	0
Release location (site coordinates)				
East	40740	63380	51860	58000
North	54130	71900	106670	62000
Grade Elevation	269	308	368	338

Data Table A-3. Meteorological Data (2014 – 2018)

Data Table A-3, Meteorological Data (2014-2018) **1 of 7**

Direction is from which the wind blows

43698 WIND STATS H_AREA 60MIN 62M 14-18 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class A
Extremely Unstable Conditions

UMAX(M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE
2.00	0.254	0.325	0.268	0.297	0.293	0.330	0.318	0.247
4.00	0.222	0.316	0.343	0.423	0.471	0.416	0.318	0.240
6.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.480	0.640	0.610	0.720	0.760	0.750	0.640	0.490

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class A
Extremely Unstable Conditions

UMAX(M/S)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.286	0.364	0.359	0.414	0.384	0.366	0.352	0.263	5.120
4.00	0.346	0.421	0.533	0.725	0.611	0.446	0.238	0.213	6.282
6.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.630	0.790	0.890	1.140	1.000	0.810	0.590	0.480	11.420

Data Table A-3. Meteorological Data (2014-2018) (continued) **2 of 7**

Direction is from which the wind blows

43698 WIND STATS H_AREA 60MIN 62M 14-18 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class B
Moderately Unstable Conditions

UMAX(M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE
2.00	0.009	0.027	0.039	0.032	0.023	0.021	0.018	0.023
4.00	0.098	0.181	0.293	0.437	0.339	0.256	0.144	0.101
6.00	0.018	0.032	0.094	0.112	0.059	0.039	0.021	0.014
8.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.130	0.240	0.430	0.580	0.420	0.320	0.180	0.140

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class B
Moderately Unstable Conditions

UMAX(M/S)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.018	0.027	0.014	0.039	0.032	0.018	0.011	0.018	0.369
4.00	0.181	0.245	0.412	0.616	0.467	0.325	0.137	0.114	4.346
6.00	0.032	0.039	0.046	0.119	0.178	0.098	0.016	0.011	0.928
8.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.230	0.310	0.470	0.770	0.680	0.440	0.160	0.140	5.640

Data Table A-3. Meteorological Data (2014-2018) (continued) **3 of 7**

Direction is from which the wind blows

43698 WIND STATS H_AREA 60MIN 62M 14-18 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class C
Slightly Unstable Conditions

UMAX(M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE
2.00	0.030	0.048	0.053	0.046	0.041	0.030	0.021	0.032
4.00	0.146	0.302	0.554	0.513	0.277	0.215	0.172	0.160
6.00	0.126	0.277	0.764	0.348	0.185	0.160	0.114	0.153
8.00	0.014	0.039	0.098	0.023	0.009	0.007	0.009	0.018
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.320	0.670	1.470	0.930	0.510	0.410	0.320	0.360

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class C
Slightly Unstable Conditions

UMAX(M/S)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.043	0.043	0.025	0.041	0.046	0.030	0.037	0.023	0.589
4.00	0.323	0.371	0.371	0.691	0.487	0.375	0.162	0.178	5.297
6.00	0.320	0.330	0.503	0.851	0.870	0.586	0.220	0.092	5.899
8.00	0.034	0.034	0.062	0.153	0.174	0.142	0.030	0.016	0.862
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.720	0.780	0.960	1.740	1.580	1.130	0.450	0.310	12.660

Data Table A-3. Meteorological Data (2014-2018) (continued)

Direction is from which the wind blows

43698 WIND STATS H_AREA 60MIN 62M 14-18 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class D
Neutral Conditions

UMAX(M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE
2.00	0.162	0.211	0.275	0.300	0.259	0.238	0.174	0.158
4.00	0.595	0.957	1.741	2.110	1.611	0.947	0.995	0.888
6.00	0.350	0.815	1.659	0.689	0.382	0.403	0.787	1.215
8.00	0.071	0.195	0.378	0.037	0.021	0.032	0.092	0.146
12.00	0.005	0.032	0.062	0.014	0.000	0.007	0.009	0.005
14.10	0.011	0.007	0.007	0.000	0.000	0.000	0.002	0.002
TOTAL	1.190	2.220	4.120	3.150	2.270	1.630	2.060	2.410

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class D
Neutral Conditions

UMAX(M/S)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.204	0.162	0.156	0.153	0.153	0.158	0.151	0.112	3.026
4.00	1.451	1.114	1.149	1.211	0.963	0.870	0.609	0.403	17.614
6.00	1.625	1.094	1.249	1.421	1.231	1.213	0.423	0.245	14.801
8.00	0.224	0.204	0.133	0.279	0.460	0.478	0.162	0.105	3.017
12.00	0.021	0.018	0.039	0.071	0.156	0.268	0.030	0.050	0.787
14.10	0.002	0.002	0.000	0.000	0.000	0.002	0.000	0.000	0.035
TOTAL	3.530	2.590	2.730	3.140	2.960	2.990	1.380	0.920	39.290

Data Table A-3. Meteorological Data (2014-2018) (continued)

Direction is from which the wind blows

43698 WIND STATS H_AREA 60MIN 62M 14-18 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class E
Slightly Stable Conditions

UMAX(M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE
2.00	0.103	0.101	0.130	0.158	0.126	0.126	0.133	0.092
4.00	0.279	0.336	0.645	1.009	0.808	0.792	0.677	0.732
6.00	0.142	0.240	0.577	0.247	0.222	0.398	0.339	0.517
8.00	0.002	0.005	0.009	0.000	0.000	0.000	0.000	0.005
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.530	0.680	1.360	1.410	1.160	1.320	1.150	1.350

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class E
Slightly Stable Conditions

UMAX(M/S)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.112	0.114	0.108	0.105	0.092	0.094	0.080	0.103	1.777
4.00	1.082	1.064	0.735	0.819	0.721	0.565	0.483	0.332	11.079
6.00	1.158	0.998	0.890	1.204	0.682	0.449	0.229	0.121	8.413
8.00	0.007	0.016	0.027	0.005	0.007	0.000	0.000	0.000	0.083
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	2.360	2.190	1.760	2.130	1.500	1.110	0.790	0.560	21.360

Data Table A-3. Meteorological Data (2014-2018) (continued) **6 of 7**

Direction is from which the wind blows

43698 WIND STATS H_AREA 60MIN 62M 14-18 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class F
Moderately Stable Conditions

UMAX(M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE
2.00	0.057	0.057	0.046	0.018	0.025	0.048	0.062	0.085
4.00	0.382	0.467	0.382	0.110	0.121	0.158	0.243	0.545
6.00	0.167	0.281	0.254	0.039	0.021	0.087	0.114	0.222
8.00	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.610	0.810	0.680	0.170	0.170	0.290	0.420	0.850

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class F
Moderately Stable Conditions

UMAX(M/S)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.073	0.064	0.071	0.082	0.066	0.076	0.082	0.050	0.962
4.00	0.474	0.675	0.517	0.350	0.293	0.405	0.405	0.407	5.934
6.00	0.238	0.396	0.263	0.144	0.153	0.169	0.082	0.140	2.770
8.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.790	1.140	0.850	0.580	0.510	0.650	0.570	0.600	9.690

Data Table A-3. Meteorological Data (2014-2018) (continued) **7 of 7**

Direction is from which the wind blows

43698 WIND STATS H_AREA 60MIN 62M 14-18 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class G
Extremely Stable Conditions

UMAX(M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE
2.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class G
Extremely Stable Conditions

UMAX(M/S)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Data Table A-4. Population Distribution Around SRS's H-Area (2020 Census)

Data Table A-4, Population Distribution Around SRS's H-Area (2020 Census)

Dir(Miles)	5-10	10-20	20-30	30-40	40-50	TOTAL
N	546	12403	9733	5797	12786	41265
NNE	151	3383	3312	6729	48073	61648
NE	140	2840	2729	6767	24032	36508
ENE	10	3357	3141	5869	43438	55815
E	45	4819	6515	6380	4604	22363
ESE	4	5151	1716	1723	2594	11188
SE	0	587	3988	4846	9156	18577
SSE	0	146	266	256	5126	5794
S	0	318	736	7275	3696	12025
SSW	0	631	2279	6118	2821	11849
SW	24	1621	2966	794	1894	7299
WSW	6	1307	9647	1362	5504	17826
W	64	3777	20199	4759	8447	37246
WNW	1748	2982	149477	129143	15701	299051
NW	581	12022	78558	26646	2130	119937
NNW	2652	38198	25675	11266	2651	80442
Total	5971	93542	320937	225730	192653	838833

For a 50-mile (80-km) radius around SRS's H-Area

Data Table A-5. Savannah River Mile 118.8 Flow Rates, 1954 – 2022

Data Table A-5, Savannah River Mile 118.8 Flow Rates, 1954-2022

Year	Mean Annual Flow (cfs)	Year	Mean Annual Flow (cfs)
1954	7,382	2000	5,550
1955	5,974	2001	5,804
1956	6,309	2002	5,386
1957	8,312	2003	12,842
1958	11,038	2004	8,778
1959	9,748	2005	11,935
1960	13,112	2006	6,818
1961	10,909	2007	6,088
1962	10,580	2008	4,833
1963	11,138	2009	7,666
1964	20,497	2010	9,893
1965	12,785	2011	5,714
1966	11,175	2012	4,570
1967	10,573	2013	8,479
1968	9,624	2014	9,440
1969	10,945	2015	8,833
1970	7,169	2016	10,150
1971	10,715	2017	5,698
1972	11,275	2018	9,787
1973	14,536	2019	10,968
1974	11,138	2020	15,345
1975	15,533	2021	10,508
1976	14,008	2022	8,751
1977	11,695	**Mean =**	10,013
1978	10,547	Harmonic Mean =	8981
1979	13,333	Geometric Mean =	9501
1980	13,282		
1981	6,544	10-year mean	9,321
1982	7,169	15-year mean	8,709
1983	12,348		
1984	12,759		
1985	7,167		
1986	6,175		
1987	8,955		
1988	5,364		
1989	7,966		
1990	11,858		
1991	11,598		
1992	11,697		
1993	14,788		
1994	12,271		
1995	12,750	(USGS #02197500)	
1996	11,467	Near River Mile 118.8 (Hwy 301 Bridge)	
1997	10,464		
1998	16,239	USGS #021973269	
1999	6,160	RM 160 Near Wayneboro, GA	

Data Table A-6. Calculated Effective Flow Rate

Data Table A-6, Calculated Effective River Flow Rates

Savannah River Monthly Flow Rate
Based on USGS Daily Flow Rate
Average is Monthly Average

	Flow, cfs
Month	River Mile 118.8 (Hwy 301)
January	10,612
February	10,589
March	12,725
April	21,152
May	6,705
June	6,564
July	7,649
August	7,948
September	4,982
October	4,662
November	4,998
December	6,694
Average	**8,773**

Savannah River Annual Flow Rate
Annual Average Based on
USGS Daily Flow Rate

Year	River Mile 118.8
	cfs
2013	8,479
2014	9,440
2015	8,833
2016	10,150
2017	5,698
2018	9,787
2019	10,968
2020	15,345
2021	10,534
2022	**8,773**
10-y Average	**9,801**

NOTE:
The annual measured river flow rate shown in the tables above is not used in the dose calculations unless the calculated "effective" river flow rate is higher.

River Flow Rate Adjustment Based on Tritium Measurements

Total Tritium Released to the Savannah River: **1,556** Curies

(For 2022, this release total is from the River Transport measurements, which were the highest)

(2022 Reported: 246 Ci from SRS, 13.2 Ci from the Barnwell Low-Level Disposal Facility, and 1430 Ci from Plant Vogtle)

Location	Finished Water Meas. Conc. pCi/ml	Calculated Total Flow ml	Effective Flow Rate cfs
River Mile 141.5 - calc [a,b]	0.241	6.46E+15	**7,230**
Beaufort-Jasper/Purrysburg - calc [a,b]	0.165	9.43E+15	**10,560**
Beaufort-Jasper/Chelsea - calc [a,b]	N/A	N/A	10,560
Savannah I&D - calc [a,b]	N/A	N/A	10,560
Estuary (1.1 x River Mile 118.8 Effective Flow Rate)[c]			7,953

a) Total flow calculated on basis of releases of tritium and measured tritium concentrations in the river using the following equation: Total flow, ml=(Q,Ci)(1.0E+12 pCi/Ci)/(Conc,pCi/ml).

b) Effective Flow rate, in cfs, is calculated using the following equation:

Flow Rate, cfs = (Total Flow, ml/yr)/(8.93E+11 ml-sec/ft^3-yr)

c) Estuary effective flow rate is used for the collective dose calculation

Data Table A-7. Radioactive Liquid Releases by Source (Curies)

Data Table 6-7, Radioactive Liquid Releases by Site Stream - (Curies)

(Used as the Source Term for the 2022 Liquid Pathway Dose Calculations)

Nuclide	Upper Three Runs (A,M,F,H)	Fourmile Branch (F,G,H,Tritium)	Steel Creek + Pen Branch (K,L)	Lower Three Runs (P,R)	Totals
H-3[a]	3.39E+01	2.07E+02	1.07E+02	0.00E+00	**3.48E+02[a]**
C-14	1.75E-04	6.92E-03	0.00E+00		**7.09E-03**
Co-60	0.00E+00	0.00E+00	0.00E+00		**0.00E+00**
Sr-90	3.57E-05	1.61E-02	1.48E-04		**1.63E-02**
Tc-99	0.00E+00	1.22E-02	0.00E+00		**1.22E-02**
I-129	0.00E+00	1.30E-02	0.00E+00		**1.30E-02**
Cs-137[b]	1.21E-04	9.47E-03	0.00E+00		**1.91E-01[b]**
Eu-154	9.47E-04	3.49E-03	0.00E+00		**6.35E-02**
U-234	6.15E-02	1.79E-03	1.97E-04		**6.35E-02**
U-235	3.62E-03	1.12E-04	0.00E+00		**3.73E-03**
U-238	6.97E-02	1.81E-03	5.21E-04		**7.20E-02**
Np-237	5.17E-08	9.06E-05	0.00E+00		**9.07E-05**
Pu-238	3.14E-06	2.50E-04	0.00E+00		**2.53E-04**
Pu-239	5.81E-07	2.66E-05	0.00E+00		**2.72E-05**
Am-241	0.00E+00	2.60E-05	0.00E+00		**2.60E-05**
Cm-244	0.00E+00	1.02E-05	0.00E+00		**1.02E-05**
Alpha[c]	2.34E-04	6.05E-03	5.90E-04	3.49E-03	**1.04E-02**
Beta-Gamma[d]	1.29E-03	2.91E-03	2.60E-02	1.37E-02	**4.39E-02**
Flow Volume (L)	1.44E+11	1.10E+10	3.89E+10	1.06E+10	

a) Depending which one is higher, the tritium release total includes direct + migration releases or tritium transport in streams totals.

The higher one is used in the dose calculations for determining SRS-only impacts.

It does not include releases to the Savannah River from the Vogtle Electric Generating Plant or migration releases into

Lower Three Runs from the Barnwell Low-Level Radioactive Waste Disposal Facility.

b) Depending on which value is higher, the Cs-137 release is based on concentrations measured in Steel Creek (mouth) fish or on the actual measured effluent + migration release total from the site. Refer to data table 6-10 for more information.

c,d) For dose calculations, unspecified alpha and beta releases are assumed to be Pu-239 and Sr-90, respectively.

Data Table A-8. Radioactive Liquid Releases, 2018 – 2022 (Curies)

Data Table A-8, Radioactive Liquid Releases, 2018-2022 (curies)

Radionuclide	2018	2019	2020	2021	2022	2021 to 2022 Percent Change
H-3	5.31E+02	4.24E+02	5.19E+02	4.83E+02	**3.48E+02**	-28%
C-14	6.22E-04	1.53E-02	5.32E-04	5.80E-04	**7.09E-03**	1123%
Mn-54				9.70E-06		-100%
Co-58				1.61E-04		-100%
Sr-89,90	3.18E-02	1.31E-02	1.43E-01	2.15E-02	**1.63E-02**	-24%
Tc-99	2.84E-02	1.66E-02	3.59E-02	3.42E-02	**1.22E-02**	-64%
I-129	1.66E-02	8.92E-03	2.87E-02	2.19E-02	**1.30E-02**	-41%
Cs-137	8.06E-03	8.24E-03	2.49E-01	2.37E-02	**9.59E-03**	-60%
Eu-154					**4.44E-03**	
Ra-226	1.03E-03	2.32E-03	2.50E-03			
U-234	2.95E-02	1.93E-02	2.56E-02	3.28E-02	**6.35E-02**	94%
U-235	5.74E-04	3.62E-04	1.03E-03	3.85E-04	**3.73E-03**	870%
U-238	3.22E-02	2.20E-02	2.93E-02	3.34E-02	**7.20E-02**	116%
Np-237	1.82E-06	8.61E-05	1.05E-04	1.17E-04	**9.07E-05**	-23%
Pu-238	5.35E-05	1.21E-04	1.00E-04	3.98E-04	**2.53E-04**	-36%
Pu-239	5.45E-06	9.38E-06	7.89E-06	2.01E-05	**2.72E-05**	36%
Am-241	1.36E-04	1.16E-05	1.11E-04	3.18E-05	**2.60E-05**	-18%
Cm-244	6.81E-05	2.17E-06	1.79E-05	1.46E-04	**1.02E-05**	-93%
Alpha	3.21E-03	4.91E-03	7.33E-03	6.22E-03	**1.04E-02**	67%
Beta-Gamma	4.51E-02	4.18E-02	5.77E-02	5.27E-02	**4.39E-02**	-17%

Measured liquid releases only, no tritium transport or cesium-137 adjustment from fish

Data Table A-9. Radionuclide Concentrations at Downriver Drinking Water Plants Compared to EPA MCLs

Data Table A-9, Radionuclide Concentrations at the Downriver Drinking Water Plants Compared to EPA MCLs

		12-Month Average Concentrations			
Nuclide	EPA MCL (pCi/L)	Below SRS [a] (pCi/L)	Fraction of EPA MCL (unitless)	BJWSA Purrysburg [b] (pCi/L)	Fraction of EPA MCL (unitless)
H-3[c]	2.00E+04	2.41E+02	1.20E-02	1.65E+02	8.24E-03
C-14	2.00E+03	1.10E-03	5.49E-07	7.51E-04	3.76E-07
Sr-90	8.00E+00	2.52E-03	3.14E-04	1.72E-03	2.15E-04
Tc-99	9.00E+02	1.89E-03	2.10E-06	1.29E-03	1.44E-06
I-129	1.00E+00	2.02E-03	2.02E-03	1.38E-03	1.38E-03
Cs-137	2.00E+02	2.95E-02	1.48E-04	2.02E-02	1.01E-04
Eu-154	6.00E+01	9.83E-03	1.64E-04	6.73E-03	1.12E-04
U-234[d]	1.03E+01	9.83E-03	9.55E-04	6.73E-03	6.54E-04
U-235[d]	4.67E-01	5.78E-04	1.24E-03	3.96E-04	8.48E-04
U-238[d]	1.00E+01	1.11E-02	1.11E-03	7.63E-03	7.63E-04
Np-237	1.50E+01	1.40E-05	9.36E-07	9.61E-06	6.41E-07
Pu-238	1.50E+01	3.92E-05	2.61E-06	2.68E-05	1.79E-06
Pu-239	1.50E+01	4.21E-06	2.81E-07	2.88E-06	1.92E-07
Am-241	1.50E+01	4.02E-06	2.68E-07	2.76E-06	1.84E-07
Cm-244	1.50E+01	1.58E-06	1.05E-07	1.08E-06	7.20E-08
Alpha	1.50E+01	1.61E-03	1.07E-04	1.10E-03	7.33E-05
Beta	8.00E+00	6.79E-03	8.49E-04	4.65E-03	5.81E-04
Sum of the Fractions =			**1.90E-02**		**1.30E-02**

a. Near Savannah River Mile 141.5, below Steel Creek mouth

b. Beaufort-Jasper Water and Sewer Authority, finished drinking water at the Purrysburg Plant

c. The tritium concentrations and source term are based on actual measurements of the Savannah River water at the various locations
They include contributions from VEGP (1430 Ci in 2022) and the Barnwell Low-Level Disposal Facility (13.2 Ci in 2022)
All other radionuclide concentrations are calculated based on the effective or measured river flow rate

d. MCLs for Uranium based on radioisotope specific activity X 30 µg/L X isotopic abundance

Data Table A-9 – *Support*. 2022 Radioactive Liquid Release Source Term and 12-Month Average Downriver Radionuclide Concentrations Compared to the US EPA's Drinking Water Maximum Contaminant Levels (MCL)

2022 Radioactive Liquid Release Source Term and 12-Month Average Downriver Radionuclide Concentrations Compared to the US EPA's Drinking Water Maximum Contaminant Levels (MCL)

		12-Month Average Concentration (pCi/L)			Output from LADTAP XL (uCi/mL)	
Nuclide	Curies Released	Below SRS [a]	at BJWSA Purrysburg [b]	EPA MCL[d]	Below SRS [a]	at BJWSA Purrysburg [b]
H-3[c]	1.56E+03	2.41E+02	1.65E+02	2.00E+04	2.41E-07	1.65E-07
C-14	7.09E-03	1.10E-03	7.51E-04	2.00E+03	1.10E-12	7.51E-13
Sr-90	1.63E-02	2.52E-03	1.72E-03	8.00E+00	2.52E-12	1.72E-12
Tc-99	1.22E-02	1.89E-03	1.29E-03	9.00E+02	1.89E-12	1.29E-12
I-129	1.30E-02	2.02E-03	1.38E-03	1.00E+00	2.02E-12	1.38E-12
Cs-137	1.91E-01	2.95E-02	2.02E-02	2.00E+02	2.95E-11	2.02E-11
Eu-154	6.35E-02	9.83E-03	6.73E-03	6.00E+01	9.83E-12	6.73E-12
U-234[d]	6.35E-02	9.83E-03	6.73E-03	1.03E+01	9.83E-12	6.73E-12
U-235[d]	3.73E-03	5.78E-04	3.96E-04	4.67E-01	5.78E-13	3.96E-13
U-238[d]	7.20E-02	1.11E-02	7.63E-03	1.00E+01	1.11E-11	7.63E-12
Np-237	9.07E-05	1.40E-05	9.61E-06	1.50E+01	1.40E-14	9.61E-15
Pu-238	2.53E-04	3.92E-05	2.68E-05	1.50E+01	3.92E-14	2.68E-14
Pu-239	2.72E-05	4.21E-06	2.88E-06	1.50E+01	4.21E-15	2.88E-15
Am-241	2.60E-05	4.02E-06	2.76E-06	1.50E+01	4.02E-15	2.76E-15
Cm-244	1.02E-05	1.58E-06	1.08E-06	1.50E+01	1.58E-15	1.08E-15
Alpha	1.04E-02	1.61E-03	1.10E-03	1.50E+01	1.61E-12	1.10E-12
Beta	4.39E-02	6.79E-03	4.65E-03	8.00E+00	6.79E-12	4.65E-12

a. Near Savannah River Mile 141.5, downriver of SRS.

b. Beaufort-Jasper Water and Sewer Authority, finished drinking water at the Purrysburg Plant

c. The tritium concentrations and source term are based on actual measurements of the Savannah River water at the various locations
They include contributions from VEGP (1430 Ci in 2022) and the Barnwell Low-Level Disposal Facility (13.2 Ci in 2022)
All other radionuclide concentrations are calculated based on the effective or measured river flow rate

d. MCLs for Uranium based on radioisotope specific activity X 30 µg/L X isotopic abundance

Data Table A-10. Adjustment of Cs-137 Release Based on Fish Concentrations

Data Table A-10, Adjustment of Cs-137 Release Based on Fish Concentrations

Activity in Fish	**Cs-137 Conc,pCi/g**
River Mile 141.5 wtd avg conc	8.87E-02

Cs-137	Measured Ci Released	LADTAP BAF	RM 118.8 Flow, cfs	Calc Fish Conc,pCi/g	Meas Fish Conc,pCi/g	Ratio meas/calc
RM141.5-Max Ind	9.59E-03	3000	7,230	4.46E-03	8.87E-02	19.89

Ratios (right column) are multipliers for measured releases in order for LADTAP to calculate the appropriate dose using the built in BAF factors. Calculated release values used in LADTAP calculations are shown below:

Cs-137	Multiplier (ratio)	Measured Ci Release	Calc Ci Release	
RM141.5-Max Ind	19.89	9.59E-03	1.91E-01	(see note below)

Cs-137 direct+migration releases:	9.59E-03	Ci
2022 total effective flow RM 141.5:	6.46E+15	ml
Calc Cs-137 conc =	1.49E-06	pCi/ml

Ratios of Measured/Calculated Conc. of Cs-137 in fish

Year	Ratio	Year	Ratio
1985	5.2	2006	0.39
1986	8.4	2007	0.6
1987	3.0	2008	0.56
1988	1.4	2009	0.45
1989	1.2	2010	1.3
1990	6.8	2011	0.34
1991	25.3	2012	0.5
1992	1.2	2013	2.36
1993	1.1	2014	0.77
1994	1.4	2015	4.33
1995	3.1	2016	2.69
1996	1.3	2017	24.9
1997	2.6	2018	13.26
1998	1.2	2019	25.45
1999	2.3	2020	2.49
2000	1.1	2021	16.44
2001	0.8	2022	19.89
2002	2.1		
2003	0.54		
2004	0.27		
2005	0.42		

NOTE: FOR 2022, THE CALCULATED CS-137 EFFLUENT RELEASE VALUE OF 0.191 CURIE WAS USED IN THE DOSE CALCULATIONS INSTEAD OF THE MEASURED EFFLUENT RELEASE VALUE OF 0.00959 CURIE.

Data Table A-10 – *Support*. Adjustment of Cs-137 Liquid Releases Based on Fish Concentrations
Adjustment of Cs-137 Liquid Release Based on Fish Concentrations

Cesium-137 Measured Mean Concentrations in Steel Creek Fish

Location	Species	Number of Composites	Cs-137, pCi/g Average	# comp X avg. conc. pCi/g
Near River Mile 141.5	bass	3	1.35E-01	4.04E-01
	catfish	3	7.66E-02	2.30E-01
	panfish	3	6.72E-02	2.02E-01
	flathead	3	7.62E-02	2.29E-01
	Total Composites	13	Sum =	1.06E+00
		Overall weighted average----->		8.87E-02

Data Table A-11. Representative Person Dose – All Liquid Pathways Including Irrigation
Data Table A-11, Representative Person Dose - All Liquid Pathways Including Irrigation

By Pathway

Pathway	Representative Person Dose, mrem [a]	Percent of Total Dose
Vegetable	3.6E-02	21.8%
Milk	7.7E-03	4.6%
Meat	3.6E-03	2.1%
Fish Consumption	1.1E-01	64.4%
Water Consumption	1.1E-02	6.4%
Shoreline	8.9E-04	0.5%
Swimming and Boating	3.4E-06	0.0%
Total	**1.7E-01**	

By Radionuclide

Radionuclide	Representative Person Dose, mrem [a]	Percent of Total Dose
H-3 (oxide)	6.8E-03	4.1%
C-14	2.7E-05	0.0%
Sr-90	3.7E-03	2.2%
Tc-99	2.5E-03	1.5%
I-129	6.1E-03	3.6%
Cs-137	1.2E-01	70.0%
Eu-154	3.3E-04	0.2%
U-234	8.2E-03	4.9%
U-235	4.5E-04	0.3%
U-238	8.4E-03	5.0%
Np-237	9.8E-06	0.0%
Pu-238	7.9E-05	0.0%
Pu-239	9.2E-06	0.0%
Am-241	1.0E-05	0.0%
Cm-244	1.3E-06	0.0%
Alpha	3.5E-03	2.1%
Nonvolatile Beta	9.9E-03	5.9%
Total	**1.67E-01**	

a) Committed effective dose

Data Table A-11 – *Support*. Representative Person Dose – All Liquid Pathways

Representative Person Dose - Liquid Pathways Except Irrigation

Irrigation Pathway Doses from IRRIDOSE

By Pathway

Pathway	LADTAPXL Representative Person Dose, mrem [a]	Food Type	IRRIDOSE (Irrigation Pathway) Representative Person, mrem
Fish Consumption	1.1E-01	Vegetable	3.6E-02
Water Consumption	1.1E-02	Milk	7.7E-03
Shoreline	8.9E-04	Meat	3.6E-03
Swimming and Boating	3.4E-06		
Total	**1.2E-01**	**Total**	**4.8E-02**

By Radionuclide

Radionuclide	LADTAPXL Representative Person Dose, mrem [a]	Radionuclide	IRRIDOSE (Irrigation Pathway) Representative Person Dose, mrem
H-3 (oxide)	4.0E-03	H-3 (oxide)	2.9E-03
C-14	7.3E-07	C-14	2.6E-05
Sr-90	3.2E-04	Sr-90	3.4E-03
Tc-99	1.7E-06	Tc-99	2.5E-03
I-129	1.2E-03	I-129	4.9E-03
Cs-137	1.1E-01	Cs-137	9.0E-03
Eu-154	2.5E-04	Eu-154	8.0E-05
U-234	1.5E-03	U-234	6.7E-03
U-235	8.8E-05	U-235	3.6E-04
U-238	1.7E-03	U-238	6.7E-03
Np-237	3.1E-06	Np-237	6.6E-06
Pu-238	3.0E-05	Pu-238	4.9E-05
Pu-239	3.5E-06	Pu-239	5.7E-06
Am-241	7.4E-06	Am-241	3.0E-06
Cm-244	5.0E-07	Cm-244	8.1E-07
Alpha	1.3E-03	Alpha	2.2E-03
Nonvolatile Beta	8.6E-04	Nonvolatile Beta	9.1E-03
Total	**1.2E-01**	**Total**	**4.8E-02**

a) Committed effective dose

Data Table A-12. Comparisons of 2018 – 2022 Offsite Doses

Data Table A-12, Comparison of 2017-2021 Offsite Doses

	2018	2019	2020	2021	2022	2022 vs 2021 %
Atmospheric Releases						
Representative Person, mrem [a]						
All Pathways	8.2E-02	1.8E-02	1.2E-02	1.7E-02	1.6E-02	**-1.8%**
Population, person-rem						
50-mile (80-km) Population	2.6E+00	7.0E-01	5.4E-01	7.3E-01	7.5E-01	**2.1%**
Liquid Releases						
Representative Person, mrem [a]						
All Pathways Except Irrigation	9.2E-02	1.1E-01	2.5E-01	2.0E-01	1.2E-01	**-39.1%**
Irrigation Pathway	9.9E-02	5.0E-02	1.0E-01	8.6E-02	4.8E-02	**-44.4%**
	1.9E-01	1.6E-01	3.5E-01	2.8E-01	1.7E-01	**-40.7%**
Population, person-rem						
Down River Population	1.1E+00	9.5E-01	1.4E+00	1.4E+00	9.8E-01	**-29.1%**
Irrigation Pathway at RM 141.5	2.3E+00	1.1E+00	2.3E+00	1.9E+00	1.0E+00	**-47.1%**
	3.4E+00	2.1E+00	3.7E+00	3.3E+00	2.0E+00	**-39.6%**
Total Representative Person (Air + Liquid + Irrigation) (mrem)	**0.27**	**0.18**	**0.36**	**0.30**	**0.18**	**-38.5%**
Total Population (Air + Liquid + Irrigation) (person-rem)	**6.0**	**2.8**	**4.2**	**4.0**	**2.7**	**-32.1%**

a. In 2012, SRS changed from the MEI to the Representative Person concept for dose compliance.

Data Table A-13. Representative Person Drink Water Dose

Data Table A-13, Representative Person Drinking Water Dose

Radionuclide	Representative Person Dose, mrem [a]	Percent of Total Dose	Representative Person Dose, mrem [b]	Percent of Total Dose
H-3 (oxide)	1.7E-02	71%	3.9E-03	36%
C-14	6.2E-07	0%	6.2E-07	0%
Sr-90	2.8E-04	1%	2.8E-04	3%
Tc-99	9.1E-07	0%	9.1E-07	0%
I-129	6.6E-04	3%	6.6E-04	6%
Cs-137	1.4E-03	6%	1.4E-03	13%
Eu-154	2.7E-05	0%	2.7E-05	0%
U-234	1.5E-03	6%	1.5E-03	14%
U-235	8.0E-05	0%	8.0E-05	1%
U-238	1.5E-03	6%	1.5E-03	14%
Np-237	1.9E-06	0%	1.9E-06	0%
Pu-238	1.7E-05	0%	1.7E-05	0%
Pu-239	2.0E-06	0%	2.0E-06	0%
Am-241	1.0E-06	0%	1.0E-06	0%
Cm-244	2.8E-07	0%	2.8E-07	0%
Alpha	7.5E-04	3%	7.5E-04	7%
Nonvolatile Beta	7.5E-04	3%	7.5E-04	7%
Total	**2.4E-02**		**1.1E-02**	

a) Based on Tritium Measurements from the BJSWA Purrysburg Treatment Plant. This includes Plant Vogtle and BLLWF releases

b) Based on SRS-Only releases of tritium

Data Table A-14. Collective Drinking Water Doses (person-rem) from SRS Only

Data Table A-14, Collective Drinking Water Doses (person-rem) from SRS Only

For the Beaufort Jasper Water and Sewer Authority Chelsea and Purrysburg Water Treatment Plants and the Savannah Industrial and Domestic Water Treatment Plant

Radionuclide	BJWSA Chelsea[a]	BJWSA Purrysburg[b]	Savannah I&D[c]
Total	**2.8E-01**	**2.2E-01**	**1.0E-01**

a) 107,000 people served (3/3/23 email from Tricia Kilgore to Brooke Stagich)

b) 83,000 people served (4/3/23 email from Tricia Kilgore to Brooke Stagich)

c) 37,637 people served (Based on production value (http://savannahwaterquality.com/reports/2020/i-and-d) and ratio of total production to population served for Chelsea & Purrysburg)

Data Table A-15. Collective Dose – All Liquid Pathways Including Irrigation

Data Table A-15, Collective Dose - All Liquid Pathways Including Irrigation

By Pathway

Pathway	Collective Dose (person-rem)[a]	Percent of Total Dose
Sport fish	3.7E-02	2%
Commercial fish	2.6E-01	13%
Saltwater invertebrates	4.8E-02	2%
Shoreline Exposure	3.7E-02	2%
Swimming	5.5E-05	0%
Boating	6.0E-05	0%
Beaufort-Jasper (Chelsea)	2.8E-01	14%
Beaufort-Jasper (Purrysburg)	2.2E-01	11%
Savannah I&D	1.0E-01	5%
Vegetable consumption	9.8E-01	49%
Milk consumption	3.9E-02	2%
Meat consumption	1.6E-03	0%
Total	**2.0E+00**	

By Radionuclide

Radionuclide	Collective Dose (person-rem)[a]	Percent of Total Dose
H-3 (oxide)	2.6E-01	13%
C-14	2.0E-03	0%
Sr-90	1.0E-01	5%
Tc-99	6.1E-02	3%
I-129	1.3E-01	7%
Cs-137	5.3E-01	26%
Eu-154	1.3E-02	1%
U-234	2.4E-01	12%
U-235	1.3E-02	1%
U-238	2.5E-01	12%
Np-237	2.9E-04	0%
Pu-238	2.9E-03	0%
Pu-239	3.4E-04	0%
Am-241	2.0E-04	0%
Cm-244	5.4E-05	0%
Alpha	1.3E-01	7%
Nonvolatile Beta	2.7E-01	14%
Total	**2.0E+00**	

a) Committed effective dose

Data Table A-15 – *Support.* Collective Dose – All Liquid Pathways

Irrigation Pathway Doses from Irridose output

Radionuclide	Population (person-rem)
H-3 (oxide)	4.3E-02
C-14	4.0E-04
Sr-90	8.4E-02
Tc-99	6.1E-02
I-129	9.1E-02
Cs-137	1.3E-01
Eu-154	2.1E-03
U-234	1.6E-01
U-235	8.4E-03
U-238	1.6E-01
Np-237	1.7E-04
Pu-238	1.3E-03
Pu-239	1.5E-04
Am-241	7.9E-05
Cm-244	2.2E-05
Alpha	5.9E-02
Nonvolatile Beta	2.3E-01
Total	**1.0E+00**

Other Liquid Pathway Doses from Ladtap output

Radionuclide	Collective Dose (person-rem)[(a)]
H-3 (oxide)	2.2E-01
C-14	1.6E-03
Sr-90	1.6E-02
Tc-99	6.8E-05
I-129	4.3E-02
Cs-137	3.9E-01
Eu-154	1.1E-02
U-234	8.6E-02
U-235	4.8E-03
U-238	9.2E-02
Np-237	1.2E-04
Pu-238	1.6E-03
Pu-239	1.9E-04
Am-241	1.2E-04
Cm-244	3.3E-05
Alpha	7.2E-02
Nonvolatile Beta	4.4E-02
Total	**9.8E-01**

Data Table A-16. 2022 Radioactive Atmospheric Releases by Source (Curies)

Data Table A-16, Radioactive Atmospheric Releases by Source (Curies)[a] **2 Pages**

Radionuclide	Half-Life[b]		Calculated[c]	Reactors	Separations[d]	SRNL	Total
Gases and Vapors							
H-3 (oxide)	12.3	y	1.03E+02	1.03E+02	6.29E+03		**6.49E+03**
H-3 (elemental)	12.3	y			3.10E+03		**3.10E+03**
H-3 Total	12.3	y	1.03E+02	1.03E+02	9.38E+03		**9.59E+03**
C-14	5700	y	3.33E-07		4.10E-02		**4.10E-02**
Hg-203	46.6	d	4.02E-10				**4.02E-10**
Kr-85	10.8	y			1.30E+04		**1.30E+04**
I-129	1.57E+07	y	7.48E-05		7.01E-03	7.48E-07	**7.08E-03**
I-131	8.02	d	6.67E-10				**6.67E-10**
Particles							
Ag-110m	250	d	1.48E-11				**1.48E-11**
Am-241	432	y	1.12E-05	0.00E+00	3.48E-06	3.10E-09	**1.47E-05**
Am-243	7370	y	3.69E-09				**3.69E-09**
Ba-133	10.5	y	1.01E-08				**1.01E-08**
Be-7	53	d	1.17E-11				**1.17E-11**
Ce-139	138	d	3.78E-10				**3.78E-10**
Ce-141	32.5	d	4.94E-11				**4.94E-11**
Ce-144	285	d	2.00E-08				**2.00E-08**
Cm-243	29.1	y	1.47E-08				**1.47E-08**
Cm-244	18.1	y	2.75E-07	1.07E-09	1.11E-08	2.46E-08	**3.12E-07**
Co-56	77.23	d	1.20E-10				**1.20E-10**
Co-57	272	d	5.12E-07				**5.12E-07**
Co-60	5.27	y	2.65E-06				**2.65E-06**
Cs-134	2.06	y	3.42E-10				**3.42E-10**
Cs-137	30.2	y	3.98E-03		1.00E-02		**1.40E-02**
Eu-152	13.5	y	8.82E-09				**8.82E-09**
Eu-154	8.59	y	3.56E-07				**3.56E-07**
Eu-155	4.76	y	1.18E-07				**1.18E-07**
Fe-55	2.74	y	7.09E-09				**7.09E-09**
K-40	1.25E+09	y	7.47E-09				**7.47E-09**
La-140	1.6781	d	5.00E-06				**5.00E-06**
Mn-54	312	d	2.91E-07				**2.91E-07**
Na-22	2.6019	y	1.50E-05				**1.50E-05**
Nb-94	2.03E+04	y	2.42E-07				**2.42E-07**
Nb-95	35.0	d	3.63E-07				**3.63E-07**
Ni-59	1.01E+05	y	5.76E-11				**5.76E-11**
Ni-63	100	y	5.56E-09				**5.56E-09**
Np-237	2.14E+06	y	1.54E-06		1.04E-07		**1.64E-06**
Pa-233	27.0	d	1.42E-06				**1.42E-06**
Pb-212	10.6	h	8.43E-07				**8.43E-07**
Pm-147	2.62	y	2.89E-06				**2.89E-06**
Pm-148m	41.3	d	1.90E-12				**1.90E-12**
Pr-144	17.3	m	2.00E-08				**2.00E-08**
Pu-236	2.86	y	4.21E-10				**4.21E-10**
Pu-238	87.7	y	3.13E-05	1.73E-11	1.55E-05	2.74E-09	**4.68E-05**
Pu-239	2.41E+04	y	6.92E-05	3.20E-10	4.90E-05	2.41E-09	**1.18E-04**
Pu-240	6560	y	7.68E-06				**7.68E-06**
Pu-241	14.4	y	2.07E-04				**2.07E-04**
Pu-242	3.75E+05	y	2.67E-08				**2.67E-08**
Ra-226	1600	y	2.66E-07				**2.66E-07**

Data Table A-16, Radioactive Atmospheric Releases by Source (Curies)[a] **2 Pages**

Radionuclide	Half-Life[b]		Calculated[c]	Reactors	Separations[d]	SRNL	Total
Ra-228	5.75	y	2.65E-07				**2.65E-07**
Rh-106(e)	29.8	s	3.04E-06		1.38E-05		**1.68E-05**
Ru-103	39.3	d	5.11E-10				**5.11E-10**
Ru-106	374	d	3.04E-06		1.38E-05		**1.68E-05**
Sb-125	2.76	y	1.18E-06				**1.18E-06**
Sb-126(e)	12.4	d	1.70E-07				**1.70E-07**
Sc-46	83.79	d	1.72E-10				**1.72E-10**
Se-79	2.95E+05	y	4.90E-09				**4.90E-09**
Sm-151	90	y	2.89E-06				**2.89E-06**
Sn-113	115	d	4.56E-10				**4.56E-10**
Sn-123	129	d	6.66E-12				**6.66E-12**
Sn-126	2.30E+05	y	1.70E-07				**1.70E-07**
Sr-85	64.8	d	4.68E-10				**4.68E-10**
Sr-89	50.5	d	4.93E-10				**4.93E-10**
Sr-90	28.8	y	3.09E-03		4.30E-05		**3.13E-03**
Tc-99	2.11E+05	y	6.02E-05				**6.02E-05**
Te-127	9.35	h	1.04E-11				**1.04E-11**
Te-129	69.6	m	1.05E-12				**1.05E-12**
Th-228	1.91	y	8.66E-09	2.76E-09			**1.14E-08**
Th-229	7340	y	1.05E-09				**1.05E-09**
Th-230	7.54E+04	y	5.70E-11	5.89E-09			**5.95E-09**
Th-231	25.5	h	2.12E-04				**2.12E-04**
Th-232	1.41E+10	y	9.06E-12	1.72E-09			**1.73E-09**
Tl-208	3.05	m	1.41E-06				**1.41E-06**
U-232	68.9	y	5.48E-09				**5.48E-09**
U-233	1.59E+05	y	1.24E-08				**1.24E-08**
U-234	2.46E+05	y	5.95E-07	2.71E-09	2.31E-05	7.57E-09	**2.37E-05**
U-235	7.04E+08	y	3.84E-08	0.00E+00	1.35E-06	3.15E-10	**1.38E-06**
U-236	2.34E+07	y	3.97E-08				**3.97E-08**
U-238	4.47E+09	y	1.62E-06	2.21E-09	2.97E-05	1.04E-08	**3.13E-05**
Y-88	107	d	3.60E-10				**3.60E-10**
Y-90(e)	64.1	h	3.09E-03	0.00E+00	4.30E-05		**3.13E-03**
Y-91	58.5	d	7.98E-10				**7.98E-10**
Zn-65	244	d	1.64E-06				**1.64E-06**
Zr-95	64.0	d	1.22E-07				**1.22E-07**
Unidentified alpha	N/A		9.82E-05	2.46E-06	2.16E-06	3.41E-07	**1.03E-04**
Unidentified beta	N/A		6.09E-04	5.44E-05	7.25E-05	1.24E-06	**7.38E-04**
TOTAL	N/A		1.03E+02	1.03E+02	2.24E+04	2.37E-06	**2.26E+04**

a. One curie equals 3.7E+10 Becquerels

b. ICRP 107, *Nuclear Decay Data for Dosimetric Calculations (2008)*

c. Estimated releases from unmonitored sources. Beginning in 2016, individual isotope annual releases below 1E-12 Ci (1 pCi) are no longer reported in this table and, therefore, not used in the dose calculations.

d. Includes separations, waste management, and tritium facilities

e. Daughter products (Sb-126, Rh-106 & Y-90) in secular equilibrium with source terms (Sn-126, Ru-106 & Sr-90, respectively). In MAXDOSE/POPDOSE, they are included in the source term and their ingrowth is included in their parents' source term.

Data Table A-17. 2018 - 2022 Atmospheric Releases (Curies)

Data Table A-17, 2018-2022 Atmospheric Releases (Curies) **2 Pages**

Radionuclide	2018[a]	2019	2020	2021	2022	2021-2022 %Change
Gases and Vapors						
H-3 (oxide)	1.38E+04	7.94E+03	5.82E+03	7.51E+03	6.49E+03	-14%
H-3 (elemental)	1.38E+03	1.31E+03	1.21E+03	1.60E+03	3.10E+03	94%
H-3 Total	1.52E+04	9.25E+03	7.03E+03	9.11E+03	9.59E+03	5%
C-14	3.00E-02	5.00E-02	5.00E-02	6.20E-02	4.10E-02	-34%
Hg-203	5.07E-10	6.51E-10	5.42E-10	5.26E-10	4.02E-10	-24%
Kr-85	5.45E+03	1.07E+04	7.37E+03	1.68E+04	1.30E+04	-22%
I-129	3.06E-03	9.99E-03	4.16E-03	5.57E-03	7.08E-03	27%
I-131	5.64E-10	7.01E-10	5.49E-10	7.10E-10	6.67E-10	-6%
Particles						
Ag-110m	1.48E-11	1.48E-11	1.48E-11	1.48E-11	1.48E-11	0%
Am-241	3.28E-05	1.73E-05	1.95E-05	2.37E-05	1.47E-05	-38%
Am-243	3.76E-09	3.97E-09	4.24E-09	3.61E-07	3.69E-09	-99%
Ba-133	1.40E-06	7.74E-07	6.90E-07	6.55E-07	1.01E-08	-98%
Be-7					1.17E-11	
Cd-109	1.20E-08	1.68E-08	1.05E-08	1.36E-08		-100%
Ce-139	5.15E-10	6.71E-10	4.73E-10	5.18E-10	3.78E-10	-27%
Ce-141	4.94E-11	4.94E-11	4.94E-11	4.94E-11	4.94E-11	0%
Ce-144	2.00E-08	2.00E-08	2.00E-08	2.00E-08	2.00E-08	0%
Cm-243	1.56E-09	2.90E-09	1.76E-09		1.47E-08	
Cm-244	6.02E-07	2.99E-07	3.02E-07	3.17E-07	3.12E-07	-2%
Co-57	4.81E-10	6.41E-10	4.24E-10	4.95E-10	5.12E-07	103407%
Co-60	5.37E-07	6.30E-07	6.37E-07	3.39E-06	2.65E-06	-22%
Cs-134	4.31E-07	4.32E-07	4.31E-07	4.31E-07	3.42E-10	-100%
Cs-137	1.13E-03	3.88E-03	4.67E-03	8.23E-03	1.40E-02	70%
Eu-152	1.43E-09	1.90E-09	8.96E-09	9.21E-09	8.82E-09	-4%
Eu-154	3.56E-07	3.56E-07	3.56E-07	7.11E-07	3.56E-07	-50%
Eu-155	1.18E-07	1.18E-07	1.18E-07	1.18E-07	1.18E-07	0%
F-18	4.00E-02	4.00E-02	0.00E+00	1.00E-02		-100%
Fe-55	6.54E-09	8.04E-09	3.64E-09	3.76E-08	7.09E-09	-81%
K-40					7.47E-09	
La-140					5.00E-06	
Mn-54	4.82E-10	6.01E-10	4.24E-10	4.55E-10	2.91E-07	63929%
Na-22					1.50E-05	
Nb-94	2.42E-07	2.42E-07	2.42E-07	2.42E-07	2.42E-07	0%
Nb-95	3.63E-07	3.63E-07	3.63E-07	3.63E-07	3.63E-07	0%
Ni-59	5.76E-11	5.76E-11	5.76E-11	3.67E-07	5.76E-11	-100%
Ni-63	4.73E-09	7.41E-09	7.26E-09	4.55E-05	5.56E-09	-100%
Np-237	2.11E-06	1.61E-06	1.69E-06	1.68E-06	1.64E-06	-2%
Pa-233	1.42E-06	1.42E-06	1.42E-06	1.42E-06	1.42E-06	0%
Pb-212	8.43E-07	8.43E-07	8.43E-07	8.43E-07	8.43E-07	0%
Pm-147	2.89E-06	2.89E-06	2.89E-06	2.89E-06	2.89E-06	0%
Pm-148m	1.90E-12	1.90E-12	1.90E-12	1.90E-12	1.90E-12	0%
Pr-144	2.00E-08	2.00E-08	2.00E-08	2.00E-08	2.00E-08	0%
Pu-236	4.21E-10	5.52E-10	5.30E-10	4.56E-10	4.21E-10	-8%
Pu-238	3.86E-05	3.57E-05	3.51E-05	3.56E-05	4.68E-05	32%
Pu-239	2.58E-04	1.38E-04	1.60E-04	1.63E-04	1.18E-04	-27%

Data Table A-17, 2018-2022 Atmospheric Releases (Curies) **2 Pages**

Radionuclide	2018[a]	2019	2020	2021	2022	2021-2022 %Change
Pu-240	7.68E-06	7.68E-06	7.69E-06	2.54E-05	7.68E-06	-70%
Pu-241	2.07E-04	2.07E-04	2.07E-04	2.37E-04	2.07E-04	-13%
Pu-242	2.88E-06	3.28E-06	5.29E-06	2.68E-05	2.67E-08	-100%
Ra-226	5.03E-07	5.97E-07	2.95E-07	4.04E-07	2.66E-07	-34%
Ra-228	4.92E-07	5.93E-07	3.12E-07	4.07E-07	2.65E-07	-35%
Rh-106	1.19E-08	3.05E-06	2.82E-05	3.04E-06	1.68E-05	453%
Ru-103	9.23E-09	5.11E-10	5.11E-10	5.11E-10	5.11E-10	0%
Ru-106	3.04E-06	3.05E-06	2.82E-05	3.04E-06	1.68E-05	453%
Sb-125	1.18E-06	1.18E-06	1.18E-06	1.18E-06	1.18E-06	0%
Sb-126	1.70E-07	1.70E-07	1.70E-07	1.70E-07	1.70E-07	0%
Sc-46					1.72E-10	
Se-79	4.90E-09	4.90E-09	4.90E-09	4.90E-09	4.90E-09	0%
Sm-151	2.89E-06	2.89E-06	2.89E-06	2.89E-06	2.89E-06	0%
Sn-113	6.43E-10	8.31E-10	6.05E-10	6.30E-10	4.56E-10	-28%
Sn-123	6.66E-12	6.66E-12	6.66E-12	6.66E-12	6.66E-12	0%
Sn-126	1.70E-07	1.70E-07	1.70E-07	1.70E-07	1.70E-07	0%
Sr-85	5.80E-10	7.61E-10	5.63E-10	5.82E-10	4.68E-10	-20%
Sr-89	6.66E-10	5.99E-10	5.67E-10	5.40E-10	4.93E-10	-9%
Sr-89,90	8.53E-05	3.35E-03	3.02E-03	2.87E-03	3.13E-03	9%
Tc-99	2.08E-05	5.08E-05	5.09E-05	5.08E-05	6.02E-05	18%
Te-127	1.04E-11	1.04E-11	1.04E-11	1.04E-11	1.04E-11	0%
Te-129	1.05E-12	1.05E-12	1.05E-12	1.05E-12	1.05E-12	0%
Th-228	1.49E-08	1.61E-08	1.68E-08	1.51E-08	1.14E-08	-24%
Th-229	1.38E-09	1.34E-09	1.23E-09	1.23E-09	1.05E-09	-14%
Th-230	3.68E-09	6.61E-09	4.75E-09	5.06E-09	5.95E-09	17%
Th-231	2.12E-04	2.12E-04	2.12E-04	2.12E-04	2.12E-04	0%
Th-232	1.92E-09	3.14E-09	3.22E-09	2.69E-09	1.73E-09	-36%
Tl-208	1.41E-06	1.41E-06	1.41E-06	1.41E-06	1.41E-06	0%
U-232	5.25E-09	5.50E-09	5.57E-09	5.35E-09	5.48E-09	3%
U-233	3.90E-09	3.42E-09	3.74E-10	2.89E-08	1.24E-08	-57%
U-234	1.19E-04	2.72E-05	3.54E-05	3.17E-05	2.37E-05	-25%
U-235	1.01E-05	1.37E-06	2.22E-06	1.83E-06	1.38E-06	-25%
U-236	3.39E-08	3.01E-08	3.01E-08	3.01E-08	3.97E-08	32%
U-238	1.66E-04	3.55E-05	4.67E-05	4.03E-05	3.13E-05	-22%
Y-88	4.67E-10	5.81E-10	4.38E-10	5.18E-10	3.60E-10	-31%
Y-90	8.53E-05	3.35E-03	3.02E-03	2.87E-03	3.13E-03	9%
Y-91	7.98E-10	2.14E-09	7.98E-10	7.98E-10	7.98E-10	0%
Zn-65	9.42E-10	5.82E-10	8.62E-10	9.41E-10	1.64E-06	174255%
Zr-95	1.22E-07	1.22E-07	1.22E-07	1.22E-07	1.22E-07	0%
Unidentified Alpha	5.44E-04	4.19E-05	5.19E-05	3.88E-05	1.03E-04	166%
Unidentified Beta	1.16E-03	1.19E-03	9.51E-04	1.02E-03	7.38E-04	-28%

a. Beginning in 2016, individual isotope annual releases below 1E-12 Ci (1 pCi) will no longer be reported in this table.

Data Table A-18. Comparison of Measured vs. Calculated Tritium in Air Concentrations

Data Table 6-18, Comparison of Measured vs. Calculated Tritium in Air Concentrations

Source of Data	Average Concentration at Site Boundary (pCi/m³)	Concentration in the North Sector[(a)] (pCi/m³)
Measured:	4.1	4.3
Calculated:		
MAXDOSE-SR	3.2	6.4
CAP88-PC	4.7	8.3

CAP88 HTO Concentration Calculated from Chi/Q based on Total (HTO & Elemental Tritium) Curies Released (Ci/y):

1.03E+02	**at 0 m**
3.73E+03	**at 15 m**
8.00E+00	**at 21 m**
1.80E+03	**at 31 m**
1.44E+03	**at 56 m**
2.51E+03	**at 59 m**
9.59E+03	**Total**

2014-2018 Chi/Q

Toward Sector	Distance m	0-m sec/m³	Concentration pCi/m³	15m sec/m3	Concentration pCi/m³	21-m sec/m³	Concentration pCi/m³	31-m sec/m3	Concentration pCi/m³	56-m sec/m³	Concentration pCi/m³	59-m sec/m³	Concentration pCi/m³	HTO Conc. pCi/m³
N	12378	3.208E-08	1.047E-01	3.122E-08	3.690E+00	3.043E-08	7.72E-03	2.869E-08	1.64E+00	2.318E-08	1.06E+00	2.250E-08	1.794E+00	8.3
NNW	12280	2.517E-08	8.219E-02	2.433E-08	2.875E+00	2.357E-08	5.98E-03	2.190E-08	1.25E+00	1.679E-08	7.67E-01	1.619E-08	1.291E+00	6.3
NW	11871	2.000E-08	6.531E-02	1.948E-08	2.302E+00	1.901E-08	4.82E-03	1.796E-08	1.02E+00	1.465E-08	6.69E-01	1.424E-08	1.135E+00	5.2
WNW	13009	1.694E-08	5.531E-02	1.656E-08	1.957E+00	1.622E-08	4.11E-03	1.546E-08	8.81E-01	1.297E-08	5.92E-01	1.265E-08	1.009E+00	4.5
W	13179	1.735E-08	5.665E-02	1.707E-08	2.017E+00	1.680E-08	4.26E-03	1.620E-08	9.23E-01	1.416E-08	6.47E-01	1.389E-08	1.107E+00	4.8
WSW	17817	1.453E-08	4.744E-02	1.433E-08	1.694E+00	1.414E-08	3.59E-03	1.372E-08	7.82E-01	1.223E-08	5.58E-01	1.203E-08	9.592E-01	4.0
SW	17089	1.828E-08	5.969E-02	1.786E-08	2.111E+00	1.746E-08	4.43E-03	1.660E-08	9.46E-01	1.384E-08	6.32E-01	1.350E-08	1.076E+00	4.8
SSW	19649	1.154E-08	3.768E-02	1.117E-08	1.320E+00	1.084E-08	2.75E-03	1.009E-08	5.75E-01	7.818E-09	3.57E-01	7.550E-09	6.020E-01	2.9
S	19763	8.502E-09	2.776E-02	8.208E-09	9.700E-01	7.941E-09	2.01E-03	7.353E-09	4.19E-01	5.547E-09	2.53E-01	5.335E-09	4.254E-01	2.1
SSE	18726	8.791E-09	2.870E-02	8.472E-09	1.001E+00	8.183E-09	2.08E-03	7.545E-09	4.30E-01	5.592E-09	2.55E-01	5.364E-09	4.277E-01	2.1
SE	18125	1.086E-08	3.546E-02	1.050E-08	1.241E+00	1.018E-08	2.58E-03	9.466E-09	5.40E-01	7.264E-09	3.32E-01	7.004E-09	5.584E-01	2.7
ESE	13728	1.964E-08	6.413E-02	1.907E-08	2.254E+00	1.855E-08	4.71E-03	1.741E-08	9.92E-01	1.389E-08	6.34E-01	1.348E-08	1.075E+00	5.0
E	16220	1.667E-08	5.443E-02	1.628E-08	1.924E+00	1.591E-08	4.04E-03	1.511E-08	8.61E-01	1.253E-08	5.72E-01	1.221E-08	9.735E-01	4.4
ENE	15788	2.110E-08	6.890E-02	2.060E-08	2.435E+00	2.015E-08	5.11E-03	1.913E-08	1.09E+00	1.586E-08	7.24E-01	1.546E-08	1.233E+00	5.6
NE	14701	2.266E-08	7.399E-02	2.199E-08	2.599E+00	2.139E-08	5.43E-03	2.005E-08	1.14E+00	1.589E-08	7.26E-01	1.539E-08	1.227E+00	5.8
NNE	13482	2.946E-08	9.619E-02	2.851E-08	3.369E+00	2.765E-08	7.01E-03	2.574E-08	1.47E+00	1.986E-08	9.07E-01	1.916E-08	1.528E+00	7.4
Maximum		3.208E-08	1.047E-01	3.122E-08	3.690E+00	3.043E-08	7.719E-03	2.869E-08	1.635E+00	2.318E-08	1.058E+00	2.250E-08	1.794E+00	8.290E+00
Minimum		8.502E-09	2.776E-02	8.208E-09	9.700E-01	7.941E-09	2.014E-03	7.353E-09	4.192E-01	5.547E-09	2.533E-01	5.335E-09	4.254E-01	2.098E+00
Mean		1.835E-08	5.991E-02	1.785E-08	2.110E+00	1.740E-08	4.414E-03	1.640E-08	9.350E-01	1.325E-08	6.052E-01	1.287E-08	1.026E+00	4.741E+00

Measured Averages of HTO Concentration in Air at Site Perimeter

Location	pCi/m³ of Air
Allendale Gate	2.0
Barnwell Gate	2.9
Barricade 8	4.3
D Area	5.9
Darkhorse	4.8
East Talatha[(a)]	4.3
Greenpond	4.0
Highways 21 & 167	4.5
Jackson	3.7
Patterson Mill Road	2.9
Talatha Gate	6.0
Maximum	**6.0**
Minimum	**2.0**
Mean	**4.1**

(a) Since the Site MEI and Reference Person are located in the North sector for air dose calculations, the East Talatha (located in the North sector) measured concentration and CAP88 North sector calculated concentration are used for comparison.

Data Table A-19a. MAXDOSE-SR Representative Person Dose Using Cow Milk Pathway

Data Table A-19a, MAXDOSE-SR Representative Person Dose Using Cow Milk Pathway

2022 MAXDOSE-SR Representative Person Dose Using Cow Milk Pathway

Pathway	Representative Person Dose (mrem)[a]	Percent of Total Dose
Plume	7.1E-04	4.37%
Ground	1.0E-03	6.37%
Inhalation	5.1E-03	31.42%
Vegetation	5.6E-03	34.70%
Cow Milk	3.4E-03	20.91%
Meat	3.6E-04	2.23%
Total	**1.6E-02**	**100.0%**

Radionuclide	Maximally Exposed Individual Dose (mrem)[a]	Percent of Total Dose [b]
Gases and Vapors		
H-3	1.2E-02	70.99%
C-14	8.8E-06	0.05%
K-85	7.1E-04	4.36%
I-129	2.3E-03	14.32%
Particulates		
Am-241	6.8E-06	0.04%
Cs-137	1.1E-03	6.67%
Pu-238	3.3E-05	0.21%
Pu-239	8.9E-05	0.55%
Pu-240	6.4E-06	0.04%
Sr-90	2.7E-04	1.67%
Tc-99	2.5E-06	0.02%
U-234	1.9E-06	0.01%
U-238	3.2E-06	0.02%
Unidentified Alpha	8.5E-05	0.52%
Unidentified Beta	7.9E-05	0.49%
Total	**1.6E-02**	**100.0%**

NOTE: (a) Committed effective dose

NOTE: (b) Radionuclides contributing 0.01% or more of the total dose

Data Table A-19b. MAXDOSE-SR Potential Dose to TRL Industrial Worker

Data Table A-19b, Potential Dose to an Adult Worker at Three Rivers Landfill

2000 h/y exposure via inhalation and shine.

Pathway	Industrial Worker Dose at TRL (mrem)[a]	Percent of Total Dose
Shine Dose[b]	5.73E-03	52.14%
Inhalation	5.26E-03	47.86%
Total	**1.10E-02**	**100.0%**

NOTE: (a) Committed effective dose

NOTE: (b) Shine dose is the total of both plume shine and ground shine output from MAXINE

Data Table A-20. Sector- Specific Representative Person Airborne Pathway Doses (Using Cow Milk Pathway)

Data Table A-20, Sector-Specific Representative Person Airborne Pathway Doses (Using Cow Milk Pathway)

2022 Representative Person Airborne Pathway Doses

N[(a)]	0.016
NNE	0.014
NE	0.012
ENE	0.011
E	0.011
ESE	0.009
SE	0.005
SSE	0.004
S	0.004
SSW	0.006
SW	0.010
WSW	0.012
W	0.011
WNW	0.010
NW	0.012
NNW	0.015

NOTE: (a) Maximum Location

Data Table A-21. MAXDOSE-SR Representative Person Dose Using Goat Milk Pathway

Data Table A-21, MAXDOSE-SR Representative Person Dose Using Goat Milk Pathway

2022 Representative Person Dose Using Goat Milk Pathway

Pathway	Maximally Exposed Individual Dose (mrem)[(a)]	Percent of Total Dose
Plume	7.1E-04	3.86%
Ground	1.0E-03	5.62%
Inhalation	5.1E-03	27.73%
Vegetation	5.6E-03	30.63%
Goat Milk	5.5E-03	30.19%
Meat	3.6E-04	1.97%
Total	**1.8E-02**	**100.0%**

Radionuclide	Maximally Exposed Individual Dose (mrem)[(a)]	Percent of Total Dose [(b)]
Gases and Vapors		
H-3	1.3E-02	70.49%
C-14	9.2E-06	0.05%
Kr-85	7.1E-04	3.86%
I-129	2.7E-03	14.86%
Particulates		
Am-241	6.8E-06	0.04%
Cs-137	1.4E-03	7.38%
Pu-238	3.3E-05	0.18%
Pu-239	8.9E-05	0.49%
Pu-240	6.4E-06	0.04%
Sr-90	2.8E-04	1.51%
Tc-99	2.3E-06	0.01%
U-234	1.9E-06	0.01%
U-238	3.2E-06	0.02%
Unidentified Alpha	8.5E-05	0.46%
Unidentified Beta	7.6E-05	0.41%
Total	**1.8E-02**	**99.8%**

NOTE: (a) Committed effective dose

NOTE: (b) Radionuclides contributing 0.01% or more of the total dose

Data Table A-22. POPDOSE-SR Population Doses from Airborne Releases

Data Table A-22, POPDOSE-SR Population Dose from Airborne Releases

2022 Population Dose from Airborne Releases

Pathway	Population Dose (person-rem)[a]	Percent of Total Dose
Plume	6.0E-02	7.99%
Ground	1.1E-01	14.10%
Inhalation	4.6E-01	61.4%
Vegetation	1.9E-02	2.52%
Cow Milk	1.0E-01	13.43%
Meat	4.5E-03	0.60%
Total	**7.4E-01**	**100.0%**

Radionuclide	Population Dose (person-rem)[a]	Percent of Total Dose[b]
Gases and Vapors		
H-3	5.3E-01	71.7%
C-14	1.0E-04	0.0%
Kr-85	6.0E-02	7.99%
I-129	3.0E-02	4.07%
Particulates		
Am-241	4.1E-04	0.05%
Cs-137	9.5E-02	12.77%
Pu-238	2.0E-03	0.27%
Pu-239	5.5E-03	0.74%
Pu-240	3.6E-04	0.05%
Pu-241	8.9E-05	0.01%
Sr-90	9.2E-03	1.24%
U-234	1.1E-04	0.02%
U-238	2.4E-04	0.03%
Unidentified Alpha	4.8E-03	0.64%
Unidentified Beta	2.8E-03	0.38%
Total	**7.4E-01**	**99.9%**

NOTE: (a) Committed effective dose

NOTE: (b) Radionuclides contributing 0.01% or more of the total dose

Data Table A-23. Airborne Releases by Stack Height for NESHAP

Data Table A-23, Airborne Releases by Stack Height for NESHAP (Curies) **2 Pages**

Radionuclide	Total 0 m Stack	Total 15 m Stack	Total 21 m Stack	Total 31 m Stack	Total 56 m Stack	Total 59 m Stack	Total All Stacks
GASES AND VAPORS							
H-3 (oxide)	1.03E+02	8.87E+02	8.00E+00	1.58E+03	1.44E+03	2.48E+03	6.49E+03
H-3 (elemental)		2.84E+03		2.19E+02		3.76E+01	3.10E+03
H-3 Total	1.03E+02	3.73E+03	8.00E+00	1.80E+03	1.44E+03	2.51E+03	9.59E+03
C-14	3.33E-07					4.10E-02	4.10E-02
Hg-203	4.02E-10						4.02E-10
Kr-85						1.30E+04	1.30E+04
I-129	7.48E-05		7.48E-07			7.01E-03	7.08E-03
I-131	6.67E-10						6.67E-10
PARTICLES							
Ag-110m	1.48E-11						1.48E-11
Am-241	1.13E-05	6.21E-08	3.10E-09	1.04E-08		3.40E-06	1.47E-05
Am-243	3.69E-09						3.69E-09
Ba-133	1.01E-08						1.01E-08
Be-7	1.17E-11						1.17E-11
Ce-139	3.78E-10						3.78E-10
Ce-141	4.94E-11						4.94E-11
Ce-144	2.00E-08						2.00E-08
Cm-243	1.47E-08						1.47E-08
Cm-244	2.75E-07	1.07E-09	2.46E-08			1.11E-08	3.12E-07
Co-56	1.20E-10						1.20E-10
Co-57	5.12E-07						5.12E-07
Co-60	2.65E-06						2.65E-06
Cs-134	3.42E-10						3.42E-10
Cs-137	3.98E-03			1.00E-02		3.95E-06	1.40E-02
Eu-152	8.82E-09						8.82E-09
Eu-154	3.56E-07						3.56E-07
Eu-155	1.18E-07						1.18E-07
Fe-55	7.09E-09						7.09E-09
K-40	7.47E-09						7.47E-09
La-140	5.00E-06						5.00E-06
Mn-54	2.91E-07						2.91E-07
Na-22	1.50E-05						1.50E-05
Nb-94	2.42E-07						2.42E-07
Nb-95	3.63E-07						3.63E-07
Ni-59	5.76E-11						5.76E-11
Ni-63	5.56E-09						5.56E-09
Np-237	1.54E-06					1.04E-07	1.64E-06
Pa-233	1.42E-06						1.42E-06
Pb-212	8.43E-07						8.43E-07
Pm-147	2.89E-06						2.89E-06
Pm-148m	1.90E-12						1.90E-12
Pr-144	2.00E-08						2.00E-08
Pu-236	4.21E-10						4.21E-10
Pu-238	3.13E-05	1.09E-07	2.74E-09			1.54E-05	4.68E-05
Pu-239	6.94E-05	2.51E-08	2.41E-09	1.19E-09		4.88E-05	1.18E-04
Pu-240	7.68E-06						7.68E-06
Pu-241	2.07E-04						2.07E-04
Pu-242	2.67E-08						2.67E-08

Data Table A-23, Airborne Releases by Stack Height for NESHAP (Curies) **2 Pages**

Radionuclide	Total 0 m Stack	Total 15 m Stack	Total 21 m Stack	Total 31 m Stack	Total 56 m Stack	Total 59 m Stack	Total All Stacks
Ra-226	2.66E-07						2.66E-07
Ra-228	2.65E-07						2.65E-07
Rh-106[(b)]	1.68E-05						1.68E-05
Ru-103	5.11E-10						5.11E-10
Ru-106	1.68E-05						1.68E-05
Sb-125	1.18E-06						1.18E-06
Sb-126[(b)]	1.70E-07						1.70E-07
Sc-46	1.72E-10						1.72E-10
Se-79	4.90E-09						4.90E-09
Sm-151	2.89E-06						2.89E-06
Sn-113	4.56E-10						4.56E-10
Sn-123	6.66E-12						6.66E-12
Sn-126	1.70E-07						1.70E-07
Sr-85	4.68E-10						4.68E-10
Sr-89	4.93E-10						4.93E-10
Sr-90	3.09E-03	4.29E-06		2.72E-05		1.16E-05	3.13E-03
Tc-99	6.02E-05						6.02E-05
Te-127	1.04E-11						1.04E-11
Te-129	1.05E-12						1.05E-12
Th-228	8.66E-09	2.76E-09					1.14E-08
Th-229	1.05E-09						1.05E-09
Th-230	5.70E-11	5.89E-09					5.95E-09
Th-231	2.12E-04						2.12E-04
Th-232	9.06E-12	1.72E-09					1.73E-09
Tl-208	1.41E-06						1.41E-06
U-232	5.48E-09						5.48E-09
U-233	1.24E-08						1.24E-08
U-234	2.59E-06	2.12E-07	7.57E-09	1.88E-06		1.90E-05	2.37E-05
U-235	3.84E-08	1.71E-08	3.15E-10			1.32E-06	1.38E-06
U-236	3.97E-08						3.97E-08
U-238	3.31E-06	2.70E-07	1.04E-08	1.85E-06		2.59E-05	3.13E-05
Y-88	3.60E-10						3.60E-10
Y-90[(b)]	3.09E-03	4.29E-06		2.72E-05		1.16E-05	3.13E-03
Y-91	7.98E-10						7.98E-10
Zn-65	1.64E-06						1.64E-06
Zr-95	1.22E-07						1.22E-07
Unidentified alpha	9.84E-05	2.04E-06	3.41E-07	2.40E-06			1.03E-04
Unidentified beta	6.22E-04	1.25E-05	1.63E-07	1.89E-05		8.40E-05	7.38E-04

a. Beginning in 2016, calculated individual isotope annual releases below 1E-12 Ci (1 pCi) are no longer reported in this table and, therefore, not used in the dose calculations.
b. Daughter products (Sb-126, Rh-106 & Y-90) are assumed to be in secular equilibrium with their parent source terms (Sn-126, Ru-106 & Sr-90, respectively).

Data Table A-24. Site-Specific Parameters Used with CAP88 PC for NESHAP

Data Table A-24, Site-Specific Parameters Used with CAP88 PC for NESHAP

2022 Parameters Used with CAP88 PC for NESHAP

Parameter	Value	
Particle size, AMAD[a]		
Gases and Vapors	0	
Particles	1	
Meteorological data	2014-2018; H Area	
Plume rise	None	
Number of stacks	6	
Stack heights, m	0, 15, 21, 31, 56, and 59	
Height of lid, m	1328	
Rainfall rate, cm/yr	126.28	
Average air temperature, C	18.5	
Absolute humidity, g/m^3	12.32	
State	South Carolina	
MEI Specific Parameters		
Distance to MEI	12378 m in North Direction	
Food supply fractions:	Home Produced	From Assessment Area
Vegetable	1.00	0.00
Meat	1.00	0.00
Milk	1.00	0.00
EPA Food Source Scenario	Local	
TRL Worker MEI Specific Parameters		
Distance to MEI	9379 m in West Southwest Direction	
Food supply fractions:	Home Produced	From Assessment Area
Vegetable	0.00	1.00
Meat	0.00	1.00
Milk	0.00	1.00
EPA Food Source Scenario	Regional	
Population Specific Parameters		
Population size (around H-Area)	838,833	
Food supply fractions:[b]	Home Produced	From Assessment Area
Vegetable	0.70	0.30
Meat	0.44	0.56
Milk	0.40	0.60
EPA Food Source Scenario	Rural	

[a]Activity Medium Aerodynamic Diameter, micrometers

[b]CAP88-PC may recalculate the input food source fractions should the productivity of the local or assessment area be insufficient to produce enough food to meet the population times the consumption rates.

Data Table A-25a. Radioactive Atmospheric Releases and MEI Doses for Site Boundary MEI

Data Table A-25a Radioactive Atmospheric Releases and MEI Doses for Site Boundary MEI

2022 CAP88 PC Dose Calculations for NESHAP Report to EPA **3 Pages**

Radionuclide	Releases (Curies)						Maximally Exposed Individual Dose (mrem)	Fraction of Dose
	0 m	15m	21m	31m	56m	59m		
H-3 (oxide)	1.03E+02	8.87E+02	8.00E+00	1.58E+03	1.44E+03	2.48E+03	1.22E-02	0.42
I-129	7.48E-05		7.48E-07			7.01E-03	7.93E-03	0.27
H-3 (elemental)		2.84E+03		2.19E+02		3.76E+01	5.95E-03	0.20
Cs-137	3.98E-03			1.00E-02		3.95E-06	1.08E-03	0.04
Ba-137m							1.02E-03	0.03
Sr-90	3.09E-03	4.29E-06		2.72E-05		1.16E-05	3.29E-04	0.01
Kr-85						1.30E+04	2.60E-04	0.01
Pu-239	6.94E-05	2.51E-08	2.41E-09	1.19E-09		4.88E-05	9.18E-05	0.003
Unidentified Alpha	9.84E-05	2.04E-06	3.41E-07	2.40E-06			8.80E-05	0.003
Unidentified Beta	6.22E-04	1.25E-05	1.63E-07	1.89E-05		8.40E-05	8.74E-05	0.003
Y-90	3.09E-03	4.29E-06		2.72E-05		1.16E-05	4.51E-05	0.002
Pu-238	3.13E-05	1.09E-07	2.74E-09			1.54E-05	3.40E-05	0.001
C-14	3.33E-07					4.10E-02	1.06E-05	0.0004
Am-241	1.13E-05	6.21E-08	3.10E-09	1.04E-08		3.40E-06	9.98E-06	0.0003
Bi-214							8.05E-06	0.0003
Pu-240	7.68E-06						6.55E-06	0.0002
Th-230	5.70E-11	5.89E-09					5.11E-06	0.0002
Ra-226	2.66E-07						4.40E-06	0.0002
Pu-241	2.07E-04						3.22E-06	0.0001
Pb-214							1.38E-06	0.00005
Tc-99	6.02E-05						1.33E-06	0.00005
U-238	3.31E-06	2.70E-07	1.04E-08	1.85E-06		2.59E-05	1.25E-06	0.00004
U-234	2.59E-06	2.12E-07	7.57E-09	1.88E-06		1.90E-05	1.13E-06	0.00004
Pa-234m							8.28E-07	0.00003
Na-22	1.50E-05						8.04E-07	0.00003
Np-237	1.54E-06					1.04E-07	6.53E-07	0.00002
Co-60	2.65E-06						2.55E-07	0.00001
Cm-244	2.75E-07	1.07E-09	2.46E-08			1.11E-08	1.36E-07	0.000005
Bi-210							1.09E-07	0.000004
U-235	3.84E-08	1.71E-08	3.15E-10			1.32E-06	1.04E-07	0.000004
Nb-94	2.42E-07						9.03E-08	0.000003
Pa-233	1.42E-06						8.39E-08	0.000003
Th-234							7.15E-08	0.000002
Ra-228	2.65E-07						6.73E-08	0.000002
Sb-126m							6.64E-08	0.000002
Rh-106	1.68E-05						4.86E-08	0.000002
Ru-106	1.68E-05						3.40E-08	0.000001
Zn-65	1.64E-06						2.48E-08	0.000001
Eu-154	3.56E-07						2.46E-08	0.000001
Pu-242	2.67E-08						2.16E-08	0.000001
Th-229	1.05E-09						1.67E-08	0.000001
Pa-234							1.63E-08	0.000001
Sb-126	1.70E-07						1.60E-08	0.000001
Tl-208	1.41E-06						1.29E-08	0.0000004
Sb-125	1.18E-06						1.09E-08	0.0000004
Th-228	8.66E-09	2.76E-09					9.68E-09	0.0000003
Ac-228							9.65E-09	0.0000003
Cm-243	1.47E-08						7.99E-09	0.0000003
Pb-210							6.77E-09	0.0000002
Th-231	2.12E-04						5.80E-09	0.0000002

Data Table A-25a Radioactive Atmospheric Releases and MEI Doses for Site Boundary MEI

2022 CAP88 PC Dose Calculations for NESHAP Report to EPA **3 Pages**

Radionuclide	Releases (Curies)						Maximally Exposed Individual Dose	Fraction of Dose
	0 m	15m	21m	31m	56m	59m	(mrem)	
Sn-126	1.70E-07						4.95E-09	0.0000002
Tl-210							3.14E-09	0.0000001
Am-243	3.69E-09						2.61E-09	0.0000001
Bi-212							2.16E-09	0.0000001
Rn-222							2.11E-09	0.0000001
U-236	3.97E-08						2.06E-09	0.0000001
Pb-212	8.43E-07						1.80E-09	0.0000001
Mn-54	2.91E-07						1.68E-09	0.0000001
Ac-225							1.27E-09	0.00000004
Ra-225							1.16E-09	0.00000004
U-232	5.48E-09						1.02E-09	0.00000003
K-40	7.47E-09						8.46E-10	0.00000003
Th-232	9.06E-12	1.72E-09					7.97E-10	0.00000003
Eu-152	8.82E-09						7.96E-10	0.00000003
Ra-224							7.25E-10	0.00000002
U-233	1.24E-08						7.17E-10	0.00000002
Bi-213							5.59E-10	0.00000002
La-140	5.00E-06						5.37E-10	0.00000002
Co-57	5.12E-07						4.66E-10	0.00000002
Te-125m							4.60E-10	0.00000002
Nb-95	3.63E-07						4.60E-10	0.00000002
Po-214							4.45E-10	0.00000002
Pm-147	2.89E-06						3.87E-10	0.00000001
Sm-151	2.89E-06						2.64E-10	0.000000009
Ba-133	1.01E-08						2.59E-10	0.000000009
Eu-155	1.18E-07						2.46E-10	0.000000008
Np-239							1.50E-10	0.000000005
Zr-95	1.22E-07						1.48E-10	0.000000005
Tl-209							1.43E-10	0.000000005
Pu-236	4.21E-10						1.37E-10	0.000000005
Se-79	4.90E-09						1.29E-10	0.000000004
Fr-221							9.12E-11	0.000000003
U-237							5.32E-11	0.000000002
Ce-144	2.00E-08						3.04E-11	0.000000001
Po-210							2.83E-11	0.000000001
Cs-134	3.42E-10						2.36E-11	0.0000000008
Pr-144	2.00E-08						2.07E-11	0.0000000007
Ra-223							1.48E-11	0.0000000005
Th-227							1.32E-11	0.0000000005
Pb-211							1.26E-11	0.0000000004
Pb-209							1.08E-11	0.0000000004
Pa-231							9.02E-12	0.0000000003
Rn-220							7.25E-12	0.0000000002
Tl-207							6.52E-12	0.0000000002
Rn-219							6.42E-12	0.0000000002
Bi-211							5.19E-12	0.0000000002
Fe-55	7.09E-09						2.74E-12	0.00000000009
Nb-95m							2.27E-12	0.00000000008
Y-88	3.60E-10						2.23E-12	0.00000000008
Ni-63	5.56E-09						2.10E-12	0.00000000007
Co-56	1.20E-10						8.87E-13	0.00000000003
At-217							7.69E-13	0.00000000003
Y-91	7.98E-10						4.40E-13	0.00000000002
Sr-85	4.68E-10						4.07E-13	0.00000000001
Sr-89	4.93E-10						3.88E-13	0.00000000001

Data Table A-25a Radioactive Atmospheric Releases and MEI Doses for Site Boundary MEI

2022 CAP88 PC Dose Calculations for NESHAP Report to EPA **3 Pages**

Radionuclide	Releases (Curies)						Maximally Exposed Individual Dose	Fraction of Dose
	0 m	15m	21m	31m	56m	59m	(mrem)	
In-113m							2.95E-13	0.00000000001
Ru-103	5.11E-10						2.79E-13	0.00000000001
I-131	6.67E-10						2.62E-13	<0.00000000001
Tl-206							2.56E-13	<0.00000000001
Ag-110m	1.48E-11						2.32E-13	<0.00000000001
Ce-139	3.78E-10						1.94E-13	<0.00000000001
Po-216							1.75E-13	<0.00000000001
Sn-113	4.56E-10						1.64E-13	<0.00000000001
At-218							1.42E-13	<0.00000000001
Fr-223							1.25E-13	<0.00000000001
Po-213							1.18E-13	<0.00000000001
Hg-203	4.02E-10						5.64E-14	<0.00000000001
Po-218							3.76E-14	<0.00000000001
Ac-227							2.77E-14	<0.00000000001
Po-215							1.95E-14	<0.00000000001
Pr-144m							1.37E-14	<0.00000000001
Ni-59	5.76E-11						1.04E-14	<0.00000000001
Hg-206							8.84E-15	<0.00000000001
Ce-141	4.94E-11						8.07E-15	<0.00000000001
Sn-123	6.66E-12						7.54E-15	<0.00000000001
Pm-148m	1.90E-12						3.98E-15	<0.00000000001
Po-211							2.50E-15	<0.00000000001
U-235m							1.04E-15	<0.00000000001
Rn-218							8.20E-16	<0.00000000001
Be-7	1.17E-11						7.46E-16	<0.00000000001
Rh-103m							3.91E-16	<0.00000000001
Pm-148							3.00E-16	<0.00000000001
Ag-110							1.85E-16	<0.00000000001
Bi-215							2.89E-17	<0.00000000001
Te-127	1.04E-11						1.68E-17	<0.00000000001
Te-129	1.05E-12						5.33E-19	<0.00000000001
Xe-131m							7.57E-22	<0.00000000001
Sm-147							3.42E-22	<0.00000000001
Gd-152							2.36E-28	<0.00000000001
Nd-144							1.20E-28	<0.00000000001
At-219								<0.00000000001
Po-212								<0.00000000001
Sm-148								<0.00000000001
Sc-46	1.72E-10						6.78E-13	<0.00000000001
Grand Total	**1.03E+02**	**3.73E+03**	**8.00E+00**	**1.80E+03**	**1.44E+03**	**1.56E+04**	**2.92E-02**	

Data Table A-25b. Radioactive Atmospheric Releases and MEI Doses at TRL Worker MEI Location

Data Table A-25b Radioactive Atmospheric Releases and MEI Doses at TRL Worker MEI Location

2022 CAP88 PC Dose Calculations for NESHAP Report to EPA **3 Pages**

Radionuclide	Releases (Curies)						Maximally Exposed Individual Dose	Fraction of Dose
	0 m	15m	21m	31m	56m	59m	(mrem)	
H-3 (oxide)	1.03E+02	8.87E+02	8.00E+00	1.58E+03	1.44E+03	2.48E+03	1.24E-02	0.40
I-129	7.48E-05		7.48E-07			7.01E-03	8.83E-03	0.29
H-3 (elemental)		2.84E+03		2.19E+02		3.76E+01	6.01E-03	0.20
Ba-137m							1.24E-03	0.04
Cs-137	3.98E-03			1.00E-02		3.95E-06	1.14E-03	0.04
Sr-90	3.09E-03	4.29E-06		2.72E-05		1.16E-05	3.48E-04	0.01
Kr-85						1.30E+04	3.13E-04	0.01
Pu-239	6.94E-05	2.51E-08	2.41E-09	1.19E-09		4.88E-05	1.03E-04	0.003
Unidentified Alpha	9.84E-05	2.04E-06	3.41E-07	2.40E-06			9.49E-05	0.003
Unidentified Beta	6.22E-04	1.25E-05	1.63E-07	1.89E-05		8.40E-05	9.39E-05	0.003
Y-90	3.09E-03	4.29E-06		2.72E-05		1.16E-05	5.43E-05	0.002
Pu-238	3.13E-05	1.09E-07	2.74E-09			1.54E-05	3.77E-05	0.001
Am-241	1.13E-05	6.21E-08	3.10E-09	1.04E-08		3.40E-06	1.10E-05	0.0004
C-14	3.33E-07					4.10E-02	1.04E-05	0.0003
Bi-214							1.01E-05	0.0003
Pu-240	7.68E-06						7.06E-06	0.0002
Th-230	5.70E-11	5.89E-09					5.91E-06	0.0002
Ra-226	2.66E-07						4.73E-06	0.0002
Pu-241	2.07E-04						3.47E-06	0.0001
Pb-214							1.73E-06	0.0001
U-238	3.31E-06	2.70E-07	1.04E-08	1.85E-06		2.59E-05	1.43E-06	0.00005
Tc-99	6.02E-05						1.41E-06	0.00005
U-234	2.59E-06	2.12E-07	7.57E-09	1.88E-06		1.90E-05	1.29E-06	0.00004
Pa-234m							1.04E-06	0.00003
Na-22	1.50E-05						9.41E-07	0.00003
Np-237	1.54E-06					1.04E-07	7.08E-07	0.00002
Co-60	2.65E-06						3.04E-07	0.00001
Cm-244	2.75E-07	1.07E-09	2.46E-08			1.11E-08	1.48E-07	0.000005
Bi-210							1.38E-07	0.000004
U-235	3.84E-08	1.71E-08	3.15E-10			1.32E-06	1.26E-07	0.000004
Nb-94	2.42E-07						1.09E-07	0.000004
Pa-233	1.42E-06						1.01E-07	0.000003
Th-234							8.78E-08	0.000003
Sb-126m							7.99E-08	0.000003
Ra-228	2.65E-07						7.15E-08	0.000002
Rh-106	1.68E-05						5.85E-08	0.000002
Ru-106	1.68E-05						3.62E-08	0.000001
Eu-154	3.56E-07						2.95E-08	0.000001
Zn-65	1.64E-06						2.69E-08	0.000001
Pu-242	2.67E-08						2.33E-08	0.000001
Pa-234							2.05E-08	0.000001
Sb-126	1.70E-07						1.93E-08	0.000001
Th-229	1.05E-09						1.81E-08	0.000001
Tl-208	1.41E-06						1.55E-08	0.0000005
Sb-125	1.18E-06						1.30E-08	0.0000004
Ac-228							1.17E-08	0.0000004
Th-228	8.66E-09	2.76E-09					1.05E-08	0.0000003
Cm-243	1.47E-08						8.64E-09	0.0000003

Data Table A-25b Radioactive Atmospheric Releases and MEI Doses at TRL Worker MEI Location

2022 CAP88 PC Dose Calculations for NESHAP Report to EPA **3 Pages**

Radionuclide	Releases (Curies)						Maximally Exposed Individual Dose	Fraction of Dose
	0 m	15m	21m	31m	56m	59m	(mrem)	
Pb-210							8.49E-09	0.0000003
Th-231	2.12E-04						7.17E-09	0.0000002
Sn-126	1.70E-07						5.54E-09	0.0000002
Tl-210							3.94E-09	0.0000001
Am-243	3.69E-09						2.82E-09	0.0000001
Rn-222							2.64E-09	0.0000001
Bi-212							2.56E-09	0.0000001
U-236	3.97E-08						2.22E-09	0.0000001
Pb-212	8.43E-07						2.14E-09	0.0000001
Mn-54	2.91E-07						2.01E-09	0.0000001
Ac-225							1.38E-09	0.00000004
Ra-225							1.26E-09	0.00000004
U-232	5.48E-09						1.09E-09	0.00000004
Eu-152	8.82E-09						9.56E-10	0.00000003
K-40	7.47E-09						9.51E-10	0.00000003
Th-232	9.06E-12	1.72E-09					8.59E-10	0.00000003
Ra-224							7.97E-10	0.00000003
U-233	1.24E-08						7.71E-10	0.00000003
Bi-213							6.71E-10	0.00000002
La-140	5.00E-06						6.31E-10	0.00000002
Po-214							5.58E-10	0.00000002
Nb-95	3.63E-07						5.48E-10	0.00000002
Co-57	5.12E-07						5.43E-10	0.00000002
Te-125m							5.17E-10	0.00000002
Pm-147	2.89E-06						4.14E-10	0.00000001
Ba-133	1.01E-08						3.12E-10	0.00000001
Eu-155	1.18E-07						2.93E-10	0.00000001
Sm-151	2.89E-06						2.83E-10	0.000000009
Np-239							1.81E-10	0.000000006
Zr-95	1.22E-07						1.75E-10	0.000000006
Tl-209							1.72E-10	0.000000006
Pu-236	4.21E-10						1.48E-10	0.000000005
Se-79	4.90E-09						1.37E-10	0.000000004
Fr-221							1.10E-10	0.000000004
U-237							6.40E-11	0.000000002
Po-210							3.55E-11	0.000000001
Ce-144	2.00E-08						3.27E-11	0.000000001
Cs-134	3.42E-10						2.62E-11	0.0000000009
Pr-144	2.00E-08						2.49E-11	0.0000000008
Ra-223							1.87E-11	0.0000000006
Th-227							1.68E-11	0.0000000005
Pb-211							1.58E-11	0.0000000005
Pb-209							1.30E-11	0.0000000004
Pa-231							1.11E-11	0.0000000004
Rn-220							8.72E-12	0.0000000003
Tl-207							8.23E-12	0.0000000003
Rn-219							8.09E-12	0.0000000003
Bi-211							6.55E-12	0.0000000002
Fe-55	7.09E-09						2.89E-12	0.00000000009
Y-88	3.60E-10						2.66E-12	0.00000000009
Nb-95m							2.54E-12	0.00000000008
Ni-63	5.56E-09						2.22E-12	0.00000000007
Co-56	1.20E-10						1.04E-12	0.00000000003
At-217							9.26E-13	0.00000000003

Data Table A-25b Radioactive Atmospheric Releases and MEI Doses at TRL Worker MEI Location

2022 CAP88 PC Dose Calculations for NESHAP Report to EPA **3 Pages**

Radionuclide	Releases (Curies)						Maximally Exposed Individual Dose	Fraction of Dose
	0 m	15m	21m	31m	56m	59m	(mrem)	
Sc-46	1.72E-10						8.08E-13	0.00000000003
Sr-85	4.68E-10						4.79E-13	0.00000000002
Y-91	7.98E-10						4.79E-13	0.00000000002
Sr-89	4.93E-10						4.17E-13	0.00000000001
In-113m							3.56E-13	0.00000000001
Ru-103	5.11E-10						3.27E-13	0.00000000001
Tl-206							3.21E-13	0.00000000001
Ag-110m	1.48E-11						2.77E-13	0.000000000009
I-131	6.67E-10						2.75E-13	0.00000000001
Ce-139	3.78E-10						2.30E-13	0.00000000001
Po-216							2.10E-13	0.00000000001
At-218							1.77E-13	0.00000000001
Sn-113	4.56E-10						1.76E-13	0.00000000001
Fr-223							1.57E-13	0.00000000001
Po-213							1.42E-13	<0.00000000001
Hg-203	4.02E-10						5.93E-14	<0.00000000001
Po-218							4.72E-14	<0.00000000001
Ac-227							3.51E-14	<0.00000000001
Po-215							2.47E-14	<0.00000000001
Pr-144m							1.65E-14	<0.00000000001
Hg-206							1.10E-14	<0.00000000001
Ni-59	5.76E-11						1.10E-14	<0.00000000001
Ce-141	4.94E-11						8.96E-15	<0.00000000001
Sn-123	6.66E-12						8.17E-15	<0.00000000001
Pm-148m	1.90E-12						4.72E-15	<0.00000000001
Po-211							3.15E-15	<0.00000000001
U-235m							1.17E-15	<0.00000000001
Rn-218							1.03E-15	<0.00000000001
Be-7	1.17E-11						8.89E-16	<0.00000000001
Rh-103m							4.69E-16	<0.00000000001
Pm-148							3.47E-16	<0.00000000001
Ag-110							2.23E-16	<0.00000000001
Bi-215							3.64E-17	<0.00000000001
Te-127	1.04E-11						1.84E-17	<0.00000000001
Te-129	1.05E-12						6.21E-19	<0.00000000001
Xe-131m							7.09E-22	<0.00000000001
Sm-147							3.27E-22	<0.00000000001
Gd-152							2.26E-28	<0.00000000001
Nd-144							1.12E-28	<0.00000000001
At-219								<0.00000000001
Po-212								<0.00000000001
Sm-148								<0.00000000001
Grand Total	**1.03E+02**	**3.73E+03**	**8.00E+00**	**1.80E+03**	**1.44E+03**	**1.56E+04**	**3.07E-02**	

Data Table A-26a. Diffuse and Fugitive Releases and MEI Doses for NESHAP at Site Boundary MEI

Data Table A-26a, Diffuse and Fugitive Releases and MEI Doses for NESHAP **3 Pages**

2022 Diffuse and Fugitive Releases[a] and MEI Doses at Site Boundary MEI

Radionuclide	Releases (curies)	Maximally Exposed Individual Dose (mrem)	Fraction of Dose
Cs-137	3.98E-03	5.97E-04	0.40
Sr-90	3.09E-03	3.25E-04	0.22
H-3 (oxide)	1.03E+02	2.43E-04	0.16
Unidentified Alpha	9.84E-05	8.39E-05	0.06
Unidentified Beta	6.22E-04	7.44E-05	0.05
Pu-239	6.94E-05	5.92E-05	0.04
Y-90	3.09E-03	4.45E-05	0.03
I-129	7.48E-05	3.13E-05	0.02
Pu-238	3.13E-05	2.45E-05	0.02
Am-241	1.13E-05	8.04E-06	0.01
Pu-240	7.68E-06	6.55E-06	0.004
Pu-241	2.07E-04	3.22E-06	0.002
Tc-99	6.02E-05	1.33E-06	0.001
Bi-214		1.02E-06	0.001
Na-22	1.50E-05	8.04E-07	0.001
Th-230	5.70E-11	6.70E-07	0.0004
Np-237	1.54E-06	6.19E-07	0.0004
Ra-226	2.66E-07	5.76E-07	0.0004
Co-60	2.65E-06	2.55E-07	0.0002
Pb-214		1.75E-07	0.0001
U-238	3.31E-06	1.57E-07	0.0001
U-234	2.59E-06	1.46E-07	0.0001
Cm-244	2.75E-07	1.21E-07	0.0001
Pa-234m		9.34E-08	0.0001
Nb-94	2.42E-07	9.03E-08	0.0001
Pa-233	1.42E-06	7.90E-08	0.0001
Ra-228	2.65E-07	6.69E-08	0.00004
Sb-126m		6.64E-08	0.00004
Rh-106	1.68E-05	4.86E-08	0.00003
Ru-106	1.68E-05	3.40E-08	0.00002
Zn-65	1.64E-06	2.48E-08	0.00002
Eu-154	3.56E-07	2.46E-08	0.00002
Pu-242	2.67E-08	2.16E-08	0.00001
Th-229	1.05E-09	1.67E-08	0.00001
Sb-126	1.70E-07	1.60E-08	0.00001
Bi-210		1.39E-08	0.00001
Tl-208	1.41E-06	1.23E-08	0.00001
Sb-125	1.18E-06	1.09E-08	0.00001
Ac-228		9.27E-09	0.00001
Th-234		8.12E-09	0.00001
Th-228	8.66E-09	8.08E-09	0.00001
Cm-243	1.47E-08	7.99E-09	0.00001
Sn-126	1.70E-07	4.95E-09	0.000003
U-235	3.84E-08	3.39E-09	0.000002
Am-243	3.69E-09	2.61E-09	0.000002
Bi-212		2.10E-09	0.000001
U-236	3.97E-08	2.06E-09	0.000001
Pa-234		1.84E-09	0.000001

Data Table A-26a, Diffuse and Fugitive Releases and MEI Doses for NESHAP **3 Pages**

2022 Diffuse and Fugitive Releases[a] and MEI Doses at Site Boundary MEI

Radionuclide	Releases (curies)	Maximally Exposed Individual Dose (mrem)	Fraction of Dose
Pb-212	8.43E-07	1.73E-09	0.000001
Mn-54	2.91E-07	1.68E-09	0.000001
Ac-225		1.27E-09	0.000001
Ra-225		1.16E-09	0.000001
Th-231	2.12E-04	1.07E-09	0.000001
U-232	5.48E-09	1.02E-09	0.000001
Pb-210		8.60E-10	0.000001
K-40	7.47E-09	8.46E-10	0.000001
Eu-152	8.82E-09	7.96E-10	0.000001
U-233	1.24E-08	7.17E-10	0.0000005
Ra-224		6.20E-10	0.0000004
Bi-213		5.59E-10	0.0000004
La-140	5.00E-06	5.37E-10	0.0000004
Co-57	5.12E-07	4.66E-10	0.0000003
Te-125m		4.60E-10	0.0000003
Nb-95	3.63E-07	4.60E-10	0.0000003
Tl-210		3.99E-10	0.0000003
Pm-147	2.89E-06	3.87E-10	0.0000003
Rn-222		2.68E-10	0.0000002
Sm-151	2.89E-06	2.6E-10	0.0000002
Ba-133	1.01E-08	2.6E-10	0.0000002
Eu-155	1.18E-07	2.5E-10	0.0000002
Np-239		1.5E-10	0.0000001
Zr-95	1.22E-07	1.5E-10	0.0000001
Tl-209		1.4E-10	0.0000001
Pu-236	4.21E-10	1.4E-10	0.0000001
Se-79	4.90E-09	1.3E-10	0.0000001
C-14	3.33E-07	1.2E-10	0.0000001
Fr-221		9.12E-11	0.0000001
Po-214		5.65E-11	0.00000004
U-237		5.32E-11	0.00000004
Ce-144	2.00E-08	3.04E-11	0.00000002
Cs-134	3.42E-10	2.36E-11	0.00000002
Pr-144	2.00E-08	2.1E-11	0.00000001
Pb-209		1.1E-11	0.00000001
Rn-220		7.0E-12	0.000000005
Th-232	9.06E-12	4.08E-12	0.000000003
Po-210		3.60E-12	0.000000002
Fe-55	7.09E-09	2.74E-12	0.000000002
Nb-95m		2.27E-12	0.000000002
Y-88	3.60E-10	2.23E-12	0.000000001
Ni-63	5.56E-09	2.1E-12	0.000000001
Pa-231		1.2E-12	0.000000001
Co-56	1.20E-10	8.9E-13	0.000000001
Ra-223		7.71E-13	0.000000001
At-217		7.69E-13	0.000000001
Th-227		6.88E-13	0.0000000005
Sc-46	1.72E-10	6.78E-13	0.0000000005
Pb-211		6.55E-13	0.0000000004
Y-91	7.98E-10	4.40E-13	0.0000000003
Sr-85	4.68E-10	4.07E-13	0.0000000003

Data Table A-26a, Diffuse and Fugitive Releases and MEI Doses for NESHAP **3 Pages**

2022 Diffuse and Fugitive Releases[a] and MEI Doses at Site Boundary MEI

Radionuclide	Releases (curies)	Maximally Exposed Individual Dose (mrem)	Fraction of Dose
Sr-89	4.93E-10	3.88E-13	0.0000000003
Tl-207		3.39E-13	0.0000000002
Rn-219		3.34E-13	0.0000000002
In-113m		2.95E-13	0.0000000002
Ru-103	5.11E-10	2.79E-13	0.0000000002
Bi-211		2.70E-13	0.0000000002
I-131	6.67E-10	2.62E-13	0.0000000002
Ag-110m	1.48E-11	2.32E-13	0.0000000002
Ce-139	3.78E-10	1.94E-13	0.0000000001
Po-216		1.68E-13	0.0000000001
Sn-113	4.56E-10	1.64E-13	0.0000000001
Po-213		1.18E-13	0.0000000001
Hg-203	4.02E-10	5.64E-14	0.00000000004
Tl-206		3.24E-14	0.00000000002
At-218		1.80E-14	0.00000000001
Pr-144m		1.37E-14	0.00000000001
Ni-59	5.76E-11	1.04E-14	0.00000000001
Ce-141	4.94E-11	8.07E-15	0.00000000001
Sn-123	6.66E-12	7.54E-15	0.00000000001
Fr-223		6.49E-15	<0.00000000001
Po-218		4.78E-15	<0.00000000001
Pm-148m	1.90E-12	3.98E-15	<0.00000000001
Ac-227		1.44E-15	<0.00000000001
Hg-206		1.12E-15	<0.00000000001
Po-215		1.02E-15	<0.00000000001
Be-7	1.17E-11	7.46E-16	<0.00000000001
U-235m		6.73E-16	<0.00000000001
Rh-103m		3.91E-16	<0.00000000001
Pm-148		3.00E-16	<0.00000000001
Ag-110		1.85E-16	<0.00000000001
Po-211		1.30E-16	<0.00000000001
Rn-218		1.04E-16	<0.00000000001
Te-127	1.04E-11	1.68E-17	<0.00000000001
Bi-215		1.50E-18	<0.00000000001
Te-129	1.05E-12	5.33E-19	<0.00000000001
Xe-131m		7.57E-22	<0.00000000001
Sm-147		3.42E-22	<0.00000000001
Gd-152		2.36E-28	<0.00000000001
Nd-144		1.20E-28	<0.00000000001
At-219			<0.00000000001
Po-212			<0.00000000001
Sm-148			<0.00000000001
Grand Total	**1.03E+02**	**1.51E-03**	

a. Beginning in 2016, calculated individual isotope annual releases below 1E-12 Ci (1 pCi) are no longer reported in this table and, therefore, not used in the dose calculations.
b. Daughter products (Sb-126 & Y-90) in secular equilibrium with source terms (Sn-126 & Sr-90, respectively). In CAP88, they are included in their parents' source term and are not run separately.
c. Radionuclides with no release values are daughter products with no original source term of their own.

Data Table A-26b. Diffuse and Fugitive Releases and MEI Doses for NESHAP at TRL Worker Location

Data Table A-26b, Diffuse and Fugitive Releases and MEI Doses for NESHAP **3 Pages**

2022 Diffuse and Fugitive Releases[a] and MEI Doses TRL Worker Location

Radionuclide	Releases (curies)	Maximally Exposed Individual Dose (mrem)	Fraction of Dose
Cs-137	3.98E-03	6.74E-04	0.41
Sr-90	3.09E-03	3.44E-04	0.21
H-3 (oxide)	1.03E+02	2.48E-04	0.15
Unidentified Alpha	9.84E-05	9.05E-05	0.06
Unidentified Beta	6.22E-04	8.00E-05	0.05
Pu-239	6.94E-05	6.38E-05	0.04
Y-90	3.09E-03	5.35E-05	0.03
I-129	7.48E-05	3.66E-05	0.02
Pu-238	3.13E-05	2.64E-05	0.02
Am-241	1.13E-05	8.68E-06	0.005
Pu-240	7.68E-06	7.06E-06	0.004
Pu-241	2.07E-04	3.47E-06	0.002
Tc-99	6.02E-05	1.41E-06	0.001
Bi-214		1.23E-06	0.001
Na-22	1.50E-05	9.41E-07	0.001
Th-230	5.70E-11	7.21E-07	0.0004
Np-237	1.54E-06	6.69E-07	0.0004
Ra-226	2.66E-07	6.12E-07	0.0004
Co-60	2.65E-06	3.04E-07	0.0002
Pb-214		2.10E-07	0.0001
U-238	3.31E-06	1.69E-07	0.0001
U-234	2.59E-06	1.57E-07	0.0001
Cm-244	2.75E-07	1.31E-07	0.0001
Pa-234m		1.12E-07	0.0001
Nb-94	2.42E-07	1.09E-07	0.0001
Pa-233	1.42E-06	9.50E-08	0.0001
Sb-126m		7.99E-08	0.00005
Ra-228	2.65E-07	7.10E-08	0.00004
Rh-106	1.68E-05	5.85E-08	0.00004
Ru-106	1.68E-05	3.62E-08	0.00002
Eu-154	3.56E-07	2.95E-08	0.00002
Zn-65	1.64E-06	2.69E-08	0.00002
Pu-242	2.67E-08	2.33E-08	0.00001
Sb-126	1.70E-07	1.93E-08	0.00001
Th-229	1.05E-09	1.81E-08	0.00001
Bi-210		1.67E-08	0.00001
Tl-208	1.41E-06	1.49E-08	0.00001
Sb-125	1.18E-06	1.30E-08	0.00001
Ac-228		1.12E-08	0.00001
Th-234		9.59E-09	0.00001
Th-228	8.66E-09	8.72E-09	0.00001
Cm-243	1.47E-08	8.64E-09	0.00001
Sn-126	1.70E-07	5.54E-09	0.000003
U-235	3.84E-08	3.83E-09	0.000002
Am-243	3.69E-09	2.82E-09	0.000002
Bi-212		2.48E-09	0.000002
U-236	3.97E-08	2.22E-09	0.000001
Pa-234		2.22E-09	0.000001

Data Table A-26b, Diffuse and Fugitive Releases and MEI Doses for NESHAP **3 Pages**

2022 Diffuse and Fugitive Releases[a] and MEI Doses TRL Worker Location

Radionuclide	Releases (curies)	Maximally Exposed Individual Dose (mrem)	Fraction of Dose
Pb-212	8.43E-07	2.07E-09	0.000001
Mn-54	2.91E-07	2.01E-09	0.000001
Ac-225		1.38E-09	0.000001
Ra-225		1.26E-09	0.000001
Th-231	2.12E-04	1.19E-09	0.000001
U-232	5.48E-09	1.09E-09	0.000001
Pb-210		1.03E-09	0.000001
Eu-152	8.82E-09	9.56E-10	0.000001
K-40	7.47E-09	9.51E-10	0.000001
U-233	1.24E-08	7.71E-10	0.0000005
Ra-224		6.83E-10	0.0000004
Bi-213		6.71E-10	0.0000004
La-140	5.00E-06	6.31E-10	0.0000004
Nb-95	3.63E-07	5.48E-10	0.0000003
Co-57	5.12E-07	5.43E-10	0.0000003
Te-125m		5.17E-10	0.0000003
Tl-210		4.79E-10	0.0000003
Pm-147	2.89E-06	4.14E-10	0.0000003
Rn-222		3.22E-10	0.0000002
Ba-133	1.01E-08	3.1E-10	0.0000002
Eu-155	1.18E-07	2.9E-10	0.0000002
Sm-151	2.89E-06	2.8E-10	0.0000002
Np-239		1.8E-10	0.0000001
Zr-95	1.22E-07	1.8E-10	0.0000001
Tl-209		1.7E-10	0.0000001
Pu-236	4.21E-10	1.5E-10	0.00000009
Se-79	4.90E-09	1.4E-10	0.00000008
C-14	3.33E-07	1.3E-10	0.00000008
Fr-221		1.10E-10	0.00000007
Po-214		6.81E-11	0.00000004
U-237		6.40E-11	0.00000004
Ce-144	2.00E-08	3.27E-11	0.00000002
Cs-134	3.42E-10	2.62E-11	0.00000002
Pr-144	2.00E-08	2.5E-11	0.000000015
Pb-209		1.3E-11	0.000000008
Rn-220		8.4E-12	0.000000005
Th-232	9.06E-12	4.40E-12	0.000000003
Po-210		4.33E-12	0.000000003
Fe-55	7.09E-09	2.89E-12	0.000000002
Y-88	3.60E-10	2.66E-12	0.000000002
Nb-95m		2.54E-12	0.000000002
Ni-63	5.56E-09	2.2E-12	0.000000001
Pa-231		1.2E-12	0.000000001
Co-56	1.20E-10	1.0E-12	0.000000001
Ra-223		9.27E-13	0.000000001
At-217		9.26E-13	0.000000001
Th-227		8.29E-13	0.0000000005
Sc-46	1.72E-10	8.08E-13	0.0000000005
Pb-211		7.89E-13	0.0000000005
Sr-85	4.68E-10	4.79E-13	0.0000000003
Y-91	7.98E-10	4.79E-13	0.0000000003

Data Table A-26b, Diffuse and Fugitive Releases and MEI Doses for NESHAP **3 Pages**

2022 Diffuse and Fugitive Releases[a] and MEI Doses TRL Worker Location

Radionuclide	Releases (curies)	Maximally Exposed Individual Dose (mrem)	Fraction of Dose
Sr-89	4.93E-10	4.17E-13	0.0000000003
Tl-207		4.08E-13	0.0000000002
Rn-219		4.02E-13	0.0000000002
In-113m		3.56E-13	0.0000000002
Ru-103	5.11E-10	3.27E-13	0.0000000002
Bi-211		3.25E-13	0.0000000002
Ag-110m	1.48E-11	2.77E-13	0.0000000002
I-131	6.67E-10	2.75E-13	0.0000000002
Ce-139	3.78E-10	2.30E-13	0.0000000001
Po-216		2.02E-13	0.0000000001
Sn-113	4.56E-10	1.76E-13	0.0000000001
Po-213		1.42E-13	0.00000000009
Hg-203	4.02E-10	5.93E-14	0.00000000004
Tl-206		3.90E-14	0.00000000002
At-218		2.16E-14	0.00000000001
Pr-144m		1.65E-14	0.00000000001
Ni-59	5.76E-11	1.10E-14	0.00000000001
Ce-141	4.94E-11	8.96E-15	0.00000000001
Sn-123	6.66E-12	8.17E-15	<0.00000000001
Fr-223		7.81E-15	<0.00000000001
Po-218		5.75E-15	<0.00000000001
Pm-148m	1.90E-12	4.72E-15	<0.00000000001
Ac-227		1.74E-15	<0.00000000001
Hg-206		1.35E-15	<0.00000000001
Po-215		1.23E-15	<0.00000000001
Be-7	1.17E-11	8.89E-16	<0.00000000001
U-235m		7.27E-16	<0.00000000001
Rh-103m		4.69E-16	<0.00000000001
Pm-148		3.47E-16	<0.00000000001
Ag-110		2.23E-16	<0.00000000001
Po-211		1.56E-16	<0.00000000001
Rn-218		1.26E-16	<0.00000000001
Te-127	1.04E-11	1.84E-17	<0.00000000001
Bi-215		1.80E-18	<0.00000000001
Te-129	1.05E-12	6.21E-19	<0.00000000001
Xe-131m		7.09E-22	<0.00000000001
Sm-147		3.27E-22	<0.00000000001
Gd-152		2.26E-28	<0.00000000001
Nd-144		1.12E-28	<0.00000000001
At-219			<0.00000000001
Po-212			<0.00000000001
Sm-148			<0.00000000001
Grand Total	**1.03E+02**	**1.64E-03**	

a. Beginning in 2016, calculated individual isotope annual releases below 1E-12 Ci (1 pCi) are no longer reported in this table and, therefore, not used in the dose calculations.
b. Daughter products (Sb-126 & Y-90) in secular equilibrium with source terms (Sn-126 & Sr-90, respectively). In CAP88, they are included in their parents' source term and are not run separately.
c. Radionuclides with no release values are daughter products with no original source term of their own.

Data Table A-27. CAP88 Offsite MEI Dose Compared to MAXDOSE-SR

Data Table A-27, CAP88 Offsite MEI Dose Compared to MAXDOSE-SR
2022 Maximally Exposed Individual Dose Commitment at Site Boundary from Atmospheric Releases

Pathway	CAP88 PC Maximally Exposed Individual		MAXDOSE-SR Representative Person	
	(Millirem)[a]	(Percent of Dose)	(Millirem)[a]	(Percent of Dose)[d]
Plume	2.6E-04	0.89%	7.1E-04	4.37%
Ground	1.3E-03	4.29%	1.0E-03	6.37%
Inhalation	2.1E-03	7.22%	5.1E-03	31.42%
Food[b]	2.6E-02	87.59%	9.4E-03	57.83%
Total	**2.9E-02**	**100.0%**	**1.6E-02**	**100.0%**

Radionuclide	CAP88 PC Maximally Exposed Individual		MAXDOSE-SR Representative Person	
	(Millirem)[a]	(Percent of Dose)	(Millirem)[a]	(Percent of Dose)[d]
Gases and Vapors				
H-3[c]	1.8E-02	62.22%	1.2E-02	70.99%
C-14	1.1E-05	0.04%	8.8E-06	0.05%
Kr-85	2.6E-04	0.89%	7.1E-04	4.36%
I-129	7.9E-03	27.18%	2.3E-03	14.32%
Particulates				
Am-241	1.0E-05	0.03%	6.8E-06	0.04%
Cs-137	2.1E-03	7.20%	1.1E-03	6.67%
Pu-238	3.4E-05	0.12%	3.3E-05	0.21%
Pu-239	9.2E-05	0.31%	8.9E-05	0.55%
Pu-240	6.6E-06	0.02%	6.4E-06	0.04%
Sr-90	3.3E-04	1.13%	2.7E-04	1.67%
Tc-99	1.3E-06	0.00%	2.5E-06	0.02%
U-234	1.1E-06	0.00%	1.9E-06	0.01%
U-238	1.3E-06	0.00%	3.2E-06	0.02%
Unidentified Alpha	8.8E-05	0.30%	8.5E-05	0.52%
Unidentified Beta	8.7E-05	0.30%	7.9E-05	0.49%
Total	**2.9E-02**	**99.8%**	**1.6E-02**	**100.0%**

NOTE: (a) Committed effective dose.

NOTE: (b) Meat, milk, and vegetables.

NOTE: (c) Dose from tritium in foods calculated with absolute humidity of 12.9 g water/cubic meter of air.

NOTE: (d) Radionuclides contributing 0.01% or more from MAXDOSE-SR output.

Data Table A-28. CAP88 PC Population Dose Compared to POPDOSE-SR

Data Table A-28, CAP88 PC Population Dose Compared to POPDOSE-SR
2022 Collective Committed Dose from Atmospheric Releases

Pathway	CAP88 Code		POPDOSE-SR Code	
	(Millirem)[a]	(Percent of Dose)	(Millirem)[a]	(Percent of Dose)[d]
Plume	3.5E-02	1.37%	6.0E-02	7.99%
Ground	1.4E-01	5.77%	1.1E-01	14.10%
Inhalation	2.7E-01	10.65%	4.6E-01	61.36%
Food[b]	2.1E+00	82.21%	1.2E-01	16.55%
Total	**2.5E+00**	**100.0%**	**7.4E-01**	**100.0%**

Radionuclide	CAP88 Code		POPDOSE-SR Code	
	(Millirem)[a]	(Percent of Dose)	(Millirem)[a]	(Percent of Dose)[d]
Gases and Vapors				
H-3[c]	1.8E+00	71.93%	5.3E-01	71.68%
C-14	1.0E-03	0.04%	1.0E-04	0.01%
Kr-85	3.5E-02	1.38%	6.0E-02	7.99%
I-129	3.6E-01	14.44%	3.0E-02	4.07%
Particulates				
Am-241	9.7E-04	0.04%	4.1E-04	0.05%
Cs-137	2.4E-01	9.41%	9.5E-02	12.77%
Pu-238	3.3E-03	0.13%	2.0E-03	0.27%
Pu-239	9.1E-03	0.36%	5.5E-03	0.74%
Pu-240	6.3E-04	0.02%	3.6E-04	0.05%
Pu-241	3.1E-04	0.01%	8.9E-05	0.01%
Sr-90	3.0E-02	1.19%	9.2E-03	1.24%
U-234	1.1E-04	0.00%	1.1E-04	0.02%
U-238	1.2E-04	0.00%	2.4E-04	0.03%
Unidentified Alpha	8.5E-03	0.34%	4.8E-03	0.64%
Unidentified Beta	9.2E-03	0.37%	2.8E-03	0.38%
Total	**2.5E+00**	**99.7%**	**7.4E-01**	**99.9%**

NOTE: (a) Committed effective dose.

NOTE: (b) Meat, milk, and vegetables.

NOTE: (c) Dose from tritium in foods calculated with absolute humidity of 12.9 g water/cubic meter of air.

NOTE: (d) Radionuclides contributing 0.01% or more from POPDOSE-SR or CAP88 output.

Data Table A-29. Deer and Hog Hunter Doses

Data Table A-29 Deer and Hog Hunter Doses

2022 Deer and Hog Hunter Doses

Onsite Deer Hunter (Actual Hunter)				
Maximum Individual Dose determined by field measurements =			**8.76**	**mrem**
1 animal harvested (1-deer)				
Total gross (live) weight =	111	lbs	*50*	*kg*
Total edible weight =	50	lbs	*23*	*kg*
Offsite Deer Hunter Dose (Hypothetical Hunter)				
Mean of the gross cesium-137 concentration in onsite deer =			1.25	pCi/g
CSRA background concentration =			0.5	pCi/g
MEI meat consumption rate =			81	kg/y
Cesium-137 adult dose coefficient (from DOE-STD-1196-2021) =			5.03E-05	mrem/pCi
Dose =			**3.06**	**mrem**
Offsite Hog Hunter Dose (Hypothetical Hunter)				
Mean of the gross cesium-137 concentration in onsite hogs =			1.29	pCi/g
CSRA background concentration =			0.5	pCi/g
MEI meat consumption rate =			81	kg/y
Cesium-137 adult dose coefficient (from DOE-STD-1196-2021) =			5.03E-05	mrem/pCi
Dose =			**3.22**	**mrem**

Data in red are from the Environmental Monitoring Program Subject Matter Expert
Email from Brian Price to Brooke Stagich (03/21/2023)

Data Table A-30a. Average Concentration in Composites used in the Dose Calculations (pCi/g)

Data Table A-30a, Average Concentration in Composites used in the Dose Calculations (pCi/g)

Location	Species	Sr-89,90	Cs-137	I-129	Tc-99
Augusta	Bass		2.88E-02		
Lock + Dam	Catfish		1.45E-02		
	Flathead Catfish		6.53E-02		
U3R	Bass	2.29E-03	3.69E-02		
Mouth	Catfish				
	Flathead Catfish		3.43E-02		
	Panfish	1.87E-03			
Fourmile	Bass	2.44E-03	8.25E-02		
Branch Mouth	Catfish	2.49E-03	4.33E-02		
	Flathead Catfish	1.72E-03	3.12E-02		
	Panfish		7.77E-02		
Steel Creek	Bass		1.35E-01		
Mouth	Catfish		7.66E-02		
	Flathead Catfish		7.63E-02		
	Panfish		6.72E-02		
L3R	Bass		2.51E-02		5.20E-02
Mouth	Catfish		4.78E-01		
	Flathead Catfish		6.12E-02		
	Panfish		2.46E-01		
Hwy-301	Bass		1.62E-02		
Bridge Area	Catfish		1.76E-02		
	Flathead Catfish		2.10E-02		
	Panfish		9.93E-03		

Note: Averages are based on three composites of up to five fish of each species from each location.
At least one of the three composite samples had to have a significant result for an average concentration to be reported.
Refer to Data Table 5-16 for the radioanalytical results.

Data Table A-30b. Total Dose from Consumption of 24 kg/y from Savannah River Fish (mrem)

Location	Species	Sr-90	Cs-137	I-129	Tc-99	Total
Augusta	Bass		3.53E-02			3.53E-02
Lock + Dam	Catfish		1.71E-02			1.71E-02
	Flathead Catfish		7.71E-02			7.71E-02
U3R	Bass	1.31E-02	4.36E-02			5.67E-02
Mouth	Catfish					0.00E+00
	Flathead Catfish		4.05E-02			4.05E-02
	Panfish	1.07E-02				1.07E-02
Fourmile	Bass	1.40E-02	9.74E-02			1.11E-01
Branch Mouth	Catfish	1.43E-02	5.11E-02			6.54E-02
	Flathead Catfish	9.86E-03	3.68E-02			4.67E-02
	Panfish		9.18E-02			9.18E-02
Steel Creek	Bass		1.59E-01			1.59E-01
Mouth	Catfish		9.05E-02			9.05E-02
	Flathead Catfish		9.01E-02			9.01E-02
	Panfish		7.94E-02			7.94E-02
L3R	Bass		2.96E-02		1.73E-03	3.14E-02
Mouth	Catfish		5.65E-01			**5.65E-01**
	Flathead Catfish		4.57E-02			5.37E-02
	Panfish		2.91E-01			2.91E-01
Hwy-301	Bass		1.91E-02			1.91E-02
Bridge Area	Catfish		2.08E-02			2.08E-02
	Flathead Catfish		4.57E-02			5.37E-02
	Panfish		1.17E-02			1.17E-02

Note: Ingestion dose coefficients are from the DOE Derived Concentration Technical Standard (DOE-STD-1196-2021)

Data Table A-30c. Total Risk from Consumption of 24 kg/y from Savannah River Fish (risk/year)

Location	Species	Sr-90	Cs-137	I-129	Tc-99	Total
Augusta	Bass		2.59E-08			2.59E-08
Lock + Dam	Catfish		1.30E-08			1.30E-08
	Flathead Catfish		5.86E-08			5.86E-08
U3R	Bass	5.24E-09	3.31E-08			3.84E-08
Mouth	Catfish					0.00E+00
	Flathead Catfish		3.08E-08			3.08E-08
	Panfish	4.28E-09				4.28E-09
Fourmile	Bass	5.58E-09	7.41E-08			7.96E-08
Branch Mouth	Catfish	5.70E-09	3.89E-08			4.46E-08
	Flathead Catfish	3.93E-09	2.80E-08			3.19E-08
	Panfish		6.97E-08			6.97E-08
Steel Creek	Bass		1.21E-07			1.21E-07
Mouth	Catfish		6.88E-08			6.88E-08
	Flathead Catfish		6.85E-08			6.85E-08
	Panfish		6.03E-08			6.03E-08
L3R	Bass		2.25E-08		4.99E-09	2.75E-08
Mouth	Catfish		4.29E-07			**4.29E-07**
	Flathead Catfish		5.49E-08			5.49E-08
	Panfish		2.21E-07			2.21E-07
Hwy-301	Bass		1.45E-08			1.45E-08
Bridge Area	Catfish		1.58E-08			1.58E-08
	Flathead Catfish		1.88E-08			1.88E-08
	Panfish		8.91E-09			8.91E-09

Note: SRS estimated the potential risks using the cancer morbidity risk coefficients from Federal Guidance Report No. 13.

Data Table A-31. SRS Supplemental Release Criteria

Data Table A-31, SRS Supplemental Release Criteria

Radionuclide Groups (a)	Removable (b) dpm/100 cm2	Total (Fixed+Removable)(c) dpm/100 cm2	Volumetric (d) pCi/g
Group 1 Radium, Thorium, and Transuranics: 210Po, 210Pb, 226Ra, 228Ra, 228Th, 230Th, 232Th, 237Np, 239Pu, 240Pu, 241Am, 244Cm, and associated decay chains(e), and others(a)	20	500	3
Group 2 U-nat, 234U, 235U, 238U, and associated decay products(f): 14C, 22Na, 24Na, 32P, 35S, 36Cl, 45Ca, 51Cr, 54Mn, 55Fe, 59Fe, 58Co, 60Co, 63Ni, 65Zn, 89Sr, 90Sr, 94Nb, 99Tc, 106Ru, 110mAg, 109Cd, 111In, 124Sb, 125I, 129I, 131I, 134Cs, 137Cs, 144Ce, 147Pm, 152Eu, 154Eu, 192Ir, 198Au, 241Pu, and others(a)	1000	5000	30
Tritium and tritiated compounds(g)	10,000/100,000(h)	N/A	2000

(a) To determine the specific group for radionuclides not shown, a comparison of the effective dose factors, by exposure pathway, listed in Table A.1 of NCRP Report No. 123 for the radionuclides in question and the radionuclides in the general groups above shall be performed and a determination of the proper group made, based on similarity of the factors.
(b) The amount of removable radioactive material per 100 cm2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper, applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. (Note - The use of dry material may not be appropriate for tritium). When removable contamination on objects of surface area less than 100 cm2 is determined, the activity per unit area shall be based on the actual area and the entire surface shall be wiped. It is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.
(c) The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 cm2 is less than three times the value specified. For purpose of averaging, any square meter of surface shall be considered to be above the surface contamination value if: (1) from measurements of a representative number of sections it is determined that the average contamination exceeds the applicable value; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm2 area exceeds three times the applicable value.
(d) Volume criteria will only be applied for the purpose of release of materials for disposal in a state, DOE, permitted or approved on-site landfill.
(e) For decay chains, the screening levels represent the total activity (i.e., the activity of the parent plus the activity of all progeny) present.
(f) Alpha component of activity
(g) Tritium contamination may diffuse into the volume or matrix of materials. Evaluation of surface contamination shall consider the extent to which such contamination may migrate to the surface in order to ensure the surface contamination value is not exceeded. Once this contamination migrates to the surface, it may be removable, not fixed; therefore, a "Total" value does not apply.
(h) The criterion of 10,000 dpm/100 cm2 will be used for release of material for unrestricted use (reuse or recycle). The criterion of 100,000 dpm/100 cm2 will be used for the controlled on-site landfill disposal of material. (Note - DOE Suspension (July 2000) for recycle of metals will apply until rescinded). However, WSRC will only implement this more relaxed tritium surface criterion if a future exemption to 10CFR835 is granted.

Data Table A-32. Biota Dose Assessment

Data Table A-32, Biota Dose Assessment

Initial Level 1 Aquatic Systems Screen using Maximum Radionuclide Concentrations in Water and Sediment[a,b]

Location	Sum-of-the-Fractions of BCGs
FM-2	0.3190
FM-2B	0.4320
FM-3A	0.1630
FM-6	0.2660
FM-A7	0.2910
L3R-1A	0.2070
L3R-3	0.0830
PB-3	0.2410
SC-2A	0.2950
SC-4	0.1110
TB-5	0.1900
U3R-3	0.0808
U3R-4	0.1040
Z-Area Basin	0.5120

Note: Values are provided in SRNL-L3220-2023-00010

Initial Level 1 Terrestrial Systems Screen using Maximum Radionuclide Concentrations in Soil[a,b]

Location	Sum-of-the-Fractions of BCGs
F-Area	0.0094
H-Area	0.0179
Z-Area	0.0046
643-26E	0.0110
Burial Ground-North	0.0035

Note: Values are provided in SRNL-L3220-2023-00009

a. Soils and sediment are sampled on an annual basis. Stream water is generally sampled monthly.
b. Negative concentrations were assumed to be 0.