Chapter 6: Dose to the Public

NE O 458.1, "Radiation Protection of the Public and the Environment," contains requirements for protecting the public and the environment against undue risk from radiation associated with radiological activities conducted under U.S. Department of Energy (DOE) control. In addition to requiring environmental monitoring to ensure compliance with the order, NE O 458.1 establishes a public dose limit. DOE sites must perform dose evaluations using mathematical models that represent various environmental pathways to demonstrate compliance with the public dose limit and to assess collective (population) doses.

Title 40 CFR Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities," establishes federal radiation dose limits for the maximally exposed member of the public from all airborne emissions and pathways. It requires that doses to members of the public from airborne releases are calculated using U.S. Environmental Protection Agency (EPA)-approved sampling procedures, computer models, or other methods and procedures.

This chapter describes the estimated potential dose to members of the public from operations at the Idaho National Laboratory (INL) Site, based on 2025 environmental monitoring measurements or calculated emissions.

6.1 Possible Exposure Pathways to the Public

Air, soil, groundwater, agricultural products, and biota are routinely sampled to document the amount of radioactivity in these media and to determine whether radioactive materials have been transported off the INL Site. The air pathway is the primary way people living beyond the INL Site boundary could be exposed to releases from INL Site operations.

Airborne radioactive materials are carried from the source and dispersed by winds. The concentrations from routine releases are too small to measure at locations around the INL Site, so atmospheric dispersion models were used to estimate the downwind concentration of air pollutants and the potential doses from these projected offsite concentrations. Also, conservative doses were calculated from the ingestion of meat from wild game animals that access the INL Site. Ingestion doses were calculated from the concentrations of radionuclides measured in game animals killed by vehicles on INL Site roads and waterfowl harvested from INL Site wastewater ponds that had detectable levels of human-made radionuclides. External exposure to radiation in the environment—primarily from naturally occurring radionuclides—was measured directly using optically-stimulated luminescence dosimeters.

Water pathways were not considered major contributors to dose, because no surface water flows off the INL Site and radionuclides associated with INL Site releases have not been measured in public drinking water wells.

6.2 Dose to the Public from INL Site Air Emissions

The potential doses from INL Site air emissions were estimated using the amounts reported to be released or could be released by the facilities. The 2025 INL National Emission Standards for Hazardous Air Pollutants (NESHAP) evaluation (DOE-ID 2026) reported potential radionuclide releases from 62 source locations at the INL Site. However, many of the sources resulted in doses that were insignificant, and many of these sources are located relatively close together, such that the sampling network response from a release would be the same for all nearby sources. Therefore, insignificant sources were not explicitly modeled, and some sources were consolidated with nearby sources. Emissions from five large operating stacks were modeled explicitly and included the Advanced Test Reactor (ATR) main stack (TRA-770), the Materials Test Reactor stack (TRA-710), the Idaho Nuclear Technology and Engineering Center (INTEC) main stack (CPP-708), the Materials and Fuels Complex (MFC) Fuel Conditioning Facility stack (MFC-764), and the Transient Reactor Test Facility (TREAT) stack (MFC-720). All other releases within a facility were assigned as near ground-level releases from a single location within that facility. These other releases include other non-fugitive releases from stacks, ducts, and vents, as well as fugitive releases from ponds, soil, or other sources. Click here to see the location of all sources modeled in the dose assessment.

The radionuclide groupings and associated activity used in the dose calculations are provided in Table 2-1 of Chapter 2. Noble gases comprised the largest emission quantity but only contributed slightly to the dose. Radionuclides in the form of noble gases tend to have short half-lives and are not typically incorporated into the food supply. Radionuclides that contributed the most to the overall maximally exposed individual (MEI) estimated dose were uranium-238 (^{238}U), uranium-234 (^{234}U), chlorine-36 (^{36}Cl), tritium (^{3}H), cesium-137 (^{137}Cs), and strontium-90 (^{90}Sr). These radionuclides are a very small fraction of the total amount of radionuclides reported.

The following two kinds of dose estimates were made using the release data:

- ***The effective dose to the hypothetical MEI, as defined by the NESHAP regulations.*** The CAP88-PC model Version 4.1.1 (EPA 2020) was used to predict the maximum concentration and dose at offsite receptor locations. The receptor location with the highest estimated dose is the MEI location.
- ***The collective effective dose (population dose) for the population within 80 km (50 mi) of any INL Site facility.*** For this calculation, the HYSPLIT model (Stein et al. 2015) was used to model atmospheric transport, dispersion, and deposition of radionuclides released to the air from the INL Site. The population dose was estimated using the Dose Multi-Media (DOSEMM) model (Rood 2019) using dispersion and deposition factors calculated by HYSPLIT to comply with NE O 458.1.

The dose estimates considered all exposure pathways. The CAP88-PC computer model uses dose and risk tables developed by the EPA. Population dose calculations were made using: (1) DOE effective dose coefficients for inhaled radionuclides (DOE 2022), (2) EPA dose conversion factors for ingested radionuclides (EPA 2002), and (3) EPA dose conversion factors for external exposure to radionuclides in the air and deposited on the ground surface (EPA 2002).

Because INL operations occur both at the desert Site and at facilities within Idaho Falls, NESHAP evaluations require separate MEI dose calculations for each location. The first MEI corresponds to offsite receptors near the INL Site (Section 6.2.1), while a second MEI is evaluated for the Idaho Falls facilities (Section 6.2.2).

6.2.1 Estimated Dose to the Maximally Exposed Individual Based on INL Site Emissions

The EPA NESHAP regulation requires a demonstration that radionuclides other than radon released to the air from any DOE nuclear facility do not result in a dose to the public of greater than 10 mrem/yr (0.1 mSv/yr) (40 CFR 61, Subpart H). The EPA requires the use of an approved computer model, such as CAP88-PC, to demonstrate compliance with 40 CFR 61, Subpart H. CAP88-PC uses a modified Gaussian plume model to estimate the average dispersion of radionuclides released from up to six sources. It uses average annual wind files based on the data collected at multiple locations on the INL Site by National Oceanic and Atmospheric Administration (NOAA).

The MEI that was calculated in 2024 remains at the same location as in previous years; however, it is now identified as Receptor 26 instead of Receptor 54. References to the MEI prior to 2019 (e.g., Receptor 1) continue to be referred to as Receptor 1 in the new arrangement (INL 2023).

The dose to the MEI from INL Site airborne releases of radionuclides was calculated to demonstrate compliance with NESHAP and is published in DOE-ID 2026. To identify the MEI, the doses at 31 offsite locations were calculated and screened for the maximum potential dose to an individual who might live at one of these locations. The highest potential dose location was determined to be Receptor 26, which is a farmhouse and cattle operation located 3.1 km south of Highway 20 and 3 km from the east entrance of the INL Site. An effective annual dose of 0.025 mrem (0.25 µSv) was calculated for a hypothetical person living at Receptor 26 during 2025. Figure 6-1 compares the MEI doses calculated for years 2016–2025. All the doses are well below the whole-body dose limit of 10 mrem/yr (0.1 mSv/yr) for airborne releases of radionuclides established by 40 CFR 61, Subpart H. The highest dose estimated during the past ten years was in 2021.

Although noble gases were the radionuclides that were released in the largest quantities in 2025, they accounted for less than 2.5% of the cumulative MEI dose from all pathways largely because of their relatively short half-lives and because they only affect the immersion dose (i.e., they are excluded from the food supply). For example, about 80% of the total INL activity released was argon-41 (^{41}Ar), yet ^{41}Ar accounted for less than 2% of the estimated MEI dose. In contrast, radionuclides typically associated with airborne particulates, such as ^{238}U, ^{234}U, ^{36}Cl, ^{137}Cs, and ^{90}Sr, comprised only a small fraction (e.g., less than 0.014%) of the total amount of radionuclides reported to be released, yet the radionuclides resulted in approximately 90.3% of the estimated MEI dose, as shown in Figure 6-2.

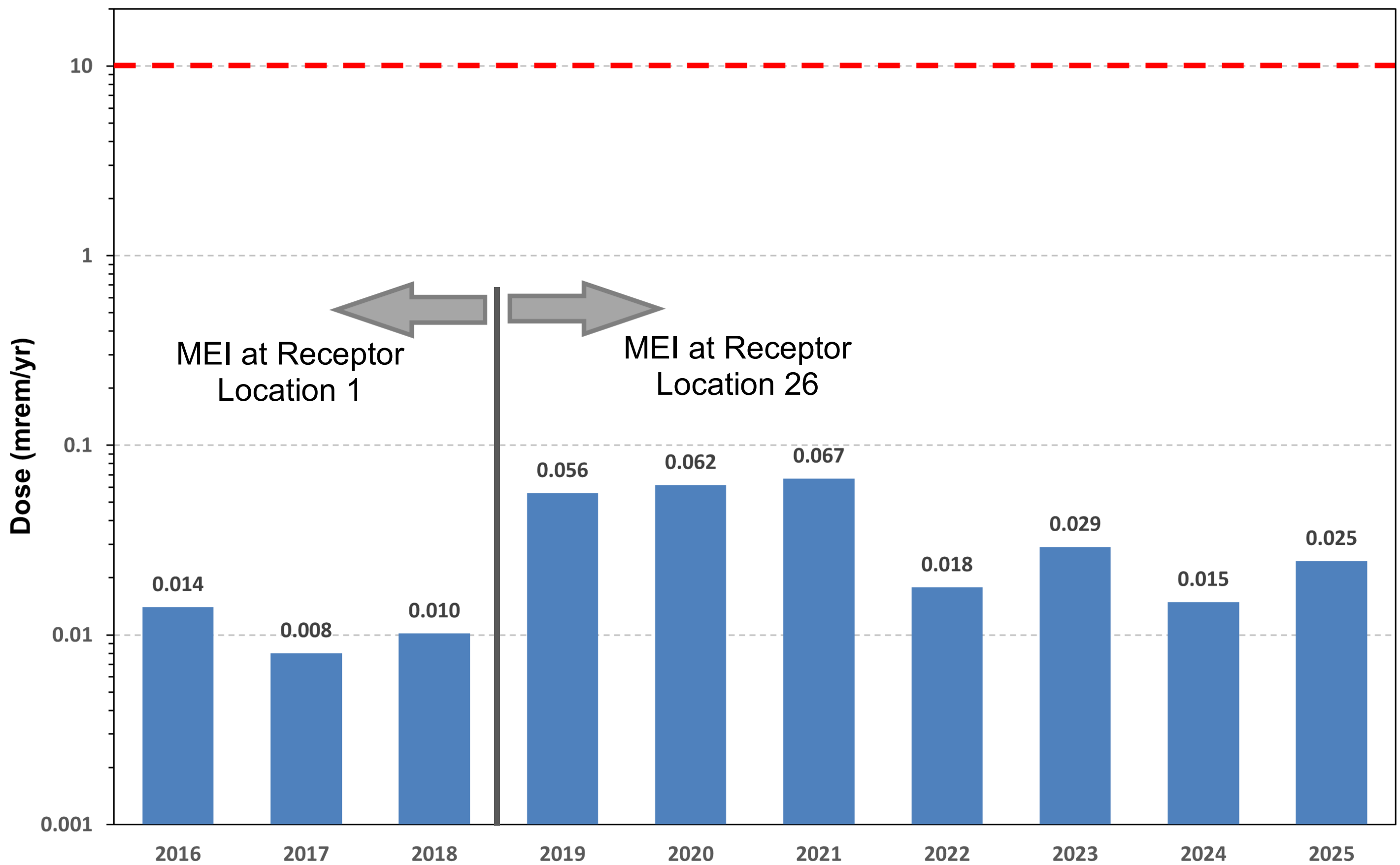

Figure 6-1. MEI dose from INL Site airborne releases estimated for 2016–2025. *See INL Site receptor locations.*

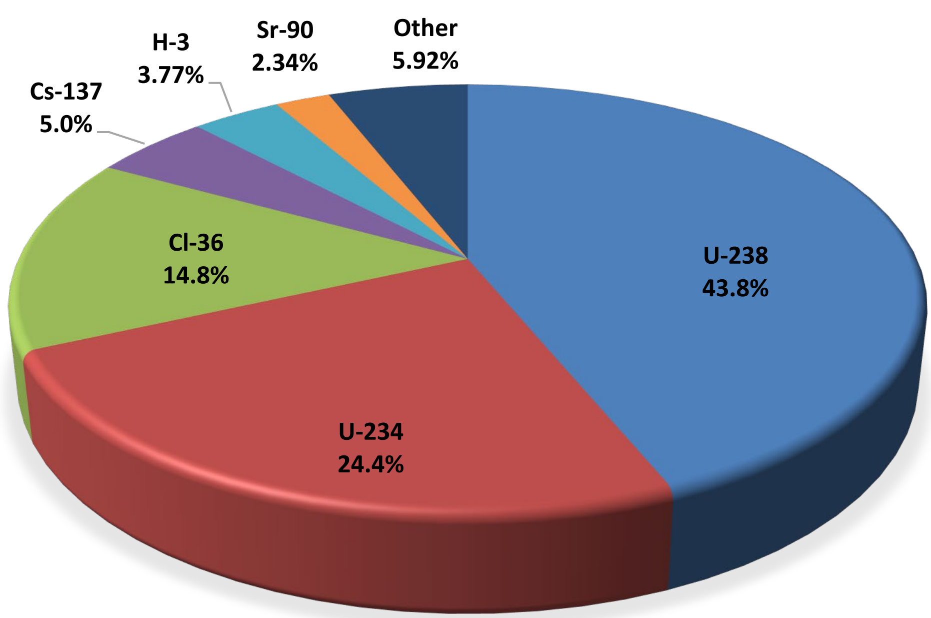

Figure 6-2. Radionuclides contributing to the MEI dose from INL Site airborne effluents as calculated using the CAP88-PC Model (2025).

Primary sources of the major radionuclides used to estimate the dose to the MEI, as indicated in Figure 6-2, were identified during the preparation of the annual NESHAP report (DOE-ID 2026) as follows:

- Amounts of ^{238}U and ^{234}U account for 43.8% and 24.4% of the MEI dose, respectively; the majority of which came from the Advanced Fuels Facility (MFC-784) at MFC.
- The second largest dose contribution was from ^{36}Cl, accounting for 14.8%, most of which originated at the Electron Microscopy Laboratory (MFC-774) at MFC.
- Tritium accounts for 3.8% of the MEI dose (92.5% coming from the beryllium blocks buried at the RWMC Subsurface Disposal Area, and 3.2% coming from MFC-774).
- Amounts of ^{137}Cs and ^{90}Sr contributed 5.0% and 2.3%, respectively. The remaining 5.9% came from other radionuclides.

The largest contribution by facility to the MEI dose overwhelmingly came from MFC at 91.9%, followed by RWMC at 3.52%, and the ATR Complex at 2.81%, as shown in Figure 6-3. This is expected for Receptor 26 given its proximity to MFC. Additionally, primary wind directions at the INL Site are from the southwest and northeast; thus, emissions from TAN, the NRF, INTEC, the ATR Complex, and RWMC are off axis from a receptor near MFC.

The dose to the MEI is higher than in 2024 at 0.025 mrem/year but remains far below the regulatory standard of 10 mrem/yr (0.1 mSv/yr) (40 CFR 61, Subpart H).

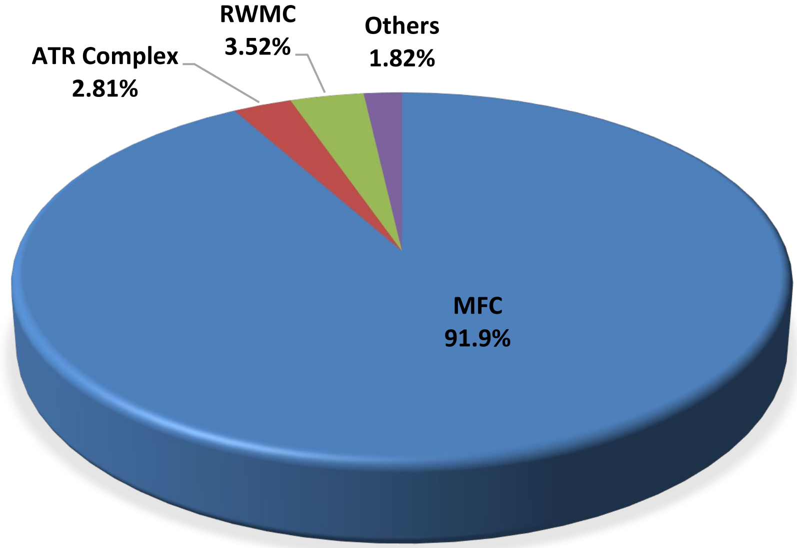

Figure 6-3. Percent contributions, by facility, to MEI dose from the INL Site airborne effluents as calculated using the CAP88-PC Model (2025).

6.2.2 Estimated Dose to the Maximally Exposed Individual Based on Idaho Falls Facilities

Facilities in Idaho Falls that reported potential radionuclide emissions for inclusion in the 2025 NESHAP report (DOE-ID 2026) include the INL Research Center (IRC) Laboratory (IF-603), DOE Radiological and Environmental Sciences Laboratory (IF-683), and the National Security Laboratory (IF-611). These facilities are located contiguously at IRC, which is part of the INL Research and Education Campus on the north side of Idaho Falls. Though programs and operations at IRC are affiliated with INL, IRC is located within the city limits of Idaho Falls and is not contiguous with the INL Site. The nearest boundary of the INL Site is about 35 km (22 mi) west of Idaho Falls. Each of the IRC buildings were modeled as separate sources in 2023. Due to radionuclide tracking limitations, IF-603 and IF-611 were modeled as one source in 2024 and now 2025. The MEI at IRC for 2025 is approximately 147 meters south-southeast of IF-683. Using CAP88-PC, the MEI effective dose equivalent was conservatively calculated to be 0.0045 mrem/yr (0.045 µSv/yr), which is less than 0.1% of the 10-mrem/yr federal standard. This represents a slight decrease from last year's value of 0.0048 mrem/yr (0.048 µSv/yr). Calculated doses from 2021–2025 have been consistently low, varying only from 0.0040 mrem/yr to 0.0062 mrem/yr.

6.2.3 Eighty Kilometer (50 Mile) Population Dose

Total effective radiation dose from airborne releases was calculated using air dispersion modeling utilizing the HYSPLIT model (Stein et al. 2015; Draxler et al. 2013) and performed by the NOAA Atmospheric Sciences Modeling Division on their cluster server in College Park Maryland (HYSPLIT-ASMD) and the DOSEMM v 250619 (Rood 2019) dose assessment model. These calculations aimed to provide a grid of total effective doses within an 80-km (50-mi) radius from any INL Site source, including Idaho Falls facilities. The data was used with geographic information system software to compute population doses. The HYSPLIT model and its capabilities are described on the NOAA Air Resources Laboratory website.

Key contributing facilities and radionuclides were modeled, selecting those that contributed more than 0.001% of the total dose at the INL Site or more than 0.01% in Idaho Falls. The HYSPLIT-ASMD model is initialized using three-dimensional meteorological data from the Weather Research Forecasting model utilizing high-resolution rapid response data assimilation. The high-resolution rapid response-Weather Research Forecasting simulation uses a 3-km grid spacing and updates the simulation every hour with surface and upper air observations. Terrain effects on wind vectors are also included in the simulation. The HYSPLIT model predicted dispersion and deposition from releases at each facility across 17,877 grid points around the INL Site, including 31 boundary receptor locations representing actual residences or places of business.

The model outputs, which included radionuclide air concentrations and deposition amounts, were converted to dispersion and deposition factors for use in DOSEMM (Rood 2019). These factors were used to estimate air concentrations and the deposition at each grid point for the year. Then, the effective dose via inhalation, ingestion, and external exposure pathways were calculated. The radionuclide source term for radionuclide-facility combinations that were used for the INL Site and in-town population dose assessment can be found in Overin (2026).

To estimate the population dose within an 80-km (50-mi) radius, data from the 2020 census was gathered and then projected to 2025. This was done by calculating the population change rate from 2010 to 2020 and then applying that same rate to the 2020 figures. Then, a geographical information system was used to import the dose values from DOSEMM and average those values within each census division. These average doses were multiplied by the estimated populations and summed to get the total population dose.

The estimated potential population dose for 2025 was 0.16 person-rem (0.0016 person-Sv) for about 363,157 people. This represents a very small 0.0001% increase as compared to the natural background radiation dose of approximately 140,179 person-rem (1,402 person-Sv). The estimated population dose for 2025 was greater than population doses estimated for 2021–2024 (Figure 6-4). Population dose calculations for 2024 and prior years used a customized version of HYSPLIT run by the NOAA Special Operations and Research Division (SORD) office in Idaho Falls. This version of HYSPLIT (HYSPLIT-SORD) utilized only the surface stations from the NOAA/INL Mesonet and no terrain data. The version used for 2025 calculations (HYSPLIT-ASMD) incorporates broader meteorological data resulting in a less compact plume and more terrain influence. Due to the wider reach of the plume modeled, population doses would be expected to be higher than those that would be calculated using HYSPLIT-SORD (Rood 2026). Additional information regarding the higher 2025 population dose relative to prior years is provided in a technical memorandum (Rood 2026).

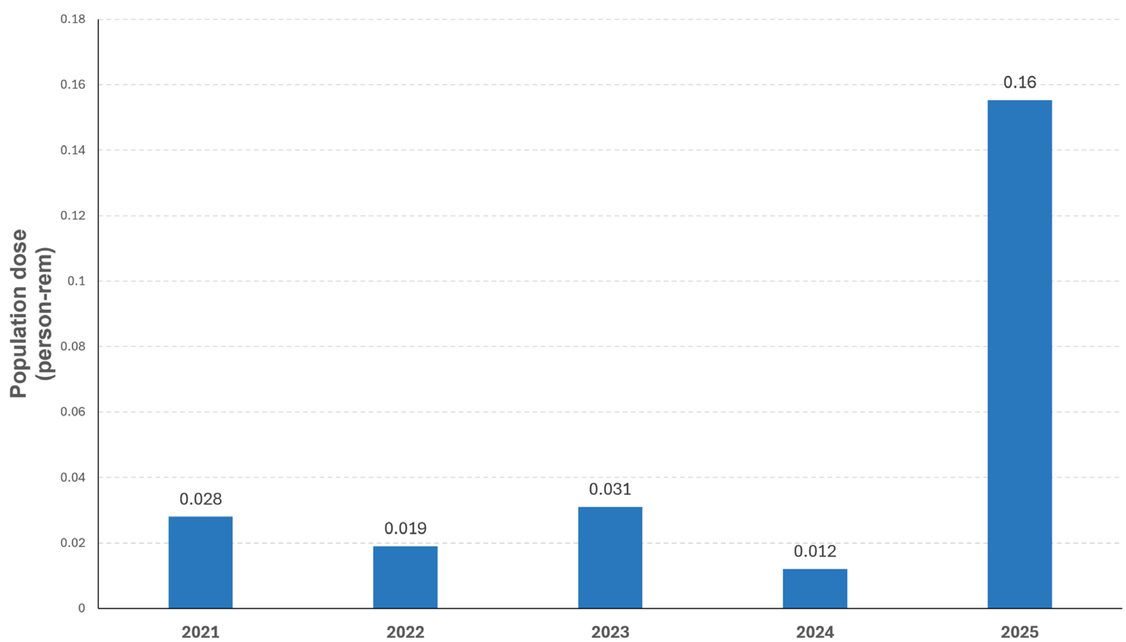

Figure 6-4. Population dose estimated for 2021–2025.

6.3 Dose to the Public from Ingestion of Wild Game from the INL Site

The potential dose that an individual may receive from occasionally ingesting meat from waterfowl or big game animals continues to be studied at the INL Site. These studies estimate the potential dose to individuals who may eat waterfowl that may briefly reside at wastewater disposal ponds at the ATR Complex and big game animals that may reside on or migrate through the INL Site.

6.3.1 Waterfowl

Waterfowl samples collected in 2025 did not have detectable concentrations of human-made radionuclides in any edible subsample (see Subsection 5.1.3). As a result, no dose from human-made radionuclides would be associated with the consumption of these animals. As in the past, the 2025 samples were not collected directly from the warm wastewater evaporation ponds at the ATR Complex but from sewage lagoons adjacent to them.

6.3.2 Big Game Animals

A study on the INL Site from 1972–1976 conservatively estimated the potential whole-body dose that could be received from an individual eating the entire muscle (27,000 g [952 oz]) and liver mass (500 g [17.6 oz]) of an antelope with the highest levels of radioactivity found in these animals. This dose was 2.7 mrem (27 µSv) (Markham et al. 1982). Game animals collected at the INL Site during the past few years have generally shown much lower concentrations of radionuclides. In 2025, none of the game samples collected from three elk and a pronghorn had a detectable concentration of ^{137}Cs or other human-made radionuclides (see Subsection 5.1.3). Therefore, no dose from human-made radionuclides would be associated with the consumption of these animals.

The contribution of game animal consumption to the population dose is calculated because only a limited percentage of the population hunts game, few deceased animals have spent time on the INL Site, and most animals that migrate from the INL Site would have reduced concentrations of radionuclides in their tissues by the time they were harvested (Halford, Markham, and White 1983). The total population dose contribution from these pathways would realistically be less than the sum of the population doses from the inhalation of air, submersion in air, vegetable ingestion, and soil deposition.

6.4 Dose to the Public from Drinking Groundwater from the INL Site

Tritium has previously been detected in three U.S. Geological Survey wells located on the INL Site along the southern boundary (Mann and Cecil 1990; Bartholomay, Hopkins, and Maimer 2015; Twining et al. 2021). These wells, located in an uninhabited area, have shown a historical downward trend in tritium detections. The maximum concentration from all wells on the INL Site (3,400 ± 100 pCi/L) in 2025 is considerably less than the maximum contaminant level established by the EPA for drinking water (20,000 pCi/L). An individual drinking water from a well with the maximum concentration would hypothetically receive a dose of 0.142 mrem (0.00142 mSv) in one year. Because these wells are not used for drinking water, this is an unrealistic scenario, and the groundwater ingestion pathway is not included in the total dose estimate to the MEI.

6.5 Dose to the Public from Direct Radiation Exposure along INL Site Borders

The direct radiation exposure pathway from gamma radiation to the public is monitored annually using optically stimulated luminescent dosimeters. The annual external radiation dose for 2025 could not be established because results for the May–October 2025 monitoring interval were invalidated following inadvertent x-ray exposure during shipment (see Chapter 5, Subsection 5.3.3). However, dosimeters deployed along the INL Site boundary and at offsite locations from November 2024–April 2025 indicated a six-month external dose of 60.4 mrem.

6.6 Dose to the Public from All Pathways

NE O 458.1A establishes a public radiation dose limit to 100 mrem/yr (1 mSv/yr) above natural background for all exposure pathways combined. This limit encompasses air transport, ingestion (e.g., water, agricultural products, and wild game), and direct-exposure pathways. For 2025, the only probable pathways from INL Site activities to a realistic MEI include the air transport pathway.

The hypothetical MEI is assumed to reside at a farmhouse, and cattle operation located 3.1 km south of Highway 20 and 3 km east of the INL Site entrance. At this location, the dose from airborne radionuclides released in 2025 was calculated in accordance with Subsection 6.2.1. No dose was attributed to the ingestion of waterfowl or big game animals, as described in Subsections 6.3.1 and 6.3.2, because no human-made radionuclides were detected in edible tissues during 2025.

Click here to see a comparison of common radiation dose sources. The total dose from all INL Site pathways in 2025 was extremely low. The combined dose to the MEI was conservatively estimated at 0.025 mrem (0.25 µSv), as summarized in Table 6-1, which remains far below the DOE public dose limit of 100 mrem/yr (1 mSv/yr). As noted in "Helpful Information," this regulatory limit is itself well below levels associated with any acute health effects.

The dose received by the entire population within an 80-km (50-mi) radius of INL Site facilities was calculated to be 0.16 person-rem (0.00165 person-Sv), as shown in Table 6-1. This is approximately 0.0001% of the 140,179 person-rem (1,402 person-Sv) dose given to be expected from exposure to regional natural background radiation.

Table 6-1. Contribution to estimated annual dose from INL Site facilities by pathway (2025).

PATHWAY	ANNUAL DOSE TO MEI		PERCENT OF DOE 100 mrem/yr LIMIT[a]	ESTIMATED POPULATION DOSE		POPULATION WITHIN 80 km	ESTIMATED BACKGROUND RADIATION POPULATION DOSE (PERSON-rem)[b]
	(mrem)	(µSv)		(PERSON -rem)	(PERSON -Sv)		
Air	0.025	0.25	0.025	0.16	0.0016	363,157	140,179
TOTAL, ALL PATHWAYS	**0.025**	**0.25**	**0.025**	**0.16**	**0.0016**	**NA**[c]	**NA**

a. The DOE public dose limit from all sources of ionizing radiation and exposure pathways that could contribute significantly to the total dose is 100 mrem/yr (1 mSv/yr) total effective dose equivalent. It does not include dose from background radiation.

b. The individual background dose was estimated to be 386 mrem or 0.386 rem in 2025, as shown previously in Table 5-1. The background population dose is calculated by multiplying the individual background dose by the population within an 80 km (50 mi) radius of the INL Site.

c. NA = Not applicable.

6.7 References

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