Appendix B
Glossary

This glossary contains selected words and phrases used within the context of this report that may not be familiar to the reader. Words appearing in *italic* within a definition are also defined in this glossary.

absorbed dose - Energy absorbed per unit mass from any kind of ionizing *radiation* in any kind of matter. Units: *rad*, which is equal to the absorption of 100 ergs per gram of material irradiated, or *Gray*, which is the International System of Units (SI) equivalent.

activation product - Material made radioactive by *exposure* to *radiation*, principally by neutron radiation as in metals in a nuclear reactor, e.g., cobalt-60 from cobalt-59 in stainless steel.

adsorption - The accumulation of gases, liquids, or solutes on the surface of a solid or liquid.

alpha particle - A positively charged particle comprised of two protons and two neutrons ejected spontaneously from the nuclei of some *radionuclides*. It has low penetrating power and short range. The most energetic alpha will generally fail to penetrate the skin. Alpha particles are hazardous when an alpha-emitting *isotope* is introduced into the body.

anion - A negatively charged ion.

aquifer - Underground sediment or rock that stores and/or transmits water.

background radiation - *Radiation* in the natural environment, including cosmic rays from space and *radiation* from naturally occurring radioactive elements in the air, in the earth, and in our bodies. In the United States, the average person receives approximately 300 *millirem* of background radiation per year.

bank storage - Hydrologic term that describes river water that flows into and is retained in permeable stream banks during periods of high river stage. Flow is reversed during periods of low river stage.

becquerel (Bq) - Unit of activity or amount of a radioactive substance (also *radioactivity*) equal to one nuclear transformation per second (1 Bq = 1 disintegration/s). Another unit of *radioactivity*, the *curie*, is related to the becquerel: 1 Ci = 3.7×10^{10} Bq.

beta particle - A light, negatively charged particle (essentially an electron) emitted from a nucleus during radioactive *decay*. Large amounts of beta particles may cause skin burns and are harmful if they enter the body. Beta particles are easily stopped by a thin sheet of metal or plastic.

cation - A positively charged ion.

clean closed - A facility is classified as "clean closed" under *Resource Conservation and Recovery Act* regulations when all dangerous waste has been removed and *groundwater* monitoring is no longer required.

collective total effective dose equivalent - Sum of the *total effective dose equivalents* for individuals composing a defined population. The units for this are "*person-rem*" or "*person-sievert*."

committed dose equivalent - The *dose equivalent* to organs or tissues that will be received from an intake of radioactive material by an individual during the 50-year period following intake.

committed effective dose equivalent - The sum of the *committed dose equivalent* from sources inside the body.

composite sample - Sample formed by mixing discrete samples taken at different times or from different locations.

confined aquifer - An *aquifer* bounded above and below by less-permeable layers. *Groundwater* in the confined aquifer is under a pressure greater than atmospheric pressure.

continuous sample - Sample formed by the continuous collection of the medium or contaminants within the medium during the entire sample period.

cosmic radiation - High-energy subatomic particles and electromagnetic *radiation* from outer space that bombard the earth. Cosmic radiation is part of natural *background radiation*.

crib - An underground structure designed to receive liquid waste that percolates into the soil directly or percolates into the soil after having traveled through a connected tile field. These structures are no longer used at Hanford.

curie (Ci) - A unit of *radioactivity* equal to 37 billion (3.7×10^{10}) nuclear transformations per second (*becquerels*).

decay - The decrease in the amount of any radioactive material (disintegration) with the passage of time. See *radioactivity*.

decay product - The atomic nucleus or nuclei that are left after radioactive transformation of a radioactive material. Decay products may be radioactive or non-radioactive (stable). Informally referred to as daughter products. See *radioactivity*.

deep-dose equivalent - The *dose equivalent* at a tissue depth of 1 centimeter from *radiation* originating outside of the body.

derived concentration guide (DCG) - Concentrations of *radionuclides* in air and water that an individual could continuously consume, inhale, or be immersed in at average annual rates, and not receive an *effective dose equivalent* of greater than 100 *millirem* per year.

detection level (or limit) - Minimum amount of a substance that can be measured with a specified or implied confidence that the analytical result is greater than a specific value (e.g., zero).

dispersion - Process whereby *effluent* is spread or mixed when it is transported by *groundwater*, surface water, or air.

dose equivalent - Product of the *absorbed dose*, a quality factor, and any other modifying factors. The dose equivalent is a quantity for comparing the biological effectiveness of different kinds of *radiation* on a common scale. The unit of dose equivalent is the *rem*.

dose rate - The rate at which a dose is delivered over time, e.g., *dose equivalent* rate in *millirem* per hour (mrem/h).

dosimeter - Portable device for measuring the accumulated *exposure* or *absorbed dose* from specific types or energies ionizing *radiation* fields.

effective dose - See *effective dose equivalent*.

effective dose equivalent - The sum of products of *dose equivalent* to selected tissues of the body and appropriate tissue weighting factors. The tissue weighting factors put doses to various tissues and organs on an equal basis in terms of health *risk*.

effluent - Liquid waste material released from a facility.

effluent monitoring - Sampling or measuring specific liquid or gaseous *effluent* streams for the presence of pollutants.

emission - Gaseous waste streams released from a facility.

exposure - The interaction of an organism with a physical agent (e.g., *radiation*) or a chemical agent (e.g., arsenic) of interest. Also used as a term for quantifying x- and *gamma radiation* fields. See *roentgen*.

external radiation - *Radiation* originating from a source outside the body.

fallout - Typically refers to radioactive materials that are released into the earth's atmosphere following a nuclear explosion or atmospheric release and that eventually fall to earth.

fission - The splitting or breaking apart of a nucleus into at least two other nuclei, accompanied with a release of a relatively large amount of energy. For example, when a heavy atom such as uranium is split, large amounts of energy, including *radiation* and neutrons, are released along with the new nuclei (which are *fission products*; see below).

fission products - Nuclides formed from fissioning. Many fission products are radioactive.

fully institutionalized - To incorporate into a formalized, structured system and be implemented and fully functional.

gamma radiation - High-energy electromagnetic *radiation* (*photons*) originating in the nucleus of decaying *radionuclides*. Gamma radiation is substantially more penetrating than *alpha* or *beta particles*.

grab sample - A short duration sample (e.g., air, water, soil) that is "grabbed" from the collection site.

grand mean - A "means of means" or an "overall *mean*" where there is some subdivision of the data where means were already provided for each subdivision.

groundwater - Subsurface water that is in the pores of sand and gravel or in the cracks of fractured rock.

Gray (Gy) - Unit of *absorbed dose* in the International System of Units (SI) equal to 1 joule per kilogram. The common unit of *absorbed dose*, the *rad*, is equal to 0.01 Gy.

half-life - Length of time in which a radioactive substance will lose one half of its *radioactivity* by *decay*. Half-lives range from a fraction of a second to billions of years, and each *radionuclide* has a unique half-life.

high-level waste - Highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains *fission products* and other *radioisotopes* in sufficient concentrations to require permanent isolation.

institutional controls - Long-term actions or restrictions including monitoring, periodic sampling, access controls, and land use restrictions designed to mitigate any risks posed by contamination following *remediation*. Institutional controls alone may be sufficient to reduce risks posed by low levels of contamination.

internal radiation - *Radiation* from radioactive material inside the body.

ion exchange - The reversible exchange of one species of ion for a different species of ion within a medium.

irradiation - *Exposure* to *radiation*.

isotopes - *Nuclides* of the same chemical element with the same number of protons but a differing number of neutrons.

isotopic plutonium - Any of two or more atoms of the chemical element *plutonium* with the same atomic number and position in the periodic table and nearly identical chemical behavior but with differing atomic mass number and different physical properties. Plutonium-239 is produced by neutron *irradiation* of uranium-238.

isotopic uranium - Any of two or more atoms of the chemical element uranium with the same atomic number and position in the periodic table and nearly identical chemical behavior but with differing atomic mass number and different physical properties. Uranium exists naturally as a mixture of three *isotopes* of mass 234, 235, and 238 in the proportions of 0.006%, 0.71%, and 99.27%, respectively.

legacy waste - Waste that was generated prior to termination of Hanford's nuclear materials production mission.

low-level waste - Radioactive waste that is not high-level radioactive waste, spent nuclear fuel, *transuranic waste*, byproduct material, or naturally occurring radioactive material.

maximally exposed individual - A hypothetical member of the public residing near the Hanford Site who, by virtue of location and living habits, would reasonably receive the highest possible *radiation* dose from materials originating from Hanford.

mean (or average) - Average value of a series of measurements. The mean is computed as:

$$\text{mean} = \frac{\Sigma x}{n}$$

where n is the number of measurements and Σx is the sum of all measurements.

median - Middle value in an odd numbered set of results when the data are ranked in increasing or decreasing order or the *average* of two central values in an even number set of results.

millirem - A unit of *radiation dose equivalent* that is equal to one one-thousandth (1/1000) of a *rem*.

minimum detectable amount or concentration - Smallest amount or concentration of a chemical or radioactive material that can be reliably detected in a sample.

mitigation - Prevention or reduction of expected *risks* to workers, the public, or the environment.

mixed waste - A U.S. Environmental Protection Agency or state designated dangerous, extremely hazardous, or acutely hazardous waste that contains both a non-radioactive hazardous component and a radioactive component.

noble gas - Any of a group of chemically and biologically inert gases that includes argon, krypton, and xenon. These gases are not retained in the body following inhalation. The principal *exposure* pathway for radioactive noble gases is direct external dose from the surrounding air.

nuclide - A particular combination of neutrons and protons. A *radionuclide* is a radioactive nuclide.

offsite locations - Sampling and measurement locations outside the Hanford Site boundary.

onsite locations - Sampling and measurement locations within the Hanford Site boundary.

operable unit - A discrete area for which an incremental step can be taken toward comprehensively addressing site problems. The cleanup of a site can be divided into a number of operable units, depending on the complexity of the problems associated with the site.

outfall - End of a drain or pipe that carries wastewater or other *effluent* into a ditch, pond, or river.

person-rem or person-sievert (person-Sv) - Unit of *collective total effective dose equivalent*. 1 person-Sv = 100 person-rem.

photon - A quantum of radiant energy. *Gamma radiation* and x-*radiation* (x-rays) are both comprised of photons of varying energy.

plume - The cloud of a pollutant in air, surface water, or *groundwater* formed after the pollutant is released from a source.

plutonium - A heavy, radioactive, metallic element consisting of several *isotopes*. One important *isotope* is ^{239}Pu, which is produced by the *irradiation* of ^{238}U. Routine analysis cannot distinguish between the ^{239}Pu and ^{240}Pu *isotopes*; hence, the term $^{239/240}$Pu as used in this report is symbolic of the presence of one or both of these *isotopes* in the analytical results.

primordial radionuclide - A radioactive material in the earth's crust that has a very long *half-life* and has existed since the beginning of the planet.

quality assurance - Actions that provide confidence that an item or process meets or exceeds that user's requirements and expectations.

quality control - Comprises all those actions necessary to control and verify the features and characteristics of a material, process, product, or service to specified requirements. Quality control is an element of *quality assurance*.

rad - The unit of *absorbed dose*. 1 rad = 0.01 *gray* (Gy).

radiation - The energy emitted in the form of *photons* or particles such as that from transforming *radionuclides*. For this report, radiation refers to ionizing types of radiation; not radiowaves, microwaves, radiant light, or other types of non-ionizing radiation.

radioactivity - Property possessed by *radioisotopes* of emitting *radiation* (such as alpha, beta, or gamma *photons*) spontaneously in their *decay* process also, the *radiation* emitted.

radioisotope - An unstable *isotope* of an element that *decays* or disintegrates spontaneously, emitting *radiation* (Shleien 1992).

radiologically controlled area - An area to which access is controlled to protect individuals from *exposure* to *radiation* or radioactive and/or hazardous materials.

radionuclide - A species of atoms having a particular number of protons (Z), a particular number of neutrons (A), and a particular atomic weight (N = Z + A) that happens to emit *radiation*. Carbon-14 is a radionuclide but carbon-12, which is not radioactive is referred to simply as a "*nuclide*."

recruitment - Survival from one life form or stage to the next or from one age class to the next.

redox - A chemical reaction involving oxidation and reduction.

rem - A unit of *dose equivalent* and *effective dose equivalent*.

remediation - Reduction of known *risks* to the public and environment to an agreed upon level.

risk - The probability that a detrimental health effect will occur.

risk-based disposal approval - A written application to the U.S. Environmental Protection Agency intended for the management and disposal of *Toxic Substances Control Act* regulated polychlorinated biphenyl waste not addressed suitably within the regulations. The risk-based disposal approval process is applicable to any person wishing to sample, clean up, or dispose of waste in a manner other than as prescribed in 40 CFR 761. For polychlorinated biphenyl *remediation* waste, the requirements for a risk-based disposal approval are specified in 40 CFR 761.61(c). A written approval from the U.S. Environmental Protection Agency is required before waste management activities are performed.

roentgen (R) - The unit of x-ray or gamma *photon exposure* as measured in air, historically used to describe *external radiation* levels. An *exposure* of 1 roentgen typically causes an *effective dose* of 1 *rem*.

sievert (Sv) - The unit of *dose equivalent* and its varients in the International System of Units (SI). The common unit for *dose equivalent* and its varients, the *rem*, is equal to 0.01 Sv.

special case waste - Waste for which there is an undetermined disposal path because of high levels of *radioactivity* and difficulties in characterization, classification, and packaging.

specific retention facilities - Historical structures consisting of cribs, ditches, trenches, or holes in the ground that received relatively small volumes of high concentration liquid radioactive waste. The small volume of liquid waste was designed to prevent flushing of the contaminants through the soil column to the *groundwater*.

spent fuel - Uranium metal or oxide and its metal container that have been used to power a nuclear reactor and for one reason or another has reached the end of its useful life. It is highly radioactive and typically contains *fission products*, *plutonium*, and residual uranium.

standard error of the mean - A measure of the precision of a *mean* of observed values; that is, an estimate of how close a *mean* of observed values is expected to be to the true *mean*.

transuranic element - An element with an atomic number greater than 92 (92 is the atomic number of uranium).

transuranic waste - Waste containing more than 100 nanocuries (10^{-9} *curies*) of alpha-emitting *transuranic isotopes* (*isotopes* with atomic numbers greater than uranium) per gram of waste with *half-lives* greater than 20 years.

thermoluminescent dosimeter - A device containing a material that, after being exposed to beta and/or *gamma radiation*, emits light when heated. The amount of light emitted is proportional to the *absorbed dose* to the thermoluminescent dosimeter.

total effective dose equivalent - The sum of *committed effective dose equivalent* from intakes of radioactive material and *dose equivalent* from *external radiation*. Unit: *rem* or *sievert*.

unconfined aquifer - An *aquifer* containing *groundwater* that is not confined above by relatively impermeable rocks. The pressure at the top of the unconfined aquifer is equal to that of the atmosphere. At Hanford, the unconfined aquifer is the uppermost *aquifer* and is most susceptible to contamination from site operations.

vadose zone - Underground area from the surface to the top of the *water table* or *aquifer*.

volatile organic compounds - Lightweight organic compounds that vaporize easily; used in solvents and degreasing compounds as raw materials.

water table - The top of the *unconfined aquifer*.

wind rose - A diagram showing how often winds of various speeds blow from different directions, usually based on yearly averages.

References

40 CFR 761. U.S. Environmental Protection Agency. "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions." *U.S. Code of Federal Regulations*.

Shleien, B. (ed.). 1992. *The Health Physics and Radiological Health Handbook, Revised Edition*. Scinta, Inc., Silver Spring, Maryland.

Resource Conservation and Recovery Act. 1976. Public Law 94-580, as amended, 90 Stat. 2795, 42 USC 6901 et seq.

Toxic Substances Control Act. 1976. Public Law 94-469, as amended, 90 Stat. 2003, 15 USC 2601 et seq.