
Glossary



A **accuracy** - Closeness of the result of a measurement to the true value of the quantity.

actinide - Group of elements of atomic number 89 through 103. Laboratory analysis of actinides by alpha spectrometry generally refers to the elements plutonium, americium, uranium, and curium but may also include neptunium and thorium.

activity - See radioactivity.

air flow - Rate of flow, measured by mass or volume per unit of time.

air stripping - Process used to decontaminate groundwater by pumping the water to the surface, “stripping” or evaporating the chemicals in a specially designed tower, and pumping the cleansed water back to the environment.

aliquot - Quantity of sample being used for analysis.

alkalinity - Alkalinity is a measure of the buffering capacity of water, and since pH has a direct effect on organisms as well as an indirect effect on the toxicity of certain other pollutants in the water, the buffering capacity is important to water quality.

alpha particle - Positively charged particle emitted from the nucleus of an atom having the same charge and mass as that of a helium nucleus (two protons and two neutrons).

ambient air - Surrounding atmosphere as it exists around people, plants, and structures.

analyte - Constituent or parameter that is being analyzed.

analytical detection limit - Lowest reasonably accurate concentration of an analyte that can be detected; this value varies depending on the method,

instrument, and dilution used.

aquifer - Saturated, permeable geologic unit that can transmit significant quantities of water under ordinary hydraulic gradients.

aquitard - Geologic unit that inhibits the flow of water.

Atomic Energy Commission - Federal agency created in 1946 to manage the development, use, and control of nuclear energy for military and civilian application. It was abolished by the Energy Reorganization Act of 1974 and succeeded by the Energy Research and Development Administration. Functions of the Energy Research and Development Administration eventually were taken over by the U.S. Department of Energy and the U.S. Nuclear Regulatory Commission.

B **background radiation** - Naturally occurring radiation, fallout, and cosmic radiation. Generally, the lowest level of radiation obtainable within the scope of an analytical measurement, i.e., a blank sample.

bailer - Container lowered into a well to remove water. The bailer is allowed to fill with water and then is removed from the well.

best management practices - Sound engineering practices that are not required by regulation or by law.

beta particle - Negatively charged particle emitted from the nucleus of an atom. It has a mass and charge equal to those of an electron.

blank - Control sample that is identical, in principle, to the sample of interest, except that the substance being analyzed is absent. In such cases, the measured value or signal for the substance being analyzed is believed to be due to artifacts. Under certain

circumstances, that value may be subtracted from the measured value to give a net result reflecting the amount of the substance in the sample. The U.S. Environmental Protection Agency does not permit the subtraction of blank results in Environmental Protection Agency-regulated analyses.

blind blank - Sample container of deionized water sent to a laboratory under an alias name as a quality control check.

blind replicate - In the Environmental Services Section groundwater monitoring program, a second sample taken from the same well at the same time as the primary sample, assigned an alias well name, and sent to a laboratory for analysis (as an unknown to the analyst).

blind sample - Control sample of known concentration in which the expected values of the constituent are unknown to the analyst

C calibration - Process of applying correction factors to equate a measurement to a known standard. Generally, a documented measurement control program of charts, graphs, and data that demonstrate that an instrument is properly calibrated.

Carolina bay - Type of shallow depression commonly found on the coastal Carolina plains. Carolina bays are typically circular or oval. Some are wet or marshy, while others are dry.

Central Savannah River Area (CSRA) - Eighteen-county area in Georgia and South Carolina surrounding Augusta, Georgia. The Savannah River Site is included in the Central Savannah River Area. Counties are Richmond, Columbia, McDuffie, Burke, Emanuel, Glascock, Jenkins, Jefferson, Lincoln, Screven, Taliaferro, Warren, and Wilkes in Georgia and Aiken, Edgefield, Allendale, Barnwell, and McCormick in South Carolina.

chemical oxygen demand - Indicates the quantity of oxidizable materials present in a water and varies with water composition, concentrations of reagent, temperature, period of contact, and other factors.

chlorocarbons - Compounds of carbon and chlorine, or carbon, hydrogen, and chlorine, such as carbon tetrachloride, chloroform, tetrachloroethylene, etc. They are among the most significant and widespread environmental contaminants. Classified as hazard-

ous wastes, chlorocarbons may have a tendency to cause detrimental effects, such as birth defects.

cleanup - Actions taken to deal with release or potential release of hazardous substances. This may mean complete removal of the substance; it also may mean stabilizing, containing, or otherwise treating the substance so that it does not affect human health or the environment.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-reportable release - Release to the environment that exceeds reportable quantities as defined by the Comprehensive Environmental Response, Compensation, and Liability Act.

concentration - Amount of a substance contained in a unit volume or mass of a sample.

conductivity - Measure of water's capacity to convey an electric current. This property is related to the total concentration of the ionized substances in a water and the temperature at which the measurement is made.

contamination - State of being made impure or unsuitable by contact or mixture with something unclean, bad, etc.

count - Signal that announces an ionization event within a counter; a measure of the radiation from an object or device.

counting geometry - Well-defined sample size and shape for which a counting system has been calibrated.

criteria pollutant - Any of the pollutants commonly used as indices for air quality that can have a serious effect on human health and the environment, including sulfur dioxide, nitrogen dioxide, total suspended particulates, PM10, carbon monoxide, ozone, gaseous fluorides, and lead.

curie - Unit of radioactivity. One curie is defined as 3.7×10^{10} (37 billion) disintegrations per second. Several fractions and multiples of the curie are commonly used:

kilocurie (kCi) - 103 Ci, one thousand curies; 3.7×10^{13} disintegrations per second.

millicurie (mCi) - 10^{-3} Ci, one-thousandth of a curie; 3.7×10^7 disintegrations per second.

microcurie (μCi) - 10⁻⁶ Ci, one-millionth of a curie; 3.7 x 10⁴ disintegrations per second.

picocurie (pCi) - 10⁻¹² Ci, one-trillionth of a curie; 0.037 disintegrations per second.

closure - Control of a hazardous waste management facility under Resource Conservation and Recovery Act requirements.

compliance - Fulfillment of applicable requirements of a plan or schedule ordered or approved by government authority.

composite - A blend of more than one portion to be used as a sample for analysis.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) - This act addresses the cleanup of hazardous substances and establishes a National Priority List of sites targeted for assessment and, if necessary, restoration (commonly known as “Superfund”).

D decay (radioactive) - Spontaneous transformation of one radionuclide into a different radioactive or nonradioactive nuclide, or into a different energy state of the same radionuclide.

decay time - Time taken by a quantity to decay to a stated fraction of its initial value.

deactivation - The process of placing a facility in a stable and known condition, including the removal of hazardous and radioactive materials to ensure adequate protection of the worker, public health and safety, and the environment—thereby limiting the long-term cost of surveillance and maintenance.

decommissioning - Process that takes place after deactivation and includes surveillance and maintenance, decontamination, and/or dismantlement.

decontamination - The removal or reduction of residual radioactive and hazardous materials by mechanical, chemical, or other techniques to achieve a stated objective or end condition.

decommissioning and demolition - Program that reduces the environmental and safety risks of surplus facilities at SRS.

derived concentration guide - Concentration of a radionuclide in air or water that, under conditions

of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in either an effective dose equivalent of 0.1 rem (1 mSv) or a dose equivalent of 5 rem (50 mSv) to any tissue, including skin and lens of the eye. The guides for radionuclides in air and water are given in U.S. Department of Energy Order 5400.5.

detection limit - See analytical detection limit, lower limit of detection, minimum detectable concentration.

detector - Material or device (instrument) that is sensitive to radiation and can produce a signal suitable for measurement or analysis.

diatometer - Diatom collection equipment consisting of a series of microscope slides in a holder that is used to determine the amount of algae in a water system.

diatoms - Unicellular or colonial algae of the class Bacillariophyceae, having siliceous cell walls with two overlapping, symmetrical parts. Diatoms represent the predominant periphyton (attached algae) in most water bodies and have been shown to be reliable indicators of water quality.

disposal - Permanent or temporary transfer of U.S. Department of Energy control and custody of real property to a third party, which thereby acquires rights to control, use, or relinquish the property.

disposition - Those activities that follow completion of program mission—including, but not limited to, surveillance and maintenance, deactivation, and decommissioning.

dissolved oxygen - Desirable indicator of satisfactory water quality in terms of low residuals of biologically available organic materials. Dissolved oxygen prevents the chemical reduction and subsequent leaching of iron and manganese from sediments.

dose - Energy imparted to matter by ionizing radiation. The unit of absorbed dose is the rad, equal to 0.01 joules per kilogram in any medium.

absorbed dose - Quantity of radiation energy absorbed by an organ, divided by the organ's mass. Absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01Gy).

dose equivalent - Product of the absorbed dose (rad) in tissue and a quality factor. Dose equivalent is expressed in units of rem (or sievert) (1 rem = 0.01 sievert).

committed dose equivalent - Calculated total dose equivalent to a tissue or organ over a 50-year period after known intake of a radionuclide into the body. Contributions from external dose are not included. Committed dose equivalent is expressed in units of rem (or sievert).

committed effective dose equivalent - Sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting factor. Committed effective dose equivalent is expressed in units of rem (or sievert).

effective dose equivalent - Sum of the dose equivalents received by all organs or tissues of the body after each one has been multiplied by an appropriate weighting factor. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent attributable to sources external to the body.

collective dose equivalent/collective effective dose equivalent - Sums of the dose equivalents or effective dose equivalents of all individuals in an exposed population within a 50-mile (80-km) radius, and expressed in units of person-rem (or person-sievert). When the collective dose equivalent of interest is for a specific organ, the units would be organ-rem (or organ-sievert). The 50-mile distance is measured from a point located centrally with respect to major facilities or U.S. Department of Energy program activities.

dosimeter - Portable detection device for measuring the total accumulated exposure to ionizing radiation.

downgradient - In the direction of decreasing hydrostatic head.

drinking water standards - Federal primary drinking water standards, both proposed and final, as set forth by the U.S. Environmental Protection Agency.

duplicate result - Result derived by taking a portion of a primary sample and performing the identical analysis on that portion as is performed on the primary sample.

effluent - Any treated or untreated air emission or liquid discharge to the environment.

Effluent monitoring - Collection and analysis of samples or measurements of liquid and gaseous effluents for purpose of characterizing and quantifying the release of contaminants, assessing radiation exposures of members to the public, and demonstrating compliance with applicable standards.

environmental compliance - Actions taken in accordance with government laws, regulations, orders, etc., that apply to site operations' effects on onsite and offsite natural resources and on human health; used interchangeably in this document with regulatory compliance.

environmental monitoring - Program at Savannah River Site that includes effluent monitoring and environmental surveillance with dual purpose of (1) showing compliance with federal, state, and local regulations, as well as with U.S. Department of Energy orders, and (2) monitoring any effects of site operations on onsite and offsite natural resources and on human health.

environmental restoration - U.S. Department of Energy program that directs the assessment and cleanup of inactive waste units and groundwater (remediation) contaminated as a result of nuclear-related activities.

environmental surveillance - Collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from U.S. Department of Energy sites and their environs and the measurement of external radiation for purpose of demonstrating compliance with applicable standards, assessing radiation exposures to members of the public, and assessing effects, if any, on the local environment.

exceedance - Term used by the U.S. Environmental Protection Agency and the South Carolina Department of Health and Environmental Control that denotes a report value is more than the upper guide limit. This term is found on the discharge monitoring report forms that are submitted to the Environmental Protection Agency or the South Carolina Department of Health and Environmental Control.

exposure (radiation) - Incidence of radiation on living or inanimate material by accident or intent. Background exposure is the exposure to natural back-

ground ionizing radiation. Occupational exposure is the exposure to ionizing radiation that takes place during a person's working hours. Population exposure is the exposure to the total number of persons who inhabit an area.

exposure pathway - Route that materials follow to get to the environment and then to people.

fallout - See worldwide fallout.

Federal Facility Agreement (FFA) - Agreement negotiated among the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the South Carolina Department of Health and Environmental Control, specifying how the Savannah River Site will address contamination or potential contamination to meet regulatory requirements at site waste units identified for evaluation and, if necessary, cleanup.

feral hog - Hog that has reverted to the wild state from domestication.

Gamma ray - High-energy, short-wavelength electromagnetic radiation emitted from the nucleus of an excited atom. Gamma rays are identical to X-rays except for the source of the emission.

gamma-emitter - Any nuclide that emits a gamma ray during the process of radioactive decay. Generally, the fission products produced in nuclear reactors.

gamma spectrometry - System consisting of a detector, associated electronics, and a multichannel analyzer that is used to analyze samples for gamma-emitting radionuclides.

grab sample - Sample collected instantaneously with a glass or plastic bottle placed below the water surface to collect surface water samples (also called dip samples).

Half-life (radiological) - Time required for half of a given number of atoms of a specific radionuclide to decay. Each nuclide has a unique half-life.

heavy water - Water in which the molecules contain oxygen and deuterium, an isotope of hydrogen that is heavier than ordinary hydrogen.

hydraulic gradient - Difference in hydraulic head over a specified distance.

hydrology - Science that treats the occurrence, circulation, distribution, and properties of the waters of the earth, and their reaction with the environment.

in situ - In its original place. Field measurements taken without removing the sample from its origin; remediation performed while groundwater remains below the surface.

inorganic - Involving matter other than plant or animal.

instrument background - Instrument signal due to electrical noise and other interferences not attributed to the sample or blank.

ion exchange - Process in which a solution containing soluble ions is passed over a solid ion exchange column that removes the soluble ions by exchanging them with labile ions from the column's surface. Process is reversible so that trapped ions are removed (eluted) from column and column is regenerated.

irradiation - Exposure to radiation.

isotopes - Forms of an element having the same number of protons in their nuclei but differing in the number of neutrons.

long-lived isotope - Radionuclide that decays at such a slow rate that a quantity of it will exist for an extended period (half-life greater than three years).

short-lived isotope - Radionuclide that decays so rapidly that a given quantity is transformed almost completely into decay products within a short period (half-life is two days or less).

Laboratory blank - Deionized water sample generated by the laboratory; a laboratory blank is analyzed with each batch of samples as an in-house check of analytical procedures. Also called an internal blank.

legacy - Anything handed down from the past; inheritance, as of nuclear waste.

lower limit of detection - Smallest concentration/amount of an analyte that can be reliably detected in a sample at a 95-percent confidence level.

M macroinvertebrates - Size-based classification used for a variety of insects and other small invertebrates; as defined by the U.S. Environmental Protection Agency, those organisms that are retained by a No. 30 (590-micron) U.S. Standard Sieve.

macrophyte - A plant that can be observed with the naked eye.

manmade radiation - Radiation from sources such as consumer products, medical procedures, and nuclear industry.

maximally exposed individual - Hypothetical individual who remains in an uncontrolled area and would, when all potential routes of exposure from a facility's operations are considered, receive the greatest possible dose equivalent.

maximum contaminant level - The maximum allowable concentration of a drinking water contaminant as legislated through the Safe Drinking Water Act

mean relative difference - Percentage error based on statistical analysis.

mercury - Silver-white, liquid metal solidifying at -38.9°C to form a tin-white, ductile, malleable mass. It is widely distributed in the environment and biologically is a nonessential or nonbeneficial element. Human poisoning due to this highly toxic element has been clinically recognized.

migration - Transfer or movement of a material through the air, soil, or groundwater.

minimum detectable concentration - Smallest amount or concentration of a radionuclide that can be distinguished in a sample by a given measurement system at a preselected counting time and at a given confidence level.

moderate - To reduce the excessiveness of; to act as a moderator.

moderator - Material, such as heavy water, used in a nuclear reactor to moderate or slow down neutrons from the high velocities at which they are created in the fission process.

monitoring - Process whereby the quantity and quality of factors that can affect the environment and/or human health are measured periodically to regulate and control potential impacts.

N nonroutine radioactive release - Unplanned or nonscheduled release of radioactivity to the environment.

nuclide - Atom specified by its atomic weight, atomic number, and energy state. A radionuclide is a radioactive nuclide.

O opacity - The reduction in visibility of an object or background as viewed through the diameter of a plume.

organic - Of, relating to, or derived from living organisms (plant or animal).

outcrop - Place where groundwater is discharged to the surface. Springs, swamps, and beds of streams and rivers are the outcrops of the water table.

outfall - Point of discharge (e.g., drain or pipe) of wastewater or other effluents into a ditch, pond, or river.

P parameter - Analytical constituent; chemical compound(s) or property for which an analytical request may be submitted.

permeability - Physical property that describes the ease with which water may move through the pore spaces and cracks in a solid.

person-rem - Collective dose to a population group. For example, a dose of one rem to 10 individuals results in a collective dose of 10 person-rem.

pH - Measure of the hydrogen ion concentration in an aqueous solution. Acidic solutions have a pH from 0 to 6, basic solutions have a pH > 7, and neutral solutions have a pH = 7.

piezometer - Instrument used to measure the potentiometric surface of the groundwater. Also, a well designed for this purpose.

plume - Volume of contaminated air or water originating at a point-source emission (e.g., a smokestack) or at a waste source (e.g., a hazardous waste disposal site).

point source - Any defined source of emission to air or water such as a stack, air vent, pipe, channel, or passage to a water body.

population dose - See collective dose equivalent under dose.

process sewer - Pipe or drain, generally located underground, used to carry off process water and/or waste matter.

purge - To remove water prior to sampling, generally by pumping or bailing.

purge water - Water that has been removed prior to sampling; water that has been released to seepage basins to allow a significant part of tritium to decay before the water outcrops to surface streams and flows to the Savannah River.

Q quality assurance (QA) - In the Environmental Monitoring System program, QA consists of the system whereby the laboratory can assure clients and other outside entities, such as government agencies and accrediting bodies, that the laboratory is generating data of proven and known quality.

quality control (QC) - In the Environmental Monitoring System program, QC refers to those operations undertaken in the laboratory to ensure that the data produced are generated within known probability limits of accuracy and precision.

R rad - Unit of absorbed dose deposited in a volume of material.

radioactivity - Spontaneous emission of radiation, generally alpha or beta particles, or gamma rays, from the nucleus of an unstable isotope.

radioisotopes - Radioactive isotopes.

radionuclide - Unstable nuclide capable of spontaneous transformation into other nuclides by changing its nuclear configuration or energy level. This transformation is accompanied by the emission of photons or particles.

real-time instrumentation - Operation in which programmed responses to an event essentially are simultaneous to the event itself.

reforestation - Process of planting new trees on land once forested.

regulatory compliance - Actions taken in accordance with government laws, regulations, orders, etc., that apply to Savannah River Site operations' effects on onsite and offsite natural resources and on human health; used interchangeably in this document with environmental compliance.

release - Any discharge to the environment. Environment is broadly defined as any water, land, or ambient air.

rem - Unit of dose equivalent (absorbed dose in rads x the radiation quality factor). Dose equivalent frequently is reported in units of millirem (mrem), which is one-thousandth of a rem.

remediation - Assessment and cleanup of U.S. Department of Energy sites contaminated with waste as a result of past activities. See environmental restoration.

remediation design - Planning aspects of remediation, such as engineering characterization, sampling studies, data compilation, and determining a path forward for a waste site.

replicate - In the Environmental Services Section groundwater monitoring program, a second sample from the same well taken at the same time as the primary sample and sent to the same laboratory for analysis.

Resource Conservation and Recovery Act (RCRA) - Federal legislation that regulates the transport, treatment, and disposal of solid and hazardous wastes. This act also requires corrective action for releases of hazardous waste at inactive waste units.

Resource Conservation and Recovery Act (RCRA) site - Solid waste management unit under Resource Conservation and Recovery Act regulation. See Resource Conservation and Recovery Act.

retention basin - Unlined basin used for emergency, temporary storage of potentially contaminated cooling water from chemical separations activities.

RFI/RI Program - RCRA Facility Investigation/ Remedial Investigation Program. At the Savannah River Site, the expansion of the RFI Program to include Comprehensive Environmental Response, Compensation, and Liability Act and hazardous substance regulations.

routine radioactive release - Planned or scheduled release of radioactivity to the environment.

S seepage basin - Excavation that receives wastewater. Insoluble materials settle out on the floor of the basin and soluble materials seep with the water through the soil column, where they are removed partially by ion exchange with the soil. Construction may include dikes to prevent overflow or surface runoff.

sensitivity - Capability of methodology or instruments to discriminate between samples with differing concentrations or containing varying amounts of analyte.

settling basin - Temporary holding basin (excavation) that receives wastewater that subsequently is discharged.

sievert - The International System of Units (SI)-derived unit of dose equivalent. It attempts to reflect the biological effects of radiation as opposed to the physical aspects, which are characterized by the absorbed dose, measured in gray. One sievert is equal to 100 rem.

site stream - Any natural stream on the Savannah River Site. Surface drainage of the site is via these streams to the Savannah River.

source - Point or object from which radiation or contamination emanates.

source check - Radioactive source (with a known amount of radioactivity) used to check the performance of the radiation detector instrument.

source term - Quantity of radioactivity (released in a set period of time) that is traceable to the starting point of an effluent stream or migration pathway.

spent nuclear fuel - Used fuel elements from reactors.

spike - Addition, to a blank sample, of a known amount of reference material containing the analyte of interest.

stable - Not radioactive or not easily decomposed or otherwise modified chemically.

stack - Vertical pipe or flue designed to exhaust air-borne gases and suspended particulate matter.

standard deviation - Indication of the dispersion of a set of results around their average.

stormwater runoff - Surface streams that appear after precipitation.

Superfund - See Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

supernate - Portion of a liquid above settled materials in a tank or other vessel.

surface water - All water on the surface of the earth, as distinguished from groundwater.

T tank farm - Installation of interconnected underground tanks for storage of high-level radioactive liquid wastes.

temperature - Thermal state of a body, considered with its ability to communicate heat to other bodies.

thermoluminescent dosimeter (TLD) - Device used to measure external gamma radiation.

total dissolved solids - Dissolved solids and total dissolved solids are terms generally associated with freshwater systems; they consist of inorganic salts, small amounts of organic matter, and dissolved materials.

total phosphorus - May occasionally stimulate excessive or nuisance growths of algae and other aquatic plants when concentrations exceed 25 mg/L at the time of the spring turnover on a volume-weighted basis in lakes or reservoirs.

total suspended particulates - Refers to the concentration of particulates in suspension in the air, regardless of the nature, source, or size of the particulates.

transport pathway - Pathway by which a released contaminant is transported physically from its point of discharge to a point of potential exposure to humans. Typical transport pathways include the atmosphere, surface water, and groundwater.

transuranic waste - Solid radioactive waste containing primarily alpha-emitting elements heavier than uranium.

trend - General drift, tendency, or pattern of a set of data plotted over time.

turbidity - Measure of the concentration of sediment or suspended particles in solution.

U unspecified alpha and beta emissions - The unidentified alpha and beta emissions that are determined at each effluent location by subtracting the sum of the individually measured alpha-emitting (e.g., plutonium-239 and uranium-235) and beta-emitting (e.g., cesium-137 and strontium-90) radionuclides from the measured gross alpha and beta values, respectively.

V vitrify - Change into glass.

vitrification - Process of changing into glass.

volatile organic compounds - Broad range of organic compounds, commonly halogenated, that vaporize at ambient, or relatively low, temperatures (e.g., acetone, benzene, chloroform, methyl alcohol).

W waste management - The U.S. Department of Energy uses this term to refer to the safe, effective management of various kinds of nonhazardous, hazardous, and radioactive waste generated at Savannah River Site.

waste unit - An inactive area known to have received contamination or to have had a release to the environment.

water table - Planar, underground surface beneath which earth materials, such as soil or rock, are saturated with water.

weighting factor - Value used to calculate dose equivalents. It is tissue specific and represents the fraction of the total health risk resulting from uniform, whole-body irradiation that could be attributed to that particular tissue. The weighting factors used in this report are recommended by the International Commission on Radiological Protection (Publication 26).

wetland - Lowland area, such as a marsh or swamp, inundated or saturated by surface or groundwater sufficiently to support hydrophytic vegetation typically adapted for life in saturated soils.

wind rose - Diagram in which statistical information concerning wind direction and speed at a location is summarized.

worldwide fallout - Radioactive debris from atmospheric weapons tests that has been deposited on the earth's surface after being airborne and cycling around the earth.

