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Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Department of Energy – Office of Science

Pacific Northwest Site Office Environmental Monitoring Plan for the DOE-SC PNNL Site

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December 2011

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

The Pacific Northwest Site Office (PNSO) manages the contract for operations at the U.S. Department of Energy (DOE) Office of Science (DOE-SC) Pacific Northwest National Laboratory Site (DOE-SC PNNL Site) in Richland, Washington. Radiological operations at the DOE-SC PNNL Site expanded in 2010 with the completion of facilities at the Physical Sciences Facility. As a result of the expanded radiological work at the site, the Washington State Department of Health (WDOH) has required that offsite environmental surveillance be conducted as part of the DOE-SC PNNL Site Radioactive Air Emissions License. The environmental monitoring and surveillance requirements of various orders, regulations, and guidance documents consider emission levels and subsequent risk of negative human and environmental impacts. This Environmental Monitoring Plan (EMP) describes air surveillance activities at the DOE-SC PNNL Site. The determination of offsite environmental surveillance needs evolved out of a Data Quality Objectives process (Barnett et al. 2010) and Implementation Plan (Snyder et al. 2010).

The entire EMP is a compilation of several documents, which include:

Main Document, this text, (PNNL-20919)

Attachment 1, Sampling and Analysis Plan (SAP) (PNNL-20919-1)[1]

Attachment 2, Data Management Plan (DMP) (PNNL-20919-2)[1]

Attachment 3, Dose Assessment Guidance (DAG) (PNNL-20919-3)[1]

Although the EMP is considered the compilation of these documents, each covers topics that can be updated independently. As a result, each may have different publication dates. Current version dates can be verified with Effluent Management staff.

The procedures, forms, and data management activities described herein may change with radiological research projects at the DOE-SC PNNL Site. The scope of this EMP will evolve as needed, during routine reviews or in response to changes in facility operations. This document provides the SAP, DMP, and DAG effective at the time of publication. Updates to this document will be published at the discretion of the Effluent Management group of PNNL.

[1] The three attachments listed above – the Sample and Analysis Plan, Data Management Plan, and Dose Assessment Guidance – are not included in this EMP; rather, they are available on PNNL's website (http://www.pnl.gov/, Publications link) as stand-alone documents that are subject to update independently of this EMP.

Acronyms and Abbreviations

ALARA	as low as reasonably achievable
CAP88-PC	*Clean Air Act* Assessment Package 1988 – Personal Computer
CFR	*Code of Federal Regulations*
DAG	Dose Assessment Guidance
DMP	Data Management Plan
DOE	U.S. Department of Energy
DOE-HQ	DOE-Headquarters
DOE-SC	DOE Office of Science
EMP	Environmental Monitoring Plan
EPA	U.S. Environmental Protection Agency
HDI	How Do I...? (management system)
ISO	International Organization for Standardization
MCSP	Meteorological and Climatological Services Project
MEI	maximally exposed individual
PNNL	Pacific Northwest National Laboratory
PNSO	(U.S. Department of Energy) Pacific Northwest Site Office
QA	quality assurance
QAPD	quality assurance program description
QC	quality control
RAEL	Radioactive Air Emissions License
RAER	Radionuclide Air Emissions Report
SAP	Sampling and Analysis Plan
SEM	Site Environmental Monitoring
WAC	*Washington Administrative Code*
WDOH	Washington State Department of Health

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1.0 Introduction

The U.S. Department of Energy (DOE) Office of Science (DOE-SC), Pacific Northwest National Laboratory (DOE-SC PNNL Site) Environmental Monitoring Plan (EMP) documents the offsite surveillance activities used to determine the radiological impact to those in the offsite environment. This EMP is being implemented to assure that potential radiological impacts associated with DOE-SC PNNL Site activities are evaluated appropriately and consistently, and are not having an unacceptable impact on human or ecological health. The 1.4-km^2 DOE-SC PNNL Site is shown in Figure 1.1 with the Hanford Site 300 Area at the top of the figure. Figure 1.2 indicates the relative locations and sizes of the DOE-SC PNNL Site and the 1,518-km^2 Hanford Site. The DOE-SC PNNL Site is a research facility managed by the Pacific Northwest Site Office (PNSO) for DOE-SC and is operated by Battelle Memorial Institute.

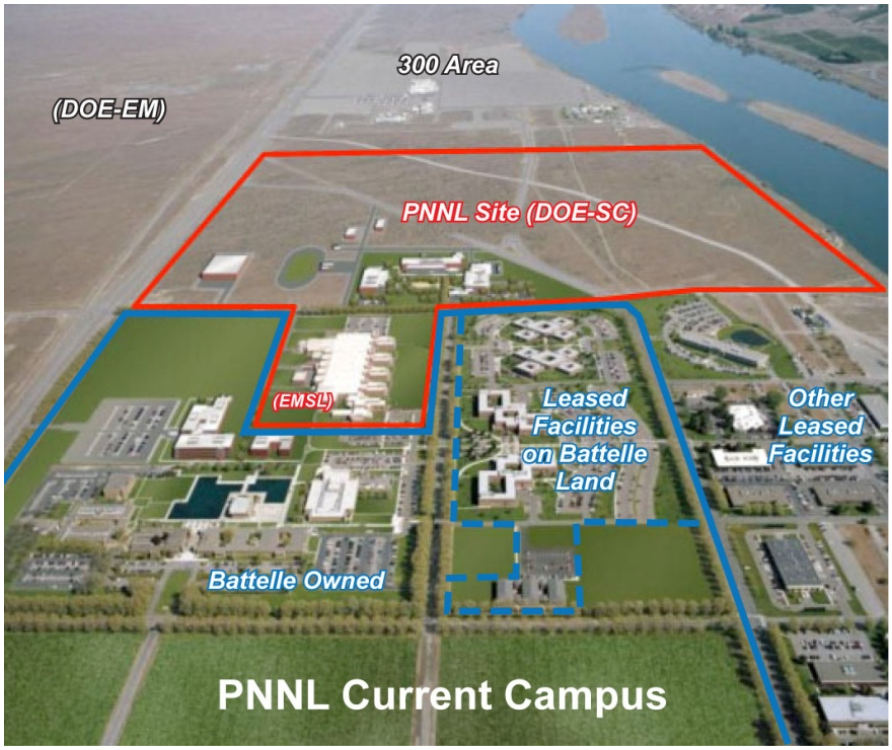

Figure 1.1. Location of DOE-SC PNNL Site

This EMP addresses operational aspects of environmental protection at a high level. Contractors are required to implement the environmental protection requirements in DOE Order 436.1, which includes the requirement for contractors to certify or conform their Environmental Management Systems with International Organization for Standardization (ISO) 14001:2004. The DOE-SC PNNL Site maintains an ISO14001:2004-compliant program. The requirements of state and federal laws, regulations, and permits related to facilities are also addressed at this level.

At a more-specific level, the program is conducted to assure the protection of site workers, the public, and the environmental resources on and around the DOE-SC PNNL Site. To accomplish this, DOE and its contractors must implement the requirements of DOE Order 458.1 (2011). The current Battelle contract for DOE-SC PNNL Site operations contains limited DOE Order 458.1 requirements.

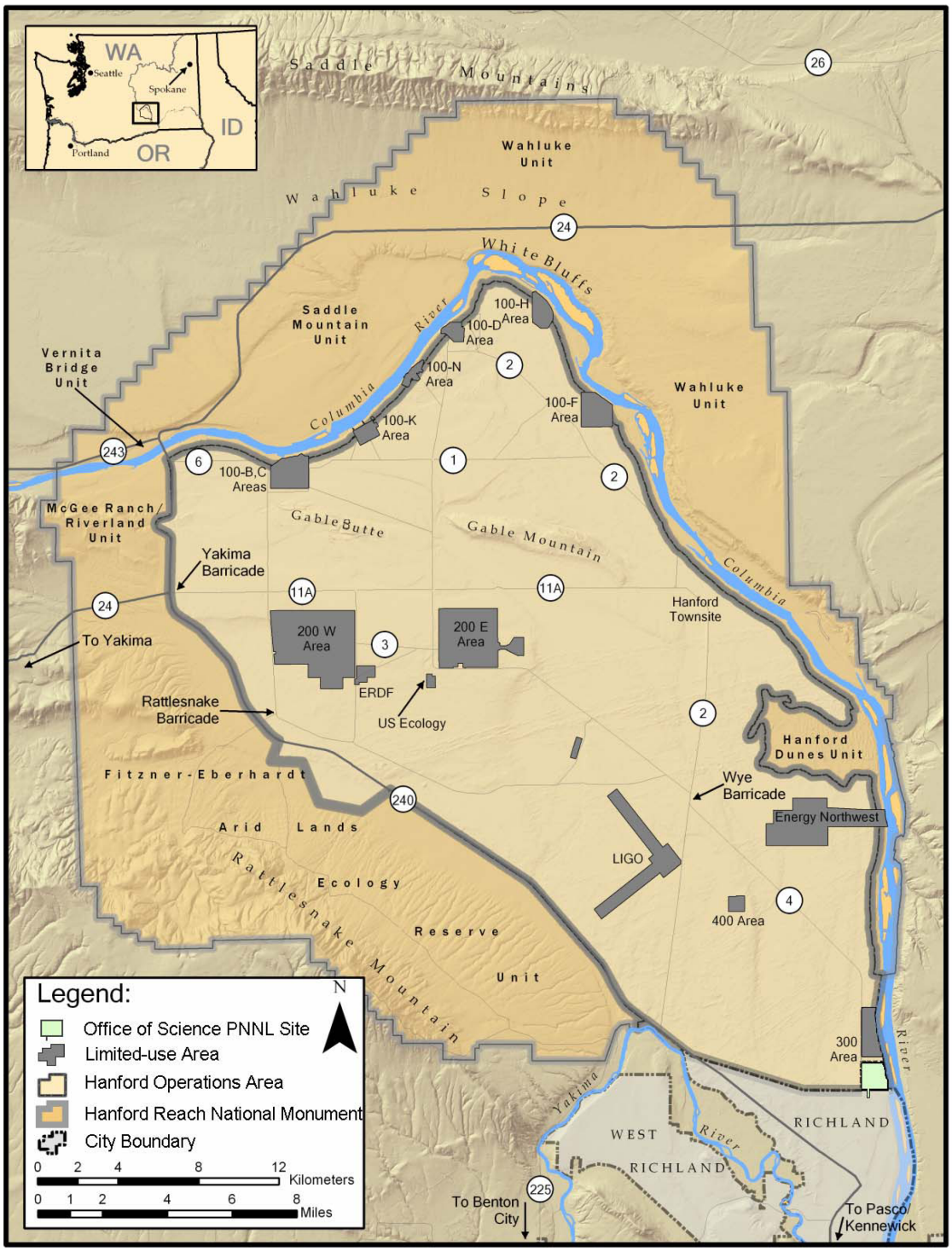

Figure 1.2. Location of the DOE-SC PNNL Site Relative to the Hanford Site

The U.S. Environmental Protection Agency (EPA) authorized the Washington State Department of Health (WDOH) to maintain regulatory oversight for radiological air emissions at Washington State DOE-SC PNNL Site facilities. In order to comply with the EPA *Clean Air Act* regulations for radiological emissions, DOE sites must meet the requirements in 40 CFR 61, Subpart H and Washington

Administrative Code (WAC) 246-247. As a result of expanded operations at the Physical Sciences Facility, the WDOH required the DOE-SC PNNL Site to implement an environmental radiological monitoring program as part of the site's Radioactive Air Emissions License (RAEL) (WDOH 2010).[1] The activities described in this EMP include radiological environmental surveillance of the ambient air from the DOE-SC PNNL Site fenceline or beyond. This DOE-SC PNNL Site EMP documents the programmatic and operational aspects of environmental air surveillance at the DOE-SC PNNL Site. Information is also included that is needed to meet reporting requirements for dose assessment activities related to DOE-SC PNNL Site air emissions.

The EMP development for the DOE-SC PNNL Site benefits from the institutional knowledge obtained through 50-plus years of monitoring at the nearby Hanford Site. Quality assurance is an integral part of all environmental surveillance activities to assure that data quality is known and documented and that the data meet DOE and contractor needs. This initial EMP for the DOE-SC PNNL Site is intentionally structured to include as much programmatic documentation as is reasonable within this one document.

1.1 Environmental Monitoring

Monitoring of radiological emissions from the DOE-SC PNNL Site occurs to assure that operations are conducted in a manner that does not pose an undue risk to human and environmental health. Programmatic elements of the DOE-SC PNNL Site's Environmental Monitoring Program include the Effluent Monitoring Program, the Air Surveillance Program managed by the PNNL Effluent Monitoring group, and the independent oversight activities of the WDOH. A brief overview of each element is provided. The remainder of this EMP discusses the program established for offsite monitoring, which is limited to the PNNL Site Air Surveillance Program.

1.1.1 Effluent Monitoring

Effluent monitoring, "in-stack sampling," at the DOE-SC PNNL Site is the responsibility of the PNNL Environmental Protection and Regulatory Programs division and is conducted in accordance with reviewed and approved monitoring procedures. Air effluent monitoring[2] consists of in-stack monitoring of facility radiological emissions. Summarized radiological effluent monitoring results (Ci emitted annually) are reported in the Radiological Air Emissions Report (e.g., Snyder et al. 2011). Other effluent (e.g., water, solids, hazardous chemicals) may also require onsite monitoring and management. The effluent monitoring quality assurance (QA) plan applies to these activities (EM-QA-01). The DOE-SC PNNL Site buildings with potential radiological emissions are shown in Figure 1.3. The emission unit categories for existing DOE-SC PNNL Site emission units are provided in Table 1.1. Emission units categorized as major emission units require continuous effluent monitoring for compliance purposes; those categorized as minor emission units require periodic monitoring for compliance purposes; fugitive emissions are not reasonably monitored and utilize inventory management controls. These emission units are the potential sources of radioactive effluent that require offsite environmental monitoring.

[1] WDOH – Washington State Department of Health. 2010. *Operation of the Physical Science Facility – RAEL-05*. AIR 10-603. Letter from P. John Martell, WDOH to Michael J. Weis, PNSO, dated June 24, 2010. Radioactive Air Emissions Section, Richland, Washington.

[2] *Air surveillance* refers to offsite ambient air monitoring (see Section 1.1.2).

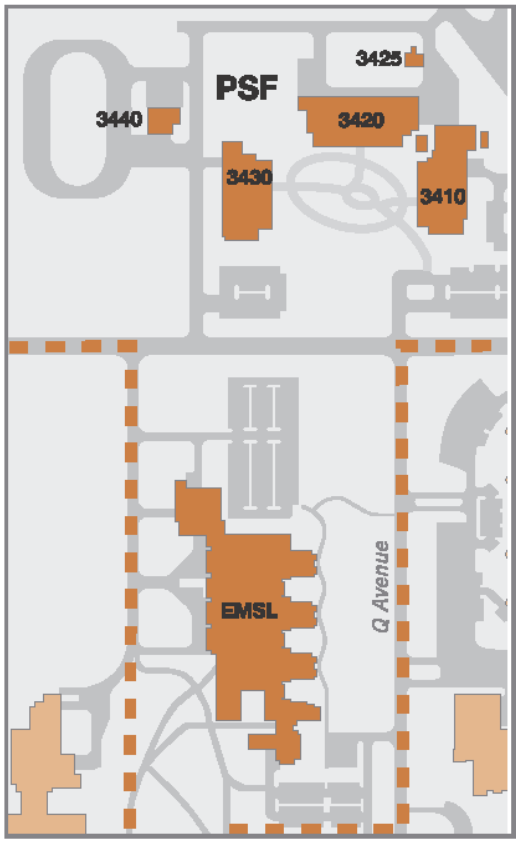

Figure 1.3. Facilities with Existing or Potential Radiological Emission Units on the DOE-SC PNNL Site

Table 1.1. Emission Units at the DOE-SC PNNL Site in 2011

Facility	Building Name	Stack ID	Emission Unit Category[(a)]	Facility Operational
3020 Building	Environmental and Molecular Sciences Laboratory	NA (previously registered as EP-3020-01-S)	Exempt (2004)	1997
3410 Building	Materials Sciences and Technology Laboratory	EP-3410-01-S	Major	2010
3420 Building	Radiation Detection Laboratory	EP-3420-01-S	Major	2010
3425 Building	Underground Laboratory	J-3425	Fugitive	2010
3430 Building	Ultra-Trace Laboratory	EP-3430-01-S	Major	2010
		EP-3430-02-S	Minor	2010
		EP-3430-1606P-S	Minor	2010
		EP-3430-1608P-S	Minor	2010
		EP-3430-1610P-S	Minor	2010
		EP-3430-1612P-S	Minor	2010
		EP-3430-1614P-S	Minor	2010

(a) Major emission units include those with potential emissions that could result in an offsite dose greater than 0.1 millirem/year to a maximally exposed member of the public. Minor emission units include those with potential emissions that would not result in an offsite dose that exceeds 0.1 millirem/year.

1.1.2 Offsite Air Surveillance

The radiological environmental air surveillance of the DOE-SC PNNL Site is the responsibility of the PNNL Effluent Management group. Environmental surveillance includes an air sampling network to determine ambient levels of radioactive emissions at locations likely to be maximally impacted by DOE-SC PNNL Site particulate emissions. Offsite air surveillance is conducted independent of facility-related effluent monitoring programs. Air surveillance provides an independent assessment of the effectiveness of effluent controls; monitors for fugitive contaminants; and establishes contaminant concentration norms. Annual design reviews are performed to assure that environmental monitoring activities are aligned with current site operations and missions and are focused on contaminants with the greatest potential for contributing to offsite doses.

1.1.3 Washington Department of Health Surveillance

The WDOH is provided access to collect air samples at the same sampling locations used for DOE-SC offsite air surveillance. The WDOH samples would be managed by the State for independent sample analyses. WDOH's environmental radiation oversight program data is published annually for the Hanford Site; data from other facilities are available upon request from the WDOH.

1.2 Meteorological and Climatological Services

Once radioactive material is emitted from a DOE-SC PNNL Site facility, the material is subject to dispersion by the atmosphere. Atmospheric dispersion may be modeled using meteorological data collected in the vicinity of the facility.

The Meteorological and Climatological Services Project (MCSP) for the Hanford Site is described in DOE/RL-91-50 (DOE 2008a), Section III.B. The MCSP, through the operation of the Hanford Meteorology Station, provides operational meteorological support to DOE and Hanford Site contractors for site operations; site-wide emergency preparedness; and construction, remediation, environmental restoration, and safety-related activities. The MCSP provides information to organizations on the Hanford Site that are doing work that could be severely affected by adverse meteorological conditions (e.g., thunderstorms, strong winds, dense fog, snowstorms). The day-to-day meteorological data generated by the MCSP are essential for assuring that work activities are conducted efficiently and under the safest conditions possible. The project can provide real-time meteorological data in the event of a suspected or actual unplanned release of radioactive or hazardous material to the atmosphere, so that personnel responding to the event can make appropriate and timely decisions. The data are also integral to the Hanford Site's annual estimates of potential public radiation exposures. Comprehensive climatological data records are maintained for use in a variety of other applications, such as post-accident analysis, dose reconstruction, building design, and environmental impact assessments. The project maintains a long-term meteorological computer database and produces an annual climatological data summary for the Hanford Site environmental report (Poston et al. 2010). DOE/RL-91-50, Rev. 4 (DOE 2008a), Section III.B describes the rationale and design of the MCSP, including the number and location of weather stations, the instruments used, forecasting capabilities, data management efforts, atmospheric dispersion modeling activities, and emergency response capabilities.

Data provided by the MCSP are also used to meet some of the requirements for DOE-SC PNNL Site air surveillance reporting. In particular, the data from a monitoring tower in the Hanford Site 300 Area (station 11), are used for annual dose assessment modeling to meet EPA regulatory requirements. Data required for use in the CAP88-PC code dose assessment include the annual average joint frequency distribution of wind speed, wind direction, and atmospheric stability class.

1.3 Environmental ALARA

The as low as reasonably achievable (ALARA) process is used at the DOE-SC PNNL Site to manage and control releases of radioactive material. Activities that release radioactive material outside of facilities must meet regulatory standards. The driving requirements behind the environmental ALARA program are DOE Order 458.1 and WAC 246-247. DOE Order 458.1 requires the ALARA process for all activities that result in public doses. WAC 246-247 also mandates the ALARA process as a standard for controlling radioactive air emissions.

The ALARA process does not define distinct limits, numerical values, or discrete thresholds for doses, but rather defines a philosophy, process, or goal of attaining doses as far below the applicable limit as is reasonably achievable. The environmental ALARA process is a logical procedure for managing projects, operations, and activities that result in radioactive releases to the environment, and evaluating ways to reduce radiation exposures and minimize releases to the extent practical. The final product of an ALARA process is a preferred system (from among several candidate radiological protection alternatives) that provides maximum benefit at the lowest cost. The ALARA process is essentially one of optimization and cost-benefit analysis.

Implementation of the PNNL ALARA process occurs through the ALARA Program Description as part of the PNNL Radiological Control Management System Description. ALARA program evaluations for radiation protection purposes primarily consider occupational human health and the requirements of 10 CFR 835. The environmental ALARA process also considers societal, technological, economic, and public policy factors and the requirements of DOE Order 458.1. Some examples of environmental factors to consider are impacts to sensitive species and habitats, effects on cultural and historic resources, real or perceived restrictions to land use, sociopolitical aspects, and public perception.

2.0 DOE-SC PNNL Site Environmental Surveillance

The initial program for conducting environmental surveillance for the DOE-SC PNNL Site is described in this section. Program requirements and objectives are elaborated. This section also covers relevant contract requirements for operations and management of the DOE-SC PNNL Site. Subsections 2.1 and 2.2 review broad environmental surveillance objectives covering DOE sites. The remaining subsections focus on the offsite surveillance of ambient air.

Environmental surveillance is conducted to measure contaminants of potential concern in various environmental media. For the DOE-SC PNNL Site, environmental surveillance is limited to sampling of particulate radionuclides in air, as determined to be appropriate during a 2010 Data Quality Objectives process (Barnett et al. 2010). Based on the current scope of DOE-SC PNNL Site operations, no requirements were identified for routine sampling of other media, such as surface water, sediment, soil, natural vegetation, agricultural products, fish, or wildlife.

Activities inherent in the operation of the environmental surveillance program for the DOE-SC PNNL Site include surveillance design and implementation, procedure development, sample collection, sample analysis, database management, data review and evaluation, and reporting. Other elements of the project include project management, QA and quality control (QC), staff supervision, training, records management, and equipment maintenance (Barnett 2011).

Surveillance activities focus on materials that are, or potentially could be, released from DOE-SC PNNL Site facilities. Surveillance results are collected for DOE and are provided annually to interested parties; federal, state, and local regulatory agencies; site contractors; and are available to other members of the public. In addition, unusual results or trends are reported to DOE and WDOH when they occur.

The sampling design described in this EMP is based on radiological pathway analyses that use data obtained under the requirements of the DOE-SC PNNL Site RAEL. The pathway analyses and radiological dose assessments conducted for this plan, and the radiological dose assessments reported in annual compliance reporting to the WDOH and EPA, use the data provided by the MCSP described in DOE/RL-91-50, Rev. 4 (DOE 2008a), Section III.B, to determine atmospheric dispersion.

The environmental pathways by which contaminants are transported through environmental media to people are strongly influenced by environmental settings. The DOE-SC PNNL Site's environmental setting is equivalent to that summarized in the *Hanford Site National Environmental Policy Act (NEPA) Characterization* report (Duncan et al. 2007) and is not described here.

2.1 Requirements and Objectives of Environmental Surveillance

The general requirements and objectives for sustainability and environmental surveillance for all U.S. DOE sites are contained in DOE Order 436.1 (2011), "Departmental Sustainability" and Order 458.1 (2011), "Radiation Protection of the Public and the Environment." The broad surveillance objectives are: to demonstrate DOE-SC PNNL Site compliance with legal and regulatory environmental requirements, to support adherence to DOE environmental protection policies and Orders, and to support environmental management decisions. These broad surveillance objectives are embodied in the primary surveillance

objectives stated in State Regulations (WAC 246-247), Federal regulations (40 CFR Part 61, Subpart H), DOE Orders and guidance documents (e.g., O 458.1 and DOE 1991):

> Support the determination of DOE's compliance status with applicable environmental quality standards, public exposure limits, and applicable laws and regulations.

Additional objectives that derive from this primary objective include:

- Assessing preoperational environmental conditions.
- Assessing radiological doses to the public from site operations.
- Assessing radiological doses from other local sources.
- Reporting any non-routine releases.
- Maintaining an environmental monitoring plan (e.g., this plan) as part of an Environmental Management System.
- Determining the effectiveness of treatments and controls for site emissions.
- Determining the validity and effectiveness of computer models used to predict the concentrations of pollutants in the environment.
- Detecting and quantifying unplanned contaminant releases.
- Identifying and quantifying new or existing environmental quality problems.

Subsidiary Objectives include:

- Providing public assurance that radiological operations are conducted in a manner protective of the public and environment.
- Providing environmental data to assist DOE or DOE contractors.

The DOE Orders require that the content of surveillance programs be determined on a site-specific basis and must reflect specific facility or site characteristics; applicable regulations; hazards potentials; quantities and concentrations of materials released or potentially released to the environment; the extent and uses of affected air, land, and water; and specific local public, contractor, stakeholder, and regulatory agency interests and concerns.

2.2 Environmental Surveillance Design

Environmental surveillance is designed to meet the objectives listed in the previous section while considering the environmental characteristics of the site, the potential for release, and the actual releases from site operations. The reporting of surveillance activities focuses on the determination of environmental impacts and on compliance with public health and environmental standards or protection guides, rather than on providing detailed radiological characterization. Experience gained from environmental surveillance activities and studies conducted at the adjacent Hanford Site for more than 50 years provided the foundation for the DOE-SC PNNL Site environmental surveillance design.

The environmental surveillance of the DOE-SC PNNL Site is structured to be site-specific and independent of Hanford Site environmental surveillance. However, efficiencies can be gained from data collected under Hanford Site programs that apply to each site, specifically meteorological data (300 Area tower) and background air concentration data (Yakima sampler station). The meteorological data from the 300 Area tower is applicable and available to the DOE-SC PNNL Site. Background air concentration data collected at the Yakima sampler station is available upon request. It is sufficient for a background determination even though it does not include the full suite of DOE-SC PNNL Site radionuclides that require offsite surveillance (Barnett et al. 2010). No americium-243 or curium-244 measurements are determined from the Yakima station samples. These nuclides are not naturally-occurring and a very limited number of facilities use or release them. Until these nuclides are added to a background sample evaluation program, any detectable levels found in DOE-SC PNNL Site samples will be presumed to come from the DOE-SC PNNL Site and will be thoroughly investigated. Regardless of the source, dose impacts from detectable levels of americium-243 and curium-244 in DOE-SC PNNL Site samples would be reported in accordance with regulatory requirements.

2.2.1 Environmental Media Selections

The highest sampling priority is given to media that could have a direct impact on members of the public. Currently, this is limited to only DOE-SC PNNL Site particulate radionuclide sampling in offsite air, as concluded in Barnett et al. (2010). Other types of media may be selected for sampling in the future, as new programs evolve at the DOE-SC PNNL Site. New media samples would be selected based on regulatory and directive requirements, as well as, their sensitivity as indicators of loss of materials control, potential use for predicting contaminant accumulations and trends, potential to function as indicators of environmental quality, potential to serve as indicators of biotic impacts, and potential for bioaccumulation in food products (e.g., milk).

2.2.2 Sampling

Environmental sampling considers appropriate sampling locations, sampling frequency, analytical measurement criteria, analytical result validation, and data reporting and assessment.

2.2.2.1 Sampling Locations

Environmental samples are collected to determine background (un-impacted media) and contamination levels (impacted media). Background sampling is conducted at locations that are reasonably expected to be unaffected by DOE-SC PNNL Site or Hanford Site discharges (e.g., Bisping 2010). These background locations are routinely sampled under the Hanford Site EMP. Sampling locations with the potential to represent the more greatly impacted offsite individual locations from DOE-SC PNNL Site emission points are selected to maximize the probability of detecting a loss of containment, and to help assess the magnitude of releases. Finally, Hanford Site sampling is conducted in nearby communities to obtain data where potential exposures may occur and to provide assurance to the communities that contaminant levels are well below standards established to protect public health and the environment. Given the greater magnitude, and therefore, potential impact, of Hanford Site facility air emissions, the Hanford Site nearby community monitoring locations sufficiently envelope the DOE-SC PNNL Site needs for community monitoring even though americium-243 and curium-244 are not included in the routine analyses.

2.2.2.2 Sampling and Analysis Schedule

Sampling frequencies are based on the need to obtain time-representative samples, environmental factors that may impact collection efficiencies, and consideration of sampling equipment or sampling substrate limitations. Samples are routinely collected and multiple samples may be composited, if necessary, to achieve lower detection levels or increase time representativeness. A DOE-SC PNNL Site Master Sampling Schedule, posted on the PNNL internal website, documents the sampling frequency and constituents planned for the year.

2.2.2.3 Analytical Detection and Precision

The general strategy for obtaining the lowest levels of detection practical is to use standard analytical procedures and to take into consideration practical sampling strategy tradeoffs (e.g., time and location compositing versus discrete samples). Where technically feasible and practical, the minimum objective for a given medium and radiological contaminant combination is to detect a concentration that is equal to or below the concentration that would result in a dose to humans of 1-millirem-per-year effective dose equivalent if exposure to that concentration was sustained for one year. This dose estimate assumes that the radionuclide is being transported to subsequent compartments of the exposure pathways and that the individual is exposed via all subsequent applicable pathways. For example, the pathway for air assumes not only inhalation but also exposure to airborne materials deposited on the ground and to contaminants from the air taken up in locally grown foods. One millirem is 10% of the public exposure level that must be reported to DOE and is 10% of the federal dose limit (40 CFR 61) for the air pathway. In general, most radionuclide concentrations in environmental samples collected around the DOE-SC PNNL Site result in an annual dose well below 1 millirem. The minimum objective analytical detection limit for air samples is determined by regulatory notification levels of 40 CFR Part 61, Appendix E.

2.2.2.4 Anomalous and Reporting Levels

When environmental sample results are received, they are reviewed and compared to the notification values of 40 CFR 61, Appendix E, Table 2 (see Sampling and Analysis Plan and Data Management Plan, Attachments 1 and 2). Each sample result that exceeds the notification level is considered anomalous and the appropriate investigations or reporting is initiated. Project personnel review the anomaly to determine the validity of the result and whether additional information is needed from the analytical laboratory. Anomaly evaluations are maintained as part of the project record.

Sample results that require notifications to DOE have also been established for some radionuclides in selected media. All reporting levels provide early indications of conditions that might require specific reporting to DOE-Headquarters as indicated by DOE Order 458.1. These DOE reporting levels are consistent with or more conservative than the EPA 40 CFR 61, Subpart H, reporting levels.

2.2.2.5 Support Documents for Environmental Surveillance Activities

A number of additional specific plans are developed to support this initial EMP. The plans describe EMP activities in more detail and may be media- or contaminant-specific (e.g., air, soil, tritium). Current plans are limited to radiological air sampling of offsite air and include:

- Sampling and Analysis Plan (SAP)
- Data Management Plan (DMP)
- Dose Assessment Guidance (DAG)
- Effluent Management QA Plan Attachment K, "Radionuclide Air Environmental Monitoring."

2.2.3 Exposure Pathways and Dose Assessments

Exposure pathways and dose assessments are conducted annually to assess site compliance with the DOE public exposure limit (DOE Order 458.1) and the criteria in 40 CFR 61. Only one annual dose assessment is currently done at the DOE-SC PNNL Site for radiological air emissions under 40 CFR 61, Subpart H and WAC 246-247. The EPA-approved software, CAP88-PC v3 (Rosnick 2007) is used. If other release pathways were relevant to site emissions (e.g., water or land disposal of wastes), additional design modifications, sampling, dose assessments and methodologies would be identified and implemented. Dose assessments may also be done as necessary when potential release or exposure conditions have changed significantly.

An exposure pathway is identified based on 1) examination of the types, locations, and sources of contaminants (e.g., contaminated air, soil, liquid effluent); 2) principal contaminant release mechanisms; 3) the probable environmental fate and transport (including persistence, partitioning, and intermediate transfer) of contaminants of interest; and 4) the locations and activities of the potentially exposed individuals and populations. Environmental processes or mechanisms that could influence the fate and movement of chemical or physical agents through the environment, and the amount of exposure a person might receive at various receptor locations, are listed below.

Once a radionuclide is released into the environment, it may be:

- Transported (e.g., migrate downstream in solution or on suspended sediment, travel through the atmosphere as a gas or associated with airborne particles, or be carried offsite in contaminated wildlife).
- Physically or chemically transformed (e.g., volatilized, photolysized, oxidized, reduced, hydrolysized, or changed through radioactive decay).
- Biologically transformed (e.g., biodegraded, metabolized).
- Accumulated in the receiving media (e.g., sorbed in water, soil, or sediment or stored in organism tissues).

The primary pathway for movement of radionuclides from the DOE-SC PNNL Site to the public is the atmosphere. As of 2011, other pathways were determined not to be relevant, such as surface water and groundwater pathways, and the air pathway is only evaluated for particulate releases (Barnett et al. 2010). The significance of a pathway is determined from measurements and calculations that estimate the

amounts of radioactive materials transported along the pathway, and by comparing contaminant concentrations, or potential doses, to environmental and public health protection standards or guides. A pathway can also be evaluated based on prior studies and observations of radionuclide movement through the environment and food chains. Calculations based on effluent data show the expected contaminant concentrations off the DOE-SC PNNL Site to be low for all potential radioactive air emissions and could frequently be below the levels detectable by current measurement technologies. For radionuclides released from major and minor emissions units, air concentrations at levels of significance for dose impacts are at detectable levels.

The surveillance design uses a sampling approach to monitor the appropriate pathways. Samples are collected, and radionuclide concentrations are measured outside of the DOE-SC PNNL Site boundary. The environmental concentrations of airborne radionuclide releases from facilities generally would be the highest, and therefore most easily detected, nearer to the point of release. Exposures at locations just outside the facility boundary are typically the maximum that any member of the public (not working on the DOE-SC PNNL Site) could receive. An additional surveillance zone could consist of farther afield community locations within an 80-kilometer radius of the DOE-SC PNNL Site.

Background concentrations, as previously described, are measured at locations distant from the DOE-SC PNNL Site and Hanford Site, as part of the Hanford Site monitoring program (see DOE 2008a). These background concentrations can be compared to concentrations measured at DOE-SC PNNL Site offsite monitoring stations. Background locations are essentially unaffected by site operations but may be affected by other man-made sources of contaminants such as fallout from nuclear weapons testing. A comparison of background concentrations to DOE-SC PNNL Site monitoring station concentrations may indicate the relative impact of DOE operations.

The amounts of most radioactive materials released from DOE-SC PNNL Site operations are very small. Often it is not possible to distinguish levels resulting from worldwide fallout and natural sources from those associated with DOE-SC PNNL Site releases. Therefore, offsite dose assessments performed for regulatory compliance may be estimated using the following methods:

- Doses from monitored air emissions are estimated by applying environmental transport and dose calculation computer models to measured in-stack effluent monitoring data. Pathway modeling results are compared to measured surveillance results to reveal potential anomalies and assess model performance. When measured results exceed model results, the measured results may be used to evaluate the relative contribution from other sources, such as emissions from other offsite facilities or from fugitive sources.
- Doses from significant sources of fugitive air emissions (e.g., soil gases or resuspended contaminated soils), where they exist, could be estimated from measured airborne concentrations at site perimeter locations.

Biota (aquatic animals, terrestrial plants, and terrestrial animals) require protection from adverse impacts of radiological emissions under DOE Order 458.1. Biota dose evaluations could be conducted using the DOE Technical Standard, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2002). Environmental pathways important to biota dose determinations typically result from sampling soil, sediment, and water. It was determined through a Data Quality Objective process (Barnett et al. 2010) that only air sampling was relevant for the DOE-SC PNNL Site at this time.

Therefore, neither biota sampling nor biota dose evaluations are performed at present. The results of the pathway analysis and exposure assessment serve as the bases for future years' surveillance program designs.

2.2.4 Quality Assurance

The QA requirements of the operating contractor of the DOE-SC PNNL Site are documented in PNNL's Environmental Management System. QA for the overall environmental surveillance program is implemented by the PNNL Effluent Management group for both air effluent monitoring (i.e., in-stack sampling) and offsite air surveillance. In addition, as indicated in Section 1.1.3, the WDOH may collect comparative samples for independent analysis. Several mechanisms are in place to assure the quality of the analytical measurements performed on environmental samples (see Attachment 1, Sampling and Analysis Plan). For example, the analytical laboratory evaluates blind-spiked samples to evaluate radio-analytical measurement performance. Details of DOE-SC PNNL Site Air Surveillance QA are described in Section 2.3.5. QA/QC are also covered under the supporting plans (see Attachments 1 and 2, Sampling and Analysis Plan and Data Management Plan).

2.2.5 Environmental Surveillance Annual Review

The environmental surveillance program design is reviewed and evaluated annually based on the above considerations, an awareness of planned DOE-SC PNNL Site activities, and consideration of the previous year's surveillance activities. This review occurs within the normal course of Environmental Management System operations and in conjunction with information compiled and evaluated in the course of meeting reporting requirements. Periodic re-evaluations may be needed during the year to respond to changing operations or environmental conditions. Steps in the process may include:

- Perform a pathway analysis – The design process starts with a radiological pathway analysis performed for the calendar year just ended. This analysis is performed for air emissions compliance and is based on facility emissions information. The pathway analysis serves as the basis for the design review. A comparison of the previous year's results with pathway analysis conclusions helps to identify changes in environmental conditions that may lead to modifications to the sampling design and reporting requirements.
- Prepare a DOE-SC PNNL Site environmental report – A site annual environmental report would summarize the findings of environmental surveillance, effluent monitoring, and cleanup activities conducted at a DOE site during the previous calendar year (see e.g., Poston et al. 2010 for the Hanford Site). However, since the DOE-SC PNNL Site currently only has air emissions, the annual radionuclide air emissions report (RAER) prepared to comply with 40 CFR 61, Subpart H and WAC 246-247 provides the radiological emissions summary. The current Contract Requirements Document for the DOE-SC PNNL Site does not specify the requirement for a Site Environmental Report.
- Evaluate future/proposed site activities – An activities projection from DOE-SC PNNL identifies future activities to be considered in the surveillance design. Resources useful in anticipating future environmental surveillance needs include various effluent and operational environmental monitoring plans, results from previous years' monitoring, and periodic technical exchanges between the Effluent Management group, PNSO, and DOE-SC PNNL Site facilities staff.

- Evaluate surveillance design – The above information is considered in an annual surveillance design evaluation. In addition, field inspections of sampling and measurement locations can indicate whether conditions at the sampling locations continue to meet site selection or sampling design criteria (see Barnett et al. 2010). The evaluation also includes an effort to identify and review new surveillance compliance requirements (e.g., DOE Orders, directives, or other applicable federal or state requirements) and DOE (1991) updates. Any actions taken in response to the evaluation are documented in the project files, in updates to the project documentation package and an environmental surveillance annual sampling schedule. Plans for the upcoming calendar year are developed.
- Prepare scope and budget – Based on the results of the annual surveillance design evaluation, scope and budget information could be prepared for upcoming fiscal years. The detail in this scope and budget information is necessarily general in nature; however, it does provide a basis for future planning and future scope and budget development. PNSO should submit scope and budget information for upcoming fiscal years to DOE Headquarters (DOE-HQ).
- Identify fiscal funding package – Specific surveillance objectives, work scope, and budget could be provided in a project-specific documentation package written for the upcoming (next) fiscal year. The package would set forth the plans and organization that will be used to conduct, control, and document project activities and represents an agreement between DOE and PNNL on the objectives, scope, and work to be performed during that fiscal year.
- Develop and update annual sampling schedule – An annual sampling schedule (e.g., Bisping 2010) update could be prepared based on the results of the annual design review process.

2.3 Air Surveillance Overview

Small amounts of radioactive particles and gases are potentially released to the atmosphere from the DOE-SC PNNL Site. Point sources (stacks and vents) may release materials during routine operations. In addition, fugitive sources may release very low amounts of radioactive materials. Table 1.1 lists existing emission units. PNSO was issued a RAEL (currently, -05) on June 24, 2010, by the WDOH for DOE-SC PNNL Site radiological air emissions. The license expires 5 years after its issue date.

Once released into the environment, radioactive materials are diluted to even lower concentrations as they are transported to locations where people may be directly exposed to radionuclides through inhalation and immersion, or indirectly exposed through deposition of contaminants onto farm crops, native vegetation, and surface soil. The three DOE-SC PNNL Site air sampling stations monitor site emissions at offsite or near boundary locations. The air samplers, which operate continuously, may also provide data useful in the evaluation of a large unplanned release. Specifics of air sampling and the analytical requirements are covered in the DOE-SC PNNL Site Sampling and Analysis Plan (see Attachment 1). Specifics regarding analytical data management, scheduling, and analytical data review are covered in the DOE-SC PNNL Site Data Management Plan (see Attachment 2).

Operations at the nearby Hanford Site, especially the 300 Area, have the potential to impact the air surveillance results of the DOE-SC PNNL Site air monitoring network (see Figure 2.1). The significance of the Hanford contributions will be considered as the monitoring results are evaluated.

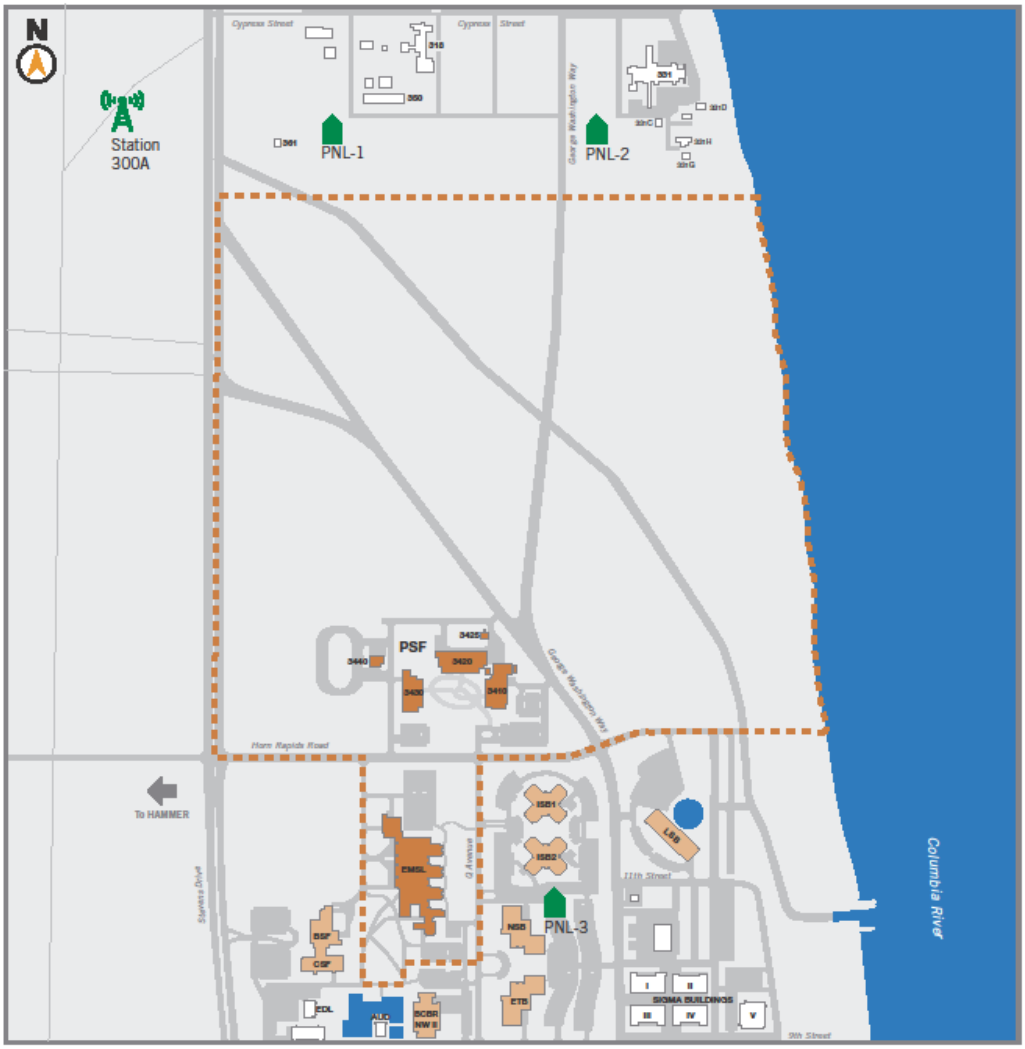

Figure 2.1. Location of PNNL Air Monitoring Stations (⌂ = monitoring station)

2.3.1 Objectives, Rationale, and Criteria

The objectives of air surveillance include:

- Obtain air concentration measurements at locations of actual and potential public occupancy to verify that possible exposures to the public from DOE operations remain low relative to standards.
- Provide early detection of potential increases in exposures to radioactive materials through gross alpha and gross beta measurements.
- Obtain measurements at the site perimeter or nearby to provide assurance to the public that the potential impacts from DOE operations are known or can be conservatively estimated.
- Obtain measurements and establish analytical laboratory contracts in accordance with analytical requirements.

- Sample offsite air per regulatory or license requirements.
- Provide data for the computer models used to predict and assess public dose compliance and environmental contamination.

The criteria for air sampling consist of those identified in DOE (1991) and the regulations governing the DOE-SC PNNL Site's RAEL (currently, RAEL-05). Air surveillance results can be used to corroborate the radiological impact assessment of the DOE-SC PNNL Site. Estimated impacts typically overestimate any actual impact received by exposed individuals as a result of conservative assumptions used in the impact evaluation. Therefore, reported dose assessment results are typically greater than actual air surveillance results predict. As a secondary function, surveillance results for monitored nuclides may also indicate the adequacy of emission control equipment and unanticipated radiological releases.

2.3.2 Media Selection

Air is sampled because it is the primary media in which radionuclides could be transported from the DOE-SC PNNL Site release locations to offsite areas where they could impact the public. All of the radionuclides of interest occur in particulate form at the DOE-SC PNNL Site. Therefore, particulate sampling of air is performed. If build-up of long-lived radioactive materials at levels of significance is a concern, additional environmental media sampling could be initiated.

2.3.3 Air Sampling and Sample Analysis

The DOE-SC PNNL Site Sampling and Analysis Plan (see Attachment 1) provides details about sample frequency, the actual sampling process, as well as the requirements imposed on the analytical laboratory for sample analysis. Sampling performed under the plan provides assurance that the quality of the analytical data produced meets programmatic objectives. The radionuclides identified for analysis are those that 1) are released in measurable quantities from DOE-SC PNNL Site facilities, 2) are calculated to potentially contribute more than 10% of the maximally exposed individual dose, or 3) are of special public or agency interest. The current list of analytes is indicated in the Sampling and Analysis Plan.

The current sampling locations (see Figure 2.1) were determined based on several factors, including access, power availability, and atmospheric dispersion modeling results. Sampling stations are located in near offsite areas to measure the concentrations of radionuclides at locations accessible by members of the public (Barnett et al. 2010).

Air samples are collected by continuously drawing air through particulate filters. Sampling procedures are used by trained staff to consistently collect samples. The sampler station design assures collection of a sample representative of the entire sampling interval (i.e., so results are not biased toward one portion of the interval). Samplers are placed outside of building wake zones, away from vegetation and in generally flat terrain. Sampling inlets are located 2 meters above the ground to provide measurements representative of radionuclide concentrations inhaled by humans.

Air samples are collected using procedures that avoid loss of sample mass, cross contamination, or misidentification. Measures such as exchanging whole sample collection media containers, rather than

handling the collection media in the field accomplishes this, as does labeling and sealing or storing each sample so that sample integrity in the field is maintained.

As indicated in the SAP, all air surveillance samples are analyzed according to an established contract with an analytical laboratory. The contract specifies the detection levels for the various matrix/analysis combinations and other analytical information requirements.

2.3.4 Air Surveillance Data Management

The objectives for air surveillance sample scheduling, data management, result analysis, and statistical treatment are fully described in the Data Management Plan (see Attachment 2) and summarized in the following sections. Scheduling is incorporated as part of the Data Management Plan, rather than the Sampling and Analysis Plan (see Attachment 1), to better implement the tracking of the defined sampling frequency. Data management objectives are primarily achieved through the DOE-SC PNNL Site Environmental Monitoring (SEM) database. The SEM database provides a repository for DOE-SC PNNL Site offsite air surveillance data.

2.3.4.1 Objectives, Rationale, and Criteria

Good data management, data validation, and statistical treatment practices are essential for the production of quality results. The objectives for data management of environmental surveillance results include:

- Managing data in a manner that assures timely collection, validation, and reporting in accordance with an annual sampling schedule and traceability from scheduling to archiving in the database.
- Estimating contaminant-of-concern concentrations at each sampling and/or measurement point for each sampling and/or measurement time and estimating accuracy and precision.
- Comparing the contaminant-of-concern concentrations at each sampling and/or measurement point to previous concentrations measured at the same point to recognize changes or inconsistencies in concentration levels.
- Comparing the contaminant-of-concern concentrations at each sampling and/or measurement point to reporting (notification) limits.
- Comparing the contaminant-of-concern concentrations at individual sampling and/or measurement points to those measured at background or other points.

The criteria for the data accumulated in the SEM database are indicated in the Sample and Analysis Plan analytical requirements (see Attachment 1, Section 4). Air samples are collected according to the Sampling and Analysis Plan, as coordinated with the Radioactive Air task lead. Data management assures timely scheduling, sample tracking, analysis tracking, and validation of analytical results. Validated results indicate the radiological air concentrations at the monitoring station locations. Maintaining a database of results allows for timely data access and report generation. The DOE-SC PNNL Site Data Management Plan (see Attachment 2) provides details about database hardware and software requirements, sample scheduling and tracking, analysis result tracking, validation and interpretation of the analytical results, and data reporting.

2.3.4.2 Data Management Overview

The SEM database is used as a repository for data gathered during air surveillance for the DOE-SC PNNL Site. It is intended to provide current and consistent data for all users. The system and its data are accessible through the Radioactive Air task lead.

An annual sample collection schedule is established prior to the beginning of the calendar year. To facilitate sample collections, the Radioactive Air task lead or designate schedules and provides the initial sample collection documentation to the sample collector. Staff also generates laboratory composite sheets to the analytical lab to identify individual samples that are combined to form composite samples. Analytical results are provided by the laboratories and reported to the Radioactive Air task lead (and others as appropriate) in either electronic or hardcopy formats. Once obtained, the data are entered into the database either electronically or manually. As results are entered into the database, several mathematical tests are performed to determine whether selected results are within the range of established limits. Various status and result reports can be generated to assist project personnel in the review of data. Finally, analytical results stored in the database can be retrieved for review, further analysis, or for use in preparing reports.

2.3.5 Air Surveillance Quality Assurance and Quality Control

In achieving the surveillance objectives identified in previous sections, it is imperative that the accuracy, precision, traceability, and limitations of data are known. The generation of quality reports and documents requires controlled and verified data. It is also important to maintain a routine and appropriate methodology to ensure control and legitimacy of project documentation. All components of the surveillance project maintain an appropriate level of QA/QC.

The goal of a QA/QC program is to assure that accurate, defensible data are produced. This subsection describes the elements of the environmental surveillance QA/QC program and how they are implemented. Achieving the QA/QC goal requires a management commitment to operating a surveillance project that accurately reflects DOE-SC PNNL Site environmental impacts and radiation doses to the environment and public. A management commitment to the QA/QC program is assured through PNNL management processes that are implemented through a laboratory-wide management system (the HDI or “How Do I...?” system). The PNNL HDI is a web-based system for communicating the PNNL management systems and procedures through work flows.

2.3.5.1 Requirements

The DOE QA requirements are contained in DOE Order 414.1C. The Order requires that QA plans be developed and documented and recommends the judicious and selective application of appropriate and recognized standards. The DOE Order identifies 10 management, performance, and assessment criteria that must be addressed in a quality assurance plan. At PNNL, these criteria are implemented through the PNNL Quality Assurance Program Description (QAPD), which implements American Society of Mechanical Engineers ASME NQA-1-2000 (2000) using a graded approach.

2.3.5.2 Quality Assurance Plan

Environmental surveillance for the DOE-SC PNNL Site is conducted under the *Effluent Management Quality Assurance Plan* (EM-QA-01). Attachment K to EM-QA-01 addresses environmental surveillance activities for the DOE-SC PNNL Site. The Effluent Management QA Plan addresses the applicable criteria in DOE Order 414.1C, the 18 criteria of the ASME (NQA-1-2000 Edition), and EPA guidance (EPA 2001). This project meets the requirements of the American Society of Mechanical Engineers NQA-1-2000, *Quality Assurance Requirements for Nuclear Facilities* (NQA-1). Air Surveillance Program software is categorized as non-safety software and shall meet the requirements for NQA-1-2000, Part I, Requirement 3, as applicable.

2.3.5.3 Assessments

Assessments are performed on environmental surveillance activities and procedures to assure compliance with project, PNNL, and DOE QA/QC requirements. The PNSO Site Manager, Radioactive Air Task Lead, or QA Engineer may also initiate an assessment on a routine and/or random basis. Assessment results are documented and, if appropriate, provided to the initiating parties for review. Corrective actions, if needed, are documented and verified (e.g., by a field performance review) as applicable.

2.3.5.4 Quality Control

Contracted analytical laboratories are required to maintain and participate in analytical QC programs that are used to determine analytical precision and accuracy. The QA Engineer or Radioactive Air task lead reviews the analytical laboratory's QC performance, along with the applicable minimum detectable concentrations and method detection limit determinations, and deficiencies in the QC data are identified and investigated. The services are performed according to QA procedures established for those services, unless a statement of work identifies special requirements.

Contracted analytical laboratories are required to maintain and participate in analytical QC programs that are used to determine analytical precision and accuracy. The project quality assurance engineer or project task leader reviews the analytical laboratory's QC performance, along with the applicable minimum detectable concentrations and method detection limit determinations, and deficiencies in the QC data are identified and investigated. If corrective actions are necessary they are documented, then implementation is verified (e.g., by laboratory surveillance or audit). In addition to each laboratory's internal QC program, the laboratory is also required to participate in EPA and DOE national comparison studies, also called performance evaluations. For these studies, blind samples containing specific amounts of contaminants are distributed to the participating laboratories. The laboratories analyze the samples and submit their analytical results to the EPA or DOE for comparison and evaluation. The laboratory also submits the results of the comparisons and evaluations to the PNNL project quality assurance engineer and Radioactive Air task lead. Additional details regarding the analytical laboratory QA/QC requirements are provided in the Sampling and Analysis Plan (see Attachment 1).

2.4 Reporting

Air surveillance results for radioactive material air sampling are reported annually to the WDOH, EPA, and DOE as part of the RAER for the DOE-SC PNNL Site. The impacts of DOE-SC PNNL Site radiological air emissions, whether these emissions were determined from air monitoring, air surveillance, or release estimation, are indicated by estimates of dose to a member of the public.

Environmental surveillance and environmental monitoring is performed, in part, to monitor potential offsite impacts. The impacts of radiological air emissions from the DOE-SC PNNL Site are typically evaluated using environmental models that estimate dose to a maximally exposed individual (MEI) member of the public. Compared to the negligible radioactive air emissions of previous years, the addition of several DOE-SC PNNL Site buildings with major emission units in calendar year 2010 requires a more complex dose evaluation effort than in previous years. Compliance with the National Emissions Standards for Hazardous Air Pollutants radionuclide air emissions standards as specified in the *Clean Air Act* regulations under 40 CFR Part 61, Subpart H require the dose to the MEI to be less than 10 mrem/yr (40 CFR 61.92). Impacts to the MEI are greatest for radionuclides that require continuous stack monitoring and also correspond to those identified for offsite air surveillance. Dose assessment results are reported in the annual RAER for the DOE-SC PNNL Site (e.g., Snyder et al. 2011). The air pathway is the only current contributor to this dose; no direct exposure pathways or water pathways from DOE-SC PNNL Site effluent contributes to offsite public dose.

Attachment 3 to this EMP presents dose assessment methodology used for the DOE-SC PNNL Site RAER. For the purposes of regulatory compliance, dose assessments use source term information from in-stack sampling from major emission units and 40 CFR Part 61, Appendix D methods for minor emission units, rather the offsite air surveillance results. Air surveillance results are used as additional confirmation that DOE-SC PNNL Site releases are at the anticipated low to undetectable levels.

Other required reporting includes Notification Level reporting, currently based on 40 CFR Part 61, Appendix E, Table 2.[1] Such reporting to the WDOH notifies the regulatory agency when an ambient air sampler result was detected at a concentration that, if continued over the entire year, may lead to MEI dose estimates that approach or exceed the regulatory limit. Unusually high air concentration levels would be first noted by processes implemented in the Data Management Plan (see Attachment 2). Under the Data Management Plan, anomalous data reports, as well as other internal programmatic reporting and special data request reports, are discussed.

2.5 Record Keeping

This section summarizes record keeping requirements for DOE-SC PNNL Site environmental surveillance activities. The Sampling and Analysis Plan and Data Management Plan (see Attachments 1 and 2) also indicate the specific records maintained by those program components. Records are those documents that furnish evidence of a completed activity or operation that has value requiring its retention for a specific period of time. They may also identify the quality of items and/or activities affecting quality. In addition to paper (i.e., hardcopy), records may include electronic documents and special process records such as analytical data, photographs and negatives.

[1] Application for PNNL Site-specific values based on historical Hanford Site exposure parameters (DOE 2008b) and updated dosimetry will be pursued in FY 2012.

The record keeping requirements are implemented by the Effluent Management QA Plan (EM-QA-01). Project records are controlled in accordance with the File and Maintain Project Records portion of the QA subject area in the PNNL HDI system.

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