U.S. DEPARTMENT OF ENERGY

PNNL-21787

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

Pacific Northwest National Laboratory Site Environmental Report

for Calendar Year 2011

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HT Tilden
GA Stoetzel
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JM Barnett
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September 2012

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NATIONAL LABORATORY

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Addressees:

THE PACIFIC NORTHWEST NATIONAL LABORATORY SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 2011 (PNNL-21787), RICHLAND, WASHINGTON, SEPTEMBER 2012

The Pacific Northwest National Laboratory (PNNL) Site Environmental Report is prepared and published annually by the U.S. Department of Energy (DOE) for distribution to local, state, and Federal government agencies, Congress, the public, news media, PNNL Site, and Hanford Site employees. This report includes information for Calendar Year 2011, but may also include Fiscal Year 2011 and some early 2012 facts. The purpose of the report is to provide the reader with the most recent information available on: 1) the status of the Site's compliance with Federal, state, and local environmental laws and regulations, and; 2) environmental monitoring efforts on and around the Site.

This report covers the PNNL Campus in Richland, Washington, and does not include PNNL satellite operations such as those located in Sequim, Seattle, and North Bonneville, Washington, or Portland, Oregon. Operations include Battelle-owned facilities, leased offices, and DOE Pacific Northwest Site Office (PNSO) operations in Richland, Washington, unless otherwise specified. Operations specific to PNSO include the Physical Sciences Facility and the Environmental Molecular Sciences Laboratory. To the extent possible, material was captured from existing summary reports prepared as required by the contracting entity, consistent with DOE guidance for the preparation of the Annual Site Environmental Reports.

This report was prepared for DOE by PNNL staff. If you have any questions or comments concerning this report, please contact Theresa Aldridge at (509) 372-4508, or via e-mail at theresa.aldridge@pnso.science.doe.gov

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Sincerely,

Roger E. Snyder
Manager

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Summary

Pacific Northwest National Laboratory (PNNL), one of 10 national laboratories supporting the U.S. Department of Energy (DOE) Office of Science, provides innovative science and technology development in the areas of energy and the environment, fundamental and computational science, and national security. DOE's Pacific Northwest Site Office (PNSO) is responsible for PNNL oversight in Richland, Washington, as well as facilities in Sequim, Seattle, and North Bonneville, Washington, and Portland, Oregon.

This site environmental report provides a synopsis of ongoing environmental management performance and compliance activities conducted during 2011. The report addresses the operations occurring on PNNL's Richland campus, which includes PNSO's PNNL Site facilities and Battelle-owned and -leased facilities. The report includes a description of the PNSO Site and setting; addresses compliance with all applicable DOE, federal, state, and local regulations; documents environmental monitoring efforts and status; presents potential radiation doses to staff and the public in the surrounding area; and data quality assurance methods.

Compliance with Federal, State, and Local Laws and Regulations in 2011

PNNL is committed to complying with all applicable federal, state, and local laws and regulations and site-specific permits. In 2011, PNNL was in compliance with applicable requirements identified below. Transient conditions of noncompliances were reported to the appropriate regulatory agencies (as required) and rectified expeditiously.

Pollution Prevention Program. The Pollution Prevention (P2) Program addresses PNNL's continuing effort to reduce the quantity and toxicity of hazardous, radioactive, mixed, and sanitary waste on its Richland campus. PNNL exceeded target goals of 50% diversion of sanitary wastes, as well as construction and demolition wastes. PNNL reduces or eliminates environmental hazards, conserves natural resources, and maximizes operational sustainability through the incorporation of electronic stewardship practices, reusing materials and conducting recycling programs (Section 2.1.6).

***Clean Air Act* Compliance**. The Washington State Department of Health, the Washington State Department of Ecology, and the Benton Clean Air Agency have issued permits for PNNL air emissions. Regular inspections of emission sources occur to verify compliance with applicable *Clean Air Act* requirements. In 2011, no events associated with air emissions of regulated substances or substances of concern were identified. Radioactive air emissions in calendar year (CY) 2011 were more than 10,000 times lower than the regulatory standard of 10 mrem/year (Section 2.3).

***Clean Water Act* Compliance**. PNNL operated under permits issued by the Washington State Department of Ecology and the City of Richland in 2011. In 2011, there was one permit exceedance of the flow limit for discharge of wastewater to the City of Richland sewer system. The City of Richland was notified of the exceedance, which occurred for one day. The excess water discharged was due to a failed sand filter. Follow-up sampling demonstrated that the excess wastewater posed no threat to human health or the environment (Section 2.4).

CERCLA Compliance. There were no *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) noncompliance issues identified in 2011 (Section 2.5.2).

RCRA Compliance. PNNL is responsible for one *Resource Conservation and Recovery Act of 1976* (RCRA)-permitted storage and treatment unit on the Hanford Site, operated by the DOE-Richland Operations Office. There were no significant noncompliance events in 2011; minor issues identified during routine inspections were corrected (Section 2.5.4).

Compliance with Biological Resources Statutes. A baseline biological survey of the PNNL Site was conducted in 2011 as were 10 ecological reviews for PNNL projects. Potential project impacts were evaluated for plant or animal species protected or candidates under the *Endangered Species Act of 1973*; species listed by the state of Washington as threatened or endangered; Washington State priority habitats; and bird species protected under the *Migratory Bird Treaty Act* and *Bald and Golden Eagle Protection Act*. There were no project impacts that violated related federal or state laws, regulations, or conservation concern guidance in 2011 (Section 2.6.1).

Compliance with Cultural Resources Statutes. *National Historic Preservation Act of 1966* Section 106 reviews are performed prior to any ground-disturbing actions on the PNNL Site. No cultural/historic resource noncompliance issues were identified in 2011 (Section 2.6.2).

Environmental Performance Measures. PNNL environmental performance measures address the goals and requirements of DOE Order 436.1, "Departmental Sustainability;" Executive Order 13423, "Strengthening Federal Environmental, Energy, and Transportation Management;" and Executive Order 13514, "Federal Leadership in Environmental, Energy, and Economic Performance." Performance measures include energy efficiency, water conservation, sustainable buildings, and transportation fleet management activities. Objectives and goals were achieved for the majority of performance measures in 2011. Minor issues were identified and corrected (Section 3.0).

Table S.1 summarizes PNNL compliance with federal statutes in 2011. Section 2.0 provides further details regarding compliance issues.

Table S.1. Compliance Actions and Status of Federal Acts at PNNL, 2011

Regulation	What It Encompasses	2011 Compliance Actions and Standing
American Indian Religious Freedom Act; *Antiquities Act of 1906*; *Archaeological and Historic Preservation Act of 1974*; *Archaeological Resources Protection Act of 1979*; *Historic Sites Act of 1935*; *National Historic Preservation Act of 1966*; and *Native American Graves Protection and Repatriation Act of 1990*	Cultural resources.	Six Section 106 cultural resource reviews were conducted for PNNL projects in fiscal year (FY) 2011, three on the PNNL Site and three in the 300 Area. No cultural/historic resource noncompliance issues were identified.
Atomic Energy Act of 1954	Management of radioactive materials.	In 2011, U.S. Department of Energy (DOE) Order 458.1, "Radiation Protection of the Public and the Environment" and DOE Guide 441.1-1C, Change 1, "Radiation Protection Programs Guide for Use with Title 10 of the *Code of Federal Regulations* Part 835, Occupational Radiation Protection" (10 CFR 835) underwent revisions. PNNL complies with the *Atomic Energy Act of 1954* through its Radiation Protection Management and Operation Program.
Bald and Golden Eagle Protection Act	Protection of bald and golden eagles.	Biological resource reviews provide assurance that proposed actions will not adversely affect bald or golden eagles. PNNL was in compliance.
Clean Air Act	Air quality including emissions from facilities and unmonitored sources.	PNNL operated under permits issued by Washington State Department of Health, the Washington State Department of Ecology, and the Benton Clean Air Agency. No events were reported for air emissions of regulated substances or substances of concern. Radioactive air emissions in calendar year (CY) 2011 were more than 10,000 times lower than the regulatory standard of 10 mrem/year. PNNL was in compliance.
Clean Water Act	Point-source discharges to United States surface waters.	PNNL operated under permits issued by the Washington State Department of Ecology and the City of Richland. PNNL has no stormwater discharges requiring monitoring under the federal or state National Pollutant Discharge Elimination System (NPDES) stormwater regulations. In 2011 there was one permit exceedance of a flow limit in City of Richland Industrial Wastewater Discharge Permit #CR-IU-001.
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)	Sites already contaminated by hazardous materials.	PNNL is not part of any Hanford CERCLA operable unit and had no continuous releases in 2011. PNNL was in compliance.

Table S.1. (contd)

Regulation	What It Encompasses	2011 Compliance Actions and Standing
Emergency Planning and Community Right-to-Know Act of 1986	The public's right to information about hazardous materials in the community and the establishment of emergency planning procedures.	In 2011, PNNL submitted a Tier Two report to the Washington State Emergency Response Commission, the local emergency planning committee, and Richland Fire Department. PNNL was not required to submit a Toxic Release Inventory Report for 2011. No toxic chemicals exceeded Hanford Site reporting thresholds during 2011. PNNL was in compliance.
Endangered Species Act of 1973	Rare plant and animal species.	In 2011, a baseline biological survey of the PNNL Site was conducted and 10 ecological reviews were conducted for PNNL projects: four on the PNNL Site and six in the 300 Area. No endangered or threatened species were observed. Ten federal species of concern potentially occur on the PNNL Site. PNNL was in compliance.
Federal Facility Compliance Act of 1992	Amends RCRA and CERCLA and requires new mixed waste reporting requirements.	PNNL provides information as part of the Hanford Site Mixed Waste Land Disposal Restrictions Summary Reports pursuant to Tri-Party Agreement Milestone M-26. PNNL was in compliance.
Federal Insecticide, Fungicide, and Rodenticide Act	Storage and use of pesticides.	Commercial pesticides were applied either by commercial pesticide operators that are listed on one of two commercial pesticide applicator licenses, or by a licensed private commercial applicator, thereby meeting compliance requirements.
Migratory Bird Treaty Act	Migratory birds or their feathers, nests, or eggs.	In 2011, a baseline biological survey of the PNNL Site was conducted and 10 ecological reviews were conducted for PNNL projects: four on the PNNL Site and six in the 300 Area. A number of migratory birds were observed and compliance with the Act was maintained.
National Environmental Policy Act of 1969 (NEPA)	Environmental impact statements, environmental assessments, and categorical exclusions for federal projects that have the potential to affect the quality of the human environment.	Environmental compliance representatives and PNNL NEPA staff conducted 1,290 NEPA reviews during FY 2011 for research and support activities. PNNL Site-wide categorical exclusions were updated in November and December 2011 to reflect changes to 10 CFR 1021. The Pacific Northwest Site Office (PNSO) approved nine updated sitewide and two project-specific categorical exclusions in 2011. Also, the DOE-Richland Operations Office approved two project-specific categorical exclusions for projects in the 300 Area. PNNL was in compliance.
Pollution Prevention Act of 1990	Reduction or prevention of wastes by treatment, control, reuse, and/or recycling.	An annual pollution prevention plan was prepared and submitted to the Washington State Department of Ecology. In 2011, PNNL was in compliance, exceeding the target diversion rates of 50% for construction and demolition wastes and non-hazardous sanitary wastes.

Table S.1. (contd)

Regulation	What It Encompasses	2011 Compliance Actions and Standing
Resource Conservation and Recovery Act of 1976 (RCRA)	Tracking hazardous waste from generator to treatment, storage, or disposal (referred to as cradle-to-grave management).	PNNL is responsible for one RCRA-permitted storage and treatment unit, operated by the DOE-Richland Operations Office. The Hanford Facility RCRA Permit expired on September 27, 2004. However, DOE and PNNL continue to operate under the expired permit until the reissued permit becomes effective. Washington State Department of Ecology personnel inspected PNNL facilities three times in 2011. No violations were noted, indicating compliance.
Safe Drinking Water Act of 1974	Drinking water systems.	The PNNL Site receives all drinking water for uses in non-laboratory and laboratory spaces from the City of Richland drinking water supply, and is not subject to requirements pursuant to the *Safe Drinking Water Act of 1974*. The *Safe Drinking Water Act of 1974* regulations require that underground injection control wells be registered; this has been accomplished. PNNL was in compliance.
Superfund Amendments and Reauthorization Act of 1986	Amends and reauthorizes CERCLA.	On May 9, 2011, the U.S. Environmental Protection Agency (EPA) implemented the Integrated Cleanup Initiative, a three-year strategy to identify and implement improvements to EPA's land cleanup programs. PNNL was in compliance.
Toxic Substances Control Act	Hazardous chemical regulation and tracking; primarily polychlorinated biphenyls (PCBs).	During 2011, PNNL contributed to the 2010 PCB annual document log report for the Hanford Site and 2010 PCB annual report; both were submitted to EPA as required, thereby meeting compliance requirements.

Environmental Monitoring and Dose Assessment

No radiological releases to the environment exceeded permitted limits on the PNNL Site in 2011.

Air Emissions. Airborne emissions from PNNL Site facilities are monitored to assess the effectiveness of emission treatment and control systems, pollution management practices, and determine compliance with state and federal regulatory requirements. There were no releases of regulated substances or substances of concern from PNNL facilities in 2011 (Section 2.3).

Liquid Effluent Monitoring. Liquid effluent discharges from PNNL Site operations are monitored under permits issued by the Washington State Department of Ecology and the City of Richland. During 2011, there was one permit exceedance for discharging in excess of a daily maximum flow limit due to a failed sand filter. Monitoring results indicate that there were no releases of regulated pollutants or wastewater of concern from PNNL facilities in 2011 (Section 2.4).

PNNL has no stormwater discharges requiring monitoring under the federal or state National Pollutant Discharge Elimination System stormwater regulations (Section 2.4.3).

Radiological Release of Property. PNNL uses the pre-approved guideline limits defined in DOE Order 5400.5, Chg 2, "Radiation Protection of the Public and the Environment." when releasing property potentially contaminated with residual radioactive material. No property with detectable residual radioactivity above authorized levels was released from PNNL in 2011 (Section 4.3).

Radiation Protection of Biota. Potential media exposure pathways (air, soil, water, and food) were considered in conjunction with both gaseous and particulate radioactive contamination of air pathways. Calculated dose rates were well below dose rate limits for aquatic, terrestrial, and riparian animals and plants (Section 4.4).

Environmental Radiological Monitoring. Radioactive particulates in ambient air are monitored using a particulate air sampling network located at the perimeter of the PNNL campus. In 2011, there was no indication that any PNNL activities increased the ambient air concentrations at the air sampling locations. With the exception of samples for uranium-233/234, and americium and curium isotopes (for which no background samples were available), all results at the PNNL sampling stations were within 2 standard deviations of the background levels. All other average air concentrations were at or near detection limits. Population exposure to radionuclide air emissions was determined using the maximum exposed individual dose estimate (1.7×10^{-5} mrem) times the 50-mi population (432,117). The 2011 total population dose from radionuclide air emissions estimated from nuclides that originate from the PNNL Site was 0.0073 person-rem (0.000073 person-Sv). The PNNL campus maximum exposed individual location was 0.55 km (0.34 mi) south-southeast of the Physical Sciences Facility and the dose to that individual from routine and nonroutine point-source emissions was 1.7×10^{-5} mrem (1.7×10^{-7} mSv) effective dose equivalent (Section 4.2).

Environmental Nonradiological Program Information. PNNL nonradiological air emissions are below levels requiring stack monitoring; compliance is achieved by conforming to permit conditions (Section 5.0).

Groundwater Protection

Groundwater under the northern part of the PNNL Site is monitored routinely through eight groundwater monitoring wells. Beneath PNNL, contaminants of concern (uranium, tritium, cis-1,2-dichloroethene, and nitrate) either were not detectable or were present in concentrations well below drinking water standards with the exception of nitrate, which exceeded drinking water standards. Nitrate is not a result of PNNL operations; it originates from offsite agricultural and industrial activities.

A ground-source heat pump is used to heat and cool the new Biological Sciences Facility/ Computational Sciences Facility. No chemicals are added to the system; it is an open-loop system where groundwater is extracted and re-injected into the aquifer. The Washington State Department of Ecology issued a temporary state waste discharge permit incorporating groundwater monitoring for temperature effects and potential influence of pollutants from nearby Hanford Site underground contamination plumes. The discharge permit requires sampling and analysis of seven groundwater monitoring wells in addition to the four heat pump injection wells, which is reported monthly to the Washington State Department of Ecology. PNNL is in compliance with all sampling requirements of the discharge permit (Section 6.0).

Quality Assurance

Comprehensive quality assurance programs, which include various quality control practices and methods to verify data, are maintained by monitoring and surveillance projects to ensure data quality (Section 7.0).

Acknowledgments

This is the first annual site report produced specifically for activities and monitoring efforts at the Pacific Northwest National Laboratory for the Pacific Northwest Site Office. Previous reporting was incorporated into annual Hanford Site environmental reports. The production of this report requires the knowledge, skills, information, and cooperation of many staff members; all are appreciatively acknowledged for their diligence and efforts.

The authors would like to express their gratitude to Eva Hickey, who provided a comprehensive review of the draft report. Her assistance is greatly appreciated.

Support for the preparation of this report was provided by Susan Ennor, editor, and Kathy Neiderhiser, text processor. Printing and compact disc production were performed by staff of the Pacific Northwest National Laboratory Duplicating Center. This report was formatted for and uploaded to the Internet by Shannon Osborn.

Acronyms and Abbreviations

ºC	degrees Celsius
ºF	degrees Fahrenheit
ac	acre(s)
ALARA	as low as reasonably achievable
ASER	annual site environmental report
BCAA	Benton Clean Air Agency
BSF/CSF	Biological Sciences Facility/Computational Sciences Facility
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
cm	centimeter(s)
CO_2	carbon dioxide
CY	calendar year
DOE	U.S. Department of Energy
dpm	disintegrations per minute
DQO	data quality objectives
EDE	effective dose equivalent
EMSL	William R. Wiley Environmental Molecular Sciences Laboratory
EPA	U.S. Environmental Protection Agency
EPCRA	*Emergency Planning and Community Right-to-Know Act of 1986*
FLC	Federal Laboratory Consortium
ft	foot (feet)
ft^2	square foot (feet)
ft^3	cubic foot (feet)
FY	fiscal year
g	gram(s)
gal	gallon(s)
g/cm^3	grams per cubic centimeter
GHG	greenhouse gas
gpd	gallon(s) per day
gpm	gallon(s) per minute
GRI	Global Reporting Initiative
ha	hectare(s)
HEPA	high efficiency particulate air
in.	inch(es)
ISO	International Organization for Standardization

kg	kilogram(s)
km	kilometer(s)
km^2	square kilometer(s)
kW	kilowatt(s)
L	liter(s)
lb	pound(s)
LEPC	local emergency planning committee
m	meter(s)
m^3	cubic meter (s)
MAPEP	Mixed-Analyte Performance Evaluation Program
mGy/day	milligray per day
m/s	meter(s) per second
M&O	management and operations
MEI	maximum exposed individual
meq	milliequivalents
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mi	mile(s)
mmhos/cm	millimhos per centimeter
mph	mile(s) per hour
mrem/yr	millirem per year
MT	metric tonne(s)
MWh	Megawatt hour(s)
NEPA	*National Environmental Policy Act of 1969*
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
ntu	nephelometric turbidity unit(s)
OSHA	Occupational Safety and Health Administration
P2	Pollution Prevention
PCB	polychlorinated biphenyls
pCi/m^3	picocurie(s) per cubic meter
pCi/mL	picocurie(s) per milliliter
PIC	Potential Impacts Category (ies)
PNNL	Pacific Northwest National Laboratory
PNSO	Pacific Northwest Site Office
ppm	parts per million
QC	quality control

R&D	research and development
RCRA	*Resource Conservation and Recovery Act of 1976*
µS/cm	microSiemens per centimeter
sd	standard deviation
SEPA	*State Environmental Policy Act*
SERC	State Emergency Response Commission
WAC	*Washington Administrative Code*
WDFW	Washington Department of Fish and Wildlife

Contents

Figures

Tables

1.0 Introduction

This environmental report was prepared pursuant to the requirements of U.S. Department of Energy (DOE) Order 231.1B, "Environment, Safety and Health Reporting" to provide a synopsis of calendar year (CY) 2011 information related to environmental management performance and compliance efforts at the Pacific Northwest National Laboratory (PNNL or the Laboratory). It summarizes site compliance with federal, state, and local environmental laws, regulations, policies, directives, permits, and Orders and environmental management performance. This is the first annual report specific to PNNL; previously information for the PNNL Site was incorporated in Hanford Site environmental reports (e.g., Poston et al. 2011).

PNNL, one of 10 DOE Office of Science National Laboratories, is a multi-program facility that delivers breakthrough science and technology in the areas of Energy and Environment, Fundamental and Computational Science, and National Security. As an Office of Science Laboratory, PNNL performs work for a diverse set of clients including the National Nuclear Security Administration, Department of Homeland Security, U.S. Nuclear Regulatory Commission, U.S. Environmental Protection Agency (EPA), DOE-Environmental Management, and other federal agencies. The Pacific Northwest Site Office (PNSO) is responsible for program implementation, acquisition management, and Laboratory stewardship at PNNL. Through its oversight role, PNSO manages the safe and efficient operation of PNNL while enabling the pursuit of visionary research and development in support of complex national energy and environmental missions.

The PNNL Site is a sub-component of the PNNL-operated facilities in Richland, Washington. This report covers the PNNL Site as well as the rest of the PNNL campus, but does not include PNNL satellite operations such as those located in Sequim, Seattle, and North Bonneville, Washington, or Portland, Oregon (Figure 1.1). Operations include Battelle-owned and -leased facilities and DOE Office of Science-owned facilities (hereafter the PNNL Site)—all on the PNNL campus in Richland, Washington, unless otherwise specified. Operations specific to the PNNL Site include the Physical Sciences Facility and the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL). To the extent possible, information was captured from existing reports, consistent with DOE guidance for the preparation of the Annual Site Environmental Reports (ASERs). While efforts were made to report information on a consistent basis and in similar formats throughout this report, reporting requirements and guidelines varied across the multitude of programs, causing some inconsistencies. In addition, there are instances where input is provided on a fiscal year basis rather than a calendar-year basis due to divergent reporting requirements. To the extent possible, the information herein is captured on a calendar-year basis and text identifies information represented by fiscal year versus calendar year. The feasibility of consolidating individual reporting requirements and streamlining the report preparation process such that a single report may meet multiple reporting requirements will be evaluated for the production of future PNNL ASERs.

1.1 Location

JP Duncan

PNNL is located in southeastern Washington State, 275 km (170 mi) east-northeast of Portland, Oregon; 270 km (170 mi) southeast of Seattle, Washington; and 200 km (125 mi) southwest of Spokane, Washington (Figure 1.2). The PNNL Site (Figure 1.1) occupies approximately 153 ha (378 ac; 0.54 mi^2

[1.4 km^2]) just south of the much larger DOE Hanford Site, adjacent to the Columbia River. Battelle-owned and -leased facilities are located adjacent to the PNNL Site. A portion of the PNNL Site is designated as a buffer area. This area has served as a buffer to provide separation between DOE operation areas and the Hanford Site boundary since the 1940s, and it is expected to continue to provide a buffer for DOE operations. No construction or other ground-disturbing activity is planned for the buffer area, and a portion of the buffer area will continue to be protected under a Preservation land-use designation. The area immediately south of PNNL is developed with office, laboratory, residential, and retail space.

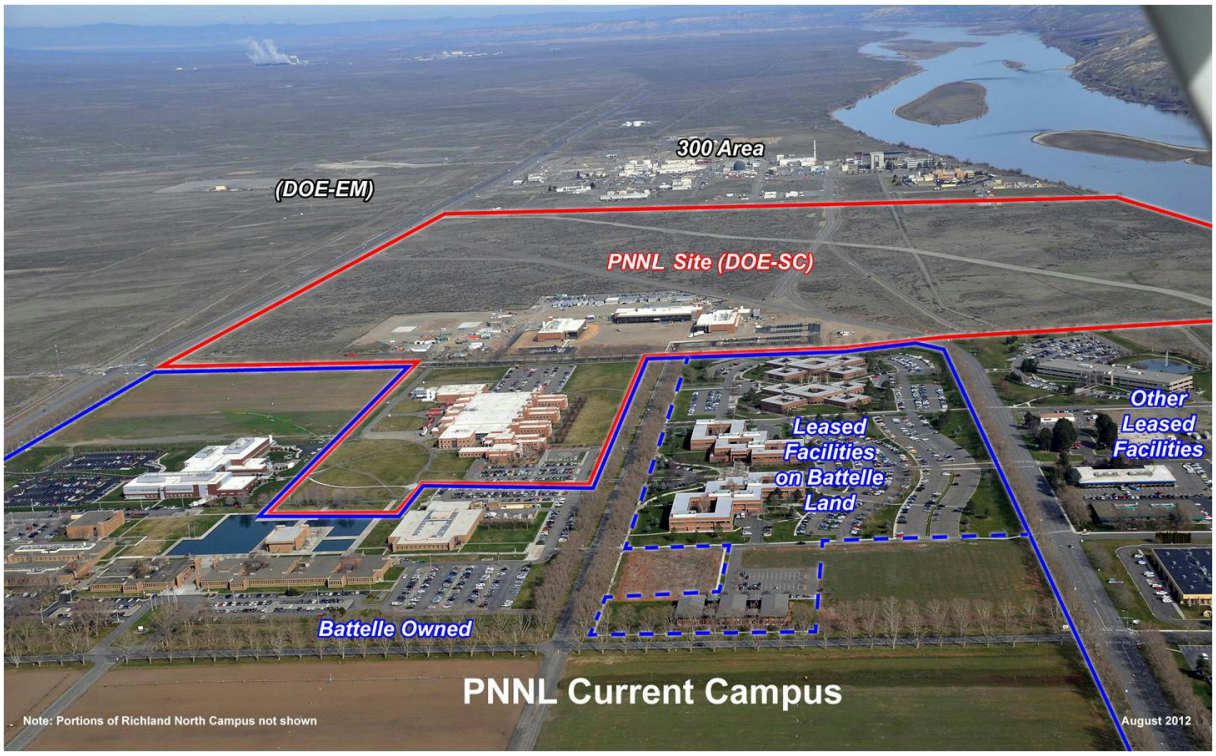

Figure 1.1. Pacific Northwest National Laboratory Campus (some eastern and southern portions of the campus are not shown)

1.2 History and Mission

JP Duncan

In January 1965, Battelle assumed the management of research and development activities related to nuclear energy and the non-destructive use of nuclear materials for the Hanford Site. Under the Atomic Energy Commission, more than 2,200 former General Electric employees joined Battelle to form the Pacific Northwest Laboratory.

In 1977, Laboratory management was transferred to DOE and research expanded into energy, health, environmental, and national security endeavors. With the expanded areas of research, the Laboratory contributed to areas such as robotics, environmental monitoring, material coatings, veterinary medicine, and the formation of new plastics. In 1995, the Laboratory was renamed as Pacific Northwest National Laboratory (PNNL). Throughout the ensuing years, PNNL researchers have developed multidisciplinary

technologies, earning numerous Research and Development (R&D) 100 awards, Federal Laboratory Consortium (FLC) awards, and Innovation awards for their R&D work and contributions to new technologies.

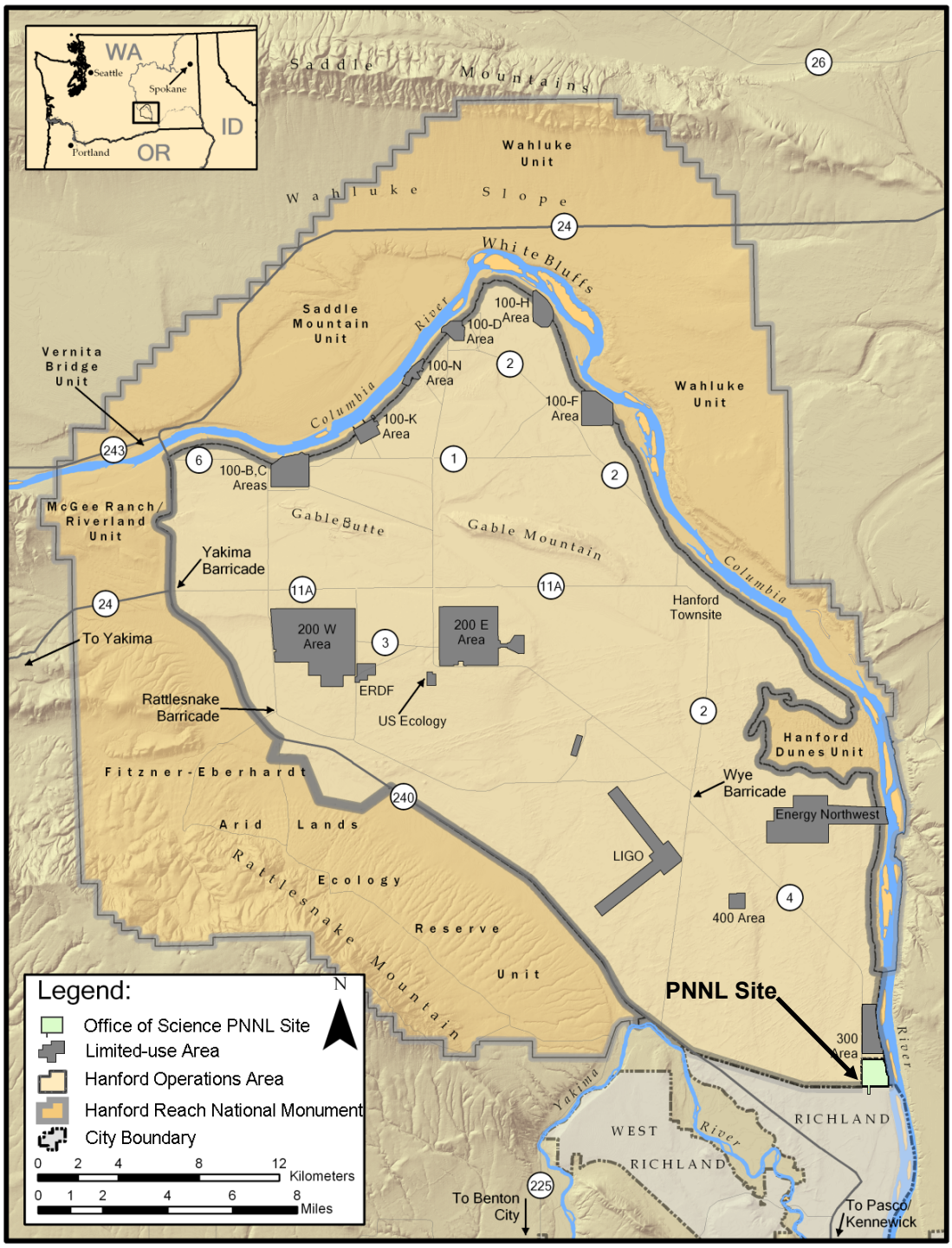

Figure 1.2. Location of the Pacific Northwest National Laboratory in Washington State

PNNL is operated by Battelle for the DOE Office of Science's PNSO, which was established in 2003. PNSO is responsible for ensuring that all activities conducted on the PNNL Site comply with applicable laws, policies, and DOE Orders. In August 2004, approximately 53 ha (130 ac) of land in the southernmost portion of the Hanford Site were reassigned from the DOE Office of Environmental Management to the DOE Office of Science (Roberson 2004). Soon thereafter, 93 additional ha (230 ac) adjacent to the 53 ha (130 ac) were reassigned from the Office of Environmental Management to PNSO to further expand the PNNL Site (Rispoli 2007). The purpose of the reassignments was to establish a federal PNNL Site (Figure 1.2) that would support the Office of Science's long-term goals of a continuing science and technology mission at PNNL. Both of these land reassignments were accomplished under *National Environmental Policy Act of 1969* Categorical Exclusions.

These two reassignments allowed the creation of an Office of Science PNNL Site and added clarity to the difference in missions between the Office of Environmental Management and the Office of Science. The Office of Science focuses on the PNNL missions to strengthen scientific foundations for innovation, increase energy capacity and reduce dependence on imported oil, prevent and counter terrorism and proliferation of weapons of mass destruction, reduce environmental effects of human activity, and create sustainable systems. The Office of Environmental Management continues to focus on Hanford Site cleanup and closure.

Research facilities on the PNNL Site include EMSL, the Biological Sciences Facility, and the Computational Sciences Facility. In 2011, seven new buildings were completed on the PNNL Site north of Horn Rapids Road. The Physical Sciences Facility complex includes the Materials and Science Technology Laboratory designed for the development and analysis of high-performance materials for energy, construction, and transportation technologies and systems and the Radiation Detection Laboratory and Ultra-Trace Laboratory for the development of radiation detection methodologies. Also, the Large Detector Laboratory and outdoor test track will develop and test radiation detection technologies for border entry points and an underground laboratory will be used for national and homeland security research projects.

1.3 Demographics

JP Duncan

The PNNL campus is located south of the Hanford Site, which is mostly flat, semiarid, and primarily restricted to public access. Residents north, east, and west of the Hanford Site generally live on farms or in farming communities. Residents to the south and southwest live in the urban communities of Richland, Kennewick, Pasco, and West Richland.

An estimated 180,700 people lived in Benton County and 83,500 people lived in Franklin County in 2011, increases of 3.1% and 6.8%, respectively, over 2010 figures. During 2011, Benton and Franklin counties accounted for 3.9% of Washington's population. The estimated regional population for residents within an 80-km (50-mi) radius of the Hanford Site 300 Area is approximately 432,000 people. This regional estimate is used to calculate the radiation dose (Section 4.2).

1.4 Environmental Setting

BG Fritz

The PNNL campus includes undisturbed lands, slightly disturbed lands, heavily disturbed lands, and previously disturbed lands with reclaimed habitat. Heavily disturbed lands are associated with the present and planned facilities that are or will be landscaped. Slightly disturbed lands include roadsides, farming-related disturbances, and gravel pads surrounding groundwater wells. Shrub-steppe and Columbia River riparian habitat exist over a majority of the undeveloped, undisturbed, and habitat-restored portions of the PNNL campus.

1.4.1 Geology and Soils

The PNNL campus lies above a gentle syncline formed by the intersection of the Yakima Fold Belt and the un-deformed eastern Columbia Basin. The uppermost basalt flow belongs to the Ice Harbor member of the Saddle Mountains basalt. Overlying sediment layers are relatively thin, consisting of Ringold Formation and Hanford formation sediments. These sediment layers are predominantly coarse sandy alluvial deposits mantled by windblown sand. A generalized suprabasalt stratigraphic column showing what underlies the PNNL campus is shown in Figure 1.3. The stratigraphic column for the upper Ringold Formation and the Hanford formation is based on information obtained from the drilling of 11 boreholes within the footprint of a construction site adjacent to the PNNL campus (Freedman et al. 2010). Additional stratigraphic information was obtained from previously existing geologic logs for nearby irrigation wells, water supply wells, monitoring wells, and characterization borings associated with environmental remediation activities. The uppermost geologic unit in the study area is the Hanford formation, a highly permeable mixture of sand and gravel that was deposited by the Ice Age floods during the late Pleistocene period. These poorly sorted and unconsolidated sediments generally cover a wide range in size, from boulder-sized gravel to sand, silt, and clay. Beneath the Hanford formation are the late Miocene to Pliocene-aged sediments of the Ringold Formation. The Ringold Formation is texturally and structurally distinct from the overlying Hanford formation and displays lower hydraulic conductivity. The Ringold Formation contains sands, gravels, and muds that are typically more consolidated and less permeable than those in the Hanford formation.

1.4.2 Hydrology

The general direction of groundwater flow under the PNNL campus is towards the east-northeast from the Yakima River to the Columbia River (Figure 1.4). The northeasterly flow direction is likely influenced by the City of Richland recharge ponds, upgradient irrigation, and the Yakima River. In addition, the 300 Area of the Hanford Site has been shown to be a convergence zone for groundwater flow (Peterson et al. 2005), which may also contribute to the local gradient at the PNNL campus.

Field data collected on and around the PNNL campus indicate that the unconfined aquifer is predominantly in the Ringold Formation; however, depending on the water table elevation the aquifer may inundate portions of the Hanford formation. The vadose zone consists of unsaturated sediments between the ground surface and the water table. This zone occurs predominantly within sandy gravel, gravelly sand, and silty, sandy gravel of the Hanford formation (Newcomer 2007). In some areas, the Ringold Formation extends above the water table into the lower part of the vadose zone. The local thickness of the vadose zone is about 15 m (49 ft) at PNNL. In general, the thickness of the vadose zone decreases with proximity to the Columbia River, as the ground surface slopes toward the river.

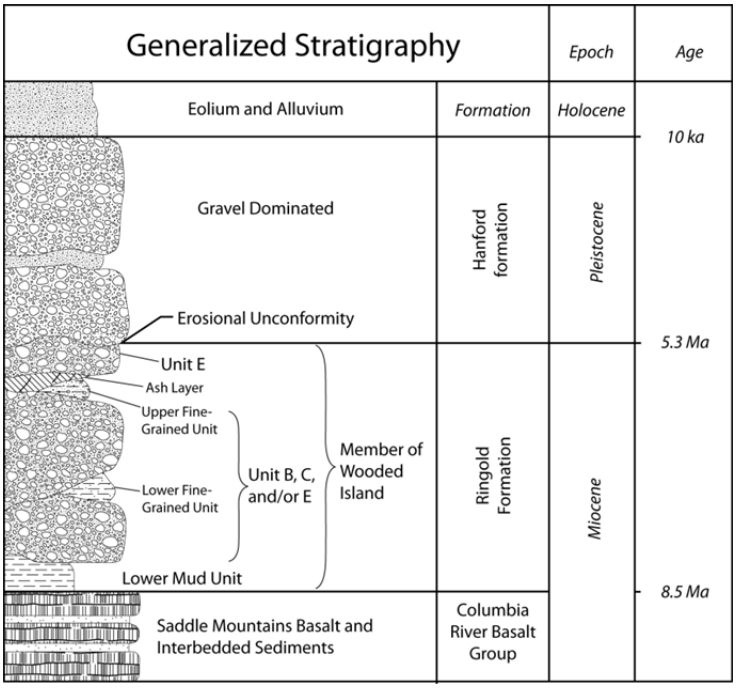

Figure 1.3. Generalized Stratigraphic Column Depicting the Stratigraphy Underlying the PNNL Campus (Modified from Reidel et al. 1992; Thorne et al. 1993; Lindsey 1995; Williams et al. 2000; DOE/RL 2002a; and Williams et al. 2007)

1.4.3 Climate and Meteorology

The Hanford Site conducts meteorological monitoring to support Hanford Site operations, emergency preparedness and response, and atmospheric dispersion calculations for dose assessments. The nearest Hanford Site weather station is located less than 500 m northwest of the PNNL campus. The meteorological measurements are sufficient for PNNL campus climate interpretation. Across the Columbia Basin, temperatures, precipitation, and winds are affected by mountain barriers. The Cascade Range, west of Yakima, greatly influences the climate at the PNNL site because of its rain-shadow effect. The Rocky Mountains and ranges in southern British Columbia protect the region from severe, cold polar air masses moving southward across Canada and winter storms associated with them. Normal monthly average temperatures on the Hanford Site range from a low of –0.2°C (31.7°F) in December to a high of 24.6°C (76.3°F) in July (Poston et al. 2011). Temperatures at the PNNL campus would be expected to follow this trend also. The normal annual relative humidity at the Hanford Meteorology Station is 54%. Humidity is highest during winter, averaging approximately 76%, and lowest during summer, averaging approximately 36% (Poston et al. 2011). Normal annual precipitation at the Hanford Meteorology Station is 18.1 cm (7.14 in.). Most precipitation occurs during late autumn and winter, with more than half of the annual amount occurring from November through February. The average temperature for CY 2011 was 11.3°C (52.3°F), 0.9°C (1.6°F) below normal (12.2°C [53.9°F]). Precipitation totals for 2011 were also below normal, totaling 11.3 cm (4.45 in.).

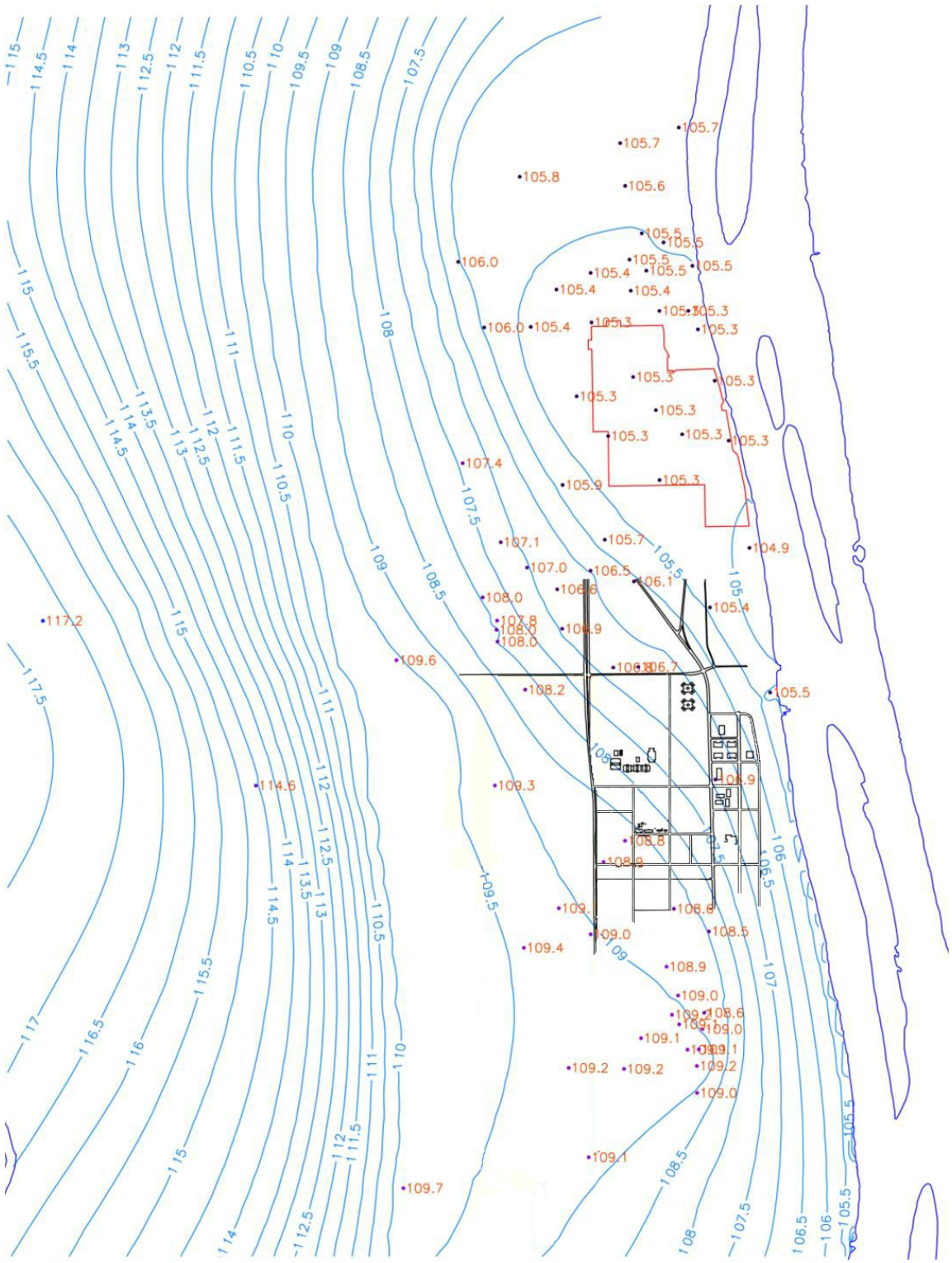

Figure 1.4. Water Table Elevation (m) in Spring 2006 (Freedman et al. 2010). Groundwater flow direction is normal to the water table contour lines.

Winds from the northwestern quadrant are the most common during winter and summer. During spring and fall, the frequency of southwesterly winds increases, with corresponding decreases in the northwesterly flow (Poston et al. 2011). Monthly average wind speeds are lowest during winter months, averaging about 3 m/s (6 to 7 mph), and highest during summer, averaging about 4 m/s (8 to 9 mph). Wind speeds well above average are usually associated with southwesterly winds. However, summertime drainage winds are generally northwesterly and frequently exceed 13 m/s (30 mph) (Poston et al. 2011).

Atmospheric dispersion is a function of wind speed, wind duration and direction, atmospheric stability, and mixing depth. Dispersion conditions are generally good if winds are moderate to strong, the atmosphere is of neutral or unstable stratification, and there is a deep mixing layer. Good dispersion conditions associated with neutral and unstable stratification exist approximately 57% of the time during summer (Poston et al. 2011). Less favorable conditions may occur when wind speed is light and the mixing layer is shallow. These conditions are most common during winter, when moderate to extremely stable stratification exists (approximately 66% of the time). Occasionally, there are extended periods of poor dispersion conditions, primarily during winter, that are associated with stagnant air in stationary high-pressure systems.

1.4.4 Ecology

The PNNL campus is located in the lowest and most arid portion of the Columbia Basin Ecoregion. Soils of the area are primarily sandy. Plant communities found on the campus are dominated primarily by big sagebrush (*Artemisia tridentata*) and perennial bunchgrasses. Some portions of the sagebrush stands also have a significant cover of cheatgrass (*Bromus tectorum*). Antelope bitterbrush (*Purshia tridentata*) and gray and green rabbitbrush (*Ericameria nauseosa* and *Chrysothamnus viscidiflorus,* respectively), are common shrubs co-occurring with big sagebrush. The most common perennial bunchgrass in the area is Sandberg's bluegrass (*Poa secunda*), but several stands of the native needle-and-thread grass (*Hesperostipa comata*) dominate sandy swales within the area, and Indian rice-grass (*Achnathrum hymenoides)* also is represented in several sandy areas growing with antelope bitterbrush. Common native forb species include Carey's balsamroot (*Balsamorhiza careyana*), long-leaved phlox (*Phlox longifolia*), yarrow (*Achillea millefolium*), and daisy fleabane (*Erigeron* spp.). Turpentine springparsley (*Cymopterus terebinthinus*) also often occurs on sandy soils dominated by this community type. Species diversity may be lower in this community type than in communities found in the surrounding foothills. Several tribes have identified food and medicinal plant species within the habitat.

In addition to shrub-steppe upland communities, a narrow riparian community exists along the Columbia River shoreline on the eastern part of the PNNL campus. Riparian vegetation is limited in extent, with narrow bands or buffers near the water consisting of a number of forbs, grasses, sedges, reeds, rushes, cattails, and deciduous trees and shrubs. A cluster of trees near a fishing area along the river shore is dominated by poplars (*Populus* spp.), and white mulberry (*Morus alba*) is sparsely scattered along the shoreline. Shrub willows (*Salix exigua*) and wild rose (*Rosa woodsii*) are common shrubs in the riparian band downstream of the Hanford Site 300 Area.

Both shrub-steppe and riparian habitats are listed by the Washington Department of Fish and Wildlife as priority habitats for the state and are considered to be priorities for management and conservation (WDFW 2008). *Priority habitats* are those habitat types or elements with unique or significant value to a

diverse assemblage of species. Sagebrush-steppe communities support a variety of wildlife, including several Washington State Species of Concern (Table 1.1).

Riparian habitats along the Columbia River in Washington support a diverse assemblage of wildlife. The area managed by PNSO extending from a point south of the 300 Area along the river shore to the barge docking facility consists of multilayered trees, shrubs, and herbaceous species. The area may be an occasional day perch for wintering bald eagles (*Haliaeetus leucocephalus*), and the riparian zone along with the upland area is used as a territory for nesting osprey (*Pandion haliaetus*). A large number of migratory bird species, such as western kingbirds (*Tyrannus verticalis*) and Bullock's orioles (*Icterus bullockii*), use riparian trees and shrubs for nesting habitat. Many migratory bird species use the riparian habitats for resting and feeding during the spring and fall migration. Several plant species of concern potentially may occur along the shoreline, including persistent sepal yellowcress (*Rorippa columbiae*), lowland toothcup (*Rotala ramosior*), and grand redstem (*Ammania robusta*).

Table 1.1. Wildlife Species of Concern That Potentially Occur on Sagebrush-Steppe Lands of the Pacific Northwest National Laboratory Campus

Animal	Genus and Species	Federal Status	State Status[(a)]
Black-tailed jackrabbit	*Lepus californicus*		Candidate
Burrowing owl	*Athene cunicularia*	Species of Concern	Candidate
Loggerhead shrike	*Lanius ludovicianus*	Species of Concern	Candidate
Northern sagebrush lizard	*Sceloporus graciosus*	Species of Concern	Candidate
Townsend ground squirrel	*Spermophilus townsendii*	Species of Concern	Candidate
Sage sparrow	*Amphispiza belli*		Candidate

(a) Candidate species are those fish and wildlife species that the Washington Department of Fish and Wildlife will review for possible listing as State Endangered, Threatened, or Sensitive.

2.0 Compliance Summary

PNNL is committed to conducting operations in a manner that is protective of the environment and compliant with applicable environmental laws and regulations. This section provides a summary of PNNL compliance with applicable federal, state, and local environmental laws and regulations, Executive Orders, as well as DOE Orders, directives, policies, and guidance.

2.1 Environmental Management System and Sustainability

JP Duncan

The initial requirement for an Environmental Management System at PNNL was driven by DOE Order 450.1A, "Environmental Protection Program," which was cancelled and replaced by DOE Order 436.1, "Departmental Sustainability" in May 2011. Similarly, DOE Order 436.1 replaced DOE Order 430.2B, "Departmental Energy, Renewable Energy and Transportation Management," which identified requirements and responsibilities for the management of energy, water, and fleet vehicles at DOE facilities. DOE Order 436.1 also includes requirements for establishing and implementing site sustainability plans at DOE sites. Brief descriptions of each are included below because the cancelled Orders were effective during the first 4 months of 2011, along with related Executive Orders.

2.1.1 DOE Order 436.1

DOE Order 436.1, "Departmental Sustainability" was approved on May 2, 2011, cancelling DOE Orders 450.1A and 430.2B. The purpose of DOE Order 436.1 is to

> "… 1) ensure the Department carries out its missions in a sustainable manner that addresses national energy security and global environmental challenges, and advances sustainable, efficient and reliable energy for the future,
>
> 2) institute wholesale cultural change to factor sustainability and greenhouse gas (GHG) reductions into all DOE corporate management decisions, and
>
> 3) ensure DOE achieves the sustainability goals established in its Strategic Sustainability Performance Plan (SSPP) pursuant to applicable laws, regulations and Executive Orders (EO), related performance scorecards, and sustainability initiatives….."

Requirements of DOE Order 436.1 include compliance with Executive Orders 13423 (72 FR 3919) and 13514 (74 FR 52117), reporting requirements of the *Emergency Planning and Community Right-to-Know Act of 1986* and the *Pollution Prevention Act of 1990*, and the preparation of a Strategic Sustainability Performance Plan and Site Sustainability Plan. The PNNL contract was modified to incorporate applicable requirements from this Order. The contract requires the development of a Site Sustainability Plan, incorporating sustainable acquisition requirements into applicable processes, and the development of an Environmental Management System that is certified to, or conforms with, the International Organization for Standardization (ISO) 14001:2004(E) standards (ISO 14001:2004).

PNNL's ISO 14001 Environmental Management System supports DOE's sustainability goals described in the DOE Strategic Sustainability Performance Plan (DOE 2011).

A PNNL Site Sustainability Plan (e.g., Richards et al. 2011) identifying Laboratory's sustainability projects status and accomplishments related to DOE's sustainability goals is prepared and submitted to DOE annually in accordance with DOE's guidance. The PNNL Site Sustainability Plan includes P2 activities, accomplishments, and continuous improvement opportunities. Section 3.0 provides additional information concerning PNNL sustainability.

2.1.2 DOE Order 450.1A

DOE Order 450.1A, "Environmental Protection Program," was approved on June 6, 2008, to "…implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by DOE operations, and by which DOE cost effectively meets or exceeds compliance with applicable environmental, public health, and resource protection requirements." In addition, implementation of an Environmental Management System that would be integrated into the site's Integrated Safety Management System, reflecting the elements and framework found in the ISO's 14001:2004(E) International Standard (ISO 14001:2004), "Environmental Management Systems – Requirements with Guidance for Use," was required. Elements of ISO 14001 include a defined environmental policy; planning, including environmental aspects, legal and other environmental requirements, and environmental objectives, targets, and programs; implementation and operations, including resources, roles, responsibility and authority, competence, training and awareness, communication, documentation, document control, operational control, and emergency preparedness and response; checking, including monitoring and measuring, evaluation of compliance, nonconformity, corrective and preventative action, control of records, and internal audit; and management review.

DOE Order 450.1A further states that each Environmental Management System must address sustainable practices for enhancing environmental, energy, and transportation performance required by Executive Order 13423, "Strengthening Federal Environmental, Energy and Transportation Management" (72 FR 3919) and DOE Order 430.2B, "Departmental Energy, Renewable Energy and Transportation Management," and include policies, procedures, and training to identify operations and activities with significant environmental impacts; to manage, control, and mitigate impacts; and to assess performance, implement corrective actions where needed, and to ensure continual environmental improvement. PNNL currently has a mature Environmental Management System that was originally established in 1996. In addition, PNNL has maintained ISO 14001 certification since 2002. Further detail is available in Section 3.0.

2.1.3 DOE Order 430.2B

DOE Order 430.2B, "Departmental Energy, Renewable Energy, and Transportation Management," issued February 27, 2008, provides requirements and responsibilities for managing energy, buildings, and vehicle fleets at all DOE facilities, laboratories, and sites. DOE Order 430.2B implements the requirements of Executive Orders 13423 and 13514 (72 FR 3919 and 74 FR 52117), including the establishment of an Environmental Management System that includes environmental, energy, and transportation objectives and targets. PNNL has developed objectives and goals for energy use, water use, transportation fleet management, and sustainable buildings. Section 3.0 provides additional information on Environmental Management System metrics.

2.1.4 Executive Order 13423

Executive Order 13423 of January 24, 2007, "Strengthening Federal Environmental, Energy and Transportation Management," established a policy for federal agencies to conduct legally, environmentally, economically, and fiscally sound environmental, transportation, and energy-related activities in an integrated, efficient, continuously improving and sustainable manner. Executive Order 13423 requires federal agencies to set goals for improved energy efficiency; reduced GHG emissions; use of renewable energy sources; renewable energy generation; reduced water consumption; acquisition of goods and services; reduced use of toxic and hazardous chemicals and materials; increased waste minimization, prevention, and recycling; use of sustainable building practices; reduced use of petroleum products for vehicles; and use of electronic products. In addition, Executive Order 13423 requires that an Environmental Management System be used as the mechanism for managing environmental goals, as well as other impacts on the environment from site operations, and that environmental objectives and targets be established. It also requires establishment of environmental management training, environmental compliance review and auditing, and leadership awards to recognize outstanding environmental, energy, or transportation management performance. PNNL has developed objectives and goals as directed by Executive Order 13423; details are available in Section 3.0.

2.1.5 Executive Order 13514

Executive Order 13514 of October 5, 2009, "Federal Leadership in Environmental, Energy, and Economic Performance," reaffirmed and, in some cases, bolstered the policy and goals established in Executive Order 13423, including increased GHG accounting and reporting. Executive Order 13514 set goals for the reduction of Scope 1, 2, and 3 GHGs;[1] improved water use efficiency and management; promotion of pollution prevention and waste elimination; advancement of regional and local integrated planning; implementation of sustainable building lifecycle management practices; advancement of sustainable acquisition; and promotion of electronics stewardship. Executive Order 13514 also requires the continued implementation of a formal sustainable Environmental Management System. Details of PNNL's conformance with Executive Order 13514 are available in Section 3.0.

2.1.6 *Pollution Prevention Act of 1990*

The *Pollution Prevention Act of 1990* requires that pollution be prevented or reduced at the source whenever possible, and that pollution that cannot be avoided be recycled or treated in an environmentally safe manner. PNNL's Pollution Prevention (P2) Program is dedicated to the site's Environmental Stewardship Policy by helping staff members prevent or minimize pollutants (non-hazardous, hazardous, radioactive, etc.) to all media (air emissions, liquid effluents, and solid waste). The program looks for opportunities for resource conservation, recycling, energy efficiency, water conservation, and purchasing environmentally preferable products and services. An annual pollution prevention plan is prepared and submitted to the Washington State Department of Ecology in accordance with *Washington Administrative Code* (WAC) 173-307-070. The plan typically contains information related to waste

[1] Scope 1 emissions are generated from site operations and activities; Scope 2 are associated with the purchase of energy (electricity, heat, or steam) used by site contractors; and Scope 3 emissions are associated with ancillary activities related to site operations, including business travel, employee commuting, vendor activities, and delivery services.

generation/reduction, P2 policy/practices and P2 accomplishments. Further information concerning PNNL's P2 Program is available in Section 3.0.

2.2 National Environmental Policy Act of 1969

JA Stegen

The *National Environmental Policy Act of 1969* (NEPA) was enacted to ensure that potential environmental impacts as well as technical factors and costs are considered during federal agency decision-making. The PNNL NEPA Compliance Program supports Laboratory compliance with NEPA and the Washington *State Environmental Policy Act* (SEPA). Program activities include preparing sitewide, project-, and activity-specific categorical exclusions; environmental assessments; and Washington State SEPA checklists. NEPA reviews for PNNL activities are conducted by both PNSO and DOE-Richland Operations Office NEPA compliance staff. The DOE office responsible for that concurring with and approving the NEPA documentation depends on the proposed project location and source of funding. NEPA compliance is verified through assessments conducted by PNNL and DOE.

Environmental compliance representatives and PNNL NEPA staff conducted 1,290 NEPA reviews during fiscal year (FY) 2011 for research and support activities (940 Electronic Prep and Risk System reviews, 295 EMSL user proposals, and 55 facility-modification permits). NEPA staff reviewed the Electronic Prep and Risk reviews to verify that potential project environmental impacts were adequately considered and NEPA (and as appropriate, SEPA) coverage was correctly applied. In nearly every case, activities were adequately addressed in previously approved NEPA documentation, such as categorical exclusions, environmental assessments, environmental impact statements, and supplement analyses. When there was no adequate previously-approved documentation, PNNL staff prepared additional NEPA documentation, such as project-specific categorical exclusions for approval by DOE.

Sitewide categorical exclusions represent an effective and necessary means for addressing activities that 1) clearly fit within a class of actions that DOE has determined do not individually or cumulatively have a significant effect on the environment, 2) do not possess extraordinary circumstances that may affect the environment, and 3) are not "connected" to other actions with potentially significant impacts. On October 13, 2011, DOE revised NEPA regulations in Title 10 of the *Code of Federal Regulations* (CFR) Part 1021, "National Environmental Implementing Procedures" (10 CFR 1021). These revisions to DOE regulations regarding implementation of the NEPA became effective on November 14, 2011. DOE established 20 new categorical exclusions, most of which include criteria (e.g., acreage, location, and height limitations) that limit the covered actions. DOE also revised many existing categorical exclusions and made other changes. The PNNL Site-wide categorical exclusions were updated in November and December 2011 to reflect the changes to 10 CFR 1021. A total of nine updated sitewide categorical exclusions were approved by PNSO in 2011, covering the following types of activities:

- small-scale R&D, laboratory operations, and pilot projects
- microbiological and biomedical research projects
- siting, constructing, modifying, and operating small-scale structures
- site characterization and environmental monitoring
- training programs, exercises, and drills

- outdoor tests on materials and components
- minor road and utility alterations
- safety and security component installation and alterations
- small-scale R&D projects using nanoscale materials.

In instances when a PNNL Site-wide categorical exclusion did not cover a specific activity or project, but the activity clearly fell within the definition of a categorical exclusion, a project- or activity-specific categorical exclusion was prepared. PNSO approved a project-specific categorical exclusion on June 30, 2011, to provide enhanced electrical service to EMSL. In addition, PNSO approved a project-specific categorical exclusion on August 30, 2011, to establish a City of Richland easement to allow enhanced electrical service to the Computational Sciences Facility. These enhancements to electric service provide increased power capacity for future facility developments.

On November 15, 2011, the DOE-Richland Operations Office approved a project-specific categorical exclusion to upgrade the existing Aquatics Research Laboratory in the 300 Area. A new 483-m^2 (5,200-ft^2) enclosed space was approved to be constructed over the footprint of the existing open air facility. On December 6, 2011, the DOE-Richland Operations Office approved an activity-specific categorical exclusion for small-scale R&D projects using nanoscale materials in the 300 Area. This categorical exclusion covers indoor small-scale R&D and pilot projects using nanoscale materials. It also includes activities related to minor modifications of existing laboratory rooms to support projects using nanoscale materials.

NEPA staff reviewed Facilities and Operations maintenance activities for CY 2011 activities. These reviews are conducted because there are usually more than 20,000 routine maintenance activities conducted annually, and maintenance activities are typically conducted with little specialized Facilities and Operations planning support or environmental review support. A randomly generated statistical subset of maintenance actions was reviewed to confirm that maintenance activities 1) did not involve significant environmental impacts; 2) were limited in scope, cost, and duration; 3) were adequately addressed under existing NEPA reviews; and 4) showed no trends that might indicate the need for a more intensive and directed review.

PNNL maintenance actions typically fall under one of several DOE categorical exclusions approved by the PNSO NEPA Compliance Officer or Hanford NEPA Compliance Officer.

Although no activity-specific NEPA review is performed before maintenance actions are implemented, the statistically selected subset of CY 2011 activities (2.5% or 514 maintenance activities) revealed that maintenance activities do not generally involve significant environmental impacts. These activities are quite limited in scope, cost, location, and duration, which helps to minimize potential environmental impacts. In addition, no activity trends were detected that might indicate that a more directed review and evaluation should be performed. Finally, the NEPA evaluations for these types of activities appear to be adequately addressed in the existing the DOE PNSO and Richland Operations Office categorical exclusions.

The annual self-assessment for 2011 was conducted in March 2012, in accordance with the internal document “Self-Assessment Procedure.” The self-assessment focused on NEPA reviews performed by

Environmental Compliance Representatives and data mining of electronic tools such as the Electronic Prep and Risk System, facility-modification permits, and EMSL user proposals. Overall performance, trends, and common errors were identified and results were focused on ways to improve the overall program and to communicate useful information and innovative techniques within the organization. Overall, projects are reviewed thoroughly and in a timely manner, and correctly identify significant environmental aspects (if any) requiring further evaluation prior to beginning the project. A few opportunities for improvement were found and included in the assessment report. The formal self-assessment was submitted in March 2012.

Since October 2011, NEPA staff have been meeting with the Environmental Compliance Representatives monthly to discuss NEPA-related regulation changes and any associated NEPA documentation errors that may occur. An informal assessment of NEPA reviews performed by the Environmental Compliance Representatives from October through December 2011 did not identify any issues.

2.3 Air Quality

JM Barnett

Federal regulations in Subpart H of 40 CFR 61 require the measurement and reporting of radionuclides emitted from DOE facilities and the resulting public dose from those emissions. Those regulations impose a standard of 10 mrem/yr effective dose equivalent, which is not to be exceeded. Washington State adopted the 40 CFR 61 standard in its regulations that require the calculation and reporting of the effective dose equivalent (EDE) to the maximally exposed individual (MEI) from both point-source emissions and from fugitive source emissions of radionuclides. WAC 246-247 further requires the reporting of radionuclide emissions, including radon, from all PNNL Site sources. Facilities with potential emissions of radioactive materials at the PNNL Site are research laboratories at the Physical Sciences Facility and EMSL. Details about the ambient air monitoring and stack emissions monitoring programs are captured in the annual *Pacific Northwest National Laboratory Site Radionuclide Air Emissions Report* (Snyder et al. 2012). During CY 2011, the PNNL Site maintained compliance with state and federal regulations and with PNNL Site issued air emissions permits as described below. In particular, radioactive air emissions were more than 10,000 times lower than the regulatory standard of 10 mrem/yr for the period.

2.3.1 *Clean Air Act*

The *Clean Air Act* (42 USC 7401) is administered by the EPA. It regulates air emissions from stationary and mobile sources, both conventional and hazardous. The Act authorized EPA to establish National Ambient Air Quality Standards for the protection of public health and welfare. The establishment of these pollutant standards was combined with state implementation plans to facilitate attainment of the standards. The *Washington Clean Air Act*, which is equivalent to and supplements the federal law, has been revised periodically to keep pace with changes at the federal level. The Washington State Department of Ecology is responsible for developing most statewide air quality rules and enforces 40 CFR 52, 40 CFR 60, 40 CFR 61, 40 CFR 63, 40 CFR 68, and 40 CFR 82, as well as the state requirements in WAC 173-400, WAC 173-460, WAC 173-480, and WAC 173-491. The Benton Clean Air Agency (BCAA) implements and enforces most federal and State requirements on the PNNL Site through BCAA Regulation 1 (BCAA 2011).

2.3.2 *Clean Air Act Amendments of 1990*

Section 112 of the *Clean Air Act* addresses emissions of hazardous air pollutants. In 1990, the *Clean Air Act Amendments of 1990* revised Section 112 to require standards for major and certain specific stationary sources. The amendments also revised the National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations (i.e., 40 CFR 61, Subpart H) to govern emissions of radionuclides from DOE facilities. These regulations are intended for the measurement of point-source emissions but are inclusive of fugitive emissions with regard to complying with the dose standard.

2.3.3 National Emissions Standards for Hazardous Air Pollutants

Section 112 of the *Clean Air Act* authorized the creation of NESHAP. The "National Emissions Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities" (40 CFR 61, Subpart H) established regulations for radioactive air emissions, including standards, monitoring provisions, and annual reporting requirements. The NESHAP cover all pollutants not regulated by the National Ambient Air Quality Standards that could cause serious health effects.

2.3.4 Radioactive Emissions

Radioactive emission point sources at PNNL are actively ventilated stacks that use electrically powered exhausters and from which emissions are discharged under controlled conditions. The point sources are major, minor, and fugitive emissions units. The regulatory standard for a maximum dose to any member of the public is 10 mrem/yr EDE (40 CFR 61, Subpart H), and applies to radionuclide air emissions, other than radon, from DOE facilities.

2.3.5 Air Permits

PNNL has several permits that authorize atmospheric emissions from facilities within the PNNL Site boundary. These include the radioactive air emission license for the Physical Sciences Facility issued by the Washington State Department of Health (RAEL-05), the nonradiological effluent permit for Physical Sciences Facility issued by the Benton Clean Air Agency (Order of Approval No. 2007-0013), and the nonradiological effluent permit for EMSL (DEO3NWP-003). In 2007, EMSL was granted a permit exemption by Washington State Department of Health (EUID:307).

2.4 Water Quality and Protection

TW Moon

This section discusses the water supply to PNNL; wastewater discharges and administrative controls; permits applicable to PNNL; monitoring and sampling; a brief discussion of the Richland North facilities; and stormwater. PNNL does not have an onsite treatment process for wastewater discharged to the sewer system. Wastewater is monitored and sampled in accordance with regulatory requirements.

2.4.1 *Clean Water Act*

The *Clean Water Act* establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the *Clean Water Act* was enacted in 1948 and was called the *Federal Water Pollution Control Act*, but the Act was significantly reorganized and expanded in 1972. The "Clean Water Act" became the Act's common name with amendments in 1972. Under the *Clean Water Act*, the EPA has implemented pollution control programs such as setting wastewater standards for industry and implementing water quality standards for all contaminants in surface waters. The *Clean Water Act* made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. The EPA's National Pollutant Discharge Elimination System (NPDES) permit program controls these point source discharges. Point sources are discrete conveyances such as pipes or man-made ditches. Industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters. The NPDES program has been delegated from EPA to the Washington State Department of Ecology.

While there are no direct discharges of wastewater from the PNNL campus to surface waters, the Washington State Department of Ecology has issued Permit #WA0020419 to the City of Richland for discharges to the Columbia River from its publicly owned Treatment Works. To ensure that it meets its NPDES permit conditions, the City of Richland issues industrial wastewater discharge permits to industrial users as codified in Richland Municipal Code, Chapter 17.30.

On the PNNL campus, three industrial wastewater discharge permits regulate the discharge of process wastewater to City of Richland sanitary sewer system. Industrial wastewater discharge permit #CR-IU005 regulates discharges from EMSL, Permit #CR-IU011 regulates process wastewater discharged from the Physical Sciences Facility, and Permit #CR-IU001 regulates discharges from Richland North facilities. All waste streams that are determined to be regulated by these permits are reviewed by PNNL staff and evaluated for compliance with the applicable permit prior to discharge.

2.4.1.1 William R. Wiley Environmental Molecular Sciences Laboratory

EMSL discharges both sanitary and laboratory or process wastewater. Industrial wastewater discharge permit #CR-IU005 regulates discharges from EMSL. Process wastewater from laboratory spaces is collected in four 15,000-L (4,000-gal) tanks. When a tank is filled, it is sampled and analyzed according to the monitoring schedule outlined in the permit. If the analyses indicate that the wastewater meets the permit conditions, approval is given to discharge the tank. If it does not meet permit conditions, the wastewater is managed alternatively either through treatment or shipped offsite to a licensed disposal company.

2.4.1.2 Physical Sciences Facility

Permit #CR-IU011 regulates process wastewater discharged from the Physical Sciences Facility. The Physical Sciences Facility also discharges sanitary wastewater, process wastewater, and process wastewater with the potential for radiologic contamination. Process wastewater discharged from laboratory spaces at the Physical Sciences Facility is sampled and analyzed in accordance with the monitoring schedule in the permit and discharged to the City of Richland sewer. Wastewater from laboratory spaces with the potential for radiological contamination is collected in one of four 3,800-L

(1,000-gal) tanks. When a tank is filled with wastewater, it is analyzed for radiological constituents. If the analyses indicate the results are in compliance with Washington State criteria for release of wastewater to a sewer system, approval is given to discharge the tank. If results do not meet the criteria, the wastewater is managed alternatively through offsite disposal to a licensed disposal company.

The monitoring schedule for EMSL and the Physical Sciences Facility is presented in Table 2.1. In 2011, EMSL tank samples showed 10 out of 110 organic priority pollutants sampled to be above minimum detection limits. All other organic constituents on the EPA priority pollutant list were below minimum detection limits. Further details are available in Section 5.1.

Because there has been insufficient wastewater discharged from the Physical Sciences Facility to collect a representative sample, no sampling has been performed. In 2011, all liquid effluent discharged from EMSL complied with permit limits.

Table 2.1. Wastewater Monitoring Schedule for 2011 for the Environmental Molecular Sciences Laboratory and Physical Sciences Facility

Frequency	Sample Type	Analytical Parameter
Environmental Molecular Sciences Laboratory		
Per batch	Grab	Flow, pH, conductivity
Quarterly	Grab	Metals
Annual	Grab	Biochemical oxygen demand, total phenols, total suspended solids, ammonia, organic priority pollutants
Physical Sciences Facility		
Continuous	Recording device	Flow
Quarterly	Grab	pH; conductivity; cyanide; total phenols; organic priority pollutants
Quarterly	Composite	Metals; ammonia
Semi-Annual	Composite	Biochemical oxygen demand; total suspended solids

2.4.1.3 Richland North

The City of Richland has issued an industrial wastewater discharge permit for the process wastewater discharged to the sewer system (Permit #CR-IU001) for facilities located in Richland North. Wastewater is analyzed in accordance with the monitoring schedule in the permit at Outfall 001, located near the Life Sciences Laboratory II, and Outfall 003, located near the Research Technology Laboratory (Building 520). The analytical results are reported to the City of Richland in a discharge monitoring report each quarter. The monitoring schedule for Richland North is presented in Table 2.2. In 2011, sewer outfall samples showed 20 out of 110 organic priority pollutants above minimum detection limits. All other organic constituents on the EPA priority pollutant list were below minimum detection limits. A summary of the analytical results for physical parameters and metals for Richland North are presented in Section 5.1.

Table 2.2. Wastewater Monitoring Schedule for 2011, Richland North – Outfall 001/003

Frequency	Sample Type	Analytical Parameter
Continuous	Recording device	Flow
Quarterly	Grab	pH; conductivity
Semi-Annual	Grab	Cyanide; total phenols; organic priority pollutants
Semi-Annual	Composite	Metals
Annual	Composite	Biochemical oxygen demand; total suspended solids

In 2011, there was one exceedance of the permit limit for maximum daily flow at Outfall 001. Investigations revealed the source of the excess water was due to the failure of a sand filter. Follow-up sampling indicated the excess wastewater discharge posed no threat to human health or the environment.

The Washington State Department of Ecology has issued permits for non-contact cooling water discharged from the Richland Research Complex Cooling Ponds (#ST-9251) through the irrigation system, and for ground-source heat pump return flow discharged to underground injection control wells (#ST-9274) for heating and cooling the Biological Sciences Facility and the Computational Sciences Facility (BSF/CSF). Each waste stream is monitored and analyzed in accordance with the applicable permit. The analytical results are reported to the Washington State Department of Ecology in monthly and annual discharge monitoring reports. Table 2.3 provides the monitoring schedule for the Richland Research Complex Cooling Ponds and the BSF/CSF ground-source heat pump. The water from the Richland Research Complex Cooling Ponds is monitored prior to being discharged to the irrigation system. Monitoring results for the BSF/CSF ground-source heat pump are available in Section 6.0 and monitoring results for the Richland Research Complex Cooling Ponds are available in Section 5.1.

Table 2.3. Wastewater Monitoring Schedule for 2011 for the Richland Research Complex Cooling Ponds and Biological Sciences Facility and the Computational Sciences Facility Ground-Source Heat Pump

Frequency	Sample Type	Analytical Parameter
Richland Research Complex Cooling Ponds		
Continuous	Recording device	Flow
Annual	Grab	pH; conductivity; total dissolved solids; soil sample
BSF/CSF Ground-Source Heat Pump		
Continuous	Recording device	Flow; temperature; air temperature; depth to water
Quarterly	Grab	Conductivity; pH; dissolved oxygen
Semi-Annual	Grab	Turbidity; total dissolved solids; nitrate + nitrite; uranium; tritium; trichloroethylene

2.4.2 Pollutant Discharge Elimination Systems

PNNL has no stormwater discharges requiring monitoring under the federal or state pollutant discharge elimination system stormwater regulations; therefore, there are no applicable pollutant discharge elimination system permits.

2.4.3 Stormwater Management

Stormwater on the PNNL Site is managed via underground injection control wells and grassy swales. The underground injection control wells are registered with the Washington State Department of Ecology as required by WAC 173-218. Stormwater discharges to the grassy swales do not require registration. Best management practices are used to minimize pollution in stormwater. These practices include storing chemicals inside or under cover to prevent contact with stormwater, routinely sweeping and cleaning parking lots, promptly notifying and cleaning up of spills, and implementing good housekeeping.

There are no industrial stormwater discharges from the PNNL Site to a surface water body, and stormwater discharges do not meet the requirements for coverage under the federal or state pollutant discharge elimination system stormwater regulations.

2.4.4 *Safe Drinking Water Act of 1974*

The *Safe Drinking Water Act of 1974* is the main federal law that ensures the quality of Americans' drinking water. Under the Act, the EPA sets standards for drinking water quality and oversees the states, localities, and water suppliers who implement those standards. The *Safe Drinking Water Act of 1974* was originally passed by Congress in 1974 to protect public health by regulating the nation's public drinking water supply. The law was amended in 1986 and 1996 and requires many actions to protect drinking water and its sources—rivers, lakes, reservoirs, springs, and groundwater wells.

The *Safe Drinking Water Act of 1974* focuses on all waters actually or potentially designed for drinking use, whether from above ground or underground sources. The Act authorizes the EPA to establish minimum standards to protect tap water and requires all owners or operators of public water systems to comply with these primary (health-related) standards. The *Safe Drinking Water Act Amendments of 1996* require that EPA consider a detailed risk and cost assessment, and best available peer-reviewed science, when developing these standards. State governments, which can be approved to implement these rules for EPA, also encourage attainment of secondary (nuisance-related) standards. Under the Act, EPA also establishes minimum standards for state programs to protect underground sources of drinking water from endangerment by underground injection of fluids.

The PNNL Site receives all drinking water for uses in non-laboratory and laboratory spaces from the City of Richland drinking water supply, and is not subject to requirements pursuant to the *Safe Drinking Water Act of 1974.* However, the registration of underground injection wells for stormwater (Section 2.4.3) and injection of ground-source heat pump return flow water (Section 2.4.1) have been completed as required by the *Safe Drinking Water Act of 1974.*

2.5 Environmental Restoration and Waste Management

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This section describes the activities at PNNL and associated facilities to protect the environment through the proper management of waste.

2.5.1 Tri-Party Agreement

The *Hanford Federal Facility Agreement and Consent Order* (also known as the Tri-Party Agreement [Ecology et al. 1989]) is an agreement among the Washington State Department of Ecology, EPA, and DOE (Tri-Party Agreement agencies) to achieve environmental regulation compliance on the Hanford Site with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), and the *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage, and disposal unit regulations and corrective action provisions. The Tri-Party Agreement is an interagency agreement (also known as a federal facility agreement) under Section 120 of CERCLA, a corrective action order under RCRA, and a consent order under the Washington State *Hazardous Waste Management Act of 1976* that 1) defines RCRA and CERCLA cleanup commitments, 2) establishes responsibilities, 3) provides a basis for budgeting, and 4) reflects a concerted goal to achieve regulatory compliance and remediation with enforceable milestones.

The Tri-Party Agreement agencies have negotiated changes to the agreement since its publication in 1989 to meet the changing conditions and needs of cleanup activities on the Hanford Site. All significant changes undergo a process of public involvement that enhances communication and addresses public concerns prior to final approvals. As changes are approved through the Tri-Party Agreement change control process, they are incorporated into the Tri-Party Agreement and made available on the Internet at the following website: http://www.hanford.gov/?page=81. Printed copies of Revision 8 of the Tri-Party Agreement, which is current as of July 25, 2012, are publicly available at DOE's Public Reading Room located in the Washington State University Tri-Cities Consolidated Information Center, 2770 University Drive, Richland, Washington, and at public reading rooms in Seattle and Spokane, Washington, and Portland, Oregon.

The PNNL Site is not part of any Hanford Site CERCLA operable unit or subject to any cleanup action under the Tri-Party Agreement. PNNL maintains administrative controls similar to those at adjacent uncontaminated portions of the Hanford 300 Area. PNNL provides information to the DOE-Richland Operations Office and its contractors with regard to the facilities it occupies on the Hanford Site in order to prepare the annual land disposal restrictions report required by Tri-Party Agreement Milestone M-26. Some wells located on the PNNL campus are monitored by Hanford Site contractors as part of the regional groundwater monitoring network. Sampling data are available in the Hanford Site Groundwater Monitoring Report for 2010 (DOE/RL 2011a).

2.5.2 *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*

CERCLA was promulgated to address response, compensation, and liability for past releases or potential releases of hazardous substances, pollutants, and contaminants to the environment. CERCLA was amended by the *Superfund Amendments and Reauthorization Act of 1986*, which made several

important changes and additions, including clarification that federal facilities are subject to the same provisions of CERCLA as any nongovernmental entity. Executive Order 12580, "Superfund Implementation" (52 FR 2923) directs that DOE, as the lead agency, must conduct CERCLA response actions (i.e., removal and remedial actions) on the PNNL Site. Such actions would be subject to oversight by EPA and/or the Washington State Department of Ecology.

On May 9, 2011, EPA implemented the Integrated Cleanup Initiative, a 3-year strategy to identify and implement improvements to EPA's land cleanup programs. The initiative goals include accelerating cleanups, addressing more contaminated sites, and placing sites back into productive use while safeguarding human health and the environment.

Under the Tri-Party Agreement (Ecology et al. 1989), waste sites were grouped into "operable units" based on geographic proximity or similarity of waste-disposal history. Two operable units are located near PNNL and are part of the "Hanford 300 Area" National Priorities List site per 40 CFR 300, listed on November 3, 1989.

A portion of PNNL land was investigated as part of the Hanford 300-FF-2 Operable Unit in the late 1990s. Site characterization efforts found vestiges of petroleum hydrocarbons, irrigation canals, and recent debris (windblown garbage, porcelain china, battery cores, cans, and glass). After a site evaluation, EPA issued a CERCLA interim Record of Decision (EPA 2001a) that concluded that PNNL areas require no further remedial action under CERCLA.

Groundwater under the northern portion of PNNL is routinely monitored for contaminants migrating from Hanford Site contamination plumes. See Section 6.0 for further information concerning groundwater monitoring on the PNNL campus.

2.5.3 Washington State Dangerous Waste/Hazardous Substance Reportable Releases to the Environment

The Washington State Dangerous Waste Regulations (WAC 173-303-145) require that spills or non-permitted discharges of dangerous waste or hazardous substances to the environment be reported to the Washington State Department of Ecology. This requirement applies to discharges to soil, surface water, groundwater, or air when such discharges threaten human health or the environment, regardless of the quantity of dangerous waste or hazardous substance released.

During CY 2011, no spills or non-permitted discharges that would threaten human health or the environment occurred at PNNL facilities. Minor spills were cleaned up immediately and disposed of in accordance with applicable requirements.

2.5.4 *Resource Conservation and Recovery Act of 1976*

RCRA was enacted in 1976 with the objective of protecting human health and the environment. The central principle of RCRA is its establishment of cradle-to-grave management to track hazardous waste from its generation to treatment, storage, and disposal. The Washington State Department of Ecology has the authority to enforce RCRA requirements in the state under WAC 173-303, "Dangerous Waste Regulations."

PNNL, in cooperation with the DOE-Richland Operations Office, operates one RCRA-permitted storage and treatment unit—the 325 Hazardous Waste Treatment Units Operating Unit. This unit is located in the Radiochemical Processing Laboratory in the Hanford 300 Area, and is permitted as part of the Hanford Facility RCRA Permit. The Hanford Facility RCRA Permit expired on September 27, 2004. However, DOE and PNNL continue to operate under the expired permit until the reissued permit becomes effective, as authorized by WAC 173-303.

With the exception of the 325 Hazardous Waste Treatment Units, PNNL facilities operate under the generator requirements of WAC 173-303. During CY 2011, PNNL facilities followed the generator requirements for waste management and shipped nonradioactive waste to offsite facilities for proper disposal.

Washington State Department of Ecology personnel inspected PNNL facilities three times in 2011. No violations were noted.

2.5.5 *Federal Facility Compliance Act of 1992*

The *Federal Facility Compliance Act of 1992*, enacted by Congress on October 6, 1992, amends Section 6001 of RCRA to specify that the United States waives sovereign immunity from civil and administrative fines and penalties for RCRA violations. In addition, RCRA requires EPA to conduct annual inspections of all federal facilities. Authorized states are also given authority to conduct inspections of federal facilities to enforce compliance with state hazardous waste programs. A portion of the Act also requires DOE to provide mixed waste information to EPA and the states. PNNL provides this information as part of the Hanford Site Mixed Waste Land Disposal Restrictions Summary Reports pursuant to Tri-Party Agreement Milestone M-26.

2.5.6 *Toxic Substances Control Act*

Toxic Substances Control Act requirements that apply to PNNL primarily involve regulation of polychlorinated biphenyls (PCBs). Federal regulations for PCB use, storage, and disposal are provided in 40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions." PCB wastes at PNNL are stored and/or disposed of in accordance with this regulation; however, some radioactive PCB waste is transferred to extended storage at the Hanford Site, pending the development of adequate treatment and disposal technologies and capacities.

The *2010 Hanford Site Polychlorinated Biphenyl Annual Document Log* (DOE/RL-2011b) and the *2010 Hanford Site Polychlorinated Biphenyl Annual Report* (DOE/RL-2011c) describe the PCB waste management and disposal activities occurring on the Hanford Site, including PNNL activities related to PCBs. These documents are provided to EPA annually as required by 40 CFR 761.180.

2.5.7 *Federal Insecticide, Fungicide, and Rodenticide Act*

The *Federal Insecticide, Fungicide, and Rodenticide Act* is administered by EPA. Washington State Department of Agriculture rules implementing the *Federal Insecticide, Fungicide, and Rodenticide Act* requirements include the *Washington Pesticide Control Act* (RCW 15.58), the *Washington Pesticide Application Act* (RCW 17.21), and rules relating to general pesticide use codified in WAC 16-228,

"General Pesticide Rules." In 2011, commercial pesticides were applied either by commercial pesticide operators that are listed on one of two commercial pesticide applicator licenses, or by a licensed private commercial applicator on the PNNL campus.

2.5.8 *Emergency Planning and Community Right-to-Know Act of 1986*

The *Emergency Planning and Community Right-to-Know Act of 1986* (EPCRA) requires each state to establish an emergency response commission and local emergency planning committees, and develop a process for distributing information about hazardous chemicals present in local facilities. These committees gather information and develop emergency plans for local planning districts. Facilities that produce, use, release, or store toxic or hazardous substances in quantities above threshold quantities must submit information about the chemicals to emergency planning committees to support emergency planning.

EPCRA has four major provisions: emergency planning, emergency release notification, hazardous chemical inventory reporting, and toxic chemical release inventory reporting (Table 2.4).

Two annual reports are required under EPCRA: 1) Tier Two Emergency and Hazardous Chemical Inventory, which contains information about hazardous chemicals stored at PNNL in amounts exceeding minimum threshold levels; and 2) Toxic Chemical Release Inventory, which contains information about total annual releases of certain toxic chemicals and associated waste management activities.

PNNL electronically submitted a Tier Two report to the Washington State Emergency Response Commission, the local emergency planning committee, and Richland Fire Department on March 1, 2012.[1] Only one chemical category (lead acid batteries, which contain sulfuric acid, an extremely hazardous substance) exceeded the reporting threshold.

PNNL was not required to submit a Toxic Release Inventory Report for 2011, because all activities were either exempt from reporting (research work in laboratories supervised by qualified staff is exempt) or below reporting thresholds.

[1] Tilden HT. February 28, 2012. "Copy of PNNL Site EPCRA 312 Report for 2011." [Email to Hubele and Duncan].

Table 2.4. Provisions of the *Emergency Planning and Community Right-to-Know Act of 1986*

Section	CFR Section	Reporting Criteria	Due Date	Agencies Receiving Report
302	40 CFR 355: Emergency Planning Notifications	The presence of an extremely hazardous substance in quantity equal to or greater than threshold planning quantity at any one time.	Within 60 days of threshold planning quantity exceedance.	SERC; LEPC
302	40 CFR 355: Emergency Planning Notifications	Change occurring at a facility that is relevant to emergency planning.	Within 30 days after the change has occurred.	LEPC
304	40 CFR 355: Emergency Release Notifications	Release of an extremely hazardous substance or a CERCLA hazardous substance in quantity equal to or greater than reportable quantity.	Initial notification: immediate (within 15 minutes of knowledge of reportable release). Written follow-up: within 14 days of the release.	SERC; LEPC
311	40 CFR 370: Material Safety Data Sheet Reporting	The presence at any one time at a facility of an OSHA hazardous chemical in quantity equal to or greater than 4,500 kg (10,000 lb) or an extremely hazardous substance in quantity equal to or greater than threshold planning quantity or 230 kg (500 lb), whichever is less.	Revised list of chemicals due within 3 months of a chemical exceeding a threshold.	SERC; LEPC; Local Fire Departments
312	40 CFR 370: Tier Two Report	The presence at any one time at a facility an OSHA hazardous chemical in quantity equal to or greater than 4,500 kg (10,000 lb), or an extremely hazardous substance in quantity equal to or greater than threshold planning quantity or 500 lb (230 kg), whichever is less.	Annually by March 1	SERC; LEPC; Local Fire Departments
313	40 CFR 372: Toxic Release Inventory Report	Manufacture, process, or use at a facility, any listed Toxic Release Inventory chemical in excess of its threshold amount during the course of a calendar year. Thresholds are 11,300 kg (25,000 lb) for manufactured or processed or 4,500 kg (10,000 lb), except for persistent, bio-accumulative, toxic chemicals, which have thresholds of 45 kg (100 lb) or less.	Annually by July 1	EPA; SERC

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*.
EPA = U.S. Environmental Protection Agency.
LEPC = Local Emergency Planning Committee.
OSHA = Occupational Safety and Health Administration.
SERC = State Emergency Response Commission.

Table 2.5 provides an overview of PNNL Site reporting under EPCRA during 2011 and early 2012.

Table 2.5. *Emergency Planning and Community Right-to-Know Act of 1986* Compliance Reporting

Section	Description of Reporting	Status	Notes
302	Emergency planning notifications	Not required	Pacific Northwest National Laboratory's chemical management system tracks *Emergency Planning and Community Right-to-Know Act of 1986* 302 reportable inventories.
304	Extremely hazardous substance release notification	Not required	No releases occurred.
311	Material safety data sheet	Not required	No new chemicals within reporting threshold requirements.
312	Chemical inventory	Yes	The 2011 Tier Two Emergency and Chemical Inventory report was submitted February 28, 2012.
313	Toxic release inventory	Not required	No emissions greater than reporting threshold requirement.

2.6 Natural and Cultural Resources

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The *Pacific Northwest Site Office Cultural and Biological Resources Management Plan* (DOE/PNSO 2008) provides direction and guidance relative to protecting and managing biological and cultural resources at PNNL in Richland. The Management Plan was developed as a requirement of DOE Policy 141.1, "Department of Energy Management of Cultural Resources," to provide for the protection and management of biological resources, identify impacts of unauthorized public use to prehistoric sites, identify actions that will protect sensitive sites, and provide details of annual monitoring activities to identify potential impacts.

2.6.1 Biological Resources

A number of federal acts and Orders provide the framework for protection of biological resources. This section summarizes the requirements and catalogs PNNL's work to demonstrate compliance in 2011.

The *Endangered Species Act of 1973* provides a program for the designation and protection of wildlife, fish, and plant species that are in danger of becoming extinct due to natural or manmade factors and the conservation of the habitats upon which they depend. Under Section 7 of the *Endangered Species Act of 1973*, federal agencies are required to evaluate actions that they perform, fund, or permit to determine if any species listed as endangered or threatened in 50 CFR 17.11 and 50 CFR 17.12 may be affected by the proposed action. Consultation with the U.S. Fish and Wildlife Service or the National Marine Fisheries Service is required if the action may affect a listed species. The biological resource review process is the primary means by which PNNL determines if any listed species may be affected by a proposed action.

The *Migratory Bird Treaty Act* makes it illegal to take, capture, or kill any migratory bird, or to take any part, nest, or egg of any such birds (affected species are listed at 50 CFR 17.11). PNNL Site projects with a potential to affect federally or state-listed species of concern comply with the requirements of this Act by using the PNNL ecological compliance review process as described in the *Hanford Site Biological Resources Management Plan* (DOE/RL 2001).

The *Bald and Golden Eagle Protection Act* (16 USC 668–668d) prohibits anyone without a permit to disturb, wound, kill, harass, or take bald or golden eagles, alive or dead, including their parts, nests, or eggs. The Act also applies to impacts made around previously used nest sites, if, upon an eagle's return normal breeding, feeding, or sheltering habits are influenced negatively. The PNNL biological resource review process provides assurance that a proposed action will not adversely affect bald or golden eagles. Mitigation includes performing work outside of the winter season, staying out of established buffer areas, or entering buffer areas at mid-day, thereby minimizing impacts by avoiding eagle roosting periods.

Executive Order 11990, "Protection of Wetlands," requires federal agencies to minimize the loss or degradation of wetlands on federal lands and to preserve and enhance the natural and beneficial values of those lands. Compliance with this Order, as well as the wetland provisions of the *Clean Water Act of 1977*, is achieved through the biological review process at PNNL.

Executive Order 11988, "Floodplain Management," requires federal agencies to evaluate the potential effects of any actions within a floodplain, minimizing any direct or indirect impacts to their natural and beneficial values. Floodplain management and consequences of flood hazards need to be considered when developing water and land-use plans, as well as alternatives to floodplain use. The biological resource review process at PNNL helps to identify floodplains within a proposed project area and is effective in identifying any impacts of the proposed action to the floodplain.

DOE PNSO prepared the *Pacific Northwest Site Office Cultural and Biological Resources Management Plan* (DOE/PNSO 2008) in response to the direction and guidance provided in DOE Policy 141.1, "Department of Energy Management of Cultural Resources," and guidance in DOE Order 450.1A relative to protecting and managing cultural and biological resources.

A baseline biological survey of the PNNL Site was conducted in 2011 to comply with the PNSO management plan requirements. The primary objective of the field surveys was to determine the occurrence of plant and animal species protected under the federal *Endangered Species Act of 1973*; candidates for such protection; priority habitats and species listed as threatened, endangered, candidate, sensitive, or monitor by the state of Washington; and species protected under the federal *Migratory Bird Treaty Act*. Ecologists performed pedestrian and visual reconnaissance of the PNNL Site in late May and throughout June 2011. The uplands and a narrow riparian corridor along the Columbia River were surveyed, but the entire riparian corridor could not be surveyed due to high water. Shrub-steppe, a Washington State priority habitat, is prevalent over much of the site. A variety of bird species protected under the *Migratory Bird Treaty Act* use the shrub-steppe habitat, as do common mammal species. No plant or animal species protected under the *Endangered Species Act of 1973* were observed during the survey. Habitats and species observed in 2011 were similar to those described in Section 1.4.4. A list of plant and animal species identified across the upland areas of the PNNL Site in 2011 is available in the *2011 Annual Ecological Survey: Pacific Northwest National Laboratory Site* (Becker and Chamness 2012).

As stipulated in the PNSO Management Plan (DOE/PNSO 2008), projects involving soil disturbance or work outdoors are routinely evaluated to determine the potential to affect biological resources. Ten ecological reviews were conducted for PNNL projects in FY 2011: four on the PNNL Site and six in the 300 Area. Potential project impacts were evaluated for plant or animal species protected under the *Endangered Species Act of 1973* and candidates for such protection, species listed by the state of Washington as threatened or endangered, Washington State priority habitats, and bird species protected under the *Migratory Bird Treaty Act* and *Bald and Golden Eagle Protection Act*. There were no project impacts that violated related federal or state law, regulation, or conservation priority guidance.

2.6.2 Cultural Resources

A number of federal acts and Orders provide the framework for protection of cultural resources. This section summarizes the requirements and catalogs PNNLs efforts to demonstrate compliance in 2011.

The *National Historic Preservation Act of 1966* (16 USC 470) and its amendments establish historic preservation as a national policy and define it as the protection, rehabilitation, restoration, and reconstruction of districts, sites, buildings, structures, and objects, which are significant in American history, architecture, archaeology, or engineering. The Act also expands the National Register of Historic Places to include resources of state and local significance, and it establishes the Advisory Council on Historic Preservation as an independent federal agency. At PNNL, compliance with the *National Historic Preservation Act of 1966* is achieved through the cultural resource review process.

The *Antiquities Act of 1906* provided for the protection of historic and prehistoric remains and structures on federal lands. It established a permit system for conducting scientific archaeological investigations and established criminal penalties and fines to manage looting and vandalism of archaeological sites on public lands. By the 1970s, the penalties were no longer commensurate with the severity of the offense, and in 1974 the Act was proclaimed to be unconstitutionally vague by the Ninth Circuit Court of Appeals. In response, Congress enacted the *Archaeological Resources Protection Act of 1979* (16 USC 470).

The *Archaeological Resources Protection Act of 1979* (16 USC 470) provides for the protection and archaeological resources and sites on federal and tribal lands. It also describes the conditions required preceding the issuance of a permit to excavate or remove any archaeological resource, the curation and record requirements for removal or excavation, and the penalties for convicted violators. At PNNL, the cultural resource review process supports compliance with the *Archaeological Resources Protection Act of 1979*.

The *Native American Graves Protection and Repatriation Act of 1990* (25 USC 3001) established a means for Native Americans to request the return of human remains and other sensitive cultural articles held by federal agencies. It also contains provisions regarding the requirement to inventory any remains and associated funerary objects, the intentional excavation of remains or cultural items, and the illegal trafficking of those items.

The *American Indian Religious Freedom Act* (42 USC 1996) was established in 1978 for the protection and preservation of the traditional religious ceremonial rights and cultural practices of American Indians. These rights include access to sacred sites, repatriation of sacred items held in museums, and freedom to worship through traditional ceremonies. The Act also required governmental

agencies not to interfere with Native American religious practices and to accommodate access to and the use of religious sites to the extent that the use is practicable and consistent with an agency's essential functions. In that the *American Indian Religious Freedom Act* could not enforce its provisions, the *American Indian Religious Freedom Act Amendments of 1994* were established to provide for the management of federal lands "in a manner that does not undermine or frustrate traditional Native American religions or religious practices" (103 HR 4155).

The *Archaeological and Historic Preservation Act of 1974* (16 USC 469) provides for the preservation of historic American sites, buildings, objects, and antiquities of national significance. It also imparts the preservation of historical and archaeological data (including relics and specimens), which might otherwise be irreparably lost or destroyed, and requires preservation of significant historic and archaeological data affected by any federal or federally related land modification activity.

Cultural resources reviews are conducted for all federal undertakings to identify their potential to affect cultural resources as part of *National Historic Preservation Act of 1966* Section 106 requirements. The Section 106 review process results in one of four outcomes: 1) No Potential to Cause Effects, 2) No Historic Properties Affected, 3) No Adverse Effect, or 4) an Adverse Effect. Six Section 106 cultural resource reviews were conducted for PNNL projects in FY 2011: three on the PNNL campus and three in the 300 Area. These resulted in the following determinations: three reviews were categorized as No Potential to Cause Effect, two reviews as No Historic Properties Affected, and one as No Adverse Affect.

To ensure that important cultural resources are protected on the PNNL Site, the 2008 DOE *Pacific Northwest Site Office Cultural and Biological Resources Management Plan* (DOE/PNSO 2008) requires annual monitoring of three eligible properties to identify potential threats and recommend appropriate actions, if necessary. As stipulated in the Management Plan, the trip results are analyzed and reported to local Tribes and the Washington State Historic Preservation Office.

The cultural resources monitoring trip was conducted on November 17, 2011, and involved visits to three archaeological sites. Minor erosion of unvegetated slopes and recent rodent activity were noted at one site. Also noted were 1) a small unvegetated patch, 2) exposure and shredding of cloth barrier emplaced during site reseeding, 3) a new coyote hole under the north boundary fence, 4) impacts on native vegetation from an off-road driving incident, and 5) an unlocked gate on the road accessing the site. All observations were considered minor except for the off-road driving and unlocked gate. Recommendations were made to monitor these areas closely in the future, place a lock and access controls on the gate, and require a cultural resources briefing for those with site access. In 2011, the lock on the access gate was replaced and a cultural resource briefing was developed. The cultural resource briefing is now required reading for staff accessing the site.

2.7 Radiation Protection

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The PNNL Richland campus is subject to the radiation protection statutes and regulations designed to protect the health and safety of the public, workforce, and the environment.

2.7.1 DOE Order 5400.5

DOE Order 5400.5, "Radiation Protection of the Public and the Environment" was initially issued in February 1990, and underwent minor revisions in June 1990 (Change 1) and January 1993 (Change 2). The purpose of this Order is to establish standards and requirements for conduct of DOE and DOE contractor operations with respect to radiological protection of the public and the environment. This Order integrated, consolidated, and updated portions of previous DOE directives that had addressed public and environmental radiation protection standards and control practices. The Order was developed and issued consistent with DOE's policy to implement legally applicable radiation protection requirements; to consider and adopt, as appropriate, recommendations by authoritative organizations (e.g., the National Council on Radiation Protection and Measurements and the International Commission on Radiological Protection); and to adopt and implement standards generally consistent with those of the U.S. Nuclear Regulatory Commission (NRC) for DOE facilities and activities not subject to NRC authority. Specifically, relative to guidance, standards, and regulatory requirements existing at the time of its issuance, this Order adopted applicable standards issued by the International Commission on Radiological Protection and the National Council on Radiation Protection and Measurements, incorporated regulatory requirements applicable to DOE operations, and consolidated and upgraded DOE guidance for contaminated property.

DOE Order 5400.5, Chg 2, applies to all DOE elements and contractors performing work for DOE, as provided by law and/or contract, and as implemented by the appropriate contracting officer. This Order was developed and issued under the authority of the *Atomic Energy Act of 1954*, as amended, which authorizes DOE to provide for the radiological health and safety of the public for operations conducted under DOE direction.

Relative to the radiological health and safety of the public, the objectives of DOE Order 5400.5, Chg 2, are to ensure that DOE operations achieve the following:

- Radiation exposures to the public are maintained within established limits.
- Radioactive contamination is controlled through the management of real and personal property.
- Potential exposures to the public are as far below established limits as is reasonably achievable.
- DOE facilities have the capabilities, consistent with the types of operations conducted, to monitor routine and nonroutine releases and to assess doses to the public.

In addition to providing radiological protection to the public, the objective of DOE Order 5400.5 is to provide radiological protection of the environment to the extent practical.

DOE Order 5400.5, Chg 2, also provides derived concentration guide values as reference values for conducting radiological environmental protection programs at operational DOE facilities and sites. These DOE-derived concentration guide values are based on a committed dose standard of 100 mrem (1 millisievert) due to ingestion, inhalation, or direct exposure during a given year, and are provided for three exposure pathways: 1) ingestion of water, 2) inhalation of air, and 3) immersion in a gaseous cloud. This Order also provides radiological protection requirements and guidelines for cleanup of residual radioactive material, management of the resulting wastes and residues, and clearance of property. These requirements and guidelines are applicable at the time the property is released.

In 2008, DOE initiated a comprehensive revision and update of DOE Order 5400.5, Chg 2; this effort continued in 2009 and 2010. A draft revision to this Order (re-numbered DOE Order 458.1) was issued for comment in October 2009, and reissued in September 2010 for comment resolution. Following resolution of all comments, a final revision of DOE Order 5400.5, Chg 2, was issued as new DOE Order 458.1 in February 2011.

During CY 2011, the PNNL contract incorporated Chapter II and Chapter IV of DOE Order 5400.5, which pertain to the ALARA (As Low As Reasonably Achievable) process and radiological releases. PNNL implemented this Order as specified in its Radiological Control Program Description and associated implementing procedures. No property with detectable residual radioactive material above the surface contamination guidelines specified in DOE Order 5400.5 and supporting guidance documents was released by PNNL during CY 2011. Further detail is available in Section 4.2.

2.7.2 DOE Order 458.1

DOE Order 458.1, issued in February 2011, superseded DOE Order 5400.5, Chg 2. Administrative changes were made to DOE Order 458.1 in March 2011 (Change 1) and June 2011 (Change 2). Section 2.d (As Low As Reasonably Achievable) and Section 2.k (Release and Clearance of Property) of DOE Order 458.1 were added to PNNL's contract with PNSO during July 2011 with full implementation due by September 1, 2012. During the reporting period of this site environmental report, PNNL was working under the requirements in DOE Order 5400.5.

Section 2.d of DOE Order 458.1 requires each contractor to establish an environmental ALARA process to control and manage radiological activities so that doses to members of the public and releases to the environment are kept as low as reasonably achievable. The ALARA process must be applied to the design or modification of facilities and the conduct of radiological work activities.

Section 2.k of the DOE Order provides the requirements with which each contractor must comply when releasing property that potentially contains residual radioactive. Dose constraints to the public are established based on the type of property (i.e., personal property and real property). Requirements for releasing property based on process knowledge, radiological surveys, or a combination of both are provided. The process of obtaining pre-approved release limits and activity-specific release limits are for releasing property is also described. The public is required to be notified annually of property released from PNNL facilities. This notification is done through issuance of an Annual Site Environmental Report.

In September 2012, PNNL issued revisions to its radiation protection procedures to implement DOE Order 458.1 to include more detailed guidance on 1) the environmental ALARA program, 2) use of process knowledge and historical knowledge when releasing property, 3) preparation and approval of authorized limits requests, and 4) preparation of an Annual Site Environmental Report.

2.7.3 DOE Order 435.1

The purpose of DOE Order 435.1, "Radioactive Waste Management," is to establish requirements to ensure DOE radioactive waste is managed in a manner that is protective of worker and public health and

safety, and the environment. The Order takes a "cradle-to-grave" approach to managing waste and includes requirements for waste generation, storage, treatment, disposal, and post-closure monitoring of facilities.

Radioactive waste shall be managed such that the requirements of other DOE Orders, standards, and regulations are met, including the following:

- 10 CFR 835, "Occupational Radiation Protection"
- DOE Order 440.1A, "Worker Protection Management for DOE Federal and Contractor Employees"
- DOE Order 450.1A, "Environmental Protection Program"
- DOE Order 5400.5, Chg 2, "Radiation Protection of the Public and the Environment."

DOE Order 435.1 establishes requirements for the management of high-level waste, transuranic waste, and low-level waste. It also covers mixed waste (i.e., high-level waste, transuranic waste, and low-level waste that also contain chemically hazardous constituents). DOE Order 435.1 (approved in 1999) superseded a previous set of requirements (DOE Order 5820.2A, dated September 26, 1988) for managing radioactive waste. DOE Order 435.1, Chg 1, approved in 2001, includes minor revisions to the original Order.

PNNL's Radioactive Waste Management Basis Program Description identifies the hazards associated with radioactive waste management at PNNL along with their potential impacts. Controls for the protection of the public, workers, and the environment are also presented. Controls are implemented through PNNL "How Do I" workflows and waste management internal procedures.

2.7.4 *Atomic Energy Act of 1954*

The *Atomic Energy Act of 1954* was promulgated to ensure the proper management of radioactive materials. The Act and its amendments include provisions to delegate the roles and responsibilities for the control of radioactive materials and nuclear energy primarily to DOE, the NRC, and EPA. Through the Act, DOE regulates the control of radioactive materials under its authority, including the treatment, storage, and disposal of low-level radioactive waste from its operations. Sections of the Act authorize DOE to establish radiation protection standards for itself and its contractors. Accordingly, DOE promulgated a series of regulations (e.g., 10 CFR 820, 10 CFR 830, and 10 CFR 835) and directives (e.g., DOE Order 435.1, Chg 1 [Section 2.7.3] and DOE Order 5400.5, Chg 2 [Section 2.7.1]) to protect public health and the environment from potential risks associated with radioactive materials. PNNL operations are subject to the requirements in these regulations and directives. PNNL complies with the *Atomic Energy Act of 1954* through its Radiation Protection Management and Operation Program.

In 2011, DOE Order 458.1, "Radiation Protection of the Public and the Environment" and DOE Guide 441.1-1C, Change 1, "Radiation Protection Programs Guide for Use with 10 CFR 835, Occupational Radiation Protection" were revised.

2.8 Major Environmental Issues and Actions

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Releases of radioactive and regulated materials to the environment are reported to DOE and other federal and state agencies as required by law. The specific agencies notified depend on the type, amount, and location of each release event. This section describes the significant releases or potential releases to the environment that occurred on the PNNL campus during CY 2011.

2.8.1 Continuous Release Reporting

A continuous release is a hazardous release exceeding reporting thresholds under CERCLA (Section 2.5.2) that is "continuous" and "stable in quantity and rate" where reduced reporting requirements apply. PNNL did not have any continuous releases in 2011.

2.8.2 Unplanned Releases

On August 26, 2011, a flow exceedance occurred at the outfall to the City of Richland sewer. The amount of effluent released exceeded the amount authorized in any 24-hour period under the PNNL industrial wastewater permit (CR-IU001). Investigations revealed that a sand filter had failed causing the increased flows. The City of Richland was notified of the exceedance. Follow-up sampling demonstrated that the excess wastewater did not threaten human health or the environment.

2.9 Summary of Permits

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Table 2.6 summarizes air, liquid, and hazardous waste permits for PNNL during 2011.

Table 2.6. PNNL Air, Liquid, and Hazardous Waste Permits, 2011

Issuer	Permit #	Location(s) Regulated	Activity(ies) Regulated	Expiration Date[a]
Air Emissions				
Washington State Department of Ecology	FF-01[b]	PNNL-occupied locations on Hanford Site	Radioactive Air Emissions	12/31/2017
Washington Department of Health	RAEL-05	PNNL Site	Radioactive Air Emissions	6/24/2015
Washington State Department of Ecology	00-05-006	PNNL-occupied locations on Hanford Site	Nonradioactive air emissions	1/1/2012
Washington Department of Health	WN-L027-1	Battelle North Richland facilities	Radioactive materials possession and radioactive air emissions	8/31/1992
Benton Clean Air Authority	Order 2007-0013	PNNL Site	Nonradioactive air emissions	None
Benton Clean Air Authority	Order 98-01	Battelle North Richland facilities	Nonradioactive air emissions	None
Liquid Effluents				
City of Richland	CR-IU001	Battelle North Richland facilities	Liquid effluent discharges to city sewer	3/31/2015
City of Richland	CR-IU005	W.R. Wiley Environmental and Molecular Sciences Laboratory	Liquid effluent discharges to city sewer	1/9/2012
City of Richland	CR-IU011	Physical Sciences Facility (new buildings north of Horn Rapids Road)	Liquid effluent discharges to city sewer	12/31/2014
City of Richland	CR-IU010[b]	PNNL-occupied locations in Hanford Site 300 Area	Liquid effluent discharges to city sewer	10/20/2016
Washington State Department of Ecology	ST 4511[b]	PNNL-occupied locations in Hanford Site 300 Area	Discharge of wastewater from maintenance, construction, and hydro testing activities; allows for cooling water, condensate, and industrial stormwater discharges to ground	2/16/2010
Washington State Department of Ecology	ST-9251	Battelle North Richland facilities	Reuse of cooling water for irrigation	6/30/2015
Washington State Department of Ecology	ST-9274	Biological Sciences Facility and Computational Sciences Facility	Reinjection of well water used in ground-source heat pump	6/4/2015
Hazardous Waste				
Washington State Department of Ecology	WA7890008967	325 Hazardous Waste Treatment Units (located in the 300 Area)	Treatment and storage of dangerous waste (primarily mixed waste)	9/27/2004

(a) Expired permits generally remain in force while renewal applications are processed by the issuing agency.
(b) Permit issued to DOE-Richland Operations Office and/or its contractor(s); PNNL is obligated to comply with these permits through an operating agreement between the DOE-Richland Operations Office and PNSO.

3.0 Environmental Management System

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PNNL is committed to providing a safe and healthy working environment for all staff; protecting the general public and the environment from unacceptable environmental, safety, and health risks; and operating in a manner that protects and restores the environment. PNNL uses the ISO 14001 Environmental Management System as a tool to manage, control, and measure environmental impacts (ISO 14001:2004). The purpose of the Environmental Management System is to achieve and demonstrate environmental excellence by assessing and controlling the impact of PNNL activities, R&D projects, and facilities on the environment, public, and employee health and safety. The ISO 14001 Environmental Management System is designed to help improve environmental performance, provide for compliance with the law, improve efficiency and effectiveness, reduce costs, and earn and retain regulator and community trust.

The cornerstone of PNNL's ISO 14001 Environmental Management System is an environmental policy:

> *At the Pacific Northwest National Laboratory, we value human life above all else and strive to provide a workplace free of occupational injuries and illnesses. We value the environment and strive to protect it, the public, and future generations from unacceptable risks resulting from its operations. PNNL fulfills these commitments through active identification, evaluation, prevention, and management of hazards and by striving to comply with the letter and spirit of all environmental, safety, and health laws and regulations.*

PNNL has a mature, robust Environmental Management System that was established in 1996 and since 2002 has maintained ISO 14001 certification, which has included yearly third-party verification. Auditing has verified that the PNNL Environmental Management System is fully integrated into its Integrated Safety Management System and meets the requirements of DOE Orders 430.2B and 450.1A, and subsequently applicable portions of DOE Order 436.1 via a PNNL contract modification. Therefore, PNSO was able to declare PNNL in conformance with DOE Order 450.1A. The 2011 Environmental Management System Scorecard developed by PNSO rates PNNL's performance for all performance metrics as "Green," which is the highest ranking.

3.1 Environmental Performance Measurements

PNNL has examined its operations to determine which categories of environmental impacts (referred to as "aspects" in the ISO 14001 standard) have the greatest potential to occur and hence are most deserving of attention and control through the Environmental Management System. The aspects identified are shown below along with the controls the Environmental Management System uses to minimize the potential impact of those aspects.

Chemical Use and Storage. As a research laboratory, PNNL has many buildings where chemicals are stored and used during research operations and maintenance activities. Controls used to avoid potential hazards include training, inventory control procedures, approvals for chemical ordering, and procedures for conducting work with chemicals that include safety requirements.

Regulated Waste Generation. The use of chemical and radioactive materials, along with normal maintenance activities, creates some waste streams that are regulated as dangerous waste, radioactive waste, or both dangerous and radioactive (mixed waste). These wastes are subject to regulations of the Washington State Department of Ecology (for dangerous and mixed waste) and DOE (for radioactive and mixed waste). Along with the controls imposed by these requirements, PNNL seeks to reduce the amount of these waste types generated by reviewing projects to reduce or eliminate the use of materials that will cause a project's waste to be regulated. Generated waste is often treated to make it less hazardous or non-hazardous for disposal.

Radioactive Material Use and Storage. Some PNNL experiments involve the use of radioactive materials. Access to areas where this type of work is conducted is restricted, and those who enter must have special training. Radioactive materials are labeled and controlled, and the same types of controls used for chemical use and storage are applied to radioactive material work.

Emissions to Air. For safety reasons, many of the PNNL laboratories contain fume hoods that prevent researchers from being exposed to the materials they work with. PNNL also has air emissions from vehicle exhaust and boilers, and potential emissions from refrigeration systems, fire suppression systems, and demolition operations. Potential air emissions are evaluated, and permits are obtained when required. Controls on the management of chemicals, radioactive materials, and regulated waste are used to minimize air emissions.

Effluents to Water. PNNL seeks to minimize any water discharges to the environment. Discharges from the laboratories to sewer systems and parking lot stormwater to dry wells are regulated by state and local permits and/or regulations. These discharges are regularly reviewed to ensure that they conform to all regulations and permits.

Physical Interaction with Environment. In order to understand the environment and perform environmental monitoring, some PNNL projects are conducted outdoors. Facility maintenance and modification also may involve outdoor work. Any work proposed to be conducted outdoors is reviewed to ensure protection of the environment and minimize any potential impacts.

Energy Use. Using energy judiciously is a prime objective of the Laboratory as it seeks to minimize the impact of Laboratory operations. PNNL maintains energy reduction goals and implements actions to reduce energy consumption across the Laboratory.

Solid Waste Generation. The use of office products, electronics, and equipment, along with construction, demolition, and normal maintenance activities, creates non-regulated solid waste streams. PNNL reduces or eliminates environmental hazards, conserves environmental resources, and maximizes operational sustainability by incorporating electronic stewardship practices, reusing materials, and conducting recycling programs. PNNL also seeks opportunities to further reduce degradation and depletion of environmental resources by purchasing environmentally friendly items (e.g., items that contain recycled content).

Water Use. PNNL recognizes the value of water in the eastern Washington environment and has made water conservation a key element of its Facility Energy Management Plan. PNNL maintains water use reduction goals and implements actions to reduce water consumption across the Laboratory.

Fuel Usage. PNNL was instrumental in obtaining the first biofuel filling station in Richland, Washington. The use of petroleum-based fuels is minimized by purchasing new vehicles that use alternative fuels such as Ethanol-85 and replacing low fuel efficiency vehicles with higher fuel efficiency ones including hybrids. Bio-diesel fuel is also used for generators, where appropriate.

3.1.1 Environmental Management

The Environmental Management and Operations (M&O) Program is a major component of the PNNL's Integrated Management System. The Environmental M&O Program enables continual improvement in the area of environmental stewardship. The Environmental M&O Program performs regulatory analysis to assist staff in conducting research and operational activities that comply with regulatory and contractual requirements, recognized standards, and sustainable practices. The Environmental M&O Program also develops laboratory systems to assist staff in achieving compliance and demonstrating environmental excellence with respect to environmental and waste management requirements.

Summaries of the program reviews are described in the following sections.

3.1.1.1 Waste Management Programs

Biological Waste Management. The Biological Waste Management Program supports Laboratory compliance with disposal of biological waste items through federal Worker Safety and Health Programs (10 CFR 851). The Biological Waste Management Program provides the procedures and oversight to allow biological waste handlers to package and ship waste to the appropriate treatment or disposal facility. In 2011, there were no biological waste management issues: no issues were identified during annual assessments of biological work permits or semi-annual walkthroughs of laboratory spaces.

Hazardous Waste Management. The Hazardous Waste Management Program documents all hazardous waste activities and operations to demonstrate that the hazards and liabilities associated with hazardous waste management at PNNL have been identified, their potential impacts analyzed, and the necessary controls are in place for protection of the public, workers, and the environment. The program also provides hands-on management of hazardous waste at PNNL.

Each year the Material Field Services Manager, Material and Waste Operations Manager, and RCRA subject matter experts review documented assessments for issues that might put PNNL at a compliance risk. Assessments have been performed according to schedule and no significant issues have been noted.

Polychlorinated Biphenyls Waste Management. The PCB Waste Management Program provides regulatory support to PCB management activities and operations including the management of waste containing Hanford tank samples. Hazards and liabilities associated with PCB waste management at PNNL are identified, their potential impacts analyzed, and the necessary controls are put in place for protection of the public, workers, and the environment. No events regarding PCB waste and no PCB transportation issues were identified in 2011.

Radioactive Waste Management. The Radioactive Waste Management Program documents radioactive waste activities and operations to show that the hazards and liabilities associated with radioactive waste management at PNNL have been identified, their potential impacts analyzed, and the

necessary controls are in place for protection of the public, workers, and the environment. The program also provides hands-on management of radioactive waste at PNNL. In 2011, no concerns were identified.

The DOE Consolidated Audit Program conducts annual audits of commercial waste treatment, storage, and disposal facilities. First formulated in the mid-1990s, the program is currently administered by the Office of Health, Safety and Security, Office of Corporate Safety Programs. The intent of this corporate departmental program is to eliminate redundant audits, previously conducted independently by DOE field element sites, and achieve standardization in audit methodology, processes, and procedures. Seven annual audits are conducted at commercial treatment, storage, and disposal facilities accepting DOE low-level radioactive and mixed waste. Four annual audits are conducted at commercial treatment, storage, and disposal facilities accepting nonradioactive waste.

As part of the Waste Storage Areas Assessment Program, Material Field Services, Material and Waste Operation, and Environmental Protection and Regulatory Program staff perform assessments on hazardous, low-level waste, and mixed waste in storage from the point of generation to the treatment, storage, and/or disposal facilities. Assessments include a combination of staff performing weekly, monthly, and bi-annual assessments. These assessments are documented and all issues are closed out during the assessment or tracked through completion using the Integrated Tracking System.

Treatment by Generator. The Treatment by Generator Program provides regulatory guidance, technical support, and activity tracking for Treatment by Generator operations in compliance with WAC 173-303, "Dangerous Waste Regulations," and Washington State Department of Ecology Technical Information Memorandum 96-412, "Treatment by Generator," and fact sheets referenced therein (Ecology 2012).

Treatment by Generator data have been prepared and submitted to the Environmental Protection and Regulatory Program on schedule for inclusion in the RCRA annual report. In 2011, there were no issues related to Treatment by Generator operations.

Waste Pending Analysis. The Waste Pending Analysis Program ensures management of unknown/uncharacterized wastes in compliance with WAC 173-303, "Dangerous Waste Regulations," Washington State Department of Ecology Technical Information Memorandum 82-5, "Effective Date of the 90-Day Storage (Accumulation) Requirement" (Ecology 2000).

The Waste Pending Analysis Program receives and evaluates the results from the following ongoing activities:

- assessment of the quality and timeliness of Waste Pending Analysis data in the Integrated Waste Management System and the safe and compliant accumulation of Waste Pending Analysis waste in research laboratories on a bi-annual schedule.
- quarterly walkthroughs of all waste accumulation areas, including Waste Pending Analysis waste storage areas.
- inspection of Waste Pending Analysis waste accumulation areas every week by Materials Field Services staff.

There were no uncharacterized wastes identified during 2011.

3.1.1.2 Material Management Programs

Controlled Substances. The Controlled Substances Program manages controlled substances and related chemical precursors in accordance with applicable U.S. Drug Enforcement Administration and Washington State Board of Pharmacy regulations. Programmatic responsibilities include verification and maintenance of registrations, inventory, security, and reporting requirements. All orders and proposed acquisitions of controlled substances are reviewed and approved by the Controlled Substance Coordinator upon verification that the substance can be legally acquired.

- **Washington State Board of Pharmacy Inspections**. An investigator from the Washington State Board of Pharmacy performs a biennial onsite inspection of controlled substance security, inventory, and recordkeeping for current registrations. The investigator also performs onsite inspections prior to issuing new Washington State Board of Pharmacy registrations. In 2011, there were no findings or adverse observations.
- **Biennial Inventories**. The controlled substance registrant is required by the Drug Enforcement Administration and the Washington State Board of Pharmacy regulations to perform biennial inventories of on-hand controlled substances. The Controlled Substance Coordinator participates in these biennial inventories and verifies that inventory records match on-hand inventories. In 2011, biennial inventories were performed and inventory records matched on-hand inventories. No deficiencies were identified.

***Emergency Planning and Community Right-to-Know Act of 1986* Reporting**. The reporting and compliance function for the EPCRA focuses on the monitoring and reporting (when necessary) of chemical inventories used by PNNL. Reporting to local, state, and federal authorities is triggered by chemical inventory or usage that exceeds the threshold quantities given in EPCRA regulations. EPCRA 302 reporting is triggered by chemical inventory exceeding a given threshold and is filed within 30 days of exceedance; there was no exceedance in 2011. An EPCRA 312 report is provided on an annual basis for quantities of chemicals being used. The 2011 Tier Two Emergency and Chemical Inventory report was submitted February 28, 2012.

EPCRA 313 reporting is prepared annually, if required for releases to the environment from covered facilities. An EPCRA 313 report was not required in 2011, because no chemical was in excess of its threshold quantity.

Pollution Prevention. The PNNL P2 Program shows its dedication to PNNL's Environmental Stewardship Policy by helping staff prevent or minimize pollutants (non-hazardous, hazardous, radioactive, etc.) to all media (air emissions, liquid effluents, and solid waste). The program also seeks opportunities for resource conservation, recycling, energy efficiency, water conservation, and purchasing environmentally preferable products and services. An annual pollution prevention plan is prepared and submitted to the Washington State Department of Ecology in accordance with WAC 173-307-070 and the annual guidance letter. In addition, a PNNL Site Sustainability Plan identifying Laboratory's sustainability projects status and accomplishments related to DOE's sustainability goals is prepared and submitted to DOE annually in accordance with DOE's guidance. The PNNL Site Sustainability Plan includes P2 activities, accomplishments, and continuous improvement opportunities.

***Toxic Substances Control Act* Import/Export**. The Toxic Substances Control Act Program provides the appropriate certifications and technical support to staff for the importation of *Toxic Substances*

Control Act chemicals into the laboratory. Incoming shipments of toxic substances are required to have a of *Toxic Substances Control Act* certification accompanying the incoming shipment. On occasion these certifications may be lost during transport, or inadvertently not provided by the shipper. In 2011, no incoming shipments were delayed more than 24 hours and certifications were satisfactory.

Underground Storage Tanks. The Underground Storage Tank Program helps PNNL address the threat posed to human health and the environment from a leaking underground storage tank by facilitating compliance with federal and state requirements. The highest risk aspect of this program is the discharge of a regulated substance from the tanks to the environment, which could contaminate the groundwater. Programmatic controls include weekly leak detection testing of tanks and automated continuous monitoring of the underground storage tank system. Any off-normal operation of the underground storage tank system will trigger a system alarm. In 2011, no off-normal operations were detected and there was no confirmed release to the environment from an underground storage tank.

3.1.1.3 Transportation Programs

Hazardous Material, Type B/Fissile Material, and Waste Transportation. The Hazardous Material Transportation and Packaging Program supports PNNL compliance with international and federal hazardous (including radioactive) material transportation requirements including those of the U.S. Department of Transportation, International Civil Aviation Organization, International Air Transport Association, and DOE. This program provides the procedures, training, and oversight to allow qualified shippers to ship hazardous material worldwide, to ship hazardous waste to the appropriate treatment or disposal facility, and in limited cases, to train and authorize staff to perform their own shipments with minimal interaction from the shippers. DOE Order 232.2, "Occurrence Reporting and Processing of Operations Information," contains the criteria for which reporting is required under the Occurrence Reporting System. Group 8 occurrences are related to packaging and transportation. In 2011, DOE changed the reporting criteria to include a number of minor issues that were not previously reportable. The Environmental Protection and Regulatory Program tracks occurrences on a quarterly basis. In 2011, there were no Group 8 occurrences (based the old criteria) and no impacts or disruption to the receiving organization's operation.

DOE Order 460.2A, Attachment 2, "Contractor Requirements Document," requires a self-assessment of transportation and packaging operation at least every 3 years; DOE may implement its Transportation Safety and Operations Compliance Assurance Program reviews in support of this requirement. The *Hanford Sitewide Transportation Safety Document* (DOE/RL 2002b) requires that each contractor conduct an annual management assessment of its transportation and packaging safety program. An internal PNNL transportation and packaging quality assurance plan requires that type B and fissile material activities be audited at least annually consistent with the *Quality Assurance Guidance for Packaging of Radioactive and Fissile Materials* (DOE 2010). All of these audits are led by an independent auditor from PNNL's quality assurance organization. PNNL completed a Transportation Compliance Assurance Program-equivalent self-assessment in FY 2011. Minor issues were identified and corrected.

3.1.1.4 Effluent Management Programs

Chemical Air Emissions. The Chemical Air Emissions Program facilitates compliance with applicable federal, state, local, and DOE requirements, and controls emissions to levels protective of the

public, staff, and environment while minimizing impacts on research and facility operations. In 2011, no events were reported for air emissions of regulated substances or substances of concern above de minimis rates.

Liquid Effluents. The Liquid Effluent Program facilitates compliance with applicable federal, state, local, and DOE requirements by monitoring the quantity and quality of liquid effluent discharges. Each waste stream is reviewed prior to discharge to make certain that the public, PNNL staff, and the environment are protected. The primary risk associated with liquid effluent discharges to sewer systems, ground, or surface water is the potential exposure of contaminants at concentrations above levels known or expected to be protective of the public, PNNL staff, or the environment. Other risks associated with liquid effluent discharges are requirements implementation, management, and compliance.

To ensure that all work complies with discharge permits, each R&D project and facility activity is reviewed and compared to regulatory limits and conditions. If applicable, guidance and requirements are provided to staff to help them comply with the permits. Permits issued by either the Washington State Department of Ecology or the City of Richland require a demonstration of compliance. This is accomplished through periodic sampling and monitoring, sample analysis, and reporting. Sampling, monitoring, and sample analysis provide the data used to determine whether discharges to sewer, ground, or to surface water meet permit requirements and regulatory limits. Calibration, maintenance, and proper operation of sampling and monitoring equipment assist in providing data that are valid and accurate. Routine discharge monitoring reports, notices, and/or certifications document compliance. The discharge monitoring reports document to the regulatory agency that all sampling, monitoring, and analyses have been completed as required by the permit. Notices and certifications provide documentation of permit violations, changes in wastewater characteristics, and status of operations. In 2011, required reports and regulatory submittals were submitted as required and on schedule.

Radioactive Air Emissions. The purpose of the Radioactive Air Emission Program is to protect the public and the environment from airborne radioactive material emanating from PNNL operations. The program complies with state and federal regulations and implements sampling and monitoring programs, permits, and required assessments. The program also conducts administrative activities that include procedures, periodic reporting, training, and records management. The Radiological Materials Tracking System is instrumental in assessing the potential-to-emit status for specific emission units/building permits. Daily reports indicate the potential-to-emit status and when certain thresholds are reached, management involvement is required to move radioactive material into the space. The Radiological Materials Tracking System is used as a central component of demonstrating compliance with radioactive air emissions licenses (Notices of Construction) and inventory status is provided to regulators when requested during an inspection.

PNNL is required under federal law to prepare an annual report to management (Snyder et al. 2012). This report contains summary information on operational, compliance, and quality aspects of the sampling and monitoring of airborne radionuclide emissions from operations conducted by PNNL. The report is posted annually on the PNNL website.

PNNL conducts sampling and monitoring programs to establish the emissions from operations. PNNL relies on the Gaseous Effluent Database for particulate air sample data and the Rad Air Gas Database for radioactive gas emissions. A Potential Impacts Category (PIC) graded approach for sampling is in place and is used to determine the need for sampling and the sampling frequency when

required. A PIC 1 emission unit requires continuous sampling monitoring; the only PIC 1 emission unit operated by PNNL is at the Radiochemical Processing Laboratory (325 Building) in the Hanford Site 300 Area. PIC 2 emissions units require continuous sampling, PIC 3 emissions require periodic sampling, and PIC 4 emissions can have inventory assessment/management in lieu of sampling. PNNL also maintains a network of monitoring stations to confirm low emissions from the PNNL campus. Collected data are used as appropriate in annual reports.

Quantitative assessments are conducted periodically to fulfill regulatory requirements and meet quality assurance goals. Biennial independent assessments are conducted and over a 10-year period cover the entire range of the Radioactive Air Emissions Program. Internal self-assessments are conducted periodically and over a 3-year period cover the operating aspects of the program.

Engineered controls and equipment include high efficiency particulate air (HEPA) filters, fans, and sampling equipment. HEPA filters are efficiency tested each year for filtration greater than or equal to 99.95%. Periodic maintenance of fans is conducted to maintain their operability. Sampling equipment is calibrated and maintained operational to meet the minimum 90% operability requirements established by the program. HEPA filter efficiency testing and associated procedures across PNNL are aligned between organizations. Fan maintenance is conducted at appropriate intervals; Facilities and Operations and the Effluent Management Program preventive maintenance programs are coordinated.

3.1.1.5 Other Environmental Programs

Biological Resource Management. The Biological Resource Management Program supports PNNL compliance with the *Endangered Species Act of 1973* and *Migratory Bird Treaty Act*, arranges for control of noxious weeds in compliance with RCW 17.10 "Noxious Weeds – Control Board," and conducts an annual survey of the vegetation and wildlife of the undeveloped portion of the PNNL Site in accordance with the requirements of the DOE PNSO Cultural and Biological Resources Management Plan (DOE/PNSO 2008).

The Biological Resource Management Program oversees monitoring of current biological conditions of the PNNL Site. This baseline biological resource information would inform restoration and rehabilitation goals in the unlikely event of a wildfire on the site. It is also used to identify the potential impacts of project work conducted outdoors.

Invasive and noxious weeds pose a continuing threat to the ecological integrity of the natural habitat on the PNNL Site. Control of certain weeds commonly found at the PNNL Site is also required by state law (RCW 17.10). The Biological Resource Management Program is charged with overseeing noxious weed control programs to identify and eradicate noxious weeds without significantly affecting other species. In 2011, PNNL staff with current Washington State applicator licenses hand-sprayed several species of noxious weeds on the PNNL Site. A total of approximately 10 ha (24 ac) were sprayed over 7 work days. This type of treatment is intended to significantly reduce the populations and reduce seed production. Herbicide applications in 2011 were successful in providing an initial level of control for populations of noxious weeds, including yellow star thistle (*Centaurea solstitialis*), rush skeletonweed (*Chondrilla juncea*), and diffuse knapweed (*Centaurea diffusa*); however, additional applications will be required to eradicate these plants from the PNNL Site.

Projects involving soil disturbance or work outdoors are routinely evaluated to determine their potential to affect biological resources. Ten ecological reviews were conducted for PNNL projects in FY 2011, four on the PNNL Site and six in the 300 Area. These reviews evaluated the potential project impacts on plant or animal species protected under the *Endangered Species Act of 1973*, candidates for such protection, species listed by the state of Washington as threatened or endangered, Washington State priority habitats, and bird species protected under the *Migratory Bird Treaty Act*. There were no project impacts that violated related federal or state laws, regulations, or conservation priority guidance. Projects on the PNNL Site did not affect species protected under the federal *Endangered Species Act of 1973* and bird species protected under the *Migratory Bird Treaty Act*.

The PNSO Cultural and Biological Resources Management Plan (DOE/PNSO 2008) requires an annual baseline biological survey of the PNNL Site conducted by staff not responsible for conduct of the Biological Resources Management Program. A baseline biological survey of the undeveloped portion of the PNNL Site was conducted in spring 2011. No plant or animal species protected under the federal *Endangered Species Act of 1973* were observed. Habitats and species observed in 2011 were similar to those observed in 2010. The report summarizing the results was completed in February 2012 (Becker and Chamness 2012).

Cultural Resource Management. The DOE PNSO Cultural Resources Management Program supports PNNL compliance with a number of federal laws governing management of cultural resources including *National Historic Preservation Act of 1966*, the *Archaeological Resources Protection Act of 1979*, and the *Native American Graves Protection and Repatriation Act of 1990*. Program activities include performing Section 106 reviews of all ground-disturbing federal activities conducted on the PNNL Site or associated with PNNL facilities, and monitoring cultural resources conditions on the PNNL Site to verify that important cultural resources are protected. Section 106 cultural resources reviews are conducted of all federal undertakings to identify their potential to affect cultural resources. The Section 106 review process results in one of four outcomes: 1) No Potential to Cause Effects, 2) No Historic Properties Affected, 3) No Adverse Effect, or 4) an Adverse Effect. Six Section 106 cultural resource reviews were conducted for PNNL projects in FY 2011, three on the PNNL Site and three in the 300 Area. The reviews resulted in the following determinations: three reviews with No Potential to Cause Effect, two with No Historic Properties Affected, and one with No Adverse Affect.

To ensure that important cultural resources are protected on the PNNL Site, the PNSO Cultural and Biological Resources Management Plan (DOE/PNSO 2008) provides for annual monitoring of three eligible properties to identify potential threats and recommend appropriate actions. Trip results are analyzed and reported to local Tribes and the State Historic Preservation Office. A cultural resources monitoring trip was conducted on November 17, 2011; the trip report was distributed within 7 days of the monitoring trip. Three archaeological sites were visited; no concerns were identified at one site and minor erosion of unvegetated slopes and recent rodent activity were noted at a second site. Several concerns were identified at one site, including 1) a small unvegetated patch, 2) exposure and shredding of cloth barrier emplaced during site reseeding, 3) a new coyote hole under the north boundary fence, 4) impacts on native vegetation from an off-road driving incident, and 5) an unlocked gate on the road accessing the site. All concerns were considered minor except for the off-road driving incident and unlocked gate. These areas will be monitored more closely in the future, a lock and access controls were placed on the gate, and cultural resources briefings for those with site access are now required.

Emergency Preparedness. The Emergency Preparedness Program was established to meet the conditions of DOE Order 151.1C, "Comprehensive Emergency Management System," as well as federal and state regulations to protect worker and public health and safety and the environment in the event of an emergency at or affecting a PNNL-managed facility. PNNL is required to address the applicable program elements of DOE Guide 151.1-3, "Programmatic Elements, Appendix D," through an annual self-assessment. Selected criteria of each applicable program element are to be addressed each year, such that all criteria of the applicable program elements are assessed every 5 years. An internal self-assessment of emergency preparedness at PNNL was conducted during June through August 2011 to verify compliance with applicable state and federal regulations and DOE Orders as defined in the PNNL Emergency Management Program. The results of this assessment indicate that PNNL effectively implemented the Emergency Preparedness program element criteria.

International Organization for Standardization Environmental Management System. The purpose of the Environmental Management System is to achieve and demonstrate environmental excellence by assessing and controlling the impact of PNNL activities, R&D projects, and facilities on the environment, public, and employee health and safety. At PNNL, the ISO 14001 Environmental Management System is used as a tool to manage, control, and measure environmental impacts. Potential environmental impacts from laboratory operations are identified and controlled using several methods. The ISO 14001 Environmental Management System is designed to help improve environmental performance, provide for compliance with the law, improve efficiency and effectiveness, reduce costs, and earn and retain regulator and community trust. PNNL's Environmental Management System was first registered to the ISO 14001:1996 Standard in November 2002, and received registration to ISO 14001:2004 in December 2005. To maintain PNNL's registration, annual audits are conducted by third-party auditors and the ISO 14001 registrar to verify the performance of PNNL's Environmental Management System.

NEPA Compliance. The PNNL NEPA Compliance Program supports compliance with NEPA and the Washington State's SEPA. Program activities include preparing site-wide categorical exclusions, project-specific categorical exclusions, environmental assessments, and Washington State SEPA checklists. NEPA reviews of PNNL activities are conducted by PNSO and DOE-Richland Operations Office NEPA compliance staff. The DOE office responsible for concurring with and approving the NEPA documentation depends on the proposed project location and source of funding. NEPA compliance is verified through assessments conducted by PNNL and DOE. An annual self-assessment of facility maintenance activities is conducted in the spring for activities during the previous year. This form of review is conducted because there are usually more than 15,000 routine maintenance activities conducted annually, and maintenance activities are typically conducted with little specialized Facilities and Operations planning support or environmental review support. The annual self-assessment summarizing facility maintenance activities in 2011 was completed in July 2012.

A self-assessment of the PNNL NEPA Compliance Program is conducted every year in accordance with the internal document "Self-Assessment Procedure." The self-assessment focuses on NEPA reviews performed by Environmental Compliance Representatives or data mining of electronic tools such as the Electronic Prep and Risk System, Facilities and Operations facility-modification permits, or EMSL user proposals. Overall performance, trends, and common errors are identified, and results are focused on ways to improve the overall program and to communicate useful tips and innovative techniques used in one facility or organization to the larger organization for possible adoption. The annual self-assessment for FY 2011 was conducted in March 2012 and it identified opportunities for improvement. Since

October 2011, the NEPA subject matter expert has been meeting with the Environmental Compliance Representative monthly to discuss NEPA-related regulation changes and any associated NEPA documentation errors that may occur. An informal assessment of Environmental Compliance Representative NEPA reviews from October to December 2011 did not identify any issues.

3.1.2 Environmental Sustainability

J Su-Coker

The PNNL Site developed its initial sustainability plan in 2010 (Olson et al. 2010). The plan was revised in 2011 (Richards et al. 2011) and describes the energy management program and identifies planned energy efficiency, water conservation, transportation fleet management, and sustainable buildings activities as required by DOE Orders 430.2B and 450.1A and Executive Orders 13423 and 13514.

PNNL has a comprehensive approach to advance the DOE sustainability mission with a diverse approach and a concentrated effort towards the goals of FY 2020 and beyond. The plan includes practical actions that can be taken to save energy and money, improve the comfort and productivity of employees, and benefit the environment.

Greenhouse Gas Emissions. In FY 2011, PNNL reduced its combined Scope 1, 2, and 3 GHG emissions by 1.7% compared to 2010 (Figure 3.1).

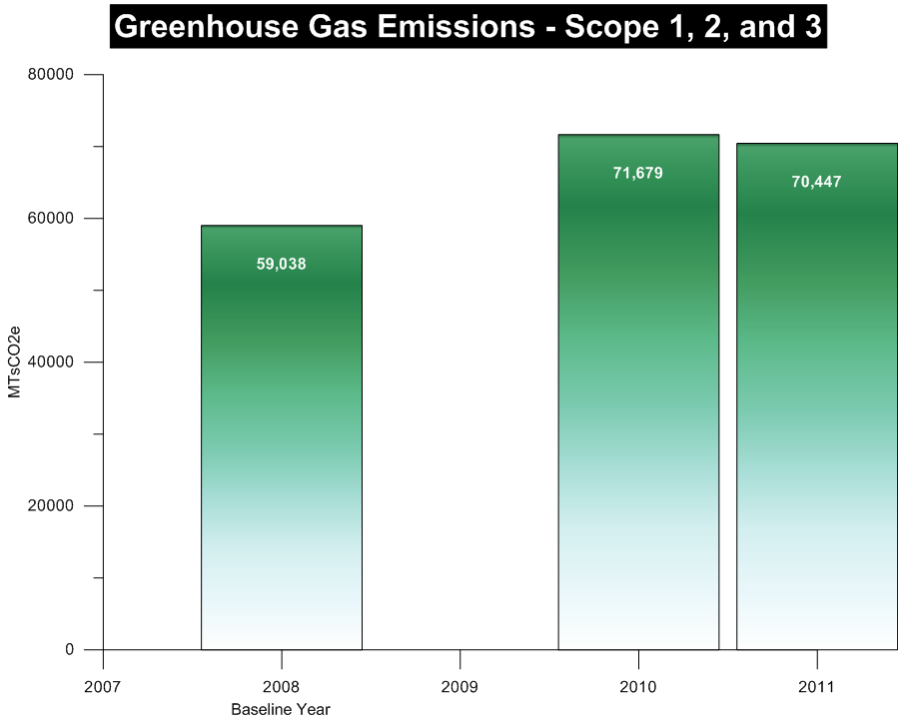

Figure 3.1. Greenhouse Gas Emissions on the PNNL Campus, Excluding Battelle Private Buildings. (Note: Data were not collected for 2009.)

Energy Intensity Reductions. Between FY 2003 and FY 2011, energy efficiency projects, operational improvements, and transitioning of work from aging to modern facilities have helped offset

energy use increases from additional staff and equipment. At the end of FY 2011, energy intensity reduction at PNNL was approximately 21.6% toward the 30% energy intensity reduction goal (Figure 3.2).

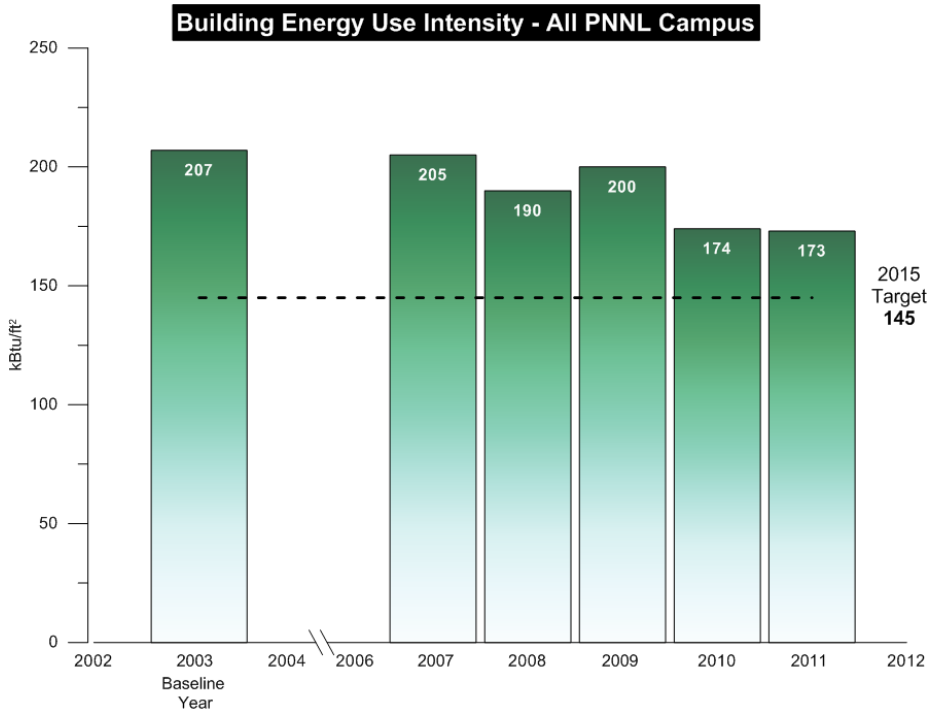

Figure 3.2. PNNL Building Energy Use Intensity, 2011. (Note: Data collection was not required for 2004 to 2006.)

Potable Water Use. The FY 2020 26% water intensity reduction goal was achieved during FY 2011. Implementation of water-saving projects, a significant reduction of potable water used for irrigation at the 331 Building, and operational improvements from advanced meters contributed to an overall water intensity reduction of 53% compared to the FY 2007 baseline (Figure 3.3).

High-Performance Sustainable Buildings. In the area of high-performance sustainable buildings, we have matched and exceeded DOE's goal for 15% of existing buildings, thereby meeting the five guiding principles:

- Employ integrated design principles
- Optimize energy performance
- Protect and conserve water
- Enhance indoor environmental quality
- Reduce environmental impact of materials.

Currently, 25% of PNNL buildings meet the high-performance sustainable building goal. In FY 2012, PNNL will certify three additional buildings and plans include certification of two additional buildings by FY 2013.

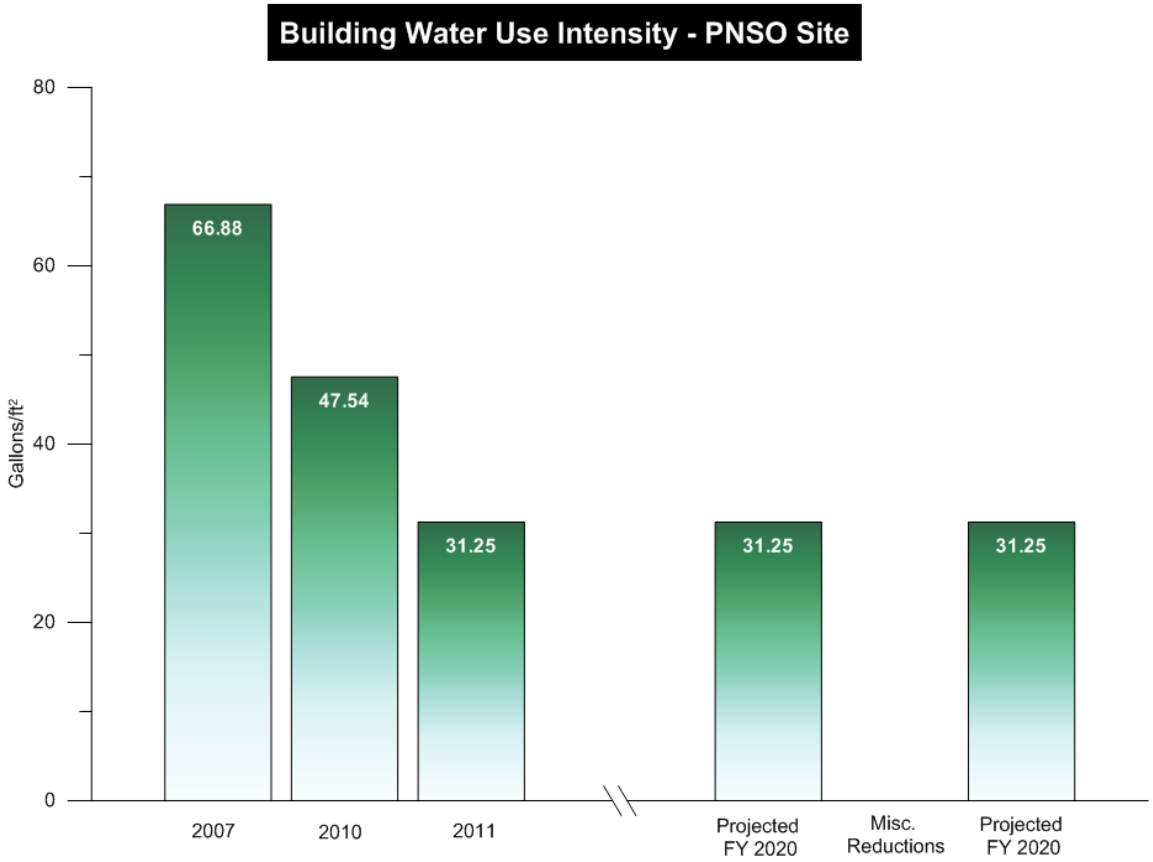

Figure 3.3. 2011 Potable Water Use on the PNNL Campus, Excluding Battelle Private Buildings

Renewable Energy. An onsite 125-kW photovoltaic array operated during FY 2011, providing electricity to the PNNL super-computing facility and adjacent car-charging stations. In FY 2011, the photovoltaic array produced 136.3 MWh of electricity. PNNL will work with regional and federal stakeholders in FY 2012 to evaluate opportunities for a large-scale renewable power project on federal land (the Northwest Energy Initiative).

Fleet Management. PNNL has achieved both the alternative fuel use (Figure 3.4) and petroleum-based fuel use targets for FY 2011 (Figure 3.5).

PNNL has reduced the number of federal fleet vehicles in inventory to 15% below the 2005 baseline, and is on track to achieve the goal of a 35% reduction by 2013 (Figure 3.6). While eliminating aging, less efficient vehicles, PNNL is meeting operational needs with alternative fuel and electric vehicles. In recent years, more than 75% of the light-duty vehicle acquisitions (purchased and leased) have been alternative fuel vehicles capable of using E85 biofuel as an alternative to gasoline.

PNNL also has added 10 low-speed electric vehicles to the fleet for on-campus transportation needs, and plans to add another 5 to 10 low-speed electric vehicles in the next year. To support the growing fleet of electric vehicles, solar-powered electric vehicle charging stations have been installed in the EMSL parking lot and across the main campus.

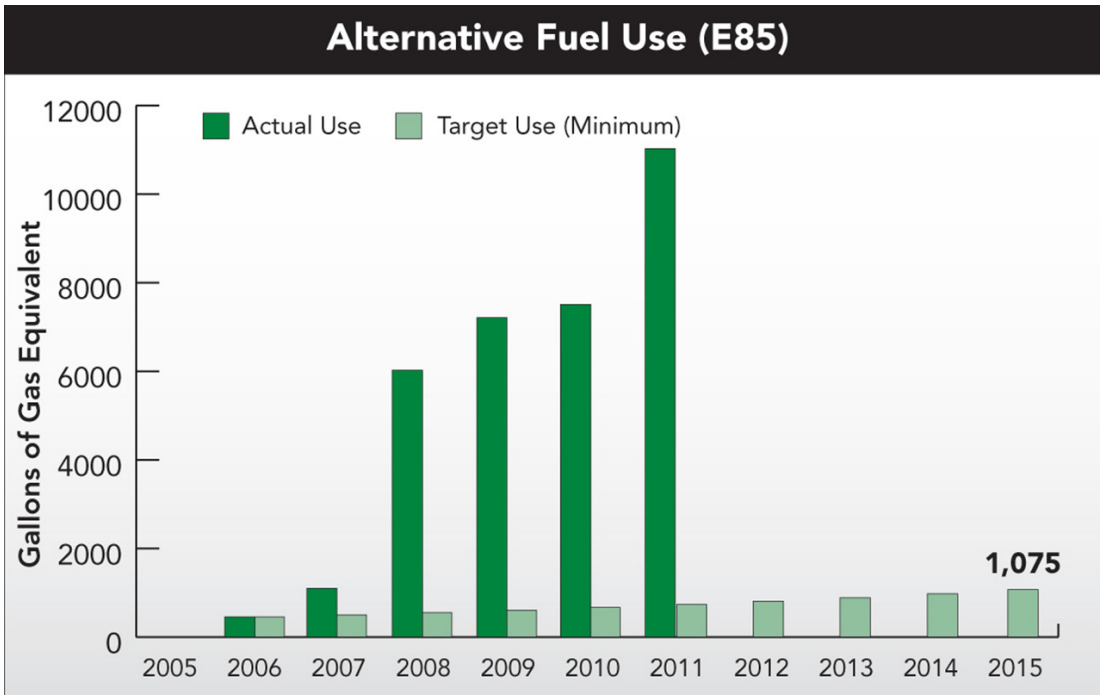

Figure 3.4. Alternative Fuel Use 2011 (federal fleet only)

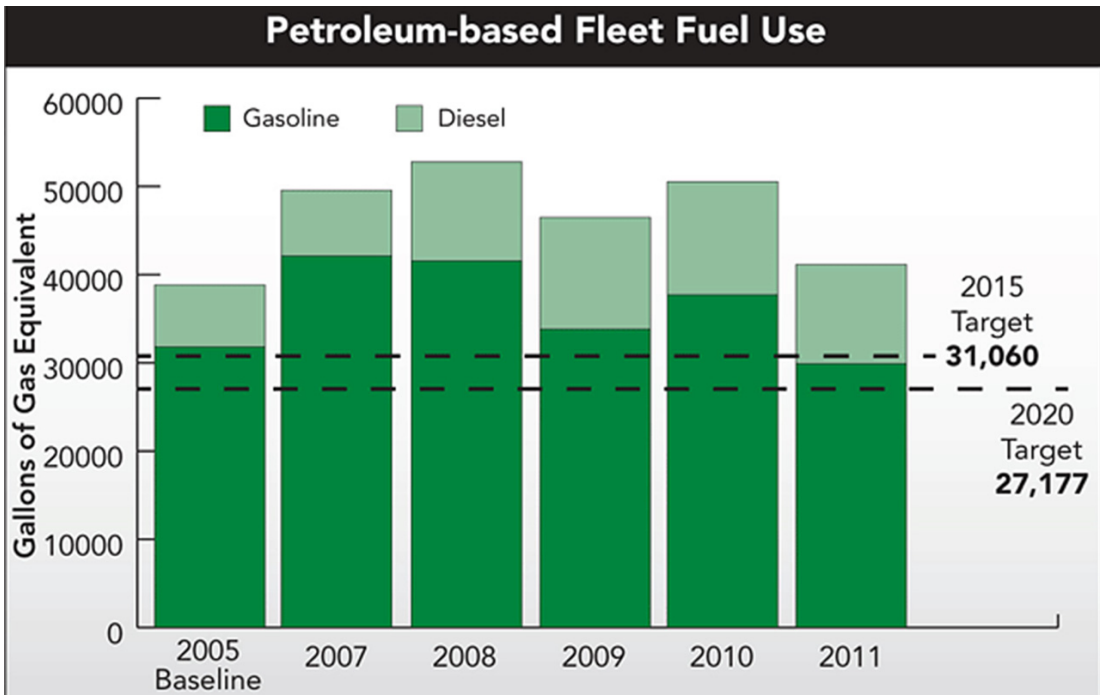

Figure 3.5. Petroleum-Based Fleet Fuel Use at PNNL (federal fleet only), 2011

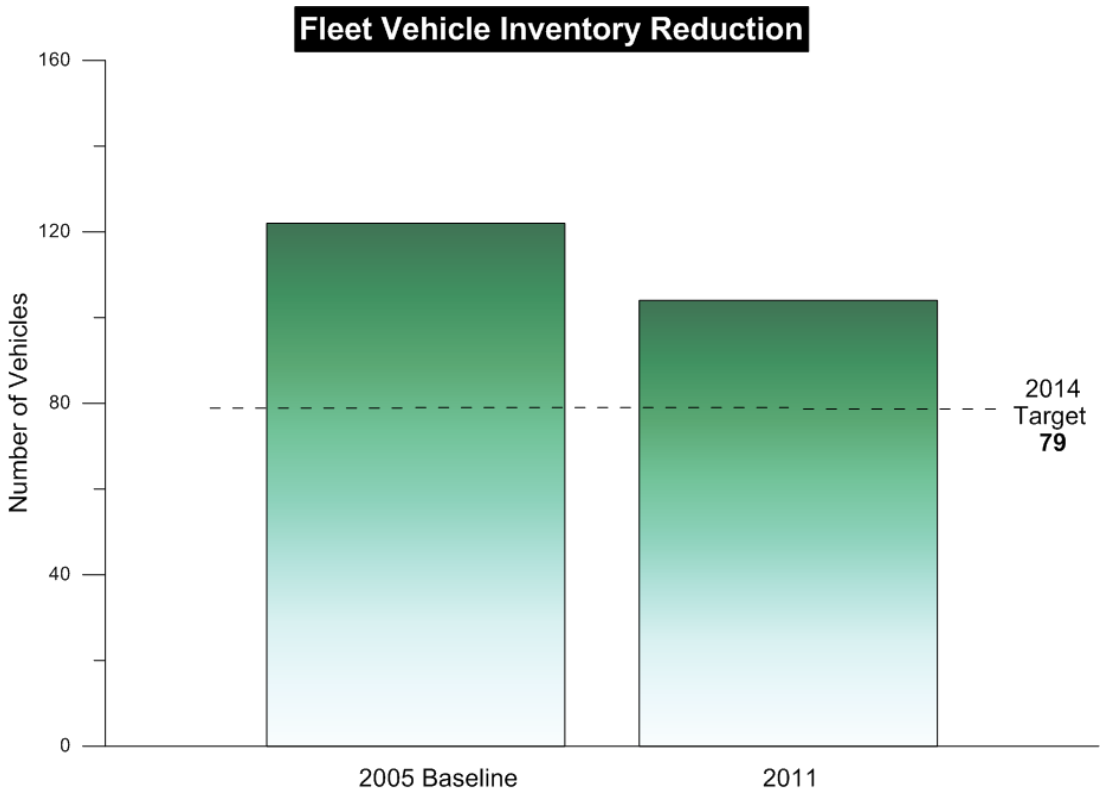

Figure 3.6. PNNL Fleet Vehicle Reduction (federal fleet only), 2011

Waste Diversion. In FY 2011, PNNL achieved the requirement to divert at least 50% of all non-hazardous sanitary waste through the P2 Program (Figure 3.7). PNNL also exceeded the 50% construction and demolition waste diversion requirement through sound project planning and the recycling of scrap metal, concrete, asphalt, and miscellaneous construction debris.

Sustainable Acquisition. PNNL has revised the general provision clause with its subcontractors to include sustainable acquisition requirements. Through sustainable acquisition practices, PNNL has been able to increase the proportion of materials purchased with recycled content. Being a service-based organization, paper for printing and other uses represents one of the most important material inputs to business. PNNL monitors consumption of uncoated copy and printing papers with recycled content. An estimated 97% of all PNNL purchases of uncoated printing paper contained 30% post-consumer content in 2011 (Figure 3.8).

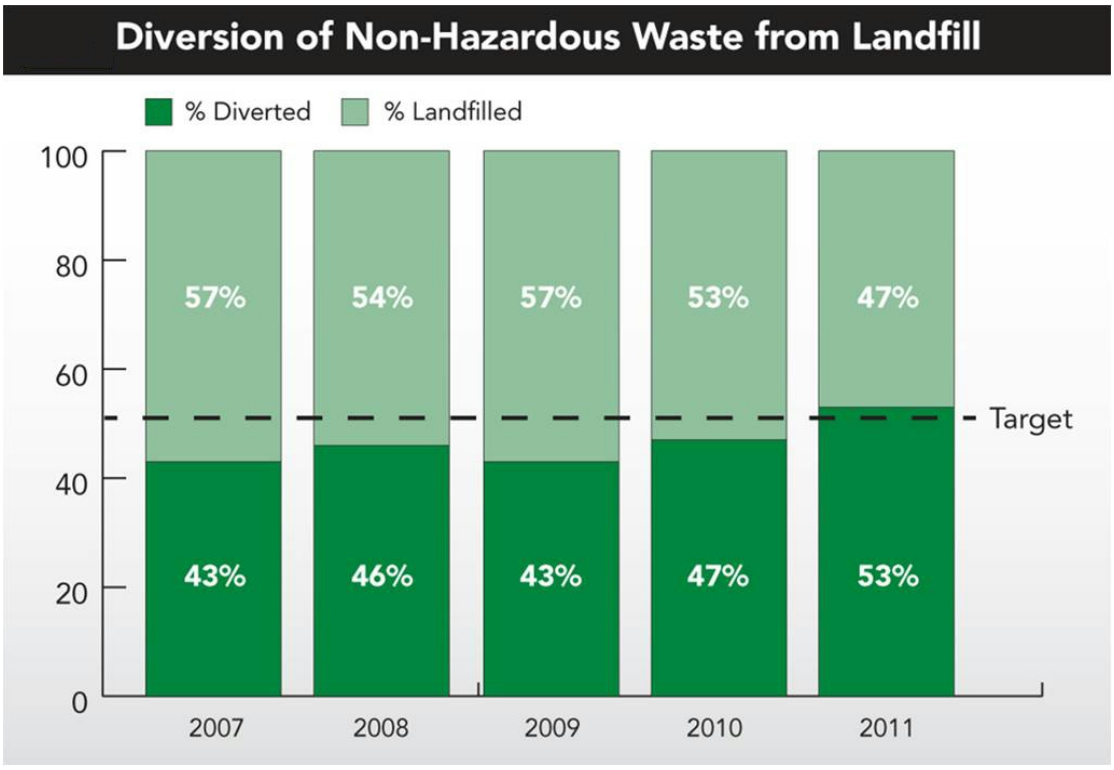

Figure 3.7. Diversion of PNNL Non-Hazardous Waste from Landfills, 2011

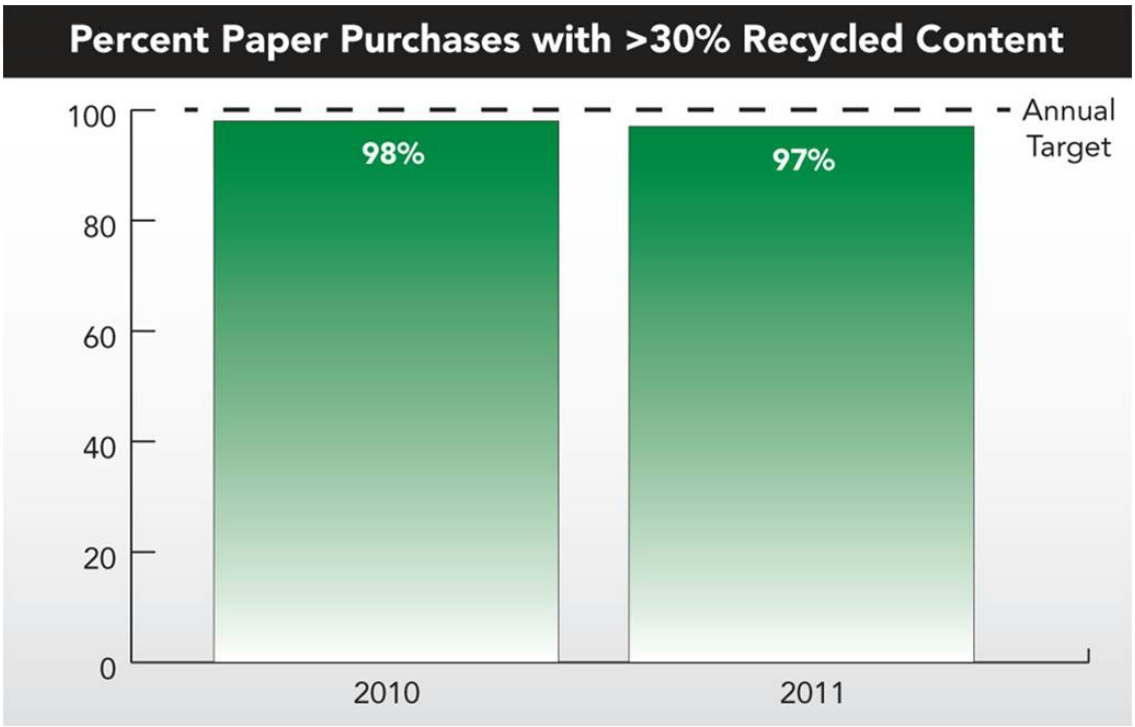

Figure 3.8. Paper Purchases with Greater than Thirty Percent Recycled Content, 2011

3.2 Awards and Recognition

PNNL received awards and recognition for environmental stewardship in 2011, including the DOE *Office of Science Best in Class Award, Greenhouse Gas Management Category* for identifying GHG abatement strategies to help reach a goal of climate neutrality (i.e., no net GHG emissions) for the PNNL campus. PNNL is now working toward implementing the most feasible of the GHG abatement strategies. PNNL also received the *Department of Energy E-STAR Award* for integrating sustainability programs into an effective and efficient operational model. The model includes a collaborative steering committee composed of research organizations, facilities, human resources, and environmental staff. A third award was the *Association of Washington Business, Environmental Excellence Award, Sustainable Communities and Green Building Category* for sustainable design of PNNL's new Biological Sciences, Computational Sciences, and Physical Sciences facilities, including efforts to identify climate neutrality strategies. In addition, PNNL received the *DOE Office of Science Best in Class Honorable Mention for Environmental Sustainability*—"Getting to the Core of Sustainability, Integrating Sustainability Programs into an Effective and Efficient Operational Model" honorable mention (Table 3.1).

PNNL also achieved re-certification to the ISO Standard—*Environmental Management Systems – Requirements with Guidance for Use* (ISO 14001:2004) in 2011. Organizations certified to the standard have developed and implemented an Environmental Management System based on ISO 14001 requirements, must pass annual external audits from an accredited registrar on a 3-year cycle, and have committed to continually improving their environmental performance.

Table 3.1. Pacific Northwest National Laboratory Awards, 2011

Award	Awarded By
Environmental Excellence Award: "Creating a Built Environment: Enhancing the Ecological and Work Environment"	Association of Washington Businesses
EStar Award: "Getting to the Core of Sustainability, Integrating Sustainability Programs into an Effective and Efficient Operational Model"	U.S. Department of Energy
Office of Science Best in Class Honorable Mention for Environmental Sustainability: "Getting to the Core of Sustainability, Integrating Sustainability Programs into an Effective and Efficient Operational Model"	U.S. Department of Energy, Office of Science
Office of Science Best in Class Award for Environmental Sustainability: "Vision Leads to Action, Greenhouse Gas (GHG) Abatement Strategies"	U.S. Department of Energy, Office of Science
Secretary's Award of Excellence: Physical Sciences Facility (PSF) Project, Pacific Northwest National Laboratory	U.S. Department of Energy, Office of Science

4.0 Environmental Monitoring and Dose Assessment

This section describes PNNL's site environmental monitoring program for radiological constituents and associated dose assessments.

4.1 Liquid Radiological Discharges and Doses

TW Moon

Wastewater is discharged from radiological areas in the Physical Sciences Facility to four retention tanks. Once a tank is filled, the wastewater is analyzed for radiological components based on screening limits in WAC 246-221-190, "Disposal by Release into Sanitary Sewerage Systems." If the analytical results indicate that the wastewater is below the screening criteria, the wastewater is released to the City of Richland's sanitary sewer system. If the analytical results are above the screening criteria, the wastewater is transported to a waste treatment facility (Section 2.4).

4.2 Radiological Discharges and Doses from Air

BG Fritz

The regulatory standard for a maximum dose to any member of the public is 10 mrem/yr EDE, which applies to radionuclide air emissions, other than radon, from DOE facilities (40 CFR 61, Subpart H). For CY 2011, the PNNL Site MEI location was 0.55 km (0.34 mi) south-southeast of the Physical Sciences Facility (Snyder et al. 2012). The dose to the PNNL Site MEI from routine and nonroutine point-source emissions was 1.7×10^{-5} mrem (1.7×10^{-7} mSv) EDE. The relative contributions of each nuclide to the MEI dose are primarily attributed to gross alpha and gross beta (Table 4.1).

For PNNL Site radionuclide air emissions, Washington State (WAC 246-247-040(1)) has adopted the federal dose standard of 10 mrem/yr EDE found in 40 CFR 61 Subpart H. In addition to the maximum dose attributable to radionuclides emitted from point sources, WAC 246-247-040(6) requires that the dose to the MEI also include doses attributable to fugitive emissions, radon, and nonroutine events. The combined PNNL Site fugitive and diffuse emissions were included in the dose evaluation. Emissions from diffuse and fugitive PNNL Site sources add 7×10^{-8} mrem (7×10^{-10} mSv) EDE to the 1.7×10^{-5} mrem (1.7×10^{-7} mSv) EDE PNNL Site dose (Table 4.1). The combined PNNL Site dose from both point and fugitive sources remains well below the WAC 246-247 limit of 10 mrem/yr. There were no radon emissions and no nonroutine emissions from the PNNL Site in 2011 that would contribute to dose that is considered for compliance determination with the WAC 246-247 standard.

The estimated regional population radiation dose (i.e., the collective EDE) from PNNL Site air emissions in 2011 was calculated using a simplified method that overestimates the population dose. The population consists of approximately 432,000 people residing within a 80-km (50-mi) radius of the 300 Area (Hamilton and Snyder 2011). The close proximity of the Hanford 300 Area and rural region within 50 mi of the PNNL Site permits the 300 Area 50-mi (80-km) population estimate to be applicable. Pathways evaluated for population exposure include inhalation, air submersion, ground-shine, and food consumption.

Population exposure to radionuclide air emissions was determined using the MEI dose estimate (1.7×10^{-5} mrem) times the 50-mi population (432,117). The 2011 total population dose from

radionuclide air emissions estimated in this very conservative manner from nuclides that originate from the PNNL Site was 0.0073 person-rem (0.000073 person-Sv).

Table 4.1. Pacific Northwest National Laboratory Radionuclide Emissions from Major and Minor Emission Units and Dose Contributions by Radionuclide, 2011

Radionuclide	Major Emissions Units Release (Ci)	Minor and Fugitive Emissions Units Release (Ci)	Total Releases Ci	EDE to MEI mrem	% of Total EDE
Gross alpha[(a)]	1.5×10^{-7}	NA	1.5×10^{-7}	9×10^{-6}	54%
Gross beta[(a)]	8.9×10^{-7}	NA	8.9×10^{-7}	3×10^{-6}	16%
Sodium-24[(b)]	NA	1.3×10^{-8}	1.3×10^{-8}	2×10^{-10}	<1%
Cobalt-60	1.0×10^{-8}	7.7×10^{-11}	1.0×10^{-8}	6×10^{-9}	<1%
Bromine-82[(b)]	NA	1.3×10^{-8}	1.3×10^{-8}	4×10^{-10}	<1%
Yttrium-88[(b)]	NA	1.3×10^{-10}	1.3×10^{-10}	1×10^{-10}	<1%
Cadmium-109[(b)]	NA	1.1×10^{-10}	1.1×10^{-10}	1×10^{-10}	<1%
Cesium-137[(b)]	NA	2.7×10^{-7}	5.5×10^{-11}	5×10^{-10}	<1%
Lead-210[(b)]	NA	5.5×10^{-11}	8.0×10^{-11}	3×10^{-9}	<1%
Radium-226[(b),(c)]	NA	8.0×10^{-11}	1.2×10^{-9}	6×10^{-8}	<1%
Uranium-233	NA	1.2×10^{-9}	1.2×10^{-9}	5×10^{-9}	<1%
Plutonium-238	1.2×10^{-9}	1.3×10^{-14} (b)	6.4×10^{-10}	4×10^{-8}	<1%
Plutonium-239/240	6.4×10^{-10}	5.7×10^{-18} (b)	6.0×10^{-9}	4×10^{-7}	2%
Americium-241	6.0×10^{-9}	1.8×10^{-16} (b)	6.6×10^{-10}	4×10^{-8}	<1%
Americium-243	6.4×10^{-10}	1.7×10^{-11}	9.1×10^{-8}	5×10^{-6}	27%
Curium-244	9.1×10^{-8}	5.1×10^{-16} (b)	6.9×10^{-11}	3×10^{-9}	<1%
Radionuclides	6.9×10^{-11}	NA	2.7×10^{-7}	1×10^{-10}	<1%
Total	**1.15×10^{-6}**	**2.98×10^{-7}**	**1.4×10^{-6}**	**1.7×10^{-5}**	**100%[(d)]**

(a) Alpha is assumed to be plutonium-239 for dose calculation purposes; beta is assumed to be strontium-90.
(b) Calculated release based on methods in 40 CFR 61, Appendix D.
(c) Dose includes radon-222 progeny.
(d) Tabulated nuclide-specific values do not add to 100% due to rounding.
NA = Not applicable.
To convert Ci to GBq, multiply Ci by 37.

4.3 Release of Property Having Residual Radioactive Material

GA Stoetzel

Principal requirements for the release of DOE property having residual radioactivity are in DOE Order 5400.5, Chg 2, "Radiation Protection of the Public and the Environment." These requirements are designed to ensure the following:

- Property is evaluated, radiologically characterized—and where appropriate—decontaminated before release.
- The level of residual radioactivity in property to be released is as near background levels as is reasonably practicable, as determined through DOE's ALARA process requirements, and meets DOE-authorized limits.

- All property releases are appropriately certified, verified, documented, and reported; public participation needs are addressed; and processes are in place to appropriately maintain records.

Property as defined in DOE Order 5400.5 consists of real property (i.e., land and structures), personal property, and material and equipment. PNNL has two paths for releasing property to the public: 1) pre-approved surface contamination guidelines for releasing property potentially contaminated on the surface, and 2) pre-approved volumetric release limits for releasing small volume research samples. A summary of the two release paths is provided in the following sections. No property with detectable residual radioactivity above DOE-authorized levels was released from PNNL during CY 2011.

4.3.1 Property Potentially Contaminated on the Surface

PNNL uses the pre-approved surface activity guideline limits (Table 4.2) derived from DOE Order 5400.5 when releasing property potentially contaminated on the surface. As part of research activities conducted in PNNL facilities, PNNL releases hundreds of items of personal property annually for excess to the general public, including office equipment, office furniture, labware, and research equipment. The PNNL Radiation Protection organization has a documented process for releasing items based on process knowledge, radiological surveys, or a combination of both. No property with detectable residual radioactivity above the pre-approved surface activity guidelines was released from PNNL during CY 2011.

Table 4.2. Pre-Approved Surface Activity Guideline Limits (DOE Order 5400.5)

	Allowable Total Residual Surface Contamination Limits (dpm/100 cm^2)		
		Total	
Radionuclides	**Removable**	**Average**	**Maximum**
U-natural, uranium-235, uranium-238, and associated decay products	1,000	5,000	15,000
Transuranics, radium-226, radium-228, thorium-230, thorium 228, protactinium-231, actinium-227, iodine-125, iodine 129	20	100	300
Natural thorium, thorium-232, strontium-90, radium-223, radium-224, uranium-232, iodine-126, iodine-131, iodine-133	200	1,000	3,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except strontium-90 and others noted above	1,000	5,000	15,000
Tritium organic compounds; surfaces contaminated with tritium gas, tritiated water vapor, and metal tritide aerosols	10,000	Not applicable	Not applicable

dpm = Disintegrations per minute.

4.3.2 Property Potentially Contaminated in Volume

PNNL uses pre-approved volumetric release limits when releasing small volume research samples and wastewaters potentially contaminated in volume (Table 4.3). DOE approved these release limits in

response to an authorized limits request submitted by PNNL in 2000 (DOE 2001, 2007). During CY 2011, PNNL released hundreds of liquid research samples with a total volume on the order of 100 L (22 gal) using the pre-approved release limits in Table 4.3. The liquid samples were not released to the public, but were used by staff without radiological controls in PNNL facilities. When disposed of the samples were treated as radioactive waste.

Table 4.3. Pre-Approved Volumetric Release Limits

Radionuclide Groups	Volumetric Release Limit (pCi/mL)
Transuranics, iodine-125, iodine-129, radium-226, actinium-227, radium-228, thorium-228, thorium-230, protactinium-231, polonium-208, polonium-209, polonium 210	1
Natural thorium, thorium-232	3
Strontium-90, iodine-126, iodine-131, iodine-133, radium 223, radium-224, uranium-232	9
Natural uranium, uranium-233, uranium-235, uranium-238	30
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except strontium-90 and others noted in above rows	45
Tritium	450

4.4 Radiation Protection of Biota

JM Barnett

During the development of PNNL data quality objectives (DQOs) supporting radiological emissions monitoring, environmental media considerations were evaluated (Barnett et al. 2010). While DQO measures are used primarily to demonstrate protection of the public, they also adequately demonstrate protection of biota. Potential media exposure pathways (air, soil, water, and food) were considered in conjunction with both gaseous and particulate radioactive contamination of the air pathway. The DQO process determined that only the air pathway necessitates monitoring, because there are no radiological emissions via liquid pathways or directly to contaminated land areas (soil pathways). It also determined that it would be impossible to differentiate between the extremely small emission amounts and background levels in nearby locations such as the Columbia River and those found in food sources (Barnett et al. 2010). Therefore, biota monitoring for radionuclides both near and distant from the PNNL Site is not conducted.

DOE Order 458.1 requires that DOE sites establish procedures and practices to protect biota. To satisfy the requirements of this Order, PNNL has adopted the dose rate limits found in DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2002). These limits (1 rad/day [10 mGy/day] for aquatic animals and terrestrial plants and 0.1 rad/day [1 mGy/day] for riparian and terrestrial animals) are considered adequate to demonstrate the protection of biota (DOE 2002).

Routine operations were conducted on the PNNL Site during CY 2011 and there were no unplanned radiological emissions. Therefore, external dose rates to biota were estimated based solely on reported particulate radionuclide emissions. A conservative assumption was made that all radioactive particulate material in PNNL atmospheric emissions was concentrated into 1 m^3 (35 ft^3) of contaminated water or 0.15 m^3 (5.3 ft^3) of contaminated soil (1 m^2 [11 ft^2], 15 cm [0.5 ft] deep, soil density of 1.5 g/cm^{-3} [0.05 $lb/in.^3$]). Dose rates were then calculated by multiplying the conservative soil or water concentration by the screening-level dose coefficients found in DOE-STD-1153-2002 (Snyder et al. 2012; DOE 2002). The resultant combined external dose rates for CY 2011 are less than 0.00007 rad/day (0.0007 mGy/day) for aquatic animals and terrestrial plants and less than 0.0006 rad/day (0.006 mGy/day) for riparian and terrestrial animals (Table 4.4). These conservative dose rates are well below PNNL dose rate limits (1 rad/day [10 mGy/day] for aquatic animals and terrestrial plants and 0.1 rad/day [1 mGy/day] for riparian and terrestrial animals).

4.5 Unplanned Radiological Releases

No radiological releases to the environment exceeded permitted limits at PNNL in 2011.

4.6 Environmental Radiological Monitoring

BG Fritz

A particulate air sampling network was established in 2010 to monitor radioactive particulates in ambient air near the PNNL Site. The first full calendar year of air surveillance was conducted in 2011. Sampling data were collected at three ambient air samplers just outside the perimeter of the PNNL Site to satisfy air permit requirements. In addition to collecting PNNL emissions, these samplers can collect radioactive particulates released from other nearby sources. During 2011, the Hanford Site 300 Area contributed most of the non-PNNL particulates detected from offsite facilities. Airborne particulate radionuclides are sampled and analyzed at all PNNL monitoring stations. Particulate air samples are routinely analyzed for gross alpha activity, gross beta activity, gamma-emitting isotopes, uranium isotopes (uranium-234,[1] uranium-235, and uranium-238), and plutonium isotopes (plutonium-238 and plutonium-239/240). In addition, americium isotopes (americium-241 and americium-243) and curium-243 are analyzed. The Hanford Site has a single background monitoring location located in Yakima, Washington. The Yakima station, which is approximately 75 km (47 mi) in the general upwind direction of both PNNL and the Hanford Site, is considered to be unaffected by either of the DOE operations, and it is used as a background (or reference) location for PNNL.

In 2011, there was no indication that any PNNL activities increased the ambient air concentrations were increased at the air sampling locations. With the exception of samples for uranium-233/234, and americium and curium isotopes (for which no background samples were available), all results at PNNL sample stations were within 2 standard deviations of the background levels (Table 4.5). All other average air concentrations were at or near detection limits.

[1] Uranium-234 is a naturally occurring radionuclide. It is co-reported with uranium-233 by the analytical laboratory because the emission peaks overlap.

Table 4.4. Screening-Level Dose Rates for PNNL, Calendar Year 2011

		Screen for Aquatic Animals and Terrestrial Plants (1 rad/day)			Screen for Riparian and Terrestrial Animals (0.1 rad/day)		
Nuclide[a]	**Particulate Emissions[a] (Ci/y)**	**Concentration in 1 m^3 Water[c] (pCi/L)**	**Screening Level[b] (rad/day per pCi/L)**	**Calculated Dose Rate (rad/day)**	**Concentration in 0.15 m^3 Soil[d] (pCi/g)**	**Screening Level[b] (rad/day per pCi/g)**	**Calculated Dose Rate (rad/day)**
Gross alpha [e, f]	1.5×10^{-7}	1.5×10^{2}	6.9×10^{-8}	1×10^{-5}	6.7×10^{-1}	7.0×10^{-5}	5×10^{-5}
Gross beta [e, g]	8.9×10^{-7}	8.9×10^{2}	6.7×10^{-8}	6×10^{-5}	4.0×10^{0}	1.3×10^{-4}	5×10^{-4}
Sodium-24[g]	1.3×10^{-8}	1.3×10^{1}	6.7×10^{-8}	9×10^{-7}	5.8×10^{-2}	1.3×10^{-4}	8×10^{-6}
Cobalt-60	1.0×10^{-8}	1.0×10^{1}	6.7×10^{-8}	7×10^{-7}	4.5×10^{-2}	1.3×10^{-4}	6×10^{-6}
Bromine-82[g]	1.3×10^{-8}	1.3×10^{1}	6.7×10^{-8}	9×10^{-7}	5.8×10^{-2}	1.3×10^{-4}	8×10^{-6}
Yttrium-88[g]	1.3×10^{-10}	1.3×10^{-1}	6.7×10^{-8}	9×10^{-9}	5.8×10^{-4}	1.3×10^{-4}	8×10^{-8}
Cadmium-109[g]	1.1×10^{-10}	1.1×10^{-1}	6.7×10^{-8}	7×10^{-9}	4.9×10^{-4}	1.3×10^{-4}	6×10^{-8}
Cesium-137	5.5×10^{-11}	5.5×10^{-2}	2.0×10^{-8}	1×10^{-9}	2.5×10^{-4}	4.1×10^{-4}	1×10^{-8}
Lead-210	8.0×10^{-11}	8.0×10^{-2}	1.1×10^{-8}	9×10^{-10}	3.6×10^{-4}	2.2×10^{-5}	8×10^{-9}
Radium-226	1.2×10^{-9}	1.2×10^{0}	6.9×10^{-8}	8×10^{-8}	5.4×10^{-3}	7.0×10^{-5}	4×10^{-7}
Uranium-233/234	1.2×10^{-9}	1.2×10^{0}	3.3×10^{-10}	4×10^{-10}	5.4×10^{-3}	6.6×10^{-7}	4×10^{-9}
Plutonium-238	6.4×10^{-10}	6.4×10^{-1}	2.5×10^{-10}	2×10^{-10}	2.9×10^{-3}	5.1×10^{-7}	1×10^{-9}
Plutonium-239/240	6.0×10^{-9}	6.0×10^{0}	2.5×10^{-10}	2×10^{-9}	2.7×10^{-2}	5.0×10^{-7}	1×10^{-8}
Americium-241	6.6×10^{-10}	$6.6 \times 10^{-1}1$	1.5×10^{-9}	1×10^{-9}	2.9×10^{-3}	2.9×10^{-6}	9×10^{-9}
Americium-243	9.1×10^{-8}	9.1×10^{-1}	1.3×10^{-8}	1×10^{-6}	4.1×10^{-1}	2.6×10^{-5}	1×10^{-5}
Curium-244	6.9×10^{-11}	6.9×10^{-2}	2.0×10^{-10}	1×10^{-11}	3.1×10^{-4}	4.0×10^{-7}	1×10^{-10}
			Sum of Fractions:	7×10^{-5}		Sum of Fractions:	6×10^{-4}

(a) Data from Snyder et al. (2012).
(b) Data from DOE (2002).
(c) Conservative dose rate assumed to be from 1 m^3 of contaminated water.
(d) Conservative dose rate assumed from 0.15 m^3 contaminated soil (1 m^2 × 15 cm deep, soil density of 1.4 g/cm^3).
(e) Maximum of the bi-weekly or semi-annual average measurement (Snyder et al. 2012).
(f) Radium-226 dose rate factor used as conservative alpha surrogate.
(g) Cobalt-60 dose rate factor used as conservative beta surrogate.

Table 4.5. Summary of 2011 Air Sampling Results for PNNL

Nuclide	Location	No. of Samples	No. of Detections	Average ± 2 sd (pCi/m^3)
Gross alpha	PNL-1	25	21	0.00077 ± 0.00086
	PNL-2	26	24	0.00074 ± 0.00096
	PNL-3	26	21	0.00086 ± 0.0014
	Yakima	26	19	0.00056 ± 0.00061
Gross beta	PNL-1	25	25	0.020 ± 0.025
	PNL-2	26	26	0.018 ± 0.022
	PNL-3	26	26	0.026 ± 0.034
	Yakima	26	26	0.018 ± 0.022
Cobalt-60	PNL-1	4	0	-0.000062 ± 0.00075
	PNL-2	4	0	-0.000091 ± 0.00039
	PNL-3	4	0	0.000013 ± 0.00098
	Yakima	4	0	0.000027 ± 0.00037
Uranium-234	PNL-1	4	4	0.000056 ± 0.000031
	PNL-2	4	4	0.000036 ± 0.000021
	PNL-3	4	4	0.000067 ± 0.000027
	Yakima	4	4	0.000039 ± 0.000017
Plutonium-238	PNL-1	4	0	-0.0000017 ± 0.0000076
	PNL-2	4	0	-0.0000058 ± 0.000011
	PNL-3	4	0	-0.0000070 ± 0.000022
	Yakima	4	0	0.00000048 ± 0.00000078
Plutonium-239/240	PNL-1	4	0	0.0000016 ± 0.0000021
	PNL-2	4	0	-0.0000017 ± 0.0000065
	PNL-3	4	1	0.00000048 ± 0.000019
	Yakima	4	0	0.00000022 ± 0.0000014
Americium-241[(a)]	PNL-1	4	1	0.0000085 ± 0.000023
	PNL-2	4	1	0.0000058 ± 0.0000096
	PNL-3	4	1	0.0000041 ± 0.0000047
	Yakima	0	0	NA
Americium-243	PNL-1	4	0	0.0000069 ± 0.000010
	PNL-2	4	0	-0.000000045 ± 0.000020
	PNL-3	4	0	0.000012 ± 0.0000090
	Yakima	0	0	NA
Curium-243/244	PNL-1	4	0	-0.0000030 ± 0.000013
	PNL-2	4	0	-0.0000080 ± 0.000016
	PNL-3	4	0	0.00000043 ± 0.0000090
	Yakima	0	0	NA

(a) Americium-241 values reported are for the analysis done by the more sensitive alpha spectroscopy method.
NA = Not analyzed.

4.7 Future Radiological Monitoring

BG Fritz

PNNL is in the process of modifying its radiological air monitoring program. The original DQOs only considered radiological emissions at PNNL from the Physical Sciences Facility major emissions units (Barnett et al. 2010). A follow-up revision considered PNNL changes subsequent to the implementation of the original DQO; specifically, atmospheric emissions from the entire PNNL campus were considered (Barnett et al. 2012). The result recommended modifications to update the monitoring program.

Initially, three monitoring station locations were determined to be sufficient to monitor atmospheric emissions from the PNNL campus. Consideration of emissions from the entire PNNL campus resulted in a recommendation to add a fourth monitoring station in the southern portion of the PNNL campus. A location near the center of the PNNL campus was chosen based on atmospheric dispersion modeling, and infrastructure modifications to support the additional monitoring location began during early 2012. The additional air monitoring station is expected to be operational sometime during CY 2012.

5.0 Environmental Nonradiological Program Information

The Effluent Management Group within the PNNL Environmental Protection and Regulatory Programs Division establishes or provides reference to discharge limits for toxic and radiological effluents to air or liquid disposal pathways. Specific effluent management services include establishing monitoring and sampling programs to characterize effluents from PNNL-operated facilities, verifying compliance with effluent standards and controls, assisting facility operations, and monitoring compliance with air and water permits.

Effluent Management provides the interface between regulatory agencies and PNNL to prepare and submit required environmental permitting documentation, and reports spills and releases to regulatory agencies. A detailed description of the responsibilities assigned to the Effluent Management Group and interactions with other PNNL organizations is provided in the internal PNNL Effluent Management Quality Assurance Plan. The ALARA principle is applied to effluent activities to minimize potential effects of emissions to the public and the environment.

5.1 Liquid Effluent Monitoring

TW Moon

The PNNL campus operates under three industrial wastewater discharge permits that regulate the discharge of process wastewater to the City of Richland sanitary sewer system. Permit #CR-IU005 regulates the wastewater discharges from EMSL, Permit #CR-IU011 regulates wastewater discharges from the Physical Sciences Facility, and Permit #CR-IU001 regulates wastewater discharged from facilities in Richland North. All waste streams that are regulated by these permits are reviewed by PNNL staff and evaluated relative to compliance with the applicable permit prior to their discharge. The Physical Sciences Facility has been operational since 2010, but because of low flows, no representative samples have been collected in conjunction with Permit #CR-IU011. The 2011 effluent data for Permit #CR-IU005, which apply to EMSL, indicate that PNNL is in compliance with all applicable requirements (Table 5.1). In 2011, permit flow levels were exceeded at Outfall 001 in Richland North because of a mechanical failure of a sand filter over a 1-day period. Table 5.2 and Table 5.3 summarize analytical results for physical parameters and metals from the process sewer for Richland North, Outfall 001 and Outfall 003, respectively. All other effluent data for Permit #CR-IU001, which apply to Richland North, indicate that PNNL is in compliance with all applicable requirements

The Washington State Department of Ecology has issued a permit for non-contact cooling water discharged from the Richland Research Complex Cooling Ponds (#ST-9251) through the irrigation system. Table 5.4 provides the monitoring results for the Richland Research Complex Cooling Ponds. The 2011 effluent data for Permit #ST-9251 indicate that PNNL is in compliance with all applicable requirements.

Table 5.1. Environmental Molecular Sciences Laboratory Process Sewer Monitoring Results, Outfall 001, Calendar Year 2011

Parameter	Number of Samples Analyzed	Quantity Found Below Detection Limit	Detection Limit	Minimum Value	Maximum Value	Sewer Discharge Limit[(a)] (lb/day)	Minimum Loading (lb/day)	Maximum Loading (lb/day)
Flow (gpd)	NA	NA	NA	2,760	4,200	10,000	NA	NA
pH (pH units)	30	NA	NA	5.8	7.2	5.0–10.0	NA	NA
Conductivity (µS/cm)	30	NA	NA	105	680	None	NA	NA
Biochemical oxygen demand (mg/L)	2	0	10	14.4	18.6	None	NA	NA
Total suspended solids (mg/L)	2	0	10	28.5	36	None	NA	NA
Ammonia (mg/L)	2	0	0.10	1.04	5.26	None	NA	NA
Total phenols (mg/L)	2	1	0.004	ND	0.016	None	NA	NA
Fluoride	1	0	0.006	0.13	0.13	None	NA	NA
Total Kjeldahl nitrogen (mg/L)	1	0	0.16	9.88	9.88	None	NA	NA
Antimony (mg/L)	5	4	0.002	<0.002	0.0037	None	NA	NA
Arsenic (mg/L)	5	5	0.004	<0.004	<0.004	0.01	<0.0001	<0.0001
Beryllium (mg/L)	5	5	0.00009	<0.00009	<0.00009	None	NA	NA
Cadmium (mg/L)	5	3	0.0003	<0.0003	0.0005	0.01	<0.000008	0.00001
Chromium (mg/L)	5	0	0.0006	0.0007	0.002	0.28	0.00002	0.00006
Copper (mg/L)	5	0	0.0008	0.255	0.413	0.14	0.0079	0.0121
Cyanide (mg/L)	5	5	0.003	<0.003	<0.003	None	<0.00009	<0.00009
Lead (mg/L)	5	0	0.004	0.0045	0.0075	0.05	0.0001	0.00023
Mercury (mg/L)	5	1	0.00002	<0.00002	0.00013	0.002	<0.0000006	0.000002
Molybdenum (mg/L)	5	0	0.0006	0.0015	0.0053	0.03	0.00004	0.0002
Nickel (mg/L)	5	0	0.0007	0.005	0.0238	0.109	0.0002	0.0007
Selenium (mg/L)	5	5	0.005	<0.005	<0.005	0.02	<0.0001	<0.0002
Silver (mg/L)	5	0	0.0008	0.0008	0.0019	0.02	0.00002	0.00006
Thallium (mg/L)	5	5	0.002	<0.002	<0.002	None	NA	NA
Zinc (mg/L)	5	0	0.0007	0.0802	0.449	0.58	0.0025	0.0132

(a) Sewer discharge limits listed were effective March 24, 2011.
gpd = Gallons per day.
lb/day = Pounds per day.
mg/L = Milligrams per liter.
NA = Not applicable.
ND = Non-detectable.

Table 5.2. Richland North Sewer Monitoring Results for Calendar Year 2011, Outfall 001

Parameter	Number of Samples Analyzed	Quantity Found Below Detection Limit	Detection Limit	Minimum Value	Maximum Value	Sewer Discharge Limit (lb/day)	Minimum Loading (lb/day)	Maximum Loading (lb/day)
Flow (gpd)	NA	NA	NA	42,600	162,100	146,520	NA	NA
pH (pH units)	4	NA	NA	5.9	8.5	5.0–10.0	NA	NA
Conductivity (µS/cm)	4	NA	NA	371	1597	None	NA	NA
Biochemical oxygen demand (mg/L)	1	NA	10	209	209	None	NA	NA
Total suspended solids (mg/L)	1	NA	10	61	61	None	NA	NA
Total phenols (mg/L)	2	0	0.004	0.032	0.036	None	NA	NA
Antimony (mg/L)	2	2	0.002	<0.002	<0.002	None	NA	NA
Arsenic (mg/L)	2	1	0.004	<0.004	0.006	0.17	<0.002	0.003
Beryllium (mg/L)	2	2	0.00009	<0.00009	<0.00009	None	NA	NA
Cadmium (mg/L)	2	1	0.0003	<0.0003	0.0003	0.19	<0.0001	0.0002
Chromium (mg/L)	2	0	0.0006	0.0011	0.0013	4.15	0.0005	0.00066
Copper (mg/L)	2	0	0.0008	0.300	0.413	2.09	0.059	0.152
Cyanide (mg/L)	2	2	0.003	<0.003	<0.003	None	NA	NA
Lead (mg/L)	2	1	0.004	<0.004	0.0041	0.80	<0.002	0.0021
Mercury (mg/L)	2	0	0.00002	0.00005	0.00007	0.03	0.00003	0.00003
Molybdenum (mg/L)	2	1	0.0006	<0.0006	0.0038	0.42	<0.0003	0.0016
Nickel (mg/L)	2	0	0.0007	0.005	0.0078	1.60	0.003	0.0032
Selenium (mg/L)	2	2	0.005	<0.005	<0.005	0.29	<0.002	<0.003
Silver (mg/L)	2	1	0.0007	<0.0007	0.001	0.26	<0.0003	0.0005
Thallium (mg/L)	2	2	0.002	<0.002	<0.002	None	NA	NA
Zinc (mg/L)	2	0	0.0007	0.0624	0.136	8.47	0.026	0.069

gpd = Gallons per day.
lb/day = Pounds per day.
mg/L = Milligrams per liter.
NA = Not applicable.
ND = Non-detectable.

Table 5.3. Richland North Sewer Monitoring Results for Calendar Year 2011, Outfall 003

Parameter	Number of Samples Analyzed	Quantity Found Below Detection Limit	Detection Limit	Minimum Value	Maximum Value	Sewer Discharge Limit (lb/day)	Minimum Loading (lb/day)	Maximum Loading (lb/day)
Flow (gpd)	NA	NA	NA	10,800	91,600	99,110	NA	NA
pH (pH units)	4	NA	NA	6.7	8.3	5.0–10.0	NA	NA
Conductivity (µS/cm)	4	NA	NA	171	656	None	NA	NA
Biochemical oxygen demand (mg/L)	1	0	10	13.5	13.5	None	NA	NA
Total suspended solids (mg/L)	1	0	10	36.5	36.5	None	NA	NA
Total phenols (mg/L)	2	0	0.004	0.018	0.144	None	NA	NA
Antimony (mg/L)	2	2	0.002	<0.002	<0.002	None	NA	NA
Arsenic (mg/L)	2	2	0.004	<0.004	<0.004	0.12	<0.0005	<0.0009
Beryllium (mg/L)	2	2	0.00009	<0.00009	<0.00009	None	NA	NA
Cadmium (mg/L)	2	2	0.0003	<0.0003	<0.0003	0.13	<0.00004	<0.00007
Chromium (mg/L)	2	2	0.0006	<0.0006	<0.0006	2.81	<0.00008	0.0001
Copper (mg/L)	2	0	0.0008	0.0801	0.0814	1.41	0.019	0.0103
Cyanide (mg/L)	2	1	0.003	<0.003	0.005	None	NA	NA
Lead (mg/L)	2	2	0.004	<0.004	<0.004	0.54	<0.0005	<0.0009
Mercury (mg/L)	2	2	0.00002	<0.00002	<0.00002	0.02	<0.000003	<0.000005
Molybdenum (mg/L)	2	0	0.0006	0.0011	0.0017	0.28	0.0001	0.0004
Nickel (mg/L)	2	0	0.0007	0.0015	0.0022	1.08	0.0003	0.0004
Selenium (mg/L)	2	2	0.005	<0.005	<0.005	0.20	<0.0006	<0.001
Silver (mg/L)	2	2	0.0007	<0.0007	<0.0007	0.18	<0.00009	<0.0002
Thallium (mg/L)	2	2	0.002	<0.002	<0.002	None	NA	NA
Zinc (mg/L)	2	0	0.0007	0.0518	0.0591	5.73	0.0067	0.014

gpd = Gallons per day.
lb/day = Pounds per day.
mg/L = Milligrams per liter.
NA = Not applicable.
ND = Non-detectable.

Table 5.4. Water Monitoring Results for the Richland Research Complex Cooling Ponds, 2011

Parameter	Number of Samples Analyzed	Quantity Found Below Detection Limit	Maximum Value
pH (pH units)	1	0	7.8
Conductivity (µS/cm)	1	0	282
Total dissolved solids (mg/L)	1	0	181

5.2 Air Effluent

BG Fritz

PNNL is not a large source of nonradiological air emissions. The air effluent program does not monitor any stacks for nonradiological constituents and compliance is ensured by complying with permit conditions. This typically involves activities including monitoring fuel use, operating hours for boilers and diesel engines, and adhering to maintenance requirements (Table 5.5). The permit applications contain emission estimates based on vendor data (e.g., emission rate/hour), so monitoring of run time or fuel use is an acceptable method of determining permit compliance. In addition, reviews of research and facility construction/renovation projects are conducted to ensure they comply with all applicable requirements.

Table 5.5. Nonradiological Atmospheric Emissions for 2011 Reported in Accordance with the Global Reporting Initiative (GRI)

GRI Indicator	Indicator Title	2011 Emissions	Units
EN 16	Total direct and indirect greenhouse gas emissions	51,567	Metric tonnes of carbon dioxide equivalent
EN17	Other relevant indirect greenhouse gas emissions	28,157	Metric tonnes of carbon dioxide equivalent
EN19	Ozone-depleting substance R12	0.018	Metric tonnes
	Ozone-depleting substance R22	0.010	Metric tonnes
	Ozone-depleting substance R123	0.0004	Metric tonnes
	Ozone-depleting substance 403B	0.0000	Metric tonnes
	Ozone-depleting substance 414B	0.0004	Metric tonnes
	Emissions of ozone-depleting substances in CFC-11 Equivalent	0.029	Metric tonnes
E20	Nitrogen oxides	3667	kg
	Sulfur dioxide	34	kg
	Volatile organic compounds	880	kg
	Hazardous air pollutants	405	kg
	Particulate matter	471	kg
	Carbon monoxide	6825	kg

5.3 Soil Monitoring

JP Duncan and TW Moon

Water from the research cooling ponds supplements irrigation system water on the PNNL campus. During the summer months, a blue dye is added to the cooling ponds to prohibit algae growth. Because this dye is considered a pollutant, Battelle samples and analyzes the surrounding soils as required by Washington State Department of Ecology state waste discharge permit #ST-9251. Table 5.6 provides monitoring results for soil affected by water from the Richland Research Complex Cooling Ponds for CY 2011.

Table 5.6. Richland Research Complex Cooling Ponds Soil Monitoring Results, 2011

Parameter	Number of Samples Analyzed	Quantity Found Below Detection Limit	Detection Limit	Minimum Value	Maximum Value
Depth (in.)	8	0	None	12	36
Moisture (%)	8	0	None	6.48	15.26
Exchangeable sodium (%)	8	0	None	0.37	0.92
Cation exchange capacity (meq/100 g)	8	0	None	8.8	10.9
Organic matter (%)	8	0	None	0.93	2.63
Total Kjeldahl Nitrogen (mg/kg)	8	0	None	504	1150
Nitrate as nitrogen (mg/kg)	8	0	None	1	4.7
Ammonia as nitrogen (mg/kg)	8	0	None	3.4	12.4
Total Phosphorus (mg/kg)	8	0	None	699	892
Conductivity 1:1 (mmhos/cm)	8	0	None	0.12	0.31
Sodium (meq/100 g)	8	0	None	0.04	0.09
Calcium (meq/100 g)	8	0	None	5.81	8.03
Magnesium (meq/100 g)	8	0	None	1.49	1.99
Potassium (mg/kg)	8	0	None	83	176
Sulfate (mg/kg)	8	0	None	9	14
pH 1:1	8	0	None	6.2	6.9
Redoximorphic features	8	0	None	Absent	Absent

6.0 Groundwater Protection Program

JP Duncan and TW Moon

Groundwater under the northern part of the PNNL Site is monitored routinely through eight groundwater monitoring wells. The Hanford groundwater monitoring report (DOE/RL 2011a) indicates that four contaminants (uranium, tritium, cis-1,2-dichloroethene, and nitrate) are found at levels that exceed drinking water standards in parts of the Hanford 300-FF-5 Operable Unit. Under the PNNL campus, the contaminants either were not detectable or were present in concentrations well below drinking water standards, with the exception of nitrate, which exceeded drinking water standards. The nitrate plume underlying the PNNL campus and much of north Richland originates from offsite agricultural and industrial activities and is not identified as a contaminant of concern for the 300-FF-5 Operable Unit.

In 2010, Battelle completed construction of the BSF/CSF. This facility uses a novel technology for heating and cooling the building that relies on a ground-source heat pump. Water is pumped from four extraction wells, passed through a non-contact heat exchanger, and returned to the aquifer through four injection wells. In February 2011, the Washington State Department of Ecology issued a water right for the nonconsumptive use of groundwater for the ground-source heat pump, allowing the withdrawal and use of groundwater by the four production wells at flow rates up to 7,200 L/min (1,900 gpm) and requiring injection of the water back to the aquifer.

Because the water is re-injected back into the ground, the Washington State Department of Ecology issued a temporary state waste discharge permit (#ST-9274) to have the groundwater monitored for temperature changes and potential influence of pollutants from underground contamination plumes. Sampling and monitoring focuses on contaminants found in regional contaminant plumes that might be drawn toward the ground-source heat pump during groundwater withdrawal, including uranium, tritium, nitrate, and trichlororethylene, and on potential increases in the temperature of groundwater that will reach the Columbia River. The groundwater is sampled and analyzed in accordance to the sampling and analysis plan for the ground-source heat pump (Fritz and Moon 2010). The discharge permit requires sampling and analysis of seven groundwater monitoring wells in addition to the four injection wells. Three of the monitoring wells were already components of the monitoring network. The sampling data are reported monthly to the Washington State Department of Ecology. Table 6.1 provides the monitoring results for the BSF/CSF ground-source heat pump for 2011. PNNL is in compliance with all sampling requirements of the discharge permit.

Table 6.1. Biological Science Facility/Computational Sciences Facility Ground-Source Heat Pump Monitoring Results, 2011

Parameter	Number of Samples Analyzed	Quantity Found Below Detection Limit	Detection Limit	Minimum Value	Maximum Value
Production Wells					
Flow (gpd)	NA	NA	NA	0	1,427
Temperature (ºC)	NA	NA	NA	15.1	22.1
pH (pH units)	4	NA	NA	7.2	7.7
Dissolved oxygen (mg/L)	4	NA	NA	5.3	8.9
Conductivity (µS/cm)	4	NA	NA	772	971
Turbidity (ntu)	2	0	0.04	0.11	0.21
Total dissolved solids (mg/L)	2	0	10	538	550
Nitrate-nitrite (mg/L)	2	0	0.09	26.4	26.5
Uranium (µg/L)	2	0	1.0	7.2	7.77
Tritium (pCi/L)	2	1	1,000	ND	295
Trichloroethylene (µg/L)	2	2	0.04	ND	ND
Injection Wells					
Flow (gpd)	NA	NA	NA	1	1,441
Temperature (ºC)	NA	NA	NA	13	30.3
pH (pH units)	4	NA	NA	7.3	7.7
Dissolved oxygen (mg/L)	4	NA	NA	8.2	8.9
Conductivity (µS/cm)	4	NA	NA	811	830
Turbidity (ntu)	2	0	0.04	0.27	0.30
Total dissolved solids (mg/L)	2	0	10	516	564
Nitrate-nitrite (mg/L)	2	0	0.09	25.1	26.3
Uranium (µg/L)	2	0	1.0	7.0	7.12
Tritium (pCi/L)	2	2	1,000	ND	ND
Trichloroethylene (µg/L)	2	2	0.04	ND	ND
Monitoring Wells					
Temperature (ºC)	NA	NA	NA	15.8	17.6
pH (pH units)	28	NA	NA	7.2	7.6
Dissolved oxygen (mg/L)	28	NA	NA	6.4	10.4
Conductivity (µS/cm)	28	NA	NA	502	816
Turbidity (ntu)	14	0	0.04	0.11	2.01
Total dissolved solids (mg/L)	14	0	10	289	507
Nitrate-nitrite (mg/L)	14	0	0.09	7.3	23.2
Uranium (µg/L)	14	0	1.0	2.7	6.38
Tritium (pCi/L)	14	14	1,000	ND	217
Trichloroethylene (µg/L)	14	14	0.04	ND	0.05

NA = Not applicable.
ND = Non-detectable.

7.0 Quality Assurance

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Environmental sampling and monitoring activities at PNNL-operated facilities in Richland were performed under PNNL's Environmental Management and Operation Program. These activities included sampling of wastewater, radiological air emissions, and ambient air and were subject to the PNNL quality assurance program, which implements the requirements of DOE Order 414.1D, "Quality Assurance." Sampling is conducted by the Effluent Management Group under a quality assurance plan that describes the specific quality assurance elements that apply to each activity. The quality assurance plan addresses requirements in the format of DOE Order 414.1D, but also contains a cross-matrix showing how the quality assurance plan meets EPA quality assurance requirements (EPA 2001b). The quality assurance plan was approved by the PNNL quality assurance organization that monitors compliance with the plan. Work performed through contracts or statements of work, such as sample analyses, must meet the same quality assurance requirements. Potential calibrated equipment and service suppliers were audited before service contracts were approved and awarded, or materials were purchased that could have a significant impact on quality.

The PNNL Site is a sub-component of the PNNL-operated facilities in Richland, Washington. Radiological environmental monitoring activities for the PNNL Site were determined using the DQO process (Barnett et. al. 2010) described in the EPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA 2006). The DQO process is a series of logical steps that guides a team to establish performance and acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of the study. The DQO process resulted in a determination and documentation of the environmental sampling and monitoring required to comply with applicable regulations. Results of the DQO process were implemented, with quality assurance requirements integrated into the Effluent Management Quality Assurance Plan (Ballinger and Beus 2012). The quality assurance plan contains and references specific quality assurance requirements for individual activities including environmental sampling and monitoring at PNNL.

Wastewater sampling and monitoring at PNNL-operated facilities in Richland were performed to meet requirements in permits issued by the City of Richland for discharges to the sewer and by the Washington State Department of Ecology for discharges to the ground. Quality assurance requirements for these activities were incorporated into the Effluent Management Quality Assurance Plan (Ballinger and Beus 2012) with specific requirements such as sampling locations, quality objective criteria, analytical methods and detection limits included.

7.1 Sample Collection Quality Assurance

Samples were collected by personnel trained to conduct sampling according to approved and documented procedures. Some samples are required to be analyzed at the time of sample collection because of holding time limits. These analyses (e.g., pH, conductivity, dissolved oxygen) are performed using controlled procedures to maintain quality assurance and compliance with method requirements. Sampling protocols include use of appropriate sampling methods and equipment, a defined sampling frequency, specified sampling locations, and protocols for sample handling, storage, packaging, and shipping to maintain sample integrity. Chain-of-custody processes were used to track transfer of samples from the point of collection to the analytical laboratory. Quality assurance requirements are integrated

into the statement of work for subcontracted analytical laboratories and include analysis of method blanks to evaluate sources of contamination, analysis of field or laboratory duplicates to evaluate method precision, and analysis of matrix spikes and laboratory control samples/blank samples to assess accuracy.

All wastewater samples are analyzed using EPA-approved methods, which include duplicate samples, trip blanks, matrix spikes, and laboratory control samples, and each analytical package is validated prior to using and reporting data. In all cases where quality issues were identified that resulted in invalid data (e.g., missed hold times; laboratory blanks, spikes, or duplicates do not meet quality control criteria), the issue was documented and resampling was required.

7.2 Quality Assurance Analytical Results

Three laboratories were used for analyses of environmental samples (i.e., wastewater, stack air emissions, and ambient air) from PNNL-operated facilities in Richland during 2011: 1) radiological air emission samples were analyzed by the PNNL Radiochemical Sciences and Engineering Group; 2) ambient air samples were analyzed for radioactivity by General Engineering Laboratories, LLC; and 3) wastewater samples were analyzed by Columbia Analytical Services, Inc. (now known as ALS Environmental). Analyses were performed according to a documented statement of work or contract, which described the activities necessary to ensure that the analysis results were of high and verifiable quality. These activities included calibrating and performance testing of analytical equipment; implementing a quality assurance program; maintaining analytical and support equipment and facilities; handling, protecting, and analyzing samples; checking data traceability, validity, and quality; recording all analytical data; and communicating and reporting to the Effluent Management Group.

In 2011, the Radiochemical Sciences and Engineering Group and General Engineering Laboratories analyzed all airborne filter samples for radioactivity according to the criteria in the respective statement of work and contract. Both laboratories participated in a quality control program that included internal quality control measurements that provide estimates of precision and accuracy of the data. Both laboratories also participated in the Mixed-Analyte Performance Evaluation Program (MAPEP) intercomparison program, which provides an evaluation of laboratory performance. The MAPEP provided standard samples of environmental media (e.g., air filters, soil, vegetation, and water) containing specific amounts of one or more radionuclides unknown to the participating laboratory. After analysis, the results were compared for accuracy by determining if each result was within ±30% of a reference value. In 2011, General Engineering Laboratories participated in two MAPEP studies (MAPEP 24 & 25) and 84% of the results were within acceptable control limits; the Radiochemical Sciences and Engineering Group participated in one of the studies (MAPEP 25) and 86% of results were within acceptable control limits.

Quality control (QC) samples (e.g., blanks, spiked samples, and sample duplicate pairs) were prepared and analyzed as required in the contract and statement of work. The Radiochemical Sciences and Engineering Group analyzed a blank and an instrument control sample against known standards for each batch of routine samples analyzed for alpha and beta activity. In addition, a spiked sample and a blank were included with each batch of composite analyses and analyzed for specific isotopes in addition to alpha and beta activity. Similar QC samples were analyzed by General Engineering Laboratories (Table 7.1). The QC samples from both laboratories indicated that the sample batches had no measurable

contamination from sample preparation activities, there was good efficiency in sample preparation, and there was adequate precision in the preparation process.

Table 7.1. Summary of Quality Control Results Used for Air Filter Analyses, 2011

QC Sample Type	Analytes	Number of Samples	Results Within Control Limits
General Engineering Laboratories, LLC Air Filter Analyses			
Laboratory blanks	Gross alpha, gross beta, Am-241, Am-243, Be-7, Cm-243/244, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, K-40, Pu-238, Pu-239/240, Ru-106, Sb-125, U-234, U-235, U-238	42	100%[(a)]
Duplicate sample pairs	Am-241, Am-243, Be-7, Cm-243/244, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, K-40, Pu-238, Pu-239/240, Ru-106, Sb-125, U-234, U-235, U-238	4	96%
Matrix spike samples	Am-241, Am-243, Cm-243/244, Pu-238, Pu-239/240, U-234, U-235, U-238	4	100%
Laboratory control samples	Am-241, Am-243, Be-7, Cm-243/244, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, K-40, Pu-238, Pu-239/240, Ru-106, Sb-125, U-234, U-235, U-238	16	100%
PNNL Radiochemical Sciences and Engineering Group			
Laboratory blanks	Gross alpha, gross beta, Am-241, Am-243, Cm-243/244, Pu-238, Pu-239/240, Pu-241, U-233	2	100%[(a)]
Matrix spike samples	Gross alpha, gross beta, Pu-241, Sr-90	2	100%

(a) All results were either below minimum detectable activity or below reporting limits.

Columbia Analytical Services analyzed all wastewater samples from the PNNL-operated facilities in Richland during 2011. Columbia Analytical Services is a Washington State Department of Ecology-accredited laboratory (C544) for the analysis of water and wastewater samples. To receive accreditation, a laboratory must implement a quality assurance plan and be periodically inspected by the Washington State Department of Ecology to ensure that it is operating within regulatory and quality assurance requirements. Wastewater analyses are performed according to *Clean Water Act* methods specified by EPA in "Guidelines Establishing Test Procedures for the Analysis of Pollutants" (40 CFR 136). Quality assurance and QC requirements included in the contract with PNNL include the measurement or assessment of accuracy, precision, reliability, representativeness, completeness, and comparability. Analytical methods, method detection limits, holding times, sample containers, and preservation must meet 40 CFR 136 requirements and are verified for each sample collected. As mentioned in Section 7.1, resampling is required when an analysis fails to meet QC criteria or DQOs and the data are considered invalid.

7.3 Data Management and Calculations

Quality assurance is integrated into data management processes and calculations through documents such as the quality assurance plan, a data management plan, and procedures. Parameters for dose calculations are documented as a component of the data management plan. A procedure identifies the process for developing, testing, maintaining, and using spreadsheets to perform calculations that support or relate to a regulatory compliance, permit, or safety requirement. Procedures also contain the basis for parameters and methods used in estimating environmental releases as well as checklists used to verify and validate analytical results.

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