



ENVIRONMENTAL PERFORMANCE REPORT 2016

Annual Site Environmental Report per the
U.S. Department of Energy Order 231.B *Chg 1*

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy
Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Cover Photo: Spirit, a 20-year-old Bald Eagle, completes a flight at the NWTC equipped with a GPS tracker on his back. Spirit and a Golden Eagle named Nova, who reside at Auburn University, are part of a research collaboration among Laufer Wind, Boulder Imaging, RES America, and NREL to develop a radar system capable of detecting avian species to assist in preventing bird strikes with wind turbines. *Photo by Dennis Schroeder, NREL 35743*

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NREL Environmental Performance Report 2016

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South Table Mountain site. Photo by Dennis Schroeder, NREL 25300



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NOMENCLATURE

AST – Aboveground Storage Tank

CCR – Colorado Code of Regulations

CDLE – Colorado Department of Labor and Employment

CDPHE – Colorado Department of Public Health
and Environment

CFR – Code of Federal Regulations

CO₂ – Carbon Dioxide

CRS – Colorado Revised Statute

CWA – Clean Water Act

DOE – U.S. Department of Energy

DOE Order – Department of Energy Order

DOPS – Division of Oil and Public Safety of the
Colorado Department of Labor and Employment

EA – Environmental Assessment

EMS – Environmental Management System

EPA – U.S. Environmental Protection Agency

EPCRA – Emergency Planning and Community
Right-to-Know Act

EPEAT – Electronic Product Environmental Assessment Tool

ESA – Endangered Species Act

EO – Executive Order

FTLB – Field Test Laboratory Building

FY – Fiscal Year

ISO – International Organization for Standardization

MBTA – Migratory Bird Treaty Act

mrem – Millirem

NEPA – National Environmental Policy Act

NREL – National Renewable Energy Laboratory

NWTC – National Wind Technology Center

ODS – Ozone Depleting Substances

SPCC – Spill Prevention Control and Countermeasures

STM – South Table Mountain

USACE – U.S. Army Corps of Engineers



A Toyota Mirai hydrogen fuel cell car being taken for a test drive. NREL is focusing on integrating renewable hydrogen fuel filling stations into the existing fueling infrastructure.

Photo by Dennis Schroeder, NREL 40200

EXECUTIVE SUMMARY

Purpose

The National Renewable Energy Laboratory's (NREL's) Environmental Performance Report provides a description of the laboratory's environmental management activities for 2016, including information on environmental and sustainability performance, environmental compliance activities and status, and environmental protection programs, highlights, and successes.

The purpose of this report is to ensure that the U.S. Department of Energy (DOE) and the public receive timely, accurate information about events that have positively affected or could adversely affect the health and safety of the public or workers, the environment, or the operations of DOE facilities. This report meets the DOE requirements of the Annual Site Environmental Report and has been prepared in accordance with the DOE Order 231.1B *Chg 1, Environment, Safety and Health Reporting*.

Environmental and Sustainability Performance

The laboratory is committed to environmental stewardship, pollution prevention, compliance with environmental requirements, and continual improvement in environmental protection and sustainability performance. NREL's Environmental Management System implements a framework of policies, procedures, and programs that integrates environmental protection into daily work practices. The Environmental Management System is structured based on a plan-do-check-act continual improvement management model and is implemented as part of an Integrated Safety Management System.

Each year, the laboratory sets measurable goals for environmental improvement through the NREL Environmental Management System planning process. Goals are also established through the Performance Evaluation Measurement Plan and the Site Sustainability Plan. Progress of all

ABOUT NREL

NREL is the principal research laboratory for DOE's Office of Energy Efficiency and Renewable Energy. The laboratory also conducts research for the Office of Science and the Office of Electricity Delivery and Energy Reliability. The Alliance for Sustainable Energy, LLC, a partnership between MRIGlobal and the Battelle Memorial Institute, manages the laboratory for the Office of Energy Efficiency and Renewable Energy.

NREL is the only DOE national laboratory solely dedicated to advancing renewable energy and energy efficiency technologies from concept to commercial application. The laboratory's innovations, analysis, and expertise have enabled the emergence of a U.S. clean energy industry and led to numerous success stories from across the laboratory. NREL's two sites, the 327-acre (132 hectares) South Table Mountain main site in Golden, Colorado, and the 305-acre (124 hectares) National Wind Technology Center in northern Jefferson County, are living models of sustainable energy integration.

NREL develops renewable energy and energy efficiency technologies and practices, advances related science and engineering, and transfers knowledge and innovations to address the nation's energy and environmental goals. The laboratory's research and development achievements have helped shape clean-energy alternatives for powering our homes and businesses, and the nation's transportation infrastructure. NREL's science and technology teams span the full spectrum of innovation, from fundamental science and market-relevant research, to systems integration and testing and validation.

goals is tracked throughout the year using an online software tracking system. A summary is prepared annually for the DOE Golden Field Office on Performance Evaluation Measurement Plan results and for DOE Headquarters on Site Sustainability Plan results. The laboratory identified several goals in 2016 to enhance sustainability and environmental performance and made—and continues to make—significant progress toward them.

Sustainability is integral to both NREL's research and operations, and the laboratory is committed to demonstrating federal leadership in sustainability and continuously improving performance. Sustainable NREL, an interdisciplinary initiative involving staff from across the organization, fosters environmental and social responsibility, working to establish NREL as a global model for sustainability.

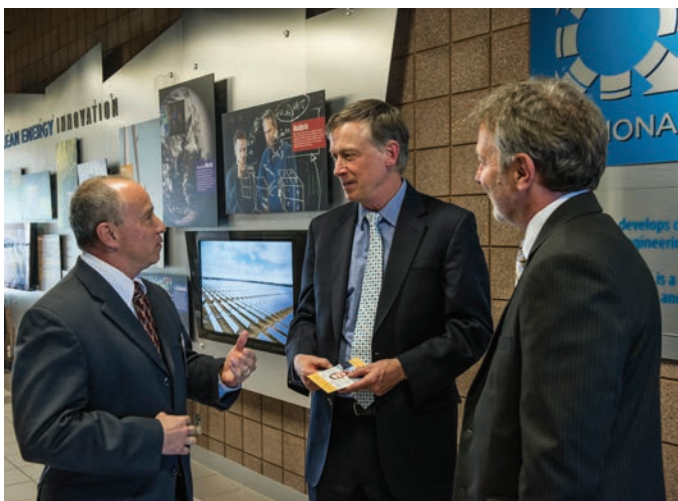
The following are some of the laboratory's key accomplishments:

- Achieved short-term internal environmental and sustainability goals, and made progress toward long-term goals (for more details, see section 2, Environmental Management System and Pollution Prevention, and section 3, Sustainability)
- Received several awards and recognitions for environmental and sustainability accomplishments (see sidebar on page 8)
- Maintained International Organization for Standardization 14001:2004 environmental management system certification, as verified by a team of external auditors
- Continued to make progress on identifying and implementing solutions to operational vulnerabilities that could result from climate change



Visitors attend the dedication of the Composites Manufacturing Education and Technology Facility at the National Wind Technology Center, where research related to innovative blade components manufacturing occurs in cooperation with the Institute for Advanced Composites Manufacturing Innovation and industry partners. *Photo by Dennis Schroeder, NREL 41857*

- Recognized with a DOE Climate Change Adaptation Sustainability Award for supporting DOE in developing a guidance document to assist other DOE laboratories in developing vulnerability assessments and resilience plans
- Piloted a nitrile glove recycling program, resulting in 39 pounds of gloves being diverted from the landfill; recycled gloves are used in making park benches, tables, and fencing
- Successfully restored an area of the South Table Mountain site that had been disturbed four years earlier; the area required several reseeding and restabilization efforts before Environmental Protection Agency stormwater permit coverage could be terminated
- Designed and constructed a means of utilizing discharge from a new, large deionizing water system at the Solar Energy Research Facility for make-up water in the cooling towers at both the Solar Energy Research Facility and the Science and Technology Facility at the South Table Mountain site
- Identified unneeded or expired chemicals as part of a cleanup effort in several laboratories; materials were collected for reuse or proper disposal
- Conducted spill tests using 55-gallon (208-liter) water-filled drums to identify the speed, direction, and distance over which a potential spill would migrate; based on the findings, purchased additional spill control equipment and modified response practices
- Obtained and stocked a rapid-response trailer to be used in the event of a large spill
- Continued to provide support to DOE in identifying potential environmental impacts related to renewable energy efforts that support DOE's mission
- Continued acoustical bat monitoring at the National Wind Technology Center and conducted additional surveys in cooperation with the U.S. Fish and Wildlife Service at the adjacent Rocky Flats National Wildlife Refuge
- Conducted wildlife surveys at the National Wind Technology Center; highlights included documentation of the northern leopard frog (a state species of concern) and feline predators (bobcat and mountain lion)
- Installed bird diverters on the South Table Mountain site employee parking garage glass windows, in an effort to eliminate possible bird-glass collisions
- Supported pollinator protection efforts by collecting onsite and then distributing milkweed seeds in the South Table Mountain site detention basin
- Participated in a symposium at the National American Ornithological conference, presenting experience gained on bird mortality due to building glass and the enhancements made to NREL facilities to reduce bird-building collisions
- The National Wind Technology Center facilitated testing of an innovative radar system intended to reduce avian collisions with wind turbines
- Surveyed and mapped vegetation at the National Wind Technology Center, the results of which will be used for conservation efforts and weed management.



NREL Director Martin Keller (right) and DOE Golden Field Office Director Derek Passarelli (left) welcome Colorado Governor John Hickenlooper to the Energy Innovator Speaker Series co-hosted by NREL and DOE's Office of Energy Efficiency and Renewable Energy's Golden Community Council. *Photo by Dennis Schroeder, NREL 36901*

ENVIRONMENTAL COMPLIANCE AND MONITORING

NREL is subject to many federal, state, and local environmental laws and regulations, in addition to executive orders, DOE requirements, and agreements with government agencies. Unlike many other DOE facilities, NREL does not conduct work involving nuclear materials and does not have legacy radiological or other contamination issues associated with past nuclear weapons production or research activities; therefore, continuous radiation or radiological contamination monitoring is not conducted.

The laboratory continued its excellent record of environmental compliance in 2016. No violation notices were received from any regulatory agency and all required permits were received or renewed; required registrations were completed, and required notifications and reports were submitted.

Environmental Management Programs

The laboratory continues to meet or exceed compliance requirements and strives to make continual improvements in environmental management. Major environmental programs include:

- Air quality protection including air permitting, ozone depleting substance management, and greenhouse gas emissions monitoring
- Water quality protection including construction stormwater management, drinking water monitoring, and preventing unallowable sanitary sewer system discharges
- Hazardous materials and waste management including pollution prevention; spill response; proper storage,

use, and disposal of hazardous chemicals and materials; planning; permitting; and reporting regarding use and emissions of such materials

- National Environmental Policy Act reviews
- Natural and cultural resources protection, including wildlife, vegetation, protected species, wetlands, and cultural resources management.

The laboratory continued to improve its environmental management and performance in 2016, as demonstrated by a track record of excellent compliance with regulatory requirements and established leadership in environmental and sustainability management.

Prestigious Environmental Sustainability Awards Received

NREL received several important recognitions in 2016 for its environmental and sustainability accomplishments, including:

- DOE Climate Change Adaptation Sustainability Award for its work in resilience planning in the face of a changing climate
- DOE Waste Diversion Sustainability Award for an innovative and effective waste diversion and composting program
- Green Buy Program Gold Award for purchasing 11 products in six different categories, achieving DOE's Green Buy leadership goal
- Three Star Electronic Product Environmental Assessment Tool Purchases Award from the Green Electronics Council for excellence in the procurement of high-performance, sustainable electronics
- Colorado Environmental Leadership Program Gold-Level Leader Award for exceeding regulatory requirements and for continued partnership with the Colorado Department of Public Health and Environment since 2004.

NREL's Continued International Organization for Standardization 14001 Certification Demonstrates Commitment to Environmental Leadership

During 2016 the laboratory maintained International Organization for Standardization 14001:2004 certification of its environmental management system. A team of external auditors conducted an independent assessment of the policies, procedures, tools, and roles and responsibilities used in environmental management. The assessment verified that the laboratory continues to meet the requirements of the International Organization for Standardization 14001 standard and demonstrates the laboratory's commitment to environmental stewardship.



1 INTRODUCTION

An NREL scientist works with a gallium indium phosphide catalyst that can be used in large-scale commercial photochemical water splitting systems to produce hydrogen. NREL scientists have identified this and other molecular catalysts as potential replacements for high-cost precious metals currently needed for large-scale commercial hydrogen production. *Photo by Dennis Schroeder, NREL 35868*

1.1 PURPOSE

This report presents a summary of the National Renewable Energy Laboratory's (NREL's) environmental management activities in 2016, including:

- Environmental protection programs
- Environmental and sustainability performance
- Environmental compliance activities and status
- Environmental management highlights and successes.

This report incorporates the U.S. Department of Energy's (DOE's) most recent guidelines for the Annual Site Environmental Report, as required by DOE Order 231.1B Admin. Chg. 1, *Environment, Safety, and Health Reporting*.

1.2 OUR MISSION

NREL's mission focuses on advancing the energy goals of DOE and our nation. This focus is captured in the mission statement:

NREL develops renewable energy and energy efficiency technologies and practices, advances related science and engineering, and transfers knowledge and innovations to address the nation's energy and environmental goals.

NREL fulfills its mission through technology portfolios. A brief description of each major technology area follows.

- **Basic science** – NREL performs fundamental research in the sciences that underlie renewable energy and energy-efficient technologies.
- **Bioenergy** – NREL has major programs in biomass-derived fuels (biofuels) and biomass-derived electricity (biopower), and projects in biomass-derived chemicals and materials.



An NREL engineer loads a wafer carrier into the Singulas tool, an automated wet-process station within the newly completed 20,000 sq. ft. (1,858 sq. meters) cleanroom located in the Science and Technology Facility. The new cleanroom and tool will enable reproducible processing of high-efficiency solar cells and collaboration with industry partners and other research laboratories. *Photo by Dennis Schroeder, NREL 45985*

- **Building energy** – NREL supports the research and development of technologies and practices for energy efficiency, working closely with the building industry and manufacturers. NREL also promotes energy- and money-saving opportunities to builders and consumers, and works with state and local regulatory groups to improve building codes and appliance standards.
- **Computational sciences** – NREL performs basic and applied research using high-performance computing and applied mathematics.
- **Distributed power** – Distributed power draws upon small-scale power generation sources (e.g., photovoltaic cells/arrays and wind turbines) located close to where the electricity is used (e.g., a home or business) and therefore provides an alternative to or an enhancement of the traditional electric power grid. NREL participates in the development of technologies, market structures, and policies that affect the incorporation of renewable and energy efficiency technologies in distributed power systems.
- **Electricity technologies** – NREL supports electricity technologies that include renewable energy, hydrogen, and superconductivity technologies, as well as utility resources.
- **Energy analysis** – Energy analysis at NREL is performed to guide policy and investment decisions as energy-efficient and renewable energy technologies advance from concept to commercial application to market penetration.

- **Hydrogen** – NREL is a leader in renewable hydrogen production technologies and the development of codes, standards, and advanced storage and sensors. Basic and applied research and material development using biology, physics, and chemistry enable and support the development of hydrogen production, storage, and end-use systems.
- **Measurements and testing** – NREL laboratories and facilities enable state-of-the-art testing on photovoltaic cells, building technologies, and wind turbines.
- **Photovoltaics** – Photovoltaic cells enable the direct conversion of sunlight to electricity using solid-state materials. The National Center for Photovoltaics develops and deploys photovoltaic technology for the generation of electric power.
- **Renewable energy resources** – Researchers develop resource information for solar, wind, biomass, and geothermal energy applications.
- **Renewable thermal technologies** – NREL scientists research thermal technologies including concentrating solar power, solar water heating, and geothermal heat and power, which generate power from heat or utilize heat from renewable resources.
- **Transportation** – NREL works with industry experts to develop advanced vehicles and transportation systems. NREL also works with energy companies and manufacturers of vehicles and engines to develop advanced motor vehicle fuels for improved energy and environmental performance.
- **Wind energy** – Through the National Wind Technology Center, NREL develops, improves, and demonstrates the viability of wind technology for electricity generation and facilitates its utilization throughout the world.



A senior engineer at the Integrated Biorefinery Facility examines a filtering basket centrifuge used in the production of biofuels. *Photo by Dennis Schroeder, NREL 35849*



Researchers at the Energy Systems Integration Facility evaluate a lithium-ion battery simulation to identify its response to mechanical, electrical, and thermal failure. Such modeling efforts contribute to improvements in battery performance and safety, and reductions in manufacturing cost. *Photo by Dennis Schroeder, NREL 41716*

1.3 SITE AND FACILITY DESCRIPTION

NREL's five facilities occupy four separate locations in Jefferson County, Colorado, and one location in the City and County of Denver. These include:

- National Wind Technology Center (NWTC)
- South Table Mountain (STM)
- Denver West Office Park
- Joyce Street Facility
- Renewable Fuels and Lubricants Research Laboratory.

The STM site and the NWTC are the primary locations for NREL research operations. The Denver West Office Park is leased space used primarily for administrative functions and limited research activities. The leased Joyce Street Facility space is primarily used for storage. The Renewable Fuels and Lubricants Research Laboratory facility is a leased research space that consists of a single vehicle high bay and small office area housed within the Regional Transportation District's District Shops and Operations Center facility in Denver.

Climate

The climate for the geographic region of NREL operations is classified as semi-arid, typified by limited precipitation, low relative humidity, abundant sunshine, and large daily and seasonal temperature variations.

The area experiences moderate precipitation, with an average annual rainfall of less than 20 inches (50 centimeters [cm]). Almost half of the annual precipitation occurs from March to June. Summer showers contribute 33% of the annual precipitation total. Precipitation



An NREL engineer assembles a prototype room air conditioner, EcoSnap-AC, which is designed as a simple snap-together system—with indoor and outdoor components that snap together through a wall connection rather than being mounted in a window opening. EcoSnap-AC delivers high efficiency cooling, with reduced noise and air leaks. The wall connection also eliminates the need to remove the device during the winter months. *Photo by Dennis Schroeder, NREL 36341*

begins to decrease significantly in the fall, reaching the minimum during winter. Winter is the driest season, contributing less than 10% of the annual precipitation, primarily in the form of snowfall.

Spring is a season of unstable air masses with strong winds along the foothills of the Rocky Mountains and the Front Range. The highest average snowfall typically occurs in March, during which time at least one heavy snowstorm of between 6 to 10 inches (15 to 25 cm) may occur.

The solar radiation (sunlight energy) of the region is excellent for outdoor research and testing of solar energy conversion devices and systems. Sunshine is abundant throughout the year and remarkably consistent from month to month and season to season.

South Table Mountain Site

The STM site is the main research center for NREL—nearly 80% of the laboratory's staff has offices and laboratories there. The STM site is approximately two miles (3.2 kilometers [km]) east of Golden and 12 miles (19.3 km) west of central Denver.

Land Use

The STM site is a roughly triangular parcel of land occupying portions of the top, sides, and lower south-facing slopes of South Table Mountain, a mesa that stands approximately 492 feet (150 meters) above the adjacent lowlands. South Table Mountain is composed of sedimentary rocks below a basalt lava cap, which is quite resistant to erosion.

The STM site is a 327-acre (132 hectares) area predominantly bordered by open grassland zoned for recreation and light commercial activity. Portions of the community of Pleasant View are located immediately to the south and west. Pleasant View has constructed a recreational park immediately south of the STM site. Offices, shops, and a tree nursery owned by the Colorado State Forest Service are located at the far western edge. Undeveloped state land and a Colorado State Highway Patrol pursuit driver-training track are located along the northwestern boundary of the STM site on top of the mesa. Jefferson County open space wraps around the northern and eastern edges of the site. Portions of the Denver West Office Park and apartment homes lie to the east.

More than half of the STM site (177 acres / 72 hectares) is preserved in a conservation easement. No development is allowed on that land, with the exception of some existing utility easements and recreational trails to be established by Jefferson County Open Space. (For more details, see section 10, Conservation Lands.)

Geology, Soils, and Hydrogeology

South Table Mountain was formed as weak sedimentary rocks surrounding lava were eroded away, leaving the lava-capped mesa in relief. Below the lava caprock, the sedimentary rocks are part of the Denver Formation that consists of layers and lenses of claystone, sandstone, and conglomerate. Sedimentary rocks of the Arapahoe Formation underlie the Denver Formation.

Both the Arapahoe and Denver Formations are considered to be aquifers in portions of the Denver Basin. The Denver Formation underlies the areas on which most NREL construction has taken place. Groundwater on the STM site occurs primarily in the weathered and fractured silts and sands of the Denver Formation. There may also be some groundwater in the form of perched aquifers below the basaltic lava cap on South Table Mountain, and within the materials above the Denver Formation, which are largely the result of stream deposits. Groundwater flow on the site is in a southeasterly direction.

The soil covering the top of South Table Mountain is lava loam. Loam is composed of a mixture of clay, sand, silt, and organic matter. The loam on the mesa top is a shallow, well-drained clayey soil. Soil on the upper side slopes of South Table Mountain is also a loam and consists of extremely stony soils with significant amounts of clay. Much of the remainder of the site, including the area designated for major development, has a deep, well-drained soil referred to as Denver clay loam. It consists of clayey material containing some calcium carbonate. There are also two smaller soil areas on the southwestern portion of the site, both of similar character to other site soils—cobble clay loam and very stony clay loam.

Surface Water

About 90% of the surface drainage from the site, both from the mesa top and across the lower portions of the site, flows in a southeasterly direction toward Lena Gulch (a tributary of Clear Creek). While there is no



NREL's South Table Mountain Site. Photo by Dennis Schroeder, NREL 30709

permanent stream flow on the STM site, occasional flow from extended periods of precipitation, usually during the late winter and early spring, is found in the drainage channels, with seasonal springs evident along some of the mesa slopes. The mesa top features one seep that is often active throughout much of the year, but the water infiltrates and evaporates quickly during the dry season.

Vegetation

Two primary vegetation types are present on the STM site: grasslands and shrublands. The most common plant communities on the STM site are mixed grasslands, comprising more than 80% of the vegetation on the site. These communities are generally dominated by short- and mid-grass species. Two primary upland shrub communities occur on the STM site: mountain mahogany shrublands, found on the shallow soils of the mesa, and upland shrublands, occurring in drainages lacking active channels as well as drainages with associated wetlands. Field surveys have identified limited wetland and riparian areas along drainages. The wetland communities identified on the STM site are a minor component of the total vegetation cover, accounting for less than 1% of the vegetation over an area of less than 0.75 acres (0.3 hectares). Riparian shrub communities also occur adjacent to the emergent wetlands. The most recent vegetation survey of the STM site was conducted in 2011. (For more details, see section 9.3, Vegetation Management.)



Elk are frequently seen at the NWTC during the winter months.
Photo by Martina Newman, NREL 36551

Wildlife

Several comprehensive wildlife surveys have been conducted on the site, starting with the original study in 1987. Additional surveys were done in 1999 of the conservation easement property. Surveys to update existing data were completed in 2005 and 2011. Numerous mammals, and several types of amphibians and reptiles, have been identified during the surveys. More than 75 species of birds and a number of raptor species have also been recorded at or above the STM site by formal wildlife surveys and through employee observations. (For more details, see section 9.1, Wildlife Management, and Appendix B, Wildlife Species Observed at the STM Site and NWTC).

National Wind Technology Center

The NWTC is the main facility for NREL's wind turbine technology research. Located on the Jefferson-Boulder County border just east of the foothills of the Rocky Mountains, the NWTC has abundant wind resources that are critical for the variety of projects conducted at the site. The NWTC is located near the intersection of Highways 93 and 128, between Boulder and Golden, and is approximately 15 miles (24.2 km) north of the STM site.

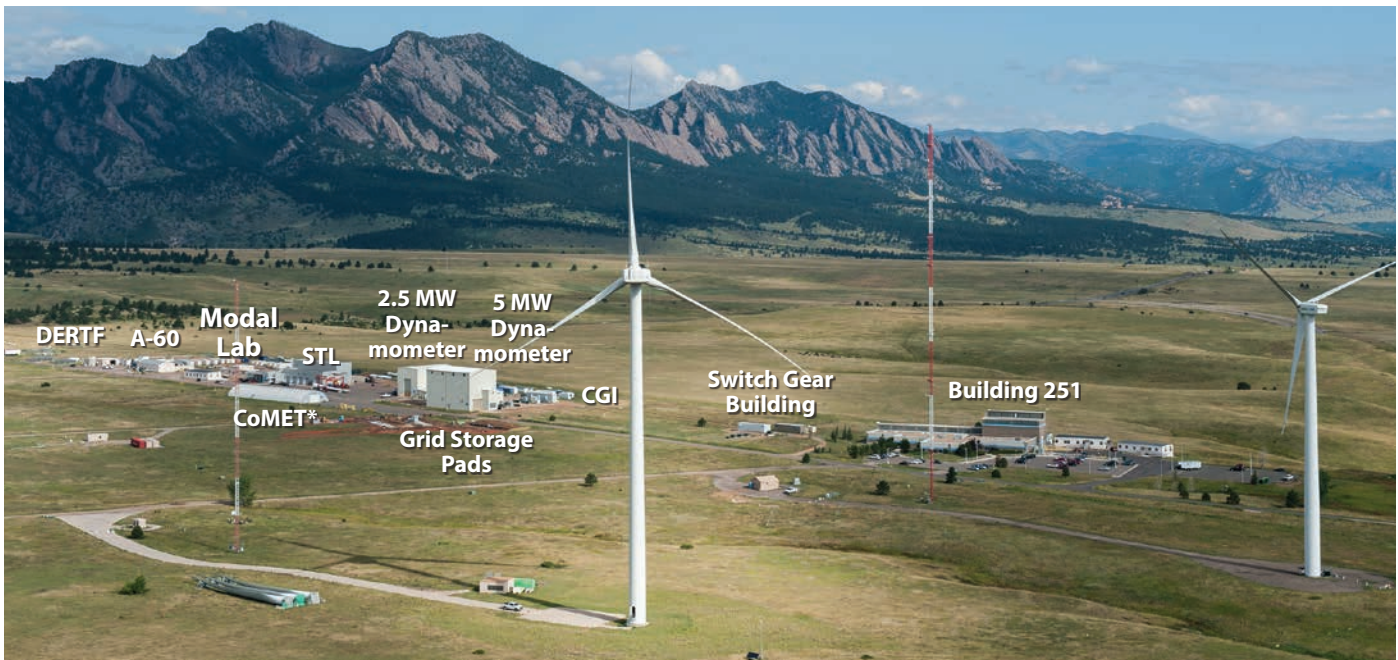
Land Use

The NWTC occupies a 305-acre (124 hectares) area surrounded by open space, grazing, and industrial land uses. The Rocky Flats National Wildlife Refuge (RFNWR) borders the NWTC to the south and east. A restored sand and gravel mine is located due south (on RFNWR property), and an expanded shale and clay lightweight aggregate production operation is located along the southern portion of the western boundary of the site. A propellant fracturing company also has a small installation along the northern portion of the western site boundary. The City of Boulder owns open space bordering the NWTC to the north; State Highway 128 lies to the north of that open space.

Geology, Soils, and Hydrogeology

The NWTC is located on a plain formed by stream deposits. The uppermost geological layer beneath the site is known as the Rocky Flats Alluvium. It is composed of cobbles, coarse gravel, sand, and gravelly clay. Below the Rocky Flats Alluvium are the Laramie Formation, Fox Hills Sandstone, and Pierre Shale. These rock formations consist primarily of claystones with some siltstones. Unconfined groundwater flow occurs in the Rocky Flats Alluvium toward the east/southeast, and small perched zones are common. Groundwater occurs as confined aquifers in the deeper bedrock formations.¹

¹ EG&G Rocky Flats, Inc. (1992). Rocky Flats Plant Site Environmental Report, January Through December 1992. Golden, Colorado.



*Composites Manufacturing Education and Technology Facility
 NREL's National Wind Technology Center. Photo by Dennis Schroeder, NREL 30766

The NWTC has a strongly developed soil defined as a very cobbly, sandy loam. The soil is characterized by a large amount of cobble and gravel in the soil volume, and subsoil dominated by clay.

Surface Water

The area surrounding the NWTC is drained by five streams: Rock Creek, North Walnut Creek, South Walnut Creek, Woman Creek, and Coal Creek. Rock Creek flows eastward and is located southeast of the NWTC. North Walnut Creek and South Walnut Creek flow eastward into the Great Western Reservoir. Woman Creek drains eastward into Standley Lake. Coal Creek flows in a northeasterly direction across the City of Boulder Open Space north of the NWTC.

The majority of the NWTC drains into a tributary to Rock Creek. Some of the northern portions of the site drain into Coal Creek or its tributaries.

Vegetation

The NWTC is located in the transition area between the Great Plains and the Rocky Mountains.² This location results in a flora that contains elements from both mountain and prairie ecosystems, and associations that represent residual tallgrass prairie, shortgrass plains, ponderosa pine woodland, and foothill ravine flora.³

Vegetation surveys conducted at the site have identified more than 270 vascular plant species and defined five

major habitat types on the NWTC, including xeric-mixed grasslands, pine woodlands, shrublands, wetlands, and disturbed areas.

Along the northwestern ridge is a ponderosa pine woodland area. Vegetation found in this area includes woody species with an understory of grasses, forbs, and shrubs. The most recent vegetation survey at the NWTC was completed in 2016. (For more details, see section 9.3, Vegetation Management.)

Wildlife

Although the site was heavily grazed by cattle prior to 1975, surveys conducted since that time identified several species of mammals that utilize vegetation and other habitat that exists at the NWTC. Included among these are mule deer, coyotes, white-tailed jackrabbits, and thirteen-lined ground squirrels. Amphibians and reptiles (including the prairie rattlesnake) and numerous species of birds and raptors have been documented in surveys conducted since 1992, with the most recent survey being performed in 2016.⁴ (For more details, see section 9.1, Wildlife Management.)

Denver West Office Park

The Denver West Office Park, located within the City of Lakewood approximately two miles (3.2 km) east of Golden and 12 miles (19.3 km) west of central Denver, is a relatively flat, landscaped office complex occupied

² Plantae Consulting Services. (2000). Vegetation Survey, NREL National Wind Technology Center. Boulder, Colorado.

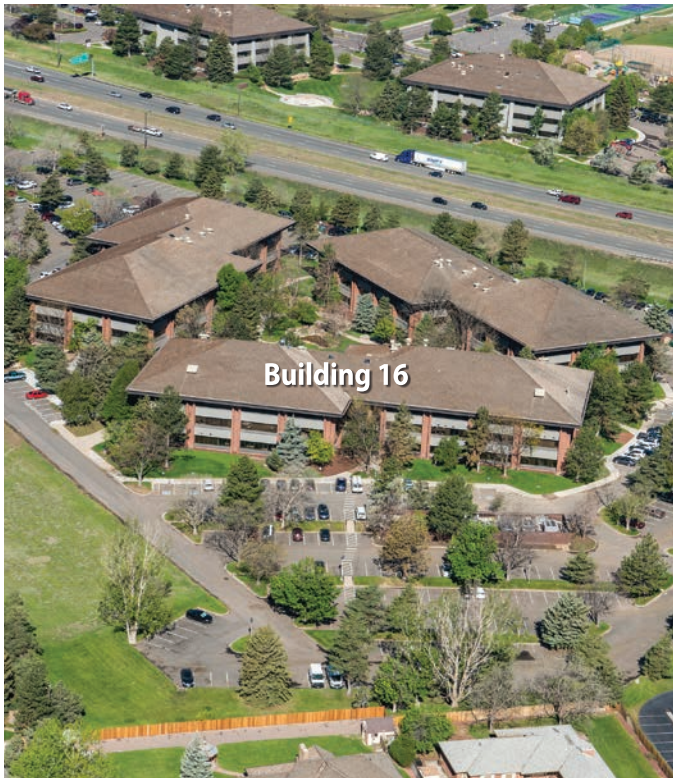
³ ERO. (2016). 2016 Wildlife and Vegetation Monitoring Report, National Wind Technology Center, Jefferson County, Colorado. Jefferson County, Colorado.

⁴ Ibid.



Joyce Street Facility (leased area indicated in blue). *Photo courtesy of Google Earth.*

by a number of four-story buildings, parking lots, and common areas. NREL-leased facilities at this location are situated approximately in the geographic center of the development. The Denver West Office Park is bordered on the south by commercial areas (West Colfax strip), and on the west by the Pleasant View residential area, Camp George West facility, and the STM site. In addition to office spaces, activities at the Denver West



Denver West Office Park, Building 16. *Photo by Dennis Schroeder, NREL 44872*



A hydraulic hybrid refuse vehicle undergoes chassis dynamometer testing at NREL's Renewable Fuel and Lubricants Research Laboratory to determine the fuel economy and emissions impact of its hydraulic hybrid technology in a controlled setting.

Photo by Dennis Schroeder, NREL 38575

Office Park include low-risk research related to fuel and battery characterization, thermal analyses of vehicle cooling loops, vehicle electrical systems analysis, and photo-electrochemical hydrogen production.

Joyce Street Facility

The Joyce Street Facility is located in a commercial area surrounded by agricultural land, residential neighborhoods, and small businesses. It is currently used by NREL primarily as warehouse space; there are no staff offices at this location. The Joyce Street Facility is located at 6800 Joyce Street, about 5.5 miles (8.9 km) north of Denver West Office Park and the STM site.

Renewable Fuel and Lubricants Research Laboratory

The Renewable Fuels and Lubricants Research Laboratory is used for research, testing, and support activities related to advanced fuels, engines, and vehicles to objectively evaluate performance, emissions, and energy efficiency impacts, including the evaluation and development of heavy-duty hybrid vehicles. The laboratory consists of a single vehicle high bay and a small office area housed within the Regional Transportation District's District Shops and Operations Center located at 1900 31st Street, Denver, approximately 12 miles (20 km) east of the STM site. The District's Shops and Operations Center facility occupies approximately 22 acres (9 hectares) of land and

serves as the primary maintenance facility for the Regional Transportation System's bus and light rail train systems. The area around the facility consists of commercial and light industrial development.

The site lies on relatively flat terrain with a slight gradient to the northwest. The general area is highly developed

with concentrated industrial and commercial activities. Very little natural vegetated habitat exists on site or in the immediate vicinity. There are trees and shrubs lining the South Platte River adjacent to the site's southern, eastern, and northeastern borders.



2 ENVIRONMENTAL MANAGEMENT SYSTEM AND POLLUTION PREVENTION

The iUNIT, a 380 sq. ft. (35 sq. meters) commercially available modular apartment, is being tested at the Energy Systems Integration Facility to identify energy efficiency and resident interaction improvements that can be incorporated into the unit's production process. *Photo by Dennis Schroeder, NREL 41418*

NREL's Environmental Management System (EMS) provides effective environmental stewardship and minimizes the environmental impacts of laboratory activities and operations. The EMS is a framework of policies, procedures, and programs that integrates environmental protection into daily work practices. The laboratory's EMS efforts include:

- Protection and enhancement of vegetation, wildlife, and natural resources of the laboratory sites
- Pollution prevention
- Compliance with environmental requirements
- Encouragement of continual improvement in environmental protection and sustainability performance.

The laboratory strives to continually minimize waste and prevent pollution, thus reducing its environmental footprint. Pollution prevention is implemented through the laboratory's EMS, the Hazard Identification and Control program, and the Sustainable NREL program.

ISO 14001:2004 Certified

NREL's EMS is certified to the International Organization for Standardization (ISO) 14001:2004 standard for environmental management systems. ISO 14001 is a globally recognized standard that defines the structure of an organization's EMS to improve its environmental performance. ISO 14001 requires an organization to identify potential environmental impacts and establish controls needed to minimize impacts, monitor and communicate environmental performance, and establish a formal process for continually improving the system.

2.1 ENVIRONMENTAL MANAGEMENT SYSTEM STRUCTURE

The EMS is structured based on a plan-do-check-act continual improvement framework described below and depicted in Figure 1.



Figure 1. NREL's continual improvement cycle

Planning

- **Environmental policy** – NREL states its commitments to the environment through this overarching policy. The policy commits specifically to:
 - Environmental stewardship
 - Pollution prevention
 - Compliance with legal requirements and voluntary commitments
 - Continual improvement of environmental and sustainability performance.
- **Environmental aspects** – NREL's environmental aspects (see Figure 2) are those activities, products, or services that are identified annually and that have the potential to interact with the environment. The significance of an identified aspect is determined by assigning a frequency of occurrence and a severity. Using this method, NREL's Environment, Safety, Health, and Quality (ESH&Q) staff review potential impacts to the environment annually, and activities in the EMS are prioritized by the identified significant aspects. NREL also utilizes a robust hazard identification and control process as part of its Integrated Safety Management System to manage environmental risks.
- **Legal and other requirements** – NREL maintains a formal process to identify regulations and standards that are necessary and sufficient to address specific

environmental hazards as well as federal laws and regulations, state and local requirements, executive orders (EOs), and DOE orders.

- **Objectives and targets** – Regular planning of activities and programs are necessary to achieve NREL's environmental goals. The ESH&Q Office and Sustainable NREL plan, implement, monitor, and report on environmental stewardship goals and actions to generate continual improvement. (For more details, see section 2.3.)



NREL encourages its employees to use alternative transportation methods by providing public transportation passes, shuttle bus connections to local transit stations, vanpools, ride-sharing information, and numerous bike racks. Such practices contribute toward management of NREL's environmental aspects. *Photo by Dennis Schroeder, NREL 38305*

Implementing

- **Structure and responsibility** – NREL policies and procedures establish roles and responsibilities for environmental management within the organization.
- **Competence, training, and awareness** – NREL verifies that workers are competent on the basis of education, training, or experience, and implements a robust environment, health, and safety training program.
- **Communication** – NREL provides a number of avenues for communication between the laboratory and the community including community meetings, lunch-and-learn events, publically available websites, periodic newsletters, and community mailings. NREL tracks and responds to all environmentally related concerns through the Public Affairs Office. Internal communication regarding environmental issues is provided via intranet sites, newsletters, emails, meetings, posters, trainings, and personal interaction with ESH&Q staff.
- **Operational control** – NREL plans and manages operations and activities in line with its environmental

policy and objectives. Staff continually identifies and reviews activities that could impact the environment, and engineering and administrative controls are put in place to minimize or avoid impacts to the environment.

- **Document and record control** – Policies and procedures ensure that the current, correct versions of documents are available for use and that records are maintained to meet requirements.

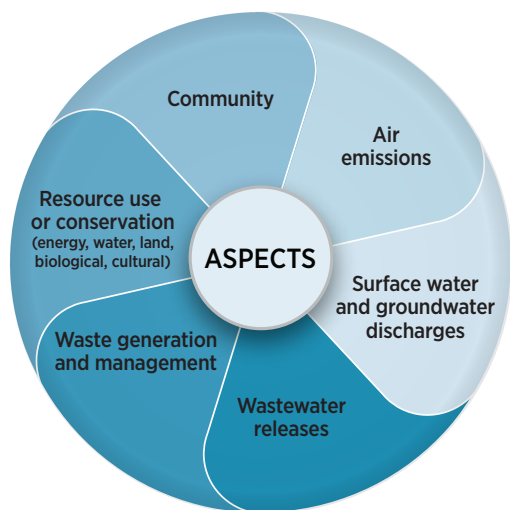


Figure 2. NREL's environmental aspects

Checking and Corrective Action

- **Monitoring, measuring, and evaluating compliance**
NREL monitors key activities, tracks performance and progress toward environmental objectives, and conducts periodic assessments of compliance with legal requirements.
- **Internal assessment** – NREL periodically conducts assessments to verify that its EMS is operating as intended. A formal system for tracking corrective and preventive actions supports continual improvement of the management system. (For more details, see section 2.4.)

Management Review

- **Management Review** – Management Review – NREL management conducts regular reviews of the EMS to provide feedback and direction for environmental performance of the organization.



Recycling paper and minimizing waste destined for the landfill are components of NREL's sustainability program. Photo by Dennis Schroeder, NREL 32222

2.2 POLLUTION PREVENTION

NREL has made a formal commitment to pollution prevention through its laboratory-wide environmental policy. NREL fulfills this commitment by implementing a variety of controls to reduce the potential environmental impacts of laboratory operations. These operations include NREL's use and storage of chemicals and fuels, as well as laboratory activities such as employee commuting and travel, and energy and water use. NREL's hazard identification and control process helps staff regularly identify opportunities to prevent pollution, and formal pollution prevention assessments are conducted periodically to identify opportunities to reduce pollution and improve program effectiveness. In addition, resources are dedicated for sustainable operations and pollution prevention through the Sustainable NREL program. While the majority of NREL's environmental management programs were established to meet compliance requirements, many of these programs go beyond compliance requirements, continually improving environmental performance.

2.3 PERFORMANCE INDICATORS AND PROGRESS

Each year measurable goals for environmental improvement are developed. Goals are identified in the following documents:

Reducing Pollution

Examples of positive impacts of reducing pollution from NREL's activities include:

- Replacing toxic chemicals with safer alternatives wherever possible to reduce potential exposure to employees, the public, and local ecosystems
- Choosing bio-based and recycled-content products to reduce impacts on natural systems
- Encouraging employees to telecommute or take

alternative transportation, and supporting Web-based meetings to reduce traffic, air pollution, and health effects on surrounding communities

- Using sustainable, low-energy, and low-water use designs for buildings to reduce greenhouse gas emissions and use of Colorado's limited water supplies
- Performing waste audits in facilities to improve diversion of materials from the waste stream to recycling/reuse streams.

- **Performance Evaluation Measurement Plan** – DOE requires every national laboratory to develop performance goals through a Performance Evaluation Measurement Plan. Each fiscal year, in collaboration with the DOE Golden Field Office, NREL's performance objectives are developed to enhance the function and compliance of laboratory activities.
- **Site Sustainability Plan** – Sustainable NREL develops a Site Sustainability Plan each year to establish sustainability performance commitments for the year and document activities that support the requirements of EO 13693, *Planning for Sustainability in the Next Decade*. Results of the plan are presented in section 3.1, Sustainability Goals.

Goals are owned by individuals and groups throughout the laboratory. Progress on each of these goals is tracked throughout the year and results are reported annually.



Xeriscaping around NREL buildings reduces water use, the risk of wildfire damage to structures, and landscape maintenance while providing attractive landscaping. *Photo by Warren Gretz, NREL 12640*

Some examples of performance related to these goals in 2016 are described in Table 1.

2.4 ASSESSMENT AND IMPROVEMENT

Assessments support the continual improvement of environmental management. Periodic assessment of the EMS and its components provides assurance that the EMS continues to be an effective tool to achieve and maintain compliance with regulatory and legal requirements, meet the established environmental goals of the laboratory, and demonstrate to ourselves and others that NREL is "walking the talk." Internal and external assessments are performed to evaluate the functionality of NREL's EMS.

- **Internal assessment** – Staff performs regular internal assessments to evaluate consistency of the EMS with the ISO 14001 standard, legal, and other requirements.
- **External assessment** – Periodically, external third-party assessments may be conducted by technical experts for specific components of environmental programs as part of continual improvement efforts. Annual surveillance assessments and triennial recertification assessments are conducted for the EMS as a whole to maintain ISO certification.

Improvements are developed and implemented as necessary based on the results of each assessment performed.

The following assessment activities took place in 2016 and have allowed NREL to enhance program effectiveness and make substantial environmental performance improvements:

- **Internal assessments** – An internal assessment of the laboratory's spill control preparedness program was completed, which involved interviews with staff and reviews of relevant procedures and records. The outcome of this assessment is included in section 7.4 Spill Prevention and Response.

TABLE 1. 2016 ENVIRONMENTAL GOALS AND ACHIEVEMENTS

2016 Goals	2016 Examples	Goal Met?
Complete National Environmental Policy Act (NEPA) enhancement project	<p>Completed NREL's NEPA Enhancement procedures to streamline the review process and successfully implemented them throughout the laboratory</p> <p>Provided NEPA training and completed quarterly monitoring</p>	Yes
Actively identify potential ESH&Q risks and modify practices accordingly	<p>Acquired stormwater structural control devices for deployment in the event of a spill</p> <p>Enhanced spill control preparedness by providing training to the Emergency Response Team and acquiring additional spill response equipment</p> <p>Initiated additional disinfectant byproducts sampling to monitor NWTC drinking water system performance</p>	Yes
Ensure procedures and controls are in place and implemented to comply with environmental regulatory requirements	<p>Staff attended trainings and webinars to continue to sharpen skills and maintain awareness of emerging emissions requirements and best practices</p> <p>Actively managed noxious weeds</p> <p>Tracked criteria air pollutants and greenhouse gases to evaluate permitting requirements (annual air emissions inventory report and Mandatory Reporting Rule report)</p> <p>Completed inspections of all STM site and NWTC petroleum drums and storage areas to verify conformance to spill prevention countermeasure and control requirements</p> <p>Provided annual Spill Response and Awareness training to NREL and contracted shuttle drivers</p>	Yes
Maintain and demonstrate continuous improvement of ISO 14001 management system	<p>Verified ISO standard compliance of management systems as documented in a surveillance performed by a third-party auditor</p> <p>Implemented all corrective actions from the prior year's ISO audit</p> <p>Developed and implemented a comprehensive assessment plan</p> <p>Completed an annual update of ESH&Q legal and other requirements applicable to operations and activities and acquired a new software service to improve access to regulatory changes</p> <p>Completed quarterly trending and analysis of ESH&Q inspection and event data in the "Quarterly ESH&Q Data Analysis Report"</p>	Yes
Develop a landscape strategy to ensure that restoration after ground-disturbing activities is efficiently and effectively completed	<p>Finalized the Landscape Restoration & Maintenance Desk Procedure, which establishes key components of landscape stewardship, identifies roles and responsibilities, and incorporates annual planning, fire protection, weed control, and de-icing management</p>	Yes

Benefits of the EMS to NREL

Reduced risk to facility/organizational mission

NREL's Hazard Identification and Control Program incorporates environmental risk assessment. System improvements also support the use of requirements to reduce the risk of non-compliance and potential enforcement actions.

Improved fiscal efficiency and/or cost avoidance

Cost savings are realized through energy efficiency projects, new renewable energy installations, waste reduction and recycling, and reduced environmental incidents such as spills.

Greater understanding and recognition of environmental issues at all levels of the organization

Staff are made aware of the potential environmental impacts from their work activities through the NREL Now internal newsletter; postings on the NREL intranet; new employee orientation, and activity-specific trainings; policies and procedures; management communications; Sustainable NREL communications; and special events such as Staff Awards (an annual employee recognition event), Earth Day, and Bike 2 Work Day. Improved awareness of environmental issues supports environmental performance throughout the laboratory.

Empowerment of individuals to contribute to the betterment of the organization's environmental footprint

Staff members are empowered to reduce the laboratory's environmental footprint by participating in programs and events for recycling single-stream materials, batteries, electronic equipment, and shredded paper, as well as a composting program. The program Be the Change encourages individuals to suggest changes to improve the environment and sustainability.

Integration of environment into organizational culture and operations

NREL strives to maintain a high level of awareness in the laboratory around safety, health, and environmental

responsibilities. This is supported through regular communications from executive management, trainings, inspections, and risk assessments.

Integration of environment into real property asset management

NREL includes environmental considerations into long-term planning for the STM site and the NWTC. Long-term site plans consider wildlife movement across the site, surface water management, and climate change impacts.

Improved community relations

The laboratory works to improve community relations by responding to and tracking all community input through phone calls, email, and community meetings, and soliciting feedback from stakeholders through the National Environmental Policy Act process. NREL takes proactive measures to engage the community with public tours, newsletters, and mailings to neighborhoods surrounding its facilities.

Improved effectiveness in overall mission

NREL's EMS supports the organization's overall mission and improves effectiveness by systematically addressing environmental opportunities and risks, ensuring compliance with regulations, and implementing voluntary commitments to achieve superior performance.

Improved collaborative conversation with other groups

The laboratory actively works in collaboration with stakeholders on environmental issues such as sustainability, renewable energy, and resource conservation and management. This includes cooperating with other agencies in controlling noxious weeds and the management of conservation areas. Additionally, NREL is a member of the West Environmental Sustainability Team, a partnership that provides outreach and resources to help the community save energy, conserve resources, use environmentally friendly products, and practice sustainability.

- **External assessments** – NREL underwent an annual assessment to verify conformance to the ISO 14001:2004 standard. The assessment was conducted by a team of external auditors and included visits to a number of the laboratory's facilities, interviews with staff at all levels of the organization, observations of

processes in place, and reviews of documents and records. The assessment resulted in two findings and ten opportunities for improvement. Findings regarding universal waste storage and labeling requirements, as well as the effectiveness of the corrective action process, have been completed.

2.5 2016 AWARDS AND RECOGNITION

In 2016, NREL received several awards and recognition of its environmental and sustainability achievements including:

- DOE Climate Change Adaptation Sustainability Award
- DOE Waste Diversion Sustainability Award
- DOE Green Buy Program Gold Award
- Green Electronics Council Electronic Product Environmental Assessment Tool (EPEAT) Purchaser Award
- Colorado Environmental Leadership Program Gold-Level Leader.

DOE Climate Change Adaptation Sustainability Award

NREL was recognized with a DOE Climate Change Adaptation Sustainability Award for its work in resilience planning in the face of a changing climate. DOE's Sustainability Performance Office funded NREL to develop a process for climate change resilience planning that could be leveraged at other DOE sites. In addition to the vulnerability assessment and resilience action plan, NREL also published a summary and best practices document to communicate the process used in the vulnerability assessment. The replicable assessment process developed at NREL will help support other DOE sites as they undertake planning efforts to manage near- and long-term climate risks.

DOE Waste Diversion Sustainability Award

NREL received an award for an innovative and effective waste-reduction program for waste diversion and composting activities. By proving that recycling and composting can be successfully accomplished in office buildings and laboratories, NREL has demonstrated the benefits of a large-scale recycling and composting program, which can be leveraged across the DOE complex.

DOE Green Buy Program Gold Award

NREL received the gold-level DOE Green Buy Award for achieving excellence in sustainable acquisition. This is the fifth year in a row that NREL has received gold-level recognition. To achieve this award, NREL met the goals for 11 product types in six different categories.

Green Electronics Council Award

In 2016, NREL received the Three-Star EPEAT Purchaser Award from the Green Electronics Council for 2015 EPEAT

purchases. Over the lifetime of those products purchased in 2015, NREL will reduce the use of primary materials by 60.5 U.S. tons (54.9 metric tons), avoid the disposal of 1,045 pounds (474 kilograms) of hazardous waste, and eliminate the equivalent of one U.S. household's solid waste—833 pounds (378 kilograms)—for 2 months. In addition, the purchase of those products will save an estimated 200,657 horsepower (149,630 kilowatt-hour) of electricity, avoid 423 pounds (192 kg) of water pollutant emissions, and reduce greenhouse gas emissions by 30.8 U.S. tons (27.9 metric tons). NREL is committed to the purchase of products designated by EPEAT, ENERGY STAR, and the Federal Emergency Management Program, wherever feasible, to continue to positively impact the environment through these purchases.

Colorado Environmental Leadership Program Gold-Level Leader

NREL maintained its status as a Colorado Environmental Leadership Program Gold-Level Leader, the highest level awarded by the program. The Colorado Environmental Leadership Program is a voluntary partnership between the Colorado Department of Public Health and Environment (CDPHE) and participating private and public Colorado facilities, and is intended to recognize environmental leadership and performance.

In early 2004, NREL was the first laboratory accepted into the program as a Gold-Level Leader and it has maintained this leadership level ever since. As a component of program membership, the laboratory's voluntary environmental performance goals, described above, further enhance operations and performance at the laboratory. Colorado Environmental Leadership Program recognizes facilities that voluntarily:

- Exceed regulatory requirements
- Implement EMS (which focuses on incorporating environmental considerations into normal management processes and improving internal environmental management effectiveness)
- Work closely with their communities
- Establish three-year goals focusing on measurable results.

Learn more about this voluntary program at the state website: www.colorado.gov/pacific/cdphe/environmental-leadership-program.

Benefits of the EMS to the Environment

Improved overall compliance management

NREL maintains a formal process to identify regulations and standards applicable to NREL, including federal laws and regulations, state and local requirements, executive orders, and DOE orders. In addition, compliance with these requirements is regularly reviewed through a variety of mechanisms, including internal assessments, inspections, and monitoring.

Personnel health and safety

Continually improving environment, safety, health, and quality management helps make NREL a safer, more environmentally responsible workplace and enhances the quality of our work processes.

Pollution prevention

Staff regularly identifies opportunities to prevent pollution through NREL's hazard identification and control process. Resources are dedicated for sustainable operations and pollution prevention through the laboratory's sustainability program.

Improved air and water quality

The EMS goals relating to the use of alternative energy sources, the use of clean burning fuels, and the minimization of the quantity of chemicals used on site contribute toward improved air quality. NREL continually strives to protect water quality onsite and offsite through

refinement and implementation of requirements related to the management of runoff, operations, and outdoor storage/use of materials at both temporary construction sites and throughout facility grounds.

Improved hazardous material, hazardous waste, and solid waste management

Hazardous material tracking through the NREL chemical inventory reduces the purchase of new supplies by allowing staff to determine if a needed chemical already exists on site. This in turn minimizes the generation of hazardous waste. The laboratory has averaged above a 75% landfill diversion rate for solid waste for several years, greatly exceeding DOE goals for waste diversion.

Improved conservation of water, natural resources, energy in facilities, fuel in vehicles

The laboratory sets goals for water, energy, and fuel usage annually and monitors progress toward each throughout the year.

Reduced number of permits needed to operate

Implementation of the EMS provides a mechanism to identify, evaluate, and implement pollution prevention opportunities including waste minimization, product substitution, and process modification. These efforts can reduce the number of regulatory requirements that the laboratory must meet.



Special fitted glass was installed on stairwell enclosures at the STM site employee parking garage to prevent bird collisions, a major cause of avian mortality, by making the glass more visible to them. *Photo by Dennis Schroeder, NREL 46044*

2.6 INTEGRATED ENVIRONMENTAL STEWARDSHIP IN CONSTRUCTION MANAGEMENT

NREL designs, builds, and refurbishes facilities using an integrated approach that allows the laboratory to achieve mission needs while addressing environmental, safety, health, and community considerations.

Project Planning and Design

An interdisciplinary team, composed of members of the laboratory's research staff, ESH&Q, the Site Operations group, and the DOE Golden Field Office, collaborates on projects beginning with conceptual planning and selection of design, and continuing through construction. Environmental staff facilitates the inclusion of environmental and sustainable requirements as well as best management practices (such as bird-friendly windows) into design.

Environmentally Responsible Construction Practices

During construction, DOE and NREL staff participates in weekly construction team meetings, monitors performance criteria, and provides ongoing feedback to the project team regarding environmental management. Environmentally responsible construction practices include: pre-construction review of project plans, performing nesting-bird surveys prior to commencing earth-disturbing activities, using a "plan of the day" to coordinate and control activities, implementing stormwater controls prior to starting excavations, minimizing impacts to wildlife, tracking waste diversion, properly storing hazardous materials, and controlling dust.

Some of the 2016 projects that demonstrate the integrated team approach and inclusion of environmental considerations in construction projects include the following:

- Renovations to an existing building for establishment of the Composite Manufacturing Education and Technology Facility at the NWTC were completed under a tight schedule and budget, yet still included the sustainable feature of a highly reflective white insulated

coating on the building interior and exterior. The exterior coating maximizes solar reflectance, thereby providing a more comfortable temperature within the building during the summer months. The interior coating, in combination with the building skylights, has eliminated the need for additional interior lighting, thus reducing the energy load of the building.

- A newly constructed cleanroom in the Science and Technology Facility was designed so that excess water from a water purifying system flows to an adjacent building, where it provides make-up water for the building's cooling tower. This design will save approximately 250,000 gallons (946,350 liters) of water per year from being directed to the sanitary sewer.

2016 Accomplishments and Highlights

- NREL successfully maintained certification to the ISO 14001:2004 standard. The assessment verified that the laboratory continues to meet the requirements of the ISO 14001 standard and demonstrates our commitment to environmental stewardship.
- All DOE laboratories are required to document and assess their performance related to topics such as environmental objectives, operational controls, compliance audits, and sustainability goal integration in their annual EMS Compliance Report. NREL received a score of "Green" (highest rating possible) for these performance metrics.
- An internal assessment of NREL's spill control preparedness program identified two areas for improvement, relating to availability of Spill Prevention Countermeasure and Control Plans and clarification of NREL environmental staff notification information used by NREL Security in the event of a petroleum spill occurrence. Both items were addressed.



Real-time energy use data at the Research Support Facility enables NREL scientists to monitor and continually improve energy performance of the Leadership in Energy and Environmental Design (LEED) Certified Platinum Building.
Photo by Genevieve Braus, NREL 46046

3 SUSTAINABILITY

NREL pursues sustainability in all laboratory operations and strives to minimize the environmental, economic, and social impacts of doing business. As one of the nation's foremost scientific institutions, the laboratory embraces the best in energy and ecological conservation practices, setting the standard for the wise use of natural resources. As a leader in sustainability, NREL's goal is to minimize the use of energy, materials, and water while carrying out the mission of clean energy research. In all site development, opportunities to integrate energy efficiency and renewable energy, high-performance buildings, and sustainable transportation options are sought. On-site deployment of technologies developed by NREL researchers is also emphasized.

3.1 SUSTAINABILITY GOALS

In accordance with DOE Order 436.1, *Departmental Sustainability*, a Site Sustainability Plan is developed each year to report on past performance and set goals for the coming year. These performance goals are integrated with the laboratory's EMS, and progress is tracked throughout the year.

To meet DOE sustainability performance goals, staff members work together regularly to improve operations and implement sustainable programs including:

- Site sustainability and pollution prevention data tracking and reporting to DOE
- Sustainability and environmental management planning
- Measurement and tracking of environmental objectives, targets, and actions
- Awareness and engagement of staff and community members.

Table 2 summarizes DOE's 2016 performance in meeting its sustainability goals at NREL. For more specific information related to each goal, please refer to the DOE's Site Sustainability Plan, which can be found at: www.nrel.gov/docs/gen/fy17/67358.pdf.

TABLE 2. SUSTAINABILITY GOALS AND PERFORMANCE SUMMARY			
Goal #	DOE Sustainability Goal	NREL Performance Status Through FY 2016	Status
1.1	50% greenhouse gas reduction from sources such as heating, cooling, and electricity use by FY 2025 from a FY 2008 baseline	Emissions decreased 86% from the baseline	Goal Met
1.2	25% greenhouse gas reduction from sources such as air travel and commuting by FY 2025 from an FY 2008 baseline	Emissions decreased 12% from the baseline	On Track
2.1	25% building energy use per square foot (energy intensity) reduction by FY 2025 from an FY 2015 baseline	Energy intensity reduced 3% from the FY 2015 baseline	On Track
2.2	Perform energy and water audits	Conducted energy and water audits on four facilities Evaluations are 100% complete	On Track
2.3	Meter all individual buildings for electricity, natural gas, steam, and water, wherever cost-effective and appropriate	100% of NREL's buildings have energy meters (including electricity, natural gas, and renewables where appropriate) 100% of NREL's buildings have chilled water meters 100% of NREL's buildings have hot water meters (NREL does not use steam) 95% of NREL's buildings have potable water meters	Goal Met
2.4	At least 17% of existing buildings greater than 5,000 gross square feet in size must comply with the revised Guiding Principles of High Performance Sustainable Buildings (HPSB) by FY 2025, with progress to 100% thereafter	Six buildings (33% of eligible buildings) are compliant with the Guiding Principles for HPSB	On Track
2.5	Efforts to increase regional and local planning coordination and involvement	Supported City of Lakewood efforts to install a new bike lane near the entrance of the STM site Successfully advocated for a route deviation on proposed new public bus route to serve NREL; new route will be instituted in conjunction with the opening of a nearby light rail line Participated in the Denver Regional Council of Governments "GoTober" multi-modal month, encouraging NREL staff to use alternative forms of transportation Developed and implemented improvements to the NEPA process with DOE Golden Field Office Monitored local bat populations at the NWTC and Rocky Flats National Wildlife Refuge property in coordination with the U.S. Fish and Wildlife Service	On Track

Table 2 continued on page 28

TABLE 2. SUSTAINABILITY GOALS AND PERFORMANCE SUMMARY			
Goal #	DOE Sustainability Goal	NREL Performance Status Through FY 2016	Status
2.6a	Net Zero Buildings: 1% of the site's existing buildings with gross square footage of more than 5,000 intended to be net zero energy, waste, or water buildings by FY 2025	One building (5%) of eligible buildings is net zero energy	On Track
2.6b	Net Zero Buildings: All new buildings (>5,000 GSF) entering the planning process designed to achieve energy net zero beginning in FY 2020	No new buildings have entered the planning process in FY 2016	On Track
3.1	Clean Energy (as defined in Executive Order 13693) requires that the percentage of an agency's total electric and thermal energy accounted for by renewable and alternative energy shall be not less than: 10% in FY 2016-FY 2017, working towards 25% by FY 2025	On-site clean energy consumed at NREL accounted for 15% of total energy consumption	On Track
3.2	Renewable Electric Energy (as defined in Executive Order 13693) requires that renewable electric energy account for not less than 10% of a total electric consumption in FY 2016-FY 2017 working towards 30% of total agency electric consumption by FY 2025	On-site renewable electric energy consumed at NREL accounted for 21% of total electric consumption	On Track
4.1	36% potable water intensity (gallons per gross square foot) reduction by FY 2025 from an FY 2007 baseline	Reduced potable water intensity 43% from the FY 2007 baseline	Goal Met
4.2	30% water consumption reduction of industrial, landscaping, and agricultural (ILA) water by FY 2025 from an FY 2010 baseline	NREL does not use ILA water at any facilities, therefore this goal does not apply	N/A
5.1	30% reduction in fleet-wide per-mile greenhouse gas emissions by FY 2025, from a FY 2014 baseline (FY 2016 target: 3%)	Fleet-wide per-mile greenhouse gas emissions represent an increase of 56% from the baseline year	Not On Track ^a
5.2	20% reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline; maintain 20% reduction thereafter (FY 2016 Target: 20%)	Petroleum consumption increased 17% from the baseline	Not On Track ^b
5.3	10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% increase thereafter (FY 2016 target: 10%)	Alternative fuel use increased 25% from FY 2015	Goal Met

^aAttainment of this goal will require acquisition of zero-emissions vehicles. Currently, the General Services Administration does not have zero-emissions vehicles available. NREL would have to purchase vehicles in order to meet this goal and funding is not currently available to do so.

^b Attainment of this goal will require replacing some/all of NREL's diesel shuttle buses with zero-emissions vehicles, for which funding and vehicle options may not be available.

Table 2 continued on page 29

TABLE 2. SUSTAINABILITY GOALS AND PERFORMANCE SUMMARY			
Goal #	DOE Sustainability Goal	NREL Performance Status Through FY 2016	Status
5.4	75% of light-duty vehicle acquisitions must consist of alternative fuel vehicles (FY 2016 target: 75%)	No light-duty vehicles were acquired	Not On Track ^c
5.5	50% of passenger vehicle acquisitions consist of zero-emissions or plug-in hybrid electric vehicles by FY 2025 (FY 2016 target: 4%)	No passenger vehicles were acquired. NREL does not currently have or plan to procure any vehicles classified as passenger vehicles	N/A
6.1	Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring that BioPreferred and bio-based provisions and clauses are included in 95% of applicable contracts	100% of construction contracts meet sustainable acquisitions requirements 100% of custodial contracts meet sustainable acquisitions requirements	Goal Met
7.1	Divert at least 50% of non-hazardous solid waste, excluding construction and demolition debris	Diverted 72% of non-hazardous solid waste from the landfill	Goal Met
7.2	Divert at least 50% of construction and demolition materials and debris	Diverted 88% of construction and demolition materials and debris from the landfill	Goal Met
8.1	Annual targets for performance contracting to be implemented in FY 2017 and annually thereafter as part of the planning of section 14 of EO 13693	Continue to utilize funding options such as Renewable Energy Credit sales, utility rebates, and in-house savings reinvestment funds. NREL will explore using Energy Savings Performance Contracts along with other alternative financing mechanisms when such options prove economically feasible	On Track
9.1	Purchases: 95% of eligible acquisitions each year are registered with the Electronics Product Environmental Assessment Tool (EPEAT), which ranks selected desktop computers, notebooks, and monitors based on their environmental attributes	99% of eligible electronic acquisitions met Electronic Product Environmental Assessment Tool standards	Goal Met
9.2	Power management—100% of eligible PCs, laptops, and monitors have power management enabled	Power management is enabled on 100% of eligible PCs, laptops, and monitors	Goal Met

^c While no light-duty vehicles were acquired in FY 2016, NREL will continue to acquire GSA-leased replacement vehicles with Alternative Fuel Vehicles, if available and as needed.

Table 2 continued on page 30

TABLE 2. SUSTAINABILITY GOALS AND PERFORMANCE SUMMARY

Goal #	DOE Sustainability Goal	NREL Performance Status Through FY 2016	Status
9.3	Automatic duplexing—100% of eligible computers and imaging equipment have automatic duplexing enabled	100% of computers and imaging equipment have automatic duplexing enabled. 100% of eligible personal printers have automatic duplexing enabled	Goal Met
9.4	End of Life—100% of used electronics are reused or recycled using environmentally sound disposition options each year	100% of electronics at their end of life were donated, resold, or recycled using environmentally sound disposition practices. 17,890 pounds of electronics were recycled in FY 2016	Goal Met
9.5	Data Center Efficiency: Establish a Power Usage Effectiveness (PUE) target in the range of 1.2-1.4 for new data centers and less than 1.5 for existing data centers (PUE is generally equal to the ratio of power used by a data center for computing functions only to the extra power needed for data center cooling and lighting)	The Research Support Facility data center PUE of 1.16 and Energy Systems Integration Facility data center PUE of 1.04 are well below the goal of 1.5 PUE for existing data centers	Goal Met
10.1	Update policies to incentivize planning for and addressing the impacts of climate change	Staff continue to make progress on goals 10.1-10.4, which are goals identified in NREL's climate change vulnerability assessment and resilience action plan	On Track
10.2	Update emergency response procedures and protocols to account for projected climate change, including extreme weather events		On Track
10.3	Ensure workforce protocols and policies reflect projected human health and safety impacts of climate change		On Track
10.4	Ensure site/lab management demonstrates commitment to adaptation efforts through internal communications and policies		On Track
10.5	Ensure that site/lab climate adaptation and resilience policies and programs reflect best available current climate change science, updated as necessary		NREL's recent climate change vulnerability assessment and resilience action plan used current climate science information provided by the Western Water Assessment (which serves as the Regional Integrated Science and Assessment climate science research team organized by the National Oceanic and Atmospheric Administration)

2016 Accomplishments and Highlights

- As indicated in Table 2, sustainability goals set by DOE were largely met or exceeded.
- Beginning in January 2016, NREL achieved net zero operational status of the Research Support Facility and maintained net zero operations throughout 2016.
- NREL's Near-Zero Waste Committee was awarded a 2016 DOE Waste Diversion Sustainability Award for the waste diversion program.
- NREL piloted a nitrile glove recycling program in 2016. Thirty-nine pounds of nitrile gloves, a non-hazardous waste, were collected from the Integrated Biorefinery Research Facility and recycled into items such as park benches, tables, and fencing. NREL plans to expand the program to other labs in 2017.
- NREL's electronics purchasing team was awarded the Three-Star 2016 EPEAT Purchaser Award from the Green Electronics Council for their exceptional commitment in support of NREL's mission to ensure purchases meet established Electronics Council Electronic Product Environmental Assessment Tool and Energy Star ratings wherever possible.



A vehicle charging station at the Vehicle Testing and Integration Facility where electric vehicles can be charged from electricity generated by solar cells mounted on an overhead canopy/shade structure. Photo by Matthew Staver, NREL 39254

2016 Compliance Summary and Activities

- Program activities were in compliance with requirements.

3.2 CLIMATE CHANGE ADAPTATION MANAGEMENT

As climate change becomes more apparent worldwide, NREL is proactively engaged in mitigation and adaptation strategies to manage site-specific climate risks, and improve resiliency of operations to ensure continuity of achieving the laboratory's mission.

2016 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- In accordance with Executive and DOE orders, NREL continued to develop specific solutions to operational vulnerabilities identified in 2015⁵ that could result from climate change. Two major activities are underway including the creation of control technologies to better manage electricity demand at NREL sites, and conducting preliminary analysis of adding battery storage on the STM site to assess the feasibility of ensuring backup power to facilities during power outages.
- The laboratory supported DOE in producing a guidance document to assist other DOE laboratories in developing climate change vulnerability screenings.
- NREL's staff provided guidance to several organizations regarding climate change vulnerability assessment and resiliency planning. These groups included the Certified Climate Change Professionals, the City of Colorado Springs Office of Sustainability, and the Energy Facility Contractor's Group, the latter with members from all DOE national laboratories.
- NREL was recognized with a 2016 DOE Climate Change Adaptation Sustainability Award for progress made in resilience planning.

⁵ J. Vogel and S. Renfrow. (2016). "Vulnerability Assessment and Resiliency Planning: The National Renewable Energy Laboratory's Process and Best Practices, May 23, 2014-June 5, 2015," Abt Associates, Inc., Boulder, CO, February 2016.



4 COMPLIANCE SUMMARY

An NREL researcher coats solar cells with a chemically tuned quantum dot solution to increase the range of wavelengths of light that can be absorbed, thus boosting the cell's efficiency. *Photo by Dennis Schroeder, NREL 44066*

NREL is subject to many federal and state laws and regulations, as well as Executive and DOE Orders and memoranda of understanding with government agencies. By observing these rules and regulations, NREL continues its excellent record of environmental compliance.

Table 3 includes a brief description of the statute or regulation and how compliance requirements were met this year. More detailed information for each area of compliance is found in the referenced sections of this report. (For information on required permits, registrations, and notifications, see Appendix C.)

TABLE 3. FEDERAL, STATE, AND LOCAL ENVIRONMENTAL LAWS AND REGULATION AND COMPLIANCE STATUS APPLICABLE TO NREL

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
Report	DOE Order 231.1B, Chg 1, <i>Environment, Safety and Health Reporting</i> , was implemented to ensure that DOE receives timely, accurate information about events that have affected or could adversely affect the health and safety of the public or workers, the environment, or the operations of DOE facilities. The order requires that DOE facilities report specific site environmental information annually, including environmental management performance, environmental occurrences and response, compliance with environmental standards and requirements, significant programs and efforts, and property clearance activities for property contaminated with radiological materials.	NREL reports annually via this Environmental Performance Report.	DOE: DOE Order 231.1B, Chg 1
EMS and Sustainability	Executive Order 13693, <i>Planning for Sustainability in the Next Decade</i> , establishes updated goals for environmental sustainability in the federal government. These goals require federal facilities to conserve natural resources, reduce energy use and greenhouse gas emissions, develop renewable energy, manage buildings and transportation in a sustainable manner, and support pollution prevention. EO 13693, together with DOE Order 436.1, <i>Departmental Sustainability</i> , requires that the laboratory implement an EMS that conforms to the ISO 14001 structure. The EMS is implemented as part of a DOE-required Integrated Safety Management System, which systematically integrates safety and environmental protection into management and work practices at all levels to protect the public, the worker, and the environment.	Each year, a Site Sustainability Plan is developed to report on past performance and set goals for the coming year. These performance goals are integrated with the laboratory's EMS, and progress is tracked throughout the year. NREL's EMS is certified to the ISO 14001:2004 international standard for environmental management systems and has been certified to ISO 14001 since 2011. Annual assessments verify that NREL meets the ISO standard and is continually improving performance.	Executive Order: EO 13693 DOE: DOE Order 436.1
Climate Change Adaptation Management	EO 13693, <i>Planning for Federal Sustainability in the Next Decade</i> , requires every federal agency to report on sustainability performance each year. DOE Order 436.1 requires federal agencies to annually submit a Site Sustainability Plan to the DOE's Sustainability Performance Office. EO 13653, <i>Preparing the United States for the Impacts of Climate Change</i> , requires NREL to include in its Site Sustainability Plan the progress the laboratory has made in meeting the climate change resilience goals specified in EO 13693.	All program activities were in compliance with requirements. In accordance with Executive and DOE Orders, NREL continued to develop specific solutions to operational vulnerabilities identified in 2015 that could result from climate change. Two major activities that are underway are the creation of control technologies to better manage electricity demand at NREL sites, and conducting a preliminary analysis of adding battery storage on the STM site to assess the feasibility of ensuring backup power to facilities during power outages.	Executive Orders: EO 13653 EO 13693 DOE: DOE Order 436.1

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TABLE 3. FEDERAL, STATE, AND LOCAL ENVIRONMENTAL LAWS AND REGULATION AND COMPLIANCE STATUS APPLICABLE TO NREL

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
Air Quality	<p>The Air Pollution Control Division of Colorado Department of Public Health and Environment (CDPHE) administers the federal Clean Air Act implementing regulations for all point sources (facilities or other types of operations) in Colorado, under authority delegated by the U.S. Environmental Protection Agency (EPA). Categories of regulated air pollutants include: criteria air pollutants, hazardous air pollutants (HAPs), ozone-depleting substances, and greenhouse gases.</p> <p>For facilities and stationary sources that emit criteria air pollutants and hazardous air pollutants, there are both federal and state requirements for permitting, reporting, emission controls, and operations, depending upon the type and amount of air pollutants emitted. Generally, these requirements become stricter as the quantity of air pollutants emitted increases, or the air pollutants have a higher potential for harm or adverse effect.</p> <p>Greenhouse gases emitted by certain facilities are required by EPA regulations to be tracked and reported if the emissions are greater than 27,557 U.S. tons (25,000 metric tons) of carbon dioxide equivalent per year. The purpose of this reporting is to better identify the actual emissions of such gases across the United States and provide the EPA with data upon which to base future greenhouse gas regulations. Reporting and permitting of greenhouse gases may be required under the EPA Prevention of Significant Deterioration regulation, Title V Tailoring Rule, and is required under the EPA Greenhouse Gas Mandatory Reporting Rule.</p> <p>Additionally, permits for major emissions sources (greater than 100 U.S. tons [9 metric tons] per year of a criteria pollutant) may be required to include greenhouse gases in the permit if carbon dioxide equivalent emissions are greater than 100,000 U.S. tons (90,718 metric tons) per year.</p> <p>EPA's Protection Of Stratospheric Ozone (40 Code of Federal Regulations [CFR 82]) requires that servicing records must be kept for appliances containing more than 50 pounds (23 kilograms) of Class 1 or 2 Ozone Depleting Substances refrigerant.</p> <p>There are several state air regulations for sources of particulate pollution, including large construction sites and street sanding operations in the winter. Particulate emissions, such as dust from construction sites larger than 25 acres (10.1 hectares), or occurring for longer than six months, are subject to state fugitive particulate emissions permits. State regulations require federal, state, and local government facilities to track street sanding in the winter and to minimize sand use.</p>	<p>All program activities were in compliance with requirements. NREL did not exceed any air permit standard or other air regulatory requirement at any facility.</p> <p>An evaluation of HAP Emissions indicated that emissions were well below reporting and permitting thresholds at all NREL sites.</p> <p>On behalf of the state, Jefferson County Public Health conducted a compliance inspection of permitted sources at the NWTC. All four standby generators and the Composites Manufacturing Education and Technology Facility were inspected. No concerns or deficiencies were identified.</p> <p>The annual evaluation of compliance with federal and state facility-wide permitting and emissions control requirements was completed. All facilities and individually permitted equipment items remain classified as minor sources.</p> <p>The required annual street sanding report was provided to the state and Jefferson County confirming that no sand was used.</p> <p>The laboratory evaluated carbon dioxide-equivalent and greenhouse gas emissions and concluded they were below the threshold for federal reporting and permitting rules.</p> <p>All equipment registrations for state-required ozone-depleting substances were completed for the STM site and NWTC. Per federal requirements, refrigerant recovery equipment has also been registered with the EPA.</p> <p>Four air permits for three standby generators at the STM site were renewed.</p> <p>An air permit covering an ammonia scrubber and particulate baghouse at the STM site was renewed.</p> <p>An Air Pollution Emission Notice was submitted to the state for new research activity at the NWTC Composites Manufacturing Education and Technology Facility.</p> <p>Final testing documentation was submitted to the state confirming that the Renewable Fuels Heating Plant emissions control equipment is operating in compliance with the air permit following firebox modifications.</p>	<p>National Ambient Air Quality Standards: 40 CFR 50</p> <p>Ozone Depleting Substances (ODS): 40 CFR 82 and CDPHE Colorado Code of Regulations (CCR) 1001-19, Reg. 15</p> <p>New Source Performance Standards: 40 CFR 60</p> <p>New Source Review, Prevention of Significant Deterioration: 40 CFR 51</p> <p>Title V: 40 CFR 70 and 71</p> <p>National Emission Standards for Hazardous Air Pollutants, Hazardous Air Pollutant: 40 CFR 63 and CDPHE 5 CCR 1001-5, Reg. 3</p> <p>Permitting: CDPHE 5 CCR 1001-5, Reg. 3</p> <p>Greenhouse Gas: 40 CFR 98 and 40 CFR 51, 52, 70, 71</p> <p>Street Sanding: CDPHE 5 CCR 1001-18, Reg. 16</p>

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TABLE 3. FEDERAL, STATE, AND LOCAL ENVIRONMENTAL LAWS AND REGULATION AND COMPLIANCE STATUS APPLICABLE TO NREL

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
Drinking Water Quality	<p>The federal Safe Drinking Water Act establishes minimum drinking water standards and monitoring requirements for drinking water supplies. Under this Act, the EPA has established allowable levels for contaminants in drinking water known as Maximum Contaminant Levels.</p> <p>The Water Quality Control Division of CDPHE implements the federal Safe Drinking Water Act in Colorado under authority delegated by the EPA.</p>	<p>Program activities were in compliance with requirements.</p> <p>All monitored parameters met applicable requirements.</p> <p>An inventory of lead- and copper-containing materials within the infrastructure for the NWTC drinking water distribution system was prepared and provided to the CDPHE Water Quality Control Commission. Recommendations were also provided to the state for revised lead and copper sampling locations that more accurately reflect higher tap use and the risk of the metals' occurrence.</p> <p>The drinking water supply at the NWTC was disrupted over the July 4 holiday weekend which depleted the water storage in the system storage tanks. The NWTC Operator in Responsible Charge worked with NREL staff to identify the cause of the disruption. Controls were subsequently modified to ensure that system shutoff would occur immediately if, in the future, a fixture/tap is stuck in the on position.</p> <p>A total of 490,656 gallons (1,857,335 liters) of drinking water were provided to NWTC users.</p>	<p>EPA: 40 CFR 141-149</p> <p>CDPHE: 5 CCR 1002-11 Reg. 11</p>
Groundwater Quality	<p>Colorado groundwater quality standards are established by CDPHE. Permits for groundwater wells are issued by the Colorado Department of Natural Resources. Permits are required for the drinking water, geothermal, irrigation, livestock watering, dewatering, monitoring, and geothermal well installations.</p>	<p>All program activities were in compliance with requirements.</p> <p>State groundwater permits obtained in 2015 from the Colorado Division of Natural Resources for three monitoring wells installed at the STM site on the north side of the Field Testing Laboratory Building were converted from temporary to permanent permits. This will allow continued monitoring of the wells to determine if groundwater or surface water is the source of water that was observed within the FTLB.</p>	<p>CDPHE: 5 CCR 1002-41 2 CCR 402-2 2 CCR 402-10</p>

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TABLE 3. FEDERAL, STATE, AND LOCAL ENVIRONMENTAL LAWS AND REGULATION AND COMPLIANCE STATUS APPLICABLE TO NREL

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
Surface Water Quality	<p>Surface water quality is controlled through the federal Clean Water Act (CWA), Energy Independence and Security Act of 2007, EO 13693, <i>Planning for Federal Sustainability in the Next Decade</i>, and the Colorado Water Quality Control Act.</p> <p>Stormwater discharges resulting from construction activities at federal facilities that disturb greater than one acre are administered in Colorado by the EPA. To obtain coverage under the EPA Construction General Permit for stormwater discharges, a site-specific Stormwater Pollution Prevention Plan must be prepared and a Notice of Intent must be filed with the EPA.</p> <p>The Water Quality Control Division within CDPHE regulates stormwater discharges at non-federal facilities within Colorado. For NREL construction projects that occur off federal property, a Colorado Discharge Permit System stormwater permit may be required.</p> <p>The Energy Independence and Security Act requires federal agencies to reduce stormwater runoff from federal development projects to protect water resources. Agencies can comply by using low-impact design elements such as porous pavers, cisterns, and bioswales, or by retaining stormwater runoff and releasing it at predevelopment rates.</p> <p>EO 13693, <i>Planning for Federal Sustainability in the Next Decade</i>, directs federal agencies to install appropriate green infrastructure features to improve stormwater management.</p>	<p>Program activities were in compliance with requirements.</p> <p>Permit coverage under the EPA Construction General Permit for one construction project was terminated after achieving the required restoration criteria. Permit coverage continues for one STM site construction project.</p> <p>Periodic stormwater inspections were performed at locations where earth-disturbing activities have occurred. The inspections and any resulting maintenance of structural stormwater erosion and sediment controls took place on construction sites operating under the EPA Construction General Permit and at smaller areas where permit coverage was not required but where stormwater best management practices are followed.</p> <p>Design was completed for stormwater conveyance improvements at the NWTC, which will improve management of frequent low flow events and address storage and water quality requirements associated with the federal Energy Independence and Security Act.</p>	<p>EPA: 40 CFR 122.26</p> <p>CDPHE: 5 CCR 1002-61 Regs. 38, 61, 65, and 93</p> <p>Executive Order: EO 13693</p>
Waste-water	<p>Wastewater is regulated at the federal level under the Clean Water Act and at the state level under the Colorado Water Quality Control Act by the Water Quality Control Division of CDPHE.</p> <p>The Metro Wastewater and Reclamation District (Metro District) manages wastewater at its treatment plant per federal and state requirements. Domestic and non-domestic wastewater flows are delivered to the Metro District's plant via conveyance systems owned, operated and regulated by numerous sanitation districts.</p> <p>Non-domestic wastewater discharges to the Metro District must comply with the Metro District's rules and regulations which incorporate requirements of the Clean Water Act.</p> <p>Onsite septic systems are regulated by the CDPHE Water Quality Control Division. Inspection and permitting of individual sewage disposal systems have been delegated to Jefferson County by CDPHE.</p>	<p>All program activities were in compliance with requirements.</p>	<p>EPA: 40 CFR 122-136</p> <p>CDPHE: 5 CCR 1002-62, 63</p>

TABLE 3. FEDERAL, STATE, AND LOCAL ENVIRONMENTAL LAWS AND REGULATION AND COMPLIANCE STATUS APPLICABLE TO NREL

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
<p>Hazardous Materials Management</p>	<p>Hazardous material management is regulated at the federal level through the Superfund Amendments and Reauthorization Act Title III, which is also known as the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA). EPCRA was created to help communities and federal, state, and local governments plan for emergencies involving hazardous substances. It also requires industry to report on the storage, use, and accidental release of hazardous chemicals to federal, state, and local governments. NREL facilities are subject to Sections 302, 304, 311, 312, and 313 of EPCRA.</p> <p>Section 302 of EPCRA requires a facility to notify the state and local emergency response and planning agencies if any extremely hazardous substances in the facility's inventory are stored in quantities greater than regulatory thresholds.</p> <p>EPCRA Section 304 requires facilities to immediately notify the state and local emergency response and planning agencies if there is an accidental spill or release of more than the predetermined reportable quantity.</p> <p>In accordance with Sections 311 and 312 of EPCRA, NREL provides Safety Data Sheets for chemicals that are stored on site in quantities greater than regulatory thresholds. In addition, NREL provides inventory reporting for these chemicals in an annual hazardous materials report, called a Tier II report, to state and local emergency response agencies and local fire departments.</p> <p>EPCRA Section 313 requires that a toxic chemical release inventory report be filed with the EPA in the event of a release for any chemical that is manufactured, processed, or otherwise used in quantities exceeding regulatory thresholds.</p> <p>Annual hazardous material permits are required by West Metro Fire Rescue for the STM site and Denver West Office Park. Permits are issued for a total of seven buildings where hazardous materials are stored and/or used. Prior to issuing the permits, a representative from West Metro Fire Rescue conducts a walk-through inspection of the entire STM site and Denver West Office Park.</p> <p>The Renewable Fuels and Lubricants Research Laboratory, located within the City and County of Denver, is subject to the Denver Fire Department's Hazardous Materials Information System requirements including permitting, inventory, and annual inspection. This facility's inventory of listed materials, including various fuels such as biodiesel, must be reported to the Denver Fire Department annually.</p> <p>Hazardous materials permits are currently not required at the NWTC or the Joyce Street Facility.</p>	<p>All program activities were in compliance with requirements.</p> <p>There were no releases of hazardous materials that required reporting. In accordance with DOE requirements, NREL screened selected chemicals to confirm that inventories are below threshold planning quantities.</p> <p>EPCRA Tier II hazardous materials reports were submitted for three facilities for reporting year 2015. The reports help state and local emergency response and planning agencies and local fire departments plan for chemical emergencies. Chemicals reported include diesel fuel, petroleum oil, and sulfuric acid contained in sealed lead-acid batteries.</p> <p>West Metro Fire Rescue conducted an annual hazardous material inspection and issued permits for seven facilities.</p> <p>The Denver Fire Department issued a hazardous materials permit for the Renewable Fuels and Lubricants Research Laboratory.</p>	<p>EPA: 40 CFR 355, 370, 372</p> <p>Executive Order: EO 13693</p> <p>DOE: DOE Order 151.1D</p>

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TABLE 3. FEDERAL, STATE, AND LOCAL ENVIRONMENTAL LAWS AND REGULATION AND COMPLIANCE STATUS APPLICABLE TO NREL

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
<p>Hazardous Waste Management (continued)</p>	<p>The Resource Conservation and Recovery Act established requirements for the management of regulated waste, including hazardous waste. In Colorado, the Hazardous Materials and Waste Management Division of CDPHE administers requirements under authority delegated by the EPA. Additional applicable requirements for hazardous material transportation are regulated by the U.S. Department of Transportation.</p> <p>NREL maintains unique EPA identification numbers for each of its five facilities: STM site, Denver West Office Park, NWTC, Joyce Street Facility, and the Renewable Fuels and Lubricants Research Laboratory. Per state and federal regulations, annual generator notifications are made and applicable fees are paid to the state based on monthly volumes of hazardous waste that are generated at each facility.</p> <p>The three waste generator classifications are:</p> <ul style="list-style-type: none"> ■ Large Quantity Generator ■ Small Quantity Generator ■ Conditionally Exempt Small Quantity Generator. <p>Four out of five of NREL's sites fall under the waste generator category of Conditionally Exempt Small Quantity Generator because they generate minimal amounts of hazardous waste per calendar month. The STM site typically produces quantities of hazardous waste well within the category of Small Quantity Generator; however, due to pilot-scale research experiments, the STM site can episodically elevate to that of Large Quantity Generator category in one or more months during the year.</p>	<p>All program activities were in compliance with requirements.</p> <p>Fourteen hazardous and 13 universal waste shipments for offsite disposal were made across NREL's five sites.</p> <p>Mandatory training on employee hazardous and universal waste management was completed in compliance with state and federal regulations.</p> <p>All regulatory notifications were submitted and applicable waste generator fees were paid.</p>	<p>EPA: 40 CFR 260- 280</p> <p>CDPHE: 6 CCR 1007-3</p>
<p>Aboveground Storage Tank Management</p>	<p>Aboveground storage tanks (ASTs) are regulated in Colorado by the Colorado Department of Labor and Employment's (CDLE) Division of Oil and Public Safety (DOPS) under the Colorado Aboveground Storage Tank regulation.</p> <p>ASTs with capacities of 660 gallons (2,498 liters) or larger must be permitted prior to installation, inspected by the state following installation, registered with the state within 30 days following commencement of use, and registration renewals submitted annually thereafter.</p> <p>Regulations require that ASTs be constructed and installed according to specific standards, be regularly inspected with all inspections documented, and that facilities meeting certain oil storage quantities employ a Spill Prevention, Control, and Countermeasures plan to manage oil sources 55 gallons (208 liters) or larger.</p>	<p>All program activities were in compliance with requirements.</p> <p>A state inspection of the five registered ASTs at the STM site was conducted. The state noted that NREL has and continues to demonstrate high levels of compliance.</p> <p>Signage on all diesel tanks was reviewed and updated to comply with new changes in National Fire Protection Association standards.</p> <p>All tanks were inspected for paint, leak detection, and piping to identify maintenance needs. Maintenance will be completed in 2017.</p>	<p>CDLE: DOPS Storage Tank Regulations 7 CCR 1101-14 Rocky Mountain Fire Protection District, West Metro Fire Protection District: International Fire Code, Sections 5003.5 and 5704.2.3.2; National Fire Protection Association 704 (2012 Ed.)</p>

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TABLE 3. FEDERAL, STATE, AND LOCAL ENVIRONMENTAL LAWS AND REGULATION AND COMPLIANCE STATUS APPLICABLE TO NREL

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
Spill Prevention and Response	<p>Oil spill prevention and response is managed at the federal level under the Oil Pollution Prevention Act and Clean Water Act, and at the state level under Colorado Storage Tank Regulations as implemented by DOPS.</p> <p>Spill Prevention, Control, and Countermeasures (SPCC) plans are required by EPA and Colorado regulations for facilities that meet certain oil storage criteria. In general, facilities that store more than 1,320 gallons (5,000 liters) of oil and have the potential for a spill to enter a waters of the United States or state of Colorado waters must have a SPCC plan. SPCC regulations require that any equipment or containers with the capacity to store 55 gallons (208 liters) or more of oil be included in the plan.</p> <p>The purpose of the SPCC plan is to prevent the discharge of oil and hazardous substances, and minimize the impact of such spills to adjacent waterways.</p>	<p>All program activities were in compliance with requirements.</p> <p>No reportable spills occurred. Eleven minor spills of diesel, lubricant, coolant, and hydraulic fluids occurred at the STM site, and three spills occurred at the NWTC. The size of spills ranged from less than 0.1 gallon to 12 gallons (0.38 to 48 liters). All spills, except for one, were the result of leaks from private and delivery vehicles and contractor and construction equipment. A total of 25 gallons (95 liters) of petroleum fluids were spilled during fourteen events, most of which occurred on paved surfaces. Each spill received immediate remedial action and there was no significant impact to the environment.</p> <p>The SPCC Plan for the NWTC was revised to include a new 280-gallon (1,060-liter) diesel fuel tank.</p> <p>The SPCC Plan for the STM site was revised to include three new oil-containing transformers located at the Energy Systems Integration Facility.</p> <p>The SPCC training required annually of all workers who manage fuel storage tanks was revised to include a knowledge test to confirm their understanding of state and NREL requirements.</p> <p>An internal assessment of the laboratory's spill-control preparedness program identified one minor deficiency. One opportunity for improvement was also identified concerning the availability of SPCC plans and clarification of NREL environmental staff notification information used by NREL Security in the event of a petroleum spill. Both items were subsequently addressed.</p>	<p>EPA: Oil Pollution Prevention 40 CFR 112</p> <p>CWA Section 319</p> <p>CDLE: DOPS Storage Tank Regulations, 7 CCR 1101-14</p> <p>CWCC: 25-8-205 CRS.</p>
Radiological Materials and Waste Management	<p>Air emissions are regulated by Section 112 of the Clean Air Act and implemented by the EPA. 40 CFR Part 61 established National Emission Standards for Hazardous Air Pollutants and, more specifically, Subpart H sets such standards for radiological materials.</p> <p>DOE Order 458.1, <i>Radiation Protection of the Public and the Environment</i>, establishes radiation emission limits for DOE facilities. These facilities, including NREL, must annually demonstrate compliance with EPA radiological air standards that limit emissions to amounts that would prevent any member of the public from receiving an effective dose equivalent of 10 mrem per year or greater.</p>	<p>All program activities were in compliance with requirements.</p> <p>No planned or unplanned radiological releases occurred.</p> <p>Only small quantities (less than 1 cubic yard [0.76 cubic meter]) of low-level (0.007 curies) radioactive waste are currently in storage awaiting off-site disposal.</p> <p>In accordance with a federal regulation and DOE Order, NREL submitted its annual Radionuclide Air Emissions Annual Report to the EPA confirming that the laboratory is in compliance with air emissions standards. For calendar year 2016, the effective dose equivalent of radiation to the public was 0.038 millirem (mrem) per year, far below the 10 mrem per year limit.</p>	<p>EPA: 40 CFR 61, Subpart H</p> <p>DOE: DOE Order 458.1</p>

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TABLE 3. FEDERAL, STATE, AND LOCAL ENVIRONMENTAL LAWS AND REGULATION AND COMPLIANCE STATUS APPLICABLE TO NREL

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
National Environmental Policy Act	<p>The National Environmental Policy Act (NEPA) requires that federal agencies determine environmental impacts of proposed federal actions and alternatives.</p> <p>NEPA regulations are established by the Council on Environmental Quality and are further implemented through DOE regulations and orders.</p> <p>Under NEPA, DOE considers and documents environmental factors used in deciding what level of analysis is required for a proposed action. These include categorical exclusions, environmental assessments and environmental impact statements.</p>	<p>All program activities were in compliance with requirements.</p> <p>A total of 383 NEPA Worksheets and 18 Environmental Checklists were completed in 2016 for project activities on- and off-site.</p> <p>A NEPA program assessment conducted in 2014 by the DOE Golden Field Office identified findings related to document control, training, and adherence to internal NEPA processes. To address the findings, the following program improvements were completed in 2016:</p> <ul style="list-style-type: none"> ■ The NEPA program was evaluated to identify projects that do not require additional review as their impacts have been thoroughly analyzed in the STM site and NWTC Environmental Assessments. ■ The NEPA worksheet was redesigned to contain all environmental review criteria on one page. A pilot program was developed to test the effectiveness of the new NEPA worksheet prior to full implementation of the revised program. ■ Training related to the new NEPA process was provided to affected staff. ■ The NREL NEPA procedure and handbook were updated and made available to all NREL employees via the NREL intranet. ■ Quarterly NEPA monitoring was conducted to determine if the updated process was effective or if adjustments need to be made. 	<p>Council on Environmental Quality: 40 CFR 1500-1508</p> <p>DOE: 10 CFR 1021</p>

Table 3 continued on page 41

TABLE 3. FEDERAL, STATE, AND LOCAL ENVIRONMENTAL LAWS AND REGULATION AND COMPLIANCE STATUS APPLICABLE TO NREL

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
Wildlife Management	<p>The Migratory Bird Treaty Act (MBTA) of 1918, as implemented by the U.S. Fish and Wildlife Service, and the Damage or Destruction of Dens or Nests-Harassment of Wildlife statute as administered by the Colorado Division of Parks and Wildlife, manage the protection of migratory birds.</p> <p>The MBTA and its amendments implement several treaties between the U.S., Great Britain, Mexico, Japan, and the former Soviet Union. The MBTA prohibits the taking, killing, or possession of migratory birds, nests, and eggs. The U.S. Fish and Wildlife Service has developed a system of permits for activities that involve the “take” of migratory birds, including those governing scientific collection and bird banding, and lethal and non-lethal measures taken to prevent depredation of agricultural crops and to protect public health and safety.</p> <p>Within the state of Colorado, no wildlife dens or nests, young, or eggs may be damaged or destroyed unless permitted by the Colorado Division of Parks and Wildlife. It is unlawful for any person to willfully harass wildlife, including birds.</p> <p>Under the “Memorandum of Understanding between DOE and the U.S. Fish and Wildlife Service Regarding Implementation of EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds,” DOE agrees to integrate migratory bird conservation principles, measures, and practices into agency activities and avoid or minimize adverse impacts on migratory bird resources and their habitats.</p> <p>Under the Presidential Memorandum, “Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators,” a Pollinator Health Task Force was created to develop a National Pollinator Health Strategy to enhance pollinator habitat on federally managed lands and facilities, and incorporate pollinator health as a component of all future restoration and reclamation projects.</p>	<p>All program activities were in compliance with requirements. Ground-nesting bird surveys were conducted prior to annual mowing operations at the NWTC in conformance with the Migratory Bird Treaty Act. A vesper sparrow (<i>Pooecetes gramineus</i>) nest was found and cordoned off; mowing was delayed in that area until it was clear that the eggs had hatched and the young had permanently left the nest.</p> <p>The site of a potential solar array at the NWTC was mowed in the late fall to accommodate spring 2017 installation. Fall mowing results in lower grass height in the following spring, decreasing the attractiveness of potential ground-nesting bird sites, and consequently avoiding conflicts with the research mission and native wildlife.</p>	<p>U.S. Fish and Wildlife Service: MBTA 16 U.S.C. 703-712</p> <p>Colorado Division of Parks and Wildlife: CRS 33-6-128 Memorandum of Understanding between DOE and the U.S. Fish and Wildlife Service</p> <p>Executive Order: EO 13186</p> <p>Presidential Memorandum – Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators</p>

TABLE 3. FEDERAL, STATE, AND LOCAL ENVIRONMENTAL LAWS AND REGULATION AND COMPLIANCE STATUS APPLICABLE TO NREL

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
Endangered Species and Species of Concern	<p>The Endangered Species Act (ESA), jointly administered by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, protects threatened and endangered wildlife and plant species and associated critical habitat.</p> <p>Federal agencies are required to abide by the Endangered Species Act and ensure that their actions do not adversely affect species that are federally listed under the Endangered Species Act as threatened, endangered, or candidate species.</p> <p>Additional federal and state laws and regulations protect wildlife, such as the Bald and Golden Eagle Protection Act.</p> <p>The Colorado Division of Parks and Wildlife identifies a list of endangered, threatened, and wildlife species of concern for Colorado. Furthermore, the Colorado Natural Heritage Program has a list of rare species that is not regulatory in nature but is unique in that it is the only designation besides the Endangered Species Act that considers rare plants.</p>	All program activities were in compliance with requirements.	<p>U.S. Fish and Wildlife Service: 50 CFR 17</p> <p>Colorado Division of Parks and Wildlife: 2 CCR 406-10, Article 2 and 3</p>
Vegetation Management	<p>The Federal Insecticide, Fungicide, and Rodenticide Act, as implemented by the EPA, regulates the use, storage, and disposal of herbicides and pesticides. For application of certain types of herbicides designated as “restricted use” by the EPA, a certified applicator must be used.</p> <p>In Colorado, the Department of Agriculture Commissioner develops and implements state noxious weed management plans for three categories of weed species. Class A plants are targeted for eradication. Class B species are subject to management plans designed to stop their continued spread. Class C species are subject to plans designed to support the efforts of local governing bodies to facilitate more effective integrated weed management on private and public lands.</p> <p>EO 13112, Invasive Species, requires the control of invasive species at federal facilities.</p>	<p>All program activities were in compliance with requirements.</p> <p>At the NWTC, herbicides were applied to approximately 122 acres (49 hectares) in April and 50 acres (20 hectares) in September to control B- and C-listed weeds.</p> <p>At the STM site, herbicides were applied to control A-, B- and C-listed weeds to approximately 20 acres (8 hectares) in May, 14 acres (6 hectares) in June and July, and 39 acres (16 hectares) in October.</p> <p>The presence of two species of knapweed weevils previously released along the Pine Ridge at the NWTC was confirmed. One species attacks the seed heads while the second attacks the roots of the knapweed plant. This effort further diversifies noxious weed control methods utilized by NREL. The effectiveness of this approach may take two or more years to determine.</p> <p>Herbicides were applied in October to a large tract (37 acres/15hectares) of grassland on the STM site conservation easement to control knapweed.</p>	<p>Executive Order: EO 13112</p> <p>EPA: 40 CFR 162-171(f)</p> <p>CRS 35-5.5</p> <p>Department of Agriculture: Federal Noxious Weed Act of 1974 (Public Law 93-629, 88 Statute 2148)</p> <p>Plant Protection Act (Public Law 106-224)</p> <p>Federal Insecticide, Fungicide, and Rodenticide Act 7 USC 136 et seq</p>

Table 3 continued on page 43

TABLE 3. FEDERAL, STATE, AND LOCAL ENVIRONMENTAL LAWS AND REGULATION AND COMPLIANCE STATUS APPLICABLE TO NREL

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
Wetlands and Floodplains	<p>Wetlands became regulated under the 1972 amendments to the Clean Water Act. Wetlands that meet certain soil, vegetation, and hydrologic criteria are protected under Section 404 of the CWA, which is administered by the U.S. Army Corps of Engineers (USACE) and the EPA.</p> <p>Under EO 11990, <i>Wetlands Protection</i>, federal agencies must provide leadership and take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands.</p> <p>EO 11988, <i>Floodplain Management</i>, requires federal agencies to provide leadership and take action to reduce the risk of flood loss; minimize the impact of floods on human safety, health, and welfare; and restore and preserve the natural and beneficial values served by floodplains.</p> <p>Counties protect floodplains by mapping the 100-year floodplain boundaries within their jurisdiction in coordination with the Federal Emergency Management Agency. They then formulate regulations to control the type and amount of development within the designated boundary.</p> <p>Jefferson County requires approval of development proposed in floodplains within its jurisdiction.</p>	<p>All program activities were in compliance with requirements.</p> <p>No NREL projects or activities that could impact wetlands or floodplains occurred.</p> <p>The STM site and the NWTC do not contain any regulatory floodplains.</p>	<p>USACE: CWA Section 404</p> <p>Executive Orders: EO 11988 EO 11990</p> <p>DOE: 10 CFR 1022</p>
Cultural Resources	<p>Cultural resources are protected under Sections 106 and 110 of the National Historic Preservation Act, which is administered in Colorado by the Colorado Office of Archaeology & Historic Preservation (State Historic Preservation Officer).</p> <p>Federal agencies must establish preservation programs—commensurate with their mission and the effects of their activities on historic properties—that provide for the careful consideration of historic properties. Significant cultural resources are either eligible for, or listed in, the National Register of Historic Places. Cultural resources are defined as any prehistoric or historic district, site, building, structure, or object considered important to a culture, subculture, or community for scientific, traditional, religious, or other reason.</p>	<p>All program activities were in compliance with requirements.</p>	<p>Advisory Council on Historic Preservation: 36 CFR 60 36 CFR 63 36 CFR 79 36 CFR 800 16 U.S.C. 470</p> <p>SHPO: 8 CCR 1504-7</p>



Air inlets and exhaust stacks for six natural-gas-fired, low-NO_x-emitting hot water boilers which provide comfort heating to the Field Test Laboratory Building. *Photo by Dennis Schroeder, NREL 45415*

5 AIR QUALITY PROTECTION

Good air quality is fundamental to the overall well-being of individuals and the environment. Each person inhales approximately 3,700 gallons (14,000 liters) of air per day, and contaminants that may be present can affect the health of individuals. In the environment, air pollutants can settle on land or wash into waterways and can affect the vegetation, aquatic life, and wildlife that depend upon those resources.

NREL strives to protect air quality by minimizing air emissions from employee commuting and research and operations activities, monitoring air emissions from the larger on-site sources, and meeting federal and state air emissions and permitting requirements. Emitted air pollutants include criteria pollutants (carbon monoxide, nitrogen oxides, volatile organic carbon, particulate matter, and sulfur dioxide) and non-criteria pollutants (hazardous air pollutants, greenhouse gas compounds, and ozone-depleting substances). Minimizing air emissions generated by the laboratory creates direct health benefits for neighbors immediately adjacent to the laboratory and for those in the Denver metropolitan area. ESH&Q staff members participate in project planning, safety evaluations, start-up, and operations activities to address air quality considerations.

The primary sources of regulated pollutants at NREL are a result of burning fuel, laboratory chemical use, and facility operations. Sources include process heat boilers, process cooling systems, comfort heating and cooling systems, standby generators, construction and maintenance equipment with gasoline or diesel engines, bench- and pilot-scale research activities using chemicals, and facility operations maintenance activities.

A summary of NREL facility estimated annual air pollutant emissions is included in Table 4.

Additional information regarding management of NREL's air quality protection program can be found in section 6

2016 Accomplishments and Highlights

- The laboratory air emissions inventory was updated, using equipment-specific emissions factors where available. This resulted in a more accurate emissions inventory.
- To reduce both criteria pollutant emissions and greenhouse gas emissions generated by the laboratory, an active transportation-demand-management program was developed and continues to reduce on-site vehicle travel and idling emissions of both private and government fleet vehicles.

of the NREL 2015 Environmental Performance Report at: www.nrel.gov/docs/fy16osti/65807.pdf.

2016 Compliance Summary and Activities

- Program activities were in compliance with requirements.
 - An evaluation of hazardous air pollutant emissions indicated that emissions were well below reporting and permitting thresholds at all NREL sites.
 - On behalf of the state, Jefferson County Public Health conducted a compliance inspection of permitted sources at the NWTC. The four NWTC standby generators and the Composites Manufacturing Education and Technology Facility were inspected. No concerns or deficiencies were identified.
- The annual evaluation of compliance with federal and state facility-wide permitting and emissions control requirements was completed. All facilities and individually permitted equipment items remain classified as minor sources.
 - The required annual street sanding report was provided to the state and Jefferson County confirming that no sand was used at the STM site or NWTC.
 - The laboratory evaluated carbon dioxide equivalent and greenhouse gas emissions and concluded they were below the threshold for federal reporting and permitting rules.
 - All equipment registrations, including annual registration renewals, for state-required ozone-depleting substances were completed for the STM site and NWTC. Per federal requirements, refrigerant recovery equipment has also been registered with the EPA.
 - Four air permits for three standby generators at the STM site were renewed.
 - An air permit covering an ammonia scrubber and particulate baghouse at the STM site was renewed.
 - An Air Pollution Emissions Notice was submitted to the state for new research activity at the NWTC Composites Manufacturing Education and Technology Facility.
 - Final compliance testing documentation was submitted to the state confirming that the Renewable Fuels Heating Plant emissions control equipment is operating in compliance with the air permit following firebox modifications.

TABLE 4. STM SITE, NWTC, AND DENVER WEST OFFICE PARK ESTIMATED ANNUAL AIR POLLUTANT EMISSIONS (IN U.S. TONS [METRIC TONS] PER YEAR)*

Year	CRITERIA POLLUTANTS					GREENHOUSE GASES			HAPs
	CO	NO _x	VOC	PM ₁₀	SO ₂	CO ₂	CH ₄	N ₂ O	Total
2011	5.82 (5.28)	8.03 (7.28)	0.44 (0.39)	0.97 (0.88)	0.15 (0.13)	8,310 (7,539)	0.24 (0.21)	0.17 (0.15)	0.19 (0.17)
2012	6.35 (5.76)	16.28 (14.77)	1.09 (0.98)	2.37 (2.15)	0.22 (0.19)	7,175 (6,509)	0.41 (0.37)	0.17 (0.15)	0.31 (0.28)
2013	6.02 (5.46)	13.83 (12.55)	0.47 (0.42)	3.16 (2.86)	0.360 (0.326)	8,584 (7,787)	0.51 (0.46)	0.25 (0.22)	0.51 (0.46)
2014	5.82 (5.28)	14.06 (12.76)	0.99 (0.89)	1.39 (1.26)	0.10 (0.09)	6,263 (5,682)	0.30 (0.27)	0.11 (0.09)	0.16 (0.15)
2015	6.42 (5.82)	15.49 (14.05)	0.54 (0.48)	3.95 (3.58)	0.45 (0.40)	9,329 (8,463)	0.56 (0.50)	0.30 (0.27)	0.63 (0.57)

*Abbreviations: HAPs – Hazardous Air Pollutants, CO – carbon monoxide, NO_x – nitrogen oxides, VOC – volatile organic carbon, PM₁₀ – respirable particulate matter less than 10 microns in aerodynamic diameter, SO₂ – sulfur dioxide, CO₂ – carbon dioxide, CH₄ – methane, N₂O – nitrous oxide.



Stormwater conveyance at the STM site. Photo by Dennis Schroeder, NREL 45420

6 WATER QUALITY PROTECTION

Water quality is critical to human health and the health of our natural ecosystems. Water quality protection at NREL falls within four main areas:

- Drinking water
- Groundwater
- Surface water
- Wastewater

Additional information regarding program management for each of these four areas can be found in section 7 of the NREL 2015 Environmental Performance Report at: www.nrel.gov/docs/fy16osti/65807.pdf.

6.1 DRINKING WATER

The STM site and NWTC are provided potable drinking water by two different means. The 2,200 staff members at the STM site are serviced by a municipal public water supplier, Consolidated Mutual Water Company. Because the NWTC is not located within the bounds of a municipal public water supply distribution system, treated water is purchased from the City of Boulder and transported by truck to the site for the 150 employees located there. Upon delivery to the NWTC, the trucked water is transferred to a large holding tank with a capacity of 15,000 gallons (56,781 liters). Water is pumped from the holding tank to a 2,000 gallon (7,580 liters) day tank, where chlorine is added to boost disinfectant levels prior to distribution to site buildings. The state of Colorado permits the system. Figures 3 and 4 show the results of chlorine and disinfection byproducts monitoring at the NWTC during 2016.

2016 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- All monitored parameters met applicable requirements.
- An inventory of lead- and copper-containing materials within the NWTC drinking water distribution system infrastructure was prepared and provided to the Colorado Department of Public Health and Environment, Water Quality Control Commission. Recommendations were also provided to the state for revised lead and copper sampling locations that more accurately reflect higher tap use and the risk of the metals' occurrence.
- The drinking water supply at the NWTC was disrupted over the July 4 holiday weekend, which depleted the water storage in the system storage tanks. The NWTC Operator in Responsible Charge worked with NREL staff to identify the cause of the disruption. Controls were subsequently modified to ensure that system shutoff would occur immediately if, in the future, a fixture/tap is stuck in the "on" position.
- A total of 490,656 gallons (1,857,335 liters) of drinking water were provided to NWTC users.

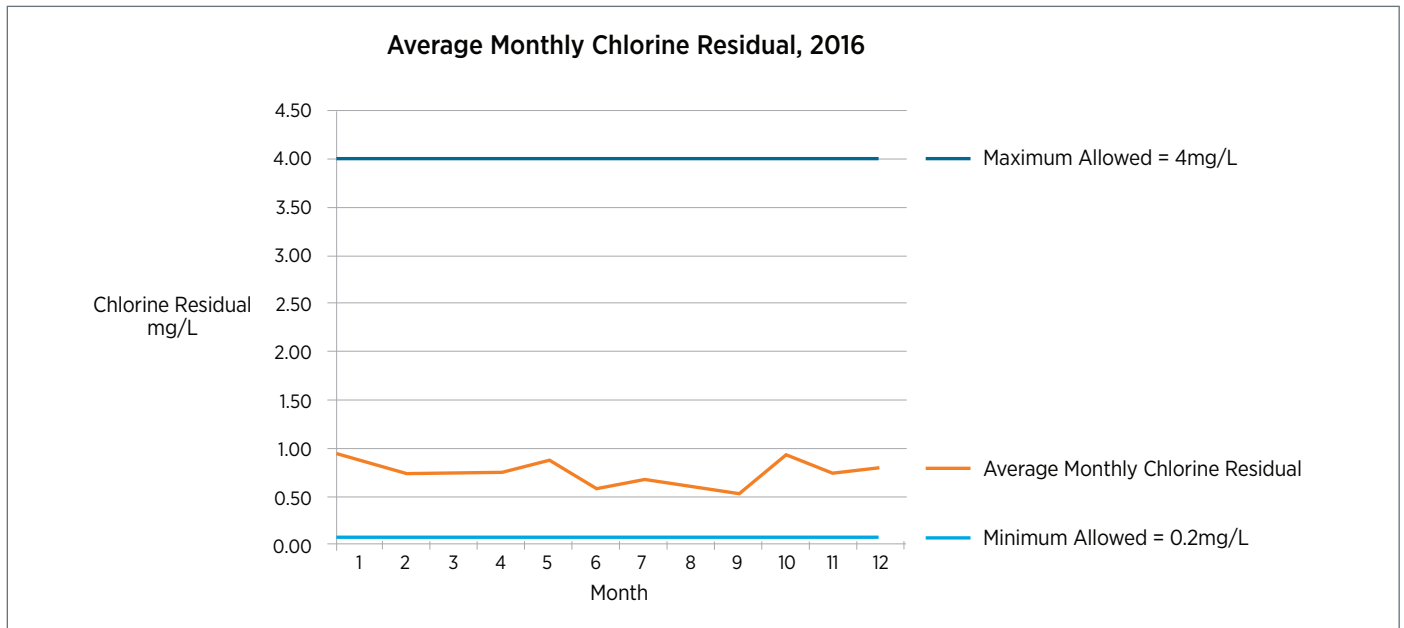


Figure 3. Results of 2016 average monthly chlorine residual monitoring at the NWTC

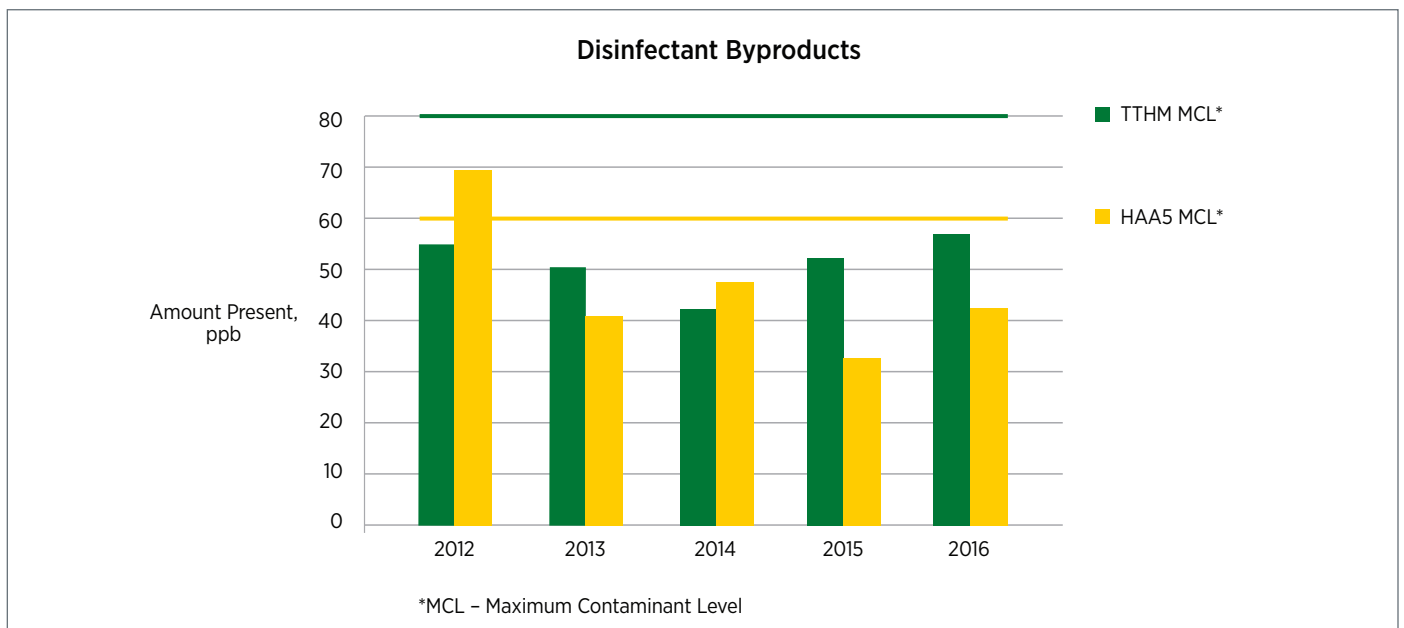


Figure 4. Comparison of disinfection byproducts monitoring at the NWTC, 2012–2016

2016 Accomplishments and Highlights

- Recordkeeping documentation for the NWTC drinking water system, including procedures and forms, was updated to incorporate new regulatory requirements and implement recommended improvements identified in a 2015 internal assessment. Additional system information about the municipally provided and delivered drinking water at the STM site was also incorporated in program documentation.
- NREL collaborated with the City of Boulder, the NWTC's water supplier, on the design of a monitoring program intended to track the change in disinfectant byproduct concentrations from source water to point of use. The results of the effort will contribute to the goals of providing excellent water quality and meeting all regulatory requirements. The first samples were collected in December 2016.



Tributaries to Rock Creek drain the northeast portion of the NWTC.
Photo by Dennis Schroeder, NREL 44789

would a source of contamination affect the groundwater quality in this aquifer.

Despite the low likelihood of reaching the Dawson aquifer, NREL's groundwater management program is focused on the control of potential pollutant sources that could affect this important resource. This includes careful evaluation of all outdoor projects to eliminate, substitute, or control potential sources of pollution.

There are currently three permitted monitoring wells at the STM site and no monitoring wells at the NWTC. There are two permitted closed-loop geothermal systems in operation at the STM site; one is located at the Solar Radiation Research Laboratory and the second is located near the South Site Entrance Building. Both of the geothermal well systems were installed as part of research activities.

6.2 GROUNDWATER

The Denver Basin aquifer system underlies an area of approximately 7,000 square miles (2,833 hectares) that extends from Greeley south to near Colorado Springs and from the Front Range east to near Limon. The aquifer provides groundwater supplies to urban, rural, and agricultural users. The aquifers within the Denver Basin aquifer system, which include the Dawson, Denver, Arapahoe, and Laramie-Fox Hills aquifers, form a layered sequence of rock in an elongated, bowl-shaped structural depression. Both the STM site and the NWTC are located at the western edge of the Denver Basin aquifer system.

The STM site overlies the shallowest portions of the Denver, Arapahoe, and Laramie-Fox Hills aquifers. The NWTC overlies the shallowest portions of the Arapahoe and Laramie-Fox Hills aquifers. The Dawson formation is the shallowest of the Denver Basin aquifers and is the one most relied on by the groundwater users in the basin. The northern extent of the Dawson aquifer is located approximately 20 miles (33 km) to the south and east of the STM site; consequently, wells drilled at either the STM site or the NWTC would not intersect the Dawson aquifer, nor

2016 Accomplishments and Highlights

- There were no spills or releases that impacted groundwater.

2016 Compliance Activities

- Program activities were in compliance with requirements.
- State groundwater permits obtained in 2015 from the Colorado Division of Natural Resources for three monitoring wells installed at the STM site on the north side of the Field Testing Laboratory Building were converted from temporary to permanent permits. This will allow continued monitoring of the wells to determine if groundwater or surface water is the source of water that was observed within the FTLB.

2016 Accomplishments and Highlights

- Successful revegetation was achieved in areas disturbed by an electrical infrastructure construction project at the STM site. Successful revegetation occurs, as defined by the EPA, when vegetative cover equals 70% of pre-disturbance cover. Carefully selected seed mixes and mulches, together with weed management and temporary irrigation, were instrumental in achieving a native grass cover sufficient to meet the EPA criteria.
- NREL and DOE Golden Field Office staff began participation in the newly formed Water Advisory Group organized by DOE Headquarters to enhance management of water resources at DOE national laboratories through collaboration during quarterly online meetings.

6.3 SURFACE WATER

Through its surface water program, NREL seeks to protect the quality of nearby receiving waters into which the STM site and the NWTC drain. These receiving waters include Lena Gulch at the STM site and Coal Creek and Rock Creek at the NWTC. Sediment, debris, and chemicals transported to these water bodies via stormwater runoff can harm or kill fish and other wildlife either directly or by destroying aquatic and riparian habitat. High volumes of sediment can result in stream bank erosion and clogging of waterways.

Water quality protection is accomplished through compliance with federal and state stormwater permitting requirements, management of stormwater runoff flowing across active construction sites, inclusion of project design elements that promote infiltration and detention of stormwater, and management of NREL grounds to minimize erosion and support infiltration.

2016 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- Permit coverage under the EPA Construction General Permit for one construction project was terminated after achieving the required restoration criteria. Permit



Erosion control measures protect native seed sown into an area disturbed during a culvert repair project at the STM site. *Photo by Dennis Schroeder, NREL 45409*

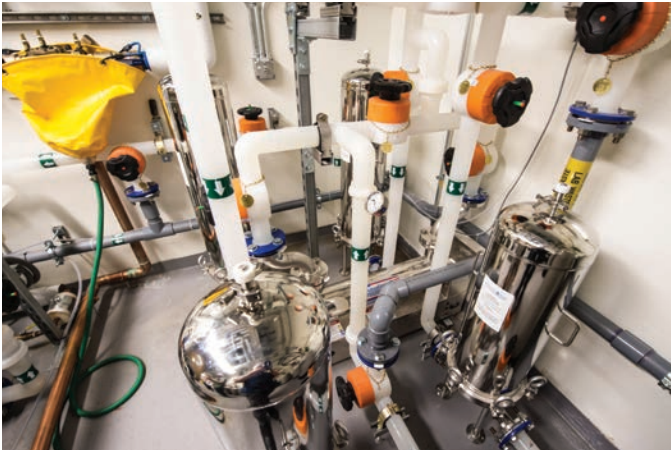
coverage continues for one STM site construction project.

- Periodic stormwater inspections were performed at locations where earth-disturbing activities have occurred. The inspections and any resulting maintenance of structural stormwater erosion and sediment controls took place on construction sites operating under the EPA Construction General Permit and at smaller areas where permit coverage was not required but where stormwater best management practices are followed.
- Design was completed for stormwater conveyance improvements at the NWTC, which will improve management of frequent low-flow events and address storage and water quality requirements associated with the federal Energy Independence and Security Act.

6.4 WASTEWATER

Untreated or poorly treated wastewater has the potential to contaminate surface and groundwater used for drinking water, irrigation, industrial, commercial, and recreational purposes. The majority of wastewater from the STM site and Denver West Office Park facilities flows into the Pleasant View Water and Sanitation District's (Pleasant View) system, and ultimately to the Metropolitan Wastewater Reclamation District's (Metro District) central treatment plant. Wastewater from the Joyce Street Facility and the Renewable Fuels and Lubricants Research Laboratory also flows to the Metro District's treatment plant.

NREL's primary non-domestic wastewater discharge is generated at the STM site's Integrated Biorefinery Research



One of several components associated with the water treatment system that delivers ultra-pure water to the wafer processing tool in the new cleanroom within the Science and Technology Facility. The discharged water from the system is used as make-up water in the cooling towers of two STM site buildings, thus drastically reducing the volume of water wasted to the sanitary sewer. *Photo by Dennis Schroeder, NREL 45977*

Facility where research related to the production of bio-based products and fuels is conducted. Acids and bases are used in pilot-scale processes for converting cellulosic biomass into a variety of fuels and chemicals. The pH of the effluent from this process is adjusted to fall within an allowable pH range prior to discharge into the sanitary sewer system. The Metro District and Pleasant View system managers periodically tour the facility and review the operational controls.

For those facilities that lack sanitary service, there are three small septic systems in place, each consisting of a tank and a leach field. One is located at the STM mesa top Solar Radiation Research Laboratory and two are at the NWTC. A preventative maintenance and inspection program is in place to confirm proper system function.

2016 Compliance Summary and Activities

- Program activities were in compliance with requirements.

2016 Accomplishments and Highlights

- NREL ESH&Q Environment staff supported a project to replace propylene glycol with ethylene glycol, the latter being a coolant capable of recovering approximately 14% more heat, in the HVAC systems at two buildings on the STM site. Samples were collected and subsequently analyzed at a specialized analytical laboratory to determine if constituents were present that would prevent directing the propylene glycol to the sanitary sewer. Chemical analyses indicated that the propylene glycol from one of the buildings contained molybdenum above the concentration allowed by the Metro District; therefore, approximately 2,000 gallons of propylene glycol from this building must be disposed of as a non-RCRA hazardous waste. An equal volume of propylene glycol was found to be compliant with the Metro District's regulations, allowing disposal to the sanitary sewer. This project is expected to be completed in 2017.
- A larger deionizing water system unit was installed to support a new solar cell thin-film research tool in the Solar Energy Research Facility. The unused portion of water passing through the system, which is equivalent to softened drinking water quality, will be used as make-up water for the cooling towers in both the Solar Energy Research Facility and the Science and Technology Facility at the STM site.



7 HAZARDOUS MATERIALS AND WASTE MANAGEMENT

Samples being agitated in the Algal Research Lab in the Field Test Laboratory Building. Laboratory research may involve the use and processing of materials that are hazardous and require special handling and disposal measures. *Photo by Werner Slocum, NREL 39512*

Responsible acquisition, use, and disposal of materials and waste are critical to meeting regulatory compliance, preventing pollution, and caring for the environment. NREL seeks to purchase materials that are sourced responsibly, contain recycled content, and have low toxicity in order to reduce the environmental impact of its waste streams. Hazardous materials used on site are thoughtfully controlled with internal procedures designed to limit health and environmental risks. Waste is carefully managed and disposed of through fully permitted facilities. Areas of focus include:

- Hazardous materials management
- Regulated waste management
- Aboveground storage tank management
- Spill prevention and response
- Radiological materials and waste management.

Additional information regarding program management for each of these five areas of focus can be found in the NREL 2015 Environmental Performance Report (www.nrel.gov/docs/fy16osti/65807.pdf), section 8.

7.1 HAZARDOUS MATERIALS MANAGEMENT

A variety of chemicals and materials, some of which are hazardous, are used in research and maintenance activities at NREL facilities. Hazardous materials are stored, used, and managed in a manner that is protective of laboratory personnel, the general public, and the environment.

2016 Compliance Summary

- Program activities were in compliance with requirements.
- There were no releases of hazardous materials that required reporting. In accordance with DOE requirements, NREL screened selected chemicals to

confirm that inventories are below threshold planning quantities.

- EPCRA Tier II hazardous materials reports were submitted for three facilities for reporting year 2015. The reports help state and local emergency response and planning agencies and local fire departments plan for chemical emergencies. Chemicals reported include diesel fuel, petroleum oil, and sulfuric acid contained in sealed lead-acid batteries. A summary of NREL's EPCRA reporting requirements are found in Table 5.
- West Metro Fire Rescue conducted an annual hazardous material inspection and issued permits for seven facilities.
- The Denver Fire Department issued a hazardous materials permit for the Renewable Fuels and Lubricants Research Laboratory.

TABLE 5. 2016 EPCRA REPORTING

EPCRA Section	Description of Reporting	Status
302	Planning Notification	Not required ^a
304	Extremely Hazardous Substance Release Notification	Not required ^a
311-312	Safety Data Sheet/ Chemical Inventory	Reported
313	Toxics Release Inventory Reporting	Not required ^a

^a"Not required" indicates that NREL was not required to report because it did not meet the threshold or did not have an extremely hazardous substance release.

2016 Accomplishments and Highlights

- Laboratory safety training was revised to reinforce workers' understanding of National Fire Protection Association standards and expand their awareness of chemical and hazardous materials safety.
- A chemical cleanout was performed in numerous laboratories.

7.2 HAZARDOUS WASTE MANAGEMENT

Research and development activities and general facility operations create a variety of waste streams, some of which contain toxic chemicals or metals. NREL typically disposes of or recycles the following categories of waste:

- Hazardous waste (as defined by environmental regulations)
- Non-hazardous waste such as diesel fuel and spent biomass processing materials (does not include municipal solid waste such as regular office trash)
- Universal waste such as mercury-containing light bulbs, lead-acid batteries, aerosol cans, and electronic waste such as computers, monitors, and research instrumentation containing electronic circuitry.

Table 6 provides a summary of quantities and types of waste generated for the past five years.

TABLE 6. COMPARISON OF FOUR WASTE CATEGORIES GENERATED AT NREL FACILITIES (IN LBS. [KGS] NET WEIGHT)

	Hazardous Waste	Non-Hazardous Waste	Universal Waste Electronics	Other Universal Waste
2012	33,386 (15,144)	8,805 (3,994)	41,355 (18,758)	4,803 (2,179)
2013	14,974 (6,792)	4,477 (2,031)	38,096 (17,280)	19,063 (8,647)
2014	14,683 (6,659)	15,198 (6,893)	28,551 (12,949)	6,738 (3,056)
2015	17,040 (7,729)	47,407 21,503	31,964 (14,499)	15,600 (7,076)
2016	14,234 (6,456)	17,340 (7,865)	14,028 (6,376)	8,686 (3,948)

2016 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- Fourteen hazardous and 13 universal waste shipments for offsite disposal were made across NREL's five sites.

- Mandatory training on employee hazardous and universal waste management was completed in compliance with state and federal regulations.
- All regulatory notifications were submitted and applicable waste generator fees were paid.

2016 Accomplishments and Highlights

- As a best management practice, all NREL facilities are managed to the stringent Large Quantity Generator hazardous waste regulations, which specify the requirements for personnel training, contingency planning, and container labeling and management.
- Waste management storage and collection areas were established in the NWTC's Composite Materials Education and Technology Facility in advance of start-up of operations.
- A DOE Golden Field Office field assessment was conducted of the laboratory's hazardous waste management program. No findings or concerns, six opportunities for improvement, and two noteworthy practices were identified. Opportunities for improvement will be implemented throughout the course of calendar year 2017.

7.3 ABOVEGROUND STORAGE TANK MANAGEMENT

Proper tank management prevents or minimizes the size of spills and leaks of fuels or oils, avoiding contamination of soils, surface water, groundwater, and drinking water, and supports the laboratory's commitments to environmental stewardship and pollution prevention.

The aboveground storage tank (AST) management program applies to petroleum fuel tanks and is intended to:

- Minimize releases from tanks
- Confirm that safety features are present and functional
- Ensure compliance with tank design, operation, training, and inspection requirements.



An example of a "satellite" waste collection station found in NREL research facilities. *Photo by Eric Schmitz, NREL 45584*

The risk of underground soil and water contamination from storage tanks is minimized by using only aboveground tanks. Unlike underground tanks, aboveground installations provide access for regular visual leak inspections and allow for less costly repair and cleanup.

NREL operates several petroleum-based ASTs, five of which are located at the NWTC with a total capacity of 1,289 gallons (4,879 liters); one is located at the NREL-occupied laboratory at the Denver West Office Park with a capacity of 500 gallons (1,893 liters); and 20 are located at the STM site with a total capacity of 13,164 gallons (49,831 liters). All ASTs are maintained using best management practices and according to applicable regulations. Five ASTs at the STM site are registered with the state. There are no ASTs that require registration at the NWTC, Renewable Fuels and Lubricants Laboratory, or Joyce Street Facility.

2016 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- A state inspection of the five registered ASTs at the STM site was conducted. The state noted that NREL has and continues to demonstrate high levels of compliance.
- Signage on all diesel tanks was reviewed and updated to comply with new changes in National Fire Protection Association standards.
- All tanks were inspected for paint, leak detection, and piping to identify maintenance needs. Maintenance is planned for spring 2017.



A double-wall 500-gallon (1,893-liter) diesel fuel tank is located inside this standby generator enclosure at the Integrated Biorefinery Facility. *Photo by Dennis Schroeder, NREL 45424*

2016 Accomplishments and Highlights

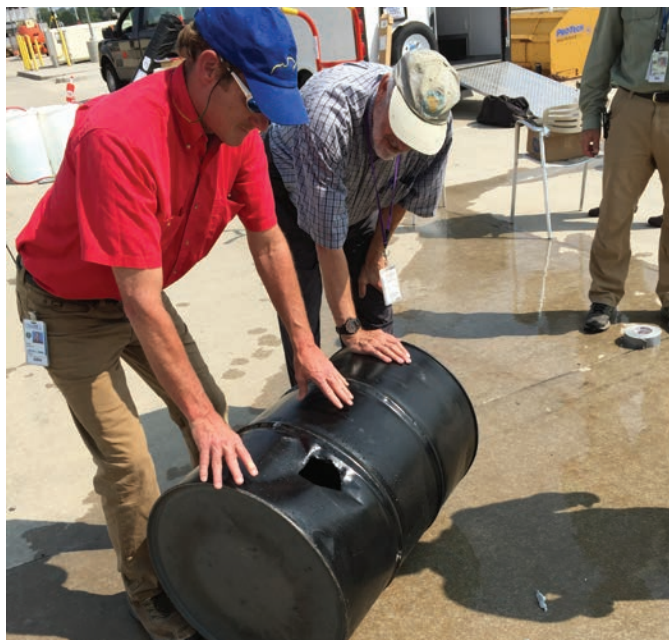
- All tanks were inspected to confirm continued adherence to recently revised state of Colorado regulations.
- A new 280-gallon (1,060-liter) diesel fuel tank was placed at the NWTC to eliminate offsite fueling trips. Because the tank complies with National Fire Protection Association standards, installation permitting and registration with the state was not required.
- Annual AST training was provided to 28 staff members identified as having responsibility for operating and fueling ASTs or that perform oversight for tank safety and environmental compliance.

7.4 SPILL PREVENTION AND RESPONSE

Spills of chemicals, fuels, and oils can result in contamination to soil, surface water, and groundwater, potentially causing damage to ecosystems, wildlife habitat, and human health. Comprehensive planning using Spill Prevention, Control, and Countermeasures plans (SPCCs), can reduce spills and limit impacts to the environment when spills do occur.

SPCC plans have been developed and are in place for the NWTC, the STM site, and the Renewable Fuels and

Lubricants Research Laboratory. As the total amount of oil stored at NREL's Joyce Street and Denver West Office Park facilities is less than 1,320 gallons (4,997 liters), SPCC plans are not required at those locations.



Tests were conducted to determine how long it would take a water-filled, 55-gallon (208-liter) drum to drain based on various rupture scenarios, providing valuable information to improve spill response. *Photo by Theodore DeVito, NREL 45579*

2016 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- No reportable spills occurred. Eleven minor spills of diesel, lubricant, coolant, and hydraulic fluids occurred at the STM site, and three spills occurred at the NWTC. The size of spills ranged from less than 0.1 gallon to 12 gallons (0.38 to 48 liters). All spills, except for one, were the result of leaks from private and delivery vehicles and contractor and construction equipment. A total of 25 gallons (95 liters) of petroleum fluids were spilled during fourteen events, most of which occurred on paved surfaces. Each spill received immediate remedial action and there was no significant impact to the environment.
- The SPCC Plan for the NWTC was revised to include a new 280-gallon (1,060-liter) diesel fuel tank.
- The SPCC Plan for the STM site was revised to include three new oil-containing transformers located at the Energy Systems Integration Facility.
- The SPCC training required annually of all workers who manage fuel storage tanks was revised to include a

knowledge test to confirm their understanding of state and NREL requirements.

- An internal assessment of the laboratory's spill-control preparedness program identified one minor deficiency. One opportunity for improvement was also identified concerning the availability of SPCC plans and clarification of NREL environmental staff notification information used by NREL Security in the event of a petroleum spill. Both items were subsequently addressed.

7.5 RADIOLOGICAL MATERIALS AND WASTE MANAGEMENT

The laboratory currently uses radiological materials in electron microscopy staining. A number of sealed sources are also present in analytical and process equipment, check sources, and emergency exit signs. Unlike many DOE facilities, NREL does not have legacy radiological contamination issues associated with past nuclear weapons production and research.

2016 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- Only small quantities (less than 1 cubic yard [0.76 cubic meter]) of low-level (0.007 curies) radioactive waste are currently in storage awaiting off-site disposal.
- In accordance with a federal regulation and DOE Order, NREL submitted its annual *Radionuclide Air Emissions Annual Report* to the EPA confirming that the laboratory is in compliance with air emissions standards. For calendar year 2016, the effective dose equivalent of radiation to the public was 0.038 millirem (mrem) per year, far below the 10 mrem per year limit.

2016 Accomplishments and Highlights

- Spill tests were conducted at two locations at the STM site using 55-gallon (208-liter) water-filled drums to determine the speed and distance with which a potential spill could reach property boundaries. Based on the information obtained, additional spill control equipment was procured and spill control and response procedures were modified.
- To be prepared for container breaches, the emergency response team practiced sealing holes in a 55-gallon (208-liter) drum filled with water. This exercise provided information on patching method effectiveness and identified patch materials best suited to NREL activities.
- A rapid response trailer was obtained and stocked with materials and equipment to be used in the event of a large spill.
- Maps delineating drainage basins and points of connection of the stormwater collection system at both the STM site and NWTC were developed for use by emergency responders in the event of a spill. This information will allow staff to quickly identify and then protect site drainages and stormwater outfalls, thus preventing impacts to offsite properties.

What Is "Effective Dose Equivalent?"

To understand *effective dose equivalent*, you must first define *dose* and *dose equivalent*:

- **Dose** – a generic term to describe the amount of radiation a person receives.
- **Dose Equivalent** – a measure of the biological risk of the energy that the radiation deposited in tissue, which depends on the type of radiation and the tissues exposed. The units of dose equivalent are called rems, and a thousandth of a rem is called a millirem, abbreviated as mrem.

- **Effective Dose Equivalent** – the total of the dose equivalent to the organ or tissue multiplied by weighting factors applicable to each of the body organs or tissues that are exposed to radiation.

An average person in the United States receives about 310 mrem each year from natural sources and an additional 310 mrem from medical procedures and consumer products.



An iris blooms amid the xeriscape landscaping at the Research Support Facility. *Photo by Brenda Beatty, NREL 45580*

8 NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (NEPA) is a federal law that requires potential environmental (human and natural) impacts to be considered for activities having a federal connection, such as those using federal funds, properties, facilities, employees and equipment. NEPA mandates that the federal agencies weigh the potential for environmental impacts equally among all factors when making decisions. In carrying out the requirements of NEPA, potential environmental impacts from a wide range of activities conducted at NREL and other DOE sites/facilities must be evaluated prior to spending funds or commencing work.

8.1 NEPA IMPLEMENTATION

NREL Project Managers or Subject Matter Experts initiate the NEPA review process. NREL NEPA Specialists provide support to the DOE Golden Field Office in conducting the NEPA environmental review. Potential environmental impacts of a specific activity are identified and evaluated and, if necessary, measures are taken to avoid or minimize those impacts. The level of review conducted is appropriate to the potential impacts of the proposed activity or may also include activities that require consultations with other federal agencies, such as with the State Historic Preservation Office or the U.S. Fish and Wildlife Service. A planned construction project, for example, receives a more rigorous and potentially more time consuming review than a project only involving routine office or laboratory work. The decision resulting from the review and analysis is considered the NEPA Determination. A final determination must be completed before federal funds are expended, before a contract award can be made, and before project activities begin.

NREL, the DOE Golden Field Office and other federal agencies use a type of programmatic NEPA document, known as a Site-Wide Environmental Assessment, to

analyze potential environmental impacts associated with current and future planned actions over a period of five to ten years. The document serves as a planning tool to aid ongoing and future operational and development decisions related to DOE sites. The NREL Site-Wide Environmental Assessments for the STM site and NWTC, both of which were updated in 2014, provide a baseline environmental analysis that streamlines future environmental reviews, improves and coordinate site and agency planning, and maximizes cost savings.

8.2 NEPA PROGRAM RESTRUCTURING

In 2016, NREL and the DOE Golden Field Office completed restructuring NREL's NEPA program that brought about a streamlined approach to the environmental review process. Five site- and activity-specific Programmatic NEPA Determinations for routine maintenance and research activities were established. The new process also outlined three levels of analysis required for proposed activities. The three levels include:

- Activities for which no additional review is required because those impacts have already been analyzed in the context of a Site-Wide Environmental Assessment or in one of the Programmatic NEPA Determinations;
- Activities that have been evaluated in a Site-Wide Environmental Assessment but must undergo a detailed review by NREL NEPA Specialists to ensure that potential environmental impacts have been previously analyzed, there are no extraordinary circumstances present, and one of the Programmatic NEPA Determinations were applicable; and
- Activities where more significant environmental impacts may be possible and/or other federal agencies are involved. A detailed questionnaire, DOE's EQ1, must be completed and submitted to the DOE Golden Field Office NEPA Specialists for review and analysis. The NEPA Determination must then be approved and signed by a DOE NEPA Compliance Officer and filed in the DOE Golden Field Office NEPA database.

Additional information regarding NREL's NEPA program management can be found in the NREL 2015 Environmental Performance Report at: www.nrel.gov/docs/fy16osti/65807.pdf, section 9.

2016 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- A total of 383 NEPA Worksheets and 18 Environmental Checklists were completed in 2016 for project activities on- and off-site.
- A NEPA program assessment conducted in 2014 by the DOE Golden Field Office identified findings related to document control, training, and adherence to internal NEPA processes. To address the findings, the following program improvements were completed in 2016:
 - The NEPA program was evaluated to identify projects that do not require additional review as their impacts have been thoroughly analyzed in the STM site and NWTC Environmental Assessments.
 - The NEPA worksheet was redesigned to contain all environmental review criteria on one page. A pilot program was developed to test the effectiveness of the new NEPA worksheet prior to full implementation of the revised program.
 - Training related to the new NEPA process was provided to affected staff.
 - The NREL NEPA procedure and handbook were updated and made available to all NREL employees via the NREL intranet.
 - Quarterly NEPA monitoring was conducted to determine if the updated process was effective or if adjustments need to be made.

2016 Accomplishments and Highlights

- Completed a restructuring of the environmental review process to identify ways to enhance the laboratory's ability to meet the spirit and intent of NEPA requirements
- NREL NEPA Specialists continued to provide NEPA support in identifying potential environmental impacts related to DOE Funding Opportunity Announcements that support DOE's mission.



A female Red-winged blackbird was observed among the cattails in a wetland area at the STM site. *Photo by Dennis Schroeder, NREL 45399*

9 NATURAL AND CULTURAL RESOURCES PROTECTION

Natural resources at the STM site and the NWTC are managed responsibly to ensure NREL's research needs are met while protecting native wildlife, vegetation, and cultural resources. Responsible management benefits not only the environment, but also NREL employees and the surrounding community. Management focuses on these key areas:

- Wildlife management
- Endangered species and species of concern
- Vegetation management
- Wetlands and floodplains
- Cultural resources
- Additional information regarding program management for these five areas can be found in section 10 of the NREL 2015 Environmental Performance Report at: www.nrel.gov/docs/fy16osti/65807.pdf.

9.1 WILDLIFE MANAGEMENT

Due to their location just east of the foothills of the Rocky Mountains, wildlife is plentiful at both the STM site and the NWTC. NREL promotes responsible management of wildlife and habitat through periodic formal surveys and review of impacts to wildlife when designing and implementing projects.

At the STM site, the original wildlife survey of the property was completed in 1987 and an additional study of the conservation easement property was performed in 1999. Subsequent surveys were completed in 2005 and in 2011.

Mammals identified during the surveys at the STM site included mule deer, coyotes, gray foxes, red foxes, raccoons, long-tailed weasels, striped skunks, badgers, bobcats, mountain lions, rabbits, and various smaller mammals. More than 75 species of birds have been

2016 Accomplishments and Highlights

- Acoustic bat monitoring at the NWTC, which has been in progress since 2011, continued from April through October near the Rock Creek drainage area on the east side of the site. NREL also coordinated with the U.S. Fish and Wildlife Service on the adjacent Rocky Flats National Wildlife Refuge for additional acoustical monitoring in June and July.
- To confirm acoustic bat monitoring software results, a wildlife biologist was hired to conduct “mist netting,” a survey method in which bats are collected in nets, identified, and then released. The survey was conducted in July and August at the NWTC in conjunction with the U.S. Fish and Wildlife Service at the adjacent Rocky Flats National Wildlife Refuge. Seven species of bats were captured during mist netting; all but one, the fringed myotis (*Myotis thysanodes*), were recorded during acoustic surveys.
- Wildlife surveys were conducted at the NWTC. Four amphibian species, two reptiles, 33 avian species, and 19 mammal species were recorded. Highlights include the northern leopard frog, a state species of concern, and feline predators (both bobcat and mountain lion).
- Four honey bee (*Apis spp.*) swarms were identified and collected by a local beekeeper, who used the swarm to create a new colony at the beekeeper’s apiary.
- Tree swallows (*Tachycineta bicolor*) again nested in two of the boxes along the eastern edge of a STM site detention basin. House wrens occupied nest boxes near the STM site historical amphitheater.
- Mason bees (*Osmia spp.*) and leaf cutter bees (*Megachile spp.*) occupied bee boxes installed previously in a STM site detention basin.
- No cases of tularemia, an infectious disease found in rabbits and other lagomorphs, occurred at NREL sites in 2016, following the epidemic that occurred in the rabbit population in 2015.
- Placement of bird deterrent in the form of fritted glass was completed on the STM site employee parking garage glass windows.
- A roll-on grape extract was tested to repel northern flickers (*Colaptes auratus*) from drilling holes into the façade of several older buildings in search of cavities in which to nest. The repellent, which was applied monthly from March through May, was somewhat successful in reducing the overall number of holes initiated by the flickers.
- A site-wide survey at the STM site was completed to identify locations where snakes could potentially enter site buildings; building modifications will occur as funding allows.
- In support of the Presidential Memorandum, *Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators*, milkweed seeds were collected onsite and distributed in the STM site detention basin.
- NREL participated in a symposium at the North American National Ornithological conference, presenting experience gained on bird mortality due to building glass and the enhancements made to NREL facilities to reduce bird-building collisions.
- NREL research staff facilitated a test of avian detection equipment at the NWTC intended to reduce avian collisions with wind turbines. To gather the data, a bald and golden eagle were fitted with a GPS logger and released from an aerial lift, while their flight paths toward their handler were tracked by both the GPS unit and two prototype avian detection devices. The project collaborators included Laufer Wind, Boulder Imaging, and RES America. Laufer Wind assessed the data collected to test and validate wind turbine radar to be used to detect birds. RES America’s device, *IdentiFlight*, created in collaboration with Boulder Imaging, used data to further refine their stereoscopic camera-based system to detect and identify avian species.

recorded by the formal wildlife surveys and supplemental employee observations. A number of raptor species have been recorded at or above the STM site, especially during spring migration. Two raptor species are residents at the site: American kestrel and red-tailed hawk. Reptiles and

amphibians inhabit the STM site as well. Most notably, the western rattlesnake is routinely encountered around the area.

DOE prepared a biological characterization inventory in 1992 for the entire Rocky Flats Plant, including the



NREL's pollinator protection plan assists pollinators such as this honey bee observed on a Hawthorne at the STM site. *Photo by Brenda Beatty, NREL 45577*

NWTC, which was part of the no-activity buffer zone of the Rocky Flats plant at the time. Signs or tracks of bears and mountain lions were identified. Approximately 20 species of birds were sighted at or near the site. Raptor surveys were conducted at the NWTC in 1994 and 1995 which identified seven raptor species on or in the vicinity of the site. An avian survey was again completed in 2003 and updated in 2011. A 2016 survey included mammals, reptiles, amphibians, and terrestrial arthropods with results duplicating the 2011 survey that showed that various mammals, including elk, mule deer, coyotes, desert cottontail rabbits, bobcats, bats, deer mice, prairie voles, and shrews, continue to feed and occupy the site. Although seldom seen, rattlesnakes, bull snakes, racers, and several other reptiles are also known to occupy the site. Amphibians, including boreal chorus frogs, Woodhouse's toad, and northern leopard frog, occupy wetlands at NWTC.

A complete list of all wildlife species identified at both the STM site and the NWTC is found in Appendix B.

2016 Compliance Summary and Activities

- Ground-nesting bird surveys were conducted prior to annual mowing operations at the NWTC in conformance with the Migratory Bird Treaty Act. A vesper sparrow (*Poecetes gramineus*) nest was found and cordoned off; mowing was delayed in that area until it was clear that the eggs had hatched and the young had permanently left the nest.
- The site of a potential solar array at the NWTC was mowed in the late fall to accommodate spring 2017 installation. Fall mowing results in lower grass height in the following spring, decreasing the attractiveness of



Natural and manmade habitats serve many wildlife species at NREL, including this Cottontail rabbit. *Photo by Nicole Gilbert, NREL 45918*

potential ground-nesting bird sites, and consequently avoiding conflicts with the research mission and native wildlife.

9.2 ENDANGERED SPECIES AND SPECIES OF CONCERN

The federal Endangered Species Act provides for the designation and protection of wildlife, fish, and plant species that are in danger of extinction and preserves the habitats on which these species depend. NREL, as a federal facility, is required to abide by the Endangered Species Act. Compliance ensures that our actions do not adversely affect threatened, endangered, or candidate species that are listed under the Endangered Species Act. NREL also complies with restrictions associated with the Colorado Division of Parks and Wildlife related to endangered, threatened, and species of concern for Colorado, as well as the rare plant species listed under the Colorado Natural Heritage Program.

The U.S. Fish and Wildlife Service, which administers the Endangered Species Act, lists nine species as threatened, endangered, or a candidate for listing that could potentially be found in Jefferson and Boulder Counties. Of these species, three have the potential to occur at the STM site or the NWTC, including the Preble's meadow jumping mouse, the Ute ladies' tresses orchid, and the Colorado butterfly plant.

Surveys conducted in 2011 did not detect threatened, endangered, or species of concern. The 2016 survey at the NWTC found the Northern leopard frog within one wetland area. The leopard frog needs open water for a



Spirit, a 20-year-old Bald Eagle, is released from an aerial lift at the NWTC and flies to its handler several hundred meters away. Equipped with a GPS tracking device, the eagle's flight path is recorded and compared to readings from an innovative radar system which, when fully developed, will be capable of detecting avian species and assist in preventing bird strikes with wind turbines. Laufer Wind, Boulder Imaging, and RES America brought their equipment to the NWTC to conduct testing in February 2016. Spirit was brought to the NWTC from Auburn University, where he serves as the university's mascot. *Photo by Mark McDade, NREL 45581*

part of its lifecycle, and ample precipitation that fell in the spring and early summer of 2015 and 2016 provided sufficient open water. Therefore, leopard frogs may only be present when enough surface water is available at the right time of year, generally through late June.

The U.S. Fish and Wildlife Service has designated critical habitat associated with the federally endangered Preble's meadow jumping mouse within the upper reaches of Rock Creek, including a small area at the southeast corner of the NWTC. This area may not be disturbed without prior coordination with the U.S. Fish and Wildlife Service.

Five other species, which occur in the Platte River watershed in Nebraska, are listed by the U.S. Fish and Wildlife Service in accordance with the Endangered Species Act as species that must be considered for Colorado and Wyoming projects that may deplete water supplies to the Platte River system. These include three birds, the Piping plover (*Charadrius melodus*), the Whooping crane (*Grus americana*), and the Least tern (*Sternula antillarum*); a fish, the Pallid sturgeon (*Scaphirhynchus albus*); and a plant, the Western prairie fringed orchid (*Platanthera praeclara*). As part of the STM site and NWTC NEPA environmental assessments conducted in 2014, NREL consulted with the U.S. Fish and Wildlife Service for future activities that have the potential to deplete water in the Platte River system. Since 2014, NREL is required to monitor water use to ensure that the amounts agreed upon in the context



Photo by Lee Jay Fingersh, NREL 35730



Photo by Lee Jay Fingersh, NREL 35731



Laufer Wind plans the release points and flight routes of the Bald and Golden eagles brought to the NWTC. The study allowed researchers to test and further develop a radar system and other equipment capable of detecting raptors and other avian species to eliminate turbine-bird collisions. *Photo by Dennis Schroeder, NREL 35742*

of the consultation are not exceeded. NREL's water use is reported to the U.S. Fish and Wildlife Service annually.

2016 Compliance Summary and Activities

- Program activities were in compliance with requirements.

2016 Accomplishments and Highlights

- Program activities were in compliance with requirements.
- Wildlife biologists completed a survey at the NWTC that is performed every five years and found no federally listed threatened or endangered species. However, the northern leopard frog was found, which is a listed species of concern by Colorado.

9.3 VEGETATION MANAGEMENT

Native plants have evolved over long periods of time in harmony with the local climate and surrounding soil, growing in association with microorganisms and resident wildlife to create diverse ecosystems. Through this evolution, native plants have developed natural defenses against pests and diseases specific to their locale. When non-native plants are introduced into an environment they often overcome indigenous plants, attract new types of pests and diseases and out-compete native plants for nutrients and water. They can also deprive wildlife of nutrients and shelter. Plants such as kochia (*Bassia scoparia*), Canada thistle (*Cirsium arvense*), Russian olive (*Elaeagnus angustifolia*), diffuse knapweed (*Centaurea diffusa*), dalmatian toadflax (*Linaria vulgaris*), and



Flowering milk thistle, a noxious weed found throughout Colorado, including the STM site and NWTC. Photo by Brent Nelson, NREL 23888

myrtle spurge (*Euphorbia myrsinites*) are examples of non-native plants that can have destructive effects on natural habitats.

Landscaped areas near NREL buildings and common areas are designed to include features such as native plantings, xeriscape principles suited to arid climates, and infiltration of stormwater to provide water and nutrients to landscape plants and to recharge groundwater in the area. Adhering to such designs helps promote wildlife-friendly vegetation and reduces the introduction of non-native species and the pests and diseases that can accompany them.

Where non-native species exist, NREL uses an integrated weed management approach that incorporates various types of weed control methods including mechanical practices (e.g., mowing or hand pulling), cultural practices (e.g., reclamation of disturbed areas), prevention (e.g., limiting or eliminating driving of vehicles off established roadways), and herbicide treatment. The effectiveness

2016 Accomplishments and Highlights

- Monthly review and coordination meetings were conducted to assess the success of seasonal herbicide applications and revegetation efforts.
- A vegetation survey was conducted at the NWTC.
- A procedural guide for landscaping subcontractors and NREL maintenance staff was finalized to effectively manage native grasses and other vegetation, the care of which is often different from that applied to non-native grasses and vegetation.
- Annual herbicide spraying was performed to continue control of diffuse knapweed (*Centaurea diffusa*) at the NWTC, and Canada thistle (*Cirsium arvense*), houndstongue (*Cynoglossum officinale*), and myrtle spurge (*Euphorbia myrsinites*) at the STM site.
- Weed mapping was performed at the NWTC. Results indicated a significant reduction in the acreage of weeds, particularly for diffuse knapweed, due to NREL's persistent weed management control efforts.

TABLE 7. NOXIOUS WEED SPECIES IDENTIFIED AT THE STM SITE AND THE NWTC^a

Noxious Weed Class	Species Present at STM	Species Present at NWTC
Class A: ^b	Myrtle spurge	None
Class B: ^c	Canada thistle Common teasel Dalmation toadflax Diffuse knapweed Hoary cress (whiteweed) Hound's tongue Musk thistle Russian olive Scotch thistle	Bull thistle Canada thistle Chicory Common mullein Common teasel Dalmation toadflax Diffuse knapweed Hoary cress (whiteweed) Moth mullian Musk thistle Sulfur cinquefoil
Class C: ^d	Field bindweed Cheatgrass	Field bindweed Cheatgrass

^a Species identified reflect findings of site-wide weed surveys performed in 2011 at the STM site and in 2016 at the NWTC.
^b Identified by the state for eradication.
^c Identified by the state to stop the spread.
^d Identified by the state to more effectively manage on private and public lands through education, research, and biological control resources.

of control methods is periodically assessed. The use of multiple control strategies has been successful in significantly reducing populations of diffuse knapweed (*Centaurea diffusa*) and Canada thistle (*Cirsium arvense*). The weed control program maintains the flexibility needed to respond to changes in weed populations from year to year.

Comprehensive site-wide weed surveys and mapping are performed approximately every five years. Smaller areas of NREL's main sites are assessed annually. A list of noxious weed species as defined on the state's noxious weed list and identified at the STM site and the NWTC is found in Table 7.

2016 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- At the NWTC, herbicides were applied to control B- and C-listed weeds to approximately 122 acres (49 hectares) in April and 50 acres (20 hectares) in September.
- At the STM site, herbicides were applied to control A-, B- and C-listed weeds to approximately 20 acres (8 hectares) in May, 14 acres (6 hectares) in June and July, and 39 acres (16 hectares) in October.

- The presence of two species of knapweed weevils previously released along the Pine Ridge at the NWTC was confirmed. One species attacks the seed heads while the second attacks the roots of the knapweed plant. This effort further diversifies noxious weed control methods utilized by NREL. The effectiveness of this approach may take two or more years to determine.
- Herbicides were applied in October to a large tract (37 acres (15 hectares) of grassland on the STM site conservation easement to control knapweed.

9.4 WETLANDS AND FLOODPLAINS

Wetlands are lands that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support distinct soil types and plant communities. Wetland areas typically take the form of swamps, marshes, bogs, and groundwater seeps and are frequently located within or adjacent to a floodplain. Floodplains are land areas adjacent to rivers and streams that are subject to recurring inundation.

Both wetlands and floodplains play a key role in providing floodwater storage, reducing flood flow rate, and filtering floodwater. The resulting enriched floodplain soils promote the growth of wetland and riparian vegetation that provide habitat for a rich diversity of terrestrial and aquatic plants and animals.

Floodplains vary in extent from those that contain the more frequent low volume rain event flows to widths that have the capacity to contain the 100-year flood event and greater. Stream channels at NREL sites generally are more characterized by the former description. There are no 100-year floodplains defined by Jefferson County or the Federal Emergency Management Agency on NREL sites.

Table 8 lists the types and acreage of wetlands at the STM site and NWTC that have been identified to date. Please refer to Appendix A for locations of these wetlands.

NREL preserves the important natural functions of its wetlands and floodplains, regardless of size or extent, to protect the physical, biological, and chemical integrity of receiving waters and riparian areas on and adjacent to the STM site and the NWTC.

2016 Compliance Summary and Activities

Program activities were in compliance with regulations.

TABLE 8. WETLAND TYPES AND ACREAGES AT THE STM SITE AND THE NWTC

Wetland Type	STM Site (acres/hectares)	NWTC (acres/hectares)
Headwater	0 (0.0)	2.0 (0.9)
Palustrine Emergent ^a	1.2 (0.5)	4.2 (1.9)
Seasonal Pond	0.6 (0.2)	0 (0.0)
Wet Meadow	0.3 (0.1)	0 (0.0)
Total	2.1 (0.8)	6.2 (2.8)

^aPalustrine wetland areas have been surveyed and meet all federal wetland criteria. Other wetlands listed were identified by vegetation type only.

9.5 CULTURAL RESOURCES

Cultural resources are defined as any prehistoric or historic district, site, building, structure, or object considered important to a culture, subculture, or community for scientific, traditional, religious, or other reasons.

Cultural resources can be divided into three major categories:

- Prehistoric and historic archaeological resources
- Architectural resources
- Traditional cultural resources.

Several formal surveys of historic and cultural resources have been performed on the STM site. As a result, three historical resources have been identified and recognized under the Archeological and Historic Preservation Act of 1974 as significant cultural resources that should be preserved. These resources are the remaining vestiges of facilities that were part of Camp George West, operated



The depression-era outdoor amphitheater at the STM site was constructed by the Work Progress Administration from 1933-1935. Photo by David Parsons, NREL 06923

by the Colorado National Guard from 1903 through the beginning of World War II, after which time much of the land currently occupied by the STM site was leased to the federal government for military training purposes. The three historical resources, constructed in the 1930s and early 1940s during the Works Progress Administration era, include:

- An open-air amphitheater
- A stone bridge spanning a natural drainage channel adjacent to the amphitheater
- A stone and concrete ammunition bunker below the amphitheater.

Through NREL's efforts, these structures have been added to the National Register, with the amphitheater and stone footbridge listed together as a single resource. Additionally, a portion of the STM site south of Denver West Parkway lies within the 98-acre Camp George West Historic District.

A formal survey of the NWTC was conducted in 1994⁶ and identified no significant historical or archeological resources.

2016 Compliance Summary and Activities

- Program activities were in compliance with requirements.

⁶ Labat-Anderson, Inc. (1994). Archaeological Resurvey of the National Wind Technology Center, National Renewable Energy Laboratory. December 2.



10 CONSERVATION LANDS

Evening primrose in bloom in the conservation easement at the STM site. *Photo by Tom Ryon, NREL 32777*

In 1999, DOE granted a conservation easement of 177 acres (72 hectares) at the STM site to Jefferson County (see Figure 5).

A baseline inventory of the property was prepared in June 1999 to document the current condition of the easement property and to assess the conservation value of that property.⁷ The baseline inventory includes descriptions of the geographical setting and adjacent property owners, access and use of the property by the public, and the existing environmental conditions of the property (including geology, hydrology, vegetation, wildlife, and cultural resources). Vegetation within the easement area includes grasslands interspersed with shrubland communities and trees, primarily in the drainages. Several seeps also occur throughout the area.

The easement helps preserve the natural character of the property, including its visual, biological, and recreational resources. The goals of the easement are to:

- Retain, preserve, and protect natural, scenic, ecological, and historic resources
- Protect the ecosystem and provide sustainable habitat for diverse vegetation and wildlife
- Ensure the scenic and biological integration with adjoining open-space land
- Prevent further industrial, commercial, or residential development
- Preserve the conservation easement property as natural open space.

Local policies established by Jefferson County, Golden, and Lakewood reflect community sensitivity with respect to the visual qualities provided by natural resources in the area around the STM site. Specifically, the Jefferson County General Land Use Plan characterizes North and South Table Mountains as “unique landscapes” and

⁷U.S. Department of Energy. Golden Field Office. (1999). National Renewable Energy Laboratory (NREL) Site Conservation Easement Baseline Inventory. Golden, Colorado.

states that “maintaining landscapes that have a unique visual quality” is key to maintaining the quality of life in Jefferson County.

Jefferson County Open Space maintains formal trails on the conservation easement property. Two trails cross the easement, connecting Denver West Parkway (near the STM site east entrance) to the trails on the mesa top. NREL staff, DOE staff, and the public use these trails frequently.

Each year, at least one visual inspection of the conservation easement property is conducted to identify management activities needed to address erosion, weed management, trail conditions, or other issues that may exist.

2016 Activities and Achievements

- On August 2, lightning struck South Table Mountain and sparked a 29-acre (12-hectare) wildfire. Photos taken once to twice per month from that time recorded the natural restoration progress. The area was

monitored regularly to identify potential management needs, such as erosion control, noxious weed management, and reseeding with native grasses.

- NREL conducted summer and fall visual inspections of the conservation easement. Potential improvements to the management of the easement were noted. Following the inspection, weeds were treated and Russian olive trees were girdled to kill and prevent the spread of this invasive species.
- Jefferson County Open Space conducted their annual assessment of the conservation easement. The resulting Conservation Easement Monitoring Report⁸ highlighted the significant natural features of the land parcel, including wildlife habitat and unique landforms, as well as the passive recreational amenities provided by the public trails that cross the area. No significant changes to the land use and condition were observed from baseline observations.

⁸ Jefferson County Open Space Department, Jerry Bader. (2016). Conservation Easement Monitoring Report. August 2, 2016. Golden, Colorado.

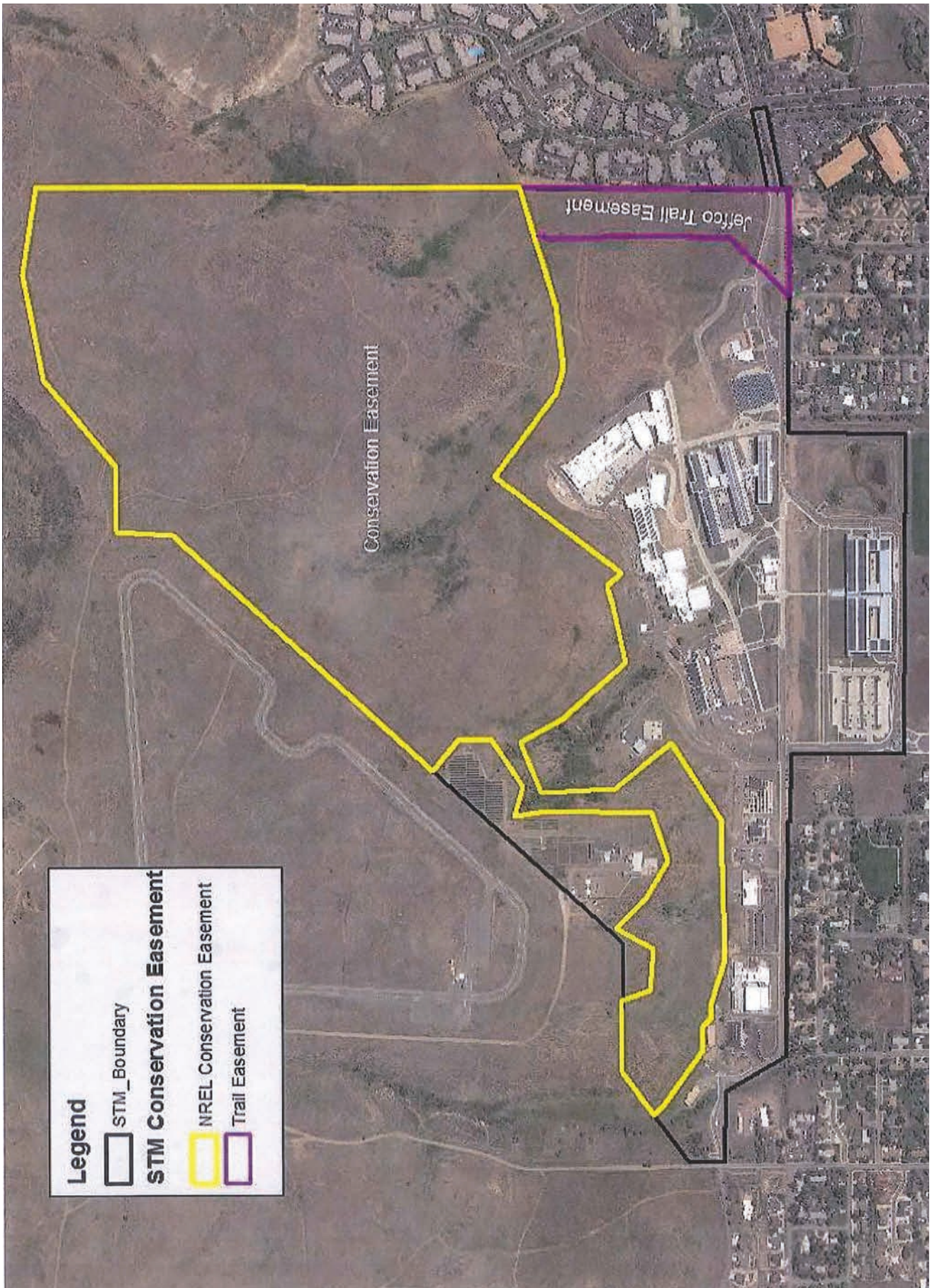


Figure 5. Conservation easement at the STM Site



APPENDIX A: PLANT COMMUNITIES AT THE STM SITE AND THE NWTC

A columbine in bloom in the xeriscape garden at the RSF.
Photo by Brenda Beatty, NREL 45578

Vegetation surveys are periodically completed for the STM site and the NWTC, with the most recent surveys occurring at the STM site in 2011 and at the NWTC in 2016. Plant communities and species were identified for each site at that time, and changes from previous surveys are noted below.

STM Plant Communities

The majority of vegetation at the STM site belongs to the grassland community type. Within that association, there are two distinct community types: short grassland on the mesa top and mixed grassland located on the mesa slopes and toe areas. Other mapped vegetation communities at the STM site include ravine shrubland, tall shrubland, short shrubland, and wetlands. The plant communities are described below and mapped as illustrated in Figure 6.

Short Grassland

Short grassland is found on the flat top of the mesa. The dominant grass species are blue grama (*Chondrosum gracile*), a native prairie species, and cheatgrass (*Anisantha tectorum*), a noxious weed. Populations of diffuse knapweed (*Acosta diffusa*) and Dalmatian toadflax (*Linaria genistifolia subsp. dalmatica*) are scattered throughout the whole community. These two noxious weeds comprise approximately 1% of the short grassland.

Alyssum (*Alyssum parviflorum*), an introduced species, is the dominant forb. Several species of prickly pear cactus (*Opuntia fragilis*, *O. macrorhiza*, *O. phaeacantha*, and *O. polyacantha*) occur throughout the short grassland on the mesa top, as does hen-and-chicks (*Echinocereus viridiflorus*) and pincushion cacti (*Coryphantha missouriensis* and *C. vivipara* var. *vivipara*). Well-draining hillocks often support thick stands of needle-and-thread grass (*Hesperostipa comata*) and yucca (*Yucca glauca*). Some short shrubs such as rubber rabbitbrush (*Chrysothamnus nauseosus subsp.*), chokecherry (*Padus virginiana*), and

skunkbrush (*Rhus aromatica* subsp. *trilobata*) occur infrequently in the short grassland area and concentrate along the rimrock areas. Several large hackberry trees (*Celtis reticulata*) are clustered at the very edge of the mesa top.

Historically, this short grassland was probably dominated by blue grama grass and other short-grass species such as buffalo grass (*Buchloë dactyloides*), intermixed with the other species associations described above. However, the entire mesa-top area has become dominated by cheatgrass, an aggressive noxious weed. This weed is changing the appearance and general species composition of the area by apparently out-competing native plants.

Mixed Grassland

The mesa slopes and toe areas on the STM site also support blue grama and cheatgrass, but are dominated by a mixed-grass species association of needle-and-thread grass and western wheatgrass (*Pascopyrum smithii*), with smaller amounts of big bluestem (*Andropogon gerardii*), sideoats grama (*Bouteloua curtipendula*), three-awn (*Aristida purpurea*), and green needlegrass (*Nassella viridula*). As in the short grassland areas, a large number of forbs also occur in the mixed grasslands.

A few patches of anomalous vegetation occur within the mixed grasslands where subsurface water appears to be close to the surface. These areas support wide swaths of mat muhly (*Muhlenbergia richardsonis*). One is located on a southern-facing slope, near the eastern property boundary. The other is located on a southwestern-facing slope of the ravine north of the NREL Education Center, formerly known as the Visitors Center. This area is notable for a large population of poison ivy (*Toxicodendron rydbergii*), which grows in thickets of tall (one meter and larger) plants that have a woody, shrub-like growth form. A small number of plains cottonwood (*Populus deltoides*) saplings, skunkbrush, chokecherry, and snowberry occurs in this patch as well.

The mixed-grass areas grade into both the upland and ravine shrublands and contribute the majority of the understory in these areas. Some mixed-grass areas also blend into disturbed areas, where reclamation species such as crested wheatgrass (*Agropyron cristatum*) and smooth brome have been planted and have subsequently spread into the mixed-grass community.

Upland ShrUBLANDS

Shrubland habitat occurs along the upper sides of ravines and on the steeper mesa slopes, becoming more prominent as elevation increases up to the top of the mesa. The upland shrubland habitat, which excludes the shrublands

in the ravine bottoms, comprises tall shrubland and short shrubland communities very similar in overall composition but distinguished by the dominant species.

Tall Shrubland

The tall shrubland areas are defined by stands of mountain mahogany (*Cercocarpus montanus*) that occur along the rim of the mesa, usually where volcanic cap rock is exposed, and on the upper mesa slopes below rimrock areas. The understory, with a large amount of bare soil, is notably sparse throughout this community. Cheatgrass is the most common herbaceous species in these areas, intermixed with needle-and-thread grass, yucca, and many cacti.

Short Shrubland

The short shrublands occur on elevated flat areas amidst the surrounding grasslands, some of which appear to have experienced surficial disturbance in the past. These areas are distinctive because of the dominance of rubber rabbitbrush. The other common location for short shrublands is on the outer slopes of the ravines. Skunkbrush defines these and other short shrublands along the upper portions of the steepest slopes of the mesa. These communities usually grade into the ravine shrublands along the drainage bottoms and the tall shrublands near the top of the mesa slopes. The short shrubland community also has a sparse understory of the same grasses and forbs as the tall-shrub community.

Ravine ShrUBLANDS

Ravine shrublands are limited to the lower sides and bottoms of the drainages that cut down through the mesa slopes. These communities support a variety of shrubs such as skunkbrush, chokecherry, and wild plum (*Prunus americana*), often growing in dense, impassible thickets. A few plains cottonwoods and peachleaf willow (*Salix amygdaloides*) trees occur at the top of the ravine channels and in other portions of the channel where the subsurface water table appears to be relatively high. A diverse herbaceous component is found in these drainages. In one instance near the southeast boundary, a ravine shrubland grades into an ephemeral drainage at the toe of the mesa. This drainage is vegetated with grassland species and conducts only occasional surface water runoff.

Wetlands

Five very small communities on the STM site were found to support wetland vegetation. These communities were not examined for the soils and hydrology that would classify them as functioning wetlands; rather, they are noted

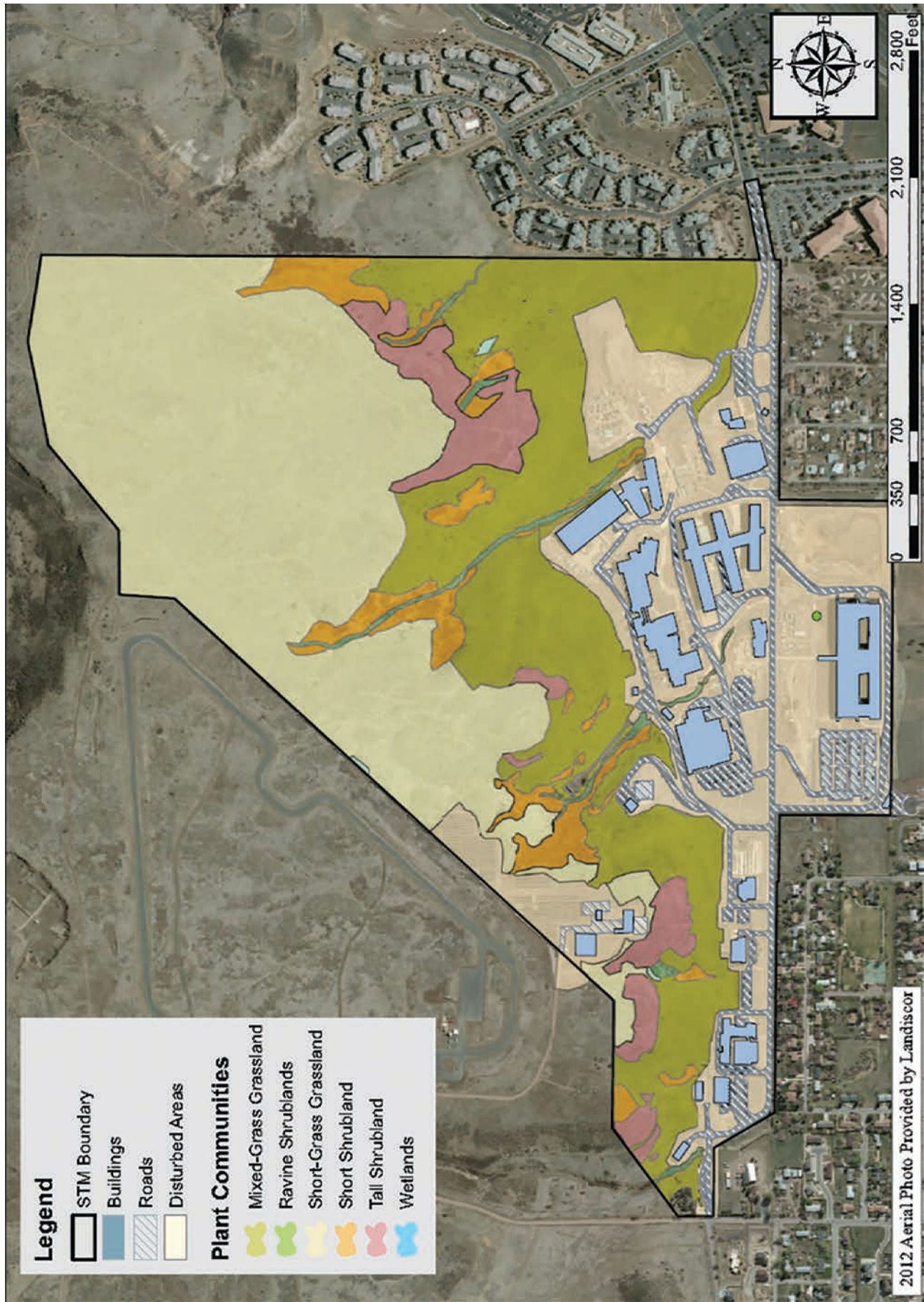


Figure 6. STM Site land cover types surveyed in 2011. Note: map was updated in 2012 to reflect building changes

only for their dominance of wetland vegetation. These are limited to very small areas (less than half an acre in total). One is in a shallow swale at the mouth of the ravine at the southwestern corner of the site boundary where surface water and/or subsurface drainage have created a pocket of saturated soil. Species here include sedges (*Carex spp.*), rushes (*Juncus spp.*), bulrush (*Schoenoplectus spp.*), and peachleaf willow. The second wetland could have formed as a result of past construction activities. This linear depression supports wetland vegetation along the central portion of the western site boundary, northeast of the photovoltaic array. Perhaps situated where equipment was once staged, this area appears to hold seasonal water for enough consecutive growing seasons to support some wetland vegetation including Arctic rush (*Juncus arcticus*), American speedwell (*Veronica americana*), and broadleaf cattail (*Typha latifolia*).

The wetland at the mouth of the ravine may no longer experience the hydrology that originally allowed these plants to establish there. In 2002, this plant community supported populations of cattails that were not observed in the 2011 survey. Three small seeps are located on the hill slope between the NREL Education Center and the public trail on the far eastern boundary of the site. These seeps are dominated with sedges, rushes, and Canada thistle (*Cirsium arvensis*).

A seventh wetland community that was observed by Plantae⁹ no longer appears to support wetland vegetation. In 2002, cattail species near an old stock tank in the eastern-most drainage appeared to have been supported by a pipe coming out of the hillside. Although the stock tank was observed in the 2011 survey, it appears the cattails have not persisted in the intervening years.

Disturbed/Reclaimed

This habitat type comprises all of the areas at the site that have experienced surface disturbance to vegetation caused by human activities. These mostly occur on the perimeter of the buildings, roads, parking lots, and soil stockpile areas. Most of these areas appear to have been re-vegetated and support a combination of native grassland plants, planted ornamental re-vegetation species, and native and introduced weeds.

NWTC Plant Communities

The majority of the vegetation at the NWTC belongs to the mixed-grass prairie association of the grassland formation. Mixed-grass prairie is defined by the presence of grass species typical of the tallgrass or true prairie

such as big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and prairie dropseed (*Sporobolus heterolepis*), with species more typical of the short-grass prairie such as blue grama (*Chondrosium gracile*) and buffalograss (*Buchlōe dactyloides*). Intermediate grasses (*mid-grasses*) such as the needle grasses (*Hesperostipa* and *Nassella spp.*), wheat grasses (*Pascopyron*, *Agropyron*, *Elytrigia*, *Elymus*, and *Thinopyrum spp.*), and blue grasses (*Poa spp.*) are also important constituents of mixed-grass prairie.

The grasslands at the NWTC fall into the xeric mixed-grassland community type identified and classified primarily on available soils and soil moisture, reflected in xeric mixed-grassland plant species assemblages.

A number of changes in vegetation patterns noted since the NWTC was previously mapped is discussed below by specific plant community. The plant communities are described below and mapped as illustrated in Figure 7.

Mixed Grassland

This community is distinguished from the non-native grassland community by the higher cover of native grasses and forbs. Native species typically make up 50%–60% of the vegetative cover. Common grasses in this community include smooth brome, Kentucky bluegrass, Canada bluegrass, big bluestem, little bluestem, switchgrass, and purple three-awn. Common forbs in this community include scurfpea, fringed sage, prairie sage, and hairy golden aster.

Non-Native Grassland

The non-native grassland community is the most common community type at the NWTC. This community is dominated by introduced pasture grasses including smooth brome, Kentucky bluegrass, and Canada bluegrass. Non-native species make up 65%–90% of the vegetative cover in this community. Commonly observed forb species include alyssum (*Alyssum simplex*), Canada horseweed (*Conyza canadensis*), fringed sage (*Artemisia frigida*), prairie sage (*Artemisia ludoviciana*), scurfpea (*Psoraleidum tenuiflorum*), and hairy golden aster (*Heterotheca villosa*). Native grasses within this community, particularly big bluestem and switchgrass, occur most frequently along roadside depressions, possibly due to higher soil moisture from captured precipitation runoff.

Disturbed Native Grassland

This community occurs along the northern fence line of NWTC. Total vegetative cover in this community ranges from 30%–70%, and exposed soil in this community

⁹Plantae Consulting Services. (2000). Vegetation Survey. NREL National Wind Technology Center. Boulder, Colorado.

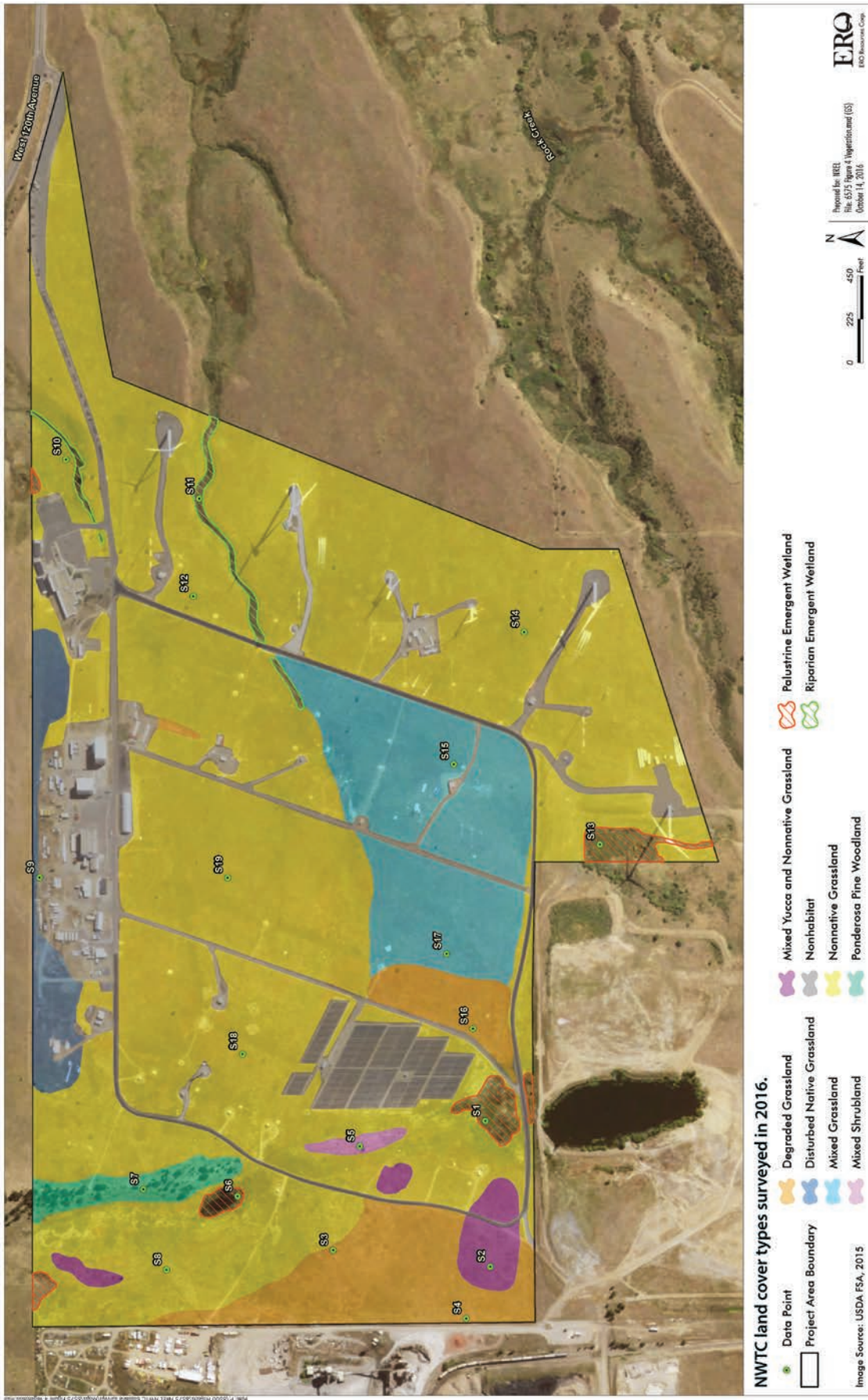


Figure 7. NWTC land cover types surveyed in 2016

consists of coarse gravel. The proximity of this community to machinery and buildings, the abundance of exposed ground, and the gravelly soil texture indicate that this area has been significantly disturbed by human activity. However, this community had the highest vegetative cover of native grasses within NWTC. This community is dominated by purple threeawn, big bluestem, and switchgrass. Other commonly observed species in this community include non-native grasses such as smooth brome, and ruderal weed species including annual sunflower (*Helianthus annuus*), prickly lettuce (*Lactuca serriola*), common mullein (*Verbascum thapsus*), and bigbract verbena (*Verbena bracteata*).

Non-Native Yucca Grassland

This community is very similar in composition to the non-native grassland community; however, it is distinguished by the presence of stands of yucca (*Yucca glauca*) shrubs. Yucca typically occurs as scattered individuals throughout the grassland communities at the NWTC. In the areas identified as non-native yucca grassland, yucca occurs at a higher density than in the surrounding grassland, and the structural change from the surrounding grasslands warrants its inclusion as a separate community. Dominant grass species in this community include downy brome (*Bromus tectorum*), smooth brome, Kentucky bluegrass, and intermediate wheatgrass (*Thinopyrum intermedium*).

Degraded Grassland

The degraded grassland community has been heavily influenced by human disturbance and is dominated by non-native and noxious grass species with minimal native vegetation (typically less than 10%). The dominant species in this community are downy brome and intermediate wheatgrass. Downy brome is a List C Noxious Weed in Colorado. Near the southwest corner of the NWTC is an area containing significant bare soil that is dominated by annual and biennial weed species including kochia (*Bassia scoparia*), downy brome, and common sunflower. The soil in this area has a distinctive red color that is visible on recent aerial imagery. The degraded grassland community along the western boundary of the NWTC is possibly influenced by historic and ongoing disturbance that may originate from off-site activities.

Ponderosa Pine Woodland

This community occurs along a granite outcrop located in the northwestern corner of the project area. Dominant tree and shrub species include ponderosa pine (*Pinus ponderosa*), skunkbrush sumac (*Rhus trilobata*),

wax currant (*Ribes cereum*), and wild plum (*Prunus americana*). Understory vegetation consists of native and non-native grass and forb species. Common species include smooth brome, crested wheatgrass (*Agropyron cristatum*), junegrass (*Koeleria macrantha*), sulphur cinquefoil (*Potentilla recta*), golden banner (*Thermopsis rhombifolia*), harebell (*Campanula rotundifolia*), and James' nailwort (*Paronychia jamesii*).

Mixed Shrubland

The mixed shrubland community occurs on the southeast end of the same granite outcrop that supports the ponderosa pine woodland. The southeast end of this outcrop is lower and less exposed than where the ponderosa pine woodland occurs. Dominant shrub species include wax currant, skunkbrush sumac, chokecherry (*Prunus virginiana*), and western serviceberry (*Amelanchier alnifolia*). This community supports higher cover and diversity of native grasses and forbs than the surrounding non-native grassland community. Common grasses in this community include smooth brome, Kentucky bluegrass, big bluestem, junegrass, and sideoats grama (*Bouteloua curtipendula*). Common forbs include scurfpea, prairie sage, golden banner, hairy golden aster, and sulphur flower (*Eriogonum umbellatum*).

An isolated group of hawthorn (*Crataegus erthyropoda*) shrubs occurs along the western site boundary within the NWTC site boundary. These trees are at the top of the slope and occur directly east of an active area of construction disturbance, which is outside the NWTC boundary.

Palustrine Emergent Wetland

Six wetlands were identified at the NWTC that fall into the palustrine emergent category.¹⁰ Dominant species in this community type include broadleaf cattail (*Typha latifolia*), Arctic rush (*Juncus arcticus*), common spikerush (*Eleocharis palustris*), and Nebraska sedge (*Carex nebrascensis*). Other commonly observed species include foxtail barley (*Hordeum jubatum*), Torrey's rush (*Juncus torreyi*), cloaked bulrush (*Scirpus pallidus*), and willowherb (*Epilobium*) species. Patches of smooth brome, Kentucky bluegrass, big bluestem, and western wheatgrass (*Pasocpyrum smithii*) occur on the fringes of these wetland communities.

A large palustrine emergent wetland (PEM) occurs south of the solar array in Row 1. The southernmost road separates this large wetland from a second smaller wetland located along the southern fence line of the

¹⁰ Cowardin, Lewis M., Virginia Carter, Edward T. LaRoe, and Francis C. Golet. (1979). Classification of Wetlands and Deepwater Habitats of the United States. Washington, D.C.

NWTC. These wetlands appear to be hydrologically connected and supported by seepage from a reservoir located south of the property boundary. Capture of surface water runoff may provide additional hydrology to these wetlands. The large wetland north of the road was previously identified by Plantae¹¹; however, Walsh¹² mapped this area as “mixed mesic grassland” dominated by big bluestem. Hydrological support has evidently increased since 2011 as this area was dominated by obligate wetland species and surface water was present throughout the area during the 2016 field surveys. A second large PEM occurs in a seasonal pond located southwest of the ponderosa pine woodland community. Walsh (2011a) indicated that wetlands at this location depend on an elevated spring and early summer water table to support the wetland community. Standing water was observed in the pond during both of the 2016 field surveys. Dominant species in this wetland are common spikerush and broadleaf cattail. Canada bluegrass is the dominant grass species in the uplands adjacent to this wetland community. Canada thistle (*Cirsium arvense*) and common mullein, both noxious weeds, were abundant on the west-facing slope above the pond.

A third large PEM occurs south of the solar array in Row 3. This wetland consists of a large stand of cattails (*Typha species*) and foxtail barley surrounded by sandbar willow (*Salix exigua*) and plains cottonwood (*Populus deltoides*) trees.

Two small PEMs occur on slopes along the northern boundary of the project area. The first PEM is located in the northwest corner of NWTC, and the second occurs along the northern fence line adjacent to the parking lot of the administration and engineering building. Dominant species in the westernmost wetland are Nebraska sedge and Arctic rush. Prairie cordgrass and Arctic rush are dominant in the easternmost wetland. These wetlands occur on gentle slopes and appear to be supported by ground water seeps. Both of these wetlands were previously identified and mapped by Walsh (2011a).

Headwater – Riparian Emergent Wetland

Headwater or riparian emergent wetland communities occur within the two prominent drainages located in the eastern half of NWTC (Figure 7). Both drainages show evidence of intermittent flow. The northernmost drainage is tributary to Coal Creek, and the southern drainage is tributary to Rock Creek. Dominant species within these wetlands include Arctic rush, foxtail barley, Nebraska sedge, and prairie cordgrass (*Spartina pectinata*). Significant patches of Canada thistle, bull thistle (*Cirsium vulgare*), and common teasel (*Dipsacus fullonum*), all List B noxious weeds, occur within the northernmost drainage. Other observed species include shortbeak sedge (*Carex brevior*), swordleaf rush (*Juncus ensifolius*), long-style rush (*Juncus longistylis*), Torrey’s rush, common spikerush, and switchgrass. Occasional plains cottonwood trees, and sandbar willow shrubs occur along these drainages.

Disturbed – Non-habitat

These cover types reflect surface disturbance due to human activities on the site. These areas include roadsides, pad sites, parking lot perimeters, construction sites, and storage areas. Some of these areas have been revegetated and now include a combination of species from surrounding natural plant communities, reclamation species, and adventive (non-native) or ruderal (native or adventive, disturbance colonizer) species. Dominant species noted include smooth brome grass and cheatgrass. These areas are not specifically called out in Figure 7.

Ornamental Trees/Shrubs

Disturbed areas around buildings have been planted with a combination of native and ornamental trees and shrubs. The trees include multiple species of junipers (*Sabina spp.*) and pines (*Pinus spp.*), interspersed with ornamental deciduous trees. Shrubs in these areas are mainly chokecherry (*Padus virginiana*) and rose (*Rosa spp.*) bushes. These areas are not specifically called out in Figure 7.

¹¹ Plantae Consulting Services. (2000). Vegetation Survey, NREL National Wind Technology Center. Boulder, Colorado.

¹² Walsh Environmental Scientists and Engineers. (2011a). 2010-2011 Vegetation and Wildlife Surveys at the National Renewable Energy Laboratory National Wind Technology Center, Jefferson County, CO. Prepared for the National Renewable Energy Laboratory. Golden, CO.



APPENDIX B: WILDLIFE SPECIES OBSERVED AT THE STM SITE AND THE NWTC

Nova, a 16-year old Golden Eagle, is held by its Auburn University eagle handler at the NWTC. Nova, and a Bald Eagle named Spirit, are part of a research collaboration among Laufer Wind, Boulder Imaging, RES America, Auburn University, and NREL to develop a radar system capable of detecting avian species that will assist in preventing bird strikes with wind turbines. *Photo by Dennis Schroeder, NREL 35734*

The following are lists of common and scientific names of wildlife species observed at the STM site and the NWTC. The species listed for STM site were observed by staff and/or observed in surveys completed in 1987, 2005, and 2011. The species for the NWTC were identified during surveys completed in 1996, 2003, 2011 and 2016. For 1996 survey results, please refer to NREL's 2015 Environmental Performance Report that can be found at: www.nrel.gov/docs/fy16osti/65807.pdf.

TABLE 9. WILDLIFE SPECIES AT THE STM SITE

SPECIES COMMON NAME	SCIENTIFIC NAME	1987 Survey	2005 Survey	2011 Survey
BIRDS				
American crow	Corvus brachyrhynchos		X	X
American goldfinch	Carduelis tristis			X
American kestrel	Falco sparverius	X	X	X
American pipit	Anthus rubescens			X
American redstart	Setophaga ruticilla			X
American robin	Turdus migratorius	X	X	X
American tree sparrow	Spizella arborea		X	X
American white pelican	Pelecanus erythrorhynchos			X
Bald eagle ¹	Haleatus leucocephalus			
Barn swallow	Hirundo rustica			X
Black-billed magpie	Pica hudsonia	X	X	X
Black-capped chickadee	Poecile atricapilla		X	
Black-crowned night heron	Nycticorax nycticorax		X	
Black-headed grosbeak	Pheucticus melanocephalus			X
Blue-gray gnatcatcher	Polioptila caerulea			X
Blue jay	Cyanocitta cristata		X	X
Brewer's blackbird	Euphagus cyanocephalus	X		X
Brewer's sparrow	Spizella breweri			X
Broad-tailed hummingbird	Selasphorus platycercus			X
Broad-winged hawk	Buteo platypterus			X
Brown-headed cowbird	Molothrus ater	X	X	X
Bullock's oriole	Icterus bullockii		X	X
Bushtit	Psaltriparus minimus			X

¹Species observed at a time other than in a survey.

Table 9 continued on page 76

TABLE 9. WILDLIFE SPECIES AT THE STM SITE

SPECIES COMMON NAME	SCIENTIFIC NAME	1987 Survey	2005 Survey	2011 Survey
BIRDS				
California gull	<i>Larus californicus</i>		X	
Canada goose	<i>Branta canadensis</i>		X	X
Cedar waxwing	<i>Bombycilla cedrorum</i>			X
Cassin's kingbird	<i>Tyrannus vociferans</i>			X
Chestnut-collared longspur	<i>Calcarius ornatus</i>			X
Chipping sparrow	<i>Spizella passerina</i>			X
Cliff swallow	<i>Petrochelidon pyrrhonota</i>			X
Common grackle	<i>Quiscalus quiscula</i>			X
Common nighthawk	<i>Chordeiles minor</i>	X	X	X
Common raven	<i>Corvus corax</i>		X	X
Common snipe	<i>Gallinago delicata</i>		X	
Cooper's hawk	<i>Accipiter cooperii</i>		X	X
Dark-eyed junco	<i>Junco hyemalis</i>		X	X
Double-crested cormorant	<i>Phalacrocorax auritus</i>			X
Eastern kingbird	<i>Tyrannus tyrannus</i>			X
Eurasian collared dove ¹	<i>Streptopelia decaocto</i>			
European starling	<i>Sturnus vulgaris</i>	X	X	X
Golden eagle	<i>Aquila chrysaetos</i>		X	
Grasshopper sparrow	<i>Ammodramus savannarum</i>			X
Great blue heron	<i>Ardea herodias</i>		X	X
Great horned owl ¹	<i>Bubo virginianus</i>			
Green-tailed towhee	<i>Pipilo chlorurus</i>			X
Hepatic tanager	<i>Piranga flava</i>			X
Hermit thrush	<i>Catharus guttatus</i>			X
Horned lark	<i>Eremophila alpestris</i>	X		X
House finch	<i>Carpodacus mexicanus</i>		X	X
House sparrow	<i>Passer domesticus</i>		X	X
House wren	<i>Troglodytes aedon</i>			X
Killdeer	<i>Charadrius vociferous</i>	X	X	X
Lark bunting	<i>Calamospiza melanocorys</i>	X	X	
Lark sparrow	<i>Chondestes grammacus</i>			X
Lazuli bunting	<i>Passerina amoena</i>			X
Lesser goldfinch	<i>Carduelis psaltria</i>			X
Loggerhead shrike	<i>Lanius ludovicianus</i>		X	
MacGillivray's warbler	<i>Oporornis tolmiei</i>		X	
Mallard	<i>Anas platyrhynchos</i>		X	
Mountain bluebird	<i>Sialia currucoides</i>	X	X	
Mountain chickadee	<i>Poecile gambeli</i>			X
Mourning dove	<i>Zenaida macroura</i>	X	X	
Northern flicker	<i>Colaptes auratus</i>	X	X	
Northern goshawk	<i>Accipiter gentilis</i>			X
Northern harrier	<i>Circus cyaneus</i>		X	
Northern saw-whet owl ¹	<i>Aegolius acadicus</i>			
Orange-crowned warbler ¹	<i>Oreothlypis celata</i>			

¹Species observed at a time other than in a survey.

TABLE 9. WILDLIFE SPECIES AT THE STM SITE

SPECIES COMMON NAME	SCIENTIFIC NAME	1987 Survey	2005 Survey	2011 Survey
BIRDS				
Osprey	<i>Pandion haliaetus</i>		X	
Peregrine falcon	<i>Falco peregrinus</i>			X
Pine siskin	<i>Carduelis pinus</i>			X
Prairie falcon	<i>Falco mexicanus</i>		X	
Red-breasted nuthatch	<i>Sitta canadensis</i>		X	
Red-tailed hawk	<i>Buteo jamaicensis</i>	X	X	
Red-winged blackbird	<i>Agelaius phoeniceus</i>	X		
Rock dove	<i>Columba livia</i>		X	
Rock wren	<i>Salpinctes obsoletus</i>		X	
Ruby-crowned kinglet	<i>Regulus calendula</i>			X
Sage thrasher	<i>Oreoscoptes montanus</i>			X
Say's phoebe	<i>Sayornis saya</i>		X	
Sharp-shinned hawk	<i>Accipiter striatus</i>			X
Spotted towhee	<i>Pipilo maculatus</i>		X	
Swainson's hawk	<i>Buteo swainsoni</i>		X	
Tree swallow	<i>Tachycineta bicolor</i>		X	X
Turkey vulture	<i>Cathartes aura</i>		X	
Vesper sparrow	<i>Poocetes gramineus</i>		X	
Virginia's warbler	<i>Oreothlypis virginiae</i>			X
Violet-green swallow	<i>Tachycineta thalassina</i>			X
Western kingbird	<i>Tyrannus verticalis</i>	X	X	
Western meadowlark	<i>Sturnella neglecta</i>	X	X	
Western scrub-jay	<i>Aphelocoma californica</i>		X	
White-crowned sparrow	<i>Zonotrichia leucophrys</i>		X	
White-faced ibis	<i>Plegadis chihi</i>			X
White-throated swift	<i>Aeronautes saxatalis</i>			X
Yellow-breasted chat	<i>Icteria virens</i>			X
Yellow-rumped warbler	<i>Dendroica coronata</i>			X

Table 9 continued on page 78

TABLE 9. WILDLIFE SPECIES AT THE STM SITE

SPECIES COMMON NAME	SCIENTIFIC NAME	1987 Survey	2005 Survey	2011 Survey
MAMMALS				
Big brown bat ¹	<i>Eptesicus fuscus</i>			
Black bear ¹	<i>Ursus americanus</i>			
Black-tailed jackrabbit	<i>Lepus californicus</i>	X		X
Bushy-tailed woodrat	<i>Neotoma cinerea</i>	X		
Coyote	<i>Canis latrans</i>	X	X	X
Deer mouse	<i>Peromyscus maniculatus</i>	X		X
Elk ¹	<i>Cervus canadensis</i>			
Fox squirrel	<i>Sciurus niger</i>		X	
Hoary bat ¹	<i>Lasiurus cinereus</i>			
Long-tailed weasel	<i>Mustela frenata</i>		X	
Mexican woodrat	<i>Neotoma mexicana</i>		X	X
Mountain cottontail	<i>Sylvilagus nuttalli</i>	X	X	X
Mule deer	<i>Odocoileus hemionus</i>	X	X	X
Prairie vole	<i>Microtus ochrogaster</i>	X	X	
Raccoon	<i>Procyon lotor</i>	X	X	X
Red fox	<i>Vulpes vulpes</i>	X		X
Striped skunk	<i>Mephitis</i>			X
Western harvest mouse	<i>Reithrodontomys megalotis</i>	X	X	X
Western spotted skunk	<i>Spilogale gracilis</i>			X
White-tailed jackrabbit	<i>Lepus townsendii</i>		X	
Yellow-bellied marmot	<i>Marmota flaviventris</i>	X		
REPTILES AND AMPHIBIANS				
Bull snake	<i>Pituophis catenifer</i>	X		X
Plains garter snake	<i>Thamnophis radix</i>	X	X	
Prairie lizard	<i>Sceloporus undulatus</i>			X
Racer	<i>Coluber constrictor</i>			X
Six-lined racerunner	<i>Cnemidophorus sexlineatus</i>		X	
Tiger salamander	<i>Ambystoma tigrinum</i>		X	X
Western chorus frog ¹	<i>Pseudacris triseriata</i>			
Western (Prairie) rattlesnake	<i>Crotalus viridus</i>	X	X	X
Woodhouse's toad	<i>Bufo woodhousii</i>			X

¹ Species observed at a time other than in a survey.

TABLE 10. WILDLIFE SPECIES AT THE NWTC

SPECIES COMMON NAME	SCIENTIFIC NAME	2003 Survey	2011 Survey	2016 Survey
BIRDS				
American crow	<i>Corvus brachyrhynchos</i>		X	
American goldfinch	<i>Spinus tristis</i>	X	X	
American kestrel	<i>Falco sparverius</i>	X	X	X
American pipit	<i>Anthus rubescens</i>		X	
American robin	<i>Turdus migratorius</i>	X	X	X
American tree sparrow	<i>Spizella arborea</i>		X	
Bald eagle	<i>Haliaeetus leucocephalus</i>		X	
Barn swallow	<i>Hirundo rustica</i>	X	X	X
Black-billed magpie	<i>Pica hudsonia</i>	X	X	X
Black-capped chickadee	<i>Poecile atricapillus</i>	X	X	
Blue-gray gnatcatcher	<i>Polioptila caerulea</i>	X		X
Blue jay	<i>Cyanocitta cristata</i>		X	
Brewer's blackbird	<i>Euphagus cyanocephalus</i>	X	X	X
Brewer's sparrow	<i>Spizella breweri</i>		X	
Broad-tailed hummingbird	<i>Selasphorus platycercus</i>	X	X	X
Broad-winged hawk	<i>Buteo platypterus</i>			
Brown-headed cowbird	<i>Molothrus ater</i>	X	X	
Bullock's oriole	<i>Icterus bullockii</i>		X	X
Canada goose	<i>Branta canadensis</i>		X	X
Cedar waxwing	<i>Bombycilla cedrorum</i>		X	
Chipping sparrow	<i>Spizella passerina</i>	X	X	
Cliff swallow	<i>Petrochelidon pyrrhonota</i>	X		
Common grackle	<i>Quiscalus quiscula</i>	X	X	
Common nighthawk	<i>Chordeiles minor</i>	X		X
Common raven	<i>Corvus corax</i>	X	X	X
Common snipe	<i>Gallinago delicata</i>		X	
Cooper's hawk	<i>Accipiter cooperii</i>			
Dark-eyed junco	<i>Junco hyemalis</i>		X	
Double-crested cormorant	<i>Phalacrocorax auritus</i>	X		X
Downy woodpecker	<i>Picoides pubescens</i>		X	
Eurasian collared-dove	<i>Streptopelia decaocto</i>		X	
European starling	<i>Sturnus vulgaris</i>	X	X	X
Ferruginous hawk	<i>Buteo regalis</i>	X	X	
Franklin's gull	<i>Larus pipixcan</i>		X	
Golden eagle	<i>Aquila chrysaetos</i>	X	X	
Grasshopper sparrow	<i>Ammodramus savannarum</i>	X	X	X
Gray catbird	<i>Dumetella carolinensis</i>		X	X
Great blue heron	<i>Ardea herodias</i>	X	X	X
Great horned owl	<i>Bubo virginianus</i>		X	X
Green-tailed towhee	<i>Pipilo chlorurus</i>	X		X
Hairy woodpecker	<i>Picoides villosus</i>		X	
Horned lark	<i>Eremophila alpestris</i>	X	X	
House finch	<i>Carpodacus mexicanus</i>	X	X	X
House wren	<i>Troglodytes aedon</i>			X

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TABLE 10. WILDLIFE SPECIES AT THE NWTC

SPECIES COMMON NAME	SCIENTIFIC NAME	2003 Survey	2011 Survey	2016 Survey
BIRDS				
Killdeer	Charadrius vociferus		X	X
Lark bunting	Calamospiza melanocorys		X	
Lark sparrow	Chondestes grammacus	X		X
Loggerhead shrike	Lanius ludovicianus		X	
Long-billed curlew	Numenius americanus		X	
Mallard	Anas platyrhynchos	X	X	
Merlin	Falco columbarius			
Mountain bluebird	Sialia currucoides	X	X	
Mountain chickadee	Poecile gambeli		X	
Mourning dove	Zenaida macroura	X	X	X
Northern flicker	Colaptes auratus	X	X	
Northern goshawk	Accipiter gentilis			
Northern harrier	Circus cyaneus	X	X	
Osprey	Pandion haliaetus			
Peregrine falcon	Falco peregrinus	X	X	
Prairie falcon	Falco mexicanus	X		
Red-headed woodpecker	Melanerpes erythrocephalus		X	
Red-tailed hawk	Buteo jamaicensis	X	X	X
Red-winged blackbird	Agelaius phoeniceus	X	X	X
Rough-legged hawk	Buteo lagopus	X	X	
Ruby-crowned kinglet	Regulus calendula		X	
Sandhill crane	Grus canadensis		X	
Savannah sparrow	Passerculus sandwichensis		X	
Say's phoebe	Sayornis saya	X	X	X
Sharp-shinned hawk	Accipiter striatus			
Song sparrow	Melospiza melodia		X	X
Spotted towhee	Pipilo maculatus		X	X
Swainson's hawk	Buteo swainsoni		X	
Townsend's solitaire	Myadestes townsendi		X	
Tree swallow	Tachycineta bicolor		X	
Turkey vulture	Cathartes aura	X	X	
Vesper sparrow	Pooecetes gramineus	X	X	X
Western kingbird	Tyrannus verticalis	X	X	X
Western meadowlark	Sturnella neglecta	X	X	X
Western wood peewee	Contopus sordidulus			X
Wilson's snipe	Gallinago delicata			X
Wilson's warbler	Wilsonia pusilla	X		
Yellow-rumped warbler	Dendroica coronata	X		

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TABLE 10. WILDLIFE SPECIES AT THE NWTC

SPECIES COMMON NAME	SCIENTIFIC NAME	2003 Survey	2011 Survey	2016 Survey
MAMMALS				
Big brown bat	<i>Eptesicus fuscus</i>		X	X
Black-tailed prairie dog ¹	<i>Cynomys ludovicianus</i>	X		
Bobcat ¹	<i>Felis rufus</i>			X
Coyote	<i>Canis latrans</i>		X	X
Deer mouse	<i>Peromyscus maniculatus</i>		X	X
Desert cottontail	<i>Sylvilagus audubonii</i>		X	X
Eastern red bat	<i>Lasiurus borealis</i>		X	X
Elk	<i>Cervus canadensis</i>		X	X
Fringed myotis	<i>Myotis thysanodes</i>		X	X
Hoary bat	<i>Lasiurus cinereus</i>		X	X
Masked shrew	<i>Sorex cinereus</i>		X	X
Meadow vole	<i>Microtus pennsylvanicus</i>		X	X
Mexican woodrat	<i>Neotoma mexicana</i>		X	X
Mountain lion ¹	<i>Puma concolor</i>			X
Mule deer	<i>Odocoileus hemionus</i>		X	X
Myotis bats	<i>Myotis</i> sp.		X	X
Prairie vole	<i>Microtus ochrogaster</i>		X	X
Silver-haired bat	<i>Lasionycteris noctivagans</i>		X	X
Thirteen-lined ground squirrel	<i>Spermophilus tridecemlineatus</i>		X	
Western harvest mouse	<i>Reithrodontomys megalotis</i>		X	X
White-tailed deer ¹	<i>Odocoileus virginiana</i>			X
REPTILES AND AMPHIBIANS				
Boreal chorus frog	<i>Pseudacris maculata</i>		X	X
Bull snake	<i>Pituophis catenifer</i>		X	X
Northern leopard frog	<i>Lithobates pipiens</i>			X
Tiger salamander	<i>Ambystoma tigrinum</i>			X
Western (Prairie) rattlesnake	<i>Crotalus viridus</i>	X	X	X
Woodhouse's toad	<i>Bufo woodhousii</i>		X	X
TERRESTRIAL ARTHROPODS²				
Aphrodite fritillary	<i>Speyeria aphrodite</i>		X	
Cabbage white	<i>Pieris rapae</i>		X	
Checkered white	<i>Pontia protodice</i>		X	
Common wood nymph	<i>Cercyonis pegala</i>		X	
Dainty sulphur	<i>Nathalis iole</i>		X	
Gray hairstreak	<i>Strymon melinus</i>		X	
Orange sulphur	<i>Colias eurytheme</i>		X	
Western white	<i>Pontia occidentalis</i>		X	

¹ Species observed at a time other than in a survey.

² Terrestrial arthropod genera of specific concern were only surveyed in 2011 at the NWTC.

APPENDIX C:

2016 ENVIRONMENTAL PERMITS, REGISTRATIONS, AND NOTIFICATIONS

TABLE 11. NREL'S ENVIRONMENTAL PERMITS, REGISTRATIONS, AND NOTIFICATIONS IN 2016

Type	Location/ Description	Category	Issuing Agency	ID #	Permit or Registration Status
AST for petroleum storage	STM ESIF AST	Registration	DOPS	19275-1	Completed
AST for petroleum storage	STM PDU AST	Registration	DOPS	2873-2	Completed
AST for petroleum storage	STM RSF2 AST	Registration	DOPS	19211-1	Completed
AST for petroleum storage	STM SERF AST	Registration	DOPS	2873-1	Completed
AST for petroleum storage	E85 AST	Registration	DOPS	2873-4	Completed
Air	Laboratory-wide servicing of CFC-containing equipment	Notification	APCD	647	Active
Air	STM SERF, 2 CFC-containing stationary sources	Registration	APCD	647	Active
Air	STM FTLB waste gas combustor	Permit	APCD	99JE0400	Active
Air	STM RFHP wood waste boiler	Permit	APCD	07JE0277	Active
Air	STM fugitive dust from construction activities	Permit	APCD	08JE0889L	Active
Air	STM RSF 1 diesel-fired standby electrical generator	Permit	APCD	10JE1400	Active
Air	STM RSF 2 diesel-fired standby electrical generator	Permit	APCD	11JE1303	Active
Air	STM FTLB diesel-fired standby electrical generator	Permit	APCD	10JE1630	Active
Air	NWTC Site 4.0 diesel-fired standby electrical generator	Permit	APCD	10JE1712	Active
Air	STM parking garage diesel-fired standby electrical generator	Permit	APCD	11JE1997	Active
Air	STM ESIF diesel-fired standby electrical generator	Permit	APCD	11JE3542	Active
Air	STM ESIF research electrical generator #3	Permit	APCD	13JE2829	Active
Air	STM IBRF scrubber and baghouse	Permit	APCD	11JE1798	Active
Air	STM ESIF research electrical generator #1	APEN	APCD	12JE1734 XP	Active
Air	STM ESIF research electrical generator #2	APEN	APCD	12JE1735 XP	Active

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TABLE 11. NREL'S ENVIRONMENTAL PERMITS, REGISTRATIONS, AND NOTIFICATIONS IN 2016

Type	Location/ Description	Category	Issuing Agency	ID #	Permit or Registration Status
Air	STM IBRF standby electrical generator	APEN	APCD	13JE2276 XP	Active
Air	NWTC STL standby electrical generator	APEN	APCD	13JE2271 XP	Active
Air	NWTC Building 251 standby electrical generator	APEN	APCD	13JE2272 XP	Active
Air	NWTC Composites Manufacturing Education and Technology facility	APEN	APCD	16JE0934	Active
Alcohol	STM IBRF alcohol fuel production	Permit	TTB	AFP-CO-00255	Active
Alcohol	STM tax-free alcohol use	Permit	TTB	TF-CO-0331	Active
Drinking water system	NWTC drinking water system ID number	Registration	WQCD	CO0230860	In Effect; Does Not Expire
Groundwater well	STM FTLB groundwater monitoring well MW-FTLB-1	Permit	DWR	301322	Active
Groundwater well	STM FTLB groundwater monitoring well MW-FTLB-2	Permit	DWR	301323	Active
Groundwater well	STM FTLB groundwater monitoring well MW-FTLB-3	Permit	DWR	301324	Active
Hazardous materials	STM WHF hazardous material storage and use permit	Permit	WMFR	11408	Active
Hazardous materials	STM SERF hazardous material storage and use permit	Permit	WMFR	11412	Active
Hazardous materials	STM S&TF hazardous material storage and use permit	Permit	WMFR	11413	Active
Hazardous materials	STM FTLB hazardous material storage and use permit	Permit	WMFR	11409	Active
Hazardous materials	STM IBRF hazardous material storage and use permit	Permit	WMFR	11410	Active
Hazardous materials	STM Shipping and Receiving hazardous material storage and use permit	Permit	WMFR	11411	Active
Hazardous materials	DWOP building 16 hazardous material storage and use permit	Permit	WMFR	11407	Active
Hazardous materials	ReFUEL hazardous material storage and use permit	Permit	Denver Fire Department	165636	Active
Hazardous waste	DWOP RCRA hazardous waste generator status EPA ID	Notification	HMWMD	CO4890000017	Completed
Hazardous waste	STM RCRA hazardous waste generator status EPA ID	Notification	HMWMD	CO3890090076	Completed
Hazardous waste	JSF RCRA hazardous waste generator status EPA ID	Notification	HMWMD	COD980805162	Completed
Hazardous waste	NWTC RCRA hazardous waste generator status EPA ID	Notification	HMWMD	COD983802448	Completed
Hazardous waste	ReFUEL RCRA hazardous waste generator status EPA ID	Notification	HMWMD	COR000207563	Completed
Historic registration	STM amphitheater	Registration	NPS	93000378	In effect; does not expire
Historic registration	STM stone bunker	Registration	NPS	93000379	In effect; does not expire
Stormwater	STM electrical upgrade project	Permit	EPA	COR12B06F	Terminated
Stormwater	STM SERF & STF Landscape Improvements/DWP Safety Enhancements (FTLB)	Permit	EPA	COR12AW4F	Active

Acronyms used in the table

APCD – Air Pollution Control Division of Colorado Department of Public Health and the Environment (CDPHE)
APEN – Air Pollutant Emission Notice
AST – Aboveground Storage Tank
CFC – Chlorofluorocarbon
DFD – Denver Fire Department
DOPS – Division of Oil and Public Safety of the Colorado Department of Labor and Employment
DWOP – Denver West Office Park
DWR – Division of Water Resources
EPA – Environmental Protection Agency
ESIF – Energy Systems Integration Facility
FTLB – Field Test Laboratory Building
HMWMD – Hazardous Materials and Waste Management Division of CDPHE
IBRF – Integrated Biorefinery Research Facility
NPS – National Park Service of the U.S. Department of the Interior
NWTC – National Wind Technology Center
PDU – Process Development Unit
RCRA – Resource Conservation and Recovery Act
ReFUEL – Renewable Fuels and Lubricants Research Laboratory
RFHP – Renewable Fuel Heat Plant
RSF – Research Support Facility
S&TF – Science and Technology Facility
SERF – Solar Energy Research Facility
STM – South Table Mountain
TTB – Alcohol and Tobacco Tax and Trade Bureau of the U.S. Department of the Treasury
WHF – Waste Handling Facility
WMFR – West Metro Fire Rescue
WQCD – Water Quality Control Division of CDPHE



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