



ENVIRONMENTAL PERFORMANCE REPORT 2015

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



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: NREL researcher characterizes the electrical properties of a solar cell and assesses the functionality of a large prototype collimating tube. *Photo by Dennis Schroeder, NREL 35526*

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NREL Environmental Performance Report 2015

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Panoramic view of the eastern portion of the South Table Mountain site. Photo by Dennis Schroeder, NREL 30254



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NOMENCLATURE

APCD – Air Pollution Control Division of CDPHE

APEN – Air Pollutant Emission Notice

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

CO₂e – Carbon Dioxide Equivalent

CRS – Colorado Revised Statute

CWA – Clean Water Act

CX – Categorical Exclusion

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

DWOP – Denver West Office Park

EA – Environmental Assessment

EERE – Energy Efficiency and Renewable Energy

EHS – Environment, Health, and Safety

EIS – Environmental Impact Statement

EMS – Environmental Management System

EPA – U.S. Environmental Protection Agency

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

ESA – Endangered Species Act

ESIF – Energy Systems Integration Facility

EO – Executive Order

FTLB – Field Test Laboratory Building

FY – Fiscal Year

IBRF – Integrated Biorefinery Research Facility

ISO – International Organization for Standardization

MBTA – Migratory Bird Treaty Act

mrem – Millirem

MW – Megawatt

NEPA – National Environmental Policy Act

NREL – National Renewable Energy Laboratory

NWTC – National Wind Technology Center

ODS – Ozone Depleting Substances

RFHP – Renewable Fuel Heating Plant

RSF – Research Support Facility

RTD – Regional Transportation District

SDS – Safety Data Sheet

SERF – Solar Energy Research Facility

SPCC – Spill Prevention Control and Countermeasures

S&TF – Science and Technology Facility

STL – Structural Testing Laboratory

STM – South Table Mountain

USACE – U.S. Army Corps of Engineers

WQCD – Water Quality Control Division of CDPHE



EXECUTIVE SUMMARY

The Peregrine supercomputer at NREL's Energy Systems Integration Facility is capable of performing more than a quadrillion calculations per second. Ninety percent of the computer's waste heat is captured and used as the primary heat source for the Energy Systems Integration Facility offices and laboratory space. *Photo by Dennis Schroeder, NREL 31716*

Purpose

The National Renewable Energy Laboratory's (NREL's) Environmental Performance Report provides a description of the laboratory's environmental management activities for 2015, 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 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.

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 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.

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 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 2015 to enhance sustainability and environmental performance 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 key short-term internal environmental and sustainability goals, and made progress toward long-term goals (For more details, see section 3, Environmental Management System and Pollution Prevention, and section 4, Sustainability)
- Received several awards and recognitions for environmental and sustainability accomplishments (see sidebar on page 7)
- Maintained International Organization for Standardization 14001:2004 environmental management system certification

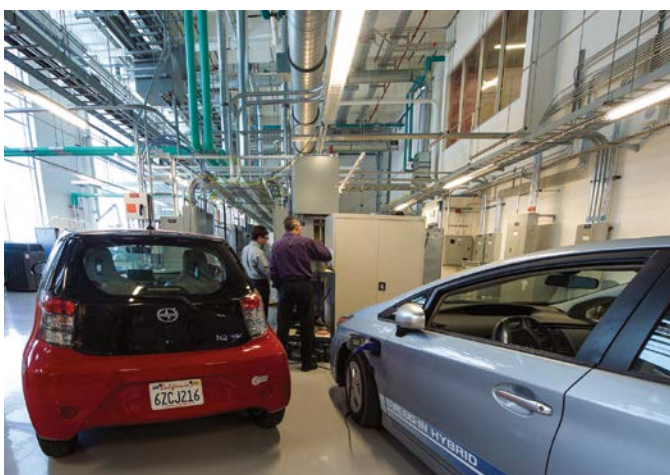


An NREL technician replaces an anemometer on a NWTC meteorological tower. Anemometers provide wind speed data that, along with other data collected, allow NREL staff and industry partners to evaluate the performance of wind turbines under varying environmental conditions. *Photo by Jerry Hur, NREL 36267*

- Maintained Colorado Environmental Leadership Program Gold-Level Leader status, the highest level awarded by the state-sponsored program
- Received commendation from Jefferson County Public Health for detailed and comprehensive management of the National Wind Technology Center drinking water system and for the extent of protection of the water from delivery to consumption
- Successfully restored, after more than two years of restoration efforts that included temporary irrigation and weed management, a portion of the South Table Mountain site disturbed as part of construction of the Energy Systems Integration Facility, thus allowing termination of Environmental Protection Agency stormwater permit coverage
- Developed slope stabilization designs for steep hill-sides at the South Table Mountain site which, when implemented, will stabilize areas that became unstable in the significant rain events of recent years, and restore native vegetation and habitat for area wildlife
- Held a community open-house in coordination with the DOE Golden Field Office during which information was presented concerning environmental stewardship at NREL
- Held a workshop sponsored by the DOE Golden Field Office and led by the U.S. Fish and Wildlife Service covering topics that included the Migratory Bird Treaty Act and associated case law, related regulations, and how these regulations specifically apply to DOE sites
- Installed nest boxes in areas around the South Table Mountain site that were used by tree swallows to successfully fledge several broods
- Girdled and applied herbicide to 15 Russian olive trees across the South Table Mountain site and within the South Table Mountain Conservation Easement to kill the trees and prevent the spread of this invasive species
- In cooperation with the Colorado Department of Agriculture, introduced a rust fungus (*Puccinia punctiformis*) at two locations, one on the South Table Mountain site and the other on the National Wind Technology Center, to combat Canada thistle a noxious weed
- Hosted the spring quarterly meeting of the Colorado Noxious Weed Network
- Reduced impacts of employee commuting by supporting alternative work schedules, telecommuting, and alternative commuting options such as providing access to mass transit, vanpool discounts, preferred parking for carpool/vanpool vehicles, ride-share coordination, and bicycle and pedestrian infrastructure.

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.



In the Systems Performance Laboratory, engineers connect electric vehicles and smart appliances to a simulated grid to study the dynamics of how they interact. *Photo by Dennis Schroeder, NREL 32474*

Prestigious Environmental Sustainability Awards Received

NREL received several important recognitions in 2015 for its environmental and sustainability accomplishments including:

- A DOE Green Buy Program Gold Award for purchasing 13 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 green procurement of electronics

The laboratory continued its excellent record of environmental compliance in 2015. 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 program areas 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, as well as 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.

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

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.

The laboratory continued to improve its environmental management and performance in 2015, as demonstrated by a track record of excellent compliance with regulatory requirements and established leadership in environmental and sustainability management.



An engineer operating the silicon cluster tool in the Science and Technology Facility. The tool is used to develop techniques to explore and enhance potential industry practices for fabricating silicon solar cells. *Photo by Pat Corkery, NREL 16555*

1 INTRODUCTION

1.1 PURPOSE

This report presents a summary of the National Renewable Energy Laboratory's (NREL's) environmental management activities in 2015, 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** – Fundamental research is conducted 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.



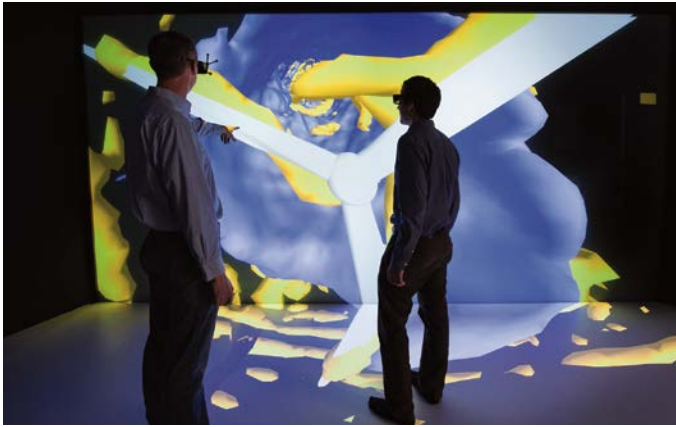
An NREL engineer analyzes fluids from materials such as corn stover and beetle kill wood that have the potential to be used as renewable transportation fuels or high value chemicals. *Photo by Dennis Schroeder, NREL 33050*



Hybrid electric vehicles charging at the Vehicle Testing and Integration Facility solar canopy. *Photo by Dennis Schroeder, NREL 31895*

- **Building energy** – NREL supports research and development of technologies and practices for energy efficiency, working closely with the building industry and manufacturers; 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** – This area includes 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** – Research is conducted to support electricity technologies that include renewable energy, hydrogen, and superconductivity technologies, as well as utility resources.
- **Energy analysis** – Energy analysis at NREL is performed to inform 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 allow 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** – Research is conducted in 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.



NREL senior engineers view velocity (blue) and turbulence (yellow) at a simulated wind farm in the Energy Systems Integration Facility's Visualization Laboratory. Photo by Dennis Schroeder, NREL 31408

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 where NREL research operations are conducted. 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.

Laboratory staff also conduct work at additional locations as needed; for example, at the Solar Technology Acceleration Center described on page 16.

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 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 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.



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

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 have their 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) has been set aside 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 11, Conservation Easement Lands.)

Geology, Soils, and Hydrogeology

The mesa 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



Melting snow from the roof of the Research Support Facility is captured in a landscaped catch basin. These same basins receive stormwater runoff from the roof later in the year, providing water to trees and grasses planted within them. *Photo by Dennis Schroeder, NREL 18643*



Flowering prickly pear at the STM site. Photo by Brent Nelson, NREL 23871

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 consisting 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 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

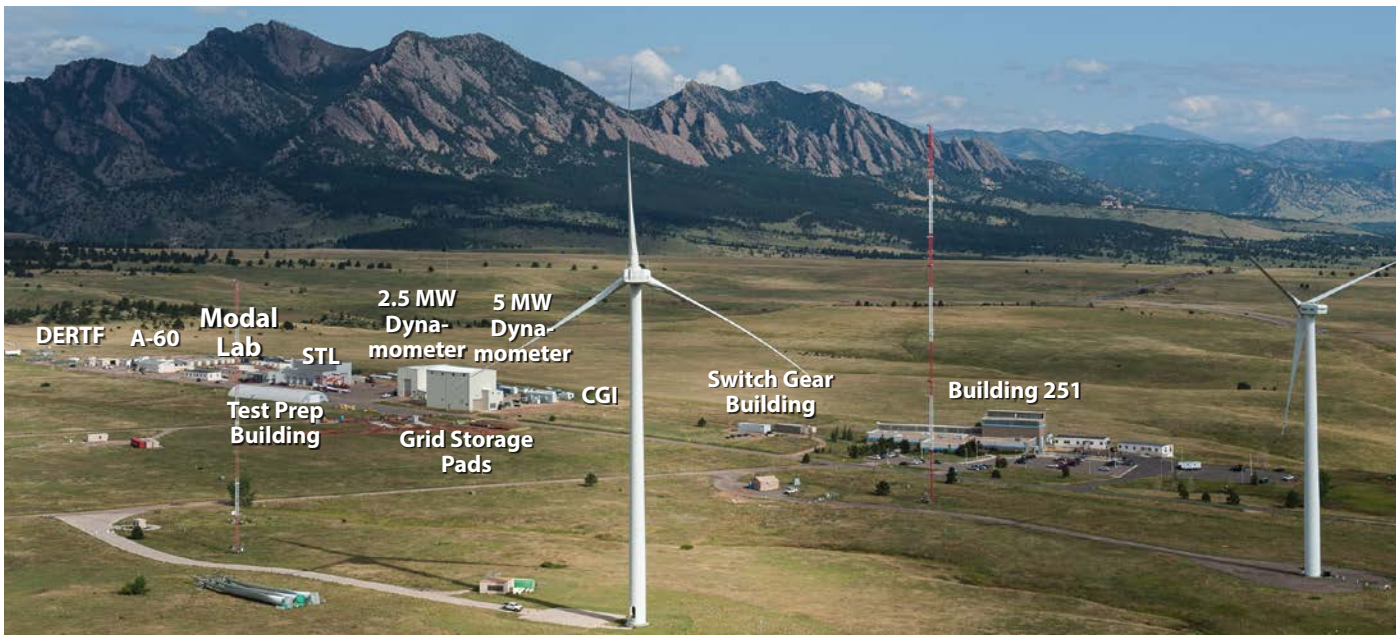
Two primary vegetation types are present on the STM site: grasslands and shrublands. The most common plant communities on the STM site are mixed grasslands, comprising more than 80% of the vegetation on the

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. A vegetation survey of the STM site was conducted in 2010. (For more details, see section 10.3, Vegetation Management.)

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 in 2011. (For more details, see section 10.1, Wildlife Management.)

Mammals identified during the surveys included mule deer, coyotes, gray foxes, red foxes, raccoons, long-tailed weasels, striped and spotted skunks, badgers, bobcats, mountain lions, rabbits, yellow-bellied marmots, and various smaller mammals. More than 50 species of birds have been recorded on the STM site 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 resident at the site: American kestrel and red-tailed hawk. Reptiles and amphibians inhabit the area as well. Most notably, the western rattlesnake is routinely encountered around the site area.



NREL's National Wind Technology Center. Photo by Dennis Schroeder, NREL 30766

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 sand and gravel mine currently being restored 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

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

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

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



Mule deer at the NWTC. Photo by Mark McDade, NREL 29825

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 NWTC have identified 271 vascular plant species and defined five major habitat types 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 was completed in 2011. (For more details, see section 10.3, Vegetation Management.)

Wildlife

Prior to 1975, livestock heavily grazed the NWTC, damaging a majority of the native vegetation. DOE prepared a biological characterization inventory in 1992 for the entire Rocky Flats Plant, including the 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. Other mammals known to feed at the site are mule deer, coyotes, desert cottontail rabbits, white-tailed jackrabbits, black-tailed jackrabbits, deer mice, prairie voles, and thirteen-lined ground squirrels. Approximately 20 species of birds were sighted at or near the site. Raptor surveys were conducted at the NWTC in 1994 and 1995, and identified seven raptor species on or in the vicinity of the site. An avian survey was also completed in 2002 and updated in 2011. (For more details, see section 10.1, Wildlife Management.) Although seldom seen, rattlesnakes, bull snakes, racers, and several other reptilian and amphibian species are known to occupy the area.

³Ibid.



NREL researcher uses a small quantity of biofuel to evaluate the combustion kinetics in an Ignition Quality Tester at an NREL Denver West laboratory. Photo by Dennis Schroeder, NREL 32870

Denver West Office Park

The Denver West Office Park, located within the City of Lakewood approximately 2 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 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 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 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.

Additional Locations

Laboratory staff work at additional locations as needed. One such location is the Solar Technology Acceleration Center, operated by MRIGlobal, located near Denver International Airport, northeast of the intersection of East 26th Avenue and North Hudson Road in Aurora, Colorado. The Solar Technology Acceleration Center is a partnership of solar equipment manufacturers, research organizations, and electric utilities that utilize a real-world outdoor site to develop, test, validate, and showcase solar products. Approximately 33 miles (54 km) east of the STM site, the 74-acre (30-hectare) facility provides users with readily accessible land and all the necessary infrastructure and resources needed to rapidly and economically install their technologies. NREL leases several acres at the site. The primary project currently being conducted by NREL is the testing of photovoltaic technologies through partnerships with various equipment manufacturers.



NREL technician working on a lubrication manifold of a next-generation drive train for a wind turbine gearbox.
Photo by Dennis Schroeder, NREL 32786

2 SIGNIFICANT SITE ACTIVITIES IN 2015

In 2015, numerous minor construction projects were commenced, continued, or completed. From concept to design to completion, environmental and sustainable stewardship practices are integrated into the management of infrastructure and building projects.

2.1 CONSTRUCTION PROJECTS

A brief description of the significant projects that occurred on NREL sites during 2015 is as follows:

STM Site

- Site preparations including gravel access roads, communications/data connectivity, and a 480V 3-phase electrical service panel were completed on a 0.7-acre (0.3 hectares) portion of the STM site where photovoltaic arrays will be installed for large scale reliability testing.
- Improvements to the electrical infrastructure at the Thermal Test Facility were completed. The increase in electrical service from 800 amps to 1,600 amps will better accommodate existing testing and enable additional future testing.
- Building maintenance occurred including the construction of a new roof at the Shipping and Receiving building, and exterior painting at the Shipping and Receiving building, Solar Energy Research Facility, and Integrated Biorefinery Facility.
- Infrastructure was erected at the STM site to communicate emergency announcements to staff walking/working out-of-doors. This infrastructure, which includes an omnidirectional speaker mounted atop a 50-foot steel pole, will complement the public address systems already installed in all site buildings.

NWTC

- Asphalt roads and parking lots that had degraded over the years were repaired and overtopped. In addition, several dirt roads that service large megawatt turbines as well as other site access roads that require annual grading and graveling were asphalt paved.

2.2 INTEGRATED ENVIRONMENTAL STEWARDSHIP IN CONSTRUCTION MANAGEMENT

NREL designs and builds new facilities using an approach that integrates planning, design, and construction. An interdisciplinary team collaborates on each project beginning with planning and selection of design, continuing through construction. This integrated approach allows the laboratory to achieve mission needs while addressing environmental, health, safety, and community considerations.

Project Planning and Design

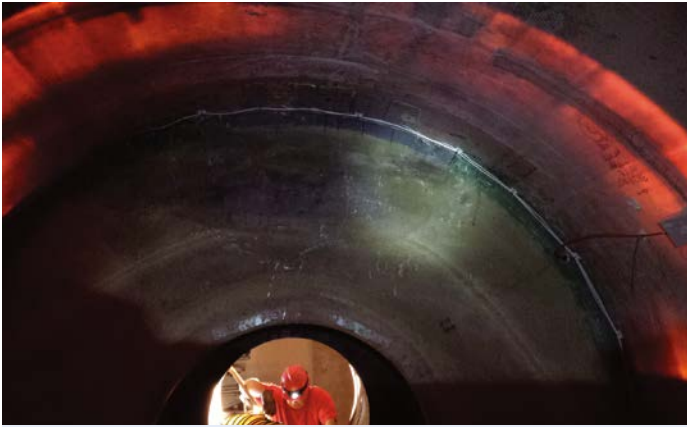
Environmental staff participate in an interdisciplinary project management team from a project's initiation through construction. This includes developing and reviewing scopes of work, facilitating the inclusion of environmental requirements and best management practices (such as bird-friendly windows) into project designs, and monitoring proposed changes throughout the project to confirm that potential environmental impacts are considered and addressed. Some of the

2015 projects that demonstrate the integration of environmental considerations in planning and design include the following:

- An outdoor gravel pad for placement of containerized equipment was designed and constructed to provide much needed storage space while also promoting stormwater infiltration, thus reducing runoff leaving NREL property.
- An electrical substation, one component of an electrical upgrade project at the NWTC, was designed to minimize the area of construction and restore surrounding native grasses and habitat in an area that has been degraded by offsite sediment deposition.

Environmentally Responsible Construction Practices

During construction, DOE and NREL environmental staff participate 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.



3 ENVIRONMENTAL MANAGEMENT SYSTEM AND POLLUTION PREVENTION

An NREL technician installs internal strain gages along a turbine blade, connecting the wires to a data acquisition system for testing. *Photo by Sara Fairchild, NREL 34719*

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.

Requirements

A new federal Executive Order, EO 13693, *Planning for Federal Sustainability in the Next Decade*, was released, cancelling EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*; and EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*. EO 13693 establishes updated goals for environmental sustainability in the federal government. To meet these goals, federal facilities must 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, *Departmental Sustainability*, 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

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.

NREL's Environmental Aspects

NREL conducts an annual review of its activities that could potentially affect the environment. The laboratory's significant environmental aspects for 2015 were:

- Air emissions
- Surface water and groundwater discharges
- Wastewater releases
- Waste generation and management
- Resource use or conservation (energy, water, land, biological, cultural)
- Community.

Each of these aspects is addressed by the EMS.

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.

3.1 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

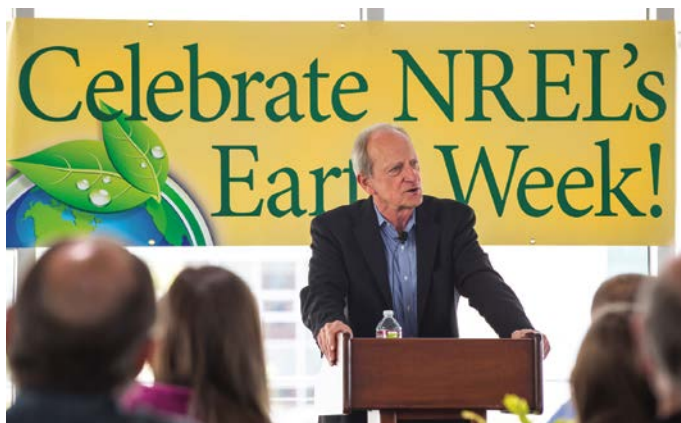
Planning

- **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 are those activities, products, or services 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 EHS 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 including 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 EHS Office and Sustainable NREL plan, implement, monitor, and report on environmental stewardship goals and actions to generate continual improvement. (For more details, see section 3.2, Performance Indicators and Progress.)

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 such as 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 EHS staff.
- **Operational control** – NREL plans and manages operations and activities in line with its environmental policy and objectives. Staff continually identify and review 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.



Earth Week kicks off with former NREL director and organizer of the first Earth Day, Denis Hayes, speaking to staff at the STM site. Photo by Dennis Schroeder, NREL 33271

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 3.3, Assessment and Improvement.)

Management Review

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

3.2 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.

Management and Reduction of Regulated Refrigerants

Certain refrigerants and other chemicals are more highly regulated than others due to their ability to damage the Earth's protective ozone layer. NREL's Ozone-Depleting Substances (ODS) management program provides guidance for the management of refrigerants used at NREL, as well as the substitution and reduction of regulated refrigerants when possible. (For more details, see

Reducing Pollution

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

- Replacing toxic chemicals with safer alternatives where 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, 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 for improving diversion of materials from the waste stream to recycling/reuse streams.



Sustainable NREL's Shred-It event collected and shredded more than 4,950 lbs. of paper from NREL staff households. Rather than being disposed of in a landfill, the shredded paper was taken to an offsite composting facility. *Photo by Dennis Schroeder, NREL 29896*

Performance Indicators and Progress

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

- **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 4, Sustainability.

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. Some examples of performance for the year are described in Table 1.

section 6, Air Quality Protection.) The policies used to reduce regulated refrigerant use and limit their releases include:

- Monitoring of the availability of acceptable substitutes for regulated refrigerants on a regular basis
- Prohibiting the purchase of any new refrigeration equipment using an ODS refrigerant
- Evaluating proposed research activities to determine if any refrigerants used are ODS and, if so, investigating the use of an EPA-approved alternative
- Adhering strictly to requirements for ODS equipment refrigerant recovery, leak detection, and repair to minimize ODS emissions
- Removing, where feasible, ODS refrigeration equipment and recycling of the refrigerant.

TABLE 1. 2015 ENVIRONMENTAL GOALS AND ACHIEVEMENTS

2015 Goals	2015 Examples	Goal Met?
Demonstrate continuous improvement in the integration of environmental planning into NREL programs, laboratory, and site operation processes	<p>Fully deployed the revised General Plant Improvement process tool for integrating environmental considerations into planning processes</p> <p>Conducted an environmental planning review of the Ten-Year Site Plan and Five-Year Plan</p> <p>Established an Exterior Design Review committee to review projects and prioritize issues to minimize environmental impacts (e.g., construction activities, laydown areas, erosion, revegetation)</p>	Yes
Actively identify potential EHS risks and modify practices accordingly	<p>Enhanced monitoring of sensitive areas (drainages, riparian areas, quality habitat), the STM Conservation Easement, and the NWTC Conservation Management Areas was completed. Developed recommendations for improved management.</p> <p>Stormwater training was attended by maintenance workers to better understand stormwater regulations and their role as it relates to best management practices.</p> <p>Provided spill management training to all NREL shuttle drivers to aid in spill recognition, reporting, and proper response actions in the event of a vehicle fluid release.</p>	Yes
Ensure procedures and controls are in place and implemented to comply with environmental regulatory requirements	<p>Provided an increased level of oversight to the new NWTC drinking water system Operator in Responsible Charge, including familiarizing the subcontractor to the system configuration and requirements, and participating in weekly sampling events. The most common issues for small systems such as the NWTC system were identified in order to reduce the risk of regulatory noncompliance.</p> <p>Provided nesting bird survey training to workers, enabling them to conduct surveys for compliance with the federal Migratory Bird Treaty Act.</p>	Yes
Maintain and demonstrate continuous improvement of International Organization for Standardization 14001 management system	<p>Verified ISO standard compliance of management systems as documented in the surveillance performed by a third party auditor</p> <p>Improved the process EHS uses for identification of legal and other requirements, as the DOE Necessary and Sufficient Standards is no longer a recognized DOE process</p> <p>Updated 20 laboratory-level procedures to flow down new or changed regulatory requirements, address findings from assessments, and make improvements identified during regular procedure reviews</p> <p>Hosted a Battelle Community of Practice group that conducted a Peer Review of the laboratory's EMS, allowing NREL to benchmark its EMS processes with other Battelle laboratories and share best practices</p>	Yes
Implement an enhanced National Environmental Policy Act (NEPA) program	<p>Continued development of program modifications to improve efficiency and operational flexibility, including development of new evaluation criteria</p> <p>Developed master milestone schedule identifying further enhancement activities that will continue throughout FY16.</p>	Yes

3.3 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

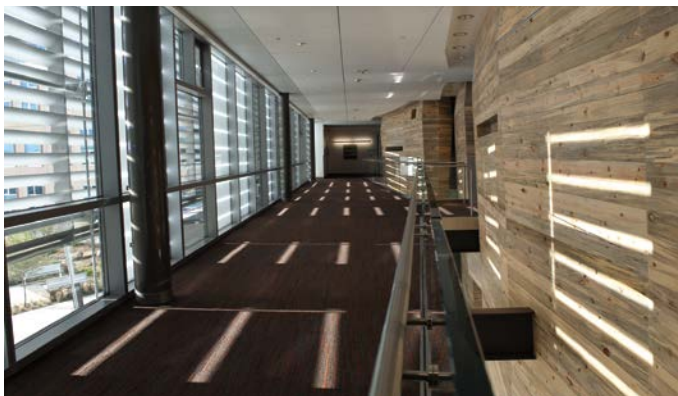
programs as part of continual improvement efforts. Annual surveillance assessments and triennial recertification assessments are conducted for the EMS as a whole to maintain ISO certification.

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

2015 Assessments

The following assessment activities took place in 2015, and have allowed NREL to enhance program effectiveness and make substantial environmental performance improvements:

- **Internal assessments** – Internal assessments of the laboratory's Drinking Water and Hazardous Waste Management programs were conducted, which involved interviews with staff and reviews of relevant procedures and records. The outcomes of these assessments are included in section 7, Water Quality Protection, and section 8, Hazardous Materials and Waste Management.
- **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 five findings and six opportunities for improvement. Corrective actions are underway to address deficiencies regarding records and data management, flowdown of requirements to construction subcontractors, and spill prevention planning.



The Research Support Facility, located on the STM site, is a Leadership in Energy and Environmental Design (LEED®) Platinum office building occupied by approximately 1,300 employees. As illustrated in this photo, the building makes use of natural daylighting in lieu of electric lighting, and beetle-kill wood rather than virgin timber. *Photo by Dennis Schroeder, NREL 17614*

2015 Accomplishments and Highlights

- NREL was successfully recertified to the ISO 14001:2004 standard. 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 ISO 14001 standard and demonstrates our commitment to environmental stewardship.
- The laboratory continued to enhance the integration of environmental considerations into planning processes.
- Internal assessments of the Drinking Water and the Hazardous Waste Management programs identified several areas for improvement.

3.4 2015 AWARDS AND RECOGNITION

In 2015, NREL received several awards and recognition of its environmental and sustainability achievements including:

- 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 Green Buy Program Gold Award

NREL received the gold-level DOE Green Buy Award for achieving excellence in sustainable acquisition. This is the fourth year in a row that NREL has received the gold-level recognition. To achieve this award, NREL met the goals for 13 product types in six different categories.

Green Electronics Council Award

In FY 2015, the Green Electronics Council awarded NREL with a Three-Star EPEAT Purchaser Award, recognizing NREL's excellence in the green procurement of electronics. The combined efforts of all of the 2015 EPEAT Purchaser Award winners resulted in enough energy savings to power more than 6,500 U.S. households for one year, the reduction of more than 771,618 pounds

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 reduce risk of non-compliance with requirements 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 To Work Day. Improved awareness of environmental issues supports environmental performance throughout the laboratory.

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

Staff are encouraged to reduce the laboratory's environmental footprint by participating in programs and events for recycling single-stream materials, batteries, electronic equipment, and shredded paper. A composting program is also in place. Furthermore, the Be The Change Program empowers individuals to develop and suggest changes to improve environmental/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, 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 collaborates 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. More information is available at: <http://www.lakewood.org/getgreen/>.

(350,000 kilograms) of hazardous waste, the elimination of enough mercury to fill more than 5,000 mercury thermometers, and carbon reductions equal to removing more than 11,000 passenger cars from the road for one year.

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 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 has maintained

this leadership level ever since. As a component of the 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 <https://www.colorado.gov/pacific/cdphe/environmental-leadership-program>.



Figure 2. NREL maintained its Colorado Environmental Leadership Program Gold Leader status.

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

Pollution prevention

Staff regularly identify 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 onsite contribute toward improved air quality. 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, NREL continually strives to protect water quality onsite and offsite.

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 onsite, which 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.



Members of the U.S. Department of Homeland Security sustainability team tour the photovoltaic array on the roof of the Research Support Facility. *Photo by Dennis Schroeder, NREL 34562*

4 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. NREL's sites are living laboratories that showcase new technologies, design practices, and best practices in operating behaviors. 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.

NREL integrates sustainability into its Environmental Management System. Staff work together regularly to improve operations and implement 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.

Requirements

The new federal order, EO 13693, *Planning for Federal Sustainability in the Next Decade*, specifies environmental sustainability performance goals for federal agencies. In addition, DOE Order 436.1, *Departmental Sustainability*, requires DOE facilities to prepare and implement an annual Site Sustainability Plan. Each site's plan reports



NREL employee test rides an electric bike during NREL's Earth Week celebration. Photo by Dennis Schroeder, NREL 33297

on the performance status of DOE facilities in addressing the sustainability goals and objectives of the executive and DOE order and also outlines plans to continue to address these objectives and goals in the upcoming year.

EO 13653, *Preparing the United States for the Impacts of Climate Change*, issued in 2013, requires each agency to continue ongoing efforts to develop, implement, and update comprehensive plans that integrate consideration of climate change into agency operations and overall mission objectives.

Program Management

The sustainability program addresses multiple areas of sustainability including greenhouse gas management and reduction, high-performance sustainable buildings, energy efficiency, renewable energy, water management, fleet management, waste management and reduction, sustainable procurement processes, climate change resiliency planning, engaging with the community, and employee behavior change. The program addresses sustainability using an integrated and holistic approach. For example, NREL is committed to the design, operation, and maintenance of high-performance sustainable buildings by employing building design and operation strategies that promote optimal performance and maximize life-cycle asset value. These operational strategies can also support NREL's mission, which includes the development of renewable energy projects, overall laboratory reductions in energy and water usage, and improving sustainable work habits of employees. The sustainability program is able to leverage a variety of expertise and experiences to integrate sustainable operations throughout the laboratory to improve performance and resilience.

In addition, the sustainability program works closely with researchers throughout the laboratory to continually

2015 Accomplishments and Highlights

In addition to meeting or exceeding nearly all DOE sustainability goals as indicated in the Sustainability Goals Performance Summary, below are some additional accomplishments:

- NREL launched the Energy Intelligent Campus tool that integrates data from building energy sensors and meters. Energy data collected may be from lighting, heating, cooling, and renewable energy systems and other building/site operations. This tool provides an integrated view of energy management with an emphasis on operational, financial, and environmental accountability.
- NREL staff replaced several pieces of less-efficient legacy IT equipment within the Research Support Facility Data Center, which reduced the energy consumption of the data center by 19 kW. The Research Support Facility data center supports staff business operations for NREL's sites.
- The installation of 11 solar photovoltaic panels completed the roof top array of the South Site Entrance Building, which now operates at net zero operational energy performance. Through the operation of the South Site Entrance Building and the Research Support Facility (also operated at net zero energy), NREL has gained critical insight into the importance of measurement and verification of facility design.

develop partnerships that support NREL's mission while improving upon facility operations. NREL serves as both a living model of sustainability and a place to develop new clean energy ideas, technologies, and practices.

4.1 SUSTAINABILITY GOALS PERFORMANCE

Table 2 summarizes DOE's 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: <http://www.nrel.gov/docs/gen/fy16/65390.pdf>.

TABLE 2. SUSTAINABILITY GOALS PERFORMANCE SUMMARY			
Goal #	DOE Sustainability Goal	NREL Performance Status Through FY 2015	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 85% from the baseline	On Track
1.2	25% greenhouse gas reduction from sources such as air travel and commuting by FY 2025 from a FY 2008 baseline	Emissions decreased 19% from the baseline	On Track
2.1	25% building energy use per square foot (energy intensity) reduction by FY 2025 from a FY 2015 baseline	Energy intensity reduced 48% from the FY 2003 baseline. New goal will be based on FY 2015 energy use as the baseline	Not On Track¹
2.2	Perform energy and water audits	Conducted energy and water audits on three facilities Evaluations are 81% complete, comprehensive evaluation due 6/30/2016	On Track
2.3	Meter all individual buildings for electricity, natural gas, steam, and water, where 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	On Track
2.4	At least 15% of existing buildings greater than 5,000 gross square feet in size must comply with the 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	Continued to work with local governments to promote and encourage alternative transportation Worked with the Regional Transport District to develop a new shuttle route for NREL employees to encourage commuting by alternative transportation Met with staff from the City of Golden and the Colorado School of Mines to discuss potential car-share and bike-share opportunities Worked with DOE and Jefferson County Open Space to improve the Cretaceous Trailhead accessing South Table Mountain Park Coordinated efforts with the U.S. Fish and Wildlife Rocky Flats National Wildlife Refuge officials to treat 102 acres for knapweed at the NWTC	On Track

¹This goal will likely not be met due to energy consumption increases that will occur as a result of expansion of the high performance data center.

TABLE 2. SUSTAINABILITY GOALS PERFORMANCE SUMMARY

Goal #	DOE Sustainability Goal	NREL Performance Status Through FY 2015	Status
2.6a	Net Zero Buildings: Percentage of the site's existing buildings above 5,000 gross square footage intended to be net zero energy and waste or water buildings by FY 2025.	New goal in FY 2016	N/A (Percentage of net zero buildings to which goal applies has not yet been defined by DOE)
2.6b	Net Zero Buildings: Percentage of new buildings (>5,000 GSF) entering the planning process designed to achieve energy net zero beginning in FY 2020	New goal in FY 2016	N/A (Percentage of net zero buildings to which goal applies has not yet been defined by DOE)
2.7	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 1.19 and Energy Systems Integration Facility PUE of 1.06 are well below the goal of 1.5 PUE for existing data centers	On Track
3.1	"Clean Energy" 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- 2017, working towards 25% by FY 2025	New goal for FY 2016	On Track
3.2	"Renewable Electric Energy" requires that renewable electric energy account for not less than 10% of a total electric consumption in FY 2016-2017, working towards 30% of total agency electric consumption by FY 2025	Onsite renewable electric energy consumed at NREL accounted for 19% of total electric consumption	On Track
4.1	36% potable water intensity (gallons per gross square foot) reduction by FY 2025 from a FY 2007 baseline	Reduced potable water intensity 42% from the FY 2007 baseline	On Track
4.2	30% water consumption reduction of Industrial, Landscaping, and Agricultural (ILA) water by FY 2025 from a FY 2010 baseline. (ILA water is defined)	NREL only uses potable water; therefore this goal does not apply.	N/A
5.1	20% reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline; maintain 20% reduction thereafter (FY 2015 target: 20%)	Petroleum consumption increased 17% from the baseline	Not On Track²
5.2	10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% increase thereafter (FY 2015 target: 10%)	Alternative fuel use increased a cumulative 127% from the baseline. This is a 53% increase from FY 2014	On Track

² Annual petroleum consumption increased as a result of the increased site demand for diesel buses and the lack of funding available to replace the diesel buses with alternative fuel vehicles.

TABLE 2. SUSTAINABILITY GOALS PERFORMANCE SUMMARY			
Goal #	DOE Sustainability Goal	NREL Performance Status Through FY 2015	Status
5.3	30% reduction in fleet-wide per-mile greenhouse gas emissions reduction by FY 2025 from a FY 2014 baseline (FY 2015 target: N/A; FY 2017 target: 4%)	New goal for FY 2016	On Track
5.4	75% of light duty vehicle acquisitions must consist of alternative fuel vehicles (FY 2015 target: 75%)	100% of light duty vehicle acquisitions consisted of alternative fuel vehicles	On Track
5.5	50% of passenger vehicle acquisitions consist of zero emission or plug-in hybrid electric vehicles by FY 2025 (FY 2015 target: N/A)	New goal in FY 2016	Not On Track³
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 81% of nonhazardous solid waste from the landfill	Goal Met
7.2	Divert at least 50% of construction and demolition materials and debris	Diverted 75% 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	Planned target of \$2 million to be used for performance contracting	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.	98% of eligible electronic acquisitions met EPEAT 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
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. 33,441 pounds of electronics were recycled in FY 2015	Goal met

³ NREL procures its fleet vehicles from the General Services Administration (GSA). For the current type of passenger vehicles NREL utilizes in its fleet, the GSA has no available zero emission or plug-in hybrid electric options. Attainment of this goal will also require charging stations and other infrastructure at the NWTC for which funding may not be available.

Table 2 continued on page 32

TABLE 2. SUSTAINABILITY GOALS PERFORMANCE SUMMARY			
Goal #	DOE Sustainability Goal	NREL Performance Status Through FY 2015	Status
10.1	Update policies to incentivize planning for and addressing the impacts of climate change	NREL's recent <i>A Climate Change Vulnerability Assessment Report for the National Renewable Energy Laboratory and A Resiliency Action Plan for the National Renewable Energy Laboratory</i> identified goals 10.1–10.4 as areas to be pursued beginning in FY 2016.	On Track
10.2	Update emergency response procedures and protocols to account for projected climate change, including extreme weather events	NREL's recent <i>A Climate Change Vulnerability Assessment Report for the National Renewable Energy Laboratory and A Resiliency Action Plan for the National Renewable Energy Laboratory</i> identified goals 10.1–10.4 as areas to be pursued beginning in FY 2016.	On Track
10.3	Ensure workforce protocols and policies reflect projected human health and safety impacts of climate change	NREL's recent <i>A Climate Change Vulnerability Assessment Report for the National Renewable Energy Laboratory and A Resiliency Action Plan for the National Renewable Energy Laboratory</i> identified goals 10.1–10.4 as areas to be pursued beginning in FY 2016.	On Track
10.4	Ensure site/laboratory management demonstrates commitment to adaptation efforts through internal communications and policies	NREL's recent <i>A Climate Change Vulnerability Assessment Report for the National Renewable Energy Laboratory and A Resiliency Action Plan for the National Renewable Energy Laboratory</i> identified goals 10.1–10.4 as areas to be pursued beginning in FY 2016.	On Track
10.5	Ensure that site/laboratory 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 (who serves as the Regional Integrated Science and Assessment [RISA] climate science research team organized by NOAA)	On Track

4.2 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.

Requirements

NREL complies with the requirements of EO 13693, *Planning for Federal Sustainability in the Next Decade*, and DOE Order 436.1, *Departmental Sustainability*, by reporting on sustainability performance in its Site Sustainability Plan, which is submitted to DOE each year. Also included in the Site Sustainability Plan is the progress made in achieving climate change resilience goals developed by DOE for their facilities needed to meet the requirements of

EO 13653, *Preparing the United States for the Impacts of Climate Change*. These goals include the following:

- Update policies to incentivize planning for, and addressing the impacts of, climate change
- Update emergency response procedures and protocols to account for projected climate change including extreme weather events
- Ensure that workforce protocols and policies reflect projected human health and safety impacts of climate change
- Ensure that site/laboratory management demonstrates commitment to adaptation efforts through internal communications and policies
- Ensure that site/laboratory climate adaptation and resilience policies and programs reflect best available current climate change science, updated as necessary.

2015 Accomplishments and Highlights

- NREL staff outlined the process of developing NREL's climate vulnerability assessment and resilience action plan to DOE national laboratory representatives at DOE's Annual Site Environmental Report workshop.
- The laboratory supported the DOE Sustainability Performance Office in evaluating four DOE pilot vulnerability assessments, which included the assessment performed by NREL. The resulting publication, *Practical Strategies Guide for Vulnerability Assessments*,⁴ detailed the commonalities, differences, and best practices of the approaches taken and identified lessons learned to be used by laboratories going forward.

Program Management

In 2014 and 2015, NREL took steps to prepare for climate change and build organizational resilience. DOE's Sustainability Performance Office funded NREL to develop a model process for climate change resilience planning that could also assist other DOE sites in preparing for the impacts of climate change. NREL worked with an outside research consultant, diverse stakeholders from across the laboratory, and key external stakeholders to conduct a vulnerability assessment and a resilience planning process. A steering committee composed of 22 staff members and smaller work groups with subject matter experts helped to identify climate-related sensitivities that could impact NREL's ability to meet its mission. These sensitivities were then scored using the most up-to-date climate science available for the region, and adaptation options for the highest risk vulnerabilities were identified. From this assessment process, NREL has developed a list of actions to manage near- and longer-term climate change risks.



Wind turbine at dusk near the Outdoor Test Facility at the STM site.
Photo by Steve Wilcox, NREL 15260

2015 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- NREL completed and published the following documents in support of its climate change management efforts and in compliance with EO 13653, EO 13963, and DOE Order 436.1:
 - A Climate Change Vulnerability Assessment Report for the National Renewable Energy Laboratory, May 23, 2014–June 5, 2015⁵
 - A Resiliency Action Plan for the National Renewable Energy Laboratory, May 23, 2014–June 5, 2015.⁶

⁴Practical Strategies for Climate Change Vulnerability Assessments. Department of Energy, Sustainability Performance Office. December 2015.

⁵A Climate Change Vulnerability Assessment Report for the National Renewable Energy Laboratory, May 23, 2014—June 5, 2015. J. Vogel, M. O'Grady, and S. Renfrow, Abt Environmental Research, Inc., Boulder, Colorado.

⁶A Resiliency Action Plan for the National Renewable Energy Laboratory, May 23, 2014—June 5, 2015. J. Vogel, C. Wagner, and S. Renfrow, Abt Environmental Research, Inc., Boulder, Colorado.



5 COMPLIANCE SUMMARY

In partnership with the United Parcel Service (UPS) and the Clean Cities initiative, NREL's fleet evaluation team is conducting dynamometer testing of medium- and heavy-duty UPS fleet vehicles running on conventional and synthetic diesel. This side-by-side evaluation is designed to determine the fuel economy and emissions impact of conventional versus synthetic diesel. *Photo by Dennis Schroeder, NREL34436*

NREL is subject to many federal, state, and local environmental laws and regulations, as well as Executive Orders (EOs) and DOE orders and memoranda of understanding with government agencies. 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 REGULATIONS APPLICABLE TO NREL AND COMPLIANCE STATUS

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	A new federal Executive Order, EO 13693, <i>Planning for Federal 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 has been certified to the ISO 14001:2004 international standard for environmental management systems 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 NREL to submit a Site Sustainability Plan to the DOE's Sustainability Performance Office each year. 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. NREL completed and published the following documents in support of its climate change management efforts and in compliance with EO 13653, EO 13963 and DOE Order 436.1: <ul style="list-style-type: none"> ■ A Climate Change Vulnerability Assessment Report for the National Renewable Energy Laboratory, May 23, 2014-June 5, 2015⁷, and, ■ A Resiliency Action Plan for the National Renewable Energy Laboratory, May 23, 2014-June 5, 2015⁸ 	Executive Orders: EO 13653 EO 13693 DOE: DOE Order 436.1

⁷ A Climate Change Vulnerability Assessment Report for the National Renewable Energy Laboratory, May 23, 2014—June 5, 2015. J. Vogel, M. O'Grady, and S. Renfrow, Abt Environmental Research, Inc., Boulder, Colorado.

⁸ A Resiliency Action Plan for the National Renewable Energy Laboratory, May 23, 2014—June 5, 2015. J. Vogel, C. Wagner, and S. Renfrow, Abt Environmental Research, Inc., Boulder, Colorado.

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

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
Air Quality	<p>The Colorado Department of Public Health and Environment (CDPHE) administers the 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>EPA's Protection Of Stratospheric Ozone (40 CFR 82) requires that servicing records must be kept for appliances containing more than 50 pounds of Class 1 or 2 Ozone Depleting Substances refrigerant.</p> <p>EPA regulations require that certain facilities that emit greenhouse gases track and report the amount of those emissions. 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>CDPHE regulations require federal, state, and local government facilities to track street sanding in the wintertime, and to minimize sand use with the goal of reducing particulate pollution in the Denver area.</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>A compliance inspection was conducted by the Jefferson County Public Health, on behalf of the state, of permitted emission sources. Inspections included six standby generators, Field Test Laboratory Building waste gas combustor, and the Renewable Fuel Heating Plant. No deficiencies were identified.</p> <p>Completed the annual evaluation of compliance with federal and state facility-wide air permitting and emissions control requirements. All facilities and individual permitted equipment items remain classified as minor sources.</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 state-required Ozone Depleting Substances equipment registrations and annual registration renewals were completed. In addition, all refrigerant recovery equipment has been registered with the EPA, and all service personnel maintain federal and state required training and certification.</p> <p>Four air permits for three standby generators and a waste gas combustor were renewed.</p> <p>Completed the annual street sanding report required by the state confirming that no sand was used at the STM site and NWTC.</p>	<p>National Ambient Air Quality Standards: 40 CFR 50</p> <p>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>

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

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
Drinking Water Quality	The Safe Drinking Water Act establishes minimum drinking water standards and monitoring requirements for drinking water supplies. Drinking water quality is regulated for all public water suppliers in Colorado by CDPHE, under authority delegated by the EPA.	<p>All program activities were in compliance with requirements.</p> <p>All monitored parameters met applicable requirements.</p> <p>Jefferson County Public Health, on behalf of the state of Colorado, conducted an inspection of the NWTC drinking water system. In addition to the absence of deficiencies and violations, NREL and its subcontractor were commended for their detailed and comprehensive management of the system and for the extent of protection of drinking water quality from delivery to consumption.</p> <p>Modifications to the backflow prevention and cross contamination plan were completed in advance of the January 1, 2016 compliance deadline, as required by revisions to the state's drinking water regulations in 2015. Implementation of the plan, including an annual inventory and assessment of all possible drinking water system contamination sources, is ongoing. 493,175 gallons (1,866,869 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	Colorado groundwater quality standards are established by CDPHE. Permits for groundwater wells are issued by the Colorado Department of Natural Resources.	<p>All program activities were in compliance with requirements.</p> <p>Five groundwater monitoring wells that were no longer being monitored at the STM site were abandoned in conformance with state regulations.</p> <p>Three groundwater monitoring and observation holes were installed in conformance with state regulations.</p>	<p>CDPHE: 5 CCR 1002-41 2 CCR 402-2 2 CCR 402-10</p>
Surface Water Quality	<p>Surface water quality is controlled through the federal Clean Water Act, 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. Construction-related stormwater discharge regulations are administered by the EPA at federal facilities in Colorado.</p> <p>Non-federal facility construction-related stormwater discharges in Colorado are regulated by the Water Quality Control Division of CDPHE.</p>	<p>All program activities were in compliance with requirements.</p> <p>Permit coverage under the EPA Construction General Permit continues for two STM site construction projects; there are no active construction stormwater permits at the NWTC.</p> <p>A Low Erosivity Waiver was prepared and submitted to the EPA for a road improvement project at the NWTC. The waiver allowed for construction to proceed without EPA Construction General Permit coverage because the required erosivity computations indicated a low potential for negative impacts on stormwater runoff from construction activity. Although the waiver was granted, NREL implemented stormwater controls to protect stormwater quality and prevent erosion and sedimentation.</p> <p>EPA Construction General Permit coverage for one completed project was terminated.</p> <p>Weekly stormwater inspections were performed on active construction sites per EPA regulations. Additionally, monthly stormwater inspections were performed for restoration-phase construction sites still under EPA Construction General Permit coverage.</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>

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

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
Wastewater	<p>The federal Clean Water Act and Colorado Water Quality Control Act regulations apply to wastewater management at NREL's STM site and Denver West Office Park. The Metro Wastewater and Reclamation District manages wastewater for much of the Denver metro area, receiving wastewater from the Pleasant View Water and Sanitation District, which services the STM site and Denver West Office Park.</p> <p>The NTWC utilizes an onsite septic system. Inspection and permitting of individual sewage disposal systems have been delegated to Jefferson County by CDPHE.</p>	All program activities were in compliance with requirements.	<p>EPA: 40 CFR 122-136</p> <p>CDPHE: 5 CCR 1002-62, 63</p>
Hazardous Materials Management	<p>EO 13693, <i>Planning for Federal Sustainability in the Next Decade</i>, outlines requirements for increasing waste and pollution prevention by reporting in accordance with requirements of Sections 301-313 of the Emergency Planning and Community Right-to-Know Act of 1986, and by minimizing the quantities of toxic chemicals and materials at federal facilities.</p> <p>NREL facilities are subject to various parts of EPCRA. 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 (SDSs) for chemicals that are stored on-site in quantities greater than regulatory thresholds, and provides inventory reporting for these chemicals in an annual hazardous materials report to state and local emergency response agencies and local fire departments, called a Tier II report.</p> <p>In the event of a release, EPCRA Section 313 requires that a toxic chemical release inventory report be filed with the EPA 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 sites. Renewable Fuels and Lubricants Research Laboratory, located within the City and County of Denver, is subject to the Denver Fire Department Hazardous Materials Information System requirements, including permitting, inventory, and annual inspection. 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 above reporting requirements.</p> <p>In accordance with DOE Order 151.1c, <i>Comprehensive Emergency Management System</i>, NREL conducted a hazardous materials screening of select chemicals to confirm that inventories are below threshold planning quantities.</p> <p>EPCRA Tier II hazardous materials reports were submitted to the appropriate state and local emergency response and planning agencies, as well as local fire departments, for three facilities for reporting year 2014. Diesel fuel, petroleum oil, and sulfuric acid in lead-acid batteries were included in the report.</p> <p>West Metro Fire Rescue conducted an annual hazardous material inspection and issued hazardous materials management permits for seven facilities.</p> <p>The inventory of hazardous materials at the Renewable Fuels and Lubricants Research Laboratory was provided to the Denver Fire Department.</p>	<p>EPA: 40 CFR 355, 370, 372</p> <p>Executive Order: EO 13693</p> <p>DOE: DOE Order 151.1c</p>

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

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
Regulated Waste Management	The Resource Conservation and Recovery Act established requirements for the management of regulated waste, including hazardous waste. In Colorado, CDPHE administers regulated waste requirements under authority delegated by the EPA.	<p>All program activities were in compliance with requirements.</p> <p>All regulatory notifications were updated and applicable waste generator fees were paid for five NREL sites.</p> <p>Nineteen hazardous and five universal waste shipments for offsite disposal were made across NREL's five sites.</p> <p>Twelve cubic yards of imported sugarcane bagasse used in biofuels research were transported and disposed of in accordance with guidelines set forth by the United States Department of Agriculture's Animal and Plant Health Inspection Service. Disposal involved placement and subsequent burial at a municipal solid waste landfill.</p>	<p>EPA: 40 CFR 260- 280</p> <p>CDPHE: 6 CCR 1007-3</p>
Aboveground Storage Tank Management	Aboveground Storage Tanks (ASTs) are regulated in Colorado by the Colorado Department of Labor and Employment (CDLE) Division of Oil and Public Safety under the Colorado Aboveground Storage Tank (AST) regulation. Colorado requires that ASTs 660 gallons or larger be permitted prior to installation, and registration renewals are submitted annually thereafter.	<p>All program activities were in compliance with requirements.</p> <p>No reportable spills or releases from NREL's ASTs or related fueling activities occurred.</p> <p>No new tanks were permitted.</p>	<p>CDLE: Division of Oil and Public Safety (DOPS) Storage Tank Regulations, 7 C.C.R. 1101-14</p>
Spill Prevention and Response	Spill Prevention, Control, and Countermeasures (SPCC) plans are required by EPA and Colorado regulations for facilities that meet certain oil storage criteria. In general, a facility must have an SPCC plan if the facility stores more than 1,320 gallons of oil or where a spill has the potential to enter waters of the United States.	<p>All program activities were in compliance with requirements.</p> <p>Staff who manage and/or operate oil-containing equipment received annual SPCC training.</p> <p>All regulated tanks were inspected on a regular basis.</p> <p>No reportable spills occurred. Sixteen minor spills of diesel, lubricant, coolant, or hydraulic fluids occurred at the STM site, and two spills occurred at the NWTC. The size of spills ranged from less than 0.1 gallon to 4 gallons (0.38 to 15 liters). The majority of these spills resulted from vehicle and construction equipment leaks. Each spill received immediate remedial action and did not result in any significant impact to the environment.</p>	<p>UEPA: Oil Pollution Prevention 40 CFR 112</p> <p>CWA Section 319</p> <p>CDLE: DOPS Storage Tank Regulations, 7 C.C.R. 1101-14</p> <p>CWCC: 25-8-205 C.R.S.</p>
Radiological Materials and Waste Management	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. DOE Order 458.1, <i>Radiation Protection of the Public and the Environment</i> , establishes radiation emission limits for DOE facilities.	<p>All program activities were in compliance with requirements.</p> <p>No planned or unplanned radiological releases occurred.</p> <p>Only small quantities of low-level radioactive waste were generated and are currently in storage awaiting off-site disposal.</p> <p>The effective dose equivalent to the public from NREL activities was 0.036 mllirem (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 REGULATIONS APPLICABLE TO NREL AND COMPLIANCE STATUS

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
National Environmental Policy Act	National Environmental Policy Act (NEPA) requires that federal agencies determine environmental impacts of proposed federal actions and alternatives. DOE implementing NEPA regulations are found in 10 CFR 1021.	<p>All program activities were in compliance with requirements.</p> <p>A total of 614 NEPA reviews were conducted for project activities on- and off-site.</p> <p>A NEPA program assessment conducted in 2014 identified findings related to document control, training, and adherence to internal NEPA processes. A NEPA enhancement project plan, designed to address the findings, is in place and progress has been made to implement it; full implementation will be completed in 2016.</p>	<p>Council for Environmental Quality: 40 CFR 1500-1508</p> <p>DOE: 10 CFR 1021</p>
Wildlife Management	<p>The Migratory Bird Treaty Act (MBTA) of 1918 is the main driver for protection of migratory birds in the United States. The MBTA and 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.</p> <p>Under Colorado Revised Statute (CRS) 33-6-128, <i>Damage or Destruction of Dens or Nests—Harassment of Wildlife</i>, 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, <i>Responsibilities of Federal Agencies to Protect Migratory Birds</i>”, 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>Visible markers were applied to a total of 6,700 square feet of glass windows of the Energy Systems Integration Facility in August of 2014 with the intent of reducing the potential for bird strikes. Post-retrofit bird survey results found that no bird strikes occurred on any of the treated windows. Based on pre-retrofit surveys and the post-retrofit surveys, the project will likely prevent 15 to 20 bird deaths due to window strikes each fall migration season.</p> <p>Cavity nesters, such as flickers and woodpeckers, commonly build nests in the exterior surfaces of buildings, causing significant damage. Building repair activities are delayed until nestlings have fledged and the adults have abandoned the nests, in compliance with the Migratory Bird Treaty Act. This situation occurred in 2015 with a nesting pair of flickers at the Outdoor Test Facility.</p> <p>NREL incorporates necessary components of the Avian Power Line Interaction Committee guidelines into project planning and design, in accordance with the Memorandum of Understanding between DOE and U. S. Fish and Wildlife Service.</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</p> <p>Memorandum of Understanding between DOE and the U.S. Fish and Wildlife Service</p> <p>Executive Order: EO 13186</p>
Endangered Species and Species of Concern	The Endangered Species Act (ESA) is intended to protect threatened and endangered wildlife and plant species and associated critical habitat.	<p>All program activities were in compliance with requirements.</p> <p>As part of its NEPA evaluation, NREL conducted natural resource surveys for a potential project at the NWTC. These surveys included presence/absence and habitat surveys for threatened and endangered species and Colorado state listed species. A rare plant survey was also conducted for the Ute ladies’ tresses orchid and the Colorado butterfly plant. No federally protected or state listed species or habitats were found.</p>	U.S. Fish and Wildlife Service: 50 CFR 17

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

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
Vegetation Management	<p>EO 13112, <i>Invasive Species</i>, requires the control of invasive species at federal facilities. 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>The Federal Insecticide, Fungicide, and Rodenticide Act 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>All program activities were in compliance with requirements.</p> <p>At the NWTC, herbicides were applied to control A-, B- and C-listed weeds on approximately 135 acres (55 hectares) in April and May, 41 acres (17 hectares) in July, and 21 acres (8 hectares) in October.</p> <p>At the STM site, herbicides were applied to control B- and C-listed weeds to approximately 15 acres (6 hectares) in May and June, 6 acres (2 hectares) in August, and 13 acres (5 hectares) in October.</p> <p>Across the STM site and within the STM Conservation Easement, 15 Russian olive trees were girdled and treated with herbicide to kill the trees and prevent the spread of this invasive species.</p> <p>A rust fungus (<i>Puccinia punctiformis</i>) was introduced at two locations, one on the STM site and the other on the NWTC, to combat Canada thistle. The locations are seep areas where Canada thistle is known to occur. Introduction of this biological control agent, done in cooperation with the Colorado Department of Agriculture, provides an integrated approach to combatting noxious weeds. The Colorado Department of Agriculture will monitor the rust fungus in subsequent years to document its establishment and effectiveness.</p> <p>Knapweed weevils were introduced along the Pine Ridge at the NWTC in August. Two species were released; one that attacks the seed heads and another that attacks the roots of knapweed. This effort further diversifies noxious weed control methods.</p>	<p>Executive Orders: 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>
Wetlands and Floodplains	<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 in carrying out its responsibilities.</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. Wetlands that meet certain soils, vegetation, and hydrologic criteria are protected under the CWA Section 404, which is administered by the U.S. Army Corps of Engineers (USACE).</p> <p>Jefferson County requires approval of development proposed in floodplains within its jurisdiction.</p>	<p>All program activities were in compliance with requirements; no actions occurred that affected wetlands or floodplains.</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>Executive Orders: EO 11988 EO 11990</p> <p>USACE: CWA Section 404</p> <p>DOE: 10 CFR 1022</p>

Table 3 continued on page 42

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

Report Sections	Regulatory Program Description	Compliance Status and Highlights	Regulator & Requirement
Cultural Resources	<p>Cultural resources are protected under Sections 106 and 110 of the National Historic Preservation Act. 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. The National Historic Preservation Act is administered in Colorado by the Colorado Office of Archaeology & Historic Preservation (State Historic Preservation Officer).</p>	<p>All program activities were in compliance with requirements.</p> <p>DOE initiated a consultation with the Colorado State Historic Preservation Office under Section 106 of the National Historic Preservation Act of 1966 for the Central Array Test Site installation and operation at the STM site. As part of the process, DOE provided a letter to the Colorado State Historic Preservation Office indicating that no historic properties would be directly or indirectly affected by the project. The State Historic Preservation Office concurred with DOE's determination.</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>
Traffic Management	<p>There are no traffic regulations that pertain to the NREL sites. Traffic demand management strategies are implemented to minimize traffic impacts in the local area.</p>	<p>Active transportation demand management activities were continued in 2015.</p> <p>The average afternoon (4:30 p.m. to 5:30 p.m.) peak-hour traffic volume, measured at the intersection of Denver West Parkway and Denver West Marriott Boulevard, was 277 vehicle trips per hour. This traffic volume remained below the threshold established as part of the traffic Mitigation Action Plan (522 vehicle trips per hour) intended to ensure acceptable traffic volumes at the intersection.</p>	<p>DOE/EA-1440-S-1 (May 2008) Traffic Mitigation Action Plan</p>



6 AIR QUALITY PROTECTION

The Renewable Fuel Heating Plant burns beetle-kill and forest thinning wood to produce hot water to heat many of the STM site buildings. *Photo by Larry Durbin, NREL 37584*

NREL strives to protect air quality by minimizing air emissions, monitoring air emissions from the larger on-site sources, and meeting federal and state air emissions and permitting requirements. Minimizing air emissions creates direct health benefits for neighbors immediately adjacent to the laboratory and for those in the Denver metropolitan area. Staff actively participate in project planning, safety evaluations, readiness verifications, and operations activities. This participation results in awareness of projects and planned air emissions while allowing staff to obtain the necessary regulatory approval for those emissions and maintain a current and accurate air emission inventory.

Requirements

The Clean Air Act, which is administered by both the EPA and the state, regulates several main categories of air pollutants:

- Criteria air pollutants – including carbon monoxide, nitrogen oxides, sulfur dioxide, particulate matter, respirable particulates, ozone, and lead
- Non-criteria pollutants – these include any air pollutant that is not defined as a criteria air pollutant. Regulated categories of these include the following:

2015 Accomplishments and Highlights

- The laboratory air emissions inventory was updated, using equipment-specific emission factors where available. This resulted in a more accurate emission inventory.
- An evaluation of Hazardous Air Pollutant emissions indicated that emissions were well below reporting and permitting thresholds at all NREL sites.

- Hazardous Air Pollutants – including specific organic and metallic compounds, certain metals, corrosive compounds, asbestos, radionuclides, and pesticides established by the EPA
- Greenhouse gas compounds – including carbon dioxide, methane, nitrous oxide, and many man-made refrigerant gases that contribute to climate change
- Ozone-Depleting Substances (ODS) – including chlorofluorocarbons or “Freon” and hydrochlorofluorocarbons that are being phased out of use in comfort heating and cooling systems and equipment.

For facilities and stationary sources that emit criteria air pollutants and hazardous air pollutants, there are various 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.

Greenhouse gases emitted by certain facilities are required by federal 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 actual emissions of such gases across the United States and provide the EPA with data upon which to base future greenhouse gas regulations. Additionally, permits for major emission 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.

Certain refrigerants and similar chemicals are more highly regulated than others due to their ability to damage the Earth’s protective ozone layer. Federal and state regulations for these ODS, depending upon the quantity of ODS and the size of the comfort heating and cooling equipment, require registration, recordkeeping, refrigerant recovery, and leak monitoring and repair. These regulations also prohibit the intentional venting of both ODS and non-ODS refrigerants into the atmosphere.

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



Baghouse filter at the Integrated Biorefinery Research Facility. The baghouse filter collects dust and particulates generated during the biomass milling process of biofuel production. *Photo by Dennis Schroeder, NREL 17679*

months, are subject to state fugitive particulate emissions permits. Winter road sanding in Colorado can also result in particulate emissions when vehicle activity turns road-applied sand into finer particulates that then become airborne. These particulates may contribute to breathing and health problems for susceptible individuals. State regulations require federal, state, and local government facilities to track street sanding in the winter and to minimize sand use. Sand is not applied to NREL roadways in an effort to minimize particulate emissions from laboratory sites.

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 electrical generators, construction and maintenance equipment with gasoline or diesel engines, bench- and pilot-scale research activities using chemicals, and facility operations maintenance activities.

Program Management

Criteria Pollutants and Hazardous Air Pollutants Permitting

The laboratory maintains an air emission inventory to track potential emissions and identify whether future

notification and permitting could be required for a particular facility or activity. Projected emissions for new sources are evaluated and air emission reporting and permitting are performed as required.

The laboratory maintains several air permits issued by the state for “minor” sources (such as standby electrical generators and pollution control systems) that are subject to minimal permit and compliance requirements. Currently, Title V “major” permitting is not required because all pollutant emissions are well below that permitting threshold.

The laboratory has a fugitive particulate emission permit in place for the STM site due to construction activity that has occurred over the last several years. To further minimize the generation of airborne particulates, NREL uses a non-sand deicer to maintain roadways. This minimizes potential fugitive particulate emissions from snow removal operations, contributing to improved air quality for neighbors and the Denver metro region.

Greenhouse Gas Emissions Tracking and Permitting

Permitting and reporting of greenhouse gases are not currently required for NREL facilities as emissions are below EPA permitting and reporting thresholds.

Ozone-Depleting Substances Permitting

The majority of refrigeration equipment at NREL either contains non-ODS refrigerants or uses very small amounts of regulated refrigerants. The only equipment containing more than 50 pounds (23 kilograms) of regulated refrigerant are two chillers located in the Solar Energy Research Facility at the STM site. Operators of the chillers must maintain records of service for this equipment.

NREL annually registers with the state those facilities where ODS maintenance activities occur, maintains EPA-approved training certification for all technicians servicing ODS-containing equipment, and renews registrations for ODS-containing equipment as necessary. The two previously mentioned Solar Energy Research Facility chillers each have more than 100 horsepower (74.6 kW) of compression, contain an ODS refrigerant, and must be registered with the state.

2015 Compliance Summary and Activities

- Program activities were in compliance with requirements. The laboratory emission sources did not exceed any air permit standard.
- A summary of NREL facility estimated annual air pollutant emissions is included in Table 4.

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.

- On behalf of the state, Jefferson County Public Health conducted a compliance inspection of permitted sources including six standby generators, the Field Test Laboratory Building waste gas combustor, and the Renewable Fuel Heating Plant. No 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 and 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 state-required ODS equipment registrations, as well as annual registration renewals, were completed at the STM site and NWTC. Per federal requirements, refrigerant recovery equipment has been registered with the EPA.
- Four air permits for three standby generators and a waste gas combustor were renewed.



7 WATER QUALITY PROTECTION

An NREL staff member analyzes the chlorine concentration of potable water being delivered to the NWTC. *Photo by Genevieve Braus, NREL 36266*

Water quality is critical to human health and the health of our natural ecosystems. The focus of water quality protection is on four main areas:

- Drinking water
- Groundwater
- Surface water
- Wastewater.

7.1 DRINKING WATER

The public water provider, Consolidated Mutual Water Company, provides drinking water at the STM site. The Maple Grove Water Treatment Plant treats the water through an advanced membrane water treatment method.

The NWTC does not have access to a public drinking water supply. For this reason, NREL operates a drinking water distribution system there, serving approximately 150 employees. Drinking water is purchased from local municipalities and transported by truck to the site, where it 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 it is circulated around the site for use. There is no treatment of the water, but chlorine is added to boost disinfectant levels. The state of Colorado permits the system.

2015 Accomplishments and Highlights

An internal assessment of the drinking water program identified a number of potential improvements, including clarification of procedures, forms, and recordkeeping. Implementation of these improvements is underway.

Requirements

As a public water system regulated by the state of Colorado, the NWTC water system must comply with the Safe Drinking Water Act and federal and state regulations. The EPA has established allowable levels for drinking water contaminants known as Maximum Contaminant Levels. Colorado has adopted these Maximum Contaminant Levels into the Colorado Primary Drinking Water Regulations. These regulations establish the state's authority to regulate drinking water providers to assure safe, reliable water supplies, and to implement EPA's special rules.

Program Management

The primary means by which NREL manages its drinking water system at the NWTC is through water quality testing as required by the monitoring plan issued by the state each year. The plan identifies which tests are to be performed and at what frequency. Monthly tests are required for bacteria and disinfectant levels, while disinfection byproducts (haloacetic acids [HAA5] and trihalo-methanes [TTHM]) are sampled once per year and testing of lead and copper are completed on a three-year rotating basis. Figures 3 and 4 show the results of the chlorine and disinfection byproducts monitoring for 2015.

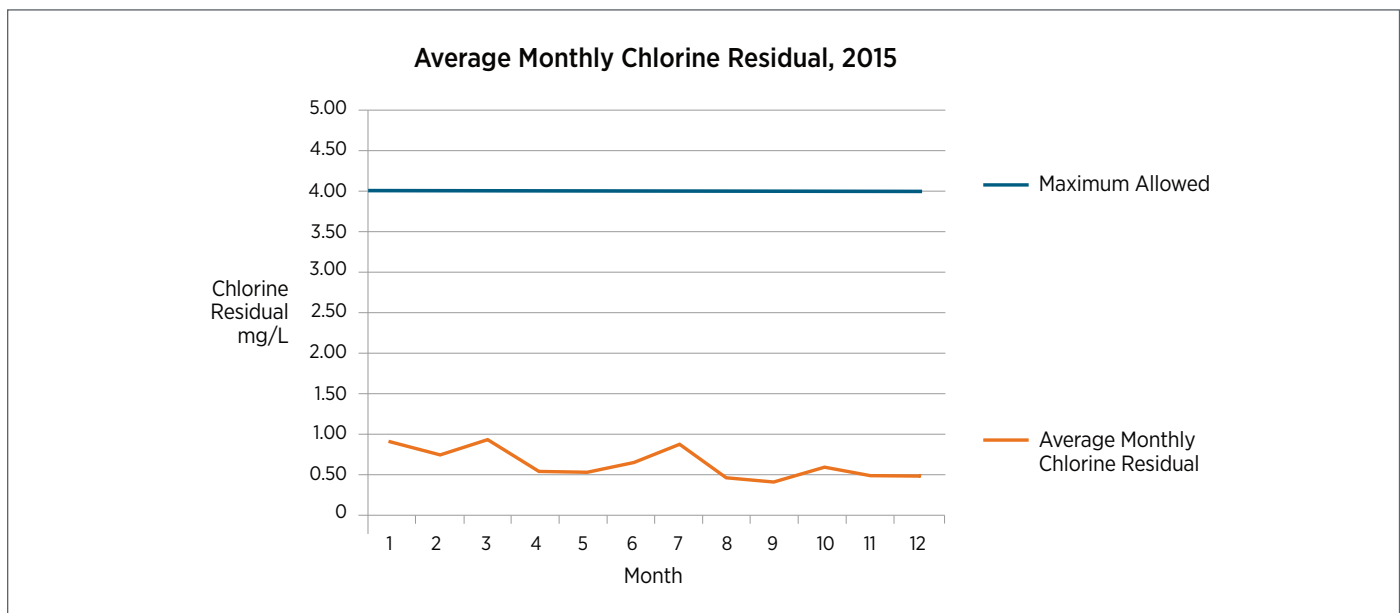


Figure 3. Results of 2015 average monthly chlorine residual monitoring

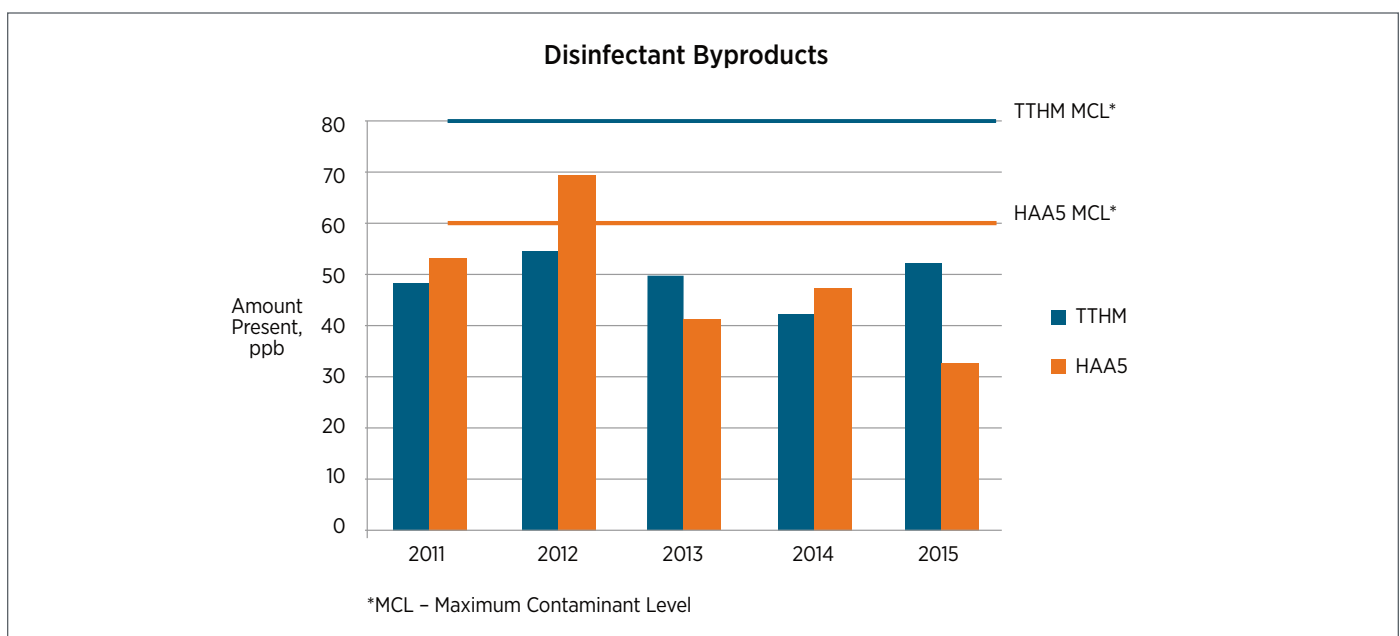


Figure 4. Comparison of disinfection byproducts monitoring, 2011 – 2015

2015 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- All monitored parameters met applicable requirements.
- Jefferson County Public Health, on behalf of the state of Colorado, inspected the NWTC drinking water system. In addition to the absence of deficiencies and violations, NREL and its subcontractor were commended for their detailed and comprehensive management of the system and for the extent of protection of water quality from delivery to consumption.
- Modifications to the backflow prevention and cross contamination plan were completed in advance of the January 1, 2016, compliance deadline, as required by 2015 revisions to the state's drinking water regulations. Implementation of the plan, including an annual inventory and assessment of all possible drinking water system contamination sources, is ongoing.
- A total of 493,175 gallons (1,866,869 liters) of drinking water were provided to NWTC users.

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

Despite the limited ability of reaching the Dawson aquifer, NREL's groundwater management program is focused on

2015 Accomplishments and Highlights

- There were no spills or releases that impacted groundwater.
- Three groundwater monitoring wells were installed at the STM site on the north side of the Field Testing Laboratory Building to determine if groundwater or surface water is the source of water seepage observed within the building. Groundwater level measurements and limited groundwater quality data collected from the wells are being used to assist with this effort.



Installation of a groundwater monitoring well near the Field Testing Laboratory Building at the STM site. Photo by Genevieve Braus, NREL 36268

the control of potential pollutant sources that could affect this important source.

Requirements

The state of Colorado regulates the installation of groundwater wells, requiring a permit for drinking water, geothermal, irrigation, livestock watering, dewatering, monitoring, and geothermal well installations. Groundwater quality is regulated by the state through the establishment of basic and site-specific standards.

Program Management

Periodically, NREL monitors site groundwater quality using one or more monitoring wells. When the laboratory conducts activities that could impact groundwater, NREL implements a monitoring program and groundwater monitoring wells are installed as needed. There are currently three permitted monitoring wells at the STM site

from which data is being collected to assist in understanding whether groundwater may be contributing to water seepage observed in one of the site buildings. There are no groundwater 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.

To protect groundwater quality, NREL carefully evaluates all outdoor projects to eliminate, substitute, or control potential sources of pollution. If any materials are used that pose a risk to groundwater, the laboratory incorporates safeguards such as secondary containment, double-walled tanks, leak detection, and collection and offsite disposal of concrete wash water.

2015 Compliance Activities

- Program activities were in compliance with requirements.
- Five groundwater monitoring wells that were no longer being sampled or monitored at the STM site were abandoned in conformance with state regulations.
- Three groundwater monitoring wells were installed in conformance with state regulations.

7.3 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



Successful restoration of native grasses in an area disturbed during construction of the Energy Systems Integration Facility. *Photo by Dennis Schroeder, NREL 34003*

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.

2015 Accomplishments and Highlights

- Revegetation was achieved in areas disturbed as a result of construction of the Energy Systems Integration Facility, thus allowing termination of EPA stormwater permit coverage. 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.
- Repeated reseeding and mulching applications as well as weed management activities were conducted on a portion of the STM site disturbed during an electrical upgrade project that was completed in 2014. These activities will continue until native grass cover meeting federal stormwater permit revegetation requirements is achieved.
- Backfilling, seeding, and mulching activities were performed in an area adjacent to the Field Test Laboratory Building where a steep slope had become eroded as a result of runoff associated with the 2013 flood event and a leaking buried domestic water line.
- Periodic stormwater inspections were performed at locations where active construction recently occurred to protect stormwater quality and prevent sedimentation and erosion.

Requirements

The federal Clean Water Act, amendments, and implementing regulations apply to stormwater discharges from construction activities that disturb greater than one acre. The EPA is the regulating authority for stormwater at NREL, which is a federally owned facility. For onsite construction projects that disturb greater than one acre, a Notice of Intent must be filed with the EPA to be covered under their Construction General Permit, and a site-specific Stormwater Pollution Prevention Plan must be prepared. The Stormwater Pollution Prevention Plan implements both the requirements of the EPA's Construction General Permit and NREL-specific requirements. For NREL construction projects that occur off federal property, Colorado Discharge Permit System stormwater permits may be required.

The Energy Independence and Security Act requires 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 retain stormwater runoff and release at predevelopment levels. In addition, EO 13693, *Planning for Federal Sustainability in the Next Decade*, directs federal agencies to install appropriate green infrastructure features to improve stormwater management.

Program Management

The surface water program focuses on managing construction site runoff, which has the potential to impact receiving waters into which NREL sites drain.

Prior to construction, NREL implements an interdisciplinary planning and design process that involves reviews and approvals for compliance with the National Environmental



Porous pavers surrounding a manhole cover in a STM site roadway. Porous pavers promote stormwater infiltration, improve stormwater runoff quality and reduce runoff volume leaving NREL sites.

Photo by Genevieve Braus, NREL 36264

Policy Act, and the assessment of design documents for potential impacts to stormwater and receiving waters. Design teams are encouraged to incorporate low-impact design elements that promote infiltration and evapotranspiration. NREL continues to monitor final design documents and construction implementation to look for additional opportunities to reduce runoff quantity and enhance runoff quality.

Erosion and sediment controls, proper chemical storage, fueling procedures, and good housekeeping practices are implemented during construction according to the stormwater management plans developed by contractors and reviewed by project staff for EPA-permitted sites as well as those construction sites for which an EPA permit is not required. While construction projects that disturb less than one acre are not regulated by the EPA and typically involve minimal disturbance within a short timeframe, such projects still have the potential to contribute pollutants to stormwater runoff. Elements of the NREL stormwater pollution prevention program are therefore followed, including the development of an abbreviated Stormwater Pollution Prevention Plan documenting basic contact, project, and best management practice information. An illustration showing the area of disturbance and locations of key site characteristics and best management practices is also required.

Regular inspections by contractors and staff are conducted throughout construction to verify that required controls are functioning properly. Any repairs or modifications to the plans are documented on an inspection report; prompt actions are required to correct any noncompliant conditions.

Management of areas outside active construction sites minimizes erosion, supports infiltration of rain water and snowmelt, and prevents contamination of stormwater with hazardous materials. Vegetation and landscaping are maintained to prevent erosion. Infiltration of precipitation is achieved through detention basins and grassy swales, as well as design elements including porous pavement and diversion of roof and perimeter drains to landscaped areas. In addition, hazardous wastes are stored indoors or in covered areas, and site roads and sidewalks are swept to reduce sediment and other potential pollutants from entering the stormwater conveyance system.

2015 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- Permit coverage under the EPA Construction General Permit continues for two STM site construction projects;

there are no active construction stormwater permits at the NWTC.

- A Low Erosivity Waiver was prepared and submitted to the EPA for a road improvement project at the NWTC. The waiver allowed for construction to proceed without EPA Construction General Permit coverage, given that required computations indicated a low potential for negative impacts to stormwater quality from construction activity. Although the waiver was granted, NREL implemented stormwater controls to protect stormwater quality and prevent erosion and sedimentation.
- EPA Construction General Permit coverage for one completed project was terminated.
- Weekly stormwater inspections were performed per EPA stormwater regulations where active construction occurs; monthly stormwater inspections were performed for construction sites where EPA Construction General Permit coverage continues during the restoration phase of these projects.

7.4 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.

Research activities at the STM site's Integrated Biorefinery Research Facility develop, test, evaluate, and demonstrate processes for the production of bio-based products and fuels. 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 site's 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.

Requirements

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, such as the Pretreatment Program. The Pretreatment Program is the set of regulations applied to industries and commercial operations that generate non-domestic wastewaters with potentially high levels of pollutants that could have an impact on wastewater treatment facilities and the environment.

The program includes specific regulations for certain types of industries, for dischargers of large quantities of industrial wastewater, and for all non-domestic wastewater discharges. NREL's operations are not among those identified as requiring specific discharge regulations, nor does the laboratory discharge a volume of water that would trigger requirement of a formal discharge permit from the Metro District for large industrial wastewater users. The laboratory does comply with all applicable requirements including the general prohibitions for all non-domestic wastewater discharges that protect Metro District's collection and treatment systems. These prohibitions include the discharge of hazardous materials, highly viscous substances, radioactive material, excessive oil and grease, or other substances that could cause material harm to the wastewater treatment system and the environment.

Program Management

NREL's wastewater management program is multi-faceted and encompasses activities across the site, from green cleaning supplies to minimization of harmful chemicals in laboratory operations, and is intended to adhere to requirements and minimize potential impacts to the treatment processes.

NREL staff are trained in the requirements of the Metro District's rules and regulations. In addition, NREL sites have design criteria for waste drains in laboratory areas to minimize the possibility of a hazardous material discharge. These criteria include measures such as secondary containment for any chemicals used near sinks in laboratory exhaust hoods, no floor drains in laboratory areas unless a specific need can be shown, and caps for floor drains that are installed in laboratory areas. New research and operations activities as well as ongoing activities that undergo significant modifications are reviewed through NREL's risk assessment process for their potential effect on wastewater character.

2015 Compliance Summary and Activities

- Program activities were in compliance with requirements.



8 HAZARDOUS MATERIALS AND WASTE MANAGEMENT

Barcode scanner being used to inventory chemicals in a laboratory. This tool is one component of a laboratory-wide chemical management program that ensures the proper handling of NREL's chemicals throughout their lifecycle.
Photo by Dennis Schroeder, NREL 33676

Responsible acquisition, use, and disposal of materials and wastes are critical to meeting our commitments to compliance, preventing pollution, and environmental stewardship. NREL seeks to purchase materials that are sourced responsibly and contain recycled content and lower-impact materials. Use of hazardous materials is thoughtfully controlled with internal procedures designed to limit health and environmental risks. Wastes are carefully managed and disposed of through select contractors. Areas of focus include:

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

8.1 HAZARDOUS MATERIALS MANAGEMENT

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

Requirements

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 releases of hazardous chemicals to federal, state, and local governments.

2015 Accomplishments and Highlights

- Laboratory safety training, required annually for all laboratory workers and NREL emergency response team members, was updated to reflect current regulations and enhanced to raise awareness of the various classes of hazardous materials stored in NREL laboratories.
- The laboratory's chemical inventory was reviewed, and unneeded or expired materials were collected for reuse or proper disposal.
- An internal assessment was conducted of the laboratory's hazardous waste management program. Five minor non-conformities, five opportunities for improvement, and one positive practice were identified. Corrective actions to address non-conformities have been developed.



NREL researcher works with cyanobacteria in the Photobiology Laboratory. Researchers attempt to reduce the amount of hazardous chemicals used and the amount of hazardous wastes generated in their experiments. *Photo by Dennis Schroeder, NREL 25032*

TABLE 5. 2015 EPCRA REPORTING

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

"Not required" indicates that the laboratory was not required to report under the provision cited because it did not meet the threshold or did not have an extremely hazardous substance release.

NREL facilities are subject to Sections 302, 304, 311, 312, and 313 of EPCRA. Please refer to Table 5 for NREL's EPCRA reporting status.

NREL is also subject to permitting requirements through local jurisdictions and obtains annual hazardous material permits from West Metro Fire Rescue for the STM site and Denver West Office Park facilities. These 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.

The Renewable Fuels and Lubricants Research Laboratory is within the jurisdiction of the City and County of Denver and is subject to the Denver Fire Department Hazardous Materials Information System requirements. This facility's inventory of listed materials, including various fuels such as biodiesel, must be reported to the Denver Fire Department annually. The Denver Fire Department inspects the facility and issues a hazardous materials permit.

Hazardous materials permits are currently not required at the NWTC or the Joyce Street Facility.

Program Management

In addition to the EPCRA reporting obligations described above, a cornerstone of NREL's hazardous material management program is its laboratory-wide chemical management system, which serves as a centralized chemical inventory and as a tool for managing and reporting on chemicals used at the laboratory. Using an electronic barcoding system, the chemical management system tracks chemicals from the point of receipt through end-use and disposal. The system also contains technical data and reporting information for many of the chemicals in the chemical management system database. Key functions of the system include:

- Providing current inventories by room, building, and/or site
- Improving research efficiency and minimizing hazardous waste generation by allowing staff to determine if needed chemicals are already available on-site prior to making chemical purchases

- Providing quick access to chemical inventories and hazard information during emergency responses
- Facilitating accurate and efficient reporting to external agencies (e.g., fire districts, state and local emergency response agencies, EPA, and DOE).

Hazardous materials are rigorously managed, starting with the chemical management system that tracks chemical amounts, locations, and hazards. Each week, safety personnel receive a list of the chemicals and their hazards that were shipped to NREL during the previous week. Researchers and safety personnel ensure that chemicals are properly stored in locations suitable for their hazards such as storing flammable materials in designated flammables cabinets.

When requested by the state and local emergency response agencies or local fire departments, additional emergency response and reporting information is provided. NREL has been represented in the Jefferson County Local Emergency Planning Committee since its inception and is actively involved in the emergency planning concepts of EPCRA, with two active members on the committee.

Emergency response plans are also in place in the event of a spill or release of a hazardous material; these plans are coordinated with state and local emergency planning and response agencies and first responders, such as the West Metro Fire Rescue, Rocky Mountain Fire Rescue, and the Jefferson County Local Emergency Planning Committee.

2015 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- There were no releases of hazardous materials requiring reporting. In accordance with DOE Order 151.1c, *Comprehensive Emergency Management System*, NREL conducted a hazardous materials screening of select chemicals to confirm that inventories are below threshold planning quantities.
- EPCRA Tier II hazardous materials reports were submitted to the required state and local emergency response and planning agencies as well as local fire departments for three facilities for reporting year 2014. Chemicals reported included diesel fuel, petroleum oil, and sulfuric acid in lead-acid batteries.
- West Metro Fire Rescue conducted an annual hazardous material inspection and issued permits for seven facilities.
- The inventory of hazardous materials at the Renewable Fuels and Lubricants Research Laboratory was provided to the Denver Fire Department.

8.2 REGULATED WASTE MANAGEMENT

Research and development activities and general facility operations create a variety of waste streams including those containing toxic chemicals or metals.

NREL typically disposes or recycles the following categories of waste:

- Hazardous waste (as defined by environmental regulations)
- Non-hazardous waste such as propylene glycol from building chillers, diesel fuel, or spent biomass processing materials (does not include municipal solid waste such as regular 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.

Requirements

Regulated wastes are handled and disposed of according to the federal Resource Conservation and Recovery Act and the state of Colorado hazardous waste regulations. Additional applicable requirements for hazardous material transportation are regulated by the U.S. Department of Transportation.

NREL maintains unique EPA identification numbers for each of its five facilities: STM site, Denver West Office Park, NWTC, Joyce Street Facility, and 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

2015 Accomplishments and Highlights

- As a best management practice, all NREL facilities are managed to the stringent Large Quantity Generator status hazardous waste regulatory requirements, which require personnel training, contingency planning, and container management.
- Twenty cubic yards (15 cubic meters) of non-hazardous, nanomaterial-bearing High Efficiency Particulate Air filters from NREL facility ventilation systems were shipped to a hazardous waste landfill as a best management practice.

hazardous waste that are generated at each facility. The three waste generator classifications are:

- Large Quantity Generator
- Small Quantity Generator
- Conditionally Exempt Small Quantity Generator.

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.

Program Management

Waste management and minimization efforts begin in the planning stages of all experimental and operational activities. Processes are evaluated based on the quantities and toxicities of products that will be brought on-site before an activity begins and continues until material use is complete and it is ready for disposal. Hazardous materials proposed for use are also assessed for the potential substitution of less hazardous products, resulting in less hazardous waste streams.

The laboratory is committed to the appropriate management of regulated waste generated through its daily operations. These wastes are handled, stored, and disposed of responsibly and per regulatory requirements to minimize the potential for health and environmental impacts that could result from a release or improper disposal.

Implementation of regulatory requirements includes:

- Documented waste management and minimization program



Regulated wastes generated across the STM site are consolidated at the Waste Handling Facility for packaging prior to offsite disposal or recycling. *Photo by Sheila Hayter, NREL 14003*

- Annual training for all staff who generate and/or handle regulated waste
- Regular inspection and tracking of all waste containers
- Storage, packaging, shipment, and tracking until final disposition at a properly permitted waste disposal or recycling facility
- Active monitoring of waste volumes to determine generator status
- Maintaining records that are generated through “cradle to grave” waste management activities.

For select unregulated materials that still pose a potential hazard, NREL follows a conservative waste management policy wherein the material is collected and disposed as non-hazardous materials at properly permitted disposal facilities. For example, non-hazardous, nanomaterial-bearing wastes are not federally regulated, but because they pose a potential health risk, are managed and disposed of via the same management methods used for hazardous waste. Waste streams are accumulated on site for time-frames well within regulatory limits prior to being shipped for final disposal. In a general order of management preference, hazardous waste items are shipped off-site for final disposal via incineration, treatment, and landfill. Universal wastes are recycled or reclaimed.

Table 6 provides a summary of quantities and types of waste generated at NREL 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
2011	20,557 (9,324)	6,156 (2,792)	29,549 (13,403)	3,539 (1,605)
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)

2015 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- Nineteen hazardous and five universal waste shipments for offsite disposal were made across NREL's five sites.
- Mandatory employee hazardous and universal waste management training was completed in compliance with state and federal requirements.
- All regulatory notifications were updated and applicable waste generator fees were paid.
- Twelve cubic yards of imported sugarcane bagasse used in biofuels research were transported and disposed of in accordance with guidelines set forth by the U. S. Department of Agriculture's Animal and Plant Health Inspection Service. Disposal involved placement and subsequent burial at a municipal solid waste landfill.

8.3 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.

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 ASTs, which are maintained using best management practices and according to applicable regulations.

Requirements

ASTs in Colorado are regulated by the state, which requires that ASTs with capacities of 660 gallons (2,498 liters) or larger be permitted prior to installation, inspected by the state following installation, and registered with the state within 30 days following commencement of use. 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. (For more details, see section 8.4, Spill Prevention and Response.)

Eighteen ASTs are maintained at the STM site with a total capacity of 13,222 gallons (50,045 liters); one AST at Denver West Office Park with a capacity of 500 gallons (1,893 liters); and four ASTs at the NWTC with a total capacity of 1,006 gallons (3,808 liters). Five ASTs at the STM site are registered with the state. There are no ASTs at the NWTC, Renewable Fuels and Lubricants Laboratory, or Joyce Street facility that need to be registered.

Program Management

NREL's AST management program consists of permit compliance, inspections, tank maintenance and improvements, training, and spill response.

Staff actively participate in the program through:

- Participating in project planning, safety evaluations, and readiness verifications

2015 Accomplishments and Highlights

- All tanks were inspected to confirm continued adherence to recently revised regulations.
- Annual AST training was provided to 27 staff members identified as having responsibility for operating and fueling ASTs or that perform oversight for tank safety and environmental compliance.



Emergency generator near the employee parking garage at the STM site. Photo by Genevieve Braus, NREL 36262

- Conducting regular tank inspections and maintenance activities
- Achieving timely, necessary regulatory approval
- Maintaining a current and accurate AST inventory
- Placing spill response supplies in key locations
- Planning and documenting of annual training activities.

Personnel who operate and manage ASTs are trained annually on program requirements including inspection and response requirements, spill history of each site, lessons learned, and recent changes in rules and regulations.

Several important mechanical and procedural safeguards have been incorporated into NREL's AST management program to prevent an accidental release of diesel or E-85 fuel from the storage tanks. Mechanical safeguards include overfill and spill protection, double-wall tanks equipped with sensors that result in an alarm if the inner tank wall is leaking, and secondary containment for single-wall tanks. Procedural safeguards include written operating and tank-filling procedures, monthly and annual inspections, and recordkeeping of inspection results. ASTs larger than 60 gallons (227 liters) are visually inspected monthly and all double-walled ASTs are inspected annually to confirm that there is no liquid in the interstitial space.

2015 Compliance Summary and Activities

- Program activities were in compliance with EPA and state AST requirements.
- No reportable spills occurred associated with tank equipment failures or tank filling operations.
- No new tanks were permitted or installed.

2015 Accomplishments and Highlights

- The laboratory SPCC training course was updated to include new facilities and revised SPCC plans. Two additional large portable spill control kits were placed at key STM site locations to improve rapid response capability.
- The STM site SPCC Plan was revised to include additional oil-containing items including transformers, hydraulic equipment and storage drums.

8.4 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 (SPCC) can reduce spills and limit impacts to the environment when spills do occur.

Requirements

SPCC plans are required by the EPA and state of Colorado 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.

The plan must address such items as:

- Topography and location of waterways
- Location and quantity of oil sources
- Possible spill pathways
- Spill scenarios and potential spill volumes
- Spill prevention and response training
- Spill notification procedures and contact information
- Emergency response activities.

Due to the quantity of oils stored at the STM site, the NWTC, and the Renewable Fuels and Lubricants Research Laboratory, a SPCC plan is required for those locations.



Spill kit near the E-85 tank at the STM site. Photo by Larry Durbin, NREL 36265

Program Management

The laboratory prepares for and continually improves spill response. Formal SPCC plans have been developed and are periodically updated for three facilities. The plans are designed to minimize the number and size of spills, and speed the control and cleanup of spilled materials. SPCC plans are updated every three years, or whenever there is a significant change in regulations, operations, or equipment. This aggressive approach to spill prevention and control exceeds the EPA's requirement that SPCC plans be updated at least every five years.

Emergency notification and hazardous materials procedures are in place to provide additional support for spill response. Proper preventive planning and training minimizes the potential for spills, and advance preparation for spill response protects water and ecological resources.

SPCC training occurs annually for individuals who are responsible for oil-containing equipment and AST operation and maintenance. SPCC training is combined with AST training and educates staff on oil-containing equipment at each site. Training also includes inspection and response requirements, location and use of spill response equipment, and notification and spill reporting protocols.

The laboratory typically does not experience spills that require notification to federal and state agencies. Small, incidental hydraulic system leaks, lubricant leaks, and fuel transfer spills may occur on occasion. Lessons learned from spill incidents and clean-up activities are used to improve management and spill response planning.

2015 Compliance Summary and Activities

- Program activities were in compliance with requirements.

- Forty-nine staff who manage and/or operate oil-containing equipment received annual SPCC training.
- No reportable spills occurred. Sixteen minor spills of diesel, lubricant, coolant, and hydraulic fluids occurred at the STM site, and two spills occurred at the NWT. The size of spills ranged from less than 0.1 gallon to 4 gallons (0.38 to 15 liters). The majority of these spills were the result of leaks from vehicles and construction equipment. Each spill received immediate remedial action and did not result in any significant impact to the environment.

8.5 RADIOLOGICAL MATERIALS AND WASTE MANAGEMENT

NREL conducts a wide range of research and operational activities that incorporate the use of radiological materials. The laboratory occasionally uses small quantities of radioisotopes for biological labeling and electron microscopy staining. All of the radioisotopes have very low activity levels and are used in extremely small amounts. A number of sealed sources are 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.

Requirements

Radiological air emissions are regulated by the EPA. DOE Order 458.1, *Radiation Protection of the Public and the Environment*, 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

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.

any member of the public from receiving an effective dose equivalent of 10 mrem per year or greater.

Program Management

NREL has established strict protocols for radiation-generating devices, equipment containing sources of radiation or for the use of radioisotopes in laboratory experiments through its radiation safety program. Some of these controls include:

- Confining work with radioisotopes to a small number of specific laboratories
- Limiting the types and quantities of radioisotopes onsite
- Monitoring equipment and facilities for removable contamination or sealed-source leakage.

No radioactive air emission monitoring is conducted at the laboratory because of the extremely low usage of radioactive material. Therefore, NREL demonstrates compliance with radiological air emission standards by using an EPA computer model (COMPLY Version 1.6) to determine the effective dose equivalent to the public.

Current laboratory procedures prohibit any activity that may result in a radioactive waste that is also federally regulated under the Resource Conservation and Recovery Act and thus categorized as "mixed waste." Therefore, all radioactive waste generated is classified solely as low-level radioactive waste. Waste is temporarily stored on-site until disposal is arranged at an off-site facility permitted to accept low-level radioactive waste. Internal procedures prohibit the disposition of property unless it has been decontaminated to background levels.

2015 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- Only small quantities of low-level radioactive waste were generated and are currently in storage awaiting off-site disposal.
- The effective dose equivalent of radiation to the public was 0.036 millirem (mrem) per year, far below the 10 mrem per year limit.



"Bio-oils" produced at the Field Testing Laboratory Building. By subjecting feedstocks such as corn stover or beetle-kill wood to high temperatures in the absence of oxygen, oils generated in this way have the potential of being used as a renewable transportation fuel. *Photo by Dennis Schroeder, NREL 33054*

9 NATIONAL ENVIRONMENTAL POLICY ACT

NREL's National Environmental Policy Act (NEPA) program provides a mechanism to consider the potential for environmental impacts in decision-making processes and to promote sustainable and environmentally responsible operations. Under this program, staff analyze the potential impacts for a wide range of activities prior to spending funds or commencing work.

Requirements

NEPA is a federal law that requires potential environmental impacts to be considered for activities having a federal connection, such as those using federal funds, property, facilities, employees, and equipment. NEPA represents the federal government's mandate to consider the environment equally to other factors when making decisions. It directs federal agencies to take into account, and publicly disclose, the environmental consequences of proposed actions.

Soon after NEPA was passed at the end of 1969, the president's Council on Environmental Quality enacted regulations that provided direction to federal agencies on how NEPA should be implemented. Subsequently, DOE established NEPA Implementing Procedures which are

2015 Accomplishments and Highlights

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

used by both DOE and NREL to comply with NEPA and the Council on Environmental Quality regulations.

Under NEPA, DOE considers and documents environmental factors used in deciding what level of evaluation is required for a proposed action. These are:

- Categorical Exclusion
- Environmental Assessment
- Environmental Impact Statement.

Categorical Exclusion (CX)

A CX determination is the lowest level of NEPA review and can be applied to activities that are known not to have a significant individual or cumulative effect on the quality of the human and natural environment. Each agency has a unique set of CXs based on their own routine activities. Examples of DOE's CXs include:

- Routine administrative and business activities
- Specific types of site and facility maintenance and improvements
- Information gathering and data analysis
- Technical assistance activities
- Research activities conducted at existing offsite non-NREL laboratories
- Small-scale renewable energy research and development projects
- Research and operations activities at NREL's ReFuel and Joyce Street facilities.



Honey bees take up temporary residence in a tree outside of the Solar Energy Research Facility. *Photo by John De La Rosa, NREL 33551*

Environmental Assessment (EA)

If the proposed action has extraordinary circumstances present (such as potential effects to environmentally sensitive resources that must be addressed, public controversy, or new construction not addressed in a site-wide EA), or the proposed action fits within a category of actions that DOE has determined to typically require an EA, then an EA must be prepared. The purpose of an EA is to determine the significance of the environmental effects and to look at alternative means to achieve the agency's objectives. The EA also provides sufficient evidence and analysis for determining whether or not to prepare an EIS.

An EA is prepared for classes of activities such as siting, construction, and/or operation of energy system demonstration actions including wind, hydropower, geothermal, biomass, and solar energy projects and operations. The EA allows for public review and comment, and demonstrates compliance with NEPA (i.e., it helps to identify better alternatives and mitigation measures). When environmental analysis and interagency reviews conducted during the EA process conclude that no significant impacts will occur related to the quality of the environment, a Finding of No Significant Impact is issued. If the EA indicates significant environmental impacts will occur, an Environmental Impact Statement is required.

Environmental Impact Statement (EIS)

An EIS provides a detailed analysis of projects that have significant prospective environmental impacts. The EIS provides a discussion of significant environmental impacts and reasonable alternatives that would avoid or minimize adverse impacts or enhance the quality of the human and natural environment (including the consideration to not pursue the project). An EIS is also made available for public review and comment. As a final step, a Record of Decision is prepared, which states the decision, the alternatives considered, including the environmentally preferred alternative, and discusses mitigation plans, including any enforcement and monitoring commitments. It should be noted that NREL, to date, has had no activities that required an EIS.

Program Management

NREL employees initiate the NEPA process and provide support to the DOE Golden Field Office in conducting a NEPA analysis before a project or activity begins. In accordance with regulations, all NREL activities (both on- and off-site) must undergo a NEPA environmental review. The outcome of this review is considered the NEPA determination. A final determination must be completed before



1.1MW solar photovoltaic array at the NWTC. *Photo by Dennis Schroeder, NREL 31432*

federal funds are expended, before a contract award can be made, and before project activities begin.

NREL and DOE Golden Field Office use a type of programmatic NEPA document unique to DOE to streamline the environmental review process. These programmatic NEPA documents, known as Site-Wide EAs, are comprehensive site-wide analyses of potential environmental impacts associated with NREL's current and future actions over a period of five to ten years. These serve as planning tools that aid ongoing and future operational and development decisions related to NREL's sites. The Site-Wide EAs for the STM site and NWTC provide a baseline environmental

analysis that streamlines future environmental reviews, improves and coordinates site and agency planning, and maximizes cost savings.

If proposed activities have not already been evaluated in an existing Site-Wide EA or supplemental NEPA document, then further environmental analysis must be conducted. Potential environmental impacts of an activity are evaluated and measures are taken, as needed, to avoid or minimize those impacts. The level of review conducted is appropriate to the potential impacts of the proposed activity. A planned construction project, for example, receives a more rigorous review than routine office or laboratory work.

2015 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- A total of 614 NEPA reviews were conducted for project activities on- and off-site.
- A NEPA program assessment (conducted in 2014) identified findings related to document control, training, and adherence to internal NEPA processes. A NEPA enhancement project plan is in place and progress has been made to address the findings, which will be completed in 2016.



10 NATURAL AND CULTURAL RESOURCES PROTECTION

Western kingbird (*Tyrannus verticalis*) in a tree outside of the Research Support Facility at the STM site. Despite NREL biologists' efforts to discourage nesting during an adjacent paving project (note the bird-deterrent tape tied on a tree branch), these birds nested and several young successfully fledged the nest. *Photo by Suzanne Belmont, NREL 35301*

NREL is committed to responsible stewardship of its natural ecosystems, native wildlife, vegetation, and important cultural resources. Natural resources at the STM site and the NWTC are managed appropriately to ensure NREL's research needs are met while protecting native wildlife and vegetation. Responsible management benefits not only our environment, but also NREL employees and the surrounding community, and demonstrates the laboratory's leadership in the DOE and federal government as a whole. Management focuses on these key areas:

- Wildlife management
- Endangered species and species of concern
- Vegetation management
- Wetlands and floodplains
- Cultural resources.



Yellow-bellied racer (*Coluber constrictor*) observed near the STM site Maintenance Shed. This common non-venomous, diurnal snake is fast moving and very docile. The underbelly color can vary from white, to a light tan, to yellow. This individual exhibits the name-sake colors. *Photo by Tom Ryon, NREL 35302*

10.1 WILDLIFE MANAGEMENT

The wildlife management program promotes responsible wildlife and habitat management, and gathers information to better consider impacts to wildlife when implementing projects onsite.

Many surrounding landowners, including residential neighbors and Jefferson County Open Space, value the benefits of maintaining wildlife habitat and opportunities to observe wildlife. Proper wildlife management at NREL therefore provides an important benefit to our community.

2015 Accomplishments and Highlights

- Acoustic bat monitoring at the NWTC continued. In cooperation with biologists from the Rocky Flats National Wildlife Refuge, an additional acoustic monitoring station was established on the refuge within the Rock Creek drainage area. Monitoring at the NWTC occurred from April through October, and at Rock Creek from June to July.
- Mammalian predator monitoring continued at the NWTC. Coyote (*Canis latrans*) and bobcat (*Felis rufus*) were again observed; no new species were documented.
- Nest boxes have been installed in areas around the STM site including the mesa slope and the stormwater detention basin. This year, tree swallows nested in two of the boxes along the eastern edge of the detention basin. Along the mesa slope, some of the older/weathered boxes were replaced and American kestrels and common flickers showed interest but did not nest.
- Bee boxes installed in previous years were found to have Mason bees; cocoons were found to be over-wintering.
- A honey bee swarm was found near the southwest corner of the Solar Energy Research Facility at the STM site. Rather than destroying the swarm, a local beekeeper was called to remove the swarm from the site. The bees were then used to create a new colony at the beekeepers' apiary.
- A community open-house was held in coordination with the DOE Golden Field Office during which environmental stewardship at NREL was presented. Topics discussed included the research related to wildlife impacts from renewable energy and efforts to reduce those impacts, past STM site and NWTC wildlife and cultural resource studies, and how NREL assesses environmental impacts of all types.
- Provided information at The Wildlife Society – North American Conference about how energy efficient building design can also minimize bird collisions with windows.
- An avian workshop sponsored by the DOE Golden Field Office and led by the U.S. Fish and Wildlife Service was held at NREL. The topics covered included a thorough review of the Migratory Bird Treaty Act and associated case law, related regulations, and how these regulations specifically apply to DOE sites. NREL provided highlights of activities implemented at the STM site and the NWTC that comply with these regulations.
- Tularemia, also known as "Rabbit Fever", was on the rise in Jefferson County in 2015. Many rabbits were found dead or dying on the STM site, especially within the Conservation Easement. It is assumed these rabbits had succumbed to the disease, which, together with predation, is a part of the normal process of population suppression. No lasting effects to local populations are realized until 90 to 95% of the population dies⁹ (ARCC 1993). Rabbits have a high annual turnover rate (typically upwards of 80%), which occurs due to weather, disease, parasites, predators, or starvation.¹⁰ Local rabbit populations have the ability to rebound after severe reduction within a year or two.
- NREL was alerted by the Colorado Parks and Wildlife Division of a buck mule deer that was extremely thin and weak near the STM site; it was found dead at the site after a week. Testing proved the buck was infected with chronic wasting disease, which is endemic to northeastern Colorado, including Jefferson County.¹¹

⁹ Australian Rabbit Control Conference, Adelaide, April 1993, pp. 26-34. Editor B.D. Cooke.

¹⁰ Yarrow, G. 2009. Cottontail Rabbit Biology and Management. Clemson University Extension Service. http://www.clemson.edu/extension/natural_resources/wildlife/publications/fs8_cottontail%20rabbit.html.

¹¹ Belay, E.D., R. A. Maddox, E.S. Williams, M.W. Miller, P. Gambetti, and L.B. Schonberger. 2004. Chronic Wasting Disease and Potential Transmission to Humans. *Emerging Infectious Diseases*, Vol 10 (6). June. www.cdc.gov/eid.

Requirements

A Colorado statute, several federal laws, and an executive order comprise the regulatory framework for NREL's wildlife management program. (Please refer to section 10.2, Endangered Species and Species of Concern, for discussion of other federal laws relating to wildlife management.)

Wildlife is considered a state resource under Colorado law, and 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.

The Migratory Bird Treaty Act is the main driver for protecting migratory birds in the United States. In the biological sense, a migratory bird is a bird that has a seasonal and somewhat predictable pattern of movement. Generally, this includes all native birds in the United States, except those non-migratory species such as quail and turkey that are managed by individual states as game species. Currently, there are 1,026 species of birds protected by this law.

The Migratory Bird Treaty Act makes it a federal crime to "take" birds or bird parts, including feathers, or to kill birds unless permitted by regulations issued by the U.S. Fish and Wildlife Service. The term "take" means to pursue, hunt, shoot, wound, kill, trap, capture, or collect any protected migratory bird or any part, nest, or egg of any protected migratory bird or to attempt those activities. 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.

In 2001, EO 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*, set requirements for federal agencies to minimize their impacts to migratory birds, to work cooperatively with the U.S. Fish & Wildlife Service, and to establish an interagency migratory bird committee for collaboration and information sharing. Additionally, the U.S. Fish & Wildlife Service issued guidance identifying goals for federal program activities based upon this executive order. This guidance highlighted measures to avoid and/or minimize potential impacts to migratory birds, eggs, and active nests including but not limited to:

- Project modification
- Time-of-year restrictions on vegetation clearing



Northern leopard frog, a Colorado species of concern, in wet meadow located at the southwest corner of the NWTC. Proper vegetation practices applied to this area, which was formerly infested with noxious weeds, along with plentiful spring and summer precipitation have contributed to the abundance of frogs at this location. *Photo by Tom Ryon, NREL 35466*

- Avoidance of cavity trees, colonial bird nests, and other active nests
- Avoidance of nests of species of concern.

The U.S. Fish & Wildlife Service also works to ensure that environmental analyses of federal activities under NEPA or other established environmental review processes evaluate the effects of actions and agency plans on migratory birds, particularly on species of concern.

The 2013 Memorandum of Understanding between DOE and the U.S. Fish & Wildlife Service regarding implementation of EO 13186 formalizes DOE's commitments regarding the protection of migratory birds. Under the Memorandum of Understanding, DOE agrees to integrate migratory bird conservation principles, measures, and practices into agency activities, and avoid or minimize, to the extent practicable, adverse impacts on migratory bird resources and their habitats.

Program Management

NREL's wildlife management program was developed to implement measures to allow the laboratory to meet or exceed the regulatory requirements discussed above and to minimize or avoid impacts to wildlife species and their habitats while achieving NREL's mission.

Staff biologists work with project managers and decision-makers as part of an integrated project team on construction projects to minimize impacts to wildlife and maintain habitat by avoiding sensitive areas and reclaiming lands once disturbance is complete.

A long-term objective is to maintain wildlife movement through the STM site by retaining linkages between the

open space areas north of the site, and Pleasant View Community Park and Lena Gulch to the south. At the NWTC, ecologically sensitive areas are preserved within the site and linkages with surrounding open space areas are maintained. At both sites, periodic monitoring using wildlife surveys informs responsible management.

When control of pest wildlife species is necessary, a graded approach is used to humanely control pests and minimize other potential impacts. Building design features and administrative controls are the first line of defense against pests. When these are not fully effective, additional controls are used. Pests are relocated whenever possible. When pests must be destroyed, mechanical methods are preferred over poisoning. When necessary, pesticides are selected that pose the least harmful effects to non-target wildlife.

Several activities occur periodically to achieve the program's intent including the following:

Monitoring – The laboratory conducts nesting bird surveys prior to any ground- or vegetation-disturbing activities conducted between March 15 and September 15 every year. If nests are found, the area is closed with a proper buffer area until nestlings fledge. Staff conduct periodic surveys on a site-wide basis to document biological conditions at NREL facilities.

- Acoustic bat monitoring at a NWTC location continued in 2015. In cooperation with biologists from the Rocky Flats National Wildlife Refuge, an additional acoustic monitoring station was established on the refuge within the Rock Creek drainage area. Using microphones, bat calls are recorded and compared to standard calls of a particular species. Monitoring at the NWTC occurred from April through November and at Rock Creek from June to July. Results for acoustic

bat monitoring at the NWTC included the presence of three species: Little Brown Bat (*Myotis lucifugus*); Hoary Bat (*Lasiurus cinereus*); and Silver-hair Bat (*Lasionycteris noctivagans*). At the Rocky Flats National Wildlife Refuge, four species of bats were recorded including the Little Brown Bat, Hoary Bat, Silver-hair Bat and Big Brown Bat (*Eptesicus fuscus*). All four of these species have been recorded at the NWTC in recent years.

Project Reviews – Biologists conduct project reviews to assess and reduce potential impacts to wildlife.

Coordination – Biologists coordinate with local, state, and federal agencies to improve wildlife management. They conduct these activities in concert with surveys for threatened and endangered species and habitats. (For more details, see section 10.2, Endangered Species and Species of Concern.) Because habitat is as much a concern as the wildlife species themselves, program activities often overlap with vegetation management.



A bobcat walks through the pine ridge at the NWTC and is captured on the game camera mounted nearby. Photo by Tom Ryon, NREL 35362



Mule deer (left) and white-tailed deer (right) at the NWTC. Smaller ears and lighter color fur around the eyes and nose distinguish the white-tailed deer from the mule deer. Photo by Tom Ryon, NREL 35364

2015 Compliance Summary and Activities

- Visible markers were applied to a total of 6,700 square feet of glass windows of the Energy Systems Integration Facility in August of 2014 to reduce the potential for bird strikes. Post-retrofit bird surveys consisting of 45-researcher-hours over two 10-week periods during two fall migration seasons were concluded in November 2015, with the results showing that no bird strikes occurred on any of the treated windows. Based on pre-retrofit surveys conducted from August 2013 through November 2013 and the post-retrofit surveys, the project will likely prevent 15 to 20 bird deaths due to window strikes each fall migration season.
- Building repair activities were delayed at the Outdoor Test Facility until nestlings produced by a pair of flickers had fledged and the adults abandoned the nests, to ensure compliance with the Migratory Bird Treaty Act. Cavity nesters, such as flickers and woodpeckers, commonly build nests in the exterior surfaces of buildings causing significant damage.
- Requirements of the Avian Power Line Interaction Committee guidelines¹² to minimize migratory bird hazards were incorporated into project planning and design. Incorporation of these guidelines ensures compliance with the DOE and U.S. Fish and Wildlife Service Memorandum of Understanding Regarding Implementation of EO 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*. This Memorandum of Understanding requires that "...whenever appropriate and feasible, DOE sites utilize avian-friendly transmission lines and power poles that are designed to minimize bird collisions and electrocutions...".

10.2 ENDANGERED SPECIES AND SPECIES OF CONCERN

NREL manages research and operational activities to preserve and protect environmental quality. The laboratory is committed to the protection of imperiled species, and monitors for these species at the STM site and the NWTC.

Periodically, surveys are conducted for declining wildlife species and rare plants, including species that are federally or state protected, or otherwise considered imperiled or declining. Biologists also survey for potential habitat for these species. Should potential habitat be found, more targeted surveys may be conducted. These surveys

identify the presence or absence of rare species or their habitats and aid in siting and planning new projects. While no protected or declining species have been detected at an NREL facility, appropriate steps would be taken should such a species be found.

Requirements

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. 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.

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 occur in Jefferson and Boulder Counties combined. 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.

Additional federal and state laws and regulations protect wildlife, such as the Bald and Golden Eagle Protection Act. 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, while not regulatory in nature, is unique in that it is the only designation besides the Endangered Species Act that considers rare plants. The list of threatened, endangered, and candidate species, and species of concern (i.e., bald and golden eagles, state-listed species, and Colorado Natural Heritage Program species) are all considered imperiled species and can be referred to as a group known as "Threatened, Endangered, or Species of Concern" species.

Program Management

NREL conducts periodic surveys for the three listed species that have the potential to occur at the STM site and the NWTC in order to document their presence or absence. While the Preble's meadow jumping mouse does not occur on-site, the U.S. Fish and Wildlife Service designated critical Preble's habitat 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 coordination with the U.S. Fish and Wildlife Service.

¹² Avian Power Line Interaction Committee. Reducing Avian Collisions with Power Lines: The State of the Art in 2012. October 2012.

NREL also considers other plant and animal species that may be state listed or generally in decline. Current information is obtained from both the Colorado Division of Parks and Wildlife and the Colorado Natural Heritage Program. These two entities work together to track declining species and habitats throughout Colorado. Although not required by federal regulation, periodic surveys are conducted for species that may occur at the STM site and the NWTC, typically every five years when baseline vegetation and wildlife studies are conducted. These baseline surveys are a vital part of NREL's National Environmental Policy Act program through which impacts to natural resources from mission activities are assessed.

The U.S. Fish and Wildlife Service lists five other species occurring in the Platte River watershed in Nebraska in accordance with the Endangered Species Act as species that must be considered for projects in Colorado and Wyoming 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*). For any NREL activities that may deplete water in the Platte River system, a consultation with the U.S. Fish and Wildlife Service must be completed to determine potential impacts.

2015 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- As part of its NEPA evaluation, NREL conducted natural resource surveys for a potential research project at the NWTC. These surveys included presence/absence and habitat surveys for threatened and endangered species and Colorado state-listed species. A rare plant survey was also conducted for the Ute ladies' tresses orchid and the Colorado butterfly plant. No federally protected species or habitats were found and no state-listed species or habitats were found.

10.3 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, attracting new types of pests and diseases and out-competing native plants for nutrients and water, while also sometimes depriving wildlife of nutrients and shelter. Plants such as kochia (*Bassia scoparia*), Canada thistle (*Cirsium arvense*), Russian olive (*Elaeagnus angustifolia*), diffuse knapweed (*Centaurea diffusa*), dalmation toadflax (*Linaria vulgaris*), and myrtle spurge (*Euphorbia myrsinites*) are examples of non-native plants that can have destructive effects on natural habitats.

Landscaped areas near buildings and common areas at the STM site and the NWTC are designed and installed with sustainability in mind, and include features such as native plantings, xeriscape principles appropriate for arid climates, and infiltration of stormwater to provide water and nutrients to landscape plants and to recharge groundwater in the area.

Requirements

Vegetation management at NREL must meet the requirements of EO 13112, *Invasive Species*, the Federal Noxious Weed Act, and the Federal Insecticide, Fungicide and Rodenticide Act.

The Federal Insecticide, Fungicide, and Rodenticide Act 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 person with a

2015 Accomplishments and Highlights

- Monthly review and coordination meetings were conducted to assess the success of seasonal herbicide applications and revegetation efforts.
- Herbicide was applied in an area at the STM site where reseeding occurred in 2014 following land disturbance from a utilities infrastructure upgrade project. Removal of weedy species results in less competition for nutrients and water that are needed by the native grasses in order for them to succeed.
- Annual herbicide spraying was performed to continue the control knapweed at the NWTC, and Canada thistle, houndstongue (*Cynoglossum officinale*) and myrtle spurge at the STM site.



Common mullein, sometimes referred to as wooly mullein, is a noxious weed. The first sign of this weed is a rosette (pictured) that grows during its first year. In the second year, a stalk will grow from the center of the rosette to produce many yellow flowers. By the second year, control of this plant is generally not possible, so identification and control of the first year stage is important for this weed. *Photo by Tom Ryon, NREL 36263*

certified applicator license must be used. Application of restricted-use herbicides is conducted in accordance with the regulation. NREL currently uses contractors for this type of application.

At the STM site, vegetation management of 177 acres is under a conservation easement agreement with Jefferson County, which requires that the unique landscapes within the easement are left undisturbed. (For more details, see section 11, Conservation Easement Lands.)

NREL voluntarily complies with the Colorado Noxious Weed Act.

Program Management

The focus of NREL's vegetation management program is to:

- Conserve existing ecosystems in their natural state as much as possible
- Strive to replace disturbed vegetation with native species, or with adapted but non-invasive species when necessary
- Implement a program of weed management to prevent the spread of noxious weeds and implement measures to control these species
- Implement a sustainable landscape design and maintenance program.

Approximately 60 acres (24 hectares) of land within the NWTC boundaries are managed as conservation areas. As within the STM site's 177-acre (71 hectares) conservation easement, the laboratory limits development in these areas at the NWTC and manages them to conserve

specific features including seeps, ephemeral drainages, ponds, native grassland habitat, areas supporting ancient soils (a soil structure in association with plant species forming a stable ecological community that is resistant to weed invasion), a small area designated as critical habitat for the Preble's meadow jumping mouse, an area of remnant tallgrass prairie, and a rocky outcropping supporting ponderosa pine and shrublands.

To maintain the existing native vegetation and to ensure the success of revegetated areas, the laboratory has developed sustainable landscape management practices that:

- Provide supplemental water during seedling growth and establishment, and minimize water use thereafter
- Reduce the need for and use of pesticides and fertilizers
- Reduce maintenance costs
- Maximize ground cover to reduce soil erosion
- Establish a variety of habitats to support diverse wildlife
- Create an aesthetically pleasing landscape environment.

Where removal of native vegetation cannot be avoided, reseeding is done using grass and forb seed mixes native to the local area. A palette of native flowering plants, shrubs, and trees has been identified for use on both the STM site and the NWTC to enhance ecosystem diversity and integrity. NREL staff continually evaluate and modify revegetation techniques as needed to promote healthy plant establishment.

NREL participated in the Sustainable Sites Initiative two-year pilot program (2010-2012) established by the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center at the University of Texas at Austin, the United States Botanic Garden, and a diverse group of other stakeholders. The purpose of the pilot program was to develop the first national rating system for sustainable landscapes. Certification under the program demonstrates that the stewardship activities necessary for regeneration of the natural benefits and services for sustaining healthy ecosystems are being implemented.

NREL developed and submitted a plan for implementing sustainable landscape practices and received a rating of three out of four stars. The plan is now integrated into NREL's landscape maintenance plan and other site-wide procedures. Integrated components of the plan include



Dalmatian toadflax, a native of western Asia and southeastern Europe, is an invasive weed in North America and has been identified at NREL. *Photo by Tom Ryon, NREL 36362*

plant stewardship, invasive species management, organic materials management, soil stewardship, irrigation and water use, stormwater management, materials management, snow and ice management, and monitoring. The Sustainable Sites Initiative program is also a critical foundation that supports NREL’s objective in creating adaptive and resilient sites to meet the challenge of dynamic climate changes.

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 (e.g., reclamation of disturbed areas), prevention (e.g., limiting or eliminating driving of vehicles off established roadways), and herbicide treatment. The effectiveness of control methods is periodically assessed. The use of multiple strategies for control 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. Periodic mapping of weed infestation areas assists in targeting weed control efforts.

The laboratory continues to address the control of these species using the integrated weed management approach described above. Comprehensive site-wide weed surveys and mapping are performed approximately every five years; smaller areas are assessed annually. A list of noxious weed species identified at the STM site and the NWTC is found in Table 7.

For information on rare and imperiled plant species, see section 10.2, Endangered Species and Species of Concern.

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

Noxious Weed Class	Species Present at STM Site	Species Present at NWTC
Class A	Myrtle spurge	None
Class B	Canada thistle	Canada thistle Chicory Dalmatian toadflax Diffuse knapweed Hoary cress (whitetop) Hoary cress (whitetop) Musk thistle Musk thistle
	Common teasel	
	Dalmatian toadflax	
	Diffuse knapweed	
	Hoary cress (whitetop)	
	Hound’s tongue	
	Musk thistle	
	Scotch thistle	
Class C	Field bindweed	Field bindweed
	Cheatgrass	Cheatgrass

2015 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 135 acres (55 hectares) in April and May, 41 acres (17 hectares) in July, and 21 acres (8 hectares) in October.
- At the STM site, herbicides were applied to control A-, B- and C-listed weeds to approximately 15 acres (6 hectares) in May and June, 6 acres (2 hectares) in August, and 13 acres (5 hectares) in October. Across the STM site and within the STM Conservation Easement 15 Russian olive trees were girdled and treated with herbicide in September to kill the trees and prevent the spread of this invasive species.
- Two locations, one on the STM site and the other on the NWTC, were selected to introduce a rust fungus (*Puccinia punctiformis*) to combat Canada thistle. The locations are seep areas where Canada thistle is known to occur. Introduction of this biological control agent, done in cooperation with the Colorado Department of Agriculture, provides an integrated approach to combatting noxious weeds. The Colorado Department of Agriculture will monitor the rust fungus in

subsequent years to document its establishment and effectiveness.

- Knapweed weevils were introduced along the Pine Ridge at the NWTC in August. Two species were released; one that attacks the seed heads and another that attacks the roots of knapweed. This effort further diversifies noxious weed control methods.

10.4 WETLANDS AND FLOODPLAINS

Floodplains are land areas adjacent to rivers and streams that are subject to recurring inundation. 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.

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. NREL preserves the important natural functions of its wetlands and floodplains, thereby protecting the physical, biological, and chemical integrity of receiving waters and riparian areas on and adjacent to the STM site and NWTC.

Requirements

- Wetlands became regulated in 1972 when, under the Clean Water Act, the definition of *waters of the United States* was expanded to include tributaries to navigable waters, interstate wetlands, wetlands that could affect interstate or foreign commerce, and wetlands adjacent to other *waters of the United States*. Wetlands that fit within the definition and that meet certain soils, vegetation, and hydrologic criteria are federally protected under programs administered by the U.S. Army Corps of Engineers, with program oversight provided by the EPA. These regulated wetlands are known as jurisdictional wetlands. Areas that do not meet the criteria above are not protected or regulated but still perform wetland functions and act as valuable ecologic components.
- Wetland areas identified at the STM site and NWTC are managed as a valuable natural resource and in a manner consistent with the Clean Water Act as well as EO 11990, *Protection of Wetlands*, which requires that federal agencies minimize the destruction, loss,

2015 Accomplishments and Highlights

According to the National Weather Service Forecast Office for the Denver-Boulder Area, the highest precipitation within the last 15 years occurred in 2014 and 2015. With this abundance of precipitation in two consecutive years, wetland vegetation has been in full expression. Low-lying areas that normally do not exhibit wetland vegetation have supported cattails and rushes or have held standing water. These wetland areas contain flood waters, reduce erosion, and support many forms of native wildlife. As an illustration of dramatic change over just a few months, below are photos of a seasonal pond at the NWTC. Most years, the pond is dry except for a few weeks after snow runoff season (April to May, annually). In 2015, this seasonal pond was filled for the entire growing season and supported wetland and aquatic plant communities that sprouted forth from the soil seed bank.



Seasonal Pond in June, 2015. Open water supports amphibians, insects, and waterbirds. *Photo by Don Young, NREL 35300*



Seasonal Pond in August, 2015. Wetland plants have emerged along the edges of the receding water. *Photo by Don Young, NREL 35299*

or degradation of wetlands; follow DOE policy to carry out the requirements of EO 11990; and preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities.

Counties regulate floodplains by mapping the 100-year floodplain boundaries within their jurisdiction in coordination with the Federal Emergency Management Agency and then develop regulations that control the type and amount of development within those areas. Federal facilities must further manage their impacts on floodplains per the requirements identified in EO 11988, *Floodplain Management*. This executive order requires federal agencies to minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values served by floodplains.

The STM site and NWTC do not contain any regulatory 100-year floodplains.

Program Management

NREL protects its wetlands and floodplains through several means:

- Periodic vegetation surveys and wetland delineations
- Mapping of wetland areas potentially affected by proposed construction
- Identification of potential impacts
- Coordination with other jurisdictions on the control of floodwaters leaving NREL's STM site and NWTC.

The U.S. Army Corps of Engineers has examined the STM site drainages and determined that they do not fit wetland criteria and are therefore not currently regulated. The U.S. Army Corp of Engineers has not evaluated the NWTC drainages to date. The new Clean Water Rule, promulgated in May 2015, would more precisely define implementation of the Clean Water Act and what constitutes a wetland, which could change which drainages at NREL are regulated. Currently, however, the Clean Water Rule is being contested within the court system, and prior regulations remain in effect nationwide. Functional wetlands, whether regulated or not, are considered valuable features, and the laboratory seeks to preserve these. Table 8 presents 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.

2015 Compliance Summary and Activities

- Program activities were in compliance with regulations.
- No NREL projects or activities that could impact wetlands or floodplains occurred.

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

Wetland Type	STM Site Acres (hectares)	NWTC Acres (hectares)
Groundwater Seep	0.2 (0.08)	0.2* (0.08)
Headwater Wetland	0 (0)	1.7* (0.68)
Palustrine Emergent	1.2 (0.48)	0.8 (0.32)
Seasonal Pond	0.6 (0.24)	0.4* (0.16)
Wet Meadow	0.3 (0.12)	4.9 (1.9)
Total	2.3 (0.93)	8.0 (3.2)

* Wetlands that have been surveyed and meet all federal wetland criteria. Other wetlands listed were identified by vegetation type only.

10.5 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.

Prehistoric and historic archaeological resources are locations where human activity measurably altered the earth or left deposits of physical remains, such as arrowheads, pottery, and tools. Prehistoric resources that predate the advent of written records in a region range from a scatter composed of a few artifacts to village sites and rock art. Historic resources may include campsites, roads, fences, trails, dumps, battlegrounds, mines, and a variety of other features.

Architectural resources include standing buildings, dams, canals, bridges, and other structures of historic or

aesthetic significance. Architectural resources generally must be more than 50 years old to be considered for protection under existing cultural resource laws. However, more recent structures, such as Cold War facilities, may warrant protection if they manifest the potential to gain significance in the future.

A traditional cultural resource can be defined as a property that is eligible for inclusion in the National Register of Historic Places because of its association with cultural practices or beliefs of a living community that are rooted in the community's history, and its importance in maintaining the continuing cultural identity of the community. Traditional resources may include archaeological resources, buildings, neighborhoods, prominent topographic features, habitats, plants, animals, and traditional culture.

The STM site has had a long history as a location with a variety of human uses. In 1903, the Colorado National Guard established the State Rifle Range at a location 3 miles (4.8 km) east of Golden, Colorado. The site, designated as "Camp George West" in 1934 in honor of Civil War veteran and Golden business man, George West, became an integral part of Colorado National Guard activities throughout the first half of the 1900s. By the 1920s, the camp totaled 750 acres (303 hectares) and many buildings were added throughout the 1930s and 1940s.

During World War II, much of Camp George West was leased to the federal government for military training purposes. From the 1930s to the 1970s, several state entities took up residence at Camp George West, including the Colorado State Highway Patrol, the Colorado Law Enforcement Training Academy, and the Colorado Correctional Center. In 1977, the Solar Energy Research Institute (SERI) began operations, and in 1981, more than 300 acres (121 hectares) were transferred to the federal government for solar energy research purposes, which would become SERI's South Table Mountain site. SERI was elevated to national laboratory status in 1991 and became NREL. An additional 25 acres (10.1 hectares) were transferred to DOE in 2003. Today, the STM site totals 327 acres (132 hectares).

SERI began the testing of small wind turbines at a 305-acre site 13 miles north of Golden on a northern portion of the previous Rocky Flats Plant. The testing area became a national center in 1994 and was designated the National Wind Technology Center. Because research activities did not begin until the late 1970s, all current NWTTC structures and buildings have been constructed since then. Consequently, none of the current structures or buildings has reached the 50-year threshold required for

2015 Accomplishments and Highlights

A cultural resource survey was completed for a proposed project that would support research conducted at the NWTTC. Although the survey found two previously documented historic properties nearby, the proposed project would not have an adverse effect on these properties.

listing consideration by the National Register of Historic Places, nor have they been determined to be of exceptional importance for earlier consideration.

Requirements

Cultural resources are protected under the National Historic Preservation Act of 1966 and the Archaeological and Historic Preservation Act of 1974. Federal agencies must establish preservation programs commensurate with their mission and the effects of their activities on historic properties. DOE is charged to uphold these laws by preserving, protecting, and perpetuating cultural resources for future generations in a spirit of stewardship to the extent feasible given the agency's mission and mandates. To do this, DOE implements management accountability for compliance with federal statutes, executive orders, treaties, DOE orders, and implementation guidance. The department also ensures that DOE contractors are obligated to implement DOE programs and projects in a manner that is consistent with these requirements. Significant cultural resources are either eligible for, or listed in, the National Register of Historic Places.

Program Management

Cultural resources are protected at NREL in several ways:

- Integrating cultural resource management into site activities and minimizing and/or mitigating impacts to historic properties and features
- Implementing procedures to manage historic features and to protect undiscovered cultural resources and artifacts
- Periodically conducting surveys to document presence or absence of cultural or historic resources and, when surveys reveal artifacts, working with the Colorado Office of Archaeology and Historic Preservation to determine if the artifacts are eligible for consideration as architectural, historic or cultural resources
- Requiring construction contractors to provide workers with site orientation training that includes guidance

on what to do in the event they discover any evidence of cultural resources during ground-disturbing activities. Workers are to stop all work in the vicinity until a qualified archaeologist evaluates the significance of the find.

Several formal surveys of historic and cultural resources have been performed on the STM site. As a result, three historical sites were recognized as significant cultural resources that should be preserved. These resources include:

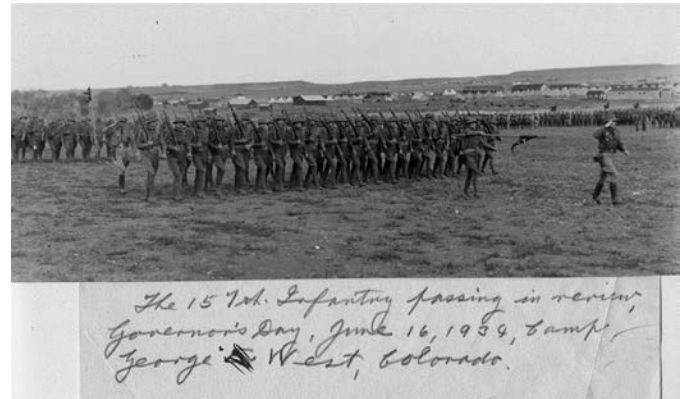
- An open-air amphitheater
- A stone bridge spanning a natural drainage channel adjacent to the amphitheater
- A stone and concrete ammunition bunker below the amphitheater.

The three structures were constructed in the 1930s and early 1940s during the Works Progress Administration era. 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.

An archeological survey of the NWTC was conducted in support of the 1996 environmental assessment to supplement previous surveys so that no gaps in cultural surveys occurred. No significant historical or archeological resources were identified.

2015 Compliance Summary and Activities

- Program activities were in compliance with requirements.
- DOE initiated a consultation with the Colorado State Historic Preservation Office under Section 106 of the National Historic Preservation Act of 1966 for the Central Array Test Site installation and operation at the STM site. As part of the process, DOE provided a letter to the Colorado State Historic Preservation Office indicating that no historic properties would be directly or indirectly affected by the project. The State Historic Preservation Office concurred with DOE's determination.



The 157th Infantry passing in review during Governor's Day at Camp George West, June 16, 1934. The training grounds encompassed all of the South Table Mountain site as well as acreage to the south in the Pleasant View community. Photo from the Denver Public Library



11 CONSERVATION EASEMENT LANDS

Spring flowers in the STM Site Conservation Easement.
Photo by Kurt Schlomberg, NREL 33337

In 1999, DOE granted a conservation easement for 177 acres (72 hectares) of the STM site to Jefferson County. The purpose of the easement is to 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 the natural, scenic, ecological, and historical aspects of the conservation easement property
- Protect the ecosystem and 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 of the conservation easement property
- 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 states that “maintaining landscapes that have a unique visual quality” is key to maintaining the quality of life in Jefferson County.

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 the property.¹³ The baseline inventory includes a description of the geographical setting and adjacent

¹³ U.S. Department of Energy, Golden Field Office (1999). National Renewable Energy Laboratory (NREL) Site Conservation Easement Baseline Inventory. Golden, Colorado.

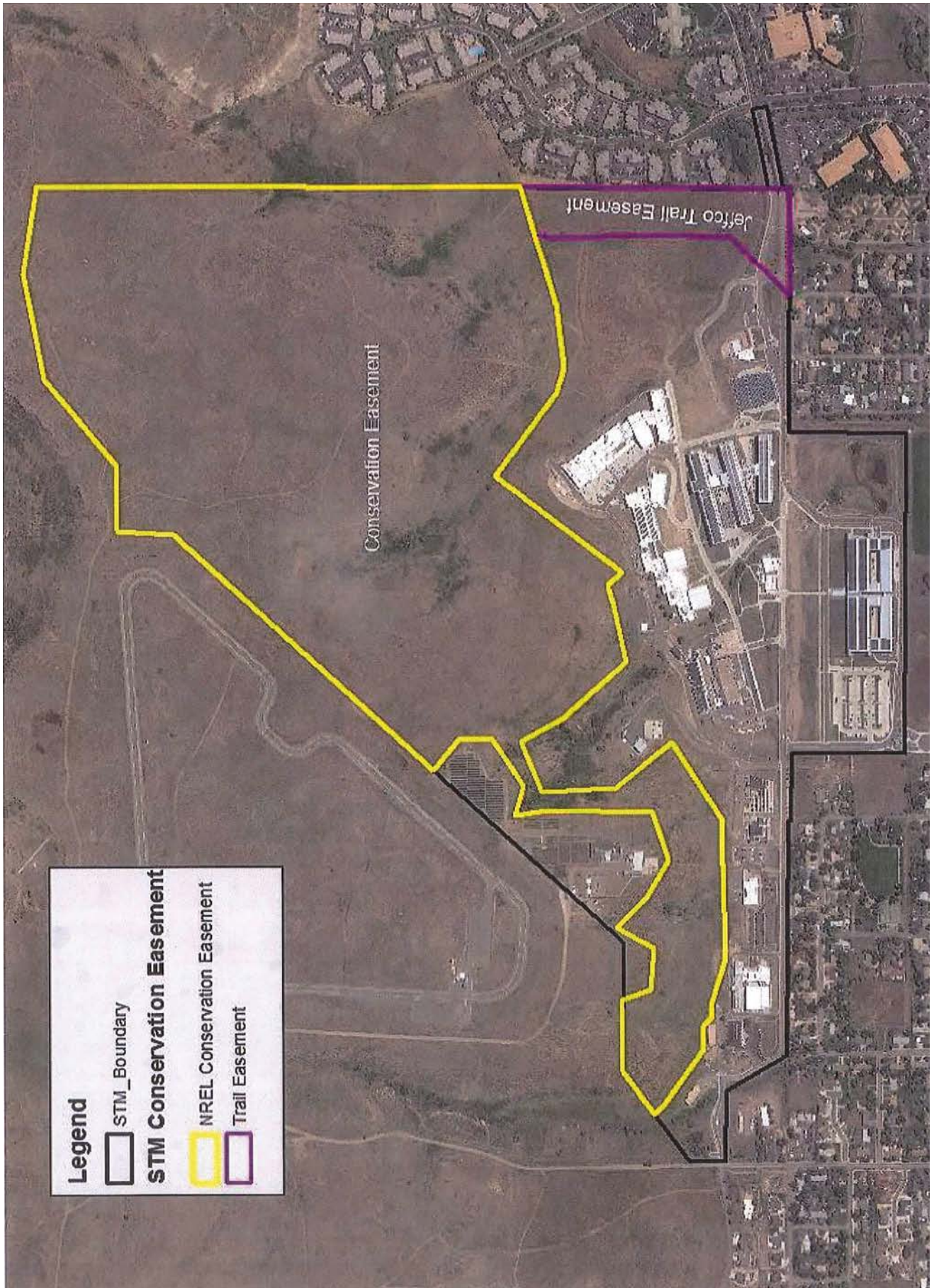


Figure 5. Conservation Easement at the STM Site.

property owners, access and use of the property by the public, and a description of 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, primarily in the drainages. Several seeps also occur throughout the area. 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.

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 and the public use these trails frequently.

2015 Compliance Summary and Activities

- NREL conducted a visual inspection of the conservation easement. Potential improvements to the management

of the easement were noted, including addressing social trails, erosion, and weed control. Following the inspection, 15 Russian olive trees were girdled to kill the trees and prevent the spread of this invasive species. NREL coordinated with Jefferson County citizens and Jefferson County Open Space to address erosion, drainage, and access at the south end of the trail located along the eastern boundary of the STM site.

- Jefferson County Open Space conducted the annual assessment of the conservation easement. The resulting Conservation Easement Monitoring Report¹⁴ highlighted the significant natural features of the 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.

¹⁴ Jefferson County Open Space. Conservation Easement Monitoring Report. August 18, 2015.



12 TRAFFIC MANAGEMENT

The RTD's new West Light Rail line has increased public transportation ridership from NREL staff living in Denver and the western suburbs. *Photo by Dennis Schroeder, NREL 25931*

The STM site is the destination of hundreds of commuter vehicles daily, as well as visitor and delivery traffic entering and leaving the site. Traffic management for the site is important for minimizing negative impacts to traffic flow on Denver West Parkway and in nearby neighborhoods and business areas. Reducing traffic also reduces noise and light pollution, vehicle emissions, fuel use, parking requirements, and road maintenance costs.

Requirements

In 2008, as part of a National Environmental Policy Act assessment for the construction of additional buildings on the STM site and the moving of additional employees to the STM site from off-site leased locations, a traffic Mitigation Action Plan was prepared. This plan established periodic monitoring at nearby intersections affected by NREL traffic, the development of traffic thresholds at those intersections, and actions to be taken to reduce the traffic generated by NREL employees.

In February 2015, with the completion and full occupancy of the Research Support Facility and Energy Systems

2015 Accomplishments and Highlights

- Implementation of the traffic Mitigation Action Plan for the STM site was completed.
- Traffic monitoring in 2015 indicated that NREL-generated traffic volumes at intersections near the STM site remained within acceptable levels.
- NREL implemented a new shuttle route to improve last-mile connections between NREL and a nearby light rail station (Oak Street) in Lakewood, increasing shuttle and transit ridership.



An employee badges in at the STM site east entrance. Hundreds of NREL staff opted out of their cars, cycling to work instead to take part in Bike To Work Day. Photo by Dennis Schroeder, NREL 34020

Integration Facility, and with offsite traffic impacts maintained below threshold levels as identified in the Mitigation Action Plan, DOE issued the *Mitigation Action Plan Completion Report*.¹⁵

The report signifies the completion of the traffic Mitigation Action Plan but notes that DOE and NREL will continue to conduct informal traffic monitoring and continue implementation of traffic control measures (such as the Regional Transportation District's transit passes, shuttle services, and telecommuting) as part of standard operations and sustainability initiatives.

Program Management

NREL has implemented an active transportation demand-management program to reduce traffic impacts on the surrounding community and to reduce petroleum fuel use and greenhouse gas emissions by promoting alternative modes of transportation. Program activities include encouraging and supporting alternative modes of commuting, flexible workplace practices, telecommuting, teleconferencing, and periodic traffic monitoring. These activities are described below.

Alternative Modes of Commuting

- EcoPasses provided to employees encourage use of the Regional Transportation District (RTD) public transportation system. This includes unlimited RTD regional, express, local, light rail, and Call-n-Ride services.
- Shuttle routes provide connections between NREL facilities in Golden and RTD transit stations in Lakewood and Wheat Ridge.
- Incentive parking is provided for vanpools and carpools at the STM site and at the Denver West Office Park.

- Vanpool incentives are available for participants who commute in formal organized vanpools.
- Bike racks, bike lockers, and bicycle maintenance stations are in key locations on the STM site. Bike racks on shuttle vehicles permit staff members to take their bikes with them when they commute or move between buildings.
- RideShare Connections, an intranet site, allows staff to post and search listings for potential carpool and vanpool partners within NREL.
- Literature kiosks in key building locations provide shuttle and RTD schedules, bicycle maps, and telecommuting information.
- Information-sharing events promote safe bicycling, rideshare (e.g., carpool and vanpool), and RTD services.

Flexible Workplace Practices

Conferencing by video, telephone, and the internet as well as alternating work schedules provide flexibility in how people work, saving staff time, energy, and money. An alternating work schedule policy allows employees to work varying schedules, with management approval, and reduces the miles driven by employees to and from the laboratory.

Telecommuting

NREL's telecommuting policy allows employees, with management approval, to work from home at an agreed-upon frequency based on job duties, reducing the days they commute to the laboratory.

Laboratory-wide employee surveys have confirmed that adoption of this program has been very strong.

Teleconferencing

The laboratory promotes and encourages the use of teleconferencing and videoconferencing for meetings to decrease local vehicle trips and air travel.

2015 Compliance Summary and Activities

- Active transportation demand management activities were continued.
- The average afternoon (4:30–5:30 p.m.) peak-hour traffic volume measured at the intersection of Denver West Parkway and Denver West Marriott Boulevard was 277 vehicle trips per hour. This traffic volume remained below the threshold established as part of the traffic Mitigation Action Plan (522 vehicle trips per hour) intended to ensure acceptable traffic volumes at the intersection.

¹⁵Mitigation Action Plan Completion Report: The Supplement to Final Site-Wide Environmental Assessment for the National Renewable Energy Laboratory's South Table Mountain Complex (prepared to accompany the Final Supplement to the Site-Wide Environmental Assessment of the National Renewable Energy Laboratory's South Table Mountain Complex, May 2008 [DOE/EA-1440-S-I]).



A new shuttle route connects the STM site to the Oak Street Station on RTD's West Light Rail Line during morning and evening commuting hours. Photo by Suzanne Belmont, NREL 35142

Detailed Traffic Metrics and Results

Previous traffic studies indicated that the greatest impact to traffic in the local area from the STM site occurs between 4:30 p.m. and 5:30 p.m. This hour has been designated the PM peak hour.

PM peak-hour video traffic counts were conducted in 2015 over three one-week periods during April, August, and December at the STM site east, west, and south entrances, to evaluate the impact of traffic at the intersections of Denver West Parkway and Denver West Marriott Boulevard, Quaker Street and South Golden Road, and South Golden Road and Research Road. Table 9 shows the traffic count results at these three locations.

Traffic counts were evaluated at the east and west entrances. At the east entrance, traffic counts were compared against the threshold, which identifies the acceptable number of vehicle trips NREL can contribute

to the intersection of Denver West Parkway and Denver West Marriott Boulevard without causing significant degradation to flow. The applicable traffic volume threshold identified at this location is 522 vehicle trips in the PM peak hour (from 4:30 to 5:30 p.m.). In 2015, the PM-peak-hour traffic volume averaged 277 vehicle trips, thus remaining below the NREL-established threshold. At the west entrance, NREL has identified a traffic threshold of 36 vehicle trips in the PM peak hour. In 2015, the PM-peak-hour traffic volume average remained below the threshold at 11 vehicle trips.

As the south entrance was not constructed at the time of the original traffic analysis conducted for the traffic Mitigation Action Plan, the 2015 average PM-peak-hour traffic volume of 235 vehicle trips cannot be compared to a vehicle trip threshold number.

TABLE 9. 2015 TRAFFIC COUNTS AND COMPARISON WITH THRESHOLD VALUES

Gate (Affected Intersection)	PM Peak-Hour Vehicles (in- and out-bound)				
	Apr-15	Aug-15	Dec-15	Average	MAP Threshold
East Entrance (Denver West Parkway/Denver West Marriott Blvd.)	292	235	304	277	387
West Entrance (Quaker Street/South Golden Road)	11	10	13	11	36
South Entrance (South Golden Road/Research Road)	273	144	290	235	N/A

APPENDIX A:

PLANT COMMUNITIES AT THE STM SITE AND THE NWTC

Vegetation surveys are periodically completed for the STM site and the NWTC, with the most recent survey occurring in 2011. Plant communities and species were identified for each site at that time, and changes from similar surveys completed in 2000 are noted below.

STM Site 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 slopes and toe area. 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.

Short Grassland

Short grassland is found on the flat top of the mesa. The dominant grass species are blue grama (*Chondrosium 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 well as 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

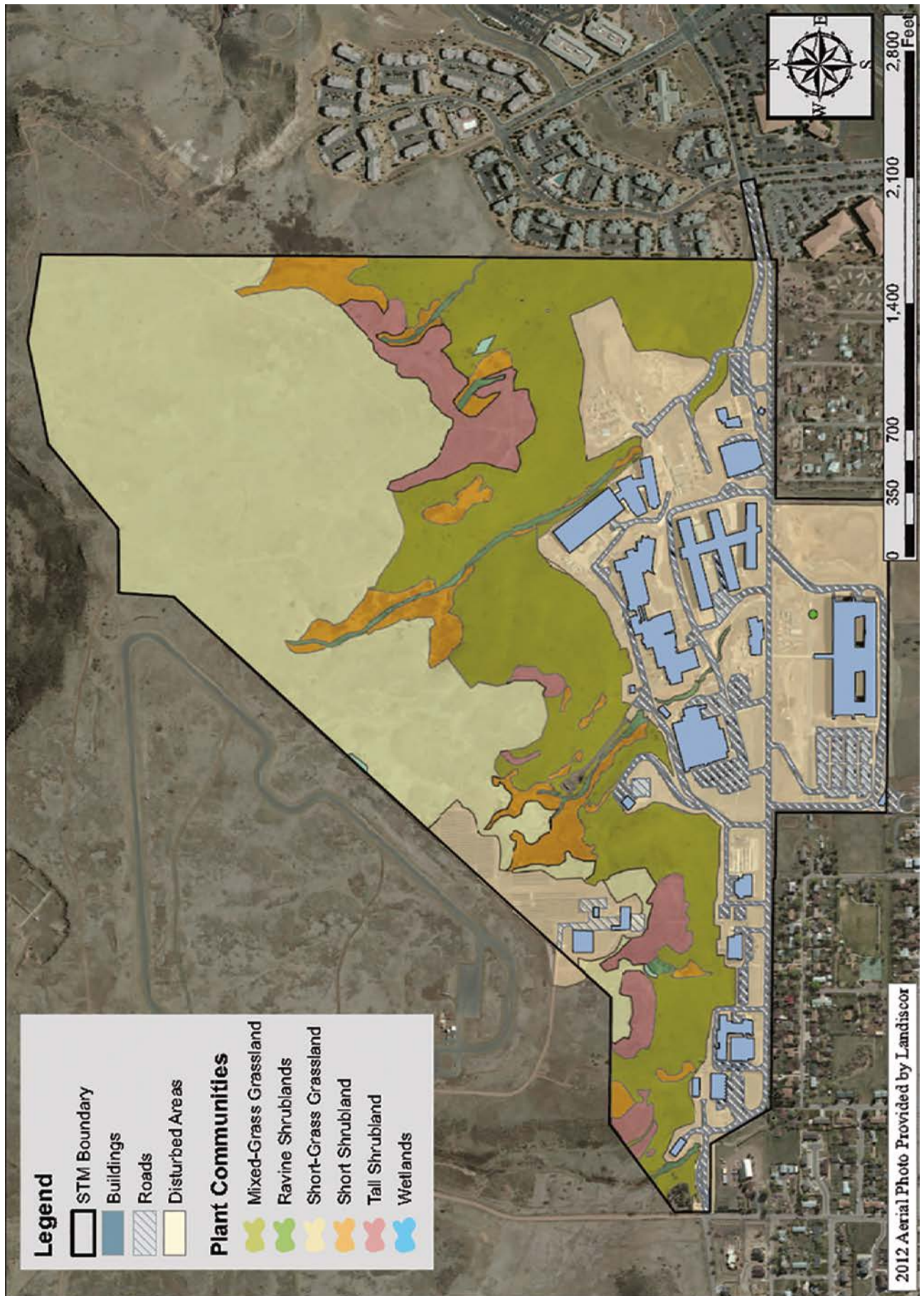


Figure 6. STM Site land cover types surveyed in 2011. Note: map was updated in 2012 to reflect building changes.

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 Education 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 Shrubbylands

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 shrubbyland habitat, which excludes the shrubbylands in the ravine bottoms, comprises tall shrubbyland and short

shrubbyland communities very similar in overall composition but distinguished by the dominant species.

Tall Shrubbyland

The tall shrubbyland 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 is notably sparse throughout this community, with a large amount of bare soil. Cheatgrass is the most common herbaceous species in these areas, intermixed with needle-and-thread grass, yucca, and many cacti.

Short Shrubbyland

The short shrubbylands 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 shrubbylands is on the outer slopes of the ravines. Skunkbrush defines these and other short shrubbylands along the upper portions of the steepest slopes of the mesa. These communities usually grade into the ravine shrubbylands along the drainage bottoms and the tall shrubbylands near the top of the mesa slopes. The short shrubbyland community also has a sparse understory of the same grasses and forbs as the tall-shrub community.

Ravine Shrubbylands

Ravine shrubbylands 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 shrubbyland 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 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 Plantae¹⁶ 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 dumping 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 mapped¹⁷ is discussed below by specific plant community.

The plant communities are described below and mapped as illustrated.

Xeric Mixed Grassland

Xeric mixed grassland is by far the largest and most widespread community type at the NWTC. These areas do not have access to regular soil moisture (xeric conditions) and are dominated by typical short- and mixed-grass prairie species. This plant community includes a large variety of native grass species as well as a diverse forb component, typical of mixed grasslands. Dominant species noted include big bluestem, little bluestem, prairie dropseed, blue grama, and buffalo grass. Intermediate grasses (mid-grasses) such as the needle grasses, wheat grasses, and blue grasses are also important constituents of mixed-grass prairie. Species flowering in late spring include little bluestem, cheatgrass, sand lily (*Leucocrinum montanum*), wild iris (*Iris missouriensis*), Lambert locoweed (*Oxytropis lambertii*), mouse-ear (*Cerastium strictum*), western wallflower (*Erysimum capitatum*), and prairie golden pea (*Thermopsis rhombifolia*).

Wet Meadow

Three locations support wet meadows¹⁸ at the NWTC. One is south of the SunEdison solar array, the second is at the upper end of the Rock Creek tributary along Row 4, and the third is adjacent to the Building 251 east parking lot. A wet meadow is a type of grassland that transitions between mesic and hydric conditions (i.e., a transition area between upland grasslands and wetlands). These areas support Arctic rush, Canada bluegrass (*Poa compressa*), redtop bentgrass (*Agrostis stolonifera*), Canada thistle,

^{16,17} Plantae Consulting Services (2000). Vegetation Survey, NREL National Wind Technology Center. Boulder, Colorado.

¹⁸ In the 2000 and 2011 surveys, wet meadows were identified as mesic mixed grassland. These areas were reclassified in 2012 as wet meadows due to an apparent change in vegetation and hydric conditions.

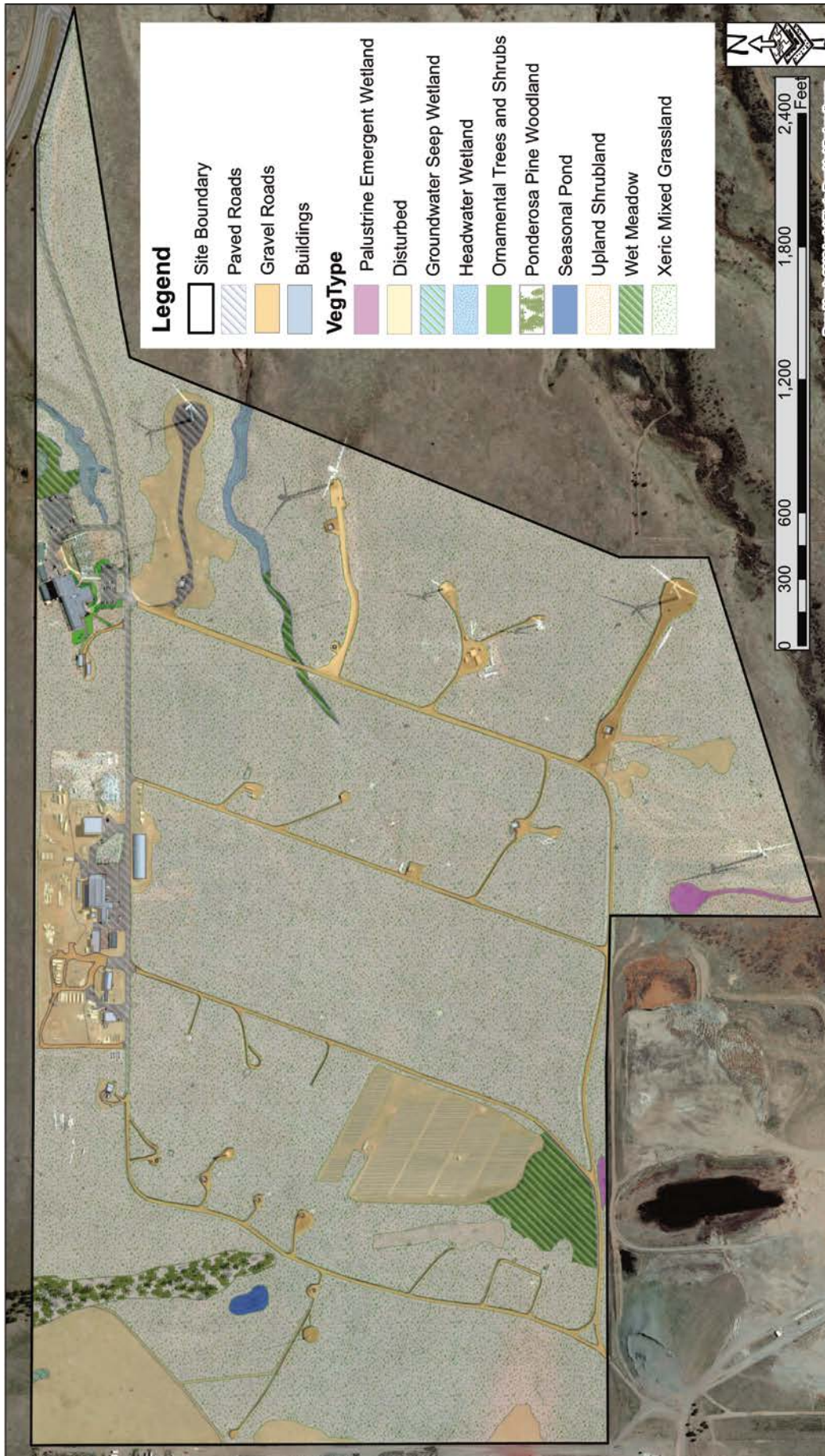


Figure 7. NWTC land cover types surveyed in 2012.

western wheatgrass, common three-square (*Schoenoplectus pungens*), showy milkweed (*Asclepias speciosa*), and wild iris (*Iris missouriensis*).

Ponderosa Pine Woodland

One woodland habitat, defined by a single community of the ponderosa pine (*Pinus ponderosa*) woodland, occurs in the northwestern corner of the site along a granite outcrop. This small area supports a very diverse native plant community including common grassland and foothills species, as well as a number of introduced and noxious weeds. Dominant species include ponderosa pine (*Pinus ponderosa*), smooth brome grass, crested wheatgrass, and green needlegrass (*Nassella viridula*). Species flowering in late spring include sand lily, western snowberry (*Symphoricarpos occidentalis*), groundsel (*Senecio sp.*), and wax current (*Ribes cereum*).

Upland Shrubland

A small upland shrub community is located to the southeast of the ponderosa pine woodland, where the same ridge rises to a lesser degree from the surrounding grassland community. This rocky ridge supports shrub species interspersed with grasses and forbs representative of the surrounding grasslands. Dominant species noted include western snowberry, Canada wild rye (*Elymus canadensis*), Canada bluegrass, Kentucky bluegrass (*Poa pratense*), and little bluestem. Species flowering in late spring include prairie golden pea.

An isolated group of hawthorn (*Crataegus erthyropoda*) shrubs occurs along the western site boundary, within the NWTC 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

Two wetlands at the site fall into the palustrine emergent category. The first is a linear depression on the southern side of the south road. This area appears to have developed as the result of soil excavation intercepting sufficient surface water runoff from the adjacent road to support sedge species (*Carex spp.*). A second wetland is located on the southern boundary in an area previously disturbed from the neighboring industrial activities. This wetland comprises a center of cattails (*Typha angustifolia*) surrounded by a stand of coyote willow (*Salix exigua*).

Two palustrine emergent wetlands were mapped in the mesic mixed grassland in the 2000 growing season. These areas appear to have dried considerably in the

intervening 10 years. The small wetland pockets of cattails (*Typha spp.*) that occurred in the southern portions of this area are no longer present, apparently replaced by large stands of Canada thistle. Dead remnants of Baltic rush (*Juncus balticus*) can be found in the area litter (prior years' herbaceous vegetation). The dominant species noted was smooth brome grass.

Headwater Wetland

Areas of headwater wetland occur along the two ephemeral drainages on the NWTC. Both drainages occur in the northeastern portion of the site, one flowing east and one flowing north. Both show evidence of intermittent surface flow. The northern-most drainage is a tributary of Coal Creek, and the second drainage is a tributary of Rock Creek.

Surface flow in the drainage to the northeast appears to be augmented by outflow from the groundwater seep wetland on the western bank. The second and larger drainage conducts surface flows through the center of the site off to the eastern fence line. The upper reaches of this drainage are a shallow grassland swale. This channel deepens as it flows east across the site. At its eastern reaches, this drainage clearly intercepts subsurface water, although not in sufficient quantities to produce consistent surface flow. At the point where this drainage leaves the NWTC, there is a human-constructed rock wall. Dominant species noted include Canada thistle, Baltic rush, curly dock (*Rumex crispus*), common evening primrose (*Oenothera villosa*), smooth brome grass, and western wheatgrass (*Pascopyrum smithii*).

Groundwater Seep Wetland

Two areas of groundwater seep wetland are located on the NWTC. The first occurs west of the ponderosa pine woodland, in the northwestern portion of the site along the northern fence line. This area now includes more upland species than noted in 2000.

The second occurs over a very small area on the banks of the northern drainage. This community is a clearly demarcated area of primarily wetland plants amidst the surrounding grassland. Fifty plant species were identified in this community in 2000, many of which also occur in the headwater wetland to the south. Dominant species noted include sedges (*Carex sp.*) and rushes (*Juncus sp.*). Common teasel (*Dipsacus fullonum*) has invaded the northern drainage area. Species flowering in late spring include common teasel, showy milkweed (*Asclepias speciosa*), wild iris, field-mint (*Mentha arvensis*), and Canada thistle.

Seasonal Pond

A seasonal pond and pond margin occur at the northwestern corner of the site, west of the southern terminus of the ponderosa pine woodland. This area appears to depend on an elevated spring and early summer water table for the hydric soil moisture conditions that support this community. Observers have noted that the pond depression often contains standing water in the spring and early summer in some years.¹⁹ However, no standing water was observed in this area during the most recent survey. These drier soil conditions are reflected in a shift of dominant plant species in this community between the 2000 and 2011 surveys. Dominant species noted include curly dock, Canada bluegrass, smooth brome grass, and Canada thistle.

Disturbed

These plant associations 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.

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.

¹⁹Plantae Consulting Services (2000). Vegetation Survey, NREL National Wind Technology Center, Boulder, Colorado.

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

The following are lists of common and scientific names of wildlife species observed at the STM site and the NWTC. The species for the NWTC were identified during surveys

completed in 2011. The species listed for STM site were observed by staff and/or observed in surveys completed in 1987, 2005, and 2011.

TABLE 10. WILDLIFE SPECIES AT THE STM SITE*

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

Table 10 continued on page 90

TABLE 10. WILDLIFE SPECIES AT THE STM SITE*

SPECIES COMMON NAME	SCIENTIFIC NAME	1987 Survey	2005 Survey	2011 Survey
BIRDS				
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**	<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**	<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**	<i>Aegolius acadicus</i>			
Orange-crowned warbler**	<i>Oreothlypis celata</i>			
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	

TABLE 10. WILDLIFE SPECIES AT THE STM SITE*

SPECIES COMMON NAME	SCIENTIFIC NAME	1987 Survey	2005 Survey	2011 Survey
BIRDS				
Rock wren	Salpinctes obsoletus		X	
Ruby-crowned kinglet	Regulus calendula			X
Sage thrasher	Oreoscoptes montanus			X
Say's phoebe	Sayornis saya		X	
Sharp-shinned hawk	Accipiter striatus			X
Spotted towhee	Pipilo maculates		X	
Swainson's hawk	Buteo swainsoni		X	
Tree swallow	Tachycineta bicolor		X	X
Turkey vulture	Cathartes aura		X	
Vesper sparrow	Pooecetes gramineus		X	
Virginia's warbler	Oreothlypis virginiae			X
Violet-green swallow	Tachycineta thalassina			X
Western kingbird	Tyrannus verticalis	X	X	
Western meadowlark	Sturnella neglecta	X	X	
Western scrub-jay	Aphelocoma californica		X	
White-crowned sparrow	Zonotrichia leucophrys		X	
White-faced ibis	Plegadis chihi			X
White-throated swift	Aeronautes saxatalis			X
Yellow-breasted chat	Icteria virens			X
Yellow-rumped warbler	Dendroica coronata			X
MAMMALS				
Big brown bat**	Eptesicus fuscus			
Black bear**	Ursus americanus			
Black-tailed jackrabbit	Lepus californicus	X		X
Bushy-tailed woodrat	Neotoma cinerea	X		
Coyote	Canis latrans	X	X	X
Deer mouse	Peromyscus maniculatus	X		X
Elk**	Cervus canadensis			
Fox squirrel	Sciurus niger		X	
Hoary bat**	Lasiurus cinereus			
Long-tailed weasel	Mustela frenata		X	
Mexican woodrat	Neotoma mexicana		X	X
Mountain cottontail	Sylvilagus nuttalli	X	X	X
Mule deer	Odocoileus hemionus	X	X	X
Prairie vole	Microtus ochrogaster	X	X	
Raccoon	Procyon lotor	X	X	X
Red fox	Vulpes vulpes	X		X
Striped skunk	Mephitis			X
Western harvest mouse	Reithrodontomys megalotis	X	X	X
Western spotted skunk	Spilogale gracilis			X
White-tailed jackrabbit	Lepus townsendii		X	
Yellow-bellied marmot	Marmota flaviventris	X		

Table 10 continued on page 92

TABLE 10. WILDLIFE SPECIES AT THE STM SITE*

SPECIES COMMON NAME	SCIENTIFIC NAME	1987 Survey	2005 Survey	2011 Survey
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**	<i>Pseudacris triseriata</i>			
Western (Prairie) rattlesnake	<i>Crotalus viridus</i>	X	X	X
Woodhouse's toad	<i>Bufo woodhousii</i>			X

*No terrestrial arthropod genera of specific concern were detected during surveys in 2010.

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

TABLE 11. WILDLIFE SPECIES AT THE NWTTC*

SPECIES COMMON NAME	SCIENTIFIC NAME	1996 Survey	2003 Survey	2011 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
American tree sparrow	<i>Spizella arborea</i>			X
Bald eagle	<i>Haliaeetus leucocephalus</i>			X
Barn swallow	<i>Hirundo rustica</i>		X	X
Black-billed magpie	<i>Pica hudsonia</i>		X	X
Black-capped chickadee	<i>Poecile atricapillus</i>		X	X
Blue-gray gnatcatcher	<i>Polioptila caerulea</i>		X	
Blue jay	<i>Cyanocitta cristata</i>			X
Brewer's blackbird	<i>Euphagus cyanocephalus</i>		X	X
Brewer's sparrow	<i>Spizella breweri</i>			X
Broad-tailed hummingbird	<i>Selasphorus platycercus</i>		X	X
Broad-winged hawk	<i>Buteo platypterus</i>	X		
Brown-headed cowbird	<i>Molothrus ater</i>		X	X
Bullock's oriole	<i>Icterus bullockii</i>			X
Canada goose	<i>Branta canadensis</i>			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	
Common raven	<i>Corvus corax</i>		X	X
Common snipe	<i>Gallinago delicata</i>			X
Cooper's hawk	<i>Accipiter cooperii</i>	X		
Dark-eyed junco	<i>Junco hyemalis</i>			X
Double-crested cormorant	<i>Phalacrocorax auritus</i>		X	
Downy woodpecker	<i>Picoides pubescens</i>			X
Eurasian collared-dove	<i>Streptopelia decaocto</i>			X
European starling	<i>Sturnus vulgaris</i>		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	X
Grasshopper sparrow	<i>Ammodramus savannarum</i>		X	X
Gray catbird	<i>Dumetella carolinensis</i>			X
Great blue heron	<i>Ardea herodias</i>		X	X
Great horned owl	<i>Bubo virginianus</i>			X
Green-tailed towhee	<i>Pipilo chlorurus</i>		X	
Hairy woodpecker	<i>Picoides villosus</i>			X
Horned lark	<i>Eremophila alpestris</i>		X	X
House finch	<i>Carpodacus mexicanus</i>		X	X
Killdeer	<i>Charadrius vociferus</i>			X

Table 11 continued on page 94

TABLE 11. WILDLIFE SPECIES AT THE NWTC*

SPECIES COMMON NAME	SCIENTIFIC NAME	1996 Survey	2003 Survey	2011 Survey
BIRDS				
Lark bunting	<i>Calamospiza melanocorys</i>			X
Lark sparrow	<i>Chondestes grammacus</i>		X	
Loggerhead shrike	<i>Lanius ludovicianus</i>			X
Long-billed curlew	<i>Numenius americanus</i>			X
Mallard	<i>Anas platyrhynchos</i>		X	X
Merlin	<i>Falco columbarius</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	X	X
Osprey	<i>Pandion haliaetus</i>	X		
Peregrine falcon	<i>Falco peregrinus</i>		X	X
Prairie falcon	<i>Falco mexicanus</i>	X	X	
Red-headed woodpecker	<i>Melanerpes erythrocephalus</i>			X
Red-tailed hawk	<i>Buteo jamaicensis</i>	X	X	X
Red-winged blackbird	<i>Agelaius phoeniceus</i>		X	X
Rough-legged hawk	<i>Buteo lagopus</i>	X	X	X
Ruby-crowned kinglet	<i>Regulus calendula</i>			X
Sandhill crane	<i>Grus canadensis</i>			X
Savannah sparrow	<i>Passerculus sandwichensis</i>			X
Say's phoebe	<i>Sayornis saya</i>		X	X
Sharp-shinned hawk	<i>Accipiter striatus</i>	X		
Song sparrow	<i>Melospiza melodia</i>			X
Spotted towhee	<i>Pipilo maculatus</i>			X
Swainson's hawk	<i>Buteo swainsoni</i>	X		X
Tree swallow	<i>Tachycineta bicolor</i>			X
Turkey vulture	<i>Cathartes aura</i>	X	X	X
Vesper sparrow	<i>Pooecetes gramineus</i>		X	X
Western kingbird	<i>Tyrannus verticalis</i>		X	X
Western meadowlark	<i>Sturnella neglecta</i>		X	X
Wilson's warbler	<i>Wilsonia pusilla</i>		X	
Yellow-rumped warbler	<i>Dendroica coronata</i>		X	

TABLE 11. WILDLIFE SPECIES AT THE NWTC*

SPECIES COMMON NAME	SCIENTIFIC NAME	1996 Survey	2003 Survey	2011 Survey
MAMMALS				
Big brown bat	<i>Eptesicus fuscus</i>			X
Black-tailed prairie dog**	<i>Cynomys ludovicianus</i>			
Bobcat**	<i>Felis rufus</i>			
Coyote	<i>Canis latrans</i>			X
Deer mouse	<i>Peromyscus maniculatus</i>			X
Desert cottontail	<i>Sylvilagus audubonii</i>			X
Eastern red bat	<i>Lasiurus borealis</i>			X
Elk	<i>Cervus canadensis</i>			X
Fringed myotis	<i>Myotis thysanodes</i>			X
Hoary bat	<i>Lasiurus cinereus</i>			X
Masked shrew	<i>Sorex cinereus</i>			X
Meadow vole	<i>Microtus pennsylvanicus</i>			X
Mexican woodrat	<i>Neotoma mexicana</i>			X
Mule deer	<i>Odocoileus hemionus</i>			X
Myotis bats	<i>Myotis sp.</i>			X
Prairie vole	<i>Microtus ochrogaster</i>			X
Silver-haired bat	<i>Lasionycteris noctivagans</i>			X
Thirteen-lined ground squirrel	<i>Spermophilus tridecemlineatus</i>			X
Western harvest mouse	<i>Reithrodontomys megalotis</i>			X
REPTILES AND AMPHIBIANS				
Boreal chorus frog	<i>Pseudacris maculata</i>			X
Bull snake	<i>Pituophis catenifer</i>			X
Western (Prairie) rattlesnake	<i>Crotalus viridis</i>	X	X	X
Woodhouse's toad	<i>Bufo woodhousii</i>			X
TERRESTRIAL ARTHROPODS				
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

*The 1996 study addressed only raptors. Mammals, reptiles, amphibians, or terrestrial arthropods were not the subject of a survey at the NWTC until the 2011 baseline survey.

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

APPENDIX C: ENVIRONMENTAL PERMITS, REGISTRATIONS, AND NOTIFICATIONS APPLICABLE TO NREL DURING 2015

TABLE 12. NREL'S ENVIRONMENTAL PERMITS, REGISTRATIONS, AND NOTIFICATIONS IN 2015

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

TABLE 12. NREL'S ENVIRONMENTAL PERMITS, REGISTRATIONS, AND NOTIFICATIONS IN 2015

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
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 groundwater monitoring well MW-1	Permit	DWR	37229	Abandoned per regulations
Groundwater well	STM groundwater monitoring well MW-2	Permit	DWR	37228	Abandoned per regulations
Groundwater well	STM groundwater monitoring well MW-3	Permit	DWR	37231	Abandoned per regulations
Groundwater well	STM groundwater monitoring well MW-4	Permit	DWR	37230	Abandoned per regulations
Groundwater well	STM groundwater monitoring well MW-5	Permit	DWR	37233	Abandoned per regulations
Groundwater well	STM FTLB groundwater monitoring well MW-FTLB-1	Permit	DWR	53674-MH	Active
Groundwater well	STM FTLB groundwater monitoring well MW-FTLB-2	Permit	DWR	53674-MH	Active
Groundwater well	STM FTLB groundwater monitoring well MW-FTLB-3	Permit	DWR	53675-MH	Active
Hazardous materials	STM WHF hazardous material storage and use permit	Permit	WMFR	9243	Active
Hazardous materials	STM SERF hazardous material storage and use permit	Permit	WMFR	9248	Active
Hazardous materials	STM S&TF hazardous material storage and use permit	Permit	WMFR	9249	Active
Hazardous materials	STM FTLB hazardous material storage and use permit	Permit	WMFR	9244	Active
Hazardous materials	STM IBRF hazardous material storage and use permit	Permit	WMFR	9245	Active
Hazardous materials	STM Shipping and Receiving hazardous material storage and use permit	Permit	WMFR	9246	Active
Hazardous materials	DWOP building 16 hazardous material storage and use permit	Permit	WMFR	9242	Active
Hazardous materials	ReFUEL hazardous material storage and use permit	Permit	Denver Fire Department	154229	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

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TABLE 12. NREL'S ENVIRONMENTAL PERMITS, REGISTRATIONS, AND NOTIFICATIONS IN 2015

Type	Location/ Description	Category	Issuing Agency	ID #	Permit or Registration Status
Stormwater	STM ESIF construction project	Permit	EPA	COR12A60F	Terminated
Stormwater	STM electrical upgrade project	Permit	EPA	COR12B06F	Active
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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