NREL
NATIONAL RENEWABLE ENERGY LABORATORY

# National Renewable Energy Laboratory Environmental Performance Report for 2010

# (Annual Site Environmental Report per the U.S. Department of Energy Order 231.1-1A Chg 2)

Prepared by Environment, Health, and Safety Office

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

**Management Report**
NREL/MP-1900-52498
September, 2011

Contract No. DE-AC36-08GO28308

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Prepared under Task No. 1960.1000.



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## List of Acronyms

| | |
|---|---|
| AEO | Annual Energy Outlook |
| AFUF | Alternative Fuels User Facility |
| APCD | Air Pollution Control Division |
| APEN | Air Pollution Emission Notice |
| APHIS | United States Department of Agriculture Animal and Plant Health Inspection Service |
| AST | above-ground storage tank |
| bgs | below ground surface |
| BMP | best management practice |
| BTU | British thermal unit |
| CDPHE | Colorado Department of Public Health and Environment |
| CEQ | Council of Environmental Quality |
| CFR | code of federal regulations |
| CGP | Construction General Permit |
| CMS | chemical management system |
| $CO_2$ | carbon dioxide |
| $CO_2e$ | carbon dioxide equivalent |
| CSP | concentrating solar power |
| CY | calendar year |
| DFD | Denver Fire Department |
| DNR | Department of Natural Resources |
| DOE | U.S. Department of Energy |
| DOE-GO | DOE Golden Field Office |
| DSOC | District Shops and Operations Center |
| DWOP | Denver West Office Park |
| EA | environmental assessment |
| EHS | Environment, Health, and Safety Office |
| EIA | Energy Information Administration |
| EISA | Energy Independence and Security Act |
| ELP | Environmental Leadership Program |
| ELT | Executive Leadership Team |
| EMS | Environmental Management System |
| EO | Executive Order |
| EPA | U.S. Environmental Protection Agency |
| EPCRA | Emergency Planning and Community Right-to-Know Act |
| ES&H | Environment, Safety, and Health |
| ESH&Q | Environmental Safety, Health, and Quality |
| FEC | Federal Electronics Challenge |
| FONSI | Finding of No Significant Impact |
| FTLB | Field Test Laboratory Building |
| FY | fiscal year |
| GHG | greenhouse gas |
| GHP | geothermal heat pump |
| gsf | gross square foot |

| | |
|---|---|
| GW | ground water |
| HABS | Historic American Buildings Survey |
| HAER | Historic American Engineering Record |
| HazMat | hazardous materials |
| HMIS | Hazardous Materials Information System |
| HMWMD | Hazardous Materials and Waste Management Division |
| HSS | U.S. Department of Energy Office of Health, Safety, and Security |
| IBRF | Integrated Biorefinery Research Facility |
| IPM | integrated pest management |
| IRCA | International Register of Certificated Auditors |
| ISM | integrated safety management |
| ISMS | Integrated Safety Management System |
| ISO | International Standards Organization |
| IUF | Industrial User Facility |
| JSF | Joyce Street Facility |
| LDRD | Laboratory Directed Research and Development Program |
| LEED | Leadership in Energy and Environmental Design |
| LEPC | Local Emergency Planning Committee |
| MAP | Mitigation Action Plan |
| MCL | maximum contaminant levels |
| MRI | Midwest Research Institute |
| MT | metric ton |
| MtC/yr | Million metrics tons of carbon per year |
| NEPA | National Environmental Policy Act |
| NESHAPs | National Emissions Standards for Hazardous Air Pollutants |
| NOI | Notice of Intent |
| NREL | National Renewable Energy Laboratory |
| NWTC | National Wind Technology Center |
| ODS | Ozone-depleting substance |
| OSHA | Occupational Safety and Health Administration |
| P2 | pollution prevention |
| PDU | Process Development Unit |
| ppm | parts per million |
| PV | photovoltaic(s) |
| PWSID | Public Water Supply Identification Number |
| RAA | Running annual average |
| RCRA | Resource Conservation and Recovery Act |
| R&D | research and development |
| RFHP | Renewable Fuels Heat Plant |
| ReFUEL | Renewable Fuels and Lubricants Research Laboratory |
| RFA | Rocky Flats Alluvium |
| RFS | renewable fuel standard |
| RQ | reportable quantity |
| RSF | Research Support Facility |
| RTD | Regional Transportation District |
| S&TF | Science and Technology Facility |

| | |
|---|---|
| SARA | Superfund Amendments and Reauthorization Act |
| SERC | State Emergency Response Commission |
| SERF | Solar Energy Research Facility |
| SERI | Solar Energy Research Institute |
| SHPO | State Historic Preservation Office |
| SIC | Standard Industrial Classification |
| SITES | Sustainable Sites Initiative |
| SOP | Safe operating procedure |
| SPCC | Spill Prevention, Control, and Countermeasures |
| SRRL | Solar Radiation Research Laboratory |
| STM | South Table Mountain |
| TCPDU | Thermochemical Process Development Unit |
| TPQ | threshold planning quantity |
| TTB | U.S. Department of the Treasury Alcohol and Tobacco Tax and Trade Bureau |
| USACE | U.S. Army Corps of Engineers |
| USDA | United States Department of Agriculture |
| USFWS | U.S. Fish and Wildlife Service |
| WCD | CDPHE Water Control Division |
| WHF | Waste Handling Facility |

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# 1 Introduction

The National Renewable Energy Laboratory (NREL) is the nation's premier laboratory for renewable energy research and development and a leading laboratory for energy efficiency research, with programs in wind energy, solar energy, plant and waste-derived fuels and chemicals, energy efficiency in buildings, geothermal energy, advanced vehicle design, hydrogen infrastructure, and fuel cells. Established in 1974, NREL began operating in 1977 as the Solar Energy Research Institute (SERI). It was designated a U.S. Department of Energy (DOE) national laboratory in September 1991 as the National Renewable Energy Laboratory. NREL conducts research primarily for DOE's Office of Energy Efficiency and Renewable Energy. In October 2008, operations at NREL were transferred to the Alliance for Sustainable Energy, LLC, a partnership between the Midwest Research Institute (MRI) and the Battelle Memorial Institute. The new operating contract has a 5-year duration and is overseen by DOE's Golden Field Office (DOE-GO).

## 1.1 Purpose

This report presents a summary of NREL's environmental protection programs and activities for 2010. It is organized according to the different environmental media (e.g., air, waste, and ground water), and includes a brief summary of how the program is managed in that area, any permitting or notification efforts that have been completed during the reporting period or are ongoing, and activities that have occurred during the reporting period in that environmental area. A description of the environmental condition and features of NREL's sites is also included to provide a basis for the program overview.

This report is organized to present many of the elements of the Global Reporting Initiative Sustainability Reporting Guidelines. It also incorporates DOE's most recent guidelines for the Annual Site Environmental Report, as required by DOE Order 231.1-1A Chg 2*, Environment, Health, and Safety Reporting*.

## 1.2 Background

NREL's mission and strategy are focused on advancing the U.S. Department of Energy's and our nation's energy goals. 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 NREL's renewable energy and energy efficient technologies.

- **Bioenergy**. NREL currently has major programs in biomass-derived fuels (biofuels) and biomass-derived electricity (biopower), and projects in biomass-derived chemicals and materials.

- **Building energy**. NREL increases the use of energy efficient technologies and expands the use of renewable energy technologies in the building sector by working to develop new, cost-effective, environmentally acceptable building equipment and envelope systems.

- **Computational sciences**. This area includes basic and applied research using high-performance computing and applied mathematics.

- **Distributed power**. Distributed power is modular electric generation or storage located near the point of use. NREL participates in the development of technologies, market structures, and policies that affect the incorporation of renewable and energy efficient technologies in distributed power systems, thus maximizing the utilization of renewable energy and energy efficient products. As a part of this initiative, NREL is involved in the development, design, and facilitation of the application of renewable and renewable/fossil hybrid distributed power systems in grid-connected applications.

- **Electricity technologies**. These technologies include renewable energy, hydrogen, and superconductivity technologies, as well as utility resources.

- **Energy analysis**. Research at NREL includes energy analysis for various programs and initiatives.

- **Hydrogen**. NREL serves as a leader in renewable hydrogen production technologies. NREL also leads in 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 labs and facilities allow state-of-the-art testing on photovoltaic (PV) cells, building technologies, and wind turbines.

- **Photovoltaics**. Photovoltaics enable the direct conversion of sunlight to electricity using solid-state materials. The National Center for Photovoltaics develops and deploys PV 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**. These technologies—including concentrating solar power (CSP), solar water heating, and geothermal heat and power—generate power from heat or utilize heat from renewable resources.

- **Transportation**. NREL works with industry experts to develop advanced vehicles and systems for transportation, and to develop viable vehicle systems that are integral to DOE transportation initiatives. NREL also works with energy companies and manufacturers of vehicles and engines to develop advanced motor vehicle fuels for improved energy and environmental performance. A systems approach is used to develop optimized engine management, fuel, and emission control technologies.

- **Wind energy**. Through the National Wind Technology Center (NWTC), NREL develops, improves, and demonstrates the viability of wind technology for electricity generation and facilitates its utilization throughout the world.

## 1.3 Site and Facility Description

NREL facilities occupy five separate locations in Jefferson County, Colorado, near the city of Denver, and one within the boundaries of the City and County of Denver. The five facilities in Jefferson County include the Denver West Office Park (DWOP), Golden Hill, the South Table Mountain site (STM), the Joyce Street Facility (JSF), and the NWTC. The Renewable Fuels and Lubricants Research Laboratory (ReFUEL) is located within the city limits of Denver. The DWOP and STM sites are approximately 2 miles (3.2 km) east of Golden and 12 miles (19.3 km) west of central Denver. 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. The JSF is located at 6800 Joyce Street, about 5.5 miles (8.9 km) north of the DWOP and STM sites. The ReFUEL facility is located with the Regional Transportation District (RTD) District Shops and Operations Center (DSOC) at 1900 31st Street, Denver, about 12 miles east of the STM and DWOP sites.

The STM and NWTC sites are the two main sites where research operations are conducted and will be addressed separately in the discussion of environmental features. The DWOP is leased space used primarily for administrative functions and limited research activities. Similarly, Golden Hill is leased office space for administrative functions. The JSF is leased space currently used for storage. The ReFUEL facility is a leased facility that consists of a small shop complex housed within the RTD/DSOC facility. NREL performs engine-testing activities pertaining to fuels and lubricants at the site.

**Figure 1. NREL's Research Support Facility**
Source: Dennis Schroeder (PIX17820)

Recent changes to the NREL South Table Mountain campus include the completion of the new Research Support Facility (RSF) in June 2010 (see Figure 1) and the initiation of a number of other construction projects. The RSF represents a major step forward in the development of the STM campus. Upon accepting the building, the Alliance for Sustainable Energy began moving staff into the new facility. By the end of 2010, the building was about 70% occupied. As a result, NREL has vacated some of the leased space in DWOP. The RSF is a 222,000 square foot building, ultimately housing 800 employees and designed to be highly energy efficient. For much of the year it will only consume as much energy as can be generated by renewable power on or near the building. It was designed to meet the stringent standards of the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program to achieve a platinum rating. The RSF showcases numerous high-performance design features, many of which are a direct result of NREL's research efforts including passive energy strategies and renewable energy technology. For example, 42 miles of piping courses through the RSF carrying water for radiant heating and cooling instead of forced air. Supplementing the completion of the RSF in 2010 is the STM infrastructure project, which extends the current utility infrastructure to support new facilities and the build-out of the STM site.

Because of the growth in NREL staff, construction began in 2010 on a third wing of the RSF, the A wing, which will be complete in 2011. Planning for a new parking structure located near the southern border of the campus near the site of the proposed new south entrance was completed in 2010 and construction will commence in 2011.

Other projects include a major expansion of the Alternative Fuels User Facility (AFUF) that improves the capabilities of the pilot plant in the Integrated Biorefinery Research Facility (IBRF) and adds more office space. Once improvements are complete, the entire expanded facility will be known as the IBRF.

In 2010, NREL completed the installation of a showcase geothermal heat pump (GHP) system at the Solar Radiation Research Laboratory (SRRL) at the top of STM. The purpose of the system is to demonstrate a state-of-the-art GHP system, provide a research and development (R&D) platform to collect and evaluate data to improve system design, and to provide renewable energy to the STM campus. A 300-foot deep, 5-inch diameter borehole is the geothermal earth connection subsystem which connects to the heat pump and heat distribution systems which provide both heating and cooling to the SRRL.

### *1.3.1 South Table Mountain Site*

The STM site is the main research center for NREL. When new office facilities are occupied in 2011, 78% of the laboratory's staff will have their offices and laboratories at the STM site.

#### *1.3.1.1 Geology, Soils, and Hydrogeology*

The STM site is a roughly triangular parcel of land occupying portions of the top, sides, and lower south-facing slopes of STM. STM is composed of sedimentary rocks below a basalt lava cap, which is quite resistant to erosion. The STM feature is a mesa that stands about 150 meters above the adjacent lowlands. The mesa was formed as weak sedimentary rocks surrounding the 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.

**Figure 2. NREL's STM campus**

Source: NREL (PIX 19049)

Both the Arapahoe and Denver Formations are considered to be aquifers in portions of the Denver Basin. The Denver Formation underlies the areas on which most NREL construction has taken place. Groundwater on the STM site occurs primarily in the weathered and fractured silts and sands of the Denver Formation. There may also be some groundwater in the form of perched aquifers below the basaltic lava cap on the STM, 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 the STM is lavina 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 the STM 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—cobbly clay loam and very stony clay loam.

#### *1.3.1.1 Surface Water*

About 90% of the surface drainage off the site, both from the mesa top and across the lower portions of the site, is in the southerly direction toward Lena Gulch (a tributary of Clear Creek). Surface water from two drainage ways on the easternmost portion of the site ultimately flows into Lena Gulch.

There is no permanent stream flow on the STM site. Only occasional flow derived 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. There is one seep on the mesa top that is often active throughout much of the year, but the water infiltrates and evaporates quickly during the dry season.

#### *1.3.1.2 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, composing 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 0.3 hectares (0.75 acres). Riparian shrub communities also occur adjacent to the emergent wetlands.

#### *1.3.1.3 Wildlife*

Several comprehensive wildlife surveys have been conducted on the site, starting with the original study in 1986 and 1987. Additional surveys were done in 1999 over the conservation easement property. A survey to update existing data began in 2004 and was completed in 2005 (Science Applications International Corporation 2005), and planning for another update began in 2010 for completion in 2011(see Section 5.11 for more detail). Mammals seen using the site 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 hawks.

Reptiles and amphibians are known to inhabit the area as well. Most notably, the western diamond-backed rattlesnake is occasionally encountered around the campus area.

#### *1.3.1.4 Land Use*

The STM site is a 327-acre 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 of the STM site. 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 the eastern edge of the site. Portions of the DWOP and apartment homes lie to the east.

More than half of the STM site (177 acres) 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. Trail development planned for implementation in phases by the county began in 2004 (see Section 6 for more detail).

### *1.3.2 National Wind Technology Center*

The National Wind Technology Center (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.

#### *1.3.2.1 Geology, Soils, and Hydrogeology*

The NWTC site is located on a plain formed by stream deposits. The uppermost geological layer beneath the site is known as the Rocky Flats Alluvium (RFA). It is composed of cobbles, coarse gravel, sand, and gravelly clay. Below the RFA 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 RFA toward the East/Southeast, and small perched zones are common. Groundwater occurs as confined aquifers in the deeper bedrock formations (EG&G Rocky Flats, Inc. 1992).

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.

#### *1.3.2.2 Surface Water*

The area surrounding the NWTC site 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.

**Figure 3. NWTC aerial view**

Source: NREL (PIX 17708)

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.

#### *1.3.2.3 Vegetation*

The NWTC is located in the transition area between the Great Plains and the Rocky Mountains (Plantae Consulting Services 2000). This location results in a flora that contains elements from both mountain and prairie ecosystems, and associations that represent residual tall grass prairie, short-grass plains, ponderosa pine woodland, and foothill ravine flora (Plantae Consulting Services 2000).

A vegetation study conducted between August 1999 and August 2000 identified 271 vascular plant species and defined five major habitat types on the NWTC site, including: seasonal wetlands/or ephemeral hydric soils, woodlands, shrublands, mixed grasslands, 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. A new vegetation survey was conducted in 2010 resulting in a new vegetation map in 2010; the final report of the study is due in 2011.

#### *1.3.2.4 Wildlife*

Prior to 1975, livestock heavily grazed the NWTC site, damaging a majority of the native vegetation. A wildlife survey was conducted in 1992 for the entire Rocky Flats Plant and buffer

zone area, including the NWTC site, which was part 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 different 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 conducted in 2001 to 2002 and an extensive avian monitoring program began in 2010 (see Section 5.11). Although seldom seen, rattlesnakes, bull snakes, racers, and several other reptilian and amphibian species are known to occupy the area.

#### *1.3.2.5 Land Use*

The NWTC facility occupies a 305-acre area surrounded largely by open space and grazing land. The former Rocky Flats Environmental Technology Site land borders the NWTC to the southeast, and a sand and gravel mining and processing operation is located along the southern and western boundaries of the site. A blasting company also has a small installation along the western site boundary.

### *1.3.3 Denver West Office Park and Golden Hill*

The Denver West Office Park (DWOP) is a relatively flat, landscaped office complex occupied by a number of four-story buildings, parking lots, and common areas. NREL-leased facilities at the DWOP are located approximately in the geographic center of the development, with the exception of one NREL-leased facility just north of I-70. The DWOP 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. The DWOP is within the City of Lakewood. Golden Hill is an office building on the south side of West Colfax about one half mile east of the DWOP area. NREL leases a small portion of the building for office space.

### *1.3.4 Joyce Street Facility*

The Joyce Street Facility (JSF) 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 only. Support activities and limited dry lab research activities are currently conducted at the facility, and there are no staff offices at JSF.

### *1.3.5 Renewable Fuels and Lubricants Research Laboratory*

The Renewable Fuels and Lubricants Research Laboratory (ReFUEL) is used for research, testing, and support activities related to advanced fuels, engines, and vehicles to objectively evaluate performance, emissions, and energy efficiency impacts. The laboratory is also used to evaluate and develop heavy hybrid electric vehicles.

ReFUEL is a small shop complex housed within the RTD/DSOC facility. The RTD/DSOC facility occupies approximately 22 acres of land and serves as the primary maintenance facility for RTD's bus and light rail train systems. The area around the RTD/DSOC 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.

## 1.4 Site Environmental Conditions/Features

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 50 cm (20 inches). 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, and reaches 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 occurs in March, and the STM site can generally expect to experience at least one heavy snowstorm with totals exceeding 15–25 cm (6–10 inches).

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.

# 2 Compliance Summary

## 2.1 Laws and Regulations

### *2.1.1 Air Quality Protection*

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). NREL is not a major source for air pollutants, but does hold one site-wide permit for particulate air emissions from construction, and five air emissions permits for three emergency generators, a pilot-scale research project, and the operation of the Renewable Fuels Heat Plant (RFHP)—a wood-waste fired heating plant. Detailed information about NREL's air quality protection program is provided in Section 5.1.

National Emissions Standards for Hazardous Air Pollutants (NESHAPs) requirements specific to radiological emissions from DOE facilities are regulated by the EPA. Details are provided in Section 5.16.

The CDPHE regulates the emission of hazardous air pollutants through a permit system that requires the reporting of any emissions in excess of allowable quantities. In 2010, NREL emissions were in compliance with all applicable requirements.

### *2.1.2 Drinking Water Quality Protection*

Drinking water quality is regulated for all public water suppliers in Colorado by the CDPHE, under authority delegated by the EPA. NREL purchases water that is delivered by truck to the NWTC, and holds a public water supply identification number to operate the NWTC distribution system. NREL conducts monitoring activities as directed by the CDPHE. Detailed information about system performance is provided in Section 5.2.

In 2010, NREL was in compliance with all applicable drinking water regulations.

### *2.1.3 Groundwater Quality Protection*

Colorado groundwater quality standards are established by the CDPHE. Permits for groundwater wells are issued by the state engineer's office. NREL has no known groundwater contamination and has obtained drilling permits for all of its monitoring wells. Detailed information about NREL's groundwater program is provided in Section 5.3.

In 2010, NREL was in compliance with all applicable groundwater regulations.

### *2.1.4 Wastewater*

Wastewater from the majority of the STM site and the Denver West Office Park is discharged into the Pleasant View Water and Sanitation District's (Pleasant View) collection system, and flows to the Metropolitan Wastewater Reclamation District (Metro) treatment plant. The federal Clean Water Act and Colorado Water Quality Control Act regulations are administered at NREL's STM and DWOP via Pleasant View and Metro pretreatment program requirements. NREL's wastewater discharge policy is in conformance with Metro's discharge requirements.

Wastewater at the NWTC site flows into two individual sewage disposal systems (septic and leach fields). These are regulated by CDPHE; inspection and permit issuance have been delegated by the CDPHE to the Jefferson County Department of Health and Environment. There is also one individual sewage disposal system at the SRRL on the mesa top at the STM site. As is the case with NWTC septic systems, the mesa top system regulations are administered by Jefferson County. Additional detail about NREL's wastewater discharge program can be found in Section 5.4.

In 2010, NREL was in compliance with all applicable wastewater discharge requirements.

### *2.1.5 Surface Water Quality Protection*

Stormwater discharge regulations are administered by the EPA at federal sites in Colorado. As a result, NREL falls under the EPA Construction General Permit (CGP) program for the STM and NWTC sites for stormwater discharge from construction activities. Permit coverage for individual NREL activities is obtained when permit thresholds are triggered.

Coverage by the general permit begins with filing a Notice of Intent (NOI) with the EPA. Once accepted by the agency, the construction activities are covered by the terms and conditions of the permit. Upon completion of activities, as defined in the permit, the permit is terminated by filing a Notice of Termination (NOT). At the STM, NOIs were filed with the EPA in 2010 for the following construction projects:

- Vehicle Test Pad Facility
- West Gate Improvements
- RSF II-Visitor Parking Lot-Cafeteria-Process Pipe Project
- Ingress/Egress (Parking Garage) Project.

At the NWTC, a NOI was filed for the NWTC Entrance Road and Building 251 Parking Lot Improvements Project . All of these projects are expected to continue through 2011.

Regular construction site inspections of stormwater control measures were conducted during 2010 at both the STM and NWTC sites as required by stormwater discharge permits.

### *2.1.6 Waste Management*

The Resource Conservation and Recovery Act (RCRA) established federal authority over hazardous waste. In Colorado, the CDPHE administers hazardous waste regulations under authority delegated by the EPA. NREL holds five EPA generator identification numbers for each of its sites. NREL's waste management program is outlined in Section 5.6. Pollution prevention efforts at NREL are described in Section 5.9.

In 2010, DOE-GO conducted a field assessment of the management of hazardous waste at the STM campus. The assessment identified one finding, three opportunities for improvement, and three noteworthy practices (see Section 5.6).

### *2.1.7 Storage Tanks*

NREL has no underground storage tanks. Above-ground storage tanks (ASTs) that are larger than 660 gallons are regulated by the Colorado Department of Labor and Employment's Division

of Oil and Public Safety. NREL has two tanks larger than 660 gallons on the STM site that are registered with the department. Details about NREL's AST program are provided in Section 5.7.

In the fall of 2010, the DOE Golden Field Office (DOE-GO) conducted a formal surveillance of the NREL AST program. While three practices were identified as notable, DOE identified five opportunities for improvement and had 13 findings. Most of these findings were administrative in nature and none were associated with a release or threat to the environment. NREL prepared a corrective action plan and initiated the corrective actions in early 2011.

No spills or releases from NREL's ASTs occurred during 2010 and NREL was in compliance with all applicable requirements.

### *2.1.8 Threatened and Endangered Species/Species of Concern*

Wildlife is protected by a number of federal laws, including (but not limited to) the Endangered Species Act, the Migratory Bird Treaty Act, and the Bald and Golden Eagle Protection Act. The Endangered Species Act also protects threatened and endangered plant species. State laws designate and protect rare or unique plants and animals as well. No threatened or endangered species or species of concern have been documented on NREL's sites. Details of NREL's wildlife and vegetation surveys are provided in Sections 5.10 and 5.11.

In 2010, NREL was in compliance with all applicable wildlife requirements.

### *2.1.9 EPCRA Compliance and Prevention of Toxic Releases*

Executive Order (EO) 13423 and DOE Order 450.1A outline requirements for Superfund Amendments and Reauthorization Act (SARA) Title III, Emergency Planning and Community Right-to-Know Act (EPCRA) compliance, and Toxic Release Inventory reductions for DOE facilities. NREL maintains hazardous materials permits with West Metro Fire Rescue (West Metro) and provides chemical inventory information to West Metro for the STM site and Building 16 in the DWOP. NREL's ReFUEL facility holds a hazardous materials permit issued by the Denver Fire Department.

Federal facilities that use, produce, or store extremely hazardous substances in quantities above specific release thresholds are required to report on their inventory to various federal, state, and local emergency planning authorities, as required by EPCRA. A summary of the EPCRA requirements and the applicability to NREL is presented in Table 1.

EPCRA Section 312 requires facilities having threshold quantities of extremely hazardous substances or Occupational Safety and Health Administration (OSHA) hazardous chemicals to submit a Tier 2 report; CDPHE regulations require the report to be submitted to the state. In 2010, NREL identified three OSHA hazardous chemicals present in quantities above the 10,000-pound threshold and used in non-exempt operations. These substances are diesel fuel, petroleum oil, and sulfuric acid in lead acid batteries. The 2010 Tier II report will be prepared for the March 1, 2011 submittal deadline.

In 2010, NREL facilities had no releases exceeding the reportable quantity of any material reportable under EPCRA Section 313. As a research and development laboratory, NREL does not manufacture or process any materials on the SARA Section 313 list in excess of the applicable threshold planning quantity. During 2010, the laboratory did not otherwise use any

materials on the SARA Section 313 list in quantities exceeding the applicable threshold planning quantity. NREL's compliance with EPCRA requirements is detailed in Section 5.8.

**Table 1. Status of EPCRA Reporting for Calendar Year (CY) 2010**

| EPCRA Section | Description of Reporting | Status |
|---|---|---|
| EPCRA Sec. 302-303 | Planning Notification | One-time requirement* |
| EPCRA Sec. 304 | EHS Release Notification | Reporting threshold not met |
| EPCRA Sec. 311-312 | MSDS/Chemical Inventory | Reporting threshold met** |
| EPCRA Sec. 313 | TRI Reporting | Reporting threshold not met |

*NREL maintains hazardous materials permits with West Metro Fire Rescue and reports chemical inventory information to West Metro for the STM site and Building 16 in the DWOP. NREL's ReFUEL facility holds a hazardous materials permit issued by the Denver Fire Department which requires an annual report of the chemical inventory.
**The NREL 2010 inventory of OSHA hazardous chemicals will be reported under Section 312 (Tier II) in 2011.

NREL maintains an emergency management policy (8-4) and supporting lab-level programs for credible on-site emergencies. In 2010, the *NREL Emergency Management Manual* was updated to include a complete description of the lab's activities that demonstrate compliance with all applicable emergency requirements of the Colorado Hazardous Waste Regulations. Hazardous material releases are specifically identified as a credible emergency, and response procedures are in place. These procedures are routinely practiced by internal response groups and with external emergency response agencies.

### *2.1.10 Cultural Resources Protection*

Various laws, including but not limited to, the National Historic Preservation Act and the Native American Graves Protection and Repatriation Act, protect cultural resources. NREL has two sites listed on the National Register of Historic Places (National Register) on its STM site. There are no known eligible sites at the NWTC (see Section 5.14).

As was previously reported in 2009, Section 106 consultations were initiated with the Colorado State Historic Preservation Office (SHPO) during the environmental assessment process for the proposed construction activities on STM, including the STM Infrastructure, Energy Systems Integration Facility, and the south access road. SHPO agreed that the infrastructure and Energy System Integration Facility projects would not result in an adverse effect to historic sources, but deferred formal Section 106 consultations on the access road until a final determination was made on its alignment. DOE and NREL continued to work with federal, state, and local agencies as well as private landowners, and finalized a specific proposed route alignment in 2010.

In August 2010, a Class III Cultural Resource Inventory was completed on the final configuration of the access road corridor, which lies within the Camp George West Historic District. The inventory identified three features that could be impacted by the construction of the new access road, including two previously documented features: rifle range firing lines associated with the former Camp George West and an undocumented linear drainage ditch feature. In December 2010, Section 106 consultations for the proposed south access road to the STM began with Colorado SHPO and other consulting parties, and a copy of the inventory report was provided to the SHPO. The SHPO concurred that the two firing line features remained contributing features of the Camp George West Historic District and the proposed access road

would result in an adverse effect to these features. Discussions on mitigation alternatives continued through December 2010, and a memorandum of agreement is expected in 2011.

## 2.2 DOE Order 450.1A, Environmental Protection Program

DOE Order 450.1 required sites to implement an environmental management system (EMS) by integrating them with the site's integrated safety management system. Sites were required to have an EMS in place by December 31, 2005. The revised Order 450.1A requires that EMSs now be structured according to the International Standards Organization (ISO) 14001 requirements by June 2009. NREL's implementation of its EMS meets this requirement and is described in detail in Section 4.0 of this report.

## 2.3 Executive Orders

There are a number of Executive Orders related to the environment that direct DOE activities and their subsequent implementation at NREL. A few representative Executive Orders are discussed below.

### *2.3.1 Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance*

On October 5, 2009, the president of the United States signed EO 13514. This order requires all federal agencies and departments to "increase energy efficiency; measure, report, and reduce their greenhouse gas (GHG) emissions from direct and indirect activities; conserve and protect water resources through efficiency, reuse, and stormwater management; eliminate waste, recycle, and prevent pollution; leverage agency acquisitions to foster markets for sustainable technologies and environmentally preferable materials, products, and services; design, construct, maintain, and operate high performance sustainable buildings in sustainable locations; strengthen the vitality and livability of the communities in which federal facilities are located; and inform federal employees about and involve them in the achievement of these goals." In 2010, DOE prepared the Strategic Sustainability Performance Plan (U.S. Department of Energy 2010) that describes how the department will implement the requirements of this EO. This plan and DOE Order 430.2B require that each DOE site develop a site sustainability plan that describes steps taken to meet the national and DOE sustainability objectives. NREL's plan was completed in December 2010 (NREL 2010) and sets the goal for the laboratory to demonstrate federal leadership in implementation of EO 13514.

### *2.3.2 Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management*

On January 24, 2007, the president of the United States signed EO 13423. This order requires all federal agencies and departments to "conduct their environmental, transportation, and energy-related activities under the law in support of their respective missions in an environmentally, economically, and fiscally sound, integrated, continuously improving, efficient, and sustainable manner" (72 FR 3919). One of the provisions of the EO is to reduce or eliminate the use of toxic materials. While the nature of NREL's research cannot meet the EO requirement to eliminate the use of toxic materials, efforts are made to reduce the quantities of toxic materials used at the laboratory. In 2010, chemical safety training classes included discussion of EO 13423 and encouraged researchers to find less toxic alternatives wherever possible.

### *2.3.3 Executive Order 11988, Floodplains Management*

EO 11988 was implemented in support of the National Environmental Policy Act (NEPA), the National Flood Insurance Act of 1968, and the Flood Disaster Protection Act of 1973 to minimize the adverse impacts associated with development and modification of floodplains. According to maps generated by the Jefferson County Department of Highways and Transportation as part of its urban drainage studies, NREL's STM site does not currently contain any floodplains, and no floodplains have been identified at the NWTC. As a best management practice (BMP), however, all construction activities that may cross a drainage channel are designed to meet the 100-year flood control standards (i.e., designed to withstand the equivalent of a 100-year flood). The new south access road to the STM campus is a project that will have some activities within a 100-year flood plain. The new entrance road crosses Lena Gulch, which has a designated 100-year flood plain. Planning for this project included designs for the 100-year flood control standard.

Further, actions with the potential for environmental impact that are undertaken by NREL at subcontractor facilities are assessed for potential impacts on floodplains and wetlands at those sites through the use of an environmental checklist.

### *2.3.4 Executive Order 11990, Wetlands Protection*

Under EO 11990, each federal agency 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. Limited wetland areas totaling less than 0.3 hectares (0.75 acres) occur on the STM site. These are narrow, linear wetlands supporting spikerush, baltic rush, sedges, bluegrass, hemlock, and field mint. Wetland areas at the NWTC are extremely limited in extent as well. These areas, along the site's eastern boundary, total less than 0.44 hectares (1 acre), but have not been officially delineated. None of the wetlands at current NREL facilities have been designated jurisdictional (see Section 5). As with flood plains, the construction of the new south access road will also have impacts on designated wetlands in the area of Lena Gulch. Project activities will be in compliance with provisions of this EO.

In 2010, NREL was in compliance with the provisions of the environmental EOs.

## 2.4 Permit Summary

Appendix A contains a table summarizing NREL's permits, registrations, and notifications.

# 3 NREL's Role in the Environment—Global and Local

As the nation's premier resource for renewable energy information, research, and technology, NREL has a unique role in supporting the "nation's energy and environmental goals." NREL has a positive environmental presence, both in the operation of the laboratory facilities and in the mitigation of impacts to global conditions by research done at NREL. Laboratory operations follow the NREL Environmental Management System (EMS), which is described in detail below and in the following chapter. NREL has earned its designation as an environmental leader by implementing a rigorous EMS to focus environmental strategies, through such longstanding NREL organizations as Sustainable NREL, and promoting sound environmental practices.

NREL's mission is stated succinctly:

> *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.*

Among the environmental imperatives addressed by NREL, carbon mitigation and a shift to a greater use of renewable energy are critical to the 21st century. Major changes in the nation's energy policy have spurred new research efforts at NREL to help address these issues. Renewable energy technologies will have a role in mitigating the effects of climate change and to moving forward to energy independence.

## 3.1 Energy Policy Updates

In 2008, there was a major shift in the energy policy of the United States with the passage of the Energy Independence and Security Act (EISA) which mandated significant changes in the energy production and use in the United States over the coming decades. The EISA has numerous provisions impacting vehicle fuel efficiency, including transportation electrification; funding for increased biofuel research and production; expanded research on solar, geothermal, marine, and hydrokinetic renewable technologies; support for research into carbon sequestration technologies; revisions to the renewable fuel standard (RFS) provisions of the Clean Air Act; and provisions that will result in a modernization of the electrical transmission system known as Smart Grid. NREL has a critical role in helping the nation meet the legislative goals set in the EISA.

The Energy Information Administration (EIA), an independent arm of DOE, evaluates energy use and projections in the Annual Energy Outlook (AEO). The EIA tracks energy use by source and predicts changes in energy demands by gauging the effects of economic trends and the impacts of energy policy changes implemented by new legislation and regulation. The EIA also assesses the impacts on energy demands from changes to tax credit structures as incentives to use alternative sources, such as the biofuels tax credit, and the effects of new or revised fuel standards, such as the Corporate Average Fuel Economy standard or the renewable fuel standards, both now set by the EPA.

The 2010 AEO projects an overall increase in energy use in the United States of 14% by the year 2035, although it did note that, for the first time, demand had decreased in the years 2008 and 2009. The decrease was attributed to economic conditions and was not expected to impact the

long-term outlook. The EIA did project that the strongest growth in fuels in the outlook period would be in renewable fuels used for the generation of electricity and for liquid fuels used for transportation.

Increased research activities at NREL in response to changes in the national policy are only one example of the interface of policy and renewable energy. In 2010, NREL continued to make advances in renewable energy technologies that will contribute to the growth of this segment of the overall energy economy and support the energy sector expected to have the strongest growth in the next 25 years.

## 3.2 NREL Research Helping Meet Legislative Goals

Since its origination as the Solar Energy Research Institute (SERI), NREL has been involved in the fundamental development of solar energy technologies. As a research institution, NREL ranks second among all U.S. laboratories in the number of energy-related publications and has the distinction of having published the number-one cited article in the energy field (Contreras 1999). In 2009, a journal article co-authored by three NREL researchers currently ranks as one of the most read articles over the past 12 months by the *Environmental Science & Technology (ES&T)* journal (Williams, Inman, Aden, and Heath 2009).

With the addition of the National Wind Technology Center (NWTC), the Alternative Fuels Users Facility (AFUF), and a number of related facilities and organizations, NREL has increased the portfolio of research activities to include wind, biofuels, and energy efficient technologies for residential, commercial, and industrial applications. Recently, NREL has increased the level of activity in energy delivery and storage, including energy transmission and distribution, alternative fuels, and hydrogen delivery and storage. For example, NREL has developed a wind-to-hydrogen project at the NWTC to demonstrate the technologies of converting wind and solar energy into hydrogen through the electrolysis of water. In addition, the Hydrogen Test Facility began operations in 2007, where research is aimed at reducing the delivered costs of electrolytic hydrogen. In 2010, final plans were prepared and in 2011, construction began for the new Energy Systems Integration Facility, a laboratory that will house research into this critical area. Cost-effective energy conversion and storage will greatly enhance the viability of renewable energy technologies, particularly those where energy production is intermittent, such as wind and solar.

### *3.2.1 Biofuels*

The EISA established rigorous goals for developing biofuel substitutes for petroleum-based fuels used for transportation (except ocean-going vessels). The RFS has now been expanded to require the annual production of 36 billion gallons of renewable fuel in motor fuels by 2022. Of that, 21 billion gallons must be from advanced biofuels, which is defined as biofuel produced from feedstocks other than corn grain or corn starch. The EISA mandates that advanced biofuels include cellulosic fuels and biomass-derived diesel substitutes, and, further, that these fuels have at least 50% less GHG emissions than petroleum fuels. NREL is well positioned to contribute to the development of biofuels technologies that will facilitate meeting these ambitious goals. The 2010 AEO predicts that the 2022 goal will not be met, projecting a total of 25.7 billion gallons production capacity; the shortfall is attributed to economic and technical factors preventing cellulosic biofuels (i.e., biofuels derived from materials other than corn grain or corn starch) production from providing the credits needed to meet the requirement. However, the EIA

continues to predict that the production of biofuels ultimately surpasses the RFS requirements by 2035.

In 2010, NREL released the BioEnergy Atlas, a visualization screening tool that gathers information on biomass feedstocks as well as on biopower and biofuels potential, production, and distribution. With this tool, technology providers and biofuels project developers can easily view areas with the highest concentration of available feedstocks and target those areas for project development. The research and development of tools such as this at NREL advance the biofuels projection capabilities needed to meet the RFS requirements.

## 3.3 NREL—Research to Mitigate Climate Change

The energy policy shift embodied by the EISA establishes rigorous goals to bring the nation to energy independence, but it also acknowledges the growing concern over climate change. The goals for reducing greenhouse gas emissions just begin to address the problem, however. In a 2007 report produced by the American Solar Energy Society, entitled, "Tackling Climate Change in the U.S.", research indicates that GHG emissions in the United States must be reduced by the equivalent of 1,100–1,300 million metrics tons of carbon per year (MtC/Yr) by 2030 to limit atmospheric carbon dioxide levels to between 450 and 500 ppm; a stabilized level of 450 ppm $CO_2$ is, according to this report, a level which can ward off the worst effects of climate change. The report goes on to say that this level of $CO_2$ reduction can be achieved with a combination of energy efficiency improvements in the building, vehicles, and industrial sectors (57%), and renewable energy installations (43%).

Of the 43% reduction (516 MtC/yr) projected to be achieved through the deployment of renewable energy technologies, a majority of the GHG reduction would come from wind energy (181 MtC/Yr). The additional reductions would be from concentrating solar power (CSP) (63), photovoltaics (63), biofuels (58), biomass (75), and geothermal (83). A recent survey of the growth of the first generation of these technologies from 2002 through 2007 shows that the installed capacity for wind generation has had the greatest increase.

NREL is active in research in most of these areas, but particularly in wind, photovoltaics, and CSP.

### *3.3.1 Wind*

NREL continues to advance wind energy technologies at the NWTC and elsewhere. In addition to the ongoing work at the NWTC, NREL joined forces with the University of Delaware in 2010 in an effort to establish a test site for commercial wind turbines off the Delaware coast. While commercial offshore wind turbine components can be tested separately on land, before installing multiple full-scale commercial turbines, researchers and industry experts need to study one or a small number of complete turbine systems at sites that expose the turbines to typical offshore conditions, such as salt water and mist, wind gusts, and weather events such as northeasters.

**Figure 4. Turbine installation at the NWTC**

Source: NREL (PIX 18888)

As part of the planning and development of a potential offshore wind turbine test site, NREL and the University of Delaware will develop test procedures specific to the area's harsh offshore wind environment and establish methods for predicting wind energy costs in the United States. It is expected that any test turbine sites would serve as valuable classrooms that could be used to train future wind energy professionals, scientists, and engineers.

### *3.3.2 Concentrating Solar Power*

Concentrating solar power technologies can be a major contributor to our nation's future need for new, clean sources of energy, particularly in the western United States. Large installations of CSP require substantial investments, however, with costs potentially exceeding $1 billion. In 2010, NREL's Resource Information and Forecasting Group published the "Concentrating Solar Power, Best Practices Handbook for the Collection and Use of Solar Resource Data." This handbook includes guidance on how to collect reliable data about the solar resource at specific locations, including seasonal, daily, hourly, and even sub-hourly variability. Such data can be used to predict the daily and annual performance of a proposed CSP plant. The handbook also provides an introduction to important concepts, an inventory of historical data, an overview of methods for modeling solar resources, and how to apply the data to CSP projects.

**Figure 5. Concentrating solar power research lab on STM**

Source: NREL (PIX 17775)

### *3.3.3 Photovoltaics*

The development of technology to capture solar energy is at the core of research conducted at NREL. The laboratory has won numerous awards for its innovative work in producing ever more efficient PV configurations, including two prestigious R&D 100 Awards in 2008, a feat repeated in 2010 with two R&D 100 awards recognizing NREL's work developing an etching technique for silicon wafers and a mammoth power generator.

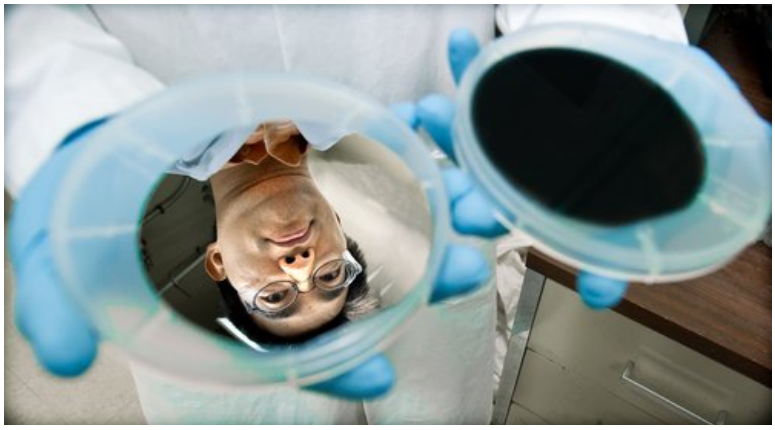

**Figure 6. Black silicon**

Source: Dennis Schroeder (PIX 17852)

One of NREL's 2010 R&D 100 awards recognized the "Black Silicon" Nanocatalytic Wet-Chemical Etch, which demonstrated that "black silicon" solar cells, chemically etched to appear black, can better absorb the sun's energy. The inexpensive, one-step method reduces light reflection from silicon wafers to less than 2%, and promises to reduce manufacturing production cost and capital expense. NREL scientists invented the anti-reflection process that turns the

silicon wafers black so they can absorb 98% of solar radiation; 3% more efficient than typical cells.

The second 2010 R&D 100 award was for the Amonix 7700 Solar Power Generator developed by a partnership of NREL and Amonix. The Amonix 7700 is a highly concentrated, highly efficient bulk power generator that produces 40% more energy than conventional fixed photovoltaic panels. The 53-kilowatt PV power generator is based on the MegaModule, a turnkey unit pairing a durable Amonix Fresnel lens with high-efficiency multi-junction solar cells. It is the first terrestrial PV system capable of converting one-fourth of the sun's energy into useable electricity.

## 3.4 NREL and the Community

During the course of operating a major national laboratory, there is the potential for events to occur which may have an impact on the environment. At NREL, there were no incidents of spills, releases, or similar events resulting in adverse impacts to the environment in 2010.

# 4 Environmental Management System

NREL's Environmental Management System (EMS) provides effective environmental stewardship and minimizes the environmental impacts of lab activities and operations. The laboratory's EMS efforts protect and enhance the vegetation, wildlife, and natural resources of the lab sites; comply with environmental requirements; and encourage continual improvement in environmental protection.

NREL's EMS implements the laboratory's commitments in its Environmental Protection Policy (below). The EMS is a framework of policies, procedures, and programs that integrates environmental protection into daily work practices of NREL workers. While the EMS is managed by the Environment, Health, and Safety office (EHS), environmental protection must involve everyone at the lab to be effective.

NREL's EMS is structured based on a plan-do-check-feedback continual improvement framework. Within this continual improvement structure, EHS and Sustainable NREL plan, implement, monitor, and report on environmental stewardship goals and actions. These activities are consistent with the NREL environmental policy, and are acknowledged and prioritized by the significant aspects identified in the EMS. In addition, these activities establish goals and objectives against which success can be measured. NREL users can see a full description of the EMS in laboratory-level procedure 6-2.20 Environmental Management System; available on NREL's intranet.

NREL's EMS meets the requirements of the ISO14001 standard for environmental management systems and was fully implemented prior to June 30, 2009, as required by DOE Order 450.1A. Based on an external audit of the management system conducted in May, 2009, DOE issued a declaration of conformance letter dated June 26, 2009.

As a DOE-owned facility, NREL is required by DOE Order 450.1A to implement its EMS as part of an integrated safety management system. NREL's EMS meets this requirement while also incorporating the elements of ISO 14001. In addition, the criteria of EO 13423—strengthening federal environmental, energy, and transportation management—are incorporated into the EMS. Policy 6-2: Environmental Protection, and supporting laboratory-level environmental programs and procedures that define the NREL EMS are coordinated and linked with Policy 2-1: Integrated Safety Management, Policy 2-7: Sustainable NREL, and the related supporting lab-level safety, health, and sustainability programs and procedures.

## 4.1 Environmental Protection Policy

In support of NREL's mission and values, the laboratory commits to:

- Environmental stewardship
- Pollution prevention (P2)
- Compliance with legal requirements and voluntary commitments
- Continual improvement of environmental and sustainability performance.

### *4.1.1 Significant Aspects*

NREL's environmental aspects are those activities, products, or services that can interact with the environment. The significance of an identified aspect is determined by assigning a frequency of occurrence and a severity of occurrence. Using a ranking system, a consequence is determined and those aspects with the highest ranking consequences are considered significant. Using this method, EHS staff, in 2010, reviewed the organization's potential impacts to the environment and reconfirmed, without changes, its determination of "significant environmental aspects":

- Emissions to air
- Surface water releases
- Wastewater releases
- Accidental releases
- Solid waste generation and management
- Hazardous waste generation and management
- Source reduction, reuse, or recycling
- Purchase of environmentally preferable products
- Energy use
- On-site energy generation using renewable sources, and use of energy efficiency technologies
- Water use
- Other natural resources and raw materials use
- Impacts to land, including restoration
- Impacts to wildlife or vegetation, including habitat impacts and preservation
- Impacts to groundwater
- Impacts on communities (e.g., traffic noise, vibration, odor, and visual appearance), including benefits.

Each of these aspects is addressed by the management system through elements such as operational controls and objectives and targets. The 2010 objectives are described in Section 4.2 below.

### *4.1.2 EMS Effectiveness—Benefits to the Environment and NREL*

NREL's management system has been in place since the 1990s and has seen numerous benefits over the years. Here is a summary of some of those benefits.

**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.

**Environmental and sustainability performance.** While NREL benefits as an organization from each of the efforts highlighted here, the larger benefit is in reduced impacts to the quality of the air, water, land, and to the flora and fauna that share the campus and community.

**Reduced risk**. NREL's Hazard Identification and Control Program is a hazard identification and risk analysis process which incorporates environmental risk assessment.

**Cost savings**. Any avoided impact represents cost savings, specifically in the event of spills and incidents. Cost savings are realized through energy efficiency projects, new renewable energy installations, and waste reduction and recycling.

**Environmental awareness**. Staff are made aware of the potential environmental impacts from their work activities through a variety of mechanisms including broad communications in the *NREL Now* 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 employee recognition annual event), Earth Day, and Bike-to-Work Day.

**Empowered individuals**. Staff is empowered to reduce NREL's environmental footprint including participation in programs and events for recycling single-stream materials, batteries, electronic equipment, and shredded paper, as well as a composting program. Staff at the new Research Support Facility is able to support a new, ultra high-efficiency energy goal for the building by reducing their energy use in the office. Researchers are participating in a self-inspection program for hazardous wastes generated in their own labs. Increased responsibility and awareness of lab wastes should reduce the amount of wastes generated.

**Organizational culture and operations**. NREL strives to maintain a high level of awareness in the laboratory around safety, health, and environmental responsibilities. This is accomplished through a variety of means, including regular communications from executive management, as well as at the ground level through each interaction of EHS staff with lab and operations staff in trainings, inspections, risk assessments, and daily interactions.

**Real property asset management**. NREL strives to achieve LEED Gold ratings for all new buildings and major renovations.

**Community relations**. NREL seeks to improve community relations by responding to and tracking all community input through phone calls, email, community meetings, and the NEPA process. NREL takes proactive measures to engage the community with public tours, newsletters, and mailings to neighborhoods surrounding its facilities.

**Cooperative conservation**. NREL regularly works with community stakeholders to improve the community. For example, with the growth of the South Table Mountain campus, NREL implemented a traffic mitigation plan to reduce forecasted impacts of increased traffic to the facility.

### *4.1.3 Notable 2010 Activities*

Each year, NREL endeavors to participate in environmental programs that promote activities supporting the goals and objectives of the EMS.

#### *4.1.3.1 Federal Electronics Challenge*

In 2010, NREL achieved the Gold-level Federal Electronics Challenge (FEC) Award. FEC is a partnership program between the Office of the Federal Environmental Executive and the EPA. The FEC recognizes federal facilities that voluntarily:

- Purchase greener electronic products
- Reduce impacts of electronic products during use
- Manage obsolete electronics in an environmentally safe way.

To learn more about the award, please see the NREL FEC poster summary (PDF 4 MB). Learn more about this voluntary program at the Federal Electronics Challenge website at http://www.federalelectronicschallenge.net/.

#### *4.1.3.2 Colorado Environmental Leadership Program*

NREL continued progress toward environmental performance commitments made as a gold-level leader in Colorado's Environmental Leadership Program (ELP). The Colorado ELP is a voluntary partnership between the CDPHE and participating private and public Colorado facilities, and is intended to recognize environmental leadership and performance.

In early 2004, NREL was the first laboratory accepted into the Colorado ELP as a gold-level leader and has maintained this leadership level ever since. NREL sets voluntary 3-year environmental performance goals as a component of ELP membership in an effort to further enhance operations and performance at the laboratory. The current goals were established in 2007 and are described in detail in Section 4.2.2.1 below.

The CDPHE ELP recognizes facilities that voluntarily:

- Exceed regulatory requirements
- Implement EMSs (which focus on incorporating environmental considerations into normal management processes and improving internal environmental management effectiveness)
- Work closely with their communities
- Set 3-year goals focusing on measurable results.

Learn more about this voluntary program at the Colorado Department of Public Health and Environment website at http://www.cdphe.state.co.us/oeis/elp/index.html.

### *4.1.4 Public Outreach*

NREL provides a number of avenues for communication between the laboratory and the community, such as community meetings, lunch-and-learn events, public-facing websites, periodic newsletters, and mailings. NREL tracks and responds to all environmentally related concerns through the Public Affairs Office.

## 4.2 Performance Indicators and Progress

Each year, NREL sets measurable objectives and targets for environmental improvement. Prior year performance and future goals are described here.

### *4.2.1 2010 Environmental Objectives and Progress Toward Goals*

Each fiscal year, in collaboration with DOE-GO, NREL develops environmental performance objectives for the upcoming year as part of the lab's 1-year plan. The fiscal year (FY) 2010 goal was "to demonstrate that ES&H is a priority; that processes and practices are in place to effectively identify and manage risks to protect NREL workers, the local community, and the environment; and that the laboratory complies with all applicable DOE requirements, regulations, laws, and laboratory policies and procedures."

For FY 2010, the environmental objectives were to:

- Promote a safe and healthful workplace based on identified and managed risks
- Further integrated safety management (ISM) through the development of improved management systems
- Transform environmental excellence to a sustainability strategy.

NREL successfully completed the 1-year plan objectives. Some noteworthy achievements in FY 2010 included:

- The creation of a vegetation test plot at the NWTC to find species adaptable to growth under solar panels
- The recommendation of two construction contractors by NREL for Colorado ELP awards. Both nominees received bronze achievement awards.

### *4.2.2 State of Colorado ELP Commitments*

As members of the Colorado Environmental Leadership Program, NREL sets 3-year goals for environmental improvement. Each year progress toward these goals is reported to the state.

#### *4.2.2.1 Current Commitments*

The following multi-year commitments were made to CDPHE's ELP program for 2007 through 2010:

- Campus Planning
    - Sustainable buildings
        - NREL actively "walks the talk," having made a tremendous start by achieving LEED Platinum designation at the Science and Technology Facility (S&TF) in March 2007. NREL plans to attain LEED Gold-level ratings or better for all future building design and construction. For planning purposes, NREL developed a grand buildout plan, including design of the 222,000 gross square foot (gsf) RSF. NREL's STM buildout plan calls for growing from 400,000 gsf to 1,100,000

gsf, and from 450 occupants to 2,700 occupants. As mentioned in Section 1, the RSF, like the S&TF, is now designated LEED Platinum.

- GHG
  - NREL committed to exceed the 3% FY 2007 GHG reduction required by EO 13423. This will be completed through the deployment of energy efficient and renewable energy technologies on site at NREL, and through the purchase of renewable energy certificates.
- Electronics
  - NREL's goal was to apply for acceptance into the FEC, and complete 19 projects in order to apply for the 2007 FEC silver-level award given jointly by the Office of the Federal Environmental Executive and the EPA.

- Results

NREL has successfully achieved the following ELP commitments for 2010:

- Sustainable buildings
  - All laboratory new construction complies with the Guiding Principles for Federal Leadership in High Performance and Sustainable Building. The completion of the RSF in FY 2010 greatly enhanced NREL's leadership position in embracing these principles.
- GHG
  - NREL easily exceeded the 3% per year GHG reduction goal required by the federal EO 13423, Strengthening Federal Environmental, Energy and Transportation Management. In addition, NREL successfully achieved its Climate Leaders goal of reducing its total GHG emissions by 75% from FY 2005 to FY 2009. NREL has exceeded this goal to totally offset the laboratory's $CO_2$ footprint with energy retrofits, onsite renewable energy projects, minimum Gold-level ratings of the LEED standards for new construction and "green power" purchases of renewable energy credits and carbon credits.
- Electronics
  - NREL was awarded the 2010 EPA FEC Gold Level Award, recognizing NREL's efforts toward environmentally sound management of electronic waste management/recycling and sustainable electronic purchasing. For 2011, NREL is seeking the FEC Platinum Level Award for activities conducted in 2010.

#### *4.2.2.2 Future Commitments*

NREL has submitted the following commitments for 2011 through 2013:

- To demonstrate environmental leadership by attaining ISO 14001 registration for its environmental management system
- To implement a P2 initiative program to identify opportunities and provide resources and funding to achieve desired results
- To increase on-site renewable energy generation by 100% to approximately 4 MW
- To participate in the Sustainable Sites Initiative (SITES) pilot program and obtain pilot certification.

### *4.2.3 2011 Environmental Objectives*

The environmental objectives developed by NREL in collaboration with DOE-GO are to meet the Environment, Safety, and Health (ES&H) management goal stated in the Performance Evaluation Measurement Plan. The FY 2011 goal is "to demonstrate that ES&H is a priority; that processes and practices are in place to effectively identify and manage risks to protect NREL workers, the local community, and the environment; and that the laboratory complies with all applicable DOE requirements, regulation, laws, and laboratory policies and procedures."

For FY 2011, the environmental objectives are:

- To ensure a safe and healthful workplace based on identified and managed risks
- To further ISM through the development of improved management systems
- To transform environmental excellence into a sustainability strategy.

Progress toward the 2011 objectives will be reported in the NREL 2011 Environmental Performance Report.

In addition to setting the Performance Evaluation Measurement Plan goals and objectives for 2011, Sustainable NREL for the first time developed a site sustainability plan to report on 2010 sustainability performance and EO 13514 targets and requirements. The plan also establishes sustainability performance commitments for 2011. Results will be included in the 2011 site sustainability plan to be developed at the end of the calendar year.

## 4.3 Assessment and Improvement

Periodic assessment and management review of NREL's EMS and its components provide verification 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 maintain management support for NREL's environmental goals. Assessments and management reviews are key elements that support the continual improvement of the EMS.

There are three different types of assessments performed to evaluate the functionality of the EMS at NREL:

- **EMS internal assessment**. NREL staff perform regular internal assessments of NREL's EMS against the ISO 14001 standard. The scope of internal assessments includes both the management of significant environmental aspects (areas where NREL activities have the

potential for environmental effects, either positive or negative) and policy implementation.

- **Evaluation of compliance.** Regular environmental compliance evaluations are conducted to verify that NREL activities meet all applicable legal and other requirements. Improvements are developed and implemented as necessary based on the results of each evaluation.
- **Third-party assessment.** Periodically, external third-party assessments may be conducted by technical experts for specific components of NREL's environmental programs or for the EMS as a whole. These assessments are conducted on an as-needed basis.

In addition to assessments and compliance evaluations, regular management review meetings are conducted with executive management review. Management provides feedback on the suitability of the environmental policy, adequacy of resources made available for achieving objectives and targets, and the need for changes to the management system.

### *4.3.1 2010 Assessment Activities*

In 2010, the following assessment activities took place:

**EMS internal assessment**. In February 2009, an EMS internal assessment was conducted by NREL's Quality Assurance group. All actions from this assessment have been completed.

The most recent internal assessment was conducted in December 2010 and January 2011. Results of this assessment and corrective actions will be included in this report in 2011.

**Evaluation of compliance.** No evaluations of compliance were conducted in 2010. The most recent compliance evaluation was conducted in February 2011. Results of this assessment and corrective actions will be included in this report in 2011.

**Third-party assessment.** In May 2009, NREL received an independent assessment of its EMS to measure the system's sufficiency and effectiveness. The recommendations for improvement and corrective and preventive actions have been completed.

No third-party assessments were conducted in 2010. In 2011, NREL is seeking certification under the ISO 14001 standard and will receive a third-party certification assessment to confirm conformance with the standard. Results and corrective actions will be included in this report in 2011.

**Management review.** In September 2010, a successful management review meeting was held with the Executive Leadership Team (ELT) as required by ISO 14001. The ELT embraced their role as providing executive leadership for the EMS and pledged support to ensure the success of the EMS. The ELT made several recommendations regarding the management system, including: 1) during planned communications for the ISO/OHSAS certification effort, the standards should be discussed in terms that people will understand; 2) communications must emphasize that NREL "issues policies and procedures that put us in compliance and keep us safe"; and 3) employee badge graphics must be redesigned. The ELT will continue to be updated on the management system on a regular basis.

## 4.4 Sustainability and the Environmental Management System

NREL's mission has always focused on a sustainable energy future for our nation and the world. Sustainability is defined as meeting the needs of the present without compromising the ability of future generations to meet their needs, and involves the simultaneous and balanced pursuit of economic viability, environmental stewardship, and public responsibility.

The Sustainable NREL program was created to realize the vision of greater sustainability in NREL operations. It is an interdisciplinary initiative involving staff from numerous NREL centers, coordinated by the Sustainable NREL Office, with the goals of maximizing the efficient use of resources; minimizing waste and pollution; and serving as a positive force in economic, environmental, and public responsibility. Elements of the environmental stewardship component of Sustainable NREL include:

- Renewable energy solutions
- Sustainable green buildings, campus planning, and transportation
- Water, electricity, and natural gas use reduction
- Greenhouse gas emission reductions
- Reduce, reuse, and recycle materials use
- Public responsibility/community outreach.

To support these elements of environmental stewardship, Sustainable NREL coordinates efforts to: 1) reduce energy use in NREL's building operations, 2) design energy efficient and environmentally sensitive new buildings, 3) reduce water consumption, 4) decrease GHG emissions, 5) minimize the impact of NREL travel on the environment, 6) use less fossil-based fuel for local operations, 7) incorporate renewable energy technologies into on-site STM and NWTC operations, and 8) create less waste by reducing, reusing, and recycling materials for laboratory operations.

# 5 Environmental Programs

The overarching objective of NREL's EMS and its component programs is responsible stewardship of the environment on its DOE-owned sites, leased properties, and to the extent practicable, on subcontractor and partner sites. NREL strives to protect the natural environment by minimizing or eliminating any adverse environmental impacts resulting from NREL activities. The laboratory's EMS is integrated with other NREL management systems and applies to all research and operations activities. The EMS includes written environmental protection policy and program implementation documents. These are put into practice at all staff and management levels.

NREL's EMS, as described in Section 4, includes components to address waste, air, water, site, natural and cultural resources, and land and soil issues, among others. Descriptions of the components of the EMS are provided in the following sections of this chapter; sections are organized by resource.

A summary of NREL's permits, registrations, and notifications are presented in Appendix A. These permits are discussed in the following relevant sections.

## 5.1 Air Quality Protection

The Air Quality Protection program identifies requirements of the Clean Air Act and the Colorado Air Quality Control Act and implements actions to ensure compliance with the statutes and the air implementing regulations.

### *5.1.1 Program Management*

Management in this area is consistent with the following NREL programs: Environmental Permitting and Notification (6-2.1), Air Quality Protection (6-2.5), Ozone-Depleting Substances Management (6-2.6), and Particulate Emissions Control for Construction (6-2.14).

#### *5.1.1.1 Criteria, Hazardous, and Non-Criteria Pollutants*

The Clean Air Act and State of Colorado laws and regulations delineate several main categories for air pollutants:

- Criteria air pollutants (e.g., carbon monoxide, nitrogen oxides, sulfur dioxide, particulate matter, respirable particulate ($PM_{10}$ and $PM_{2.5}$), ozone, and lead, all of which have been issued National Ambient Air Quality Standards by the EPA
- Non-criteria pollutants (e.g., ammonia, hydrogen sulfide, pesticides, certain volatile organic compounds classified as ozone precursors, metallic compounds, greenhouse gases, and corrosives)
- Hazardous air pollutants (includes a specific list of organic compounds, metals, corrosives, asbestos, radionuclides, and pesticides established by the EPA)
- Ozone-depleting substances (e.g., chlorofluorocarbons or "Freon" and hydro chlorofluorocarbons that are being phased out of use in comfort heating and cooling systems and equipment)
- GHG compounds that have been implicated in global warming.

There are notification and permitting thresholds for criteria, hazardous, non-criteria, and greenhouse gas pollutants. The primary potential sources of these pollutants at NREL include boilers, heating and cooling systems, emergency generators, experimental laboratory hoods and ventilation systems, pilot and large-scale research projects, and small equipment with gasoline or diesel engines. NREL maintains an air emission inventory to track potential air emissions and identify whether notification and permitting could be required for a particular facility or activity. Certain equipment and emissions are exempt from reporting and permitting by the CDPHE Air Pollution Control Division (APCD). NREL maintains several air permits issued by the CDPHE for "minor" sources including emergency generators and pollution control systems at the STM and NWTC sites.

Fugitive particulate emissions from construction activities occur at NREL's STM and NWTC sites. Particulate emissions from construction sites larger than 25 acres are subject to APCD fugitive particulate emissions permits. Appropriate permits have been obtained and are in effect for construction activities at the STM and NWTC facilities. One such Air Pollution Emission Notice (APEN) was in effect for construction at the NWTC at the beginning of 2010. As the construction area became smaller, the APEN was no longer needed and was allowed to expire by its own terms and conditions.

#### *5.1.1.2 Ozone-Depleting Substances*

There are three categories of ozone-depleting substances (ODSs) registration and certification in Colorado: 1) facilities where maintenance activities are performed on refrigeration equipment containing ODS are required to file an annual notification with the CDPHE, 2) technicians that service ODS-containing equipment must be EPA-certified, and 3) refrigeration equipment larger than 100 hp containing ODSs must be registered with CDPHE. NREL has a total of three chillers that are registered with CDPHE—two located at the Solar Energy Research Facility (SERF) on the STM site, and one at the DWOP. Refrigeration equipment that uses non-ODS compounds are not required to be registered. NREL also files an annual notification that maintenance activities occur and the NREL technicians maintain the appropriate professional certification.

NREL eliminated halon-based fire suppression systems in 1999 and transferred their halon supplies to other DOE facilities for "banking." Halon is a Class 1 ODS, the category presenting the most severe environmental impact. EPA banned the manufacturing of halon in 1998, but allowed existing supplies of new and recycled material to be stockpiled or "banked" for future use in existing equipment. As banked supplies are used and not replaced, they will become less available, promoting conversion to non-ODS refrigerants.

#### *5.1.1.3 Street Sanding*

CDPHE regulations require federal, state, and local government facilities to track street sanding in the wintertime, and to minimize sand use. NREL complies with this requirement and files an annual sanding report with CDPHE. From October 2009 to May 2010, NREL used 50 tons of sand and 36 tons of Ice Slicer in 25 sanding deployments while maintaining 12 miles of roadway. From October 2010 to May 2011, NREL applied 50.5 tons of Ice Slicer during 20 sanding deployments in maintaining the same length of roadway. Ice Slicer does not contain sand and minimizes fugitive particulate emissions from road sanding. Increased use of Ice Slicer decreases the use of sand and contributes to NREL compliance with federal and Colorado sanding regulations. In fact, no sand was used during the 2010-2011 season.

#### *5.1.1.4 GHG Emissions Tracking and Permitting*

EPA regulations require that certain facilities which emit GHGs track and report the amount of those emissions. 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 GHG regulations. The reporting and permitting of these emissions is required under two EPA regulations: the EPA Prevention of Significant Deterioration and Title V Tailoring Rule (Tailoring Rule); and the EPA GHG Mandatory Reporting Rule.

GHGs include carbon dioxide ($CO_2$), methane, nitric oxide, and ODS chloro-fluorinated hydrocarbons including hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and certain other fluorinated gases.

The NREL 2010 GHG inventory shows that NREL GHG emissions are below the exempt level for EPA reporting and permitting rules. The Tailoring Rule requires air emission permitting of GHG emissions if $CO_2$ equivalent ($CO_2e$) emissions are greater than 100,000 U.S. tons per year. The Mandatory Reporting Rule requires annual GHG reporting to EPA if $CO_2e$ emissions are greater than 25,000 metric tons (MT) per year. NRELs $CO_2e$ inventory is 4,020 U.S. tons, or 3,555 MT.

### *5.1.2 Permitting*

Most sources of air emissions from NREL laboratory and facility operations in 2010 were of small scale and did not require permitting. Permitting thresholds vary, depending on the pollutant. Projected emissions for new sources were evaluated and air emission reporting and permitting was performed as required.

NREL holds one site-wide permit for particulate air emissions from construction, and five air emissions permits for a pilot-scale research project, the operation of the RFHP, and three emergency generators.

#### *5.1.2.1 2010 Activities*

APEN applications were submitted to the CDPHE APCD during 2010 for the STM RSF1 emergency generator, STM Field Test Laboratory Building (FTLB) replacement emergency generator, and the NWTC site 4.0 emergency generator. Permits were issued and approval to construct these three generators was received from the APCD in 2010.

The preparation of APEN applications began in 2010 for the STM RSF 2 emergency generator and the IBRF cellulose digestion large pilot-scale project. APENs are not expected to be issued for these projects until 2011.

All required ODS registrations and certifications required in 2010 were filed with the CDPHE.

## 5.2 Drinking Water

NREL operates a drinking water distribution system at the NWTC regulated as a Non-Transient Non-Community Public Water system by the CDPHE. Drinking water from nearby municipalities is trucked to the NWTC and delivered to the distribution system. This program ensures that the system is operated in accordance with state requirements.

### *5.2.1 Program Management*

Management in this area is consistent with the following NREL Programs: Drinking Water (6-2.3) and Environmental Permitting and Notification (6-2.1).

Drinking water is provided to NREL's STM and DWOP sites by a public water supply, Consolidated Mutual Water Company. Water to the Joyce Street and ReFUEL facilities is also provided by a public water supply. NREL supplies drinking water to its NWTC by trucking in water from local public water supplies through a subcontracted water hauler. NREL stores the water on site in a buried 15,000-gallon storage tank and an above-ground 2,000-gallon tank. The water hauler fills the 15,000-gallon tank, and water is pumped on demand to the 2,000-gallon tank where it is distributed to the Industrial User Facility (IUF), Building 251, and the Distributed Energy Resource Test Facility on the west end of the site.

Disinfection boosting is performed at the NWTC using an automated chlorine disinfection system.

Monitoring for bacteria (total coliforms), chlorine levels, haloacetic acids, trihalomethanes (disinfection by-products), and lead and copper is performed at the NWTC according to the CDPHE requirements. NREL qualifies for reduced lead and copper monitoring. Current state requirements for NWTC system monitoring are as follows:

- Bacteria – monthly
- Chlorine levels – weekly or more frequently as needed
- Haloacetic acids – annually
- Total trihalomethanes – annually
- Lead and copper – triennially.

Samples are collected from three locations at the NWTC: Building 251, the IUF, and the hydrogen test pad. No coliforms were detected in any of the samples taken during 2010. Monthly results for the bacterial analyses are provided to the state.

Monitoring for lead and copper was most recently completed as required during the summer of 2008; lead and copper monitoring will be required again in 2011. All samples collected were well below EPA's action levels. Five sampling locations were tested for lead and copper. Four of the five lead results were below detection with the fifth result showing 0.002 parts per million (ppm), well below the action level of 0.015 ppm. Copper values ranged from 0.095 ppm to 0.474 ppm, with an average value of 0.200 ppm, well below the action level of 1.3 ppm.

Chlorine residual monitoring of the NWTC drinking water system began with the installation of the chlorine disinfection system in 2000. Monitoring is performed to ensure the chlorine residual levels are detectable, with a target concentration of at least 0.2 milligrams per liter (mg/L) of chlorine present to provide sufficient disinfection. Colorado requires that chlorine residual monitoring occur when collecting monthly bacterial samples. NREL monitors chlorine residual levels in the system on a weekly basis and also measures chlorine levels of drinking water that is delivered to the NWTC. Results are provided to the state on a monthly basis. Chlorine was

present at appropriate levels in all samples collected in 2010. The running annual average of the maximum residual disinfectant level for CY 2010 was 0.77 ppm.

If any treatment is performed on supplied drinking water, state regulation requires that a state-licensed operator supervise the treatment. NREL hires a subcontracted operator with a Class A license to supervise the disinfection and filtration operations and to perform the necessary sampling.

### *5.2.2 Permitting/Notifications*

NREL has a registered Public Water Supply Identification Number (PWSID) issued by the CDPHE for the drinking water distribution system at the NWTC. This identification number does not require periodic renewal, but periodic testing, record keeping, and reporting are required. All other NREL facilities (STM, DWOP, JSF, and ReFUEL) are provided drinking water from municipal sources.

### *5.2.3 2010 Activities*

In 2010, 320,897 gallons of potable water were delivered to the NWTC, with an average daily consumption rate of 879 gallons. NREL conducted all required monitoring in 2010 and all reported results met drinking water standards. Bacteria were reported as "absent in all samples collected, and disinfectant was detected at all locations tested." The annual running average for chlorine was 0.77 ppm.

It was previously reported that CDPHE notified NREL that the maximum contaminant level for total trihalomethanes had been exceeded. As a result, quarterly monitoring for disinfection byproducts was implemented in 2006 and continued throughout 2007 and 2008. Annual monitoring resumed in 2009 and continued in 2010. The 2010 sample was collected in August, as required by the CDPHE-issued monitoring plan and the results demonstrated compliance with disinfection byproduct maximum containment levels (MCLs).

## 5.3 Groundwater Protection

NREL is located at the northwest fringe of the Denver Basin, a large groundwater resource underlying much of the greater Denver metropolitan area. Protecting the groundwater quality and preventing off-site contamination are the main objectives of this program.

### *5.3.1 Program Management*

Management in this area is consistent with NREL's Groundwater Protection and Maintenance Program (6-2.4).

Both the STM and the NWTC are located at the western edge of the Denver Basin aquifer system that supplies water to urban, rural, and agricultural users along the Front Range of the Rocky Mountains in Northeastern Colorado. The aquifers within the Denver Basin, which include the Dawson, Denver, Arapahoe, and Laramie-Fox Hills aquifers, form a layered sequence of rock in an elongated bowl-shaped structural depression.

The shallowest aquifer is the Dawson formation that is located between 60–100 feet below ground surface (bgs) and extends to approximately 1,000 feet bgs. This is followed by the Denver aquifer, the Arapahoe aquifer, and finally the deepest aquifer, the Laramie-Fox Hills

aquifer, which extends from approximately 2,270 feet to 2,970 feet bgs. Thicknesses of the aquifers decrease with depth below ground surface ranging from 1,100 feet in the Dawson, 400–800 feet in the Denver, 500–600 feet in the Arapahoe, and 200 feet in the Laramie-Fox Hills aquifer. Limited connection exists among these deep aquifers and with the shallow alluvial aquifers associated with the South Platte River valley and its tributaries.

The STM site overlies the shallowest portions of the Denver, Arapahoe, and Laramie-Fox Hills aquifers. The NWTC site overlies the shallowest portions of the Arapahoe and Laramie-Fox Hills aquifers. The northern extent of the Dawson aquifer is located approximately 20 miles to the south and east of the STM site; as the shallowest aquifer, it is used most frequently as a drinking water supply. Should a well be drilled at either the STM site or the NWTC site, it could not intersect the Dawson aquifer and present a pathway for potential contamination.

Because of the sensitive nature of the groundwater resource, NREL carefully evaluates all outdoor projects to eliminate potential impacts to groundwater quality. If any materials are used that pose a risk to groundwater, the laboratory typically insists that safeguards to protect groundwater be established. Safeguards include, but are not limited to, secondary containment for equipment with the potential to leak oil and double-walled tanks with leak detection for diesel fuel storage of NREL facilities' emergency generators. In addition to measures taken to prevent release of materials onto the ground, precautionary measures are also taken when wells are drilled. In 2010, NREL completed the installation of a geothermal heat pump system at the SRRL that included a 300-foot deep well (see below). Well completion included properly grouting the hole around the heat exchange piping to protect the surrounding formation, groundwater resources and the environment, as required by state regulations.

The NWTC currently has no open or active groundwater wells. A water supply well once provided water to Building 251 when DOE's Rocky Flats Field Office operated the site. In 1993, NREL collected samples from the well and the associated water distribution and treatment system as part of an evaluation of alternatives for water supply to the site. Based on the sampling results, it was determined that the maintenance and repairs required to make the existing well and treatment system effective were extensive, and there was an indication of the potential for trace organic compounds in the water. Therefore, when DOE's Golden Field Office assumed landlord responsibility for the site in 1993, the connection between the building and the well was severed. The water supply well was plugged and abandoned in accordance with state regulations in 1996. Potable water is currently transported to the site, as described in Section 5.2 of this report. NREL has done no other groundwater sampling at the site.

There have been no groundwater studies performed by NREL at either the JSF or the ReFUEL facilities, as there have been no activities at these sites that pose an unusual risk to ground water.

There is currently no ongoing routine groundwater monitoring program on any NREL site. Groundwater sampling will be conducted if future activities pose a risk to the groundwater quality.

### *5.3.2 Permitting*

Five groundwater monitoring wells installed by NREL at the STM sites have been permitted with the Colorado Department of Natural Resources (DNR) Division of Water Resources. These

wells were installed in 1990 and are currently not in use. A well permit was obtained for the SRRL geothermal installation in December 2009 and the well completion report was submitted in January 2010.

### *5.3.3 2010 Activities*

In 2010, NREL measured flow and evaluated water quality of groundwater collected from the perimeter drains surrounding the RSF building. Flow into the sump, which decreased greatly from the start of construction until approximately six months after building completion when flow essentially ceased, was evaluated for ammonia, biochemical oxygen demand, oil and grease, sulfide, hydrogen sulfide, and coliform bacteria (total, fecal, and E. Coli). Results were below State of Colorado groundwater standards and were consistent with results from historic STM groundwater analytical results.

## 5.4 Wastewater Discharge

NREL discharges very little non-domestic wastewater due to the small volumes generated by pilot plant operations and the laboratory's policy of minimizing or eliminating discharges to the sanitary collection system.

### *5.4.1 Program Management*

Management in this area is consistent with NREL's Waste Management and Minimization Program (6-2.8).

Wastewater from NREL's STM and DWOP facilities flows into the Pleasant View Water and Sanitation District's system, and ultimately to the Metropolitan Wastewater Reclamation District's (Metro) treatment plant. There is a small septic system consisting of a tank and absorption field on the mesa top, serving the SRRL, because there is no sewer line to the mesa top. Wastewater from the JSF and the ReFUEL facilities also flows to Metro's treatment plant. The NWTC is not connected to a sewer system, but has two septic systems that include tanks and absorption fields for the treatment of wastewater.

It is NREL policy to comply with all requirements of Metro's Pretreatment Program, including the list of general prohibitions that protect the collection and treatment systems. The list of prohibitions includes hazardous materials, highly viscous substances, radioactive material, excessive oil and grease, and similar substances that could cause material harm to the sanitary system. NREL staff is trained in this policy. In addition, NREL sites have design criteria for waste drains in lab 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 any floor drains that are installed in lab areas. New research and operations activities as well as ongoing activities that undergo significant modifications are reviewed for their potential effect on wastewater character through NREL's risk assessment process.

### *5.4.2 Permitting*

Permitting for the majority of NREL's wastewater discharges is not required. NREL has no direct wastewater discharges to the environment at the DWOP, ReFUEL, or JSF, so National Pollutant Discharge Elimination System permitting is not necessary. NREL maintains three individual sewage disposal systems: two at the NWTC, and one at the STM site. The remainder

of NREL facility wastewater is discharged to Metro through the sanitary sewer system. NREL facilities are currently classified by Metro as non-industrial water users at these sites. As non-industrial users, NREL sites do not need a permit from Metro for sewer discharge, and monitoring for pollutants in wastewater is not required.

### *5.4.3 2010 Activities*

In 2010, major renovations were made to the NWTC septic system serving buildings 254 and the IUF and the Dynamometer Test Facility, Building 255. The existing septic system has a 1,000-gallon tank which now flows into a new 2,000-gallon tank to serve the IUF and Building 254. In addition, a 1,500-gallon tank was added for future flows from the Dynamometer Test Facility which will also flow into the 2,000-gallon tank. To accommodate the increased capacity of the septic system, the leach field was expanded to 9,600 square feet of drainage area.

## 5.5 Surface Water Protection (Stormwater and Erosion Control)

The recent surge in construction activities at NREL has increased the number of activities in the surface water protection program.

### *5.5.1 Program Management*

Management in this area is consistent with the following NREL programs: Stormwater Pollution Prevention for Construction Activities at the STM (6-2.15), Stormwater Pollution Prevention for Construction Activities at the NWTC (6-2.16), and the Environmental Permitting and Notification (6-2.1), EO 13514 Federal Leadership in Environmental, Energy, and Economic Performance.

#### *5.5.1.1 Past Investigations*

Stormwater monitoring was conducted at the STM site during the summers of 1992 and 1993 to characterize stormwater quality at NREL, confirm that NREL's activities were not adversely impacting stormwater quality leaving the STM site, and provide a baseline against which future monitoring results could be compared.

Samples were collected at three locations: the east, middle, and west drainages. Water quality data indicate that NREL's activities did not result in contamination of storm water runoff. For that reason, instream water quality samples of Lena Gulch, the receiving water to which stormwater from the STM site ultimately flows, were not collected.

Lena Gulch is a tributary to Clear Creek, a major waterway in the west Denver region. The Urban Drainage and Flood Control District has mapped the 100-year floodplains of this region and determined that none of the NREL facilities encroach upon a floodplain.

In 1998, surface water samples were taken in two drainages at the NWTC in connection with NREL's weed control efforts. No traces of the herbicide applied to weed-infested areas were detected in the water samples collected. Stormwater and surface water quality monitoring has not been conducted at NREL's DWOP, JSF, and ReFUEL sites.

#### *5.5.1.2 Current Management Practices*

Outdoor research projects and building construction are reviewed during the planning stages through NREL's NEPA, risk assessment, and design review processes for potential impacts to stormwater and receiving waters. Low-impact development stormwater best practices are also

encouraged during design review to retain stormwater on site through infiltration, promotion of evapotranspiration, and/or use of stormwater runoff for irrigation and other purposes. Low-impact development design elements incorporated during 2010 construction projects include:

- **Porous pavement**. Porous pavers were included in the RSF courtyards and driveways, and porous concrete and Filterpave product were included in the new 300-car surface parking lot to promote infiltration.
- **Vegetated bioswales**. These landscape elements were used in the RSF courtyards to promote infiltration and to filter roof drainage and stormwater runoff diverted from perimeter drains, in the 300-car surface parking lot to collect runoff for infiltration and pollutant uptake by vegetation, and finally to convey runoff from the 300-car surface parking lot to the current site detention basin.
- **Native prairie grasses, shrubs, and trees**. These types of vegetation were planted to prevent wind erosion and erosion and sedimentation from stormwater/snowmelt on steep slopes.

During construction, erosion, and sediment controls, proper chemical storage and fueling procedures, and good housekeeping practices are implemented according to the stormwater plans developed by contractors and reviewed by NREL EHS staff per NREL stormwater procedures.

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

#### *5.5.1.3 Permitting*

Stormwater quality on federal facilities in Colorado is regulated by the U.S. EPA Region 8. To obtain coverage under the EPA's National Pollutant Discharge Elimination System General Construction Stormwater permit, a NOI must be submitted to the EPA. The site owner (DOE), site operator (Alliance for Sustainable Energy), and construction subcontractors have filed NOIs with the EPA.

In 2010, construction projects at the STM site for which permits were obtained or coverage was continued included the RSF, RSF visitor parking lot and stormwater detention basin, the addition to RSF (RSF II), supporting infrastructure for the RSF, the West Gate Improvements project, and the Vehicle Test Pad Facility. An additional permit was obtained at the NWTC for improvements to the site entrance road, security building, and Building 251 parking lot.

### *5.5.2 2010 Activities*

In addition to implementation of stormwater pollution prevention plans associated with permitted construction projects described above, NREL also applied numerous stormwater protection and erosion control practices and controls on small project sites whose individual area of disturbance was less than 1 acre for which EPA General Construction Stormwater permits are not required. At the STM site, these projects included the AFUF stairs/entrance improvements and the site-wide sidewalk and building entrance improvements for handicap access. At the NWTC, projects requiring erosion/sediment controls were related to the placement of the Site 4.1 turbine pad,

erection of the Site 4.0 and 4.4 meteorological towers, installation of a new septic and leach field system to serve the IUF building, and paving of the area around a Quonset hut.

## 5.6 Waste Management

NREL's waste program covers hazardous and radioactive waste but does not cover sanitary waste. The increase in the size of the work force and the related rise in research activities have resulted in an increase in waste generation at the laboratory.

### *5.6.1 Program Management*

Management in this area is consistent with the following NREL programs: Waste Management and Minimization (6-2.8) and Environmental Permitting and Notification (6-2.1).

Hazardous wastes are handled and disposed of according to the Resource Conservation and Recovery Act (RCRA) and the Colorado Hazardous Waste Act. NREL's waste primarily consists of a broad range of hazardous laboratory chemicals in small quantities. Wastes in solid or liquid form are collected in each laboratory or at each experiment site and prepared for off-site disposal by the NREL EHS personnel.

Hazardous waste is transported to EPA-permitted facilities for treatment and disposal. In addition, NREL has a conservative waste management policy where materials that are not regulated by RCRA, yet pose a potential hazard, are collected and disposed of as non-hazardous materials at RCRA-permitted disposal facilities. This category includes nanomaterial-bearing wastes, which were added to the waste procedure in 2008.

NREL facilities also generate small quantities of low-level radioactive wastes. This waste normally consists of personal protective equipment, disposable labware, scintillation fluids, and water-based liquids. Radioactive waste is shipped off-site for disposal on an as-needed basis.

### *5.6.2 Permitting*

NREL has five separate sites that have the potential to generate quantities of hazardous waste in various amounts. Each of the five sites has a RCRA waste generator identification number issued by the State of Colorado. The STM location is classified as a "small quantity generator," generating less than 1,000 kg of waste per month. The other four sites—the Joyce Street Facility, the NWTC, the DWOP, and the ReFUEL facility—are classified as "conditionally exempt small quantity generators," generating less than 100 kilograms (kg) of waste per month.

### *5.6.3 2010 Activities*

In CY 2010, NREL shipped 18,322 pounds (8,328 kg) of hazardous waste, 12,129 pounds (5,513 kg) of non-RCRA regulated waste, and 17,467 pounds (7,940 kg) of universal waste for disposal and recycling from all five sites combined. Universal waste includes batteries, fluorescent light bulbs, and electronic equipment. In CY 2010, there was a 15% increase in the amount of hazardous waste shipped from the CY 2009 levels.

In 2010, low-level radioactive waste was neither generated nor shipped for off-site disposal.

In 2007, a number of national laboratories, including NREL, developed an approach for the management of nanomaterials at DOE facilities. In 2008, DOE directed the laboratories to implement control programs at the laboratories for nanomaterials and for wastes that contain

these substances. NREL developed a program that instituted administrative and engineering controls on the use of nanomaterials, the creation of nanoparticles, and the management of nanomaterial-bearing wastes. There is some uncertainty surrounding the risk of these substances to human health and the environment, so DOE and the national laboratories have taken a conservative approach to the use and disposal of nanomaterials. In CY 2010, NREL continued to implement the management procedures for nanomaterial-bearing waste as described in the updated Waste Management and Minimization procedure. This material is collected and stored as hazardous waste, and ultimately sent to licensed treatment storage and disposal facilities for disposal.

In September 2010, DOE-GO conducted a field assessment of the management of hazardous waste at the STM campus. The assessment identified one finding, three opportunities for improvement, and three noteworthy practices. The finding identified the improper disposal of non-green tipped broken fluorescent light bulbs into the municipal solid waste stream instead of the proper containerization and management as hazardous waste due to the mercury content. Steps were taken to reinforce the training of site personnel on the proper disposal of broken light bulbs. In its assessment, DOE-GO also recommended changes in the management of fluorescent bulbs, waste stream tracking software, and weekly waste inspection procedures as opportunities for improvement. Finally, DOE-GO commented on the high quality of waste characterization processes and procedures, the program for waste management, and the adoption of large quantity generator standards as noteworthy practices.

## 5.7 Storage Tanks

The main function of this program is to ensure that the storage tanks at NREL facilities meet the regulatory requirements of the State of Colorado.

### *5.7.1 Program Management*

Management in this area is consistent with the following NREL programs: Aboveground Storage Tank Management (6-2.7) and Spill Prevention Control and Countermeasures for the South Table Mountain Site (6-2.10), Spill Prevention Control and Countermeasures for the National Wind Technology Center (6-2.17), and Spill Prevention Control and Countermeasures for the Renewable Fuels and Lubricants Research Laboratory (6-2.18). NREL does not have any underground tanks containing hazardous materials.

NREL facilities store diesel fuel for emergency generators and ethanol from research activities in above-ground storage tanks. NREL's tank management program focuses on proper tank design, operation, training, and inspection to protect against spills and leaks. The program is designed to meet regulatory requirements and is more stringent in some aspects than regulations require.

Several important mechanical and procedural safeguards have been incorporated into NREL’s tank management program to prevent any accidental releases of diesel fuel from the storage tanks. Mechanical safeguards include overfill and spill protection, double-wall tanks for diesel fuel equipped with sensors that result in an alarm if the inner tank wall is leaking, and an exterior concrete containment structure for the ethanol storage tank. Procedural safeguards include written operating procedures and tank filling procedures. All tanks larger than 110 gallons are visually inspected once per month.

Due to the quantity of fuels stored on the STM, NWTC, and ReFUEL sites, a Spill Prevention, Control, and Countermeasures plan (SPCC) is required for each of these locations. See Section 5.9 for more information regarding these types of plans.

### *5.7.2 Permitting*

Above-ground tanks larger than 660 gallons require annual registration with the State of Colorado. Currently, only two tanks meet the registration threshold: the SERF emergency generator diesel storage tank and the Process Development Unit (PDU) ethanol storage tank at the AFUF. Both are located on the STM site.

### *5.7.3 2010 Activities*

No spills or releases from NREL's ASTs occurred during 2010.

An informal compliance inspection was performed by NREL EHS staff during September and October, 2010. The purpose of this inspection was to evaluate: the condition of all ASTs and spill containment structures; compliance with AST signage, venting, and other requirements established under the NREL AST Management Program; and if ASTs were in compliance with record-keeping requirements including monthly inspection logs and ullage logs. That informal inspection revealed some signage and record-keeping issues that are being remedied.

Initial compliance inspections were performed on three ASTs in August and September 2010. Those inspections were performed on two new ASTs and one AST relocated from the STM to the NWTC. These inspections are a normal part of the AST Management Program and are performed soon after the AST installation to assure that new tanks meet the NREL AST Program requirements. Should an AST not meet all requirements, this inspection program includes appropriate notification and follow-up with site operations and contractors to assure that those issues are addressed in a timely manner.

The PDU 6,000-gallon stainless steel ethanol storage tank was temporarily removed from service in 2010 to allow replacement of transfer piping between the tank and the PDU. The new pipe trace will be overhead instead of underground, allowing visual inspection of the pipe.

In October and November 2010, DOE-GO performed a surveillance of the management of above-ground storage tanks to evaluate NREL's performance of its responsibilities in this area. The field inspections occurred on November 2, 3, and 4, 2010, and evaluated NREL AST program activities in 10 criteria areas. In its draft report dated December 2010, DOE-GO identified 15 findings, five opportunities for improvement, and three noteworthy practices. The final DOE-GO AST Program Surveillance report was issued in early 2011; details of the surveillance findings and the NREL corrective action plan will be included in the 2011 annual report.

## 5.8 Hazardous Materials Management

Research activities at NREL involve the use of a wide variety of materials, many of which are hazardous or extremely hazardous. This program oversees the reporting requirements applicable to facilities that maintain hazardous materials inventories.

### *5.8.1 Program Management*

Management in this area is consistent with the following NREL programs: Chemical Safety Program (6-4.6) and Asbestos Management Program (6-4.18).

No active or abandoned hazardous waste sites have been identified on any of the laboratory sites. Therefore, many sections of the Comprehensive Environmental Response, Compensation, and Liability Act which cover past releases to the environment do not apply to NREL facilities. Emergency planning and reporting provisions in the Act do apply and are discussed below.

NREL facilities are subject to the EPCRA Section 302 emergency reporting provisions which require a facility to notify the State Emergency Response Commission (SERC) if any extremely hazardous substances in the facility's inventory are stored in quantities greater than prescribed threshold planning quantities (TPQs). NREL facilities first became subject to planning and notification requirements in 1988, but the laboratory inventory of extremely hazardous substances has never exceeded the TPQ.

EPCRA Section 304 requires facilities to immediately notify the SERC and Local Emergency Planning Committee (LEPC) if there is an accidental spill or release of more than the predetermined reportable quantity (RQ).

In accordance with Section 311 and 312 of EPCRA, NREL provides Material Safety Data Sheets for chemicals that are stored on site in quantities greater than TPQs, and provides inventory reporting for these same chemicals in the form of a Tier II report to emergency planning and response groups, such as the SERC, LEPC, and West Metro Fire Rescue District (West Metro).

When requested, NREL provides additional emergency response and reporting information to the Jefferson County LEPC, the SERC, the West Metro Fire Rescue District (West Metro), and the Rocky Mountain Fire Protection District. The Jefferson County LEPC uses hazard categories and threshold reporting quantities as defined by the Uniform Fire Code rather than those specified in SARA Title III, resulting in a larger number of individual hazard categories and lower reporting thresholds. NREL has been represented in the LEPC since its inception and is actively involved in the emergency planning concepts of SARA Title III with two active members on the Jefferson County LEPC.

The laboratory is also subject to reporting requirements in the event of a release of an RQ of any hazardous substance listed by EPCRA. EPCRA Section 313 requires that a toxic chemical release inventory report (Form R) be filed with the EPA for any chemical that is manufactured, processed, or otherwise used in quantities exceeding TPQs. Although NREL is not a manufacturing facility and does not fall within any of the Standard Industrial Classification (SIC) codes for which Section 313 reporting is required, EO 12856 requires all federal facilities to file a report, if applicable, regardless of SIC code. Because NREL has never manufactured, processed, or otherwise used chemicals on the 313 list in quantities exceeding TPQs, the lab has never had to report under Section 313.

Section 112r of the Clean Air Act regulates numerous toxic and flammable substances, and, similar to EPCRA, establishes threshold quantities for these materials. Unlike EPCRA, however, the Section 112r threshold quantity applies to the amount of substance in a single process, not the

entire facility. To date, NREL has not met the thresholds that trigger applicability of Section 112r.

NREL has a laboratory-wide chemical management system (CMS) that serves as a centralized chemical inventory as well as a tool for managing and reporting on chemicals used at the laboratory. Using an electronic bar-coding system, the CMS 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 CMS 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, LEPC, EPA, and DOE).

In 2009, the software and hardware of the CMS system were upgraded to better serve these functions. The EHS organization coordinates the operation of the CMS, but other organizations are critical to keeping the system information up-to-date. The Shipping and Receiving department is responsible for chemical labeling and data entry, the Information Services department provides support for the dedicated server that hosts the CMS, and researchers are responsible for reporting the transfer and disposal of chemicals.

Asbestos surveys have been conducted in a number of NREL facilities, including the Joyce Street Facility, Building 251 at the NWTC, Building 16 at the STM site, the AFUF (only older areas of the building), the FTLB, and the SRRL. No asbestos was found at the Joyce Street Facility and the AFUF. The other facilities have limited amounts of asbestos-containing material in areas such as floor tiles, lab countertops, caulking and sealants, and roofing materials. Asbestos-containing materials are left undisturbed whenever possible. If renovation is planned that will disturb asbestos-containing material, then certified asbestos removal contractors are used and strict asbestos removal procedures are followed. An asbestos management program is in effect for all NREL facilities.

### *5.8.2 Permitting*

NREL obtains annual hazardous material permits from West Metro for the STM and DWOP sites. The permits are required by West Metro. NREL obtains permits for a total of six buildings where hazardous materials are stored, used, or both. Prior to issuing the permits, a representative from West Metro conducts a walk-through inspection of the entire STM site and DWOP.

The ReFUEL facility is within the jurisdiction of the City of Denver Fire Department (DFD) and is subject to the DFD Hazardous Materials Information System (HMIS) requirements. The ReFUEL facility's inventory of listed materials, including various fuels such as biodiesel, must be reported to the DFD annually. The DFD inspects the facility and issues a hazardous materials permit.

### *5.8.3 2010 Activities*

The annual West Metro walk-through inspection of NREL's STM and DWOP facilities for 2010 was conducted in February 2011. Annual hazardous materials permits for the six buildings were issued following the inspection. The CMS was used to provide complete chemical inventories for each facility as part of the permit application process.

## 5.9 Pollution Prevention and Sustainability

The EHS office supports the pollution prevention initiatives that originate in the Sustainable NREL organization.

### *5.9.1 Program Management*

Management in this area is consistent with the following NREL programs: Environmental Management (6-2), Sustainable NREL (2-7), and NREL's EMS description. Most of the activities conducted by the Sustainable NREL program are in the following areas:

- Waste minimization, recycling, and green purchasing
- Transportation
- Energy
- Renewable energy
- GHG emissions
- Water conservation
- Sustainable building design
- Technical assistance and outreach
- Spill Prevention, Control, and Countermeasures (SPCC).

### *5.9.2 Permitting*

NREL has no permit requirements applicable to pollution prevention and sustainability management except as previously indentified under Section 5.1, GHG Reporting and Permitting. As a DOE facility, NREL does set objectives to meet goals established by federal executive orders (e.g., EO 13423) and DOE orders.

### *5.9.3 2010 Activities*

The Sustainable NREL program publishes an annual report that provides the details of accomplishments in the areas of activities listed above. Because the Sustainable NREL program is closely linked to the environmental management system, the program accomplishments of these efforts are covered in Section 4 of this report.

#### *5.9.3.1 Renewable Energy*

NREL has been operating the RFHP since 2008. The purpose of the facility is to generate hot water for comfort heating of several laboratories and the STM site. The RFHP is fueled with waste and pine beetle-killed forest wood. This wood fuel: 1) is a renewable resource; 2) utilizes material that would otherwise result in an adverse impact to the environment; and 3) minimizes

the use of fossil fuel that would be used to generate this heat if this source of energy were not used.

The use of an efficient, clean-burning combustor, staged air injection, advanced cyclone particulate removal system, and emission monitors ensures that air emissions are minimized.

During the winter heating season, the RFHP can use as much as 18 tons per day of waste wood. During the 2010-2011 season, the RFHP received 1,093 tons of fuel which resulted in 9,839 million British thermal units (MBTUs) of hot water delivered to the campus, about one-third of the heat delivered by the central plants in the SERF and FTLB.

#### *5.9.3.2 GHG Emissions*

GHG emissions are inventoried and reported annually by Sustainable NREL. In addition, the GHG emission inventory is evaluated annually to determine if reporting or permitting is required under EPA regulations. This evaluation is addressed in Section 5.1.

#### *5.9.3.3 Spill Prevention, Control, and Countermeasures*

SPCC plans are required by EPA and Colorado regulations for facilities that meet certain oil storage criteria. In general, facilities that store more than 1,320 gallons of oil and a spill has the potential to enter a water of the United States must have a plant that addresses such items as:

- Topography and location of waterways
- Location and quantity of oil sources
- Spill scenarios and travel time to waterways
- Spill prevention and response training
- Spill notification information
- Emergency response plan.

Due to the quantity of fuels stored on the STM, NWTC, and ReFUEL sites, an SPCC plan is required for each of these locations. These plans must, at a minimum, be updated every 3 years or whenever there is a significant change in regulations, operations, or equipment that renders the plan incomplete or inaccurate.

Due to the rapid changes at NREL's STM, NWTC, and ReFUEL facilities and significant changes to EPA SPCC regulations, the SPCC plans for all three facilities were scheduled updates in 2010. By December 2010, a revised ReFUEL SPCC plan was completed and effective and major revisions to the STM and NWTC SPCC plans were near completion. EPA SPCC regulations require that any equipment or container with the capacity to store 55 gallons or more of oil be included in the plan. The reported quantity of oil currently at the STM and NWTC facilities is 18,100 gallons and 12,500 gallons, respectively.

NREL had not had any reportable spills during the last 10 years. However, in September 2010, a contractor on the infrastructure construction project ruptured a fuel tank on a diesel-powered truck and released more than 25 gallons of fuel. Immediate action was taken to clean up the spill, and the event was reported to the state as required. Small incidental spills also occur on occasion.

These are typically very small, incidental hydraulic system leaks and fuel spills during fuel transfer activities. NREL maintains an effective notification and spill reporting program and follows the procedures in the respective SPCC plans for spills that might occur at any NREL facility. NREL maintains spill response carts and caches at multiple locations allowing response and cleanup activities to occur immediately.

## 5.10 Vegetation Management

Vegetation management requires detailed knowledge of the species of plants found at NREL sites, the plant associations or communities established by the species present, and the status of certain species, from those on the threatened and endangered list to those considered invasive species or noxious weeds. Knowledge of the plant communities is used to develop seed mixes for vegetation restoration projects, and the weed list helps in the selection of control methods.

### *5.10.1 Program Management*

Management in this area is consistent with NREL's Weed Management Programs for the STM and NWTC (6-2.12 and 6-2.13, respectively) and the Sustainable Landscape Design and Management Program (6-2.19).

NREL's approach to vegetation management is to conserve existing ecosystems in their natural state as much as possible. There is some landscaping using non-native drought-tolerant species adjacent to some of the buildings, and even a few areas of bluegrass and smooth brome at the STM site. However, the native vegetation and natural character of the landscape is maintained over the majority of both the NWTC and the STM sites.

Revegetation of areas to be left in their natural state following disturbance from construction or other outdoor activities is conducted using a native seed mix of grasses and forbs. These mixes are site-specific and are composed predominantly of native species that were originally present on the site before disturbance. Seed mix and revegetation procedures are outlined in NREL's Storm Water Pollution Prevention Programs for the STM and NWTC sites (6-2.15 and 6-2.16, respectively). The use of native species is required at both the STM and NWTC whenever possible. When feasible, high-water demand species like Kentucky bluegrass are replaced with drought-tolerant native species. A STM vegetation survey was conducted between June 2001 and May 2002 (an updated vegetation survey was initiated in the summer of 2010, and the final report is due in 2011). Five general habitats were described on the STM site, comprising seven plant communities (Plantae Consulting Services 2002). No rare or imperiled plant species were found on the site. Areas of mixed foothills shrublands (also called tall upland shrubland) were identified on top of the mesa within the conservation easement area. This natural community is listed as rare and imperiled by the Colorado Natural Heritage Program. No development will occur in the conservation easement area.

In Colorado, the Department of Agriculture Commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, develops and implements state noxious weed management plans for three categories of weed species. Class A plants are targeted for eradication while Class B species are subject to management plans designed to stop the continued spread of these species. 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. Of the noxious weed species that have been

identified on the STM site, three—Canada thistle, diffuse knapweed, and musk thistle—are Class B species and one, field bindweed, is on the Class C list. As part of the 2010 vegetation survey, mapping of weed areas was done. This information, when finalized in 2011, will be used to assist in targeting weed management areas, in accordance with NREL's Weed Management Procedure (6.2-12).

A three-season vegetation survey of the NWTC site was performed between August 1999 and August 2000 (an updated vegetation survey was initiated in the summer of 2010, and the final report is due in 2011). The 1999–2000 survey defined five general habitats on the NWTC site, comprising nine plant communities and 271 vascular plant species (Plantae Consulting Services 2000). No rare or imperiled plant species were found on the site. However, the survey identified a small area of xeric tallgrass prairie (defined as mesic mixed grassland in this study) located in the southwest corner of the NWTC. This natural community is listed as rare and imperiled by the Colorado Natural Heritage Program. This listing implies no legal designation or regulatory enforcement. It is so designated primarily for management purposes. This area of the NWTC is not impacted by research or construction activities on the site, and was specifically protected during construction activities associated with the installation of a 7-acre photovoltaic array. Preliminary results from the 2010 vegetation study field work identifies the continued presence of the mesic mixed grassland community at the NWTC; it will be described in the final report of the vegetation study in 2011.

Of the weed species identified at the NWTC site, four—Canada thistle, diffuse knapweed, musk thistle, and leafy spurge—are Class B species and one, field bindweed, is on the Class C list. Based on the survey, recommendations were made to continue using a comprehensive weed management program, founded on an integrated pest management (IPM) philosophy. In addition, as part of the 2010 vegetation survey, mapping of weed areas was done. This information will be used to assist in further implementation of the comprehensive weed management program.

The survey showed the native seed mix used for revegetation at the NWTC to be very successful in many areas of the site. NREL is continuing the use this seed mix for revegetation at the NWTC, with one exception—the area beneath the 7-acre PV array in the western portion of the site. Since the native seed mix is comprised of plants that are adapted to full sun conditions, and the land beneath the PV array experiences varying levels of sun and shade, a modification of the seed mix was warranted to include some species that could tolerate those conditions. Weed control efforts have been ongoing since 1997 at the NWTC and 1998 at the STM site. NREL uses an IPM approach that incorporates various types of weed control methods. Some of these include mechanical practices (e.g., mowing), 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 and Canada thistle on the sites. The key aspect of the weed control program is to maintain flexibility to respond to the changes in weed populations from year to year. The recent mapping of areas of weed infestation will help to maintain this flexibility by targeting efforts on areas having the most immediate need of weed control.

In 1998, aerial herbicide application of Tordon 22K was conducted using helicopter application over about 200 acres of the NWTC to target diffuse knapweed. It was very effective in

controlling the weed, and healthy stands of native grasses have proliferated with the decrease in weed competition. Since that time, infested areas of the NWTC have been treated with ground-applied herbicide.

Weed infestations at the STM site are much less severe than at the NWTC. Limited ground application of herbicides has been conducted at the STM since 1998.

NREL promotes the sustainable management of its government-owned land by practicing environmentally sound, cost-effective landscaping practices. These practices reduce adverse impacts to the natural environment while providing essential shade and cooling for indoor and outdoor spaces, and a more aesthetically appealing appearance for the sites. This commitment is implemented by a sustainable landscape design and management program. This commitment was demonstrated in the spring of 2010, by the sustainable landscape design used at the new RSF building. Design features included the use of native plants, recycled materials, and water conservation features. The result is an attractive campus where employees can feel as though they are part of the surrounding environment, and landscaping that also provides wildlife habitat (i.e., spaces for nesting birds, plants for pollinators such as hummingbirds, and protective cover for other species).

### *5.10.2 Permitting*

There is no permitting applicable to vegetation management, although there is a state weed law that requires property owners to control certain species of invasive weeds (e.g., diffuse knapweed). For application of certain types of herbicides designated as "restricted use" by the EPA, a certified applicator must be used.

### *5.10.3 2010 Activities*

2010 activities included updated vegetation surveys, resulting in Geographical Information System map layers of plant communities and weed areas; implementation of sustainable landscape practices following construction of the RSF, and modification of the seed mix used at the NWTC to accommodate partial shade conditions beneath the 7-acre PV array.

NREL routinely practices IPM using various weed control methods, as described in the previous section. These are implemented during the normal course of site operation. In addition to the revegetation, off-road driving restrictions, and other weed control methods, ground applications of herbicides are used. Very limited herbicide applications were made on the STM and NWTC sites in the summer and fall of 2010, focusing primarily on areas adjacent to roadways and buildings. A total of six applications were made at the STM site, and one at the NWTC. The spraying was performed using a four-wheel-drive vehicle or hand-operated sprayers. Primary target weeds were diffuse knapweed, leafy spurge, Canada thistle, common teasel, and hoary cress at the NWTC. At the STM, target weeds were mainly diffuse knapweed and Canada thistle with small areas of Dalmatian Toadflax.

In 2006, the weed management plans for the NWTC and STM were consolidated into an integrated weed management plan. Weed management activities used in 2010 were consistent with the integrated plan.

A master plant list for NREL was compiled in 2007. This list is based on information gathered during comprehensive vegetation surveys of the STM and NWTC completed in FY 2000-2002 by Plantae Consulting Services. An updated vegetation survey was initiated in the summer of 2010, and the final report is due in 2011.

## 5.11 Wildlife Management

Similar to the Vegetation Management Program, knowledge of the species present at NREL sites is the foundation of the wildlife program. As a result, most of the activities in this area are survey oriented. There are few active wildlife management practices at NREL, but site activities are managed with wildlife protection in mind.

### *5.11.1 Program Management*

Wildlife program activities include planning and implementing new comprehensive surveys of wildlife at both the STM site and the NWTC site in support of pending environmental assessments, conducting breeding bird surveys in areas of construction or other research activity, maintaining compliance with Migratory Bird Treaty Act requirements, including avian protection planning, and representing wildlife interests in campus planning and development activities, such as the design of wildlife-friendly fencing for south access improvements or recommending bird-friendly glass for bus shelters and other structures.

### *5.11.2 NWTC Site*

The NWTC site is located in the transition zone between the Great Plains and the Rocky Mountains, resulting in habitat that contains elements from both mountain and prairie ecosystems. Wildlife habitat at the NWTC comprises grasslands, woodlands, shrublands, and wetlands, providing a variety of habitat for mammals, birds, reptiles, and amphibians. The DOE prepared a biological characterization inventory for the adjoining Rocky Flats Plant, including the NWTC, in 1992. At that time, 11 mammals and eight species of reptiles or amphibians were documented. Representative species currently using the site include deer mouse, prairie vole, desert cottontail, coyote, mule deer, prairie rattlesnake, bullsnake, plains garter snake, and tiger salamander.

**Figure 7. Mule deer and solar panels at NWTC**

Source: Brenda Beatty (PIX18234)

Following the 1992 inventory, field surveys of avian use patterns at the NWTC were conducted in 1994 and 1995 to identify potential impacts of wind-turbine research on birds. Several species of raptors, including red-tailed hawk, American kestrel, and great-horned owl, were noted on the site, primarily resting and hunting, although a pair of kestrels were found nesting during the spring. Birds of prey of concern, such as eagles, generally fly in excess of 152 meters (500 ft.) over the site. No significant impacts to the birds from NREL activities were found during these surveys.

In early 2001, a year-long monitoring project for birds and bats was initiated at the NWTC (Armstrong et al. 2002). Standardized plot surveys were conducted to document the occurrence of songbirds and raptors on the site and adjacent undeveloped areas. This work also included systematic searches of turbines and meteorological towers to document avian mortality. The study was completed in July 2002. Notable findings of the study were as follows (Schmidt et al. 2003):

- Abundances of individual raptor species on the NWTC site were similar to surrounding areas. However, the average number of species detected per count at the NWTC was nearly double that of surrounding areas in winter, the season when raptors are most abundant in the region. This difference is likely attributable to increased availability of perches at the site. Raptors flew and perched higher at the NWTC than in adjacent areas, again probably related to the wind turbines and other structures at the site.
- Forty-six bird species were counted on grassland plots during this study. Only one differed in abundance between the NWTC and adjacent areas; the horned lark was about 16 times more common off site. This difference is attributable to cattle on Boulder open space, creating low-stature grasslands preferred by this species.

- Bird abundance and variety on the undeveloped southern portion of the NWTC site were generally similar to the developed areas, except for the relative scarcity of raptors on the undeveloped site, which probably was due to a lack of perches.
- The NWTC does not support a large diversity or abundance of bat species (possibly six species of bats use the site), but an area on the northwest side of the site, with trees close to a rocky outcrop, provides foraging and potential roosting habitat.
- No raptor carcasses were found during the 12-month survey of the NWTC except one American kestrel that had died before the study started. Bird mortality associated with the site appears to be minimal. Extrapolating from four passerine (songbird) carcasses found during the searches, estimated annual bird mortality attributable to NWTC activities was 24 individuals, all songbirds (Passeriformes). Most of these deaths were probably the result of collisions with support wires for the meteorological towers rather than the turbines themselves. No evidence was found of bat fatalities at the site.

### *5.11.3 STM Site*

Similar to the NWTC, the STM site is located in the transition zone between the Great Plains and the Rocky Mountains, resulting in habitat that contains elements from both mountain and prairie ecosystems. Wildlife habitat at the STM site is primarily grasslands and shrublands, which supports a variety of wildlife species including birds, mammals, reptiles, and amphibians. The variety of vegetation types attracts species that may use the site as year-round habitat, for breeding only, during migration, or as winter habitat.

**Figure 8. Young rabbit at RSF**

Source: Barb O'Kane (PIX 19583)

Wildlife surveys were conducted on the STM site in 1987 (with follow-up verification surveys conducted in 1998 and 1999) and 2005. A site-wide wildlife survey of the STM site began in April 2004 and was completed in June 2005. The most recent wildlife study was initiated in July 2010, as discussed in Section 5.11.5 below. The objectives of the survey were to update existing data in light of expanded development of both the site and the surrounding area, and to develop

best management practices for future construction projects to maximize protection for site wildlife.

The survey included large and small mammals, predators, migratory birds and raptors, upland game birds, and invertebrates identified on an opportunistic basis (i.e., only as they are found during other surveys). A list of species observed at NREL is found in Appendix B; it includes the species observed during the year-long STM wildlife survey.

**Figure 9. Scrub-jay often found at STM**

Source: Bob Fiehweg (PIX 19582)

Baseline biological characterization studies have begun on the STM in preparation for a NEPA environmental assessment (EA) planned in the future. These baseline surveys will provide information for the affected environment sections of the EA and will make comparisons to past baseline studies. A completed final report is not available at this time, therefore no results are provided here.

Several ground-nesting bird surveys were conducted at the STM in advance of planned construction activities associated with the ongoing construction of the Research Support Facility, infrastructure projects, and new parking lots. No active nests were found during any of these surveys, and construction activities were allowed to proceed.

### *5.11.4 Permitting*

Scientific collection licenses must be obtained from the Colorado Division of Wildlife for the small mammal trapping portion of the wildlife surveys; the trapping permit is the responsibility of the successful contractor, not NREL. NREL has no other permitting requirements for this area of environmental management.

### *5.11.5 2010 Activities*

As noted above, a number of wildlife surveys and studies have been initiated at both the STM campus and the NWTC. The 2010 activities are described below.

### *5.11.5.1 Avian and Wildlife Surveys and Studies*

Many species of migratory birds may be observed on both the STM site and the NWTC, with many potentially nesting on site. Additionally, both sites provide important migration and winter habitat. In compliance with the Migratory Bird Treaty Act, surveys for ground-nesting birds were completed prior to activities that could adversely affect such species as Western Meadowlark and Vesper Sparrow. Surveys were conducted during the nesting season, from mid-April through mid-September. If an active nest was found, a buffer zone was set up around the nest to avoid impacts to nests during site activities. In 2010, ground-nesting bird surveys were done at the NWTC in areas slated for construction including the installation of new wind turbines.

Several species of raptors have been recorded at the STM site and two species, red-tailed hawk and American kestrel, are known to nest on site. No construction activity in 2010 impinged on known nests of raptors at the STM site. Raptors also use the structures at the NWTC for perching and are often seen hunting over parts of the site. In 2010, no raptors were known to have nested on the NWTC.

Avian and bat surveys have resumed at NWTC in 2010 with several studies. These studies include avian use and avian and bat mortality studies, baseline wildlife surveys, and spring raptor surveys. The avian use and avian and bat mortality studies will compare bird use on site and off site and compare to results in 2003 (Schmidt et al. 2003) and in 1995 (Monahan 1996). EHS staff began implementation of the avian monitoring study in January 2010 by conducting weekly surveys of the 12 fixed-point locations described in the 2009 methodology (Western Ecosystems Technology 2009). EHS began the study while contractor selection was underway. The EHS fixed-point surveys continued into July when a contractor was selected to complete the year-long fixed-point surveys and conduct the additional transect and mortality studies. Another study is a systematic search for bird and bat mortalities at the NWTC.

Baseline biological characterization studies have begun on the NWTC in preparation for a NEPA environmental assessment planned for 2010-2012. These baseline surveys will provide information for the affected environment sections of the EA and will make comparisons to past baseline studies. Neither the avian use nor baseline biological studies have completed a final report, therefore no results are provided here. The final baseline study and avian monitoring reports are due in 2011.

A spring raptor survey was conducted at the NWTC during the month of April 2010; a final report was prepared by the contractor detailing the daily observations. These data are being compared to the April data collected at the Dinosaur Ridge Hawk Watch Program conducted further south in Jefferson County and will be reported as part of the comprehensive avian study at the NWTC expected in 2011.

### *5.11.5.2 Bat Acoustic Monitoring*

One aspect of the wildlife surveys is of particular note. From July through November 2010, an acoustic monitoring device was operated near the western perimeter of the NWTC to record bat vocalizations. A sound-activated recording device sensitive to the frequency range of bat sounds was mounted on the 80-meter meteorological tower. Sounds were recorded for later analysis. Because the sonograms of many bat species are unique, it is possible to identify the types of bats

that occur in this area. The preliminary results showed a high number of bats in the area—more than 12,000 vocalizations recorded in 125 nights. Fully three quarters of the recordings could be distinguished to species or species groups, with the genus *Myotis* being the most common. Most of the recordings were made in July and August, suggesting that the bat population was resident rather than migratory. The data collected during this phase of the baseline study are still being analyzed and will be included in the final report due in 2011.

### *5.11.6 Planning Activities*

Planning activities for 2011 primarily involve the continuation and completion of the wildlife survey activities and the avian monitoring work. Bird and bat mortality surveys and the breeding bird transects will also be completed in 2011. The final reports for these efforts will be generated, reviewed, and finalized in 2011. The need for ground-nesting bird surveys is anticipated. NREL is also planning to install bat acoustic monitoring stations to continue data collection on bat presence and abundance.

**Figure 10. Ring-necked ducks found in winter at DWOP**

Source: Bob Fiehweg (PIX 19584)

## 5.12 Endangered Species/Species of Concern

The catalog of plant and wildlife species at NREL sites maintained by their respective programs may include species identified as threatened and endangered or species of concern. If present, NREL implements additional protective measures.

### *5.12.1 Program Management*

The Endangered Species Act (ESA) provides for the designation and protection of wildlife, fish, and plant species that are in danger of extinction, and preserves the ecosystems on which these species depend. For the purposes of site wildlife surveys, a species of concern is defined as one protected under federal statutes, including the Endangered Species Act of 1973, as amended, the Bald and Golden Eagle Protection Act of 1940, as amended, and the Colorado Division of Wildlife list of endangered, threatened, and wildlife species of concern. Federal agencies are also required to abide by the Migratory Bird Treaty Act of 1918, as amended, but for this report, these species are not included as species of concern. For plant surveys, the Colorado Natural Heritage

Program designation is also considered. Although the program's listing of rare species is not regulatory in nature, NREL uses it for management purposes.

The U.S. Fish and Wildlife Service (USFWS) lists seven species in accordance with the Endangered Species Act as threatened, endangered, or a candidate for listing that could potentially occur in Jefferson County. Of these seven species, three have potential to occur on the STM or the NWTC sites. These are the Preble's meadow jumping mouse, the Ute ladies'-tresses orchid, and the Colorado butterfly plant. In 2009 and 2010, surveys for all three of these species were conducted in likely habitats at the STM and the NWTC.

Survey results demonstrated that these three species do not occur at either site. The USFWS has been informed of the survey results and concurs with NREL staff biologist's findings. In fact, the USFWS has included the STM site and adjacent lands along Lena Gulch to the South as part of the Denver Metro Area Preble's Mouse Block Clearance Zone at the request of NREL. Areas within the block exclusion zone, including the STM, are relieved of the Endangered Species Act requirements to conduct surveys for the Preble's mouse on a project-by-project basis. The block clearance is reviewed every 5 years and can be renewed with boundary changes. The NWTC is not included in the block clearance and is adjacent to areas designated as critical habitat for the Preble's mouse on the USFWS Rocky Flats Wildlife Refuge. Conservation of drainage ways and wetlands on the NWTC may indirectly benefit the Preble's mouse in downstream areas of Rock Creek.

Of the State of Colorado's species of concern, six species may potentially occur at the STM site or at the NWTC site. None of these species were observed during any of the site surveys conducted in 2010. However, two species, the bald eagle and the black-tailed prairie dog, are resident nearby or have been resident on the NWTC in the past.

- A colony of black-tailed prairie dogs was moved to the northwest corner of the NWTC in 2009. However, since that time, sylvatic plague has greatly reduced prairie dog populations in northern Jefferson County and southern Boulder County. The NWTC colony was reduced to a few individuals in 2010, but in time should re-colonize.
- In 2010, a bald eagle nest was active along Coal Creek approximately 1.5 miles north of the NWTC. There have been no observations to date of bald eagles over the NWTC but there have been observations over adjacent Rocky Flats Wildlife Refuge.

Preliminary results from the comprehensive vegetation surveys conducted at both the STM campus and the NWTC in 2010 indicate that no endangered or threatened plant species are present on NREL facilities. As noted in previous surveys and reconfirmed during the 2010 field work, the remnant mesic mixed grassland community continues to be present at the NWTC. While not a community of threatened or endangered species, this plant association has been recognized as rare and imperiled by the Colorado Natural Heritage Program. The area is located in an area away from current construction activities and none are anticipated in close proximity to this community. As noted above, steps are taken to protect the area, such as during the installation of the nearby 7-acre PV array.

### *5.12.2 Permitting*
NREL has no permitting requirements for this area of environmental management.

### *5.12.3 2010 Activities*
In 2010, the presence of the non-native Eurasian Collared Dove continued at NREL's STM site and the species was first found at the NWTC. This invasive species, first spotted at STM in 2006 as a new avian species, had just begun to inhabit the Denver area at that time. The Eurasian Collared Dove is native to Asia and Europe, but after its introduction into the Bahamas in the 1970s and its first appearance in Florida in 1982, it has spread rapidly across North America. The Colorado Division of Wildlife considers this species to be a threat to native avian species.

## 5.13 Wetlands/Floodplains
Management in this area is consistent with the following NREL programs: Stormwater Pollution Prevention for Construction Activities at the STM (6-2.15), Stormwater Pollution Prevention for Construction Activities at the NWTC (6-2.16), and Environmental Permitting and Notification (6-2.1).

Wetlands are defined by the Environmental Protection Agency and the U.S. Army Corps of Engineers (USACE) as areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Wetlands became regulated in 1972 when, under the Clean Water Act, the definition of waters of the United States was expanded from only those waters capable of supporting interstate or foreign commerce as defined under the Rivers and Harbors Act of 1899, to waters that also include tributaries to navigable waters, interstate wetlands, wetlands which could affect interstate or foreign commerce, and wetlands adjacent to other waters of the United States.

Wetlands that meet hydric soils, vegetation, and hydrologic criteria, are protected under the Clean Water Act Section 404, which is administered by the USACE, with program oversight provided by the EPA. Areas that do not meet the criteria established by the USACE may perform wetland functions and serve as valuable ecologic components, but do not fall within the jurisdiction of the USACE and are therefore not protected or regulated under Section 404 of the Clean Water Act.

In early 2009, the USACE was invited to the STM site to determine whether the observed wetlands and drainages that cross the STM site are considered jurisdictional and therefore regulated by the USACE. The following six drainages were identified:

- East Drainage (east of the Visitor Center)
- Middle Drainage (originating upstream of the amphitheater and flowing between the Field Test Laboratory Building and the Solar Energy Research Facility)
- Middle West Drainage (above the Thermal Test Facility)
- West Drainage (near the west entrance gate)

- Jefferson County Easement Drainage (south of Denver West Parkway and east of the "lower 25")
- Roadside drainages and trickle channel drainages (constructed drainages generally on the north side of Denver West Parkway).

Following their site visit, the USACE issued a letter stating that all drainages examined were considered upland swales vegetated with upland vegetation and are, consequently, not regulated/protected by the USACE. They provided a jurisdictional determination documenting their finding. The USACE jurisdictional determination, valid for 5 years (through April 27, 2014), enables NREL to perform work in the upland swales/wetlands without a USACE permit. While the USACE did not consider wetlands located at STM to be jurisdictional, NREL regards them as ecologically functional wetlands. Vegetation surveys in 2000 and 2001 at STM and the NWTC identified wetland areas totaling 0.3 hectares, or ha, (0.75 ac) and 0.4 ha (1 ac), respectively. The areal extent of these wetlands was reconfirmed during the 2010 vegetation studies. These areas will continue to be protected for the benefits they provide which include water quality filtration, attenuation of stormwater flows, and habitat for site fauna.

In 2010, NREL and DOE began working with USACE regarding the designated wetlands complex associated with Lena Gulch that would be impacted by the proposed south access road to STM. Filing for a 404 permit and mitigation activities would occur in 2011. Also in 2010, the vegetation surveys at both the STM and NWTC identified plant species characteristic of wetlands; the extent of the occurrence of these species will be described in the final vegetation survey reports due in 2011.

## 5.14 Cultural Resources

NREL's STM site has had a long history as a location with a variety of human uses over the decades. The cultural resources program oversees preservation of artifacts that may be found at any of the NREL facilities. The program defines archaeological resources as:

> *Material remains of past human life or activities that are of archaeological interest and at least 100 years of age including, but not limited to, pottery, basketry, bottles, weapons, weapon projectiles, tools, structures or portions of structures, pit houses, rock paintings, rock carvings, intaglios, graves, human skeletal materials, or portions or pieces of such items.*

### *5.14.1 Program Management*

Cultural resources are protected under Section 106 of the National Historic Preservation Act of 1966, as amended. Significant cultural resources are either eligible for, or listed in, the National Register.

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 any other reason. 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 (e.g., arrowheads and bottles). 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 because of its association with cultural practices or beliefs of a living community that are rooted in the community's history, and are important 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.

#### *5.14.1.1 Site Surveys*

Three formal surveys of historic and cultural resources have been performed on the STM site. These surveys were completed in 1980, 1987, and 2003. Two additional surveys of the Camp George West district involving the STM site have also been conducted.

As a result of these STM surveys, three historical sites were recognized as significant cultural resources that should be preserved. These sites include an open-air amphitheater, a stone bridge spanning a natural drainage channel adjacent to the amphitheater, and a stone and concrete ammunition bunker below the amphitheater site. The three structures were constructed during the Works Progress Administration era in the 1930s. Through NREL's efforts, these sites have been added to the National Register, with the amphitheater and stone footbridge listed together as a single site. NREL also participated in an interagency survey of STM and Camp George West to identify historic structures and sites eligible for nomination to the National Register.

The Camp George West Historic District, also listed on the National Register, includes the 25-acre parcel of NREL's site, south of Denver West Parkway which crosses the campus from east to west. Two types of historic archaeological resources (firing range lines and a low rock wall) have been identified on this parcel. These resources have been determined to contribute to the National Register eligibility of the Camp George West Historic District.

The Camp George West Historic District overlaps the NREL STM property by 25 acres. Two contributing resources occur within those 25 acres. Contributing resources are those features within a historic district that contribute to the district's overall eligibility for the National Register.

A 2003 cultural resource survey was conducted of the 25-acre parcel south of Denver West Parkway on the STM site. The survey confirmed the existence of the contributing features to the

Camp George West Historic District occurring within the 25-acre parcel. The contributing resources are:

- Two firing lines located on the 25 acres. There are also firing lines located south of the NREL property on land owned by Jefferson County Open Space and proposed for development as the Camp George West Park.
- Portions of a low rock wall are also present on the 25 acres. There is also a rock wall located south of the NREL property.

DOE consulted with the Colorado State Historic Preservation Officer (SHPO) under Section 106 of the NHPA regarding the significant resources located on the 25 acres. DOE and the SHPO agreed that the development of the parcel would result in an adverse affect to those resources and subsequently entered into a memorandum of agreement where DOE agreed to perform further surveys to fully document the resources on the 25 acres prior to any development of the parcel.

In 2005, DOE-GO and NREL conducted documentation of the Camp George West firing range lines and low rock walls, which contribute to the Camp George West Historic District's eligibility to the National Register. The documentation resulted in Level II documentation from the Historic American Buildings Survey (HABS) and the Historic American Engineering Record (HAER) that consisted of mapping, photographs, and detailed description of the resources. The documentation was submitted using archival quality materials to the SHPO in late 2005.

In January 2006, the Camp George West Level II HABS/HAER documentation (originally dated August 2005) was revised to include field drawings of the "low rock wall" as requested by the Colorado SHPO. This was the final report submitted to the SHPO. It is on file with the Colorado SHPO.

Also in CY 2006, a site survey for cultural resources was conducted in support of NREL/DOE EAs for the first of three site development projects (RFHP, and two potential solar field sites). The RFHP EA was completed in early summer 2007.

An archaeological survey of the NWTC site was conducted in support of the 1996 environmental assessment to supplement previous surveys so there were no gaps in cultural surveys on the site. No significant historical or archaeological resources were identified. However, the wooded ridge area on the west portion of the site was identified as a location with potential for cultural resources, so further testing or observation during excavation would be done should there be any future need for work in the utility corridor in the vicinity of the ridge.

### *5.14.2 Permitting and Requirements*

NREL has no permitting requirements for this area of environmental management. In order to comply with cultural resource protection requirements, NREL instructs construction contractors at their site orientation that in the event they discover any evidence of cultural resources during ground-disturbing activities at the STM or NWTC sites, they are to stop all work in the vicinity until a qualified archaeologist evaluates the significance of the find.

### *5.14.3 2010 Activities*

In 2010, construction activities were completed on the first phase of the Research Support Facility and initiated on the second phase near the site entrance building. During the preliminary excavations, a few items were unearthed that were reviewed under the Cultural Resource Management procedure; while of interest, none were found to be of unique value.

In August 2010, a Class III Cultural Resource Inventory was completed on the final configuration of the access road corridor, which lies within the Camp George West Historic District. The inventory identified three features that could be impacted by the construction of the new access road, including two previously documented features, rifle range firing lines associated with the former Camp George West, and an undocumented linear drainage ditch feature. In December 2010, Section 106 consultations for the proposed south access road to the STM began with Colorado SHPO and other consulting parties, and a copy of the inventory report was provided to the SHPO. SHPO concurred that the two firing line features remained contributing features of the Camp George West Historic District and the proposed access road would result in an adverse effect to these features. Discussions on mitigation alternates continued through December 2010, and a memorandum of agreement is expected in 2011.

## 5.15 NEPA Program

### *5.15.1 Program Management*

Management in this area is consistent with NREL's NEPA Implementation Program (6-2.2). As a federal agency, DOE is obligated to comply with NEPA by evaluating the potential for environmental impacts prior to conducting its activities or actions. Potential effects are considered in categorical exclusions or environmental assessments. Environmental analysis under an EA that finds potentially significant effects necessitates the preparation of an Environmental Impact Statement. NEPA compliance for minor or routine activities are documented through the use of a NEPA worksheet. For larger, more complex projects that meet certain criteria, a NEPA checklist is used which requires a more detailed review and DOE concurrence. The Council of Environmental Quality (CEQ) issues regulations for compliance with the Act. DOE has also issued implementing regulations at 10 CFR 1021 that complement the CEQ requirements including listing classes of actions that require the level of documentation mentioned above or that are categorically excluded from further NEPA review.

In accordance with the requirements of DOE NEPA implementing regulations, NREL has prepared site-wide EAs for its activity at the STM site and DWOP, and separate EAs for the NWTC and JSF activities (U. S. Department of Energy 1993, 1998, 2002, 2003, and 2007). Supplemental EAs have been prepared for STM projects that tiered off of the STM site-wide EA (DOE 1440-S-I 2008 and DOE 1440-S-II 2009). NREL has established procedures, with the approval of the DOE-GO, to assist DOE in meeting their NEPA obligation. Proposed activities are evaluated for their potential environmental effects using the appropriate level of NEPA review in conjunction with DOE-GO.

The NREL NEPA Handbook has been prepared to provide NREL project managers and procurement specialists with guidance on implementing the NEPA procedures, and training is provided to staff, as appropriate.

### *5.15.2 Permitting*
NREL has no permitting requirements under NEPA.

### *5.15.3 2010 Activities*
During 2010, numerous NEPA reviews of both onsite and offsite activities occurred through completion of NEPA worksheets and NREL environmental checklists. In 2010, over 500 worksheets and 45 checklists were reviewed by NREL.

In November, the supplemental EA (DOE 1440-S-II) for the south access road, Energy Systems Integration Facility and Infrastructure was completed and a Finding of No Significant Impact (FONSI) was issued. Completion of this document and FONSI allowed work to begin on these projects.

Because environmental assessments must be reevaluated every 5 years, planning began in 2010 for updates to the site-wide EAs for both the STM campus and the NWTC. Wildlife and vegetation surveys have been initiated at both facilities to support the future NEPA evaluations. Supportive survey reports are expected in 2011.

In 2008, DOE issued the Final Supplement to Final Site-Wide EA of the NREL STM Complex (DOE/EA 1440-S-1), which received a FONSI. As a condition of the FONSI, a Mitigation Action Plan (MAP) was developed to address a DOE determination that there are potential environmental impacts from these projects that require mitigation to assure that the impacts do not become significant. The MAP identified steps that would be taken to reduce traffic impacts resulting from the transfer of approximately 800 employees to the new RSF. Implementation of the mitigation measures is divided into three phases: 1) Startup (2008 – 2010); 2) Occupancy; and 3) Buildout. NREL took ownership of the RSF in June 2010 and immediately began moving employees into the new workspace. By year's end, approximately 650 of the expected 800 occupants had arrived. In 2010, several key mitigation measures set forth in the MAP were implemented or continued, including transit and vanpool fare subsides, telecommuting and flextime, and having a transportation coordinator on staff to ensure compliance with the MAP.

The MAP also requires that a report of the implementation and effectiveness of the STM mitigation measures be published in the Annual Site Environmental Report after occupation of the RSF, now expected to be early 2012.

## 5.16 Radiological Program
As a research facility, NREL has certain equipment that uses radiological sources, and periodically, experiments are conducted using radioactive isotopes. These materials are managed under this program.

### *5.16.1 Program Management*
Management in this area is consistent with the following NREL programs: Air Quality Protection (6-2.5) and Radiation Safety (6-4.5). All radioactive material at NREL facilities is handled according to NREL's Radiation Safety Program. Elements of the program include a Radiation Safety Committee, a Radiation Safety Lab-Level Procedure, safe operating procedures, safe work permits, radiological control areas and postings, monitoring, training (Rad

Worker 1: Radiation Equipment Safety and Rad Worker 1: Radiation Materials Safety), and purchasing controls for radioactive materials.

NREL's radiation sources are either used or stored in facilities located on the STM site. These include three x-ray diffraction machines at the SERF and one at the FTLB. In addition, one laboratory at the FTLB, on the STM site, occasionally uses small quantities of radioisotopes for biological labeling. All x-ray generating machines are inspected annually. A state-licensed surveyor inspects and certifies the x-ray machines and audits NREL's program for radiation safety in connection with operating the machines every other year. NREL's radiation safety officer conducts the inspections in alternating years.

Monitoring of equipment and facilities for removable contamination is performed in the laboratory where radioisotopes are used. Wipe tests are performed on any laboratory surfaces that could have become contaminated by the radioisotope work at least monthly and more frequently if needed. These wipes are analyzed using a scintillation counter.

DOE Order 5400.5, "Radiation Protection of the Public and the Environment," established radiation emission limits for DOE facilities. Such emissions are also regulated by Section 112 of the Clean Air Act as implemented by 40 CFR 61, Subpart H, promulgated by the EPA. 40 CFR 61 established National Emission Standards for Hazardous Air Pollutants (NESHAPs), and, more specifically, Subpart H, sets such standards for radiological materials, known as Rad NESHAPs. DOE facilities, including NREL, must annually demonstrate compliance with the Rad NESHAP, which limits emissions to amounts that would prevent any member of the public from receiving an effective dose of 10 millirem per year (mRem/yr) or greater. Radioactive air-emission monitoring is not required to be conducted at NREL because of the extremely low usage of radioactive material. Instead NREL demonstrates compliance with the Rad NESHAPs in 40 CFR 61, Subpart H, by utilizing the EPA's COMPLY computer model to determine the effective dose equivalent to the public.

In 2010, the effective dose equivalent to the public was 0.017 mRem/yr.

All radioactive waste generated during NREL activities is classified as low-level waste. Waste from the STM site is temporarily stored at the STM Waste Handling Facility (WHF) until disposal is arranged at an offsite facility permitted to accept low-level radioactive waste.

### *5.16.2 Permitting*

NREL does not have a radioactive materials license from the State of Colorado, as the laboratory is currently under DOE jurisdiction for radioactive materials handling.

# 6 Conservation Easement Lands

In 1999, DOE granted a conservation easement for 177 acres of the STM site to Jefferson County. The purpose of the conservation easement is to preserve the natural character of the property, including its visual, biological, and recreational resources, especially in relation to the changing land uses adjacent to the NREL site and within the region.

The goals of the easement are to:

- Retain, preserve, and protect natural, scenic, ecological, and historical aspects of the conservation easement property
- Protect the ecosystem of the STM area and the sustainable habitat for diverse vegetation, birds, and terrestrial animals
- 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.

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 (Department of Energy Golden Field Office 1999). The baseline inventory includes a description of the geographical setting and adjacent 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).

Jefferson County began the development of the South Table Mountain Management Plan in 2000, with a final version approved by the Jefferson County Open Space Advisory Committee and the Board of County Commissioners in 2004.

## 6.1 2010 Property Assessment

During 2010, there was no NREL activity on the conservation easement property having the potential to degrade the environmental condition of the property. Jefferson County Open Space conducted a site inspection during the summer of 2004; no degraded conditions or other environmental issues were found.

Jefferson County Open Space has the responsibility to establish and maintain formal trails on the conservation easement property. The trail plan calls for establishing trails in phases. The first phase began in 2004, with Jefferson County Open Space installing two trails from Denver West Parkway (near the NREL site entrance) to the mesa top. Routine trail maintenance occurred in CY 2010.

# 7 Contacts for Feedback or More Information

We welcome your feedback and suggestions on this report and on NREL's efforts at sustainability and environmental stewardship. To provide comments or to obtain additional information about NREL's environmental and sustainability programs, please contact:


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NREL- August 2011

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# 9 Appendices

## Appendix A – Summary of NREL Environmental Permits and Notifications

| Category | Document Number | Permit or Reg. Holder | Document Type | Description | Issuing Agency | Status |
|---|---|---|---|---|---|---|
| Notification | COR000207563 | DOE | Hazardous Waste Generator | Notification of Regulated Waste Activity; ReFUEL | CDPHE Hazardous Materials and Waste Management Division (HMWMD) | In Effect |
| Notification | COD980805162 | DOE | Hazardous Waste Generator | Notification of Regulated Waste Activity; JSF | HMWMD | In Effect |
| Notification | COD983802448 | DOE | Hazardous Waste Generator | Notification of Regulated Waste Activity; NWTC | HMWMD | In Effect |
| Notification | CO4890000017 | DOE | Hazardous Waste Generator | Notification of Regulated Waste Activity; DWOP | HMWMD | In Effect |
| Notification | CO3890090076 | DOE | Hazardous Waste Generator | Notification of Regulated Waste Activity; STM | HMWMD | In Effect |
| Notification | N/A | DOE | Air | Facility Notification - Chlorofluorocarbons | CDPHE Air Pollution Control Division (APCD) | In Service |
| Other | Army Corps File# NWO-2009-1014-DEN | Alliance | Wetlands | Jurisdictional Determination, STM wetlands | United States Army Corps of Engineers (USACE) | Active |
| Other | Army Corps File# NWO-2009-1014-DEN | Alliance | Wetlands | Jurisdictional Determination, Jeffco Open Space | USACE | Active |
| Permit | AFP-CO-00255 | DOE | Alcohol | AFUF/PDU, 500-proof gal max production | U.S. Department of the Treasury Alcohol and Tobacco Tax and Trade Bureau (TTB) | In Effect |
| Permit | TF-CO-0331 | DOE | Alcohol | Industrial Alcohol User Permit, NREL-wide | TTB | In Effect |
| Permit | PWSID # CO0230860 | DOE | Drinking Water | Non-community supply of hauled water from a surface water source | CDPHE Water Quality Control Division (WQCD) | In Effect |
| Permit | 07JE0277 | DOE | Air | Air Permit and APEN update; RFHP | APCD | Active |

| Category | Document Number | Permit or Reg. Holder | Document Type | Description | Issuing Agency | Status |
|---|---|---|---|---|---|---|
| Permit | 10JE1400 | DOE | Air | Air Permit and APEN update; RSF I Genset | APCD | Active |
| Permit | 10JE1630 | DOE | Air | Air Permit and APEN update; FTLB Genset | APCD | Active |
| Permit | 10JE1712 | DOE | Air | Air Permit and APEN update; Site 4.0 Genset | APCD | Active |
| Permit | 99JE0400 | NREL/DOE | Air | Air Permit and APEN update; TCPDU, F-131 | APCD | Active |
| Permit | 08JE0889L | DOE | Air | APEN (land development) STM | APCD | Active |
| Permit | 04JE1442L | DOE | Air | APEN (land development) NWTC | APCD | Inactive |
| Permit | 04JE1443L | DOE | Air | APEN (land development) STM | APCD | Inactive |
| Permit | P15-07-00003 | NREL | BioSafety Permit | Sugarcane Bagasse | USDA Animal and Plant Health Inspection Service (APHIS) | Inactive |
| Permit | PDEP-07-00222 | NREL | BioSafety Permit | Wheat Streams | APHIS | Inactive |
| Permit | PDEP-06-00178 | NREL | BioSafety Permit | Oryza sativa leaves and stems | APHIS | Inactive |
| Permit | 37232 | SERI | Ground water (GW) | Permit to Construct a Well (MW-1) | Colorado Department of Natural Resources (DNR) | Active |
| Permit | 37229 | SERI | GW | Permit to Construct a Well (MW-2) | DNR | Active |
| Permit | 37228 | SERI | GW | Permit to Construct a Well (MW-3) | DNR | Active |
| Permit | 37231 | SERI | GW | Permit to Construct a Well (MW-4) | DNR | Active |
| Permit | 37230 | SERI | GW | Permit to Construct a Well (MW-5) | DNR | Active |

| Category | Document Number | Permit or Reg. Holder | Document Type | Description | Issuing Agency | Status |
|---|---|---|---|---|---|---|
| Permit | 214960 | NREL/DOE | GW | Permit to Construct a Well (MW-11) | DNR | Inactive |
| Permit | 214961 | NREL/DOE | GW | Permit to Construct a Well (MW-10) | DNR | Inactive |
| Permit | 214962 | NREL/DOE | GW | Permit to Construct a Well (MW-09) | DNR | Inactive |
| Permit | 74-GX 0918750B | NREL | Geothermal | Permit to Construct a Geothermal Well | DNR | Active |
| Permit | 3448 | NREL | Hazardous Materials (HazMat) | Hazardous material storage and use permit; WHF | West Metro Fire Rescue | Active |
| Permit | 3476 | NREL | HazMat | Hazardous material storage and use permit; SERF | West Metro Fire Rescue | Active |
| Permit | 3451 | NREL | HazMat | Hazardous material storage and use permit; S&TF | West Metro Fire Rescue | Active |
| Permit | 3447 | NREL | HazMat | Hazardous material storage and use permit; FTLB | West Metro Fire Rescue | Active |
| Permit | 3450 | NREL | HazMat | Hazardous material storage and use permit; AFUF | West Metro Fire Rescue | Active |
| Permit | 3452 | NREL | HazMat | Hazardous material storage and use permit; Shipping & Receiving) | West Metro Fire Rescue | Active |
| Permit | 3453 | NREL | HazMat | Hazardous material storage and use permit; Bldg. 16 | West Metro Fire Rescue | Active |
| Permit | COR10CY5F | Alliance | Stormwater | Construction General Permit (Stormwater) COR10000F; RSF1 & Infrastructure1 | EPA | Active |
| Permit | COR10CY6F | DOE | Stormwater | Construction General Permit (Stormwater) COR10000F; RSF1 & Infrastructure1 | EPA | Active |
| Permit | COR10D88F | Alliance | Stormwater | Construction General Permit (Stormwater) COR10000F; RSF Infrastructure DOE--error | EPA | Active |

| Category | Document Number | Permit or Reg. Holder | Document Type | Description | Issuing Agency | Status |
|---|---|---|---|---|---|---|
| Permit | COR10DH3F | Alliance | Stormwater | Construction General Permit (Stormwater) COR10000F; RSF Infrastructure Zone 2 | EPA | Active |
| Permit | COR10DH4F | DOE | Stormwater | Construction General Permit (Stormwater) COR10000F; RSF Infrastructure Zone 2 | EPA | Active |
| Permit | COR10DI9F | Haselden Construction | Stormwater | Construction General Permit (Stormwater) COR10000F; RSF Infrastructure Zone 2 | EPA | Active |
| Permit | COR10E21F | Alliance | Stormwater | Construction General Permit (Stormwater) COR10000F; STM RSF2 | EPA | Active |
| Permit | COR10E20F | DOE | Stormwater | Construction General Permit (Stormwater) COR10000F; STM RSF2 | EPA | Active |
| Permit | COR10E23F | Haselden Construction | Stormwater | Construction General Permit (Stormwater) COR10000F; STM RSF2 | EPA | Active |
| Permit | COR10DA6F | Alliance | Stormwater | Construction General Permit (Stormwater) COR10000F; NREL STM IBRF | EPA | Active |
| Permit | COR10DA5F | DOE | Stormwater | Construction General Permit (Stormwater) COR10000F; STM IBRF | EPA | Active |
| Permit | COR10DA9F | Mortenson Construction | Stormwater | Construction General Permit (Stormwater) COR10000F; STM IBRF | EPA | Active |
| Permit | COR10E08F | Alliance | Stormwater | Construction General Permit (Stormwater) COR10000F; STM West Gate Improvements | EPA | Active |
| Permit | COR10E09F | DOE | Stormwater | Construction General Permit (Stormwater) COR10000F; STM West Gate Improvements | EPA | Active |

| Category | Document Number | Permit or Reg. Holder | Document Type | Description | Issuing Agency | Status |
|---|---|---|---|---|---|---|
| Permit | COR10E16F | CG Construction | Stormwater | Construction General Permit (Stormwater) COR10000F; STM West Gate Improvements | EPA | Active |
| Permit | COR10E12F | Alliance | Stormwater | Construction General Permit (Stormwater) COR10000F; STM Vehicle Test Pad | EPA | Active |
| Permit | COR10E10F | DOE | Stormwater | Construction General Permit (Stormwater) COR10000F; STM Vehicle Test Pad | EPA | Active |
| Permit | COR10E13F | CG Construction | Stormwater | Construction General Permit (Stormwater) COR10000F; STM Vehicle Test Pad | EPA | Active |
| Permit | COR10DD2F | Alliance | Stormwater | Construction General Permit (Stormwater) COR10000F; NWTC 1 MW PV | EPA | Active |
| Permit | COR10DD1F | DOE | Stormwater | Construction General Permit (Stormwater) COR10000F; NWTC 1 MW PV | EPA | Active |
| Permit | COR10DD4F | Sun Edison | Stormwater | Construction General Permit (Stormwater) COR10000F; NWTC 1 MW PV | EPA | Active |
| Permit | COR10DB4F | Alliance | Stormwater | Construction General Permit (Stormwater) COR10000F; NWTC Row 4 Infrastructure | EPA | Active |
| Permit | COR10E06F | Alliance | Stormwater | Construction General Permit (Stormwater) COR10000F; NWTC Site Entrance | EPA | Active |
| Permit | COR10E07F | DOE | Stormwater | Construction General Permit (Stormwater) COR10000F; NWTC Site Entrance | EPA | Active |
| Permit | COR10E15F | CG Construction | Stormwater | Construction General Permit (Stormwater) COR10000F; NWTC Site Entrance | EPA | Active |
| Permit | COR10EE0F | Alliance | Stormwater | Construction General Permit (Stormwater) COR10000F;STM Ingress/Egress | EPA | Active |

| Category | Document Number | Permit or Reg. Holder | Document Type | Description | Issuing Agency | Status |
|---|---|---|---|---|---|---|
| Permit | COR10EE6F | DOE | Stormwater | Construction General Permit (Stormwater) COR10000F;STM Ingress/Egress | EPA | Active |
| Permit | COR10EE1F | Haselden Construction | Stormwater | Construction General Permit (Stormwater) COR10000F;STM Ingress/Egress | EPA | Active |
| Permit | COR10CT8F | DOE | Stormwater | Construction General Permit (Stormwater) COR10000F | EPA | Inactive |
| Permit | N/A | NREL | Waiver | Federal Aviation Administration (FAA) Certificate of Waiver or Authorization; for moored balloon | FAA | Inactive |
| Permit | 09-106687GP | DOE | Earth Disturbance | Grading permit, Jefferson County (Jeffco) Open Space | Jeffco | Inactive |
| Permit | 10-106216GB | DOE | Earth Disturbance | Grading permit, Berm, southeast of ball field | Jeffco | Active |

## Appendix B – Wildlife Species Observed at NREL's STM Site

The following is a list of common and scientific names of wildlife species observed during formal wildlife surveys and from employee observations at NREL's STM site in Golden, Colorado.

| Common Name | Scientific Name |
|---|---|
| **Reptiles and Amphibians** | |
| Bull snake | *Pituophis catenifer* |
| Plains garter snake | *Thamnophis radix* |
| Six-lined racerunner | *Cnemidophorus sexlineatus* |
| Tiger salamander | *Ambystoma tigrinum* |
| Western rattlesnake | *Crotalus viridus* |
| Woodhouse's Toad | *Bufo woodhousii* |
| | |
| **Birds** | |
| American crow | *Corvus brachyrhynchos* |
| American kestrel | *Falco sparverius* |
| American robin | *Turdus migratorius* |
| American tree sparrow | *Spizella arborea* |
| Bald eagle | *Haleatus leucocephalus* |
| Barn swallow | *Hirundo rustica* |
| Black-billed magpie | *Pica pica* |
| Black-capped chickadee | *Poecile atricapilla* |
| Black-crowned night heron | *Nycticorax nycticorax* |
| Blue-gray gnatcatcher | *Polioptila caerulea* |
| Blue jay | *Cyanocitta cristata* |
| Brewer's blackbird | *Euphagus cyanocephalus* |
| Brown headed cowbird | *Molothrus ater* |
| Bullock's oriole | *Icterus bullockii* |
| California gull | *Larus californicus* |
| Canada goose | *Branta canadensis* |
| Cedar Waxwing | *Bombycilla cedrorum* |
| Common nighthawk | *Chordeiles minor* |
| Common raven | *Corvus corax* |
| Common snipe | *Gallinago gallinago* |
| Cooper's hawk | *Accipiter cooperii* |
| Dark-eyed junco | *Junco hyemalis* |
| Downy woodpecker | *Picoides pubescens* |
| Eurasian Collared Dove | *Streptopelia decaocto* |
| European starling | *Sturnus vulgaris* |
| Golden eagle | *Aquila chrysaetos* |
| Great blue heron | *Ardea herodias* |
| Horned lark | *Eremophila alpestris* |
| House finch | *Carpodacus mexicanus* |
| House sparrow | *Passer domesticus* |
| Killdeer | *Charadrius vociferous* |
| Lark bunting | *Calamospiza melanocorys* |
| Lark sparrow | *Chondestes grammacus* |
| Loggerhead shrike | *Lanius ludovicianus* |

| Common Name | Scientific Name |
|---|---|
| MacGillivray's warbler | *Oporornis tolmiei* |
| Mallard | *Anas platyrhynchos* |
| Mountain bluebird | *Sialia currucoides* |
| Mourning dove | *Zenaida macroura* |
| Northern flicker | *Colaptes auratus* |
| Northern harrier | *Circus cyaneus* |
| Osprey | *Pandion haliaetus* |
| Prairie falcon | *Falco mexicanus* |
| Red-breasted nuthatch | *Sitta canadensis* |
| Red-tailed hawk | *Buteo jamaicensis* |
| Red-winged blackbird | *Agelaius phoeniceus* |
| Rock dove | *Columba livia* |
| Rock wren | *Salpinctes obsoletus* |
| Say's phoebe | *Sayornis saya* |
| Sharp-shinned hawk | *Accipiter striatus* |
| Spotted towhee | *Pipilo maculates* |
| Swainson's hawk | *Buteo swainsoni* |
| Tree swallow | *Tachycineta bicolor* |
| Turkey vulture | *Cathartes aura* |
| Vesper sparrow | *Pooecetes gramineus* |
| Virginia Warbler | *Oreothlypis virginiae* |
| Western kingbird | *Tyrannus verticalis* |
| Western meadowlark | *Sturnella neglecta* |
| Western scrub-jay | *Aphelocoma californica* |
| White-crowned sparrow | *Zonotrichia leucophrys* |
| | |
| **Mammals** | |
| Black-tailed jackrabbit | *Lepus californicus* |
| Bushy-tailed woodrat | *Neotoma cinerea* |
| Coyote | *Canis latrans* |
| Deer mouse | *Peromyscus maniculatus* |
| Fox squirrel | *Sciurus niger* |
| Long-tailed weasel | *Mustela frenata* |
| Mexican woodrat | *Neotoma mexicana* |
| Mountain cottontail | *Sylvilagus nuttalli* |
| Mule deer | *Odocoileus hemionus* |
| Prairie vole | *Microtus ochrogaster* |
| Raccoon | *Procyon lotor* |
| Red fox | *Vulpes vulpes* |
| Western harvest mouse | *Reithrodontomys megalotis* |
| White-tailed jackrabbit | *Lepus townsendii* |
| Yellow-bellied marmot | *Marmota flaviventris* |