NATIONAL RENEWABLE ENERGY LABORATORY

ENVIRONMENTAL PERFORMANCE REPORT for 2008

(Annual Site Environmental Report per DOE Orders 231.1 and 5400.5)

Prepared by:
Environment, Health, and Safety Office
National Renewable Energy Laboratory

NREL is a national laboratory of the
U.S. Department of Energy and is
Operated by the Alliance for Sustainable Energy, LLC

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Cover photo contributed by Bob Fiehweg, 2008 – View of Eldorado Canyon from the National Wind Technology Center.

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List of Acronyms

AEO	Annual Energy Outlook
AFUF	Alternative Fuels User Facility
APEN	Air Pollution Emission Notice
AST	Aboveground storage tank
bgs	Below ground surface
BMP	Best management practice
BTU	British thermal unit
CDPHE	Colorado Department of Public Health and Environment
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CGP	Construction General Permit
CMS	Chemical Management System
CSP	Concentrating solar power
CY	Calendar Year
DBP	Disinfection byproduct
DFD	Denver Fire Department
DOE	U.S. Department of Energy
DOE-GO	Department of Energy Golden Field Office
DSOC	District Shops and Operation Center
DWOP	Denver West Office Park
EA	Environmental Assessment
EHS	Environment, Health, and Safety Office
EIA	Energy Information Agency
EISA	Energy Independence and Security Act
ELP	Environmental Leadership Program
EMS	Environmental Management System
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Reporting and Community Right-to-Know Act
ESH&Q	Environmental Safety, Health, and Quality
FEC	Federal Electronics Challenge
FTLB	Field Test Laboratory Building
FY	Fiscal Year
GH	Golden Hill
GHG	Greenhouse gas
gsf	Gross square foot
HABS	Historic American Buildings Survey
HAER	Historic American Engineering Record
HMIS	Hazardous Materials Information System
HSS	U.S. Department of Energy Office of Health, Safety, and Security
IPM	Integrated pest management
IRCA	International Register of Certificated Auditors
ISM	Integrated Safety Management
ISO	International Organization for Standardization
IUF	Industrial User Facility

JSF	Joyce Street Facility
LDRD	Laboratory directed research and development
LEED	Leadership in Energy and Environmental Design
LEPC	Local Emergency Planning Committee
MCL	Maximum contaminant levels
MtC/yr	Million metrics tons of carbon per year
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutant
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NREL	National Renewable Energy Laboratory
NWTC	National Wind Technology Center
ODS	Ozone-depleting substances
PDU	Process Demonstration Unit
ppm	Parts per million
PV	Photovoltaics
PWSID	Public Water Supply Identification Number
RAA	Running annual average
RCRA	Resource Conservation and Recovery Act
RFHP	Renewable Fuels Heat Plant
ReFUEL	Renewable Fuels and Lubricants Research Laboratory
RQ	Reportable quantity
RSF	Research Support Facilities
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 Officer
SIC	Standard industrial classification
SOP	Safe operating procedure
SRRL	Solar Radiation Research Laboratory
STM	South Table Mountain
TCPDU	Thermochemical Process Demonstration Unit
TEAM	Transformation Energy Action Management
TPQ	Threshold planning quantity
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
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 and the Battelle Memorial Institute. The new operating contract has a 5-year duration and is overseen by the Department of Energy's Golden Office (DOE-GO).

1.1 Purpose

This report presents a summary of NREL's environmental protection programs and activities for 2008. It is organized according to the different environmental media (e.g., air, waste, ground water, etc.), 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 Orders 231.1 and 5400.5.

1.2 Background

NREL's mission is to develop renewable energy and energy efficiency technologies and practices, advance related science and engineering, and transfer knowledge and innovations to the private sector 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 efficiency 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 renewables and energy efficiency technologies in distributed power systems, maximizing the utilization of renewable energy and energy efficiency 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 cells, building technologies, and wind turbines.

Photovoltaics: Photovoltaics (PV) 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 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 (GH), 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, GH, and STM sites are approximately two 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 Operation Center (DSOC) at 1900 31st Street, Denver, about 12 miles east of the STM and DWOP sites. Figure 1 illustrates the locations of the STM, DWOP, NWTC, and JSF sites on a regional map. The location of the ReFUEL facility is shown in Figure 2. Figure 3 provides a more detailed map of the STM site, and Figure 4 provides detail for the NWTC site.

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. The JSF is also a leased space that is 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.

A number of significant changes to the NREL South Table Mountain campus were made in 2008. The new Renewable Fuels Heat Plant (RFHP) was constructed between the Field Test Laboratory Building and the Solar Energy Research Facility to provide heat to STM campus buildings. Using wood chips from forest thinning projects along Colorado's Front Range and other urban wood waste, the RFHP provides hot water through underground pipes to heat most of NREL's facilities on the STM site. The RFHP has an estimate output of 29 billion BTUs per year; however, it saves more than 40 billion BTUs of natural gas due to conversion efficiencies. The RFHP will offset fossil fuel CO_2 emissions of 4.8 million pounds per year.

In addition to the RFHP, a large solar panel array was constructed on NREL property on top of STM. The 750 kW Mesa Top Photovoltaic Array is expected to produce 1.2 gigawatt hours of solar electricity per year. The array ensures NREL will exceed the Energy Policy Act of 2005 goal of 7.5% of a federal facility's electricity coming from renewable sources. In fact, the installation alone could provide as much as 7.2% of the electricity the lab uses. It will offset 2.4 million pounds of fossil fuel CO_2 production annually.

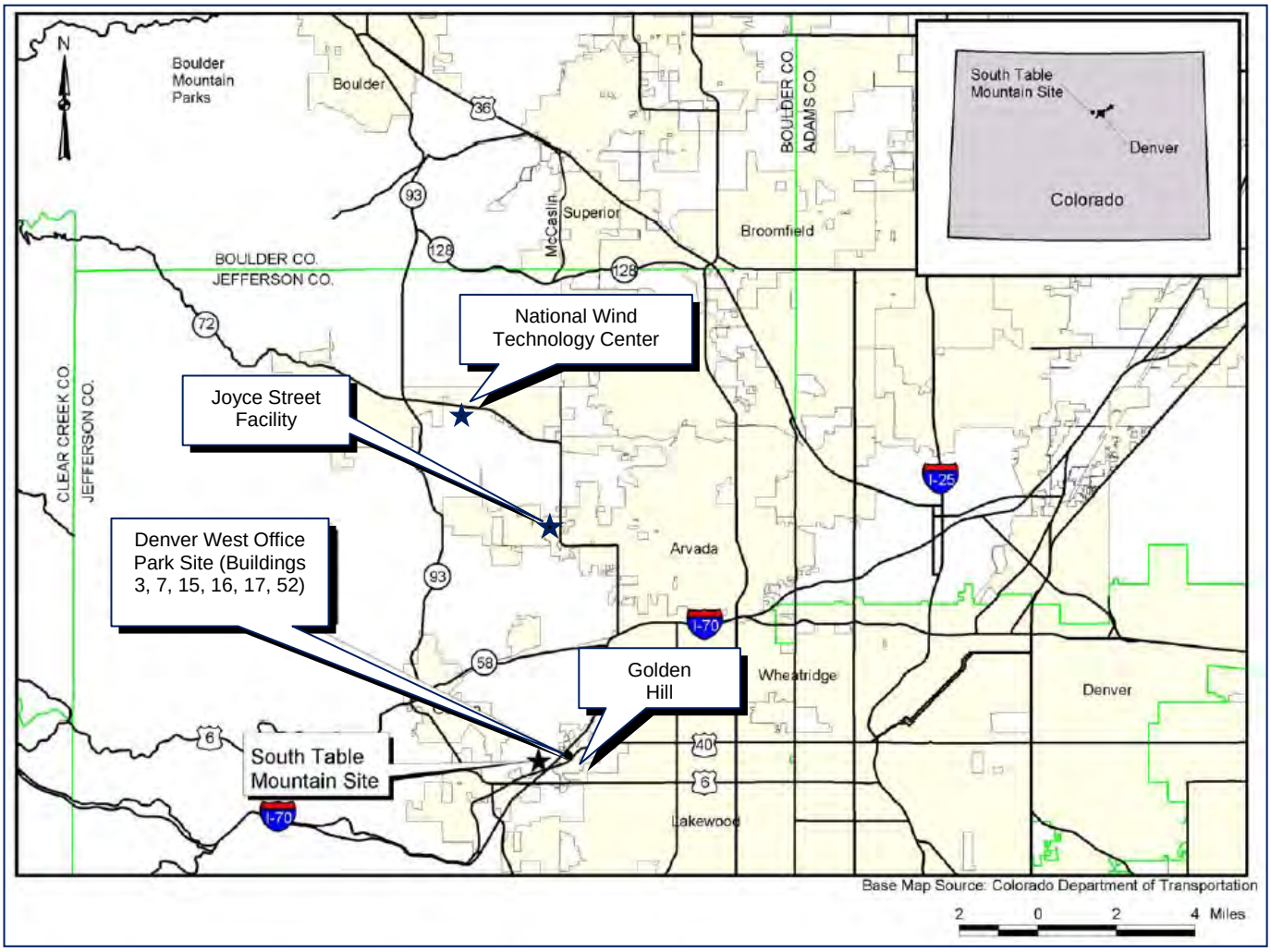

Figure 1. Regional map showing NREL locations in Jefferson County, CO

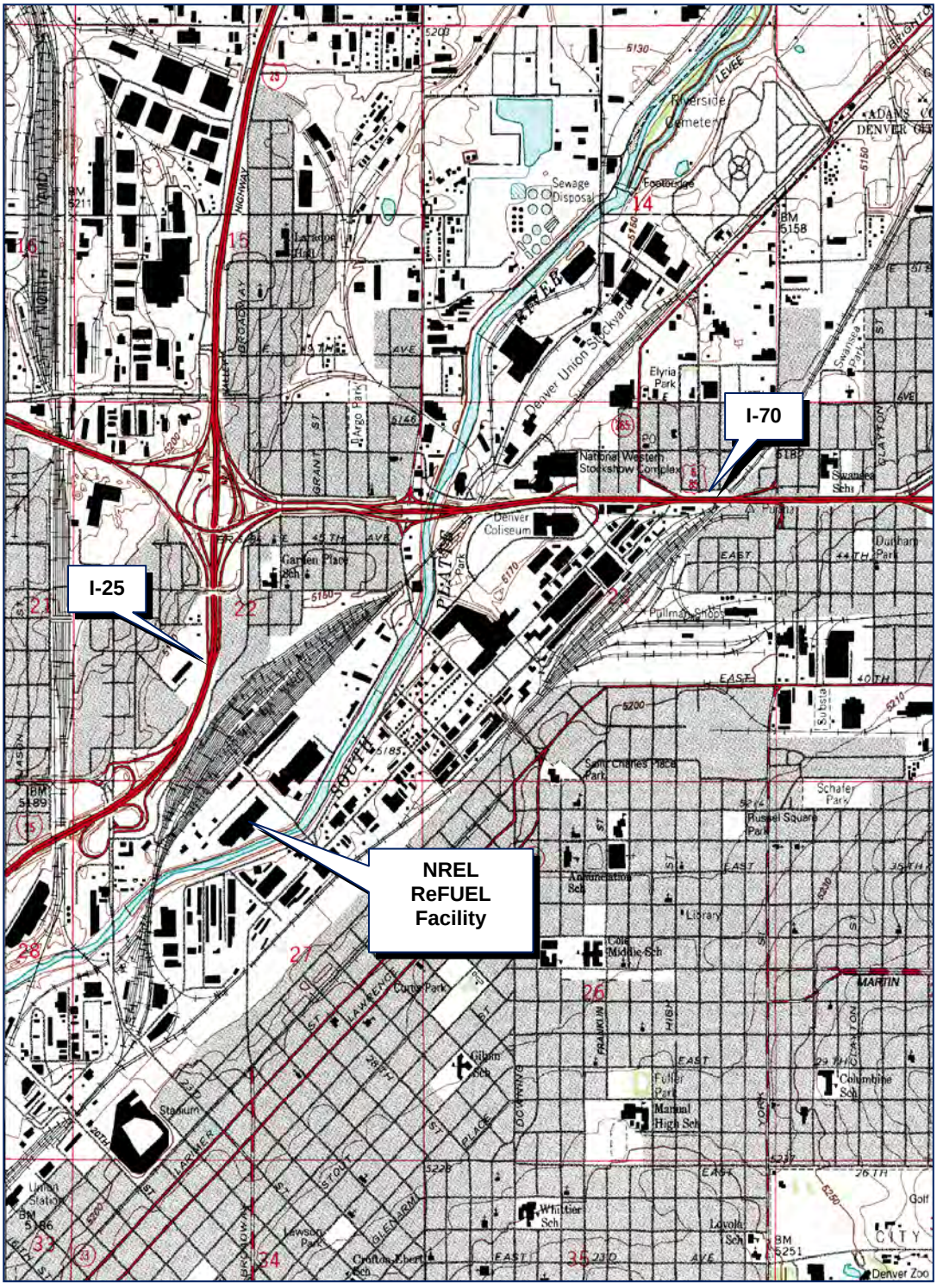

Figure 2. ReFUEL Facility location map, located in Denver County, CO

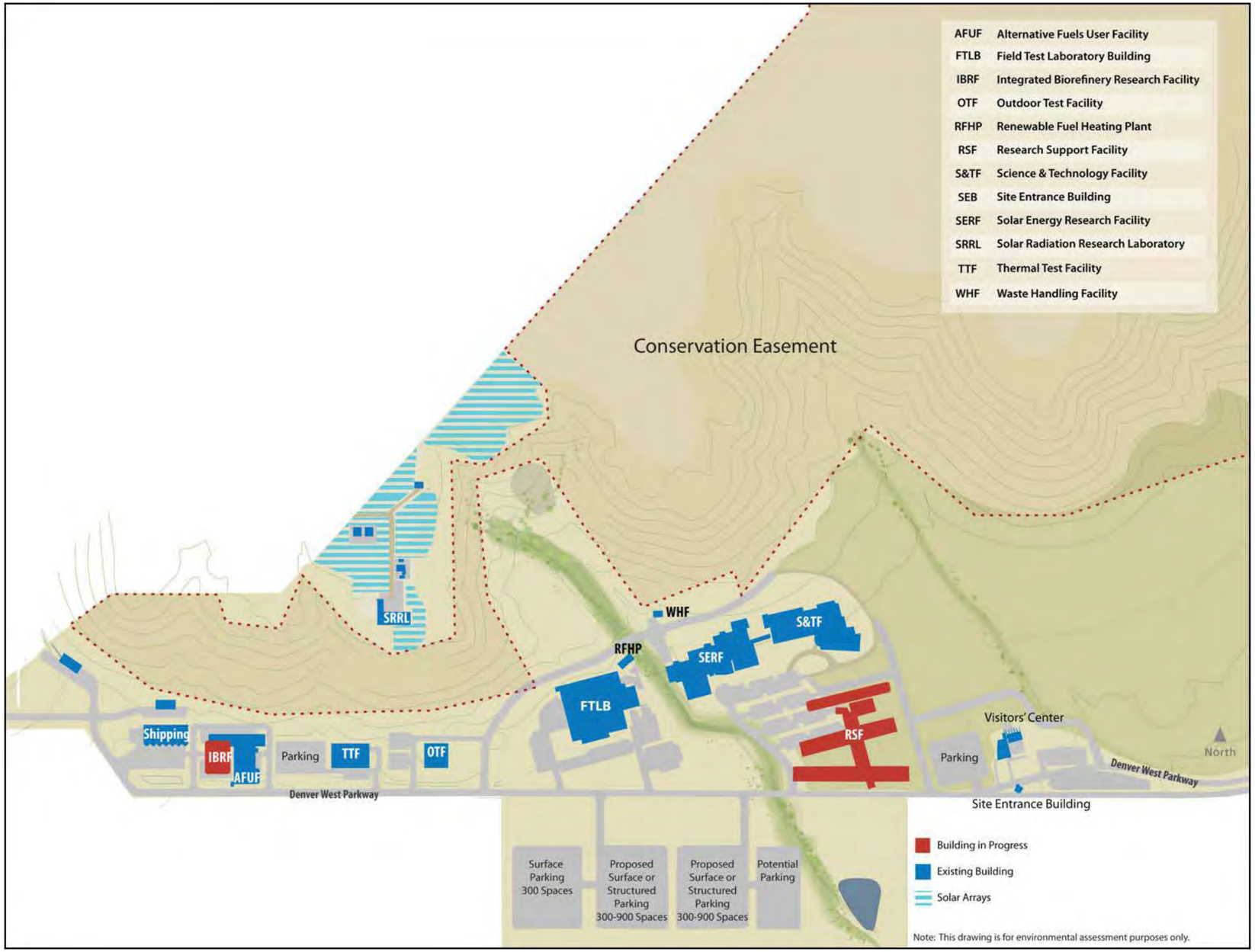

Figure 3. STM site detail

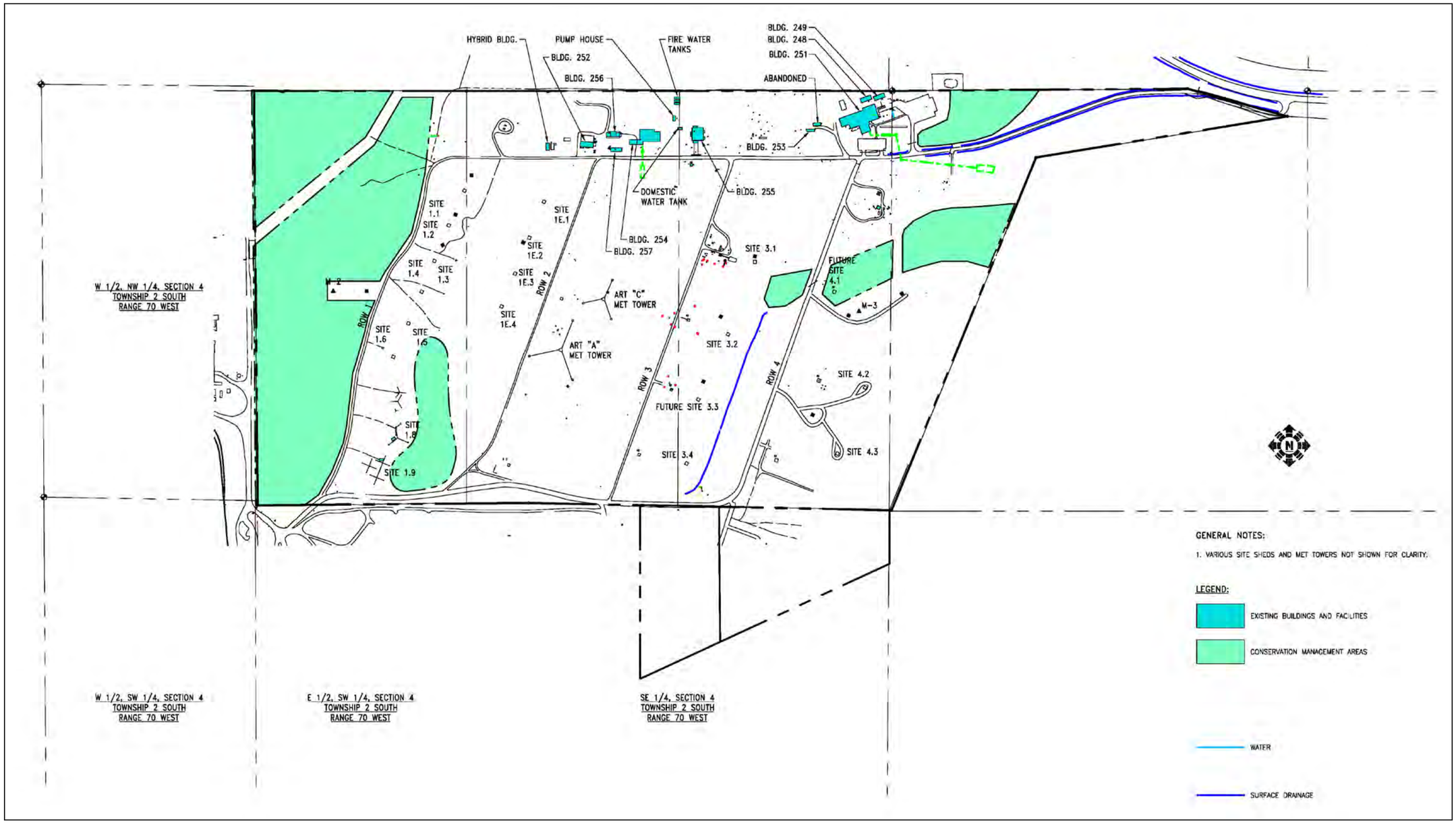

Figure 4. NWTC site detail

1.3.1 South Table Mountain Site

1.3.1.1 Geology, Soils, and Hydrogeology

The South Table Mountain (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.

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.

1.3.1.2 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.

1.3.1.3 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/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.

1.3.1.4 Wildlife

A wildlife survey was conducted on the site during 1986 and 1987, and additional surveys were done in 1999 over the conservation easement property. A survey to update the existing data began in 2004 and was completed in 2005 (see Section 5.11 for more detail). Mammals seen using the site during the surveys include mule deer, coyotes, gray foxes, red foxes, raccoons, long tailed weasels, striped skunks, spotted skunks, badgers, bobcats, mountain lions, rabbits, and yellow-bellied marmots.

Seventeen species of birds have been observed on the STM site, along with two species of raptors: American kestrels and two nesting pairs of red-tailed hawks. Amphibian species and snakes are known to inhabit the area as well.

1.3.1.5 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 western portions 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 6.0 for more detail).

1.3.2 National Wind Technology Center

1.3.2.1 Geology, Soils, and Hydrogeology

The National Wind Technology Center (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 (USDA 1995).

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.

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 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.

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. 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 (birds of prey) 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 (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

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 West Colfax. The DWOP is bordered on the south by commercial areas (West Colfax strip), 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.

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 the 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.

The 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 south, east, and northeast borders.

1.4 Site Environmental Conditions/Features

Photos for each site documenting the site features and development are included at the end of this section. Figures 5, 6, 7, and 8 show the STM and DWOP sites, and Figures 9 and 10 provide images of the NWTC site. The views on the STM site also illustrate the conservation easement property and the Camp George West property acquired in 1999.

1.4.1 Climate

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

The area experiences moderate precipitation, with an average annual rainfall of less than 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 to 25 cm (6 to 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, season to season.

Figure 5. South Table Mountain site – west end of the site

Figure 6. South Table Mountain site – east view

Figure 7. South Table Mountain site – Mesa Top facilities and amphitheater

Figure 8. South Table Mountain site – Denver West Office Park

Figure 9. NWTC site – northwest view

Figure 10. NWTC site – northwest view with research facilities

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 two site-wide permits for particulate air emissions from construction, one air emissions permit for a pilot-scale research project, and one air permit for the operation of the RFHP, a woodwaste-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 (NESHAP) requirements specific to radiological emissions from DOE facilities are regulated by the EPA. Details are provided in Section 5.16.

During 2008, NREL had no air quality compliance issues.

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 has been conducting increased monitoring since the fourth quarter of 2006 for disinfection byproducts. Detailed information about system performance is provided in Section 5.2.

In 2008, NREL had no drinking water compliance issues.

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 2008, NREL had no groundwater compliance issues.

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 CDPHE to the Jefferson County Department of Health and Environment. There is also one individual sewage disposal system at the Solar Radiation Research Laboratory (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 2008, NREL had no wastewater compliance issues.

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.

At the STM, a Notice of Intent (NOI) was filed with the EPA in 2005 for the construction of a new research facility. This project was managed under the EPA's Construction General Permit program. Sufficient vegetative coverage was achieved in mid-2008 and a Notice of Termination for the permit was filed with the EPA.

At the NWTC, one small construction project was undertaken in 2007 that required a CGP. Sufficient vegetative coverage was achieved in mid-2008 and a Notice of Termination for the permit was filed with the EPA. Details of NREL's surface water protection program are provided in Section 5.5.

In 2008, NREL had no surface water compliance issues.

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.

A hazardous waste program improvement plan was developed in 2008 in response to an EPA inspection and warning letter issued in 2007. The EPA's findings were addressed immediately and the agency issued a letter closing the matter in February 2008. Program details are discussed in Section 5.6.

In 2008, NREL had no waste management compliance issues.

2.1.7 Storage Tanks

NREL has no underground storage tanks containing hazardous materials. Aboveground storage tanks (ASTs) that are larger than 660 gallons are regulated in Colorado by the Colorado Department of Labor and Employment's Oil Inspection Section. NREL has two tanks larger than

660 gallons on the STM site that are registered with the Colorado Department of Labor and Employment. Details about NREL's AST program are provided in Section 5.7.

No spills or releases from NREL's ASTs occurred during 2008.

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 Golden and Bald 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 2008, NREL had no compliance issues regarding wildlife.

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 Reporting 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.

In 2008, NREL facilities had no releases exceeding the reportable quantity (RQ) of any material reportable under EPCRA. As a research and development laboratory, NREL does not manufacture or process any materials on the SARA Section 313 list in excess of the 4,526-kg (10,000-lb) threshold planning quantity. During 2008, the laboratory did not otherwise use any materials on the SARA Section 313 list in quantities exceeding the 4,526-kg (10,000-lb) threshold planning quantity. NREL's compliance with EPCRA requirements is detailed in Section 5.8.

NREL maintains an Emergency Management Policy (8-4) and supporting lab-level programs for credible on-site emergencies. 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).

In 2008, NREL had no compliance issues regarding cultural resources.

2.1.11 2008 Events

During the course of operating a major national laboratory, events occur which may have an impact on the environment. NREL experienced four incidents in 2008 that had minor environmental impacts.

2.1.11.1 Nitric Acid Spill

On March 25, 2008, a cardboard box containing a bottle of nitric acid was being delivered to the Field Test Laboratory Building (FTLB) when it was dropped. The bottle broke in the box and some of the contents leaked onto the loading dock. Site personnel responded immediately, contained the spilled material, applied absorbent, and cleaned the area thoroughly. The area of the spill was restricted to a few square feet of concrete at the base of the loading dock. Absorbents and cleaning materials were packaged for disposal.

2.1.11.2 Antifreeze Release

On May 7, 2008, an 18-wheeler truck had a ruptured radiator and leaked 5 to 10 gallons of coolant onto the paved road immediately north of the Outdoor Test Facility (OTF). The coolant flowed down the gutter and pooled in an area downhill from the truck. Site personnel responded, applied absorbent material, and cleaned the area thoroughly. The area of the spill was restricted to the paved surface and a small area of unpaved ground where the coolant had pooled. The absorbents, cleaning materials, and a small amount of sand and soil were packaged for disposal.

2.1.11.3 Propylene Glycol Spill on South Table Mountain

On May 30, 2008, approximately 175 gallons of propylene glycol and water was released onto a concrete and asphalt surface at the Solar Industrial Mesa Test Area, located on top of STM. The release was the result of a leaking PVC line serving a 28 ton chiller. The release occurred over a weekend and, when discovered on the following Monday, the spilled material had largely evaporated or was absorbed by the asphalt.

2.1.11.4 Epoxy spill

On September 8, 2008, a truck carrying flooring materials for the RFHP was traveling on the north access road when a 5-gallon container of epoxy adhesive fell from the open tailgate. Site personnel responded and contained the material with absorbents. The area of the spill was restricted to the paved surface of the road. The absorbents and remnant epoxy materials were packaged for disposal.

2.2 DOE Order 450.1, 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 International Organization for Standardization (ISO) 14001 requirements by June 2009. NREL's implementation of its EMS is described in Section 4.0 of this report.

2.3 Executive Orders

2.3.1 Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management

On January 24, 2007, the President 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). DOE's senior management, with NREL's participation, has been working on a Transformational Energy Action Management (TEAM) Initiative to create and implement a plan intended to expedite meeting the EO requirements. NREL's progress in meeting this EO is described in Section 4.2.

2.3.2 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 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 (designed to withstand the equivalent of a 100-year flood). 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.

2.3.3 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 0.4 hectares (1 acre). In 2008, NREL had no compliance issues regarding environment-related 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 one of the nation's premier resources 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 major 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 an EMS and promoting sound environmental and sustainability strategies and 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 land and water use are critical to the 21st century. A major change in the nation's energy policy has spurred new research efforts at NREL to help address these issues. Renewable energy technologies will be critical to help reduce carbon emissions that contribute to climate change and help the world move toward energy independence.

3.1 Energy Policy Changes in 2008

In 2008, there was a major shift in the energy policy of the United States with the passage of new legislation designed to address what former President George H. W. Bush characterized as the nation's addiction to foreign oil. In December 2007, the Energy Independence and Security Act (EISA) was signed into law, mandating significant changes in the energy policy of the United States over the coming decades. The new legislation 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; 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.

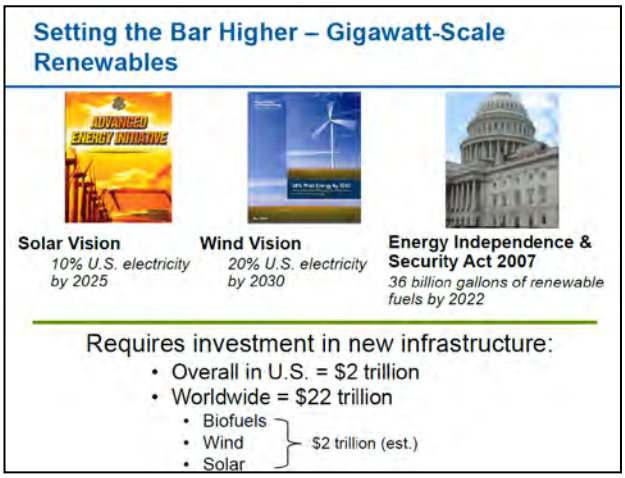

Figure 11. Energy policy changes in 2008
Source: D. Arvizu, Nov. 2008 presentation

The Energy Information Agency (EIA), an independent arm of DOE, produces a summary document of energy use and projections called the Annual Energy Outlook (AEO). The 2008

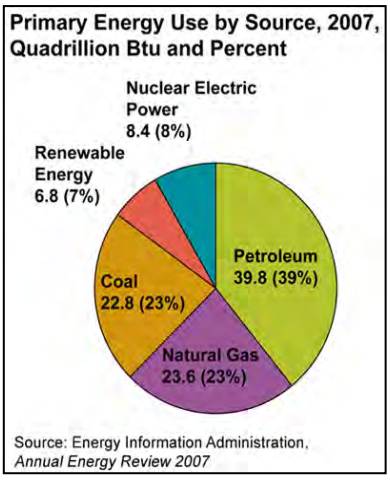

Figure 12. Primary energy use by source, 2007

AEO had been prepared with an early-release scenario in 2007, but was revised to account for the changes that the EISA 2007 would have on primary energy consumption and the emission of greenhouse gases (GHG) associated with the use of fossil fuels. The EIA projected a reduction of 5.3 quadrillion BTUs in total energy consumption from 2008 to 2030 as a result of EISA, and a 7% annual reduction in GHG emissions.

By some estimates, the reduction of GHG emissions must be reduced by far greater amounts in the coming years (see the discussion below). Renewable energy is part of the solution to the nation's growing appetite for energy. The EIA has summarized the sources of energy and the expenditures of energy in the United States (see Figure 13). Renewable energy is currently only a small contributor to the overall supply.

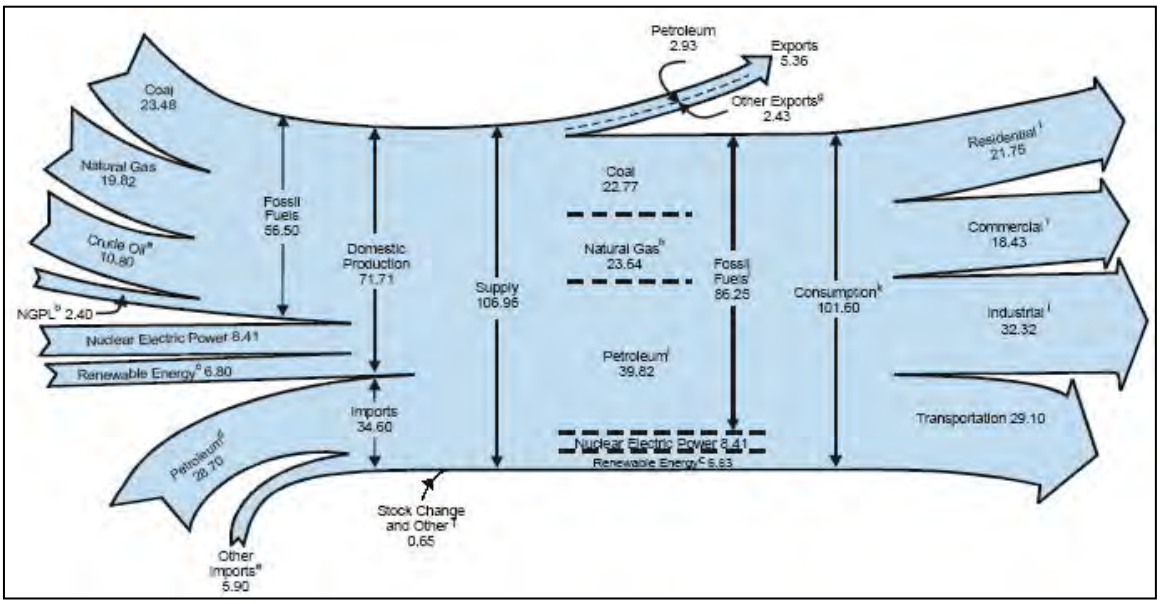

Figure 13. Sources of energy and the expenditures of energy in the United States, summary (quadrillion BTUs)

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 2008, NREL studied the impacts of state policies on the development of renewable energy. Research into the effectiveness of policies that promote energy efficiencies and the use of renewable sources is in transition to a quantitative model. This work compiled and evaluated the status of "best-practice" state policy design and connected the existence of some policies with increased renewable energy development through correlation analysis. A strategy was developed to better understand the role of policy in renewable energy development, based on market-transformation principles.

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 unique distinction of having published the number one cited article in the energy field (Contreras et al. 1999).

Figure 14. Seizing the moment to make transformational change

3.2.1 General Capabilities

Through projects at 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 efficiency 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. 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.

3.2.2 Biofuels

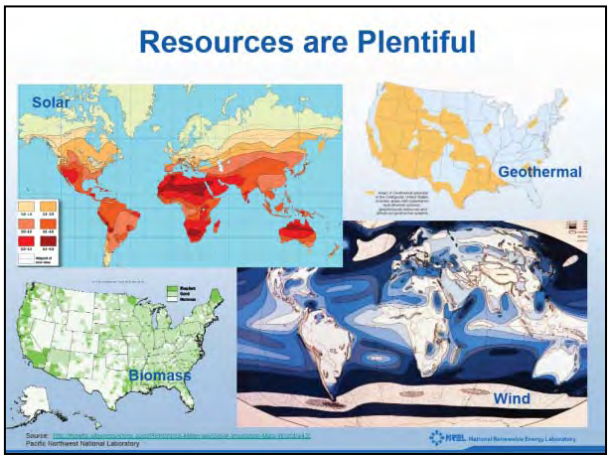

Figure 15. Global and nationwide renewable resources are plentiful

The EISA established rigorous goals, known as the Renewable Fuels Standard, for developing biofuel substitutes for petroleum-based fuels used for transportation (except ocean-going vessels). The Standard 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 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.

From 1978 to 1996, NREL administered the Aquatic Species Program which was charged with developing renewable fuels from algae. NREL made significant progress in the science of manipulating algal metabolism and engineering microalgae production systems. Researchers screened and characterized more than 3,000 potential strains of algae, and identified about 300 species of green algae and diatoms that had the demonstrated ability to produce oil and were adaptable to extreme conditions of temperature, salinity, and pH.

Record high petroleum prices in 2008 have sparked renewed interest in producing fuels from algal sources. Research and development efforts at NREL have been renewed with a combination of funding from several sources, including a cooperative research and development agreement with a major oil company to collaboratively develop techniques to research the production of liquid transportation fuels using microalgae. Within the laboratory, two laboratory directed research and development (LDRD) algae projects were approved in 2008.

One of the LDRD projects makes use of the Illumina Genome Analyzer, a novel gene-sequencing technology for high-throughput transcriptomics analysis of microbial strains used for biofuel production. Transcriptomics is the study of gene expression patterns that vary with external environmental conditions. By examining the changes in messenger ribonucleic acid populations within cells grown under conditions of enhanced lipid production, scientists can determine the biological triggers for lipid production in microalgae. This technology represents the latest generation in rapid DNA-sequencing methodology and allows for the generation of de novo genome sequences and whole transcriptome analyses to aid researchers in identifying genes and pathways involved in algal biofuel production.

The second algae LDRD project funded in 2008 aims to engineer cyanobacteria (a form of prokaryotic algae) to divert biosynthetic pathways away from glycogen synthesis and toward lipid synthesis. Cyanobacteria are not considered good candidates for high-density biofuel production because they typically produce carbohydrates as storage products rather than lipids. This project takes advantage of advanced methods for genetic manipulation available for cyanobacteria.

3.3 NREL – Research to Address 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 GHG 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. The report goes on to say that this level of

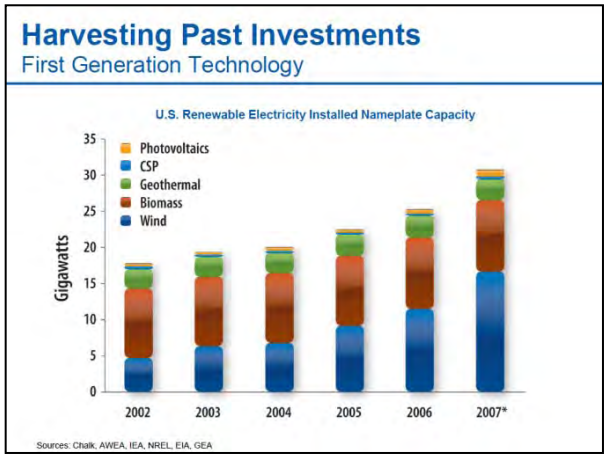

Figure 16. Building on existing renewable energy technologies

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), PV (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, PV, and CSP.

3.3.1 Wind

NREL has developed sophisticated methods of evaluating renewable energy resources. Analysts track the development of wind generating sources on a state-by-state basis; Figure 17 shows the current installed capacity. In 2008, NREL led an analytic effort that resulted in the DOE report *20% Wind Energy by 2030; Increasing Wind Energy's Contribution to the U.S. Electricity Supply*. NREL's analysis led to a new strategic framework for the wind energy program to help meet the challenges of producing 300 gigawatts of wind energy capacity by 2030.

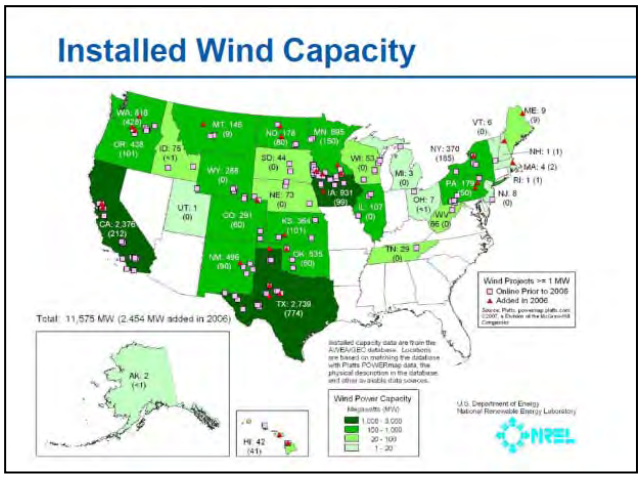

Figure 17. Nationwide installed wind capacity

3.3.2 Concentrating Solar Power

Concentrating solar power (CSP) technologies can be a major contributor to our nation's future need for new, clean sources of energy, particularly in the Western United States.

A reliable and affordable supply of electricity is essential to protect public health and safety, and to sustain a vigorous economy in the West. Constraints in natural gas supplies, low hydropower generation due to drought, and increasing demand for electricity have led to enormous volatility in the West's power market. And as the population in the western states continues to grow, energy demand will continue to increase. With the addition of thermal storage, CSP technologies can provide power during periods when demand on the utilities is at its peak, even if the sun isn't shining. This ability to provide dispatchable power during periods of peak demand establishes CSP technologies as a viable energy choice for the West.

Working in partnership with public and private organizations, NREL supports research and development that advances concentrating solar power technologies, with the goal of making them competitive in U.S. and global power markets.

3.3.3 Photovoltaics

The development of technology that captures 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 photovoltaic (PV) configurations, including two prestigious R&D 100 Awards in 2008.

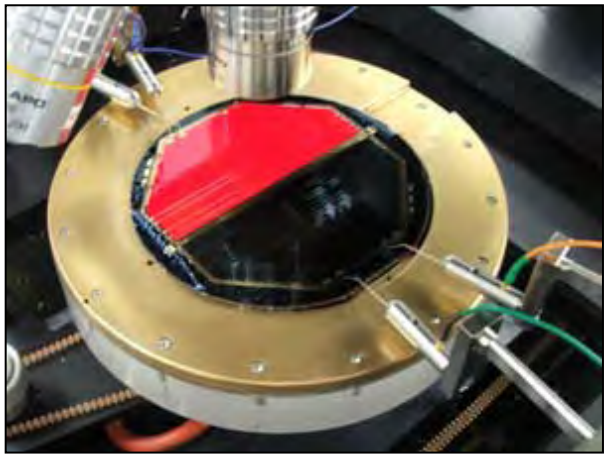

Figure 18. NREL's IMM solar cell

One of NREL's R&D 100 awards recognized the IMM Solar Cell, a breakthrough in solar cell design and performance. The ultra-light, highly efficient solar cell represents a new class of solar cells with clear advantages in performance, engineering design, operation and cost. In this new method of development, the cell is grown upside down, allowing for greater absorption and use of sunlight. By turning the conventional approach to cells literally on its head, the result is an ultra-light and flexible cell that converts solar energy with record efficiency. Having already set a pair of world records for solar conversion efficiency when it was nominated, the cell has just set a third world record with a solar conversion rate exceeding 40%.

The second R&D 100 award spotlights a new technology for manufacturing Hybrid CIGS—thin film PV employing layers of copper indium gallium diselenide. NREL, in partnership with HelioVolt, developed a method where hybrid CIGS cells are manufactured in layers by using ink-jet and ultrasonic technology to precisely apply metal-organic inks in separate layers directly into common building materials like metal and glass. This simple approach could integrate enough flexible PV film into windows, roofing and other structural components to turn entire buildings into small, self-sustaining power plants.

4 Environmental Management System

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

4.1 Policy

Environmental protection is a priority at NREL, as indicated by the laboratory's Environmental Protection Policy:

NREL Environmental Policy Statement

NREL exemplifies sustainability by maximizing efficient use of resources, minimizing waste and pollution, and serving as a positive force in economic, environmental, and community responsibility. To this end, NREL is committed to:

Economic Viability. Managing laboratory fiscal resources efficiently to meet applicable regulations and effectively accomplishing the laboratory's mission, taking sustainability into consideration.

Environmental Stewardship. NREL is committed to sound environmental management that serves as an example to others and supports the laboratory's mission to protect natural resources through research, development, and deployment of renewable energy and energy efficiency technologies. . . . To this end, NREL is committed to:

- **Pollution Prevention. . . .** Incorporating pollution prevention practices in research and support activities.
- **Continuous Improvement. . . .** Continuously improving the effectiveness of NREL's environmental management system (EMS).
- **Campus. . . .** Managing the impact on the environment caused by the placement and general design of NREL structures; maintaining, protecting, and restoring natural and landscaped environments to sustain natural and native ecological systems, both on and adjacent to NREL campuses.
- **Water. . . .** Reducing water consumption and managing water discharges from the site.
- **Electricity/Natural Gas. . . .** Reducing energy use in building designs and operations, within available funds; using cost effective renewable energy sources for remaining energy needs; and purchasing power generated by renewable energy sources.
- **Transportation. . . .** Reducing the impact of local NREL travel on the environment; reducing the use of fossil-based gasoline/diesel fuel for NREL onsite and local operations through the use of alternative fuel vehicles or hybrids; and increasing the use of video and teleconferencing to reduce the environmental impacts of air travel.
- **Materials. . . .** Reducing the use of materials and the creation of waste by reducing, reusing, and recycling materials needed for laboratory operations; increasing the purchase and use of environmentally sensitive products and products with recycled content.
- **Environmental Management. . . .** Providing an environment that promotes efficiency, effectiveness, and sustainability, and encourages the creativity and personal motivation required for excellence in scientific, engineering, technology development, and support functions.
- **Education/Communication. . . .** Informing and providing outreach to workers about sustainability activities, including a method for interaction and feedback; educating workers about participating and contributing to sustainable activities. . . ; informing workers and the public about NREL's environmental performance, including a method for interaction and feedback.
- **Compliance with Requirements. . . .** Complying with applicable federal, state, and other environmental requirements and exceeding those requirements, when feasible, by implementing environmental best management practices.

Public Responsibility. Working with local stakeholders to identify and implement collaborative projects to improve sustainability of the local community; educating others about sustainability through a variety of outreach mechanisms.

4.1.1 NREL's EMS and Integrated Safety Management (ISM) System

NREL's EMS implements the laboratory's Environmental Protection Policy. It is a framework of policies, procedures, and programs integrated with normal management processes, and combined with the environmentally sound daily work practices of the Environment, Health, and Safety (EHS) Office staff and personnel. Environmental protection must involve everyone at the lab to be effective. All activities conducted at NREL must comply with federal and state environmental laws and regulations, and DOE requirements.

As a DOE-owned facility, NREL is required by DOE Order 450.1A to implement its EMS as part of an ISM System. NREL's EMS meets this requirement while also incorporating the elements of ISO 14001, the international environmental management standard. 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. An example of an integrated task specific procedure flowing down from the related policies and procedures is Procedure 6-6.2: *Hazard Identification and Control*.

4.1.2 Notable 2008 Activities

4.1.2.1 Federal Electronics Challenge

In 2008, NREL was accepted into the Federal Electronics Challenge (FEC), 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.

The NREL FEC team, which met monthly throughout 2008, received a Silver-level Award by completing 23 projects, including:

- Ensuring computer monitors are ENERGY STAR®-rated and incorporate a "sleep" mode
- Hosting an employee personal computer and electronics recycling program
- Using an environmentally friendly, third-party electronics recycler.

In 2009, NREL applied for and achieved the Gold-level FEC Award.

To learn more about the award, please see the NREL FEC poster summary (PDF 4 MB). Download Adobe Reader. Learn more about this voluntary program at the FEC Web site at http://www.federalelectronicschallenge.net/.

4.1.2.2 Notable Practice among DOE Laboratories

An external review of work practices for nanoscale material activities at DOE laboratories was completed in 2008 by the DOE Office of Health, Safety, and Security (HSS), Office of

Independent Oversight. A final report identified several notable nanomaterials practices at the laboratory. The review team noted that the engineering and administrative controls employed at the laboratory are very effective in controlling exposures.

Specific to the EMS, the report identified a notable practice, warranting consideration by other DOE sites:
As part of the Environmental Management System Aspect/Impact Analysis in May 2008, research activities involving nanoscale materials were reviewed and incorporated.

This is a significant notable practice finding because EMS consideration of nanoscale materials is not currently a routine practice in the EMS of other facilities. NREL included nanomaterials research in the environmental aspect/impact spreadsheet analysis, which is among the systematic EMS tools.

4.1.2.3 Lead Auditor Training – ISO 14001:2004

NREL EHS and Quality Assurance staff participated in a one-week training toward ISO 14001:2004 Lead Auditor certification in August 2008. NREL staff received verification of the successful completion of the training requirements for certification as EMS Auditors/Lead Auditors by the RABQSA International, Inc. Management System Auditor Certification Program. The certificate is recognized by the International Register of Certificated Auditors (IRCA) as meeting the requirement for IRCA certification as EMS Auditors/Lead Auditors.

4.1.2.4 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 the voluntary partnership between Colorado Department of Public Health and Environment (CDPHE) and participating private and public Colorado facilities, recognizing 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 to date. NREL sets voluntary three-year environmental performance goals as a component of ELP membership, in an effort to further enhance operations and performance at the laboratory.

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 three-year goals focusing on measurable results.

Learn more about this voluntary program at the CDPHE Web site at http://www.cdphe.state.co.us/el/elp/index.html.

4.1.3 Public Outreach

NREL hosted several public meetings where discussion of environmental performance and other issues occurred. Example public meetings are described below. Approximately 14,000 people passed through NREL's Visitors Center in 2008. All are asked to sign in, and space is provided on the sign-in sheet for comments. Concerns about the lab's environmental performance are relayed to appropriate staff.

NREL and DOE-GO hosted a community meeting on November 12, 2008, inviting community members to learn about the laboratory's 2009 research outlook and site development plans. More than 85 community members attended. Presentations made by the NREL Deputy Director, Director of NREL's Infrastructure and Campus Development Office, and DOE-GO's Supervisory Engineer and Project Officer are available online at: http://www.nrel.gov/visitors_center/community_news.html.

Figure 19. Science on a Sphere exhibit

Credit: Pat Corkery

In July, 2008, NREL installed a new "Science on a Sphere" exhibit. This unique visualization system is one of only about 20 spheres operating around the world. The sphere consists of a 6-foot diameter globe-shaped screen, four digital projectors, and five computers. While the sphere is preloaded with more than 200 Earth science maps and charts, NREL generates unique energy-related programs, maps, and charts for the display. NREL is currently the only source for energy-related sphere programming, and shares this information at no cost with museums and visitors centers worldwide.

A new public seminar series began in 2008 entitled, "Consumer Power for the 21st Century." More than 160 people participated in these quarterly seminars occurring on Saturdays, capturing audiences who were unable to visit during standard Monday through Friday operating hours. Topics for the seminars included: Solar Power; Strategies, Devices, and Appliances for Using Energy Wisely; and Investment Opportunities.

In addition, the public was invited to six "Smart Energy Living" workshops in 2008 at the NREL Visitors Center before and after the Denver Tour of Solar and Green Built Homes. More than 155 attendees received information on renewable energy and energy efficient technologies for their homes.

A series of "Power Lunches" open to the public are held monthly at the Visitors Center. In 2008, more than 630 attendees heard topics ranging from Zero Energy Housing to Xeriscaping Your Garden, Making Vehicle Power Electronics COOL, Net Metering, and Biofuels Sustainability.

Visits to NREL by elected officials are common. In Fiscal Year (FY) 2008, NREL's Visitors Program hosted 300 site visits for more than 3,000 VIP visitors, including 16 Members of Congress during the Democratic National Convention, U.S. Representative John Salazar (D-CO),

Senator John Thune, New Zealand Minister of Research, Science & Technology, Pete Hodgson, Swiss Ambassador, Urs Ziswiler, U.S. Ambassador to Spain, Eduardo Aguirre, and Ireland's Chief Scientific Advisor, Professor Patrick Cunningham.

The lab hosts a public Web site for visitors at: http://www.nrel.gov/visitors_center/. Past editions of "NREL Community News" are located on this site, with contact information for public comment to NREL. In addition, www.nrel.gov features links where the public can access copies of NREL's Sustainability Reports (http://www.nrel.gov/sustainable_nrel/) and Environmental Reports (http://www.nrel.gov/eshq/environmental_protection.html).

4.2 Performance Indicators and Progress

4.2.1 2008 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 One-Year Plan. The FY 2008 One-Year Plan established the goal to "advance ESH&Q as a core value to protect the health and safety of NREL workers and the community and to strengthen environmental quality." The environmental objectives for meeting this goal were:

- Implementation of integrated safety, health, and environmental management into laboratory operations/management systems;
- Effective response to laboratory challenges; and
- Response to environment, health, and safety issues.

NREL successfully completed the One-Year Plan objectives. Some noteworthy achievements in FY 2008 include:

- Implementing a tracking system for safety inspection findings
- Streamlining the process of developing and maintaining Safe Operating Procedures (SOPs)
- Meeting a 10% paper consumption reduction goal in the areas of document services center paper usage (copy center; about 11% reduction), and in copiers paper usage (deployed throughout the lab; about 13%)
- Updating P-card users training on pollution prevention and green products
- Using an integrated team approach to meet environmental goals for electronics management, incorporating all phases of the life cycle of electronics, resulting in external recognition through the FEC
- Developing and implementing a Hazardous Waste Program Improvement Plan, including introduction of required annual training and identification of all satellite accumulation areas with inspectors for each area
- Conducting a nanomaterial safety program assessment, enhancement, and HSS audit.

4.2.2 State of Colorado ELP Commitments (2007 – 2010)

The following multi-year commitments, as stated in CDPHE ELP Annual Environmental Awards Program, support the laboratory-wide EHS objectives for both 2008 and the upcoming objectives for 2009.

4.2.2.1 "Campus Planning"

- NREL actively "walks the talk," having made a tremendous start by achieving Leadership in Energy and Environmental Design (LEED) Platinum designation at the Science and Technology Facility (S&TF) in March 2007. In 2008, NREL began construction of the 220,000 gross square foot (gsf) Research Support Facilities (RSF) with the goal of achieving a LEED Platinum designation.
- NREL continues to reduce GHG emissions as required by the federal EO 13423, *Strengthening Federal Environmental, Energy and Transportation Management*. This is completed through the deployment of energy efficient and renewable energy technologies on site at NREL, and through the purchase of renewable energy certificates.
- NREL has been accepted in the FEC, and completed projects that qualified for Silver-level and Gold-level Awards given jointly by the Office of the Federal Environmental Executive and the EPA.

Please see NREL's 2008 Sustainability Report for progress in campus planning areas of sustainable building design, and GHG emissions. For results of the FEC application submittal, please see Section 4.1.2.

As an additional indicator of NREL's environmental performance in 2008, Sustainable NREL and EMS staff supported NREL efforts in receiving the following awards:

- Transformation Energy Action Management (TEAM) Renewable Energy Award; awarded by DOE's Federal Energy Management Program
- Pollution Prevention STAR Award – Leadership in Environmental and Energy Design – S&TF; awarded by DOE
- Laboratory of the Year Special Mention Award; awarded by *R&D Magazine*
- ASHRAE Technology Award – Institutional Buildings (New Construction); awarded by ASHRAE Region X
- Colorado Renewable Energy and Sustainable Design in Buildings Award – Institutional Buildings; awarded by the Colorado Renewable Energy Society
- Federal Electronics Challenge – Silver-level Award; awarded by the Office of the Federal Environmental Executive and the EPA
- Continued recognition as a Gold-level Environmental Leader; awarded by the CDPHE Environmental Leadership Program.

4.2.3 2009 Environmental Objectives

The environmental objectives developed by NREL in collaboration with DOE-GO are to meet the EHS management goal stated in the Performance Evaluation Measurement Plan. The stated goal is "to demonstrate that EHS 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 2009, the environmental objectives are:

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

Progress toward the 2009 objectives will be reported in the NREL 2009 Environmental Performance Report.

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 also provide for continuous improvement of the EMS.

There are three different types of assessments performed to evaluate the functionality of the EMS at NREL: EMS assessments, periodic compliance assessments, and third-party assessments.

A team of NREL staff generally performs periodic assessments of NREL's EMS internally. The scope of the 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. The team evaluates the EMS based on an appropriate set of criteria, such as ISO 14000 standards, DOE Order requirements, Colorado Environmental Leadership Program standards, or other applicable environmental management standards.

Periodic compliance assessments are conducted of individual environmental programs to verify that each program, as written, meets all applicable legislative and regulatory requirements and that the program is implemented as intended (see Section 5.0 for examples). Improvements are developed and implemented as necessary, based on the results of each assessment.

In addition to compliance assessments of individual NREL environmental programs, NREL has management system review processes in place for regular reviews and updates of the set of policies, lab-level programs, and task-specific procedures, including EMS policies and programs. NREL reviews its EHS policies and laboratory-level procedures as needed, but at least every five years, making revisions as necessary. All SOPs are reviewed on an annual basis and are revised as necessary to help ensure the required controls are appropriate for the hazards present. Environmental hazards and controls are specifically called out in each SOP.

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. A third-party, external audit of the EMS is planned for 2009 and every three years thereafter, as required by DOE Order 450.1A.

4.3.1 2008 Assessment Activities

In August 2008, NREL's Quality Assurance team performed an assessment of the EMS to measure the overall effectiveness and level of deployment and maturity of NREL's EMS.

The assessment was based on the ISO 14001:2004 standard, the NREL EMS description, and any related process documents such as lab-level and desk procedures. The assessment consisted of documentation review and interviews with EMS staff and other workers involved with or affected by the EMS. Several recommendations for improvement were identified and

incorporated into corrective action plans. Corrective action plan elements are entered into the quality assurance organization's action tracking database.

Annual EMS assessments, conducted by the NREL Quality Management and Systems Assurance assessment team, will continue to monitor performance of the system.

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 and offices with the goals of maximizing 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
- GHG emission reductions
- Reduce, reuse, and recycle materials use
- Public responsibility/community outreach
- Environmental management.

Sustainable NREL carries out the laboratory's commitments to, among other things, reducing energy use in its building operations, designing energy efficient and environmentally sensitive new buildings, reducing water consumption, decreasing GHG emissions, minimizing the impact of NREL local and air travel on the environment, using less fossil-based fuel for local operations, incorporating renewable energy technologies into its on-site STM and NWTC operations, and creating less waste by reducing, reusing, and recycling materials for laboratory operations.

In addition, the EMS supports Sustainable NREL's goals by focusing on protecting the natural and cultural resources on and around NREL sites by:

- Minimizing NREL's potential for environmental impacts through emissions, discharges, waste generation, purchases, and land use
- Conducting required permitting activities
- Managing site natural resources for protection and preservation of their natural character to the extent possible, while still fulfilling NREL's mission
- Managing site cultural resources for documenting resources of significance and minimizing disturbances whenever possible
- Recommending and coordinating measures to minimize any potential impacts NREL's activities have on the environment.

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 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. Each section is composed of three areas of discussion: a summary of the environmental management of the resource, a discussion of any relevant permitting, and a summary of significant activities that have occurred throughout Calendar Year (CY) 2008.

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

5.1 Air Quality Protection

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, Non-criteria, and Hazardous Pollutants

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

- Criteria air pollutants (e.g., carbon monoxide, nitrogen oxides, sulfur dioxide, particulate matter, ozone, and lead)
- Non-criteria pollutants (e.g., ammonia, hydrogen sulfide, pesticides, organic compounds, metallic compounds, and corrosives)
- Hazardous air pollutants (e.g., organic compounds, metals, corrosives, asbestos, radionuclides, and pesticides)
- Ozone-depleting substances (e.g., chlorofluorocarbons or "freons").

There are notification and permitting thresholds for criteria, non-criteria, and hazardous pollutants. The primary potential sources of these pollutants at NREL include boilers, emergency generators, experimental laboratory hoods, pilot-scale research projects, and small pieces of equipment with gasoline or diesel engines. NREL maintains air emission inventories to track potential air emissions and identify whether notification and permitting could be required for a particular facility or activity. Fugitive particulate emissions from construction activities occurring on NREL's sites are also a potential source.

5.1.1.2 Ozone-depleting Substances

Facilities that service refrigeration equipment containing ozone-depleting substances (ODS) are required to file an annual notification with the CDPHE. NREL employs EPA-certified technicians that service ODS-containing equipment. Another requirement of Colorado's chlorofluoro carbon program is that all refrigeration equipment larger than 100 hp that uses ODS 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.

Halon-based fire suppression systems previously used at NREL were eliminated by 1999, with all supplies of Halon being transferred to other DOE facilities for "banking."

5.1.1.3 Street Sanding

CDPHE regulations require federal, state, and local government facilities to track street sanding in the wintertime, and to make efforts to minimize sand use. NREL complies with this requirement and files an annual sanding report with CDPHE. From October 2007 to May 2008, NREL used 25 tons of sand during 22 sanding episodes. NREL maintains 12.3 lane-miles of roads. From October 2008 to May 2009, NREL used 79 tons of sand during 24 sanding episodes, while continuing to maintain 12.3 lane-miles of road.

5.1.2 Permitting

Most potential sources of air emissions from NREL operations in 2008 were small scale and did not require permitting. Permitting thresholds vary, depending on the pollutant. Projected emissions for these sources were below thresholds for air permitting.

Two site-wide permits for particulate emissions from construction activities have been issued to NREL by CDPHE. NREL has held such permits for a number of years. New site-wide permits were issued in February 2005 to replace previously held permits, at which the time period of applicability had expired. One permit covers the STM site and the other covers the NWTC.

NREL also holds one air emissions permit for an experimental pilot process in the Field Test Laboratory Building (FTLB) on the STM site. The permit was issued in 2000 for the operation of a thermal oxidizer emission control device for the experimental Thermochemical Process Demonstration Unit (TCPDU). An Air Pollution Emission Notice (APEN) update was filed with the Colorado Air Pollution Control Division in 2005.

5.1.3 2008 Activities

Two APENs were filed in early 2005, one for the STM and one for the NWTC, for overlot grading and associated construction activities to address fugitive particulate emissions. These APENs for the NWTC will expire in 2010. In the fall of 2008, NREL filed a new APEN for upcoming major construction activities anticipated in the upcoming five years at STM. Significant activities not associated with routine maintenance or small construction projects identified in the APEN submission were evaluated on a case-by-case basis in 2008. It was not necessary to submit an updated APEN.

As required by CDPHE every five years, an APEN update was filed in May 2005 to update the information provided in the original APEN for TCPDU activities. There have been no significant changes to the operating parameters or air emissions of the TCPDU in the last eight years, including 2008.

In early 2007, NREL received initial approval from CDPHE's Air Pollution Control Division for the construction and operation of the RFHP, a woodwaste-fired boiler to provide building comfort heating for the STM campus. Prior to the completion of construction, additional information became available regarding the configuration of the equipment and it was necessary to request a permit modification. CDPHE issued an initial approval for the permit modification in the fall of 2008. Construction of the RFHP was completed and the equipment became operational in late 2008. In April 2009, NREL completed the self-certification process for final approval and submitted the required documentation to CDPHE.

5.2 Drinking Water

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 JSF and ReFUEL 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 in 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 hydrogen test pad 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 byproducts), and lead and copper is performed at the NWTC according to the requirements of CDPHE. NREL qualifies for reduced lead and copper monitoring. Current state requirements for the NWTC system monitoring are as follows:

- Bacteria – monthly
- Chlorine levels – weekly, or more frequently as needed
- Haloacetic acids – quarterly
- Total Trihalomethanes – quarterly
- 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 in 2008. Monthly results for the bacterial analyses are provided to the state.

Monitoring for lead and copper was completed as scheduled during the summer of 2008. All samples collected were well below the maximum contaminant levels (MCL). 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 ppm, well below the MCL of 0.015 ppm. Copper values ranged from 0.095ppm to 0.474 ppm, with an average value of 0.200 ppm, well below the MCL 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 of chlorine present to provide sufficient disinfection at the monitoring locations. 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 2008. The running annual average of the maximum residual disinfectant level for CY 2008 was 0.518 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 CDPHE for the drinking water distribution system at the NWTC. This identification number does not require periodic renewal; however, periodic testing, record keeping, and reporting are required. All other NREL facilities (STM, DWOP, GH, JSF, and ReFUEL) receive drinking water from municipal sources.

5.2.3 2008 Activities

In 2008, 195,648 gallons of potable water were delivered to the NWTC, with an average daily consumption rate of 536 gallons. NREL conducted all required monitoring in 2008 and all reported results met drinking water standards. Bacteria were absent in all samples collected, and disinfectant was detected at all locations tested. The annual running average for chlorine was 0.518 ppm.

Quarterly monitoring for disinfection byproducts (DBPs) continued throughout 2008. The running annual average (RAA) for total trihalomethanes in 2008 was 0.051 mg/L, below the maximum contaminant level of 0.080 mg/L and in compliance with the water quality requirement. The RAA for haloacetics acids was 0.038 mg/L, below the maximum contaminant level of 0.060 mg/L, also in compliance with the water quality requirement.

CDPHE's Water Quality Control Division conducted a formal Sanitary Survey of the NWTC drinking water system on September 23, 2008, and found the system to be in compliance with all requirements. Three recommendations for improvement were identified during the survey:

Observation 1: Monitoring, Reporting, and Data Verification

"The system should continue to evaluate source water quality from the wholesaler, the system's booster chlorination system, and the amount of residence time in the storage tank and distribution system in order to minimize formation of disinfection by products."

Observation 2: System Operations and Maintenance

"It is recommended that the system develop and implement a valve exercising program for valves in the distribution system in order to maximize the life of such devices."

Observation 3: Storage Management

"It is recommended that the water system create a tank maintenance plan to evaluate and inspect the condition of the buried storage tank and to ensure the tank is a safe and viable component of the water system. Preventative maintenance and timely inspections will help prolong the life of the tanks and ensure early detection of needed repairs. The water system should examine the tank and piping, and look for signs of compromised integrity and leaks on a yearly basis. Additionally, the water system should routinely inspect the integrity of the access manhole and vents on a frequent basis to ensure the sanitary integrity of these components. In addition to the tank maintenance plan, the water system should have the tank drained, cleaned, and professionally evaluated every three to five years (as recommended by the American Water Works Association)."

Actions on these recommendations will be reported in the CY 2009 Annual Site Environmental Report.

5.3 Groundwater

5.3.1 Program Management

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

Both the STM and 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 located between 60'-100' 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 2,270-2,970 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 southeast of the STM site. Consequently, wells drilled at the STM site and NWTC would not intersect the Dawson aquifer.

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 be established to protect groundwater. Safeguards include, but are not limited to, secondary containment for equipment with the potential to leak oil, double-walled tanks with leak detection for diesel fuel storage of NREL facilities' emergency generators, and bermed areas to contain experimental materials.

In 1990 groundwater characterization began with the installation of a monitoring well network at the STM site. Eight wells were installed at the base of the mesa slope. Four upgradient wells were installed to investigate background water quality prior to its crossing NREL facility boundaries, and four wells were placed in a generally downgradient direction to verify that NREL activities had not adversely affected groundwater quality. Quarterly sampling was performed for five calendar quarters, followed by annual sampling for three years. No evidence of contamination was found. Groundwater quality at NREL was similar to other portions of the Denver Basin. In addition, routine follow-up sampling was done in 1997. Three of the initial eight wells were closed (in accordance with state requirements) due to construction activities in 1993, and a fourth was found to be inaccessible during the 1997 sampling, also due to construction activity in the area. Therefore, follow-up samples were only collected from four of the original monitoring wells: three upgradient wells and one downgradient of NREL development. No evidence of contamination was found in the 1997 sampling.

In June 1998, a diesel leak to the environment from a failed check valve on the Process Demonstration Unit (PDU) emergency generator aboveground storage tank at the AFUF occurred. The majority of contaminated soil was excavated and removed from the site for disposal at a permitted landfill. Three groundwater monitoring wells were installed at the site in September 1998, one upgradient and two downgradient. No hydrocarbon contamination was detected in the groundwater during the initial sampling of the three wells, or during follow-up sampling conducted in March and September 1999, and March 2000. These three monitoring wells were closed in 2006 in accordance with state requirements.

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-GO 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.

NREL has not conducted groundwater monitoring at its leased DWOP site, as there have been no activities that pose an unusual risk to groundwater quality. If NREL had reason to suspect a groundwater quality problem, the issue would be addressed with DWOP management. DWOP management contracted with an engineering firm to conduct a groundwater monitoring study in 1988 adjacent to the NREL-leased buildings. Two monitoring wells were drilled. There were no detections of significant levels of contaminants.

There have been no groundwater studies performed by NREL at either the JSF or the ReFUEL Facility, as there have been no activities at these site 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

All groundwater monitoring wells installed by NREL at the STM sites have been permitted with the Colorado Department of Natural Resources.

5.3.3 2008 Activities

In 2008, there were no new groundwater-related activities.

5.4 Wastewater Discharge

5.4.1 Program Management

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

The majority of wastewater from NREL's STM and DWOP facilities flows into the Pleasant View Water and Sanitation District's system, and ultimately to 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 Solar Radiation Research Laboratory (SRRL), because there is no sewer line to the mesa top. Wastewater from the JSF and the ReFUEL Facility 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 that hazardous chemicals are not to be discharged to the sewer system, and 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

No permitting for the majority of NREL's wastewater discharges is required. NREL has no direct wastewater discharges to the environment at the DWOP, ReFUEL, GH, or JSF, so no National Pollutant Discharge Elimination System (NPDES) permitting is 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.

NREL maintains septic permits from Jefferson County (an authority delegated to the counties under a state of Colorado program) for the NWTC's IUF and Building 251 septic systems, as well as for the SRRL facility on the STM site mesa top.

5.4.3 2008 Activities

In 2008, there were no new wastewater discharge activities.

5.5 Surface Water Protection (Stormwater and Erosion Control)

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).

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 sampling could be compared.

Samples were collected at three locations: the western portion of the east drainage, the middle drainage, and the middle-west drainage located between the west and middle drainages. Water quality data indicate that NREL's activities did not result in contamination of stormwater 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 on 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 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. Measures to prevent impacts to stormwater are incorporated, as appropriate, into the design for each project. Potential control measures include secondary containment and bermed areas for chemicals use and storage, covers or roofs to protect chemical use, and storage areas from precipitation and minimizing impervious areas to promote infiltration and decrease site runoff.

During construction, erosion and sediment controls are implemented according to the plans developed by contractors and reviewed by the laboratory's EHS staff per NREL's stormwater procedures. Regular inspections by contractors and periodic site inspections by NREL staff are conducted to verify that the controls are functioning properly and to identify any required repairs. Written reports are prepared for all inspections; prompt corrective actions are required to rectify any noncompliant conditions.

5.5.2 Permitting

Stormwater quality on federal facilities in Colorado is regulated by the EPA Region 8. To obtain coverage under the EPA's NPDES General Construction Stormwater permit, NREL must submit an NOI form. Both the site owner (DOE) and the site operator (Alliance for Sustainable Energy, LLC or previously, Midwest Research Institute) have filed NOIs with the EPA.

In 2008, NREL filed a NOI for construction activities at the STM site for the RSF and associated stormwater detention basin and access road. In August of 2008, permit coverage for construction of a small Quonset-type metal building constructed at the NWTC for wind turbine blade preparation activities was terminated. No new NOIs were obtained for the NWTC in 2008 because no construction activities involved more than 1 acre. Stormwater permits are not required for NREL's routine operation.

5.5.3 2008 Activities

In addition to implementing 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 for which General Construction Stormwater permits were not required. These were primarily located at the NWTC where the following activities occurred over the course of the year: placement of new data sheds and pads at Sites 3.3, 4.0, and 4.4; placement of a new trailer near Building 251; construction of foundations for wind turbines at Sites 1.2E, 3.3A, 3.3B, and 3.3C; construction of foundations for meteorological towers at Site 3.3; and construction of a hydrogen vehicle fueling island at the Distributed Energy Resources Test Facility.

5.6 Waste Management

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 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 (see Section 5.6.3).

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 produce quantities of hazardous waste in various amounts. Each of the five sites has an RCRA waste generator identification number issued by 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 JSF, the NWTC, the DWOP, and the ReFUEL Facility—are classified as "conditionally exempt small quantity generators," generating less than 100 kg of waste per month.

5.6.3 2008 Activities

In CY 2008, NREL shipped 23,177 pounds (10,535 kg) of hazardous waste, 5,148 pounds (2,340 kg) of non-RCRA regulated waste, and 5,407 pounds (2,548 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 2008, there was a 15% reduction in the amount of hazardous waste shipped from the CY 2007 levels.

In 2008, no radioactive waste was shipped for off-site disposal. However, in September 2008, work began in the FTLB using phosphorus-32, a radioactive isotope. Waste generated by these activities will be shipped in CY 2009. Information regarding the types and quantities of radioactive materials used at NREL facilities is detailed in Section 5.16.

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 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; therefore, DOE and the national laboratories have taken a conservative approach to the use and disposal of nanomaterials. In May 2008, the NREL Waste Management and Minimization procedure was updated to include a new section that imposes new requirements for the packaging and disposal of nanomaterial-bearing waste. This material is

collected and stored as hazardous waste, and ultimately sent to licensed treatment storage and disposal facilities for disposal.

As reported in the CY 2007 Annual Site Evaluation Report, the EPA conducted RCRA site inspections at NREL's leased facilities in the DWOP and at the STM facilities. The items noted by EPA inspectors for the STM facilities resulted in a warning letter issued on December 19, 2007. NREL took immediate corrective actions to address and resolve the EPA findings and developed a Hazardous Waste Program Improvement Plan to fortify hazardous waste management activities at NREL. In CY 2008, NREL increased the waste management training requirements to once per year, implemented documented weekly inspections of all waste collection areas, and requested an intensive program audit from the laboratory's Quality Assurance organization. The increase training requirements and the weekly inspections satisfy the regulatory requirements anticipated when waste production increases to above the large quantity generator threshold.

5.7 Storage Tanks (Underground and Aboveground)

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 (6-2.10). NREL does not have any underground tanks with hazardous materials.

NREL facilities store diesel fuel for emergency generators and ethanol from research activities in aboveground storage tanks. NREL's tank management program focuses on proper tank design, operation, and inspection to protect against spills and leaks. The program is designed to meet regulatory requirements and is more stringent in many areas 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, as well as double wall tanks with sensors that result in an alarm if the inner tank wall is leaking. Procedural safeguards include written operating procedures and tank filling procedures. All tanks larger than 110 gallons are visually inspected at least once per month.

Due to the quantity of fuels stored on the STM, NWTC, and ReFUEL sites, a Spill Prevention Control and Countermeasures Plan is required. This plan describes the site topography and neighboring areas, and outlines the steps necessary to mitigate any spills or leaks of diesel fuel. To date, NREL has not had any off-site impacts related to tank activities.

5.7.2 Permitting

Aboveground 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 PDU ethanol storage tank at the AFUF. Both are located on the STM site.

5.7.3 2008 Activities

An inspection of NREL's regulated aboveground storage tanks (ASTs) was conducted by the Colorado Department of Labor and Employment's Division of Oil and Public Safety on July 10,

2008. The inspector found no deficiencies. No spills or releases from NREL's ASTs occurred during 2008.

5.8 Hazardous Materials Management

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 do not apply to NREL facilities.

NREL facilities are subject to the emergency reporting requirements in Title III of the SARA, also known as the Emergency Reporting and Community Right-to-Know Act (EPCRA). Section 302 of the EPCRA requires a facility to notify the State Emergency Response Commission (SERC) that it is subject to emergency planning and notification requirements if any chemicals 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.

EPCRA Section 304 requires facilities to immediately notify the Local Emergency Planning Committee (LEPC) if there is an accidental spill or release of more than the predetermined RQ. In accordance with Section 311 and 312 of the 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 Tier I or Tier II reports to emergency planning and response groups.

When requested, NREL provides additional emergency response and reporting information to the Jefferson County LEPC, the SERC, the West Metro Fire Protection District, 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 acting 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 the 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. NREL, never having manufactured, processed, or otherwise used chemicals on the 313 list in quantities exceeding TPQs, has never had to report under Section 313.

Section 112r of the Clean Air Act regulates numerous toxic and flammable substances, and, similar to the EPCRA, establishes threshold quantities for these materials. Unlike the EPCRA, however, the Section 112r TPQ 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 recent years, the CMS system was upgraded to new software and hardware 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. Shipping and Receiving is responsible for chemical labeling and data entry, Information Services 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: the JSF, Building 251 at the NWTC, Building 16, the STM site, the older areas of the AFUF, the FTLB, and the SRRL. No asbestos was found at the JSF or the AFUF. The other facilities have limited amounts of asbestos-containing material in areas such as floor tile, 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 Fire Protection District (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 and/or used. 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. DFD inspects the facility and issues a Hazardous Materials Permit.

5.8.3 2008 Activities

West Metro conducted a walk-through inspection of NREL's STM and DWOP facilities in the summer of 2008. 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.

Similarly, the CMS provided inventory information to meet the DFD's HMIS requirements. The ReFUEL facility's Hazardous Material Permit was renewed by the DFD in July 2008.

5.9 Pollution Prevention and Sustainability

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.

The Sustainable NREL Program publishes an annual report that provides the details of accomplishments in the areas of activities listed above. The 2008 report was not available at the time of this report; the reader is referred to http://www.nrel.gov/sustainable_nrel/ to find the latest report on Sustainable NREL activities and accomplishments.

5.9.2 Permitting

NREL has no permit requirements applicable to Pollution Prevention and sustainability management. As a DOE facility, NREL does set objectives to meet goals established by federal executive orders, (e.g., EO 13423), and DOE orders.

5.10 Vegetation Management

5.10.1 Program Management

Vegetation management 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 at the STM site. However, the native vegetation and natural character of the landscape is maintained over the majority of the site.

Figure 20. Sego Lily at the NWTC

Credit: Bob Fiehweg

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 the disturbance. Seed mix and revegetation procedures are outlined in NREL's Stormwater Pollution Prevention Programs for the STM and NWTC Sites. 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. The most recent vegetation survey of the STM was conducted between June 2001 and May 2002. 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. The goal of such plans will not be to stop the continued spread of these species but to provide additional education, research, and biological control resources to jurisdictions that choose to require management of List C species. 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.

A three-season vegetation survey of the NWTC site was performed between August 1999 and August 2000. The 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.

Figure 21. Prairie Goldenpea Thermopsis at the NWTC

Credit: Bob Fiehweg

Of the weed species identified at the NWTC site, four are Class B species—Canada thistle, diffuse knapweed, musk thistle, and leafy spurge—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.

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 of this seed mix for revegetation at the NWTC.

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.

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.

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 2008 Activities

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 reclamation, off-road driving restrictions, and other weed control methods, ground applications of herbicides occurred at the NWTC in the spring of 2008. Very limited herbicide application was conducted on the STM site in the spring of 2008, focusing primarily on areas adjacent to roadways and buildings. The spraying was performed using a four-wheel drive vehicle. 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 in 2008 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 2000-02 by Plantae Consulting Services. No formal field work has been completed since the FY 2002 survey, but the list is updated as NREL EHS staff becomes aware of species not on the list (see Appendix B).

5.11 Wildlife

5.11.1 Program Management

Wildlife habitat at the STM site is primarily grasslands, shrublands, and wetlands, while the habitat at the NWTC is comprised of grasslands, woodlands, shrublands, and wetlands. Both sites provide vegetation types for a variety of wildlife species, including birds, mammals, reptiles, and amphibians. The variety of vegetation types attracts species that may use the site as a year-round habitat, for breeding, during migration, or as winter habitat. Wildlife surveys were conducted on the STM site in 1987 and 2005, with follow-up verification surveys conducted in 1998 and 1999. Follow-up surveys are planned for both the NWTC and STM in the near future.

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. DOE prepared a biological characterization inventory for the adjoining Rocky Flats site, 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 the deer mouse, prairie vole, desert cottontail, coyote, mule deer, prairie rattlesnake, bullsnake, plains garter snake, and tiger salamander.

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 the red-tailed hawk, American kestrel, and great-horned owl, were noted on the site, primarily resting and hunting; however, 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 feet)

over the site. No significant impacts to the birds from NREL activities were found during these surveys.

Figure 22. Vesper Sparrow at NWTC

Credit: Bob Fiehweg

In early 2001, a year-long monitoring project for birds and bats was initiated at the NWTC. 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, E. 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 offsite. 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 began. 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 a habitat that contains elements from both mountain and prairie ecosystems. The most recent site-wide wildlife survey of the STM site began in April 2004 and was completed in June 2005. 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 23. Western Meadowlark on STM

Credit: Bob Fiehweg

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. NREL has no other permitting requirements for this area of environmental management.

5.11.5 2008 Activities

In compliance with the Migratory Bird Treaty Act, surveys for ground-nesting birds were completed prior to activities that could adversely affect these species. 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.

Several ground-nesting bird surveys were conducted in 2008 on the mesa top portion of the STM in advance of planned construction activities associated with the installation of the mesa top PV system. No active nests were found during any of these surveys, and construction activities were allowed to proceed. During these surveys, three additional bird species were seen on site that had not been observed in the 2005 wildlife survey: the lark sparrow, cliff swallow, and blue-gray gnatcatcher.

In May 2008, two ground-nesting bird surveys were done at the NWTC in areas slated for herbicide application and mowing. Although a few ground-nesting bird species were observed, no active nests were found; approval was given to commence spraying and mowing.

5.11.5.1 Migratory Birds and Raptors

Many species of migratory birds were observed on the STM site, with many of these species potentially nesting on site. Additionally, the STM site provides important migration and winter habitat for migratory birds. For example, American tree sparrows are only observed on site during the winter, and northern harriers have been observed hunting on site only in the fall and winter. Several species were only observed during the fall, including the blue jay, downy woodpecker, red-breasted nuthatch, loggerhead shrike, and rock wren, suggesting that these species may use the STM site as a stopover during migration. Habitat for migrating birds is important, as some of these species may migrate as far south as Central and South America.

Figure 24. Red-tailed Hawk soaring over STM

Credit: Bob Fiehweg

Several species of raptors were observed at the STM site, and two species were observed nesting on site by both studies (1987 and 2004-2005): the red-tailed hawk and the American kestrel. Both of these species were observed hunting on site during the 2004-2005 surveys, in addition to the Cooper's hawk, which is known to nest along nearby Clear Creek. The NREL STM site provides habitat and a prey base of small birds and mammals for these raptor species. Species such as the Swainson's hawk migrate thousands of miles each year to winter in Argentina, and return to the western United States and Canada to breed. Areas such as the STM site may provide a prey source for the Swainson's hawk and other species during migration.

5.11.5.2 Large Mammals

Mule deer at the STM site have been observed in all habitat types. Mule deer were often observed in the amphitheater drainage or in the tall shrubland on the slope. When approached on the mesa top, the mule deer tended to move away from the disturbance and into the amphitheater drainage.

The tall shrubland vegetation type may provide important hiding cover for this species. Spring pellet group surveys resulted in nearly double the amount of pellet groups and plots of the pellet groups than were observed in the fall surveys. This may suggest that winter use of the STM site by deer may be higher than summer use, or that deer use different habitats on site for these periods as affected by the availability of habitats and the location of survey plots; however, the single year of data is not sufficient to draw conclusions regarding seasonal variation.

5.11.5.3 Predators

Coyotes are one of the most widespread and adaptable carnivores in North America and occur at all elevation levels and in all ecosystems in Colorado (Fitzgerald, et al. 1994). Lagomorphs (rabbits) and rodents are an important part of the coyote's diet, both of which are abundant on the STM site. Evidence of predation on cottontail rabbits (i.e., entrails and fur) was observed during site visits. Coyotes may breed on the STM site as two potential dens were observed in two of the site drainages.

5.11.5.4 Small Mammals

The deer mouse is the widest ranging and most common small mammal in North America (Fitzgerald et al. 1994), and based on the 1987 and 2004-2005 survey data, it is also the most common small mammal on the NREL STM site. Deer mice can occur anyplace where cover occurs (Fitzgerald et al. 1994) and were observed in the four vegetation types sampled on the STM site. This species is a generalist and is known to exploit disturbed habitats.

Mexican woodrats and prairie voles have more restricted ranges at the STM site. Mexican woodrats are associated with rocky slopes and do not build dens away from rocky areas (Fitzgerald et al. 1994); this habitat is limited at the STM site. Prairie voles are adapted to grasslands, constructing burrows and runway systems throughout the grassland, essentially limiting this species to the short grass and mixed grass vegetation types on the STM site.

All of these species are active throughout the year. Winter surveys (2004-2005) were conducted during a warm weather trend, which may have contributed to the highest number of small mammals caught compared to the three other surveys.

Figure 25. Black-tailed prairie dog at the NWTC

Credit: Bob Fiehweg

In November 2008, NREL developed a plan for the environmentally responsible removal of an estimated 50 prairie dogs from the western portion of the NWTC. A 1 MW photovoltaic array is planned for the area currently colonized by the prairie dogs, necessitating the removal. Biologists at NREL determined that the most cost-effective and environmentally responsible procedure included onsite relocation of the prairie dog colony to the northwest corner of the NWTC within one of the designated conservation management areas. By the end of 2008, a capture/relocation company was awarded a contract, monitoring of current conditions was completed, and trenching in the relocation area was initiated. This project continued into CY 2009 with the successful relocation of the colony.

5.11.5.5 Reptiles/Amphibians

Rattlesnakes are often observed on the STM site, usually in rocky areas, but also in the grasslands, and sometimes in and near the STM buildings. Snakes found near or in buildings are removed by NREL security or environmental personnel and relocated to remote areas of STM. Hibernation generally occurs in rock outcrops, with this species usually active from mid-April through late-September (Hammerson 1999).

To avoid or minimize disturbance to wildlife species on site, site-wide best management practices (BMPs) are employed during ongoing normal site operations and future construction projects. The BMPs address migratory birds and raptors, mammals, all wildlife, and general site operations. For example, rattlesnakes found near STM buildings are relocated, not destroyed; the no-kill policy is a BMP.

5.12 Endangered Species/Species of Concern

5.12.1 Program Management

The Endangered Species Act 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 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; however, 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 this listing of rare species is not regulatory in nature, NREL uses it for management purposes.

The U.S. Fish and Wildlife Service has identified eight species listed in accordance with the Endangered Species Act as threatened, endangered, or a candidate for listing, that could potentially occur within the STM site project area. Of Colorado's species of concern, eight species may potentially occur at the STM site. None of these were observed during any of the site surveys. However, based on existing habitat, four species could potentially be found at the site: the American peregrine falcon, bald eagle, ferruginous hawk, and black-tailed prairie dog. Although a similar comparison of existing habitat at the NWTC to listed species has not been done to date, there is a colony of black-tailed prairie dogs present at the NWTC. As mentioned, the colony has been relocated to the northwestern portion of the site, in one of the designated conservation management areas.

The vegetation survey at NWTC, conducted between August 1999 and August 2000, identified a small area of xeric tallgrass (defined in the survey as mesic mixed grassland) prairie located in the southwest corner of the NWTC site. This natural community is listed as rare and imperiled by the Colorado Natural Heritage Program. This listing implies no legal designation, but is made primarily for management planning purposes. This xeric tallgrass prairie area has been designated by NREL as a conservation management area. Most of the conservation management areas on the NWTC are formally designated as areas on which building will not occur. However, as the xeric tallgrass prairie is in the active turbine testing area, it is not reasonable to preclude all development on portions of the site inhabited by this plant community. However, to the greatest extent possible, disturbance will be minimized on this biome.

The STM site vegetation survey completed in May 2002 found no rare or imperiled plant species on the site, but areas of mixed foothills shrublands (also called tall upland shrubland) were identified along the top of the mesa within the conservation easement area. That natural community is listed as rare and imperiled by the Colorado Natural Heritage program. It is within a designated conservation easement area where no development will occur except trails being established by Jefferson County Open Space (see Section 6.1).

As reported in Section 5.11.3, a site-wide wildlife survey of the STM site has recently been completed. No species observed on the STM site during the 1987 or the 2004-2005 wildlife surveys were present on either agency's list. However, golden eagles were incidentally observed

on the STM site (outside of raptor surveys) and are protected under the Bald and Golden Eagle Protection Act. Golden eagles were observed flying over the site and may use the site for hunting. No golden eagle nests or nesting activities were observed on the STM site.

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

5.12.3 2008 Activities
In 2008, the presence of the non-native Eurasian Collared Dove continued at NREL's STM. 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 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 the Environmental Permitting and Notification (6-2.1).

5.13.1 Program Management
Wetlands are defined by the EPA 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 Section 404 of the Clean Water Act, 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.

5.13.2 2008-2009 Activities
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 Visitors Center)
- Middle drainage (originating upstream of the amphitheater and flowing between the FTLB and the SERF)
- 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 five 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 0.3ha (0.75 acres) and 0.4ha (1 acre), respectively. 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.

5.14 Cultural Resources

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, 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. Figure 7 provides an aerial view of the amphitheater.

The Camp George West Historic District, also listed on the National Register, includes the 25-acre parcel of NREL's site, south of the DWOP. 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, features within a historic district that contribute to the district's overall eligibility for the National Register, occur within those 25 acres.

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 State Historic Preservation Office (SHPO) regarding the significant resources located on the 25 acres. DOE and the SHPO 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 descriptions 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, and also at the DOE-GO and NREL offices.

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 2008 Activities

In 2008, the NREL procedure 6-2.11 Cultural Resource Management was revised, effective December 22, 2008. This procedure is a management tool for achieving proper coordination regarding cultural resource protection among appropriate NREL managers and workers. In 2008, construction activities began on the RSF 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, no one were found to be of unique value.

5.15 National Environmental Policy Act

5.15.1 Program Management

Management in this area is consistent with NREL's National Environmental Policy Act (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. The Council on Environmental Quality (CEQ) issues regulations for compliance with the Act. DOE has also issued implementing regulations at 10 Code of Federal Regulations (CFR) that complement the CEQ requirements.

DOE has written a site-wide EA for its activity at the STM site and DWOP, and separate EAs for the NWTC and JSF activities.

NREL has established procedures, with the approval of DOE-GO, to assist DOE in meeting their NEPA obligation. Proposed activities that will be conducted at NREL's five sites 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 2008 Activities

During 2008, numerous NEPA reviews of both onsite and offsite activities occurred through completion of NEPA Worksheets and NREL environmental checklists. As outlined in NREL's NEPA implementation procedures, these reviews were coordinated among NREL project managers, subcontracting staff, the NREL NEPA coordinator, and the DOE-GO NEPA Compliance Officer. NEPA requirements were also coordinated with future program planning (e.g., development of NREL's 2007 Grand Buildout Infrastructure Design) through interaction between NREL's EHS Office director and NREL's technology program and project managers. Requirements were also coordinated through participation in the NREL management annual planning process, Environmental Management System implementation, and other reviews of proposed projects for the upcoming FY 2009.

In CY 2008, NREL began the EA process for the second STM site-wide EA supplement (DOE/EA 1441-S-2) to address proposed site development projects, including the Energy Systems Integration Facility, site infrastructure improvements (Phase II), a second full service access road, expansion of the Waste Handling Facility, and expansion of the Visitors Center.

5.16 Radiological 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.

There are no nuclear operations at NREL sites. All of NREL's radiation sources are used/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. A new x-ray fluorescence machine was

installed in the SERF in 2008. 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 at least monthly, and more frequently if needed, on any laboratory surfaces that could have become contaminated by the radioisotope work. 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 or greater. No radioactive air-emission monitoring is conducted at NREL because of the extremely low usage of radioactive material. Therefore, NREL demonstrates compliance with the Rad NESHAPs in 40 CFR 61, Subpart H by using the EPA's COMPLY computer model to determine the potential dose to the public. NREL completed the 2008 report and the results of the COMPLY model showed that the potential dose to the public was well below the limit.

All radioactive waste generated during NREL activities is classified as low-level waste. Waste from the STM site is temporarily stored at the 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.

Figure 26. Conservation easement lands

Credit: Steve Wilcox

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; and
- 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 (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 2008 Property Assessment

During 2008, 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 2008. The access trail along the NREL entrance road was improved in 2008.

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 2009

Figure 27. Site wildlife at sunset

Credit: Steve Wilcox

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9 Appendices

Appendix A – Summary of NREL Environmental Permits, Registrations, Notifications
Appendix B – Wildlife Species Observed on the STM Site

Appendix A – Summary of NREL Environmental Permits, Registrations, Notifications

Table 1. Summary of NREL Environmental Permits, Registrations, Notifications

Tracking Number	Permit or Registration Number	Permit or Reg. Holder	Permit Type	Permit Description	Issuing Agency Name	Location Description	Status/Expiration Date	Reporting Required
Permits								
1	04JE1442L	DOE	Air	Air Emission Permit for Land Development (fugitive dust from construction activities)	Colorado Dept. of Public Health and Environment (CDPHE)	NWTC	01/31/2010 (originally issued 3/1/2000)	None
2	04JE1443L	DOE	Air	Air Emission Permit for Land Development (fugitive dust from construction activities)	CDPHE	STM	01/31/2010 (originally issued 3/1/2000)	None
7	37232	SERI	Groundwater Monitoring Well	Permit to Construct a Well (MW-1)	Colo. Div. Of Water Resources	STM	Construction complete; permit number active until well is closed	None
8	37229	SERI	Groundwater Monitoring Well	Permit to Construct a Well (MW-2)	Colo. Div. Of Water Resources	STM	Construction complete; permit number active until well is closed	None
9	37228	SERI	Groundwater Monitoring Well	Permit to Construct a Well (MW-3)	Colo. Div. Of Water Resources	STM	Construction complete; permit number active until well is closed	None
10	37231	SERI	Groundwater Monitoring Well	Permit to Construct a Well (MW-4)	Colo. Div. Of Water Resources	STM	Construction complete; permit number active until well is closed	None
11	37230	SERI	Groundwater Monitoring Well	Permit to Construct a Well (MW-5)	Colo. Div. Of Water Resources	STM	Construction complete; permit number active until well is closed	None

Tracking Number	Permit or Registration Number	Permit or Reg. Holder	Permit Type	Permit Description	Issuing Agency Name	Location Description	Status/Expiration Date	Reporting Required
12	214960 Closed	NREL/DOE	Groundwater Monitoring Well	Permit to Construct a Well (MW-11)	Colo. Div. Of Water Resources	STM	Well closed October 12, 2006. Permit number was active until well closed	None
13	214961 Closed	NREL/DOE	Groundwater Monitoring Well	Permit to Construct a Well (MW-10)	Colo. Div. Of Water Resources	STM	Well closed October 12, 2006. Permit number was active until well closed	None
14	214962 Closed	NREL/DOE	Groundwater Monitoring Well	Permit to Construct a Well (MW-09)	Colo Div. Of Water Resources	STM	Well closed October 12, 2006. Permit number was active until well closed	None
15	99JE0400	NREL/DOE	Air	TCPDU air emissions	CDPHE	STM	Initial approval issued 7/20/2000	None
16	20070617 through 20070623	NREL	Permit	Hazardous material storage and use permit	West Metro Fire Protection District	7 STM facilities (Bldg 16, WHF, SERF, S&TF, FTLB, AFUF, S&R)	July 2010	Annual fee, fire dept. inspection; new chemical inventory provided annually
17	P15-07-00003	NREL	BioSafety Permit	Sugarcane Bagasse	USDA - APHIS	STM	02/06/2010	None
18	PDEP-07-00222	NREL	BioSafety Permit	Wheat Streams	USDA - APHIS	STM	02/01/2008	None
19	PDEP-06-00178	NREL	BioSafety Permit	Oryza sativa leaves and stems	USDA - APHIS	STM	12/05/2007	None

Tracking Number	Permit or Registration Number	Permit or Reg. Holder	Permit Type	Permit Description	Issuing Agency Name	Location Description	Status/Expiration Date	Reporting Required
Notifications and Registrations								
20	PWSID Number CO0230860	DOE	Drinking Water	Non-community Supply of hauled water from a surface water source	CDPHE	NWTC	N/A	Periodic chlorine residual; monthly Bacteriological; Periodic lead and copper monitoring
21	CO4890000017	DOE	Hazardous Waste	Notification of Regulated Waste Activity	CDPHE	DWOP	Update recommended every 3-5 years, or sooner if substantial changes in activity occur. Last update: 7/97	Annual fee to Colorado Hazardous Waste Commission
22	CO3890090076	DOE	Hazardous Waste	Notification of Regulated Waste Activity	CDPHE	STM	Update recommended every 3-5 years, or sooner if substantial changes in activity occur. Last update: 9/07	Annual fee to Colorado Hazardous Waste Commission
23	COD980805162	DOE	Hazardous Waste	Notification of Regulated Waste Activity	CDPHE	JSF	Update recommended every 3-5 years, or sooner if substantial changes in activity occur. Last update: 7/97	None
24	COD983802448	DOE	Hazardous Waste	Notification of Regulated Waste Activity	CDPHE	NWTC	Update recommended every 3-5 years, or sooner if substantial changes in activity occur. Last update: 7/97	None

Tracking Number	Permit or Registration Number	Permit or Reg. Holder	Permit Type	Permit Description	Issuing Agency Name	Location Description	Status/Expiration Date	Reporting Required
25	COR000207563	DOE	Hazardous Waste	Notification of Regulated Waste Activity	CDPHE	ReFUEL	Issued Jan 9, 2004	None
26	001 and 002	DOE	Air: Ozone Depleting Substances	Registration of stationary appliances (2 SERF chillers)	CDPHE	SERF	Annual renewal due July 1	None
27	N/A	DOE	Air: Ozone Depleting Substances	Facility Notification	CDPHE	STM, NWTC	Annual notification and fee due December 1	
28	001	DOE	Air: Ozone Depleting Substances	Registration of stationary appliance (chiller in DWOP)	CDPHE	DWOP	Annual renewal due July 1	
29	2873-001 and 2873-002	DOE	Above Ground Storage Tank	Registration of aboveground storage tanks	Colorado Dept. of Labor	STM--PDU Ethanol Storage Tank, SERF Emergency Generator Tank	Annual registration and fee, due April/May	None
30	93000378	DOE	Historic Registration	National Register of Historic Places	National Park Service	Colorado Amphitheater	No expiration	None
31	93000379	DOE	Historic Registration	National Register of Historic Places	National Park Service	Ammunition Igloo	No expiration	None
32	AFP-CO-00255	DOE	Alcohol (not an environmental permit)	Alcohol Producer's Permit	Bureau of Alcohol, Tobacco, and Firearms	AFUF (PDU)	Annual renewal due July 1	Annual report due Jan 30

Tracking Number	Permit or Registration Number	Permit or Reg. Holder	Permit Type	Permit Description	Issuing Agency Name	Location Description	Status/Expiration Date	Reporting Required
33	TF-CO-0331	DOE	Alcohol (not an environmental permit)	Industrial Alcohol User Permit	Bureau of Alcohol, Tobacco, and Firearms	NREL-wide	Annual renewal due July 1	None
34	N/A	NREL	Transportation	Hazardous Material Transportation	U.S. Department of Transportation	NREL-wide	Annual renewal and fee	None
35	85936	NREL	Registration	X-Ray Machine Certification Report	CDPHE	SERF	November 2007	None
36	85938	NREL	Registration	X-Ray Machine Certification Report	CDPHE	SERF	November 2007	None
37	92056	NREL	Registration	X-Ray Machine Certification Report	CDPHE	SERF	November 2008	None
38	85937	NREL	Registration	X-Ray Machine Certification Report	CDPHE	SERF	November 2007	None
39	COR10CY5F	ASE	Notice of Intent (NOI)	Stormwater Discharges Associated with Construction Activity Under and NPDES General Permit	EPA	RSF	June 30, 2010	None

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 wildlife surveys at the National Renewable Energy Laboratory's South Table Mountain site in Golden, Colorado.

Table 2. Wildlife Species Observed at NREL's STM Site

Common Name	Scientific Name
Reptiles	
Bull snake[1]	*Pituophis catenifer*
Plains garter snake	*Thamnophis radix*
Six-lined racerunner	*Cnemidophorus sexlineatus*
Tiger salamander	*Ambystoma tigrinum*
Western rattlesnake	*Crotalus viridus*
Birds	
American crow	*Corvus brachyrhynchos*
American kestrel	*Falco sparverius*
American robin	*Turdus migratorius*
American tree sparrow	*Spizella arborea*
Barn swallow	*Hirundo rustica*
Black-billed magpie	*Pica pica*
Black-capped chickadee	*Poecile atricapilla*
Black-crowned night heron	*Nycticorax nycticorax*
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*
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*
European starling	*Sturnus vulgaris*
Flycatcher	*Empidonax sp.*
Golden eagle	*Aquila chrysaetos*
Great blue heron	*Ardea herodias*
Horned lark[1]	*Eremophila alpestris*
House finch	*Carpodacus mexicanus*
House sparrow	*Passer domesticus*
Killdeer	*Charadrius vociferous*
Lark bunting	*Calamospiza melanocorys*
Loggerhead shrike	*Lanius ludovicianus*
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*

Common Name	Scientific Name
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*
Unidentified sparrow 1	-
Unidentified sparrow 2	-
Unidentified species	-
Unidentified warbler	-
Vesper sparrow	*Pooecetes gramineus*
Western kingbird	*Tyrannus verticalis*
Western meadowlark	*Sturnella neglecta*
Western scrub jay	*Aphelocoma californica*
White-crowned sparrow	*Zonotrichia leucophrys*
Mammals	
Black-tailed jackrabbit[1]	*Lepus californicus*
Bushy-tailed woodrat[1]	*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[1]	*Marmota flaviventris*

[1] Species observed during the 1987 survey, but not during the 2004-2005 surveys.

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This report presents a summary of NREL's environmental protection programs and activities for 2008. It is organized according to the different environmental media (e.g., air, waste, ground water, etc.), 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.

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