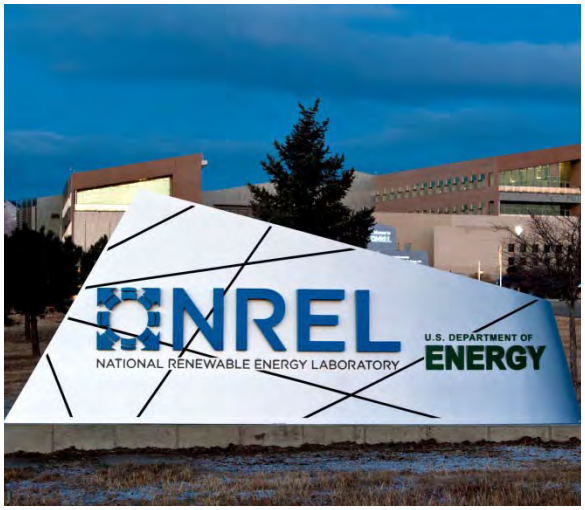
Final Site-Wide Environmental Assessment
U.S. Department of Energy
National Renewable Energy Laboratory
South Table Mountain Campus
Golden, Colorado

DOE/EA-1968

December 2014



THIS PAGE INTENTIONALLY LEFT BLANK

DOE/EA-1968

FINAL
SITE-WIDE ENVIRONMENTAL ASSESSMENT
U.S. DEPARTMENT OF ENERGY
NATIONAL RENEWABLE ENERGY LABORATORY
SOUTH TABLE MOUNTAIN CAMPUS
GOLDEN, COLORADO

U.S. Department of Energy
National Renewable Energy Laboratory
15013 Denver West Parkway
Golden, CO 80401

DECEMBER 2014

Executive Summary

This Final Site-Wide Environmental Assessment (Final SWEA) of the U.S. Department of Energy's (DOE) South Table Mountain (STM) campus at the National Renewable Energy Laboratory (NREL) analyzes the potential impacts of possible site operations and improvements over the next 5 to 10 years at NREL's STM campus and nearby leased facilities in the Denver West Office Park (DWOP) in Golden, Colorado.

DOE defines a SWEA as follows:

> "A broad-scope EIS or EA that is programmatic in nature and identifies and assesses the individual and cumulative impacts of ongoing and reasonably foreseeable future actions at a DOE site." (10 CFR Part 1021.104)

A SWEA streamlines the environmental review process by providing a site-wide analysis of potential environmental impacts associated with current and future actions. This provides an overall National Environmental Policy Act (NEPA) baseline analysis that is useful for tiering or as a reference when preparing project-specific NEPA reviews for new proposals. Site-wide reviews are conducted for a number of reasons, such as to improve and coordinate site and agency planning and to maximize cost-savings. If a particular project or activity in the future requires a more detailed analysis, that site-specific evaluation can be "tiered" off the SWEA by incorporating, by reference, much of the general discussion from the Environmental Assessment (EA). At the STM campus and leased facilities in DWOP, this Final SWEA will serve as a planning tool that aids decisions about future use and development of the site. This Final SWEA:

- Examines the potential environmental impacts of the Proposed Action and a reasonable range of alternatives;
- Addresses direct, indirect, and cumulative impacts;
- Identifies unavoidable adverse environmental impacts and corresponding mitigation measures;
- Describes the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity; and
- Characterizes any irreversible and irretrievable commitments of resources that would be involved should DOE decide to implement its Proposed Action or alternatives.

These requirements must be met before DOE can make a final decision to proceed with any action that could cause significant impacts to human health or the environment. This Final SWEA provides DOE decision-makers with the information needed to make an informed decision about allocating funds for changes to the facilities and continued operation of the STM campus and DWOP.

Purpose and Need

The purpose of the Proposed Action is to provide enhanced facilities and infrastructure to support DOE's Office of Energy Efficiency and Renewable Energy (EERE) mission in the continued advancement of state-of-the-art renewable energy, distributed energy, and energy efficiency research and development. The renewable energy and energy efficiency industry is advancing at a rapid pace and enhanced resources are needed at NREL to support the evolving needs for testing, research, development, deployment, and demonstration in the growing industry. The proposed improvements at the STM campus and DWOP are needed at NREL for continued development of renewable energy and energy efficiency technologies and practices, advancement of related science and engineering, and transfer of knowledge and innovations to the market.

Proposed Action

DOE's Proposed Action consists of improvements at the STM campus and leased facilities in the DWOP. The 327-acre (132-hectares [ha]) STM campus is located in northern Jefferson County, Colorado, along the southeast side of the South Table Mountain mesa, north of Interstate -70 (I-70) and west of the I-70 and Denver West Boulevard interchange, in unincorporated Jefferson County, Colorado. The DWOP site is located east of the STM campus in the vicinity of the I-70/Denver West Boulevard interchange in Lakewood, Colorado. DOE and NREL lease space in two buildings located at the eastern end of the office complex (Buildings 15 and 16) and one building (Building 52) located north of I-70, east of the STM campus. Building 52 houses the Colorado Center for Renewable Energy Economic Development, which is a joint effort between the State of Colorado and NREL. Buildings 15 and 16 provide administrative offices and space for limited laboratory activity.

The Proposed Action is composed of individual, short-term and long-term components, which together constitute potential activities and improvements to the STM campus and leased facilities over the next 5 to 10 years. The Proposed Action would consist of:

- Research, routine laboratory, and site operation enhancements;
- New building construction and modifications of existing buildings; and
- Infrastructure and utilities upgrades and enhancements.

The primary improvements are identified as Proposed Action components A through R as follows:

	Proposed Action Components
A	Science &Technology Facility Photovoltaic Research Modifications
B	Thermochemical Biofuels Research Facility (TBRF)
C	Field Test Laboratory Building (FTLB) Workstation and Lab Space Addition
D	FTLB Modification for Algae and Other Research Organisms for Fuel
E	Outdoor Test Pads
F	Internal Reconfiguration of the Thermal Test Facility (TTF)
G	Energy Systems Integration Facility (ESIF) Security Enhancements
H	Research Support Facility (RSF) III
I	Renewable Fuels and Lubricants (ReFUEL) Laboratory Relocation
J	Renewable Energy Vehicle Systems (REVS)
K	Waste Handling Facility (WHF) Expansion
L	NREL Sustainability, Infrastructure Transformation, Engineering (SITE) Operations Support Space
M	Metrology Laboratory Relocation
N	High Flux Solar Furnace Upgrade
O	TriGen Central Plant
P	On Campus Renewable Energy Deployment
Q	Additional Infrastructure at East Campus
R	On-site Vehicle Fuel Storage

Federal budgeting decisions and fluctuating research and development priorities would determine which components of the Proposed Action would be selected for funding and implementation. Thus, the specific physical requirements and locations of proposed facilities as well as their actual construction schedules may be uncertain for some components. In many cases, the descriptions of the improvements are in general terms and the locations and schedules for components were estimated based on currently available information and campus planning. Some of the Proposed Action components may never occur, or if implemented, may be of a smaller scale than currently presented. Therefore, a "bounding analysis" approach was used to consider the full range of possible development scenarios and worst case effects.

No Action Alternative

The No Action Alternative would be composed of baseline conditions described in Chapter 2.0, including all existing facilities and operations and previously approved facility modifications and operational changes that have not yet occurred as of June 2014. Under the No Action Alternative, no new construction or changes in operations or workforce would be made to the STM campus, beyond what has been previously approved.

No other facility improvements would occur. Research, operation, and management activities associated with these conditions would remain in place in the future. No substantial changes to current levels of research, operation, and management activities would occur at the DWOP. Routine operations and maintenance would occur in the future as it does currently.

There are two previously planned and approved projects that would occur under the No Action Alternative. These projects include the South Table Mountain 15-megawatt (MW) electrical upgrade and the Smart Power Lab move. These actions have been previously assessed under NEPA. Details are provided in Chapter 3.0.

Other Alternatives

A number of alternatives were considered that were not carried forward for analysis because they were not considered feasible due to technical, legal, or policy considerations. The rationales for eliminating these alternatives are summarized below:

- **Site Development Configuration Alternative(s):** This alternative involved different site planning possibilities that would put the proposed facilities in other locations than those identified in the Final SWEA. Variations of this alternative were not considered feasible because of the interrelated nature of the proposed facilities (logical site planning with the proposed locations for the new facilities), site development constraints, general consensus surrounding the Proposed Action and site planning assumptions, and the inherent flexibility of the Proposed Action with respect to future facility footprints and its ability to avoid substantial environmental effects.
- **Increased Development Alternative:** This alternative involved more development that has been proposed and included additional Proposed Action components and larger and more involved facilities. The additional development associated with the increased development alternative within the 10-year timeframe was not considered reasonably foreseeable or feasible given technical and financial site development constraints.
- **Reduced Development Intensity Alternative:** Not considered feasible because it is inconsistent with the Proposed Action's purpose and need and the intent of preparing the Final SWEA, which is to facilitate NREL in carrying out its mission.
- **Off-site Improvements Alternative:** Not considered feasible because of the technical and cost implications associated with decentralized operations and site/infrastructure complications.

Scoping Process

DOE used a variety of techniques to provide notice about the Proposed Action and Draft SWEA process to local residents and businesses, government agencies, stakeholder groups, and other interested parties. DOE requested comments during a 30-day scoping period on any potential issues or associated environmental impacts of implementing the Proposed Action or alternatives by December 13, 2013.

As part of the public and agency involvement process, DOE provided a Notice of Availability (NOA) to local residents and businesses, government agencies, stakeholder groups, and other interested parties similar to the process for scoping. DOE requested comments on the Draft Site –Wide Environmental Assessment during a 30-day comment period ending on October 3, 2014.

Environmental Consequences

Chapter 4.0 describes existing conditions and the effects of the Proposed Action and No Action Alternatives at the STM campus and DWOP as described in Chapter 3.0. The analysis considers NREL's key environmental commitments and measures to eliminate, minimize, and reduce identified effects as characterized in Chapter 2.0. NREL's key measures and policies are referenced as appropriate, within the affected environment and/or environmental consequences discussions.

Initial analysis and input obtained during the scoping process identified the specific set of resources to be analyzed in this Final SWEA. The effects analysis in Chapter 4.0 addresses the following technical disciplines and related impacts:

Chapter 4.0 Sections	Technical Disciplines and Related Impacts
4.1	Land Use: Effects on existing neighborhoods, development and undeveloped lands
4.2	Transportation and Traffic: Trip generation and congestion at local intersections
4.3	Air Quality and Climate Change: Changes in pollutant emissions, permit conditions and related effects
4.4	Noise: Effects on nearby sensitive receptors (residences) from construction and operations
4.5	Visual Quality and Aesthetics: Changes in views from new development
4.6	Water Resources: Effects on storm water, drainage, and flooding
4.7	Geologic Resources: Effects on site conditions and new development
4.8	Soils: Loss of resource value from construction disruption
4.9	Vegetation: Temporary and permanent losses of existing vegetation types
4.10	Wildlife Resources: Changes in habitat and the potential for effects on individuals and their populations
4.11	Cultural Resources: Potential effects on known resources and their setting
4.12	Hazardous Materials and Waste Management: Potential changes in use, management and risks from hazardous substances
4.13	Socioeconomics and Environmental Justice: Effects on populations, housing and the economy
4.14	Human Health and Safety: Potential for changes in health and safety risks from new operations
4.15	Accident Risks: The increasing possibility of an incident that presents risks to workers or neighbors
4.16	Intentional Destructive Acts: Changes in the potential for terrorism or related activity

Effects on public services (police protection, fire protection, ambulance service, etc.), and utilities (electrical power, gas, water, sanitary sewer, and telecommunications) were not addressed because the incremental effects of additional development were considered inconsequential to the existing service providers. Water depletion issues involving the South Platte River are addressed in the water resources, vegetation, wildlife and cumulative effects discussions.

The effects analysis considers the type, context, duration, and intensity of the alternatives on relevant resource areas. The effects of the Proposed Action primarily involve the STM campus where virtually all of the changes would occur. More specifically, the effects of the Proposed Action involve temporary facility construction effects caused by normal construction activities associated with land development and permanent effects. Effects associated with the DWOP are limited to minor and negligible effects from modified operations within existing buildings occupied by NREL. These effects would occur over a period of up to 10 years. The primary construction effects include: increased air pollutant emissions, increased noise, changes to visual and drainage conditions, soil disruption, and vegetation and wildlife habitat disruption and displacement.

The primary permanent effects involve land use changes, increases in vehicle trip generation, increases in air pollutant emissions, increases in site noise, changes to views, loss of soil productivity, displacement of vegetation and wildlife habitat, changes to the context surrounding historic resources, increased use and generation of hazardous materials and increased risks from accidents and intentional destructive acts. The Final SWEA defines the potential effects as minor considering the nature of the proposed infill development relative to existing site conditions, the continuation and increased intensity of current research and development, and NREL's environmental commitments and measures to eliminate, minimize, and reduce identified effects.

Contents

List of Appendices

List of Tables

List of Figures

List of Acronyms and Abbreviations

°F	degrees Fahrenheit
ACHP	Advisory Council on Historic Preservation
ACM	asbestos-containing material
APCD	Air Pollution Control Division
APEN	Air Pollutant Emission Notice
AST	aboveground storage tank
BGEPA	Bald and Golden Eagle Protection Act
BMPs	Best Management Practices
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAQCC	Colorado Air Quality Control Commission
CCR	Colorado Code of Regulations
CDA	Colorado Department of Agriculture
CDLE	Colorado Department of Labor and Employment
CDPHE	Colorado Department of Public Health and Environment
CDOT	Colorado Department of Transportation
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulation
CGS	Colorado Geological Survey
CH_4	methane
CMP	Comprehensive Master Plan
CMS	Chemical Management System
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COGCC	Colorado Oil and Gas Conservation Commission
CPW	Colorado Parks and Wildlife
CRADA	Cooperative Research and Development Agreement
CRS	Colorado Revised Statute
CSP	Concentrating Solar Power
CWA	Clean Water Act
dB	decibels
dBA	A-weighted decibels

DOE	Department of Energy
DOLA	Colorado Department of Local Affairs
DWOP	Denver West Office Park
EA	environmental assessment
EDE	effective dose equivalent
EERE	DOE Office of Energy Efficiency and Renewable Energy
EHS	Environment, Health, and Safety
EIS	Environmental Impact Statement
EMS	Environmental Management System
EO	Executive Order
EPCRA	Emergency Planning and Community Right-to-Know Act
EPEAT	Electronic Product Environmental Assessment Tool
ESA	Endangered Species Act
ESIF	Energy Systems Integration Facility
FEC	Federal Electronics Challenge
FEMA	Federal Emergency Management Agency
FFRDC	Federally Funded Research and Development Center
FHU	Felsburg Holt & Ullevig
FHWA	Federal Highway Administration
FONSI	Finding of No Significant Impact
FTLB	Field Test Laboratory Building
GHG	greenhouse gas
GO	Golden Field Office (DOE)
gsf	gross square feet
GWP	global warming potential
ha	hectare
H_2O_2	hydrogen peroxide
H_2SO_4	sulfuric acid
HABS/HAER	Historic American Building Survey/Historic American Engineering Record
HAP	hazardous air pollutant
HCl	hydrochloric acid
HF	hydrofluoric acid
HFSF	High-Flux Solar Furnace
hp	horsepower
HNO_3	nitric acid
HPLC	high-performance liquid chromatography

HVAC	Heating, Ventilating, and Air Conditioning Systems Laboratory
I-70	Interstate 70
IBRF	Integrated Biorefinery Research Facility
IPCC	Intergovernmental Panel on Climate Change
IPT	Integrated Project Team
ISMS	Integrated Safety Management System
ISO	International Organization for Standardization
kg	kilogram
km	kilometer
KOH	potassium hydroxide
kW	kilowatt
kWh	kilowatt-hours
KWh/yr	kilowatt hours per year
LEED	Leadership in Energy and Environmental Design
LOS	level of service
MAP	Mitigation Action Plan
MBTA	Migratory Bird Treaty Act
mCi	millicurie
MMBtu/hr	million British thermal units per hour
MOA	Memorandum of Agreement
MOU	Memoranda of Understanding
mph	miles per hour
MW	megawatt
MWh	megawatt-hours
N_aOH	sodium hydroxide
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NH_4OH	ammonium hydroxide
NHPA	National Historic Preservation Act
NPO	no potential occurrence
NO_x	oxides of nitrogen
NRCS	Natural Resources Conservation Service
NREL	National Renewable Energy Laboratory

NSPS	New Source Performance Standards
NRHP	National Register of Historic Places
NWS	National Weather Service
NWTC	National Wind Technology Center
OAHP	Office of Archaeological and Historic Preservation
O_3	ozone
ODS	ozone-depleting substance
ORPS	Occurrence Reporting and Processing System
OSHA	Occupational Safety and Health Administration
OTF	Outdoor Test Facility
Pb	lead
PDIL	Process Development and Integration Laboratory
PGA	peak ground acceleration
P.L.	Public Law
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
PM_{10}	particulate matter less than 10 microns in diameter
PRRIP	Platte River Recovery Implementation Program
PSD	Prevention of Significant Deterioration
PTE	potential to emit
RCRA	Resource Conservation and Recovery Act
RECs	renewable energy certificates
ReFUEL	Renewable Fuels and Lubricants Research Laboratory
REVS	Renewable Energy Vehicle Systems
RFHP	Renewable Fuel Heat Plant
ROW	right-of-way
RSF	Research Support Facility
RTD	Regional Transportation District (Denver)
S&R	Shipping and Receiving
S&TF	Science & Technology Facility
SARA	Superfund Amendments and Reauthorization Act
SEB	Site Entrance Building
SERF	Solar Energy Research Facility
SERI	Solar Energy Research Institute
SHPO	State Historic Preservation Office(r)
SIP	State Implementation Plan
SIMTA	Solar Industrial Mesa Test Area

SITE	Sustainability, Infrastructure Transformation, Engineering (operations)
SO_2	sulfur dioxide
SolarTAC	Solar Technology Acceleration Center
SPCC Plan	Spill Prevention Control and Countermeasures Plan
SPWRAP	South Platte Water Related Activities Program
SRRL	Solar Radiation Research Laboratory
SSP	Site Sustainability Plan
SSURGO	Soil Survey Geographic Database
STM	South Table Mountain campus
SWEA	Site-Wide Environmental Assessment
TBRF	Thermochemical Biofuels Research Facility
TCPDU	Thermochemical Process Development Unit
tpy	tons per year
TTF	Thermal Test Facility
U.S.	United States
USACE	United States Army Corps of Engineers
USC	United States Code
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGBC	United States Green Building Council
USGS	United States Geological Survey
VOC	volatile organic compound
VTIF	Vehicle Testing and Integration Facility
WFO	work for others
WHF	Waste Handling Facility
WRCC	Western Regional Climate Center

1.0 Introduction

This Site-Wide Environmental Assessment (SWEA) of the U.S. Department of Energy's (DOE) South Table Mountain (STM) campus at the National Renewable Energy Laboratory (NREL) analyzes the potential impacts of possible site operations and improvements over the next 5 to 10 years at the STM campus at the NREL and nearby leased facilities in the Denver West Office Park (DWOP) in Golden, Colorado. DOE is proposing an action (the Proposed Action) consisting of improvements to the NREL STM campus and leased facilities in the DWOP to support DOE's mission to research, develop, and deploy energy efficiency and renewable energy technologies. The Proposed Action would consist of:

- Research, routine laboratory, and site operation enhancements;
- New building construction and modifications of existing buildings; and
- Infrastructure and utilities upgrades and enhancements.

In accordance with DOE's National Environmental Policy Act (NEPA) implementing regulations (Title 10 Code of Federal Regulations [CFR] Part 1021), DOE is required to evaluate SWEAs at least every 5 years to determine whether the documentation and findings continue to adequately address current agency plans, functions, programs, and resource utilization with respect to environmental impacts.

In July 2003, DOE issued the Final Site-Wide Environmental Assessment of the National Renewable Energy Laboratory's South Table Mountain Complex and a Finding of No Significant Impact (FONSI) for proposed site development activities (DOE/EA-1440) (DOE 2003). DOE/EA-1440 evaluated the impacts that would be associated with long-term buildout of the STM campus and the areas suitable for future development. As project-specific funding has become available to implement the STM campus build-out vision, additional project-specific NEPA analyses have been generated, as well as supplemental NEPA analyses, to update the SWEA in accordance with 10 CFR 1021.330. DOE has now determined that a new comprehensive SWEA should be prepared to address the ongoing and foreseeable future operations of the STM campus and leased facilities in the DWOP.

1.1 Purpose of and Need for Proposed Action

The purpose of the Proposed Action is to provide enhanced facilities and infrastructure to support DOE's Office of Energy Efficiency and Renewable Energy (EERE) mission in the continued advancement of state-of-the-art renewable energy, distributed energy, and energy efficiency research and development. The renewable energy and energy efficiency industry is advancing at a rapid pace and enhanced resources are needed at NREL to support the evolving needs for testing, research, development, deployment, and demonstration in the growing industry. The proposed improvements at the STM campus and DWOP are needed at NREL for continued development of renewable energy and energy efficiency technologies and practices, advancement of related science and engineering, and transfer of knowledge and innovations to the market.

1.2 National Environmental Policy Act and Related Procedures

Federal agencies, including DOE, must consider the potential environmental impacts of a proposed federal action before making a decision on that action that could have environmental effects (NEPA 42 United States Code (USC) 4321 et seq., the Council on Environmental Quality (CEQ) NEPA regulations (40 CFR Parts 1500 to 1508), and DOE's NEPA implementing regulations (10 CFR Part 1021). The intent of NEPA is to help decision-makers make well-informed decisions based on an understanding of the potential environmental consequences and takes action to protect, restore, or enhance the environment.

The CEQ regulations mandate that all federal agencies use a prescribed structured approach to environmental impact analysis. This approach also requires federal agencies to use an interdisciplinary and systematic approach in their decision-making process. This process evaluates potential environmental consequences associated with a proposed action and considers alternative courses of action. The CEQ regulations specify that an Environmental Assessment (EA) be prepared to provide evidence and analysis for determining whether to prepare a FONSI or whether the preparation of an Environmental Impact Statement (EIS) is necessary. The EA can aid in an agency's compliance with NEPA when an EIS is unnecessary and facilitate preparation of an EIS when one is required.

This final document is a SWEA similar to the documents DOE prepared for the STM campus and DWOP in 2003 (DOE/EA-1440 [DOE 2003]) and in 1994 (DOE/EA-0850 [DOE 1994]). DOE defines a SWEA as follows:

> "A broad-scope EIS or EA that is programmatic in nature and identifies and assesses the individual and cumulative impacts of ongoing and reasonably foreseeable future actions at a DOE site." (10 CFR Part 1021.104)

A SWEA streamlines the environmental review process by providing a site-wide analysis of potential environmental impacts associated with current and future actions. This provides an overall NEPA baseline that is useful for tiering or as a reference when preparing project-specific NEPA reviews for new proposals. Site-wide reviews are conducted for a number of reasons, such as to improve and coordinate site and agency planning and to maximize cost-savings. If a particular project or activity in the future requires a more detailed analysis, that site-specific evaluation can be "tiered" off the SWEA by incorporating, by reference, much of the general discussion from the EA. At the STM campus and leased facilities in DWOP, this SWEA will serve as a planning tool that aids decisions about future use and development of the site.

In compliance with the above referenced regulations and DOE's procedures, this Final SWEA:

- Examines the potential environmental impacts of the Proposed Action and a reasonable range of alternatives;
- Addresses direct, indirect, and cumulative impacts;
- Identifies unavoidable adverse environmental impacts and corresponding mitigation measures;
- Describes the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity; and
- Characterizes any irreversible and irretrievable commitments of resources that would be involved should DOE decide to implement its Proposed Action or alternatives.

These requirements must be met before DOE can make a final decision to proceed with any action that could cause significant impacts to human health or the environment. This Final SWEA provides DOE decision-makers with the information needed to make an informed decision about allocating funds for changes to the facilities and continued operation of the STM campus and DWOP.

If new activities arise in the future, DOE would prepare subsequent environmental reviews or documents that would incorporate information from or tier from this Final SWEA if applicable, and would be focused only on those issues that have not been adequately addressed in this Final SWEA. If new proposals or conditions would have no effects beyond those analyzed in this Final SWEA, no additional NEPA documentation would be necessary.

1.3 Background

The mission of DOE is to ensure America's security and prosperity by addressing its energy, environmental, and other challenges through transformative science and technology solutions.

1.3.1 Overview of EERE and the Golden Field Office

DOE's Office of EERE is 1 of 11 DOE Program Offices that support DOE mission. EERE supports research, development, and deployment projects that increase energy efficiency nationwide and advance the use and adoption of clean, renewable energy technologies.

DOE's Office of EERE can be divided into two main areas of emphasis: energy efficiency and renewable energy. Energy efficiency supports research into making residential homes, commercial buildings, vehicles, manufacturing, and government facilities more energy efficient by providing avenues for research and development, providing standards for energy efficiency, and providing incentives to governments and industry. Renewable energy supports research and development in the areas of solar, wind, water, biomass, geothermal, hydrogen, and fuel cells. DOE's Office of EERE also provides incentives to promote and inspire deployment of renewable energy projects in the private sector. More information on DOE's Office of EERE's programs can be found at: http://energy.gov/eere/office-energy-efficiency-renewable-energy

Golden Field Office

DOE Golden Field Office (GO) is one of eight EERE offices. GO serves as EERE's business service center by awarding grants and contracts for renewable energy and energy efficiency projects and facilitating research and development partnerships to support those technologies. GO also is responsible for contract administration and oversight of the management and operation of NREL for DOE.

1.3.2 Overview of NREL

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 marketplace, addressing the nation's energy and environmental goals. Currently, NREL is operated for EERE by the Alliance for Sustainable Energy, LLC. NREL is a congressionally designated Federally Funded Research and Development Center (FFRDC) specializing in energy efficiency and renewable energy.

NREL facilities occupy four separate locations in Jefferson County, one in Adams County (Colorado), and one in the District of Columbia. The STM campus (located near Golden, Colorado) and the National Wind Technology Center (NWTC) located between Golden and Boulder, Colorado) are the two main government-owned sites where research and development operations are conducted (**Figure 1-1**). The five other NREL-leased facilities are: 1) portions of the DWOP in Golden, Colorado; 2) Renewable Fuels and Lubricants (ReFUEL) Research Laboratory in Denver, Colorado; 3) Joyce Street facilities in Arvada, Colorado; 4) Solar Technology Acceleration Center (SolarTAC), Adams County, Colorado; and 5) District of Columbia leased office space, Washington, D.C. The scope of this document only includes the STM campus and the adjacent leased facilities in DWOP.

The 327-acre (132 hectares [ha]) STM campus is located in northern Jefferson County, Colorado, along the southeast side of the South Table Mountain mesa, north of Interstate 70 (I-70) and west of the I-70 and Denver West Boulevard interchange, near Golden, Colorado (**Figure 1-2**). Only a portion of the site (136 acres [or 55 ha]) is available for development. A total of 177 acres (55 ha) is protected by a conservation easement, and development of the remaining 14 acres (5.6 ha) is restricted by utility easements. The community of Pleasant View is adjacent to the southern border of the STM campus. The STM campus includes acreage on the South Table Mountain mesa top, slope, and toe, and was formerly part of the Colorado National Guard facility at Camp George West. The STM campus is comprised of eight main laboratory buildings, a few small test facilities, and several support buildings.

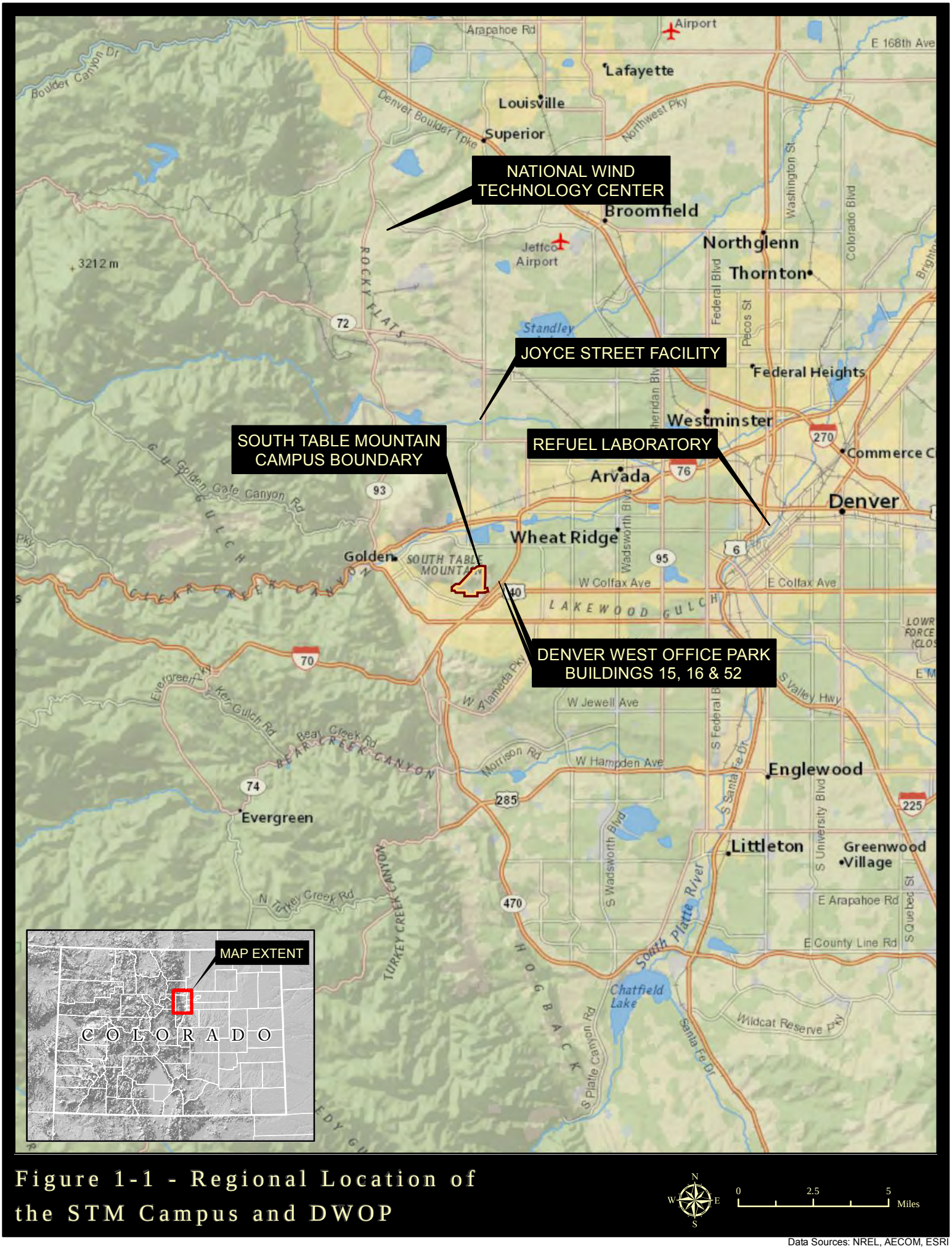


Figure 1-1 - Regional Location of the STM Campus and DWOP

Data Sources: NREL, AECOM, ESRI

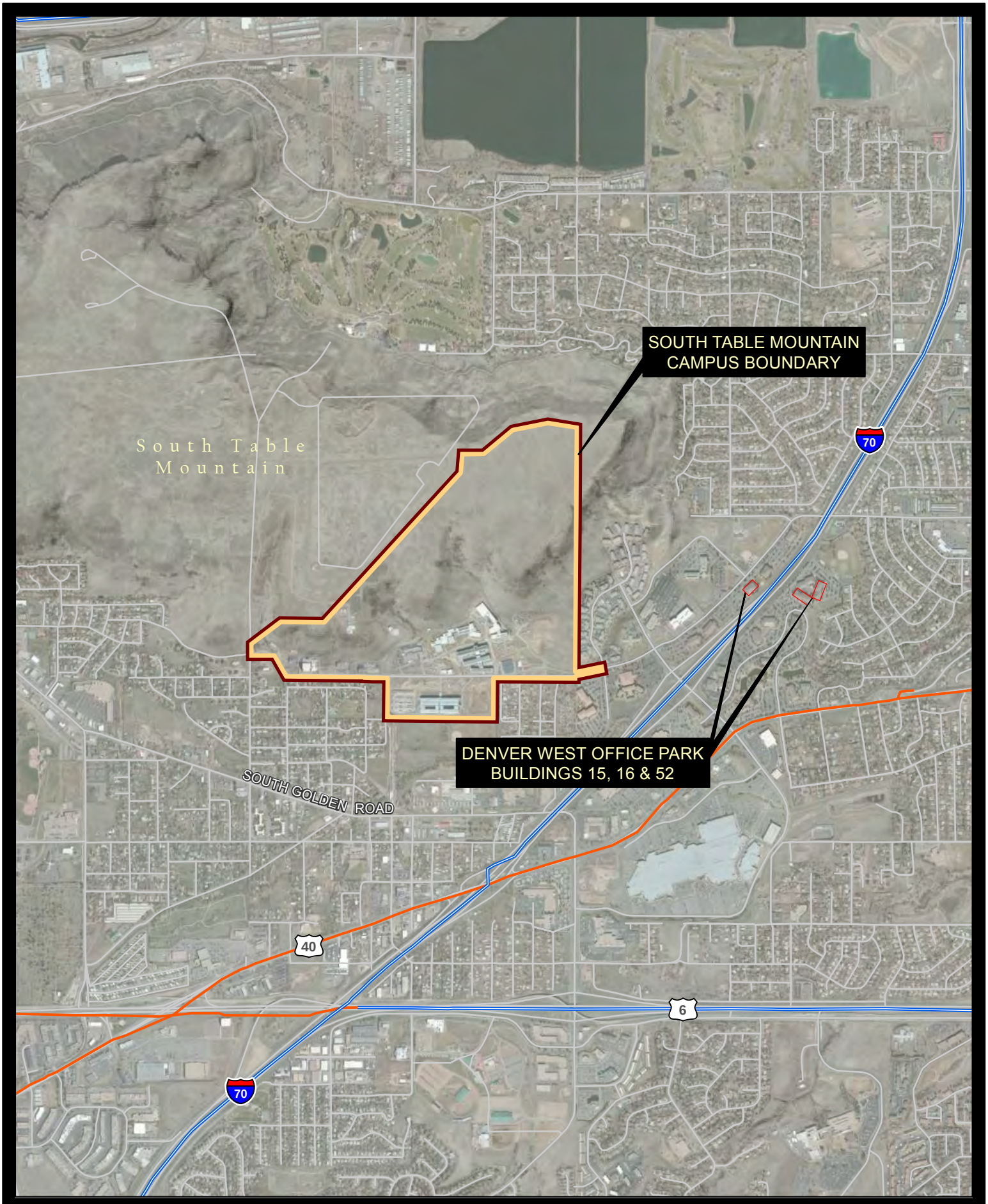


Figure 1-2 - Local Setting of the STM Campus and DWOP Buildings

Data Sources: NREL, AECOM, ESRI

The DWOP site is located east of the STM campus in the vicinity of the I-70/Denver West Boulevard interchange in Lakewood, Colorado. DOE and NREL lease space in two buildings located at the eastern end of the office complex (Buildings 15 and 16) and one building (Building 52) located north of I-70 east of the STM campus. Building 52 houses the Colorado Center for Renewable Energy Economic Development and administrative offices. Buildings 15 and 16 provide administrative offices and space for limited laboratory activity.

Researchers at the STM campus and DWOP conduct research in:

- **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 (bio power), and projects in biomass-derived chemicals and materials.
- **Building technologies** – 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 renewable and energy efficiency technologies in distributed power systems, thus maximizing the utilization of renewable energy and energy efficient products. 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** – Research is conducted to support electricity technologies which 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 is a leader in renewable hydrogen production technologies and the development of codes, standards, and advanced storage and sensors. Basic and applied research and material development using biology, physics, and chemistry enable and support the development of hydrogen production, storage, and end-use systems.
- **Measurements and testing** – NREL laboratories and facilities allow state-of-the-art testing on photovoltaic cells, building technologies, and wind turbines.
- **Photovoltaics** – Photovoltaics enables the direct conversion of sunlight to electricity using solid-state materials. The National Center for Photovoltaics develops and deploys photovoltaic technology for the generation of electric power.
- **Renewable energy resources** – Researchers develop resource information for solar, wind, biomass, and geothermal energy applications.
- **Renewable thermal technologies** – These technologies (concentrating solar power [CSP], solar water heating, and geothermal heat and power) generate power from heat or utilize heat from renewable resources.

- **Transportation** – NREL works with industry experts to develop advanced vehicles and transportation systems. NREL also works with energy companies and manufacturers of vehicles and engines to develop advanced motor vehicle fuels for improved energy and environmental performance.

1.3.3 History of the South Table Mountain Campus

The Solar Energy Research, Deployment and Demonstration Act of 1974, as amended (42 USC 5551 et seq.) authorized a federal program to develop solar energy as a viable source of the nation's future energy needs. Initially, the Solar Energy Research Institute (SERI) was established in leased DWOP buildings. The State of Colorado donated 300 acres along the southeast side of South Table Mountain mesa to DOE for the institute's permanent site. The 300 acres had been part of the Colorado National Guard's Camp George West.

While office and lab space continue to be used in leased space of DWOP, SERI's first permanent research facility, the Field Test Laboratory Building (FTLB) opened in 1985. Much of the original site infrastructure also was developed at that time. Since 1985, several additional laboratory buildings, support facilities, outdoor testing areas, and an Education Center (formerly called the Visitor's Center) have been added to the STM campus. SERI was designated as a DOE national laboratory in September 1991 and the name changed to NREL.

Since 2010, the STM campus has undergone considerable growth to continue to support the mission of DOE's EERE and NREL. This includes the award winning, net zero-energy Research Support Facility (RSF) and the state-of-the-art Energy Systems Integration Facility (ESIF). Also added to the STM campus were a sustainable-designed aboveground parking garage, a new 6-acre regional storm water detention basin, and a south access gate and road connecting the STM campus to South Golden Road. Additionally, DOE and NREL have continued to occupy administrative and limited laboratory leased space at the DWOP.

A more detailed description of existing features and buildings of the STM campus and leased facilities at DWOP can be found in Chapter 2.0.

1.4 Public and Agency Involvement

Public participation and outreach efforts are a fundamental component of DOE's NEPA process, planning activities, and decision-making. As part of the scoping process, DOE GO mailed over 6,100 scoping notices to local residents and businesses near the STM campus. Additionally, electronic copies of the scoping letter were transmitted to 78 federal, state, and local agencies and governments, as well as to 10 other stakeholder groups or other interested parties. Electronic copies of the scoping letter were posted on DOE and NREL websites. Notices also were advertised in the local Golden Transcript newspaper and hardcopies of the scoping letter were available for review at the Education Center on the NREL STM campus. DOE requested that interested parties provide comments, during a 30-day scoping period, on any potential issues or associated environmental impacts of implementing the Proposed Action or alternatives by December 13, 2013. **Appendix A** contains the scoping notice and comments received during the scoping period. The scope of the Proposed Action has been revised based on the input from the public and agencies.

As part of the public and agency involvement process, the DOE GO distributed Notices of Availability to local residents and businesses near the STM campus and to federal, state, and local agencies, stakeholders, and other interested parties informing them of the availability of the Draft Site-Wide EA for public review and DOE's intention of receiving comments on it. The same distribution lists and processes for mailings, electronic postings, and availability of hardcopies were used for the notice of availability of the Draft Site-Wide EA as was used during notice of scoping. DOE requested that interested parties provide comments during a 30-day public review period that ended on October 3, 2014. A public

informational meeting was held on September 10, 2014. DOE received comments from one party, Jefferson County, on the Draft Site-Wide EA during this process. **Appendix B** contains a copy of the Notice of Availability a copy of the newspaper notices, distribution lists and comments received. DOE responses to comments received are also presented in **Appendix B**.

2.0 Existing Facilities, Infrastructure and Applicable Environmental Policies, Programs and Environmental Commitments

This chapter describes existing facilities and infrastructure as well as NREL's environmental policies, programs, and commitments that form the baseline conditions for this document. Section 2.1 presents descriptions of existing campus facilities and infrastructure. Section 2.2 presents NREL's current policies, procedures, best management practices (BMPs), and commitments that would be implemented for both the Proposed Action and the No Action Alternative.

2.1 Existing Facilities and Infrastructure

The STM campus houses five major research and support facilities located in the central part of the campus. The campus also contains several user and testing facilities located in the west end of the campus, as well as the mesa top facilities.

DOE-owned buildings on the STM campus provide 1,006,400 square feet of space. In addition, DOE and NREL lease 187,200 square feet of space at the DWOP. NREL's major research and support facilities are described below, followed by descriptions of user and testing facilities, other research support facilities, and major campus infrastructure components.

2.1.1 Major Research and Support Facilities

The FTLB is 126,590 square feet and was the first permanent research facility at NREL built in 1985. It is a multi-purpose facility with low-bay laboratories and high-bay research areas. Research in the FTLB includes photovoltaics, biomass, hydrogen, and buildings research with the purpose of exploring new and more efficient methods of using resources such as unwanted waste to create useful fuels, electricity, and chemicals.

Field Test Laboratory Building

The 115,560-square-foot Solar Energy Research Facility (SERF), built in 1993, provides low-bay laboratories and associated office space. The SERF houses laboratories for research in photovoltaics, superconductivity, and related material science. Scientists at this facility research and test silicon solar cells, thin films, and nanostructures in laboratory space that is both functional and flexible.

Solar Energy Research Facility

The Science and Technology Facility (S&TF) is 71,350 square feet and was constructed in 2004. It is a multi-level facility containing laboratory and office space focusing on activities in photovoltaic research to reduce time delays associated with transferring technology to industry. The S&TF houses the Process Development and Integration Laboratory (PDIL) and nine advanced material synthesis, characterization, and general support laboratories. Scientists research and test silicon solar cells, thin films, and nanostructures. The S&TF was the first building on the STM campus to receive a Leadership in Energy and Environmental Design (LEED) Platinum certification[1] by the U.S. Green Building Council (USGBC) and is connected to the SERF by an elevated and enclosed walkway.

Science and Technology Building

[1] Information on the USGBC LEED certification and rating system can be found at http://www.usgbc.org/leed.

The RSF is a 362,055-square-foot, multi-level facility providing office space for administrative and support functions housing up to 1,325 staff. It was completed in two phases (RSF I and RSF II), with the southern and central wings (218,715 square feet) completed in June 2010 and the northern wing (143,340 square feet) in October 2011. The facility has received a LEED Platinum certification and is net zero-energy, producing at least as much energy as it uses over the course of 1 year from photovoltaic solar panels. The RSF also functions as a living laboratory for sustainable practices in commercial office building design.

Research Support Facility

The newest and largest laboratory building on the STM campus is the Energy Systems Integration Facility (ESIF). Completed in 2012, the 182,500-square-foot ESIF houses research aimed at overcoming challenges related to the interconnection of distributed energy systems and the integration of renewable energy technologies into the United States (U.S.) electricity grid. ESIF houses 15 laboratories where NREL scientists, engineers, and industry partners research, engineer, design, simulate, test, and analyze components and systems for a broad range of renewable energy generation capabilities and systems. In addition to laboratory space, ESIF has an additional 17,000 square feet of outdoor research test pads, a state-of-the-art, high-performance computing and data center, and administrative office space. Like many other buildings on the NREL STM campus, ESIF was designed and constructed to be a high-performance building and has received LEED Platinum certification.

Energy Systems Integration Facility

2.1.2 User and Testing Facilities

The Integrated Biorefinery Research Facility (IBRF) is a 70,490-square-foot bioenergy research facility that enables researchers and industry partners to develop, test, evaluate, and demonstrate processes for the production of bio-based products and fuels. This building was initially built in 1994. The building has undergone several expansions over the years to more than double its size and has improved its capabilities. Within the IBRF is a 27,000-square-foot high-bay biochemical conversion pilot plant capable of converting biomass into a variety of fuels and chemicals. This pilot plant and other pilot-scale operations are small industrial systems which are operated to generate information about the behavior of a system for use in design of larger facilities. A bench-scale operation is smaller and more focused than a pilot-scale operation. The IBRF facility also houses biomass analytical laboratory space and office space.

Integrated Biorefinery Research Facility

In the 11,250-square-foot Outdoor Test Facility (OTF), researchers study and evaluate advanced or emerging photovoltaic technologies under simulated, accelerated indoor and outdoor, and normal outdoor conditions. One of the primary roles of the researchers at the OTF is to work with industry to develop uniform standards and codes for testing of photovoltaic devices. This building was built in 1995. The OTF includes indoor laboratory and office space, as well as a large outdoor photovoltaic array test area.

Outdoor Test Facility

The Thermal Test Facility (TTF) was completed in 1996 and houses laboratories for researching building technologies and energy storage technologies for vehicles. It is 11,000 square feet and provides office space, laboratory space, an open bay test area, and a roof-top test area. The advanced Heating, Ventilating, and Air Conditioning (HVAC) Systems Laboratory tests the performance and energy efficiency of various types of building heating, cooling, and ventilation equipment. The Hot Water Systems Laboratory evaluates the capabilities of domestic hot water systems, from natural gas tankless water heaters to small boilers, electric on-demand water heaters to large heat pump systems, as well as solar water heaters. The Energy Storage Laboratory conducts energy storage and battery research and testing to help electric and hybrid cars run more efficiently and longer.

Thermal Test Facility

Located on the top of the mesa, the Solar Radiation Research Laboratory (SRRL) has been gathering solar radiation and meteorological data since 1984 in support of renewable energy research and development. Once housed in storage sheds, and after two phases of construction in 2000 and again in 2010, SRRL today consists of a 4,980-square-foot building housing office space and five laboratories supporting metrology, optics, electronics, and data acquisition. In addition, SRRL has an outdoor test area for testing of new research instrumentation and photovoltaic modules. The Metrology Laboratory within SRRL plays a unique role in calibration of all measurement and test equipment at the STM campus, DWOP, and other NREL facilities. SRRL also incorporates sustainable building design using a geothermal ground source heat pump to minimize heating and cooling costs. The heat pump system involves 23 borings to a depth of 300 feet.

Solar Radiation Research Laboratory

Besides the SRRL, two test facilities also are located on the top of the mesa, the High-Flux Solar Furnace (HFSF) and the Solar Industrial Mesa Test Area (SIMTA). The HFSF facility uses mirrors and lenses to concentrate the sun's solar energy to create temperatures over 1,500 degrees Celsius (2,732 degrees Fahrenheit [°F]). This is used to expose, test, and evaluate components used in concentrating solar power systems and to test high-temperature materials, coatings on metals and ceramics, and other materials-related applications. Additionally, the heat generated at the facility can be used for research in generating hydrogen from water.

The SIMTA is a testing facility for concentrating solar power. A parabolic mirror is used in research to reflect sunlight to a focal point or length and concentrates energy to produce electricity. NREL recently acquired a multipurpose, large payload solar tracker to support testing of solar components that require tracking the sun in elevation and azimuth, such as concentrating solar collectors that require 2-axis tracking to focus sunlight on a thermal or photovoltaic receiver.

Solar Industrial Mesa Test Area

The Vehicle Testing and Integration Facility (VTIF) was completed in 2012 and is located midway up the slope of the South Table Mountain mesa to the north of the FTLB. The VTIF consists of a 2,990-square-foot building with four vehicle bays, a 10,000-square-foot outdoor vehicle testing pad, and an electric car solar charging station. The VTIF conducts vehicle efficiency research, such as electric vehicle integration into the power grid and minimizing vehicle fuel consumption related to passenger comfort heating and cooling (climate control). The VTIF building has been awarded LEED Gold certification from the USGBC.

Vehicle Testing and Integration Facility

2.1.3 Support Facilities and Infrastructure

STM campus support facilities include the Education Center, East Site Entrance Building (SEB), the Shipping and Receiving (S&R) Facility, Maintenance Building, STM Campus Cafeteria, South SEB, and parking facilities.

Shipping and Receiving Facility

The Education Center, which was formerly called the NREL Visitors Center, is 6,459 square feet and was built in 1994 to provide outreach and education to the community on renewable energy and energy efficiency technology. The Education Center is open to the public and includes exhibits and provides information on energy from the sun, wind, biomass, hydrogen, and other sources of renewable energy.

Education Center

Located in the western part of the STM campus, the 14,207-square-foot S&R facility provides space for S&R functions in support of the entire campus and includes a stockroom. Adjacent to this is the 4,000-square-foot Facility Maintenance Building that houses facilities for maintenance personnel responsible for maintaining facilities and infrastructure on campus. A 4,000-square-foot Bulk Storage building is located west of both the S&R and the Maintenance Building and is used to store large items and materials. Together, the Maintenance and Bulk Storage buildings consist of the STM campus maintenance facilities.

Facility Maintenance Building

Bulk Storage Building

The STM campus Cafeteria, known as the NREL Café, is a 12,140-square-foot building completed in 2012 and is located in the center of the campus. This full service cafeteria can seat 240 occupants and also can be used to host special events. It is a model of energy efficiency and sustainable practices in the food service industry, is a LEED Platinum building, and uses 25 percent less electricity than a cafeteria built to the current commercial code.

NREL Café

The Waste Handling Facility (WHF) is a 1,000 square feet cinder block and concrete building north of the SERF. The purpose of the WHF is the packaging and short-term storage of NREL's hazardous waste and other special wastes before they are shipped off-site for proper management and disposal. The facility was constructed in 1991.

Waste Handling Facility

Three SEBs house security activities involving visitors, general site access, and campus monitoring. The 810-square-foot eastern SEB on Denver West Parkway is the main entrance of NREL and supports campus security, visitor greeting, badging, deliveries, and the monitoring of alarms. The 1,660-square-foot southern SEB on Research Road provides vehicle, bicycle, and pedestrian access to campus from South Golden Road, West Colfax Avenue, and I-70, and is limited to access for badged staff only. The southern SEB is a LEED Platinum building with a geothermal heat pump used to supplement the heating and cooling of the building. The heat pump system involves four borings to a depth of 400 feet. The West SEB (200 square feet) also is for badged staff only, with separate vehicle and bicycle/pedestrian entrances providing access to Quaker Street, as well as access to the NREL mesa top facilities.

South Entrance Building

Site Entrance Building

West Entrance

Campus infrastructure includes on-site roads, walkways, bicycle paths, parking facilities, and utilities, which have been expanded and improved since the campus was first developed in 1984. On-site roadways such as Denver West Parkway, Urban Street, South Loop Road, North Loop Road, East Loop Road, and West Loop Road, are a mixture of roadways for all vehicles, shuttle only loop roads and service roads. Several of the roadways include porous paver construction that allows rainwater to flow through them, reducing the amount of storm water runoff. Sidewalks, pedestrian walkways, and bicycle lanes are present throughout the campus. Several small parking areas are adjacent to several buildings on campus, such as the visitors' lot between the Education Center and RSF that is covered by a canopy with photovoltaic solar panels.

The southern portion of the campus, south of Denver West Parkway, contains the main 4-story parking garage, a 2.5-acre surface parking lot, and a 6-acre regional storm water detention basin. The 578,320-square-foot parking garage was built in 2012 and provides over 1,630 parking stalls. It includes many sustainable features, such as photovoltaic panels on the roof and south side of the structure, energy efficient LED lighting, electric vehicle charging stations, and bird friendly glass. The regional storm water detention basin, also completed in 2012, receives, detains, and naturally filters the storm water runoff from a majority of the STM campus and drainages on the mesa. The basin also provides flood protection to the adjacent neighborhood, Pleasant View Park, and Lena Gulch by limiting the discharge flow rate during large storm events, as well as providing habitat for a variety of animals and plants.

Bus Shelter

Campus utility loops are present throughout the most developed areas of the STM campus. This includes underground lines or conduits for common utility systems such as electrical, natural gas, telecommunications and data networks, water, sewer, and storm water. The campus utility infrastructure also includes a heating and cooling water distribution system connected to a majority of the facilities in the central campus.

Infrastructure Improvements

Parking Structure

2.1.4 On-site Renewable Energy Systems

The Renewable Fuel Heat Plant (RFHP) efficiently burns wood chips for heating during cold months of the year and currently provides 40 percent of NREL's STM campus heating requirements. This reduces NREL's natural gas consumption and provides a reuse for wood waste, such as pine beetle kill. The RFHP is 2,000 square feet and is located northeast of the FTLB.

Renewable Fuel Heat Plant

Located on NREL property on the top of the South Table Mountain mesa is a 5-acre (2-ha) photovoltaic array. The 720 kilowatt (kW) mesa top photovoltaic array is a single-axis design that tracks the panels with the sun and resets the panels in the evening. It began operation in 2008 and has a typical annual output of over 1,200 megawatt-hours (MWh).

Mesa Top Facilities

In addition to the mesa top photovoltaic array, the STM campus contains numerous facilities that support roof-mounted photovoltaic arrays. **Table 2-1** presents the facilities with roof-mounted solar arrays and the associated capacity rating in kWs and typical production in kilowatt-hours (kWh).

The renewable energy certificates (RECs) associated with all photovoltaic systems, except the South SEB and minor roof-mounted systems, are sold to Xcel Energy, which uses the environmental attributes from the power generated to meet the state's Renewable Portfolio Standard.

Table 2-1 STM Campus Roof-mounted Photovoltaic Arrays

Facility	Capacity Rating (kW)	Typical Production (kilowatt hours per year [kWh/yr])
S&TF	94	126,475
RSF I	449	606,150
RSF II	408	550,800
Visitor's Parking Lot	524	707,400
Parking Garage	1,153	1,556,550
South SEB	15	20,124
Other Minor Roof-Mounted Photovoltaics	36	54,300
Total	**3,180**	**4,280,950**

2.1.5 Conservation Easement

In 1999, DOE granted a conservation easement for 177 acres of the STM campus to Jefferson County. The purpose of the 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 STM campus and within the region.

South Table Mountain Mesa Top, Portion of Conservation Area in Zone 2

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 campus and the sustainable habitat for diverse vegetation, birds, and terrestrial animals.
- Ensure the scenic and biological integration with adjoining open-space land.
- Prevent further industrial, commercial, or residential development of the conservation easement property.
- Preserve the conservation easement property as natural open space.

Local policies established by Jefferson County, Golden, and Lakewood reflect community sensitivity with respect to the visual qualities provided by natural resources in the STM campus. Specifically, the

Jefferson County Comprehensive Master Plan (CMP)characterizes North and South Table Mountain as "unique landscapes," and states that "maintaining landscapes that have a unique visual quality" is a key to maintaining the quality of life in Jefferson County.

The conservation easement land is located on the mesa top, slope, and toe of South Table Mountain. Vegetation includes grassland interspersed with shrubland communities, primarily in the drainages. Several seeps also occur throughout the area.

A baseline inventory of the property was prepared in June 1999 to document the existing condition of the easement property and to assess the conservation value of the property. The baseline inventory includes a description of the geographical setting and adjacent property owners, access and use of the property by the public, and a description of the existing environmental conditions of the property (including geology, hydrology, vegetation, wildlife, and cultural resources). Current conditions of the conservation easement were included in the vegetation and wildlife surveys for South Table Mountain in 2011.

Jefferson County Open Space maintains formal trails on the conservation easement property. Two trails cross the easement, connecting Denver West Parkway (near the NREL site entrance) to the trails on the mesa top. NREL staff and the public use these trails daily (see **Figure 2-1**).

A trail easement is located on the east side of the campus as a permanent north-south trail connection to other existing trails. An existing regional trail system on and near the campus provides a connection from the Jefferson County Open Space located to the south of the site, through the NREL campus, to portions of South Table Mountain Open Space. The mesa top has long been a favorite area for hikers, and the public is allowed to access the mesa via the established trail easement.

2.1.6 Off Campus Leased Space

NREL and DOE lease space in three buildings at DWOP: Buildings 15, 16, and 52. These buildings house approximately 5 percent of NREL's workers, as well as a portion of DOE GO staff and contractors. These facilities provide space for laboratory research, administration, research support activities, and government offices. The three buildings include approximately 180,000 square feet of leased space and are used primarily for administrative activities. Building 16 also is used for research support activities, as well as limited laboratory research.

Denver West Office Park

2.2 NREL's Environmental Policies, Programs, and Commitments

Development of the STM campus by NREL has and will continue to occur within a context that is highlighted by compliance with environmental regulations and formalized commitments to environmental stewardship.

NREL is committed to environmental stewardship, pollution prevention, compliance with environmental requirements, and continual improvement in environmental protection and sustainability performance.

NREL achieves its commitments to environmental stewardship in several ways. These include:

- Policies, procedures, programs, and BMPs that ensure compliance with environmental requirements.
- Implementation of an Environmental Management System (EMS) to achieve continual improvement in environmental performance.
- Sustainable NREL, a longstanding laboratory program that fosters environmental and social responsibility and works to establish the lab as a global model for sustainability.

The following discussions summarize NREL environmental commitments that should be understood and applied to accurately characterize potential effects of the Proposed Action and the No Action Alternative, and the need for additional environmental commitments or mitigation measures.

2.2.1 Policies, Programs, Procedures, and Best Management Practices

NREL is subject to many federal, state, and local environmental laws and regulations, as well as Executive Orders (EOs), DOE orders, and Memoranda of Understanding (MOU) with government agencies. A list of current environmental permits, registrations, and notifications can be found in **Appendix C**. Additionally, key environmental statutes or regulations, EOs, and DOE orders that are applicable to current NREL operations also are listed in **Appendix C**, and are summarized, as needed, in the individual subsections of Chapter 4.0. These applicable statues are explained further in the 2012 NREL Environmental Performance Report (NREL 2013), which is available at: http://www.nrel.gov/ehsq/environmental_protection.html.

If NREL undertakes new activities in energy efficiency and renewable energy research and development, NREL would abide by additional applicable environmental requirements if they are not already addressed in existing policies, programs, and procedures.

NREL has developed and implements a wide range of environmental policies, programs, procedures, and BMPs aimed at meeting compliance requirements and avoiding, minimizing, and mitigating adverse environmental and human health effects that may be created in achieving NREL's mission.

NREL's environmental policies are implemented through the following major environmental program areas and integrated with health and safety program areas:

- **Air Quality Protection**: Air permitting, ozone-depleting substance management and greenhouse gas (GHG) emissions monitoring.
- **Water Quality Protection**: Construction storm water management, groundwater protection, drinking water monitoring, and preventing unallowable sanitary sewer system discharges.
- **Hazardous Materials and Waste Management**: Pollution prevention, spill response; proper storage, use, and disposal of hazardous chemicals and materials; as well as planning, permitting, and reporting regarding use and emissions of such materials.
- **NEPA**: Periodic site-wide environmental impact analysis and additional NEPA reviews, as needed, to address new development proposals and changes to site conditions.

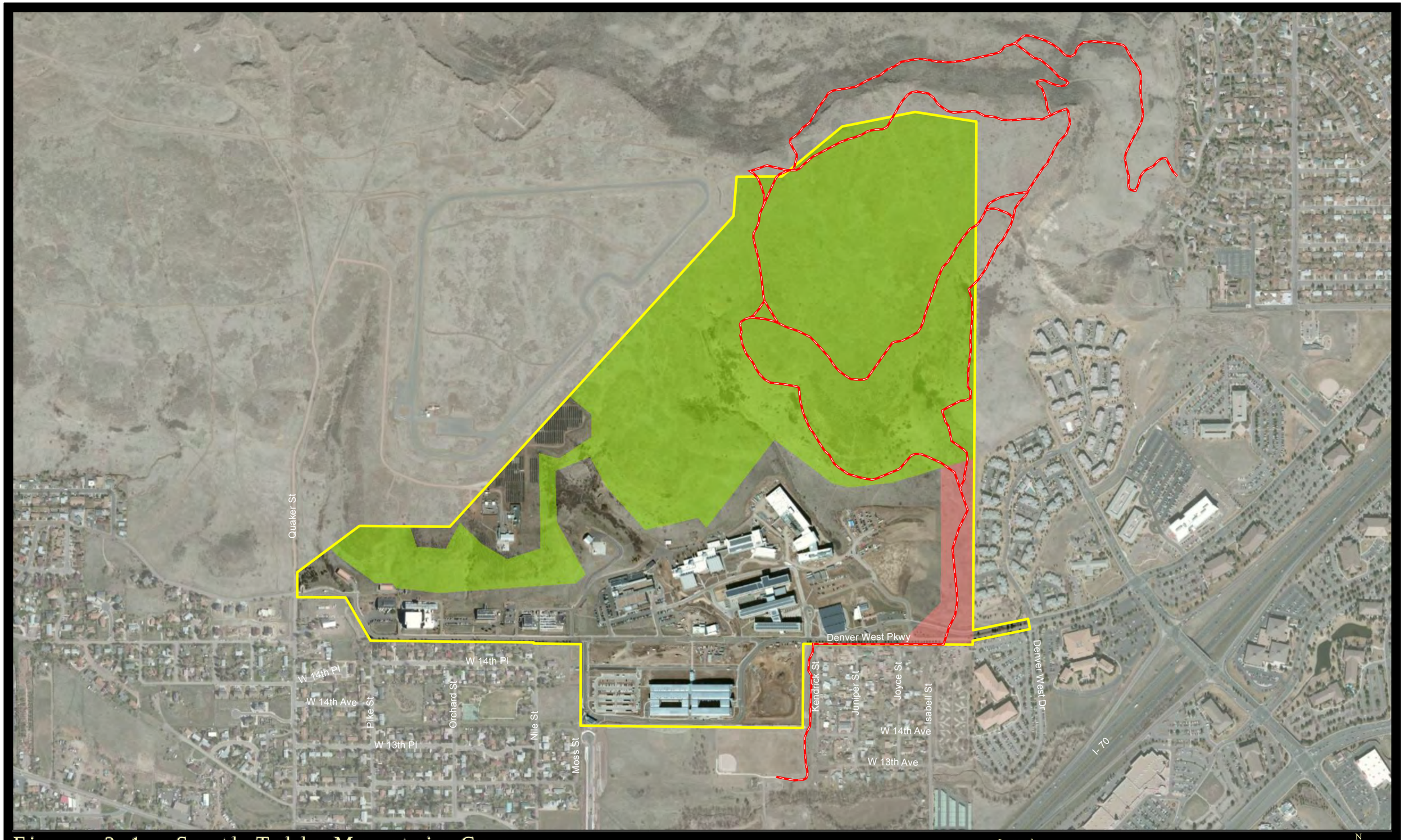


Figure 2-1 - South Table Mountain Campus Trails & Easements

Legend

- Campus Boundary
- Jeffco Trail
- DOE Conservation Easement
- Jeffco Trail Easement

0 400 800

Feet

N W E S

Data Sources: NREL, AECOM, ESRI

- **Natural and Cultural Resources Protection:** Wildlife, vegetation, protected species, wetlands, and cultural resources management.
- **Health & Safety Compliance**: Hazard identification and control, bio-safety, chemical safety, radiation safety, construction safety, and electrical safety.

Each program addresses compliance requirements and develops and refines NREL policies and BMPs. When NREL designs and builds new facilities, an integrated planning, design, and construction process is used. More specifically, an interdisciplinary team collaborates on each project beginning with planning and selection of design continuing through construction. This integrated approach allows the laboratory to achieve mission needs while addressing environmental, health, safety, and community considerations. As a result, environmental requirements are incorporated into project designs, and monitoring occurs to assure potential environmental impacts are considered and addressed. Some examples include: wildlife-friendly design, site sensitive drainage and vegetation, dust control, waste reduction, and reuse and recycling.

2.2.2 Environmental Management System

NREL's EMS implements a framework of policies, procedures, and programs that integrates environmental protection into daily work practices. The EMS is structured based on a 'plan-do-check-feedback' continual improvement cycle and is implemented as part of an Integrated Safety Management System (ISMS).

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

Since 2011, the laboratory has maintained International Organization for Standardization (ISO) 14001:2004 certification of its EMS. Each year a team of external auditors conducts an independent assessment of the policies, procedures, tools, and roles and responsibilities used in environmental management. The assessment provides external verification that the laboratory continues to meet the requirements of the ISO 14001 standard and demonstrates NREL's commitment to environmental stewardship.

2.2.3 Site Sustainability

Sustainability is integral to NREL's research and operations, and NREL is committed to demonstrating federal leadership in sustainability and continuously improving performance. Sustainable NREL, an interdisciplinary initiative involving staff from across the organization, fosters environmental and social responsibility, working to establish the laboratory as a global model for sustainability. Each year, NREL develops a Site Sustainability Plan (SSP) to report on steps taken to meet the national and DOE sustainability objectives and outline plans for the upcoming year. Information about Sustainable NREL and NREL's FY2014 SSP can be found at http://www.nrel.gov/sustainable_nrel/.

NREL is a leader in sustainability. The lab's sustainability practices are fully integrated into the campus and operations through resource optimization and innovative and high-performance buildings that showcase state-of-the-art energy efficiency and renewable energy technologies. At NREL, sustainability encompasses environmental stewardship, economic viability, and public responsibility. At NREL's two campuses – South Table Mountain and the NWTC – this translates to:

- Optimizing and managing natural resources to help sustain the environment. Program focus areas include:
  - Mitigating GHGs;
  - Energy efficiency and renewable energy;

  - Increasing water efficiency;
  - Reducing waste and prevent pollution;
  - Green purchasing; and
  - Transportation infrastructure and efforts to reduce petroleum use.

- Reducing the environmental footprint by constructing and monitoring the performance of green buildings and providing alternative working and commuting programs for staff.
- Supporting the community by stimulating the local economy, managing NREL's environmental impacts, and creating educational programs.

As one of Colorado's foremost scientific institutions, NREL embraces the best in energy and ecological conservation practices, setting the standard for the wise use of natural resources.

2.2.4 Annual Environmental Performance Report

As a DOE facility, NREL is required to publish an annual site environmental report as a means of formalizing and documenting environmental compliance performance and achievements. NREL's 2012 Environmental Performance Report (NREL 2013) provides a description of the laboratory's environmental management activities for 2012, including information on environmental and sustainability performance; environmental compliance activities and status; and environmental protection programs, highlights, and successes. The 2012 Environmental Performance Report and previous annual reports are available at http://www.nrel.gov/ehsq/environmental_protection.html.

3.0 Proposed Action and Alternatives

This chapter describes DOE's Proposed Action and Alternatives. As discussed in Section 1.2, the NEPA process evaluates potential environmental consequences associated with a Proposed Action and considers alternative courses of action. In addition, CEQ regulations also specify the inclusion of a No Action Alternative to which potential impacts of the other alternatives can be compared. While the No Action Alternative would not satisfy the purpose of or need for the Proposed Action, it is still analyzed in accordance with CEQ regulations.

Section 3.1 provides a description of site development zones used at the STM campus. Implementation of the Proposed Action, as described in Section 3.2, is DOE's Preferred Alternative. The No Action Alternative is described in Section 3.3. Other alternatives were considered, but were dismissed from further analysis and are described in Section 3.4.

3.1 Site Development Zones

NREL has established seven development zones on the STM campus. A map showing their boundaries is presented in Section 3.2 (see **Figure 3-1**). Future development that would be allowed in these zones is summarized as follows:

Zone 1: Top of Mesa, Buildable Area (13 acres) – This zone includes land for specialized research such as solar collection and solar radiation. Additional facilities, if any, would be of minimal size, low occupancy, and designed for minimal disruption to views of the mesa.

Zone 2: Conservation Area (177 acres) – This zone includes approximately 87.5 percent of the mesa top area within the STM campus boundary and the mesa slopes on the site. Land within Zone 2 provides broad vistas of the surrounding community and is highly visible from numerous vantage points. Zone 2 would be preserved in its natural form; no development is allowed in this area with the exception of hiking trails and associated signage and maintenance activities.

Zone 3: West Campus (20 acres) – Includes the OTF, TTF, IBRF, S&R, Maintenance, Bulk Storage, and West Entrance. Buildings in this zone are smaller than those in Zone 4, largely due to space limitations. This zone is primarily for general research and development and process pilot facilities. It also may include functions such as wet chemistry, transportation research, and biological sciences. This portion of the site is considered suitable for using hazardous materials. The pattern of development for this zone is to continue development with density increased by in-filling between existing facilities.

Zone 4: Central Campus (55 acres) – This zone includes major buildings such as SERF, FTLB, S&TF, RSF, and the ESIF. Zone 4 also includes wet laboratories and space for heavy research such as experiments with hydrogen, toxic gases, photovoltaics, biofuels, and industrial technology. This portion of the site is considered suitable for the use of potentially hazardous materials and process demonstration activities. This zone is considered the center of the campus.

Zone 5: East Campus (26 acres) – This zone includes the Education Center, visitor parking, and East Entrance and is otherwise undeveloped. The zone is designated to be for general research and development with dry laboratories, limited wet laboratories, and minimal use of hazardous materials. It also is a zone where additional research support facilities could be located. Deliveries of materials including chemicals for laboratory use are made through the East Entrance.

Zone 6: Camp George West Parcel (25 acres) – This zone includes a recently developed area of the site providing parking, a 6-acre regional detention basin, other associated storm water detention and conveyance, and the South Entrance connecting Research Road to South Golden Road. This parcel is

PROPOSED ACTION	
A	S&TF PV Research Modifications
B	FTLB - Thermochemical Biofuels Research Facility (TBRF)
C	FTLB - Workstation and Lab Space Addition
D	FTLB - Expansion for Algae and Other Research Organisms for Fuel
E	Outdoor Test Pad (Zones 1, 3, 4, 5 & 6) - Not Mapped
F	Internal Reconfiguration of the Thermal Test Facility
G	ESIF Security Enhancements
H	Research Support Facility III
I	ReFUEL Laboratory Relocation
J	Renewable Energy Vehicle Systems (REVS) Facility
K	Waste Handling Facility Expansion
L	NREL SITE Operations Support Space
M	Metrology Laboratory Relocation (Zones 4 or 6) - Not Mapped in Zone 4
N	High Flux Furnace Upgrade
O	TriGEN Central Plant
P	On Campus Renewable Energy Deployment (Zones 3, 4, 5 & 6)*
Q	Additional Infrastructure at the East Campus
R	On-Site Vehicle Fuel Storage**

*Proposed action P calls for PV to be added in multiple locations throughout the STM campus.

**Proposed action R calls for storage tanks to be added in existing parking lots in Zone 4. (Two examples are mapped.)

MAP NUMBER	FACILITY NAME	MAP NUMBER	FACILITY NAME
1	Energy Systems Integration Facility (ESIF)	15	Maintenance Building
2	Education Center	16	Shipping & Recieving
3	Science & Technology Facility (S&TF)	17	Integrated Biorefinery Research Facility (IBRF)
4	Solar Energy Research Facility (SERF)	18	Thermal Test Facility (TTF)
5	Research Support Facility I (RSF I)	19	Outdoor Test Facility (OTF)
6	NREL Cafe	20	South Entrance, Site Entrance Building (SEB), (Employee Only Entrance)
7	Renewable Fuel Heat Plant (RFHP)	21	Research Support Facility II (RSF II)
8	East Entrance, Site Entrance Building (SEB), (Visitor's Entrance & Check-In)	22	Bulk Storage Building
9	Field Test Laboratory Building (FTLB)	23	Parking Garage
10	Vehicle Testing & Integration Facility (VTIF)	24	Surface Parking
11	High-Flux Solar Furnace (HFSF)	25	Waste Handling Facility (WHF)
12	Solar Radiation Research Laboratory (SRRL)	26	PV Array
13	Solar Industrial Mesa Test Area (SIMTA)	27	Detention Pond
14	West Gate Entrance Facility (SEB), (Employee Only Entrance)		

Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
Zone 6
Zone 7

Quaker St
W 14th Pl
W 14th Ave
W 13th Pl
W 13th Ave
Pike St
Orchard St
Nile St
Moss St
Kendrick St
Juniper St
Joyce St
Isabell St
Denver West Pkwy
Denver West Dr
I-70

Figure 3-1 - South Table Mountain Campus Map & Proposed Action Components

Legend
Existing Building
Existing Feature
Proposed Construction
Campus Boundary
Development Zone
A-R Proposed Action Approximate Location

0 400 800
Feet

N W E S

Data Sources: NREL, AECOM, ESRI

bordered on the east and west by residential properties and on the south by the Pleasant View Community Park. This zone is designated to be for general research and development with minimal use of hazardous materials. It also is a zone where research support facilities could be located.

Zone 7: Historic Resources (11 acres) – Zone 7 has two parts. Both parts include areas previously developed as part of Camp George West and include protected cultural resources. The amphitheater and associated footbridge are in the larger part of Zone 7. The ammunition igloo is located in the smaller part of Zone 7. NREL plans no new improvements in this zone.

3.2 Proposed Action (Preferred Alternative)

The Proposed Action is composed of individual, short-term and long-term components, which together constitute potential activities and improvements to the STM campus and leased facilities over the next 5 to 10 years. Federal budgeting decisions and changing research and development priorities would determine which components of the Proposed Action would be selected for funding and implementation. Thus, the specific physical requirements and locations of proposed facilities, as well as their actual construction schedules, may be uncertain for some components. In many cases, the descriptions of the improvements are in general terms and the locations and schedules for components were estimated based on currently available information and campus planning. Some of the Proposed Action components may never occur, or if implemented, may be of a smaller scale than currently presented. Therefore, a "bounding analysis" approach was used to consider the full range of possible development scenarios.

Table 3-3, presented at the end of this chapter, describes each Proposed Action component and defines corresponding impact analysis bounding assumptions. **Figure 3-1** clarifies where specific Proposed Action components may occur on the site within each of the STM campus development zones. The bounding assumptions in **Table 3-3** include estimated added floor space and construction disruption footprints representing the largest potential sizes for each Proposed Action component. These estimates ensure that the analysis presented in Chapter 4.0 reflects a worst-case effects analysis. A summary of these estimates is provided at the end of **Table 3-3**.

This approach provides implementation flexibility in the future as funding and further details for Proposed Action components become available. If the bounding assumptions are exceeded when a Proposed Action component is ready to move forward, the need for additional environmental analysis and documentation would be evaluated and appropriately addressed.

Baseline conditions within the project area include all existing facilities, operations, and site disturbance, plus previously analyzed facility modifications and operational changes that have not occurred as of June 2014. Baseline conditions extended into the future define the No Action Alternative as discussed in Section 3.3.

Under the Proposed Action, DOE proposes the following improvements to the NREL STM campus and leased facilities in the DWOP to support DOE's mission to research, develop, and deploy energy efficiency and renewable energy technologies. The Proposed Action would consist of:

- Research, laboratory activities, and site operations enhancements;
- New building construction and modifications of existing buildings; and
- Infrastructure and utilities upgrades and enhancements.

3.2.1 Research Activities, Laboratory Activities, and Site Operations Enhancements

This component of the Proposed Action would include research activities and routine laboratory operations in new and modified facilities, as well as the operation and maintenance of new and modified facilities.

Enhancing Research Activities

This Proposed Action component would include research activities in new and modified facilities in the following areas of renewable energy and energy efficiency:

- Photovoltaics
- Concentrating Solar Power
- Solar Buildings
- Hydrogen
- Geothermal Energy
- Bioenergy
- Distributed Power
- Superconductivity
- Energy Analysis
- Fuels Testing and Utilization
- Advanced Automotive Technologies
- Buildings Technologies
- Federal Energy Management Program
- Basic Sciences (Material, Chemical, and Biological Sciences)

Enhancing Laboratory Operations

This component of the Proposed Action would include routine activities in new and modified laboratory, test, and support facilities such as:

- Purchasing new research and support equipment;
- Operation of new, modified, or relocated research and support equipment;
- Maintaining, cleaning, and upgrading existing research and support equipment;
- Installing and removing test articles and experiments;
- Monitoring and data collection of experiments; and
- Inspections and assessments of systems, processes, and equipment.

Enhancing Site Operations

This component of the Proposed Action would include the operation and maintenance of new and modified facilities and infrastructure. Examples of activities under this category would include:

- Maintaining and cleaning new and modified facilities, building systems, and infrastructure;
- Upgrading or replacing existing utilities as needed. This would include hot and cold process water, domestic water, sewer, data, and electrical lines and infrastructure;
- Snowplowing and road maintenance;
- Realignment of on-site roads, parking lots, sidewalks, bike paths, pedestrian paths, and site entrances, as needed, to maintain safe and adequate traffic flow;
- Maintaining and enhancing site security, such as upgrading site entrances and replacing existing perimeter fencing as necessary;
- Performing pest and weed management;

- Landscape maintenance and upgrades; and
- On-site environmental monitoring, such as for wildlife and vegetation.

3.2.2 New Building Construction and Modifications of Existing Buildings

DOE is proposing the construction of new buildings and modification of existing buildings at the STM campus. The primary improvements are identified as Proposed Action components A through R as follows:

	Proposed Action Components
A	S&TF Photovoltaic Research Modifications
B	Thermochemical Biofuels Research Facility (TBRF)
C	FTLB Workstation and Lab Space Addition
D	FTLB Modification for Algae and Other Research Organisms for Fuel
E	Outdoor Test Pads
F	Internal Reconfiguration of the TTF
G	ESIF Security Enhancements
H	RSF III
I	ReFUEL Laboratory Relocation
J	Renewable Energy Vehicle Systems (REVS)
K	WHF Expansion
L	NREL Sustainability, Infrastructure Transformation, Engineering (SITE) Operations Support Space
M	Metrology Laboratory Relocation
N	High Flux Solar Furnace Upgrade
O	TriGen Central Plant
P	On Campus Renewable Energy Deployment
Q	Additional Infrastructure at East Campus
R	On-site Vehicle Fuel Storage

Each component (A-R) and the other aspects of the Proposed Action are described in the following discussion. **Figure 3-1** describes where these actions may occur on the STM campus.

S&TF Photovoltaic Research Modifications (A)

DOE is proposing interior improvements to the S&TF to expand NREL's silicon wafer washing and etching capabilities in support of thin-film photovoltaic research and development. Washing and etching silicon wafers requires the wafers to be subjected to acid and other caustic baths in a properly controlled environment. Currently, several existing laboratories throughout the S&TF and SERF are washing or etching 1-inch silicon wafers at a very small production scale. The use of 1-inch wafers on small scales would continue, but under this Proposed Action, DOE would build a clean room within the S&TF to contain the proposed development of a 156-millimeter (6.1-inch) silicon wafer washing and etching operation. The clean room would be equipped with industry standard wafer washing and etching equipment, and a gravity-fed centralized wastewater treatment system for corrosive waste likely located

on a level below the clean room. The chemicals used to wash and etch the wafers would be treated and either reused or disposed of using proper waste disposal protocols.

Thermochemical Biofuels Research Facility (TBRF) (B)

DOE would create the TBRF through either repurposing space in the FTLB, by constructing an expansion of the FTLB of up to 35,000 square feet, or as part of construction of a new building within the central or east campus (Campus Development Zones 4, 5, or 6), such as the REVS facility discussed below. The TBRF would expand NREL's capabilities in researching thermochemical conversation, which is one of the processes used to convert biomass (e.g., trees, grasses, agricultural crops) into biofuels. This proposed facility would consist of high-bay laboratory and support laboratory space for bench-scale to approaching pilot-scale thermochemical biomass conversion research activities. The TBRF would be properly designed to meet industrial safety standards.

FTLB Workstation and Lab Space Addition (C)

DOE would reconfigure existing space within the FTLB and construct an addition up to 7,500 square feet. The purpose of this project is to add critical bench-scale labs needed for work force growth, balance the lab space to workstation space in the building, and create some additional new workstation space. The addition and reconfiguration would provide approximately 50 additional workstations and the vacated existing internal office space and cubicles would then be converted to laboratory space.

FTLB Modification for Algae and Other Research Organisms for Fuel (D)

DOE proposes the repurposing of existing FTLB laboratory space and a building expansion to enhance research in the production of biofuels from living organisms including bacteria, algae, plankton, and plants. The building expansion would consist of up to a two-story 30,000-square-foot addition that would provide significant new space for several programs, and would include greenhouses, preparation rooms, support laboratories, and office space. This would provide new facilities to research and grow algae and other organisms in a controlled environment at a laboratory bench-scale, but may approach pilot-scale periodically. Research in this facility also would continue to explore the use of nanotechnology and genetically modified organisms, in a controlled and safe manner.

Outdoor Test Pads (E)

DOE proposes to develop outdoor test areas and/or test pads to conduct multiple, short-term and long-term research demonstration and pilot renewable energy, energy efficiency, and energy system integration projects. This could include projects in photovoltaics, building systems or materials, wind energy, bioenergy demonstrations including algae growth, and other pilot scale research. These projects would be used for research and demonstration purposes, rather than on-site energy generation.

The outdoor test areas would be developed at currently unused locations on the STM campus. Test area development would include the reconfiguration of unused, previously disturbed areas, and underutilized existing paved areas, like parking lots and roof tops, within Zones 1, 3, 4, 5, and 6.

These outdoor test areas and pads would be located in areas with access to existing campus infrastructure and utilities. Individual test areas/pads could be configured to host multiple types of projects or could be designed for specific types of technology or fields of research. They would not be located within the Conservation Easement, within the Historic Resources Zone (Zone 7), within 50 feet of the four major drainage ways (see Section 4.6 Water Resources, **Figure 4-1**), within or around the detention basin, and other areas of quality wildlife habitat.

Wind energy projects would be limited to small-scale wind turbines up to 100 kW in capacity. This would include no more than two 100-kW turbines with rotor hub heights less than 200 feet to be used for

distributive energy and grid integration testing at ESIF. Additionally, multiple smaller (less than 10 kW) may be mounted on buildings or monopoles and would be less than 50 feet. No turbines would be located on the mesa top (Zone 1).

Internal Reconfiguration of the TTF (F)

With the Smart Power Laboratory having moved to its new location in the ESIF, DOE would reconfigure the now vacant 5,300-square-foot space within the TTF by expanding the existing battery testing area, while also providing additional space for building system equipment testing, storage, and calibration.

ESIF Security Enhancements (G)

DOE proposes various security enhancements at ESIF to promote proprietary and classified work in the ESIF laboratories. While a majority of these enhancements would occur in the building interior, exterior security enhancements such as building perimeter fencing and security cameras are possible. Any additional fencing would occur around the building perimeter in previously disturbed areas. Improvements to the building interior would include additional security personnel, physical, electronic, and operational modifications to secure a portion of the facility to applicable sensitive information management standards.

Research Support Facility III (H)

DOE would construct an on-site office building or multi-building office complex providing 100,000 to 150,000 square feet of office and research support space. It would house up to approximately 300 staff, including staff currently housed in leased, off-campus offices. The possible locations for the RSF III are within the central part of the STM campus, either in Site Development Zone 4, Zone 5 south of ESIF and north of the Education Center or in the north central portion of Site Development Zone 6 south of Denver West Parkway. A specific building design or location has not been selected, and the building footprint would vary from 150,000 square feet for a single story building to 30,000 square feet for a five-story building. Additional permanent features, such as loading docks, utilities and exterior building systems, walkways, patios, bike paths, common areas and other amenities could cover up to an additional 100,000 square feet, or about 2.3 additional acres. In addition, up to several acres would be used temporarily for laydown and staging during construction, and these areas would be reclaimed and restored after completion of RSF III. RSF III would incorporate high-efficiency building features and would likely be of a similar design to the RSF I/II.

ReFUEL Laboratory Relocation (I)

To consolidate and enhance vehicle systems testing on the STM campus, DOE proposes to relocate the existing, leased, off-site ReFUEL Laboratory located in Denver, Colorado, to the STM campus. The relocated ReFUEL Laboratory would be approximately 5,000 square feet and would house a new engine dynamometer, in addition to equipment relocated from the existing facility, such as the chassis dynamometer, fuel mixing and testing equipment, measurement devices for air emissions, etc. The relocated ReFUEL Laboratory would consist of high- and low-bay laboratories, outside test areas, and office and support for researchers and partners. This laboratory may be an addition to an existing or planned building, such as VTIF or REVS, or as a stand-alone building, and would likely be located within the central or eastern portion of the STM campus in Site Development Zones 4 or 5.

Renewable Energy Vehicle Systems (REVS) Facility (J)

To consolidate and enhance vehicle systems testing on the STM campus, DOE would construct a new building approximately 100,000 square feet in size, with up to 45,000 square feet of paved area for visitor parking and vehicle testing. The REVS facility would provide specifically designed space for crucial, systems-level research associated with advanced transportation systems, such as electric storage and battery systems, electric motors and other propulsion systems; the integration and testing of advanced biofuels, hydrogen and other alternative fuels; and the design, testing and optimization of alternative

vehicle fueling infrastructure. The REVS facility would incorporate many activities currently conducted at ReFUEL, DWOP Building 16 labs, and FTLB. The REVS facility would likely be located to the east of ESIF in the eastern portion of STM campus in Site Development Zones 4 and 5.

Waste Handling Facility Expansion (K)

The current WHF would be expanded from 1,000 square feet to 4,000 square feet. This expansion would accommodate anticipated future needs of the campus. This expanded facility would be used for packaging and short-term storage of NREL's hazardous waste and other special wastes before the wastes are shipped off-site for proper management and disposal. No on-site waste treatment or disposal at this facility is proposed. The building would likely be of cinder block and concrete construction, to match the existing architecture. The expanded facility would include ventilation, fire detection and suppression, containment, and spill response systems to protect human health and the environment. One or two small rooms may be included in the floor plan that could be used for temporary office space or field equipment storage for the EHS group.

NREL Site Operations Support Space (L)

DOE would meet the need for the additional space for maintenance activities and support by repurposing existing site operations and maintenance facilities and by potentially expanding the Bulk Storage and Maintenance Buildings. In order to support campus growth and maintain modified and new facilities and infrastructure, more staff and supporting office space, storage space, supplies, and work/maintenance shop areas would be needed. The Bulk Storage building may be expanded up to 8,000 square feet and the Maintenance Building up to 10,000 square feet.

Metrology Laboratory Relocation (M)

DOE proposes to relocate the existing Metrology Laboratory currently within the SRRL building on the mesa top to a more accessible location closer to the rest of the STM campus and more readily available to off-site customers. A new building, between 2,000 to 4,000 square feet in size and meeting the standards for metrology and calibration laboratory space, would be designed and built. The new Metrology Laboratory would be located in the center of the STM campus in Site Development Zones 4 or 6, and its operation would be similar to current activities at the existing facility. Possible locations include Site Development Zone 6, south of Denver West Parkway and north of the new parking structure.

High Flux Solar Furnace Facility Upgrades (N)

DOE would upgrade key components of the HFSF facility on the mesa top (Zone 1). This would entail the upgrading of equipment, components, electronic hardware and software, and would not expand the footprint of the facility from its current size.

3.2.3 Infrastructure and Utilities Upgrades and Enhancements

In order to support modified and new facilities, campus infrastructure would be upgraded or enhanced to support renewable energy research, development, and deployment at the STM campus.

TriGen Central Plant (O)

If one or two large buildings are added to the campus, a new central plant may be needed. The proposed TriGen Central Plant would generate electricity, as well as provide hot and cold water to the campus. The plant would include a 1.5-megawatt (MW) stationary fuel cell, fueled by natural gas to add to on-site electricity generation (existing central plants in the FTLB and SERF). The TriGen Central Plant would include approximately 75 million British thermal units per hour (MMBtu/hr) of natural gas fired heating capacity and 3,700 tons of cooling. The facility would be between 40,000 to 80,000 square feet in size, and would be located behind the S&TF and ESIF in Site Development Zone 4. This facility could replace existing plants on the STM campus or could work in conjunction with these existing facilities. The

TriGen would be connected via new process pipelines and electrical conduit into existing utilities and infrastructure which are mainly under existing roadways or previously disturbed rights-of-way (ROWs). The natural gas fuel cell would increase campus-wide natural gas consumption, but would reduce the need for a corresponding amount of electricity generated off-site. All applicable federal, state, and local air regulations and permitting would be followed.

On Campus Renewable Energy Deployment (P)

To meet various sustainable goals, additional on-site renewable energy sources may be deployed on the STM campus, including solar and geothermal. Additional photovoltaic systems could be added to rooftops of existing or new buildings, over parking lots, or on land unsuitable for buildings. No changes are proposed to the existing mesa top photovoltaic array. Closed loop geothermal systems could be installed for existing or new facilities to reduce heating and cooling costs. Stationary fuel cell systems could be deployed to generate electricity and heat. No new renewable energy systems would be installed within drainage buffers, on the mesa top portion of the campus (Zone 1), or within the Conservation Easement (Zone 2). Closed loop geothermal systems are typically a temporary disturbance and land disturbed would be reclaimed once systems were installed.

Additional Infrastructure at the East Campus (Q)

If new building construction would occur to the east of ESIF, new roads, electrical loops, data lines, sewer, hot and cold process water loops, and storm water infrastructure would be required. East Campus infrastructure would be added in phases as specific new facilities are built. Infrastructure development within the eastern part of the STM campus in Site Development Zones 4 or 5 would create an area of disturbance up to 300,000 square feet of area, which was previously disturbed during construction of the ESIF and RSF.

On-site Vehicle Fuel Storage (R)

Beyond storage at the new REVS and ReFUEL facilities, there may be a need to store various vehicle fuels at locations within the Central Campus (Development Zone 4). These could include the storage of biofuels and petroleum based blends prior to pilot demonstrations or waiting to be subjected to further research. The fuels would be contained in properly designed and permitted aboveground storage tanks (ASTs) no larger than 1,500 gallons and limited to only four tanks.

3.2.4 Site Planning and Development Assumptions

The Proposed Action would improve research capabilities within the current 327-acre (132-ha) STM campus. No additional property acquisition or permanent off-campus development is proposed. The overall balance of program activities and personnel assigned to the STM campus and DWOP sites, respectively, would be expected to fluctuate over time based on the timing of new facility development and other site changes, site management efficiencies, and associated federal budget priorities and available funding.

At this time, site planning and development assumptions are flexible. Detailed site plans are not available for any of the proposed construction projects. This reflects the need for flexibility for site planning that would guide and refine future development proposals.

In order to further refine the bounding analysis assumptions applied in this Final SWEA, the following additional site development assumptions also would apply:

- No major, off-site road or utility services would be required.
- New buildings and/or building modifications would not exceed five stories above ground level.

- New buildings would be set back from the STM campus parcel boundaries. These setbacks would vary and would be determined during the site planning process and/or during the final design processes for individual buildings.
- New buildings would be set back from STM campus drainage ways. These setbacks would vary and would be determined during the site planning process and/or during the final design processes for individual buildings, but would be determined with the intention of conserving drainage-way integrity, wildlife habitat and movement corridors, and flood control.
- The need for additional off-campus leased space for office and limited laboratory space would be met by leasing additional space in existing commercial building space within 2 miles of the STM campus.

The maximum acreage for site disturbance from the Proposed Action was calculated based on the proposed construction shown in **Figure 3-1**. The maximum acreage that could be disturbed during construction includes the largest potential construction footprint for each new building or expansion of existing buildings, parking facilities, soil stockpiles, material storage sites, and operation and storage of equipment and vehicles. This approach generates a worst case scenario for the site-wide effects analysis. Consequently, the worst case scenario for total disturbance was used in the effects analysis. The maximum area of disturbance is estimated to be approximately 21.5 acres.

3.2.5 Anticipated Employment Growth

The number of workers and square footage of space at the STM campus would be expected to increase as components of the Proposed Action are implemented. Workers are defined as full and part time employees, contract employees, consultants, and others who work on the site. The totals for workers presented in the following discussion represent estimates of the annual average number of workers at the STM campus and DWOP. The anticipated increase in workers from 2013 is anticipated to occur as follows:

- Worker totals would increase by up to 2 percent compounded annually; and
- The relative proportions of personnel between the STM campus and DWOP would change such that 90 to 95 percent of anticipated worker increases would be housed at the STM campus with the remainder at DWOP or other facilities up to within 2 miles of the STM campus.

Table 3-1 provides estimated present and future workers at both locations based on these assumptions.

Table 3-1 Estimated Present and Future Workers at the STM Campus and DWOP Locations

	STM Campus	DWOP
Current (2013)		
DOE Employees and Contractors	260	110
NREL Regular and Temporary Employees	1,240	93
NREL Joint Faculty, Postdocs, Students, Visiting Scientists, Collaborative Appointments, Cooperative Research and Development Agreement (CRADA)/Work for Others (WFO)	333	24
Total	**1,833**	**227**

Table 3-1 Estimated Present and Future Workers at the STM Campus and DWOP Locations

	STM Campus	DWOP
Future (5 years)[1]		
DOE Employees and Contractors	280	120
NREL Regular and Temporary Employees	1,344	100
NREL Joint Faculty, Postdocs, Students, Visiting Scientists, Collaborative Appointments, CRADA/WFO	360	26
Total	**1,984**	**246**
Future (10 years)[1]		
DOE Employees and Contractors	310	130
NREL Regular and Temporary Employees	1,482	111
NREL Joint Faculty, Postdocs, Students, Visiting Scientists, Collaborative Appointments, CRADA/ WFO	398	29
Total	**2,190**	**270**

[1] Based on a 2 percent increase annually.

3.3 No Action Alternative

The No Action Alternative would be composed of baseline conditions described in Chapter 2.0, including all existing facilities and operations and previously approved facility modifications and operational changes that have not yet occurred as of June 2014. Under the No Action Alternative, no new construction or changes in operations or workforce would be made to the STM campus, beyond what has been previously approved.

No other facility improvements would occur. Research, operation, and management activities associated with these conditions would remain in place in the future. No substantial changes to current levels of research, operation, and management activities would occur at the DWOP. Routine operations and maintenance would occur in the future as it does currently.

There are two previously planned and approved projects that would occur under the No Action Alternative. These projects are presented in **Table 3-2** and have been previously assessed under NEPA.

Table 3-2 Previously Approved Facility Modifications and Operational Changes

Project Name	Description	Estimated Completion	Existing NEPA Determination Information
STM Campus 15-MW Electrical Upgrade	On-site improvements to electrical infrastructure to accommodate the increasing electrical demands of the site, including the new high performance data center in the ESIF. The project would include 5,500 feet of trenching to install electrical utility loops on the STM campus to create redundancy in the electrical infrastructure, to provide a	2014	NEPA Determination Control Number NREL-13-007 signed February 25, 2013. Available at: http://www.eere.energy.gov/golden/ReadingRoom/NEPA/Categorical_Exclusions/

Table 3-2 Previously Approved Facility Modifications and Operational Changes

Project Name	Description	Estimated Completion	Existing NEPA Determination Information
	dedicated distribution feed with 10 MW supply capacity for the ESIF data center, and add or relocate electrical equipment, such as Vista switches with future campus development in mind. Trenching would occur in Site Development Zones 3, 4, 5, and 6 in previously disturbed areas.		
Smart Power Lab Move	The Smart Power Laboratory previously in the TTF has moved to the ESIF. Research at NREL's Smart Power Laboratory in the ESIF focuses on the development and integration of smart technologies including the integration of distributed and renewable energy resources through power electronics and smart energy management for building applications. The 5,300-square-foot laboratory is designed to be highly flexible and configurable, essential for a large variety of smart power applications that range from developing advanced inverters and power converters to testing residential and commercial scale meters and control technologies.	2014	November 2009 Final Supplement-II to the Final Site-Wide Environmental Assessment of the National Renewable Energy Laboratory's South Table Mountain Complex (DOE/EA-1440-S-II) DOE (2009) Available at: http://www.eere.energy.gov/golden/NREL_Enviro_NEPA.aspx

3.4 Alternatives Considered but Dismissed

The Proposed Action and the No Action Alternative are the only alternatives specifically addressed in this Final SWEA. A number of alternatives were considered that were not carried forward for analysis because they were not considered feasible due to technical, legal, or policy considerations. The rationales for eliminating these alternatives are summarized below:

- **Site Development Configuration Alternative(s):** This alternative involved different site planning possibilities that would put the proposed facilities in other locations than those identified in the Final SWEA. Variations of this alternative were not considered feasible because of the interrelated nature of the proposed facilities (logical site planning with the proposed locations for the new facilities), site development constraints, general consensus surrounding the Proposed Action and site planning assumptions, and the inherent flexibility of the Proposed Action with respect to future facility footprints and its ability to avoid substantial environmental effects.
- **Increased Development Alternative:** This alternative involved more development that has been proposed and included additional Proposed Action components and larger and more involved facilities. The additional development associated with the increased development

alternative within the 10-year timeframe was not considered reasonably foreseeable or feasible given technical and financial site development constraints.

- **Reduced Development Intensity Alternative:** Not considered feasible because it is inconsistent with the Proposed Action's purpose and need and the intent of preparing the Final SWEA, which is to facilitate NREL in carrying out its mission.
- **Off-site Improvements Alternative:** Not considered feasible because of the technical and cost implications associated with decentralized operations and site/infrastructure complications.

Table 3-3 Proposed Action Components and Primary Bounding Analysis Assumptions

Proposed Action Description **Reasonably Foreseeable Changes to Existing Facilities and Ongoing Operations** **Proposed Action Component Reference Letter (A-R) & Name** **(see Figure 3-1)**	**Potential Cause for Creating Ongoing or New Adverse Environmental Impacts** Impact Analysis Bounding Assumptions (Worst-case for Site-wide Effects Analysis)
A. S&TF Photovoltaic Research Modifications: Interior improvements to the S&TF to expand NREL's silicon wafer washing and etching capabilities in support of thin-film photovoltaic research and development. Wafers to be subjected to acid and other caustic baths in a properly controlled environment. DOE would build a clean room within the S&TF to contain the proposed consolidated and expanded silicon wafer washing and etching operation. The clean room would be equipped with industry standard wafer washing and etching equipment, and a gravity-fed centralized wastewater treatment system for corrosive waste. The chemicals used to wash and etch the wafers would be treated and either reused or disposed of using proper waste disposal protocols. The amount of acidic and basic chemicals used to clean silicon wafers would include: 1. A process line that includes the following chemicals: hydrofluoric acid (HF), nitric acid (HNO_3), hydrochloric acid (HCl), sulfuric acid (H_2SO_4), hydrogen peroxide (H_2O_2,), ammonium hydroxide (NH_4OH), and potassium hydroxide (KOH). 2. The pH neutralization system includes the following chemicals: H_2SO_4 and sodium hydroxide (NaOH).	**Change to Operations and New Activities** Added Floor Space: 0 gross square feet (gsf) Construction Disruption Footprint = 0 square feet Clean Room construction for a silicon wafer cleaning facility. Construction of treatment system and nature of emissions and effluent Amount of acidic and basic chemicals needed for initial setup: HF (10 gallons); HNO_3 (10 gallons); HCl (10 gallons); H_2SO_4 (60 gallons); H_2O_2 (10 gallons); NH_4OH (10 gallons); KOH:H_2O (10 gallons); and NaOH (30 gallons). Chemicals would be used as needed but at least once per month and therefore be changed out monthly or recycled as needed. Would increase water use, hazardous materials use, and volume of wastewater discharge. Wastewater may require notification to local authorities and would meet federal, state, and local wastewater regulations.
B. FTLB – Thermochemical Biofuels Research Facility (TBRF): TBRF created through either repurposing space in the FTLB, by constructing an expansion of the FTLB of up to 35,000 square feet, or as part of construction of a new building within the central or east campus (Campus Development Zones 4, 5, or 6). This facility would expand NREL's capabilities in researching thermochemical conversion of biomass to biofuel. Consists of high-bay laboratory and support laboratory space for bench-scale to approaching pilot-scale thermochemical biomass conversion research activities.	**Construction of a New or Expanded Building** Added Floor Space: 35,000 gsf Construction Disruption Footprint = 45,000 square feet Expand the FTLB to develop additional laboratory space Bench-scale bioenergy work with support laboratories. Potential increases in existing hazardous chemicals and hazardous waste generation.

Table 3-3 Proposed Action Components and Primary Bounding Analysis Assumptions

Proposed Action Description Reasonably Foreseeable Changes to Existing Facilities and Ongoing Operations Proposed Action Component Reference Letter (A-R) & Name (see Figure 3-1)	**Potential Cause for Creating Ongoing or New Adverse Environmental Impacts** Impact Analysis Bounding Assumptions (Worst-case for Site-wide Effects Analysis)
C. FTLB – Workstation and Lab Space Addition: Reconfiguration of existing space within the FTLB and the construction of an addition up to 7,500 square feet. The addition and reconfiguration would provide approximately 50 additional workstations and the vacated existing internal office space and cubicles would then be converted to laboratory space.	**Construction of a New or Expanded Building** Added Floor Space: 7,500 gsf Construction Disruption Footprint = 10,000 square feet
D. FTLB – Expansion for Algae and Other Research Organisms for Fuel: Repurposing of existing FTLB laboratory space and a building expansion to enhance research in the production of biofuels from living organisms including bacteria, algae, plankton, and plants. The building expansion would consist of up to a two-story 30,000-square-foot addition that would provide significant new space for several programs, and would include greenhouses, preparation rooms, support laboratories, and office space. This would provide new facilities to research and grow algae and other organisms in a controlled environment at a laboratory bench-scale, but may approach pilot-scale periodically. Research in this facility also would continue to explore the use of nanotechnology and genetically modified organisms, in a controlled and safe manner.	**Construction of a New or Expanded Building** Added Floor Space: 30,000 gsf Construction Disruption Footprint = 20,000 square feet Two-story addition that would provide new space for several programs.
E. Outdoor Test Areas: Development of outdoor test areas and/or test pads to conduct multiple, short-term and long-term research demonstration and pilot renewable energy, energy efficiency, and energy system integration projects. This could include projects in photovoltaics; building systems or materials; wind energy; bioenergy demonstrations, including algae growth; and other pilot scale research. These projects would be used for research and demonstration purposes, rather than on-site energy generation. The outdoor test areas would be developed at currently unused locations on the STM campus. Test area development would include the reconfiguration of unused, previously disturbed areas and underutilized existing paved areas, like parking lots and roof tops, within Campus Development Zones 1, 3, 4, 5, and 6. These outdoor test areas and pads would be located in areas with access to existing campus infrastructure and utilities. Individual test areas/pads could be configured to host multiple types of projects or could be designed for specific types of technology or fields of research.	**Reconfiguration of Existing Operations** Added Floor Space: 0 gsf Construction Disruption Footprint = No more than 10,000 square feet not including hardscapes such as parking lots or graveled areas Would not be located within the Conservation Easement, within the Historic Resources Zone (Zone 7), within 50 feet of the four major drainage ways (Chapter 4.0, **Figure 4-1**), within or around the detention basin and other areas of quality wildlife habitat. Wind turbines may have impacts to birds and bats. Small wind turbines would be limited to: 1) No more than two 100-kW turbines with rotor hub heights of less than 200 feet mounted on monopoles at the ESIF. 2) Multiple turbines less than 10 kW either mounted on buildings or on monopoles less than 50 feet. 3) No wind turbines would be located on the mesa top (Zones 1 or 2).

Table 3-3 Proposed Action Components and Primary Bounding Analysis Assumptions

Proposed Action Description Reasonably Foreseeable Changes to Existing Facilities and Ongoing Operations Proposed Action Component Reference Letter (A-R) & Name (see Figure 3-1)	**Potential Cause for Creating Ongoing or New Adverse Environmental Impacts** Impact Analysis Bounding Assumptions (Worst-case for Site-wide Effects Analysis)
F. Internal Reconfiguration of the Thermal Test Facility (TTF): Internal remodeling and reconfiguration of the now vacant 5,300-square-foot space within the TTF by expanding the existing battery testing area, while also providing additional space for building system equipment testing and calibration.	**Reconfiguration of Existing Operations** Added Floor Space: 0 gsf Construction Disruption Footprint = 0 square feet
G. ESIF Security Enhancements: Enhancements would occur in the building interior and would include exterior security enhancements such as building perimeter fencing and security cameras. Improvements to the building interior would include additional security personnel and physical, electronic, and operational modifications to secure a portion of the facility to applicable sensitive information management standards.	**Reconfiguration of Existing Operations** Added Floor Space: 0 gsf Construction Disruption Footprint = 2,000 square feet Mostly internal modifications to existing facility. Some exterior fencing may be added (up to 1,000 linear feet) in previously disturbed areas around building perimeter, cameras, and other electronic security equipment installed.
H. Research Support Facility (RSF) III: On-site office building or multi-building office complex providing 100,000 to 150,000 square feet of office and research support space and would incorporate high-efficiency building features. A specific building design or location has not been selected, and the building footprint would vary from 150,000 square feet for a single story building to 30,000 square feet for a five story building. Additional permanent features, such as loading docks, utilities and exterior building systems, walkways, patios, bike paths, common areas, and other amenities could cover up to an additional 100,000 square feet. In addition, up to several acres would be used temporarily for laydown and staging during construction, and these areas would be reclaimed and restored after completion of RSF III.	**Construction of a New or Expanded Building** Added Floor Space: 150,000 gsf Construction Disruption Footprint = 250,000 square feet New office building located within the center of the STM campus in Development Zones 4, 5, or 6. Building would be of similar design of the RSF I/II, one to five stories with wings oriented east to west to maximize day lighting and incorporate high-efficiency sustainable design principles.
I. ReFUEL Laboratory Relocation: Relocate the existing, leased, off-site ReFUEL Laboratory located in Denver, Colorado, to the STM campus. The ReFUEL Laboratory would be approximately 5,000 square feet and would house a new engine dynamometer, chassis dynamometer, fuel mixing and testing equipment, measurement devices for air emissions, etc. The relocated ReFUEL Laboratory would consist of high- and low-bay laboratories, outside test areas, and office and support for researchers and partners. This laboratory may be an addition to an existing or planned building, such as VTIF or REVS, or as a stand-alone building, and would likely be located within the central or eastern portion of the STM campus in Campus Development Zones 4 or 5.	**Construction of a New or Expanded Building** Added Floor Space: 5,000 gsf Construction Disruption Footprint = 10,000 square feet New building located adjacent to VTIF in Zone 4 or in a new stand-alone building in Zones 4 or 5. Would include petroleum based and biofuel based hazardous materials, batteries, engine and vehicle testing, hydrogen storage, and would increase air emissions.

Table 3-3 Proposed Action Components and Primary Bounding Analysis Assumptions

Proposed Action Description Reasonably Foreseeable Changes to Existing Facilities and Ongoing Operations Proposed Action Component Reference Letter (A-R) & Name (see Figure 3-1)	**Potential Cause for Creating Ongoing or New Adverse Environmental Impacts** Impact Analysis Bounding Assumptions (Worst-case for Site-wide Effects Analysis)
J. Renewable Energy Vehicle Systems (REVS) Facility: A new building would be constructed in the East Campus, approximately 100,000 square feet with 45,000 square feet of paved space for visitor parking and other appropriate uses. The REVS facility would provide specifically designed space for crucial, systems-level research associated with advanced transportation systems, such as electric storage and battery systems, electric motors and other propulsion systems, the integration and testing of advanced biofuels, hydrogen and other alternative fuels, and the design, testing and optimization of alternative vehicle fueling infrastructure. The REVS facility would incorporate many activities currently conducted at ReFUEL, DWOP Building 16 labs, and FTLB.	**Construction of a New or Expanded Building** Added Floor Space: 100,000 gsf Construction Disruption Footprint = 145,000 square feet, including a parking lot in the eastern part of the STM campus in Zones 4 or 5. Waste generation could be as much as: 1,800 pounds of hazardous and 2,000 pounds of non-hazardous waste in 1 year.
K. Waste Handling Facility (WHF) Expansion: Expand facility from 1,000 square feet to 4,000 square feet for the use of packaging and short-term storage of NREL's hazardous waste and other special wastes before the wastes are shipped off-site for proper management and disposal. No on-site waste treatment or disposal at this facility. One or two small rooms may be included in the floor plan that could be used for temporary office space or field equipment storage for the EHS group. The building would likely be of cinder block and concrete construction, to match the existing architecture and would include ventilation, fire detection and suppression, containment and spill response systems.	**Construction of a New or Expanded Building** Added Floor Space: 4,000 gsf Construction Disruption Footprint = 6,000 square feet
L. NREL SITE Operations Support Space: Repurposing existing site operations and maintenance facilities and by potentially expanding the Bulk Storage and Maintenance Buildings. The Bulk Storage building may be expanded up to 8,000 square feet and the Maintenance Building up to 10,000 square feet.	**Construction of a New or Expanded Building** Added Floor Space: 14,000 gsf Construction Disruption Footprint = 28,000 square feet
M. Metrology Laboratory Relocation: The Metrology Laboratory would be relocated from the mesa top to a more accessible location closer to the rest of the STM campus and more readily available to off-site customers. A new building, between 2,000 to 4,000 square feet in size and meeting the standards for metrology and calibration laboratory space, would be designed and built. The new Metrology Laboratory would be located in the center of the STM campus in Site Development Zones 4 or 6, and its operation would be similar to current activities at the existing facility. Possible locations include Site Development Zone 6, south of Denver West Parkway and north of the new parking structure.	**Construction of a New or Expanded Building** Added Floor Space: 4,000 gsf Construction Disruption Footprint = 6,000 square feet

Table 3-3 Proposed Action Components and Primary Bounding Analysis Assumptions

Proposed Action Description Reasonably Foreseeable Changes to Existing Facilities and Ongoing Operations Proposed Action Component Reference Letter (A-R) & Name (see Figure 3-1)	**Potential Cause for Creating Ongoing or New Adverse Environmental Impacts** Impact Analysis Bounding Assumptions (Worst-case for Site-wide Effects Analysis)
N. High Flux Furnace Upgrade: DOE would upgrade key components of the HFSF facility including equipment, components, electronic hardware and software, and would not expand the footprint of the facility from its current size.	**Reconfiguration of Existing Operations** Added Floor Space: 0 gsf Construction Disruption Footprint = 0 square feet Internal modifications of an existing facility. Updating equipment systems.
O. TriGen Central Plant: TriGen Central Plant would generate electricity, as well as provide hot and cold water to the campus. The plant would include a 1.5-MW stationary fuel cell, fueled by natural gas to add to on-site electricity generation (existing central plants in the FTLB and SERF). The TriGen Central Plant would include approximately 75 MMBtu/hr of natural gas fired heating capacity and 3,700 tons of cooling. The facility would be between 40,000 to 80,000 square feet in size, and would be located behind the S&TF and ESIF in Site Development Zone 4.	**Construction of a New or Expanded Building** Added Floor Space: 0 Construction Disruption Footprint = 80,000 square feet. New building located northeast of S&TF and west of ESIF. Would need to connect new process pipelines into existing process piping and infrastructure (mostly located under existing roadways or ROWs). Air permitting likely involved.
P. On Campus Renewable Energy Deployment: Additional renewable energy sources may be deployed on the STM campus, including solar and geothermal. Additional photovoltaic systems could be added to rooftops of existing or new buildings, over parking lots, or on land unsuitable for buildings. Closed loop geothermal systems could be installed for existing or new facilities to reduce heating and cooling costs. Stationary fuel cell systems could be deployed to generate electricity and heat.	**Facility Construction** Added Floor Space: 0 gsf Construction Disruption Footprint = 25,000 square feet. No new photovoltaic within 100-foot drainage buffers, or on conservation easement/mesa top portion of campus. Some existing land that is not “buildable” may be used for new energy deployment. Geothermal is typically a temporary disturbance. Fuel cells may require air permitting.
Q. Additional Infrastructure at the East Campus: Expanding to the East Campus would require new roads, electrical loops, data lines, sewer, hot and cold process water loops, and storm water infrastructure would be required. East Campus infrastructure would be added in phases as specific new facilities are built.	**Facility Construction** Added Floor Space: 0 gsf Construction Disruption Footprint = 300,000 square feet (area mostly disturbed by the ESIF project, but now reclaimed). Impacts of new roads, sewer, water, data, electric, process water (heating and cooling) in Zones 4 and 5.

Table 3-3 Proposed Action Components and Primary Bounding Analysis Assumptions

Proposed Action Description Reasonably Foreseeable Changes to Existing Facilities and Ongoing Operations Proposed Action Component Reference Letter (A-R) & Name (see Figure 3-1)	**Potential Cause for Creating Ongoing or New Adverse Environmental Impacts** Impact Analysis Bounding Assumptions (Worst-case for Site-wide Effects Analysis)
R. On-Site Vehicle Fuel Storage: In addition, beyond storage at the new REVS and ReFUEL facilities, there would be a need to store various vehicle fuels at locations within the Central Campus (Development Zone 4). These could include the storage of biofuels and petroleum-based blends prior to pilot demonstrations or waiting to be subjected to further research. The fuels would be contained in ASTs no larger than 1,500 gallons and limited to only four tanks beyond current conditions.	**Facility Construction** Added Floor Space: 0 gsf Construction Disruption Footprint = 500 square feet for installation of four tanks at four different locations (likely installed in existing parking lots or on concrete pads with secondary containment).

Summary

Proposed Action Component	Added Floor Space (gsf)	Construction Disruption Footprint (square feet)	Zones
A	0	0	4
B	35,000	45,000	4, 5, or 6
C	7,500	10,000	4
D	30,000	20,000	4
E	0	10,000	1, 3, 4, 5, and/or 6
F	0	0	3
G	0	2,000	4
H	150,000	250,000	4, 5, or 6
I	5,000	10,000	4 or 5
J	100,000	145,000	4 or 5
K	4,000	6,000	4
L	14,000	28,000	3
M	4,000	6,000	4 or 6
N	0	0	1
O	0	80,000	4
P	0	25,000	3, 4, 5, and 6
Q	0	300,000	4 and 5
R	0	500	4
Total	**349,500**	**938,500**	
Acres		**21.5**	

4.0 Affected Environment and Environmental Consequences

Chapter 4.0 describes existing conditions and the effects of the Proposed Action and No Action Alternatives at the STM campus and DWOP as described in Chapter 3.0. There are no plans for off-site development or acquisition of additional property. All of the Proposed Action components would occur within the boundaries of the STM campus and nearby existing leased facilities such as DWOP.

DOE must evaluate the significance of potential environmental impacts (or effects) of a Proposed Action by considering the type, context, duration, and intensity. General definitions of these terms are as follows:

- **Type** describes the impact as beneficial or adverse, direct or indirect.
  - **Beneficial:** A positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.
  - **Adverse:** A change that moves the resource away from a desired condition or detracts from its appearance or condition.
  - **Direct:** An effect on a resource by an action at the same place and time. For example, soil compaction from construction traffic is a direct impact on soils.
  - **Indirect:** An effect from an action that occurs later or perhaps at a different place and often to a different resource, but is still reasonably foreseeable. For example, removing vegetation may increase soil erosion and cause increased sediment in a stream.
  - **Cumulative:** Impacts to resources that are added to existing impacts from other actions. For example, surface water runoff from the project, added to the runoff from other unrelated projects in the area, may produce additional storm water flows downstream.
- **Context** describes the area (site-specific) or location (local or regional) in which the impact would occur.
- **Duration** is the length of time an effect would occur.
  - **Short-term** impacts generally occur during construction or deployment or for a limited time thereafter, generally less than 2 years, by the end of which the resources recover their construction conditions. For example, increased traffic during construction activities would be short-term since traffic would return to normal levels once construction has been completed.
  - **Long-term** impacts last beyond the construction period, and the resources may not regain their construction conditions for a longer period of time. For example, visual impacts from a new building would be long-term since they continue as long as the building is in place.
- **Intensity** of an impact is based on how the Proposed Action would affect each resource. The levels used in this Final SWEA are:
  - **Negligible:** Impact at the lowest levels of detection with barely measurable consequences.
  - **Minor:** Impact is measurable or perceptible, with little loss of resource integrity and changes are small, localized, and of little consequence.

- **Moderate:** Impact is measurable and perceptible and would alter the resource but not modify overall resource integrity, or the impact could be mitigated successfully in the short term.
- **Major:** Impacts would be substantial, highly noticeable, and long-term.

The following environmental analysis considers the type, context, duration, and intensity of the Proposed Action on relevant resource areas. DOE makes the related findings in the decision record.

The analysis also considers NREL's key environmental commitments and measures to eliminate, minimize, and reduce identified effects. NREL's key measures and policies are referenced as appropriate, within the affected environment and/or environmental consequences discussions.

Under NEPA, the human environment is the natural and physical environment and the relationship of people to that environment. The affected environment for individual resources was delineated based on the area of potential direct and indirect environmental impacts for the Proposed Action and the associated cumulative effects area. For some resources, the resulting study area is limited to the STM campus and DWOP, while other resources (e.g., geology and air quality) are addressed in a larger regional context.

Initial analysis and input obtained during the scoping process identified the specific set of resources to be analyzed in this Final SWEA. Where no adverse effects were anticipated and/or the effects of the Proposed Action were beneficial, certain topics were dismissed from further analysis.

The impacts of the Proposed Action and alternatives on public services (police protection, fire protection, ambulance service, etc.), and utilities (electrical power, gas, water, sanitary sewer, and telecommunications) are not addressed in Chapter 4.0 because the incremental effects of additional development would be inconsequential to the existing service providers given NREL's:

- Existing and ongoing site management commitments;
- Minimization of on-site use of electricity, gas, and water; and
- Generation of on-site energy.

The addition of new staff on the STM campus and DWOP would incrementally increase on-site sanitary sewer, telecommunication, and other infrastructure needs, but no substantive off-site facilities would be needed to address anticipated demand. With respect to energy consumption and other uses of natural resources, NREL's commitment to energy efficiency, renewable energy sources, and sustainability reduces the impact footprint of existing and anticipated facilities and activities.

4.1 Land Use

4.1.1 Affected Environment

STM Campus

NREL's 327-acre STM campus is located on federal land in unincorporated Jefferson County. The land surrounding the STM campus is within unincorporated Jefferson County, or within the Lakewood and Golden city limits. The Lakewood City limits are adjacent to the east edge of the STM campus. The Golden city limits are located approximately 1,500 feet (457.2 meters) to the west (west of Quaker Street).

The STM campus has been developed with a mix of office and research and development uses (refer to Chapters 1.0 through 3.0 and **Figures 1-1**, **1-2**, and **3-1**). Development on the STM campus began in 1984 with the construction of the FTLB. The campus is divided into development zones as described in

Chapter 3.0 and shown in **Figure 3-1**. **Table 4-1** displays each zone, the associated acreage, and existing facilities.

Table 4-1 STM Campus Infrastructure

Zone	Name	Acreage	Existing Facilities
1	Top of the Mesa, Buildable Area	13	SRRL
			HFSF
			SIMTA
2	Conservation Area	177	None
3	West Campus	20	OTF
			TTF
			IBRF
			S&R
			Maintenance Building
			Bulk Storage Facility
			West Site Entrance
4	Central Campus	55	SERF
			FTLB
			S&TF
			VTIF
			ESIF
			RSF I (southern and central wings)
			RSF II (northern wing)
			Campus Cafeteria
5	East Campus	26	Education Center
			East Site Entrance
			Visitor Parking
6	Camp George West Parcel	25	Four-story Parking Garage (1,630 spaces) and Surface Parking
			Storm water Detention Pond – 6 acres
			South Site Entrance
7	Historic Resources	11	None

The STM campus provides 136 acres available for development. A total of 177 acres is protected by a conservation easement executed in June of 1999. The remaining 14 acres of the conservation easement are occupied by a utility easement. The conservation easement was created as a condition in acquiring the 25-acre Camp George West parcel south of Denver West Parkway. All existing NREL facilities are

within the 136 acres identified for development. This includes seven laboratory facilities, multiple test facilities, support buildings, and a parking garage. **Figure 3-1** shows the layout of facilities within the campus.

Examples of Office and Research and Development Uses at the STM Campus

New development occurs in compliance with NREL's Site Operations Project Manager Handbook, which requires a formal, internal design review process for all construction proposals (new facilities and modifications to existing facilities). As described in NREL's 2012 Environmental Performance Report (NREL 2013), NREL designs and builds new facilities using an approach that integrates planning, design, and construction. An inter-disciplinary team collaborates on each project beginning with planning and selection of design, continuing through construction. This integrated approach allows the laboratory to achieve mission needs while addressing environmental, health, safety, and community considerations.

Although the federal land within the STM campus is not subject to local zoning and development requirements, Jefferson County provides general recommendations and guidance for the campus. The STM campus is zoned as A-2, which allows for residential, commercial, and industrial development uses while protecting the surrounding land from any harmful effects (Jefferson County, Colorado 2013a). One of the goals of the Jefferson County CMP, adopted in 2013, is to "encourage infill and redevelopment projects." One section of the CMP is devoted to renewable and alternative development. This section specifically recognizes NREL (Jefferson County, Colorado 2013).

Denver West Office Park

NREL leases just under 200,000 gsf of office space within the DWOP in the City of Lakewood. Local zoning for office uses and development regulation is applicable to the private land within this office park.

Denver West Office Park

Surrounding Land Uses

Land uses adjacent to the STM campus include mesa top open space to the north; multi-family residential, office, and commercial uses to the east; residential and public park land uses to the south; residential uses and open space to the west; and open space and a Colorado State Highway Patrol driver training track to the north. A public hiking trail is located in an easement on the east side of the STM campus near the Camden Denver West multi-family complex.

Camp George West currently occupies approximately 100 acres to the south of the STM campus. The site now provides space for Colorado National Guard classrooms and maintenance and storage facilities, and space for other activities and entities including the Colorado Department of Transportation (CDOT), Colorado Highway Patrol Academy, and the Department of Corrections.

The Jefferson County CMP addresses areas surrounding the STM campus. The commercial and residential development areas to the east are zoned as planned development. This is a versatile county zoning mechanism that allows for development of any nature (commercial, residential, conservation, mining, industrial, etc.) (Jefferson County, Colorado 2013a). Permitted uses in planned development zones are approved through an Official Development Plan by the Board of County Commissioners.

To the south, the area is primarily zoned as R-2 which allows for single-family or two-family dwellings or group housing for up to eight persons only. The area contains approximately 1,600 residential units and a park with a baseball diamond and two multi-use fields.

The open spaces to the north of the campus are zoned A-2. The Agricultural Zone Districts provide for limited farming, ranching, and agricultural related uses.

The Camp George West area is zoned as A-2. This state land is not subject to local zoning and development regulations.

A small portion of the area to the west of the STM campus is zoned as A-1 which is very similar to A-2, in regard to uses allowed, but the minimum lot size is 5 acres. The remainder of the property to the west is zoned as A-2. The Colorado State Highway Patrol driver training track also is zoned as A-2.

The eastern limits of the City of Golden near the STM campus are zoned for residential uses.

4.1.2 Environmental Consequences

Proposed Action

The Proposed Action would involve construction of new facilities and expansion of existing facilities within the NREL STM campus. This new development would occur within zones NREL has set aside for development. All building plans would be developed to be consistent with the campus' Site Operations Project Manager Handbook and NREL's site planning and development commitments as described in NREL's annual Environmental Performance Report (NREL 2013).

At this time, no site plans or building/facility design details are available; however, the following stipulations would guide the process:

- No major, off-site road or utility services would be required.
- New buildings and building modifications would not exceed five stories above ground level.
- New buildings would be set back from the STM campus' parcel boundaries. These setbacks would vary and would be determined during the site planning process and/or during the final design processes for individual buildings.
- New buildings would be set back from STM campus drainage ways. These setbacks would vary and would be determined during the site planning process and/or during the final design processes for individual buildings, but would be determined with the intention of conserving drainage-way integrity, wildlife habitat and movement corridors, and flood control.

No structures would be constructed in Zones 2 (Conservation Easement) or 7 (Historical Resources). Development in Zones 1, 3, 4, 5, and 6 would involve infill construction in the southern portion of the campus and away from the South Table Mountain mesa top and the steepest slopes. The proposed development would occur in close proximity to adjacent residential areas to the south and east of the campus. East campus construction would be buffered by the Jefferson County conservation easement and would be located on the western side of Zone 5. No development would be in close proximity to the Richard Heights neighborhood which is located to the southeast of the STM campus. Future design and review processes would establish setback and other development considerations.

Overall, the proposed construction within Zones 1, 3, 4, 5, and 6 would increase development density within the STM campus to the extent that it would be noticeable to adjacent residents, but resulting long-term development would not be incompatible with the existing facilities or with the combination of residential and commercial development in the immediate area.

The proposed development of the STM campus would generally be consistent with Jefferson County's planning and development guidance. No direct or indirect impacts to the Pleasant View Community Park would be expected. Development would occur on undeveloped land near the hiking trail along the eastern boundary of the campus. This development would be compatible with existing and future trail use. Visual impacts resulting from construction activities and new and expanded structures are discussed in Section 4.5. Adherence to NREL's site development stipulations and related planning and development policies would address land use compatibility with existing adjacent land uses.

No substantive land use effects would be expected at DWOP.

No Action Alternative

Under the No Action Alternative, the minor changes to the campus would be expected from operational changes, but infill development associated with the Proposed Action would not occur. Existing land uses within the STM campus would not change.

4.2 Transportation and Traffic

4.2.1 Affected Environment

Overview

Measurement of traffic levels are expressed in the form of a standard traffic assessment method used by traffic engineers known as Level of Service (LOS). LOS considers traffic movement from all directions of a given traffic intersection. In a signalized intersection controlled by stoplights, LOS is defined in terms of the average total vehicle delay of all traffic movements through an intersection. For an unsignalized or stop-sign controlled intersection, LOS considers vehicle delay results for each movement direction which must yield to conflicting traffic at the intersection.

LOS is comprised of six categories represented by the letters A through F, with A being the best and F the worst. An LOS "A" represents conditions with minimal delay, while a LOS "F" represents conditions with much longer delays. **Table 4-2** summarizes LOS criteria for both signalized and unsignalized intersections. Traffic engineers consider LOS A through D to be acceptable and LOS E and F to be unacceptable. Vehicle delay calculated by LOS can help quantify several difficult-to-measure factors, such as driver discomfort, frustration, and lost travel time, and is influenced by many variables, such as traffic signal phasing, traffic signal length, and traffic volumes with respect to the intersection's capacity.

Table 4-2 LOS Threshold Definitions

Level of Service	Average Control Delay per Vehicle (seconds per vehicle)	
	Signalized Intersection	Unsignalized Intersection
A	≤10	≤10
B	10-20	10-15
C	20-35	15-25
D	35-55	25-35
E	55-80	35-50
F	≥80	≥50

Source: Highway Capacity Manual (Transportation Research Board 2000).

Current STM Campus Transportation and Traffic Infrastructure

The STM campus is served by the Denver West/Colorado Mills Boulevard and West Colfax Avenue interchanges with I-70. Access to the STM campus is provided by three gated entrances.

The east gate is the main entrance to the STM campus and provides two-lane access from Denver West Marriott Boulevard via Denver West Parkway. The east gate serves as the primary gate for visitors, contractors, and deliveries in addition to providing employee access. During AM (7:30 AM to 8:30 AM) and PM (4:30 PM to 5:30 PM) peak hours, approximately 52 percent of STM campus vehicle traffic passes through this gate. The east gate also provides pedestrian and bicycle access for employees. Currently, a bus stop for Regional Transportation District (RTD) Route 20 is located just outside the east gate, providing mass transit commuting options from Denver and Aurora.

The south gate opened in May 2012 and provides employee access from West Colfax Avenue and South Golden Road via Moss Street and Research Road. The south gate was added to address existing and future site access and on-site and off-site roadway system capacity needs. Forty-four percent of AM

and PM peak STM campus vehicle traffic currently uses this gate. Similar to the east gate, the south gate also provides pedestrian and bicycle access for employees. Also, a bus stop for RTD Route GS is located outside of the south gate, providing mass transit commuting options from Boulder and Golden.

The west gate is located off of Quaker Street opposite Golden Hills Road and provides an employee access and emergency exit. Visitors do not use this gate unless there is an emergency. This gate and the local streets in the vicinity are not intended for high volumes of traffic and do not provide convenient connections to the regional roadway system. Approximately 2 percent of STM campus vehicle traffic passes through the west gate during AM and PM peak traffic hours.

Leased facilities in the DWOP are served by the Denver West Marriott Boulevard interchange with I-70, and via West Colfax Avenue, Cole Boulevard, and facilities located in DWOP on the north side of I-70 by Denver West Parkway.

STM Campus Transportation and Traffic Background

STM campus and DWOP access needs have been analyzed by traffic engineers for the last several years in compliance with DOE NEPA implementing regulations as the development of the STM campus has evolved. The engineers' findings have been presented in traffic impact studies, traffic mitigation plans, and various NEPA documents associated with STM campus development. The May 2008 Final Supplement to the Final Site-Wide Environmental Assessment of the National Renewable Energy Laboratory's South Table Mountain Complex (DOE/EA-1440-S-I) (DOE 2008a) proposed to build and operate RSFs that would result in increasing the STM campus population from 500 to approximately 1,430 employees by the relocation of employees from off-site leased locations and new hires (DOE 2008a). Traffic impact studies completed in support of DOE/EA-1440-S-I indicated that this would result in PM peak traffic flows at the Denver West Parkway and Denver West Marriott Boulevard intersection at unacceptable LOS E level without mitigation measures (Felsburg Holt & Ullevig [FHU] 2008).

In May 2008, DOE implemented a Mitigation Action Plan (MAP) to mitigate potential traffic impacts as a result of the relocation of employees from off-site leased locations to the STM campus once the RSF was completed. The MAP provided specific short-term and long-term actions that DOE and NREL could employ to reduce traffic levels at affected intersections, identified metrics to gauge the success of mitigation measures, and specified periodic traffic monitoring to verify the effectiveness of the traffic mitigation measures. The goal of the MAP was to maintain a LOS of D or better at the intersections affected by STM campus traffic (DOE 2008b). The short-term measures in the MAP are traffic management control strategies that form the foundation of NREL's traffic management program and commitments (refer to the following discussion). However, the MAP and traffic impacts studies showed that even with these measures, an additional access road would be required to divert campus traffic from the east gate to keep the traffic flow at the Denver West Parkway and Denver West Marriott Boulevard intersection at acceptable levels. A subsequent traffic impact study was prepared in 2009 with updated projections on STM campus population and background traffic volumes for 2012 and 2030, and analyzed potential options of a third access road to the campus (Baseline Engineering 2009). Through the NEPA process (DOE/EA-1440-S-II) (DOE 2009), the results of the 2009 traffic impact study, discussions with land owners, and negotiations with local and state agencies, it was determined that the preferred second full service access road to the STM campus would be an extension of Moss Street north of South Golden Road to the NREL property boundary. Construction on the south access road was completed in May 2012.

To further improve the capacity of the Denver West Parkway and Denver West Marriott Boulevard intersection to handle increased eastbound PM peak STM campus traffic and prevent an unacceptable LOS of E or F at the intersection, DOE and NREL also committed in the May 2008 MAP to pursue funding and approvals for the addition of a second right turn lane for eastbound Denver West Parkway.

Construction of the second right turn lane for eastbound Denver West Parkway began in May 2013 and was completed in June 2013.

Transportation and Traffic Management Program

DOE and NREL transportation and traffic management program will continue to implement a variety of measures to manage traffic and control peak levels. These commitments include the following traffic management measures.

Program Management:

- In-house traffic and transportation management staff to monitor and manage the program and make adjustments as necessary.
- Periodic formal and informal traffic measuring to monitor peak traffic flows and volumes at off-campus intersections.

Encourage Alternative Modes of Commuting:

- Providing Eco Passes to employees to encourage use of the RTD public transportation system. This includes unlimited RTD regional, express, local, light rail, and Call-n-Ride services.
- Establishing shuttle routes to provide connections between NREL facilities in Golden and RTD transit hubs and stations.
- Promoting vanpools and carpools at the STM campus and DWOP by providing incentivized parking.
- Making vanpool incentives available for participants who commute in formal organized vanpools.
- Providing infrastructure and services to promote biking. Bike racks, bike lockers, and bicycle maintenance stations are located in key locations on the STM campus. Bike racks on shuttle vehicles permit staff to take their bikes with them when they commute or move between buildings.
- Maintaining an intranet site that allows staff to post and search listings for potential carpool and vanpool partners within NREL.
- Setting up literature kiosks in key building locations that provide shuttle and RTD schedules, bicycle maps, and telecommuting information.
- Hosting information sharing events to promote safe bicycling, rideshare (e.g., carpool and vanpool), and RTD services.

Employ Alternative Workweek Practices:

- Establishing alternative workweek strategies, such as flextime[2] and teleworking[3], to spread out the arrival and departure times of vehicle trips and reduce overall vehicle trips on a given workday.
- Promoting and encouraging use of teleconferencing and videoconferencing for meetings to decrease local vehicle trips and air travel.

[2] Flextime is intended to spread out employee arrival and departure times to avoid AM and PM peak traffic hours as well as reduce the overall daily vehicle trips. Typically it consists of employees working either four 10-hour work days per week or working 80 hours in 9 workdays during the 2-week pay period resulting in 1 day off every other week.

[3] Telecommuting allows staff, with management approval, to work from home at least 1 day per week or occasionally as needed, reducing the days they commute to the STM campus.

Current Traffic Measurements

Periodic traffic monitoring has shown that the infrastructure improvements and traffic control mitigation measures have successfully kept traffic impacts at the affected intersections at acceptable levels (e.g., LOS of D or better). A formal LOS analysis conducted in December 2011 showed that the Denver West Parkway and Denver West Marriott Boulevard intersection was operating at LOS A in AM peak hours and LOS B in the PM peak hours (Baseline Engineering 2012). The same analysis also concluded that the Quaker Street and South Golden Road intersection also was operating at LOS A in AM peak hours and LOS B in the PM peak hours.

As part of NREL's traffic management program, periodic informal monitoring is conducted several times a year. In 2013, video traffic surveillance was conducted at all three STM campus traffic gates during the PM peak hour at three different times of the year. **Table 4-3** shows the results of the traffic counts at the east, west, and south entrances to the STM campus in April, August, and November 2013.

Table 4-3 2013 PM Peak Traffic Counts

Gate	PM Peak Hour Vehicles (in- and out-bound)			
	April	August	November	Average
East Entrance (Denver West Parkway and Denver West Marriott Boulevard)	285	294	343	307
West Entrance (Quaker Street and South Golden Road)	0	18	13	10
South Entrance (South Golden Road and Research Road)	183	213	282	226

These results were compared to thresholds designated in the MAP that would cause an unacceptable LOS rating at the Denver West Parkway and Denver West Marriott Boulevard intersection during peak AM and PM hours. These MAP thresholds identify the acceptable number of vehicle trips DOE and NREL can contribute to the intersection without causing significant degradation to traffic flow. The MAP threshold was 387 vehicle trips and is now 522 vehicle trips with the completion of the additional right turn lane on eastbound Denver West Parkway. In 2013, PM peak hour traffic volume averages remained below MAP thresholds even with the permanent relocation of approximately 250 DOE staff members to the STM campus from off-site leased office space.

4.2.2 Environmental Consequences

Proposed Action

The 2008, 2009, and 2012 traffic impact studies all analyzed long-term traffic impacts of continued STM campus growth. The 2009 traffic impact study, an update of the 2008 study, assumed a total of 3,896 employees on the STM campus by 2030. The analysis concluded that operation of the south access road and the second right turn lane on eastbound Denver West Parkway would keep the targeted intersections serving the STM campus at an acceptable LOS through 2030. Additionally, the 2012 traffic study concluded that DOE and NREL could add 1,000 additional employees to the STM campus and maintain a LOS B at the Denver West Parkway and Denver West Marriott Boulevard intersection.

The Proposed Action components would be expected to add a total of 357 employees to the STM campus and 43 employees to DWOP by 2023 (see **Table 3-1**). These changes would reflect an annual

increase of 2 percent per year. With this employment growth, the on-site employee total at the STM campus in 2023 would be 2,190 employees. This on-site employee total would be far lower than the anticipated 2030 total of 3,896 employees that generated the LOS B and C findings at the Denver West Parkway and Denver West Marriott Boulevard intersection. Consequently, the Proposed Action components would not create substantial short-term or long-term traffic impacts between 2013 and 2023. Similarly, the LOS would remain acceptable for Quaker Street or South Golden Road.

The Proposed Action would include adding new internal roadways and potential adjustments to on-campus traffic circulation. No short-term or long term traffic capacity or safety effects would be anticipated from these improvements following NREL design review.

No Action Alternative

The No Action Alternative would limit overall employee growth and traffic increases through 2023 relative to the Proposed Action. Vehicle use at all gates and along entrance routes would increase incrementally every year, but this increase would be minor and handled by existing roads and traffic management facilities.

4.3 Air Quality and Climate Change

4.3.1 Affected Environment

Overview

Air quality describes the state or health of the air in the surrounding environment and often refers to the measurement of pollutants within it. Ambient air quality is evaluated by comparing the concentration of various pollutants in the atmosphere to the standards set by federal and state agencies. Several groups of air pollutants have been defined by the Clean Air Act (CAA) and are regulated by the U.S. Environmental Protection Agency (USEPA). Criteria pollutants refer to carbon monoxide (CO), oxides of nitrogen (NO_X), ozone (O_3), particulate matter, sulfur dioxide (SO_2), and lead (Pb). Also important to criteria pollutants are the precursor pollutants NO_X and volatile organic compound (VOC) that lead to the formation of O_3, SO_2, and NO_X, which contribute to particulate matter formation. Non-criteria pollutants also are regulated and include, among other pollutants, 187 toxic chemicals defined by the USEPA as hazardous air pollutants (HAPs). Criteria pollutants, non-criteria pollutants, and HAPs originate from a variety of man-made sources including mobile sources, stationary sources, and other manufacturing, processing, and cleaning activities. All pollutant groups are regulated because they cause or may cause serious health, property, environmental, and ecological effects; however, these pollutant groups are regulated by significantly different means.

Ongoing scientific research has identified other pollutants affecting the atmosphere called GHGs. GHGs also are regulated by the CAA and include gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Globally, man-made GHG emissions have increased at unprecedented rates over the last 250 years primarily due to changes in fossil fuel use, agriculture, and land use. Through complex interactions on a regional and global scale, these GHG emissions are suspected of causing a net warming of the atmosphere. This net warming is a result of GHGs reducing the amount of heat energy radiated by the earth back into space. Global climate change impacts documented include increasing air, land, and sea surface temperatures; changing ocean and atmospheric circulation; precipitation changes; reduction in sea ice; and increasing sea level (Intergovernmental Panel on Climate Change [IPCC] 2007). While ongoing research seeks to address uncertainties in the current and future climate change impacts, it may be difficult to discern the effects of global climate change on small and regional scales.

NREL Air Quality Programs

As part of its EMS, NREL is committed to environmental stewardship by pollution prevention, compliance with legal requirements and voluntary commitments, and continual improvement of environmental and sustainability performance. The Air Quality Protection Program administered by the NREL's

Environmental, Health, and Safety (EHS) Office sets continual goals to minimize air emissions, track emissions from large on-site sources, and maintain compliance and permitting requirements of all on-site sources with the USEPA and State of Colorado (NREL 2011a).

NREL's EMS implements a "plan-do-check-feedback" improvement framework. Consistent with this framework, NREL project managers notify the NREL EHS office prior to the beginning of any project that poses the potential for air emissions. The EHS office evaluates potential air emissions and permitting requirements early in the project's planning phase. The NREL EHS office also is notified of new fuel-burning equipment and changes in the status of existing equipment. Subsequently, the EHS office is in contact with the appropriate regulatory authority as necessary. NREL operates all facilities at the STM campus in compliance with all applicable regulations. DOE provides oversight to verify compliance with those regulations, and NREL regularly conducts internal and external compliance evaluations.

The following discussions provide information about NREL air quality programs; local climate; applicable regulatory authorities and standards; and air quality conditions, emission sources, and permits at the STM campus.

Local Climate

The STM campus is located in a semi-arid region that generally experiences limited precipitation, low relative humidity, ample sunshine, and large short-term and seasonal temperature variations. The STM campus is at an elevation of over 5,800 feet above mean sea level, which results in a thinner atmosphere and the large daily temperature variations. The area also is subject to occasional periods of severe drought. Average daily summer temperatures vary from approximately 61°F to 88°F in July; average daily winter temperatures vary from approximately 22°F to 44°F in December. The area generally experiences temperatures above freezing and no snowfall between mid-May and mid-September. Annual precipitation is approximately 15 to 20 inches, and seasonal snowfall generally ranges from 60 to 70 inches. Average wind speeds are approximately 10 miles per hour (mph), prevailing westerly throughout most of the year (NREL 2011a; Western Regional Climate Center 2013 [WRCC]).

Applicable Air Quality Regulatory Authorities and Standards

The purpose of air quality standards is to allow an adequate margin of safety for the protection of public health and welfare from adverse effects resulting from pollutants in the ambient air. The primary pollutants of concern for which federal and state ambient air quality standards have been established include criteria pollutants, non-criteria pollutants, and HAPs, as described previously, and certain other toxic air pollutants. The Colorado Department of Public Health and Environment (CDPHE) Air Quality Control Commission (CAQCC) administers the CAA under the authority of the USEPA.

Clean Air Act

The National Ambient Air Quality Standards (NAAQS) are designed to set upper concentration limits for the six criteria pollutants in order to protect human health and the environment. The NAAQS are set out in 40 CFR 50 and were established in the Clean Air Act Amendments (CAAA) of 1970. Geographic areas that currently exceed or have recently exceeded the limit for one or more of the criteria air pollutants or O_3 precursors are called nonattainment areas, or maintenance areas.

National Emission Standards for Hazardous Air Pollutants

The National Emission Standards for Hazardous Air Pollutants (NESHAPs) are designed to protect human health and the environment by reducing toxic air emissions. The underlying authority for NESHAPs is Title III of the CAAA of 1990 (CAAA-90), which established a listing of HAPs. Title III of the CAAA-90 specified requirements for the USEPA to identify those source categories that emit, or have the potential to emit (PTE), one or more HAPs. For each source category identified, the USEPA was directed to promulgate NESHAPs using standards that are modeled on the best practices and most

effective emission reduction methodologies in use at the affected facilities. Threshold quantities determine application of various requirements or exemption from those requirements.

The emission of radionuclides other than radon from DOE facilities is regulated by NESHAPs (40 CFR 61 Subpart H). The requirements establish a radionuclide emission standard equal to those emissions that yield an effective dose equivalent (EDE) of 10 millirems per year to any member of the public. The requirements also address measuring and monitoring fugitive emissions of airborne particles that may contain radionuclides and notification to USEPA when emission limits are exceeded. NREL does not engage in nuclear activities and, therefore, has only very limited activity with radionuclides. In 2012, extremely conservative estimates indicated the potential highest dose to the nearest member of the public was 0.035 millirems per year; over 285 times lower than the standard. NREL and DOE obtained a waiver for measuring and monitoring fugitive emissions of radionuclides in 1990 and submit an annual compliance report to USEPA each year.

New Source Performance Standards

The New Source Performance Standards (NSPS) are designed to regulate emissions of air pollutants by applying technology-based standards under 40 CFR 60. The standards apply to new, modified, and reconstructed affected facilities in certain categories of stationary sources. Some stationary sources subject to NSPS include industrial, commercial, or institutional steam generating units, engines, municipal waste landfills and combustors, incinerators, Portland cement plants, and various types of chemical and metal processing and manufacturing plants. Some sources subject to NSPS regulations are required to perform an initial performance test to demonstrate compliance and may require continuous monitoring depending on the type of source. Engines, such as the emergency and research generators, are currently the only sources at the STM campus that are subject to NSPS, but these units do not generally require testing.

Prevention of Significant Deterioration

Prevention of Significant Deterioration (PSD) regulations limit emissions of pollutants from new and modified major sources in established attainment areas. A major source, as defined for PSD regulations, is a source with the PTE greater than either 100 tons per year (tpy) or 250 tpy of a regulated PSD pollutant, depending on the type of pollutant and source. PSD permitting is triggered at 100 tpy for a source that falls into one of the 28 major source categories listed in 40 CFR 52.21 and at 250 tpy for all other sources. To implement its policy of non-degradation, the USEPA designated increments of additional pollution that would be allowed in certain areas. Class I areas include federal lands such as national parks, national wilderness areas, and national monuments. These areas are granted special air quality protections under Section 162(a) of the federal CAA. Class II areas allow additional, well controlled growth. Under PSD regulations, a construction permit may be necessary to install a new stationary source or modification of a stationary source prior to initiation of construction activities. Stationary sources may include any building, equipment, structure, facility, or installation or any combination thereof, including construction activities. Construction permits are issued on the basis of production or process rates related to emissions of criteria pollutants and HAPs. The STM campus and DWOP facility are not considered to fall under one of the 28 major source categories, are not currently subject to PSD regulations, and are not expected to be in the near future.

Title V Operating Permits

Operating permits are regulations to improve compliance with other permits and state and federal regulations. They are required to be issued to major sources under Title V of the CAA. A major source under Title V is defined as a source with the PTE greater than 100 tpy of a criteria air pollutant, 10 tpy of a single HAP, or 25 tpy for any combination of HAPs. These permits typically include pollution-control requirements, as well as compliance requirements. Minimum standards for operating permits are established under 40 CFR 70 and 71. Operating permits are issued to the source after operations have begun.

Conformity

Section 176(c)(1) of the CAA requires that federal actions conform to applicable State Implementation Plans (SIPs) for achieving and maintaining the NAAQS for the criteria air pollutants. In 1993, the USEPA promulgated a rule titled "Determining Conformity of General Federal Actions to State or Federal Implementation Plans" (40 CFR 6, 51, and 93). The "conformity rule" is intended to ensure that emissions of criteria air pollutants and their precursors are specifically identified and accounted for in the attainment or maintenance demonstration contained in SIPs. For there to be conformity, a federal action must not contribute to new violations of air quality standards, increase the frequency or severity of existing violations, or delay timely attainment of standards in areas of concern.

The conformity rule applies to non-exempt, federal actions that would cause emissions of criteria air pollutants (or their precursors) above USEPA's established threshold levels (de minimis levels) in designated nonattainment or maintenance areas. Under the rule, an agency must engage in a conformity review and, depending on the outcome of that review, conduct a conformity determination. In a conformity review, the federal agency must: 1) determine whether a proposed action would cause emissions of criteria pollutants or their precursors; 2) determine whether the emissions would occur in a nonattainment or maintenance area for any of the criteria air pollutants; 3) determine whether the proposed action is exempt from the conformity rule requirements; 4) estimate the emission rates of criteria air pollutants impacting a nonattainment or maintenance area; and 5) compare the estimate to the applicable threshold emission rates. If the estimated emission rates are below the threshold, the proposed action is assumed to conform and no further action is required. If they exceed the threshold, a more detailed conformity determination is required.

Greenhouse Gases

GHG emission requirements for reporting and permitting are under the USEPA PSD and Title V GHG Tailoring Rule (40 CFR 51, 52, 70, and 71) and the GHG Mandatory Reporting Rule (40 CFR 98). Annual USEPA GHG reporting is required for all sources that, in general, emit over 25,000 metric tpy of GHG in CO_2-equivalents (CO_2e). Operating and construction permits, however, are mostly required for large sources of GHG emissions, emitting at least 100,000 tpy CO_2e, planning increases in emissions of at least 75,000 tpy CO_2e, or certain sources that already require non-GHG permits by the CAA, and also emit over 100 tpy of GHG on a mass basis.

Protection of Stratospheric Ozone

Use of ozone-depleting substances (ODS) is regulated by the USEPA under 40 CFR 82 Protection of Stratospheric Ozone. Appliances containing more than 50 pounds of Class I or II ODS refrigerant must meet specific USEPA recordkeeping, ODS recovery, leak monitoring, and repair requirements. Facilities where maintenance activities are performed on refrigeration equipment containing ODS are required to file an annual notification with the CDPHE. Technicians that service ODS-containing equipment must be registered through attendance of an USEPA-certified training course and service equipment in accordance with the specific certification requirements. Refrigeration equipment larger than 100 horsepower (hp) containing ODS must be registered annually with CDPHE.

Colorado Regulations

The CAQCC Regulation No. 3, Air Contaminant Emissions Notices, provides the provisions for construction and operating permits. For the purposes of this reporting, an Air Pollution Emission Notice (APEN) may be required for individual emission point sources of criteria and non-criteria pollutants as previously defined. An APEN is required in an attainment area for uncontrolled actual emissions of 2 tpy or more of any individual criteria pollutant, in a nonattainment area for uncontrolled actual emissions of 1 tpy or more of any individual criteria pollutant. An APEN also is required for any source of uncontrolled actual emissions of lead of 100 pounds per year or more or for non-criteria pollutants above the de minimis levels stated in Appendix A of CAQCC Regulation No. 3.

In addition, CDPHE regulations (5 Colorado Code of Regulations [CCR] 1001-18, Regulation 16) require federal, state, and local government facilities to track street sanding in the winter, to minimize sand use, and to file an annual sanding report. Sanding of roads followed by vehicle activity turns sand and gravel into finer particulates which may become airborne, contributing to pollution in the Denver area. NREL provides annual sanding reports; however, NREL has substituted sand with ice slicer type products.

STM Campus Air Quality Conditions and Emissions Sources

The STM campus is located in an area that is currently designated a marginal nonattainment area for 8-hour O_3 NAAQS by the USEPA. The nonattainment designation is a result of violations of the NAAQS based on a 3-year average of monitoring data. The Denver metropolitan area and surrounding counties are designated an attainment/maintenance area for CO and particulate matter less than 10 microns in diameter (PM_{10},) and an attainment area for SO_2, nitrogen dioxide, and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). The nearest Class I area is Rocky Mountain National Park, approximately 40 miles to the northwest of the STM campus and DWOP.

NREL maintains an air emissions inventory for the STM campus and DWOP to identify potential air emissions and to determine if permitting is expected to be required for particular facilities, equipment, or activities. The air emissions inventory compiled in 2012 indicates that the STM campus and DWOP includes 54 stationary sources. These sources include boilers, the Thermochemical Process Development Unit (TCPDU) or thermal oxidizer within the FTLB, hot water and radiant heaters, emergency and research generators, IBRF particulate baghouse and ammonia scrubber system, and the RFHP operations. Several of the aforementioned stationary emission sources at the STM campus require permits that are described in greater detail under the heading STM Campus Permit Status.

Emissions from the 2012 inventory are listed in **Table 4-4** for criteria pollutants, GHGs, and non-criteria pollutants (including HAPs) at the STM campus and DWOP. HAP emissions include certain aliphatic and aromatic hydrocarbons, chlorinated and non-chlorinated compounds, inorganic acids, and alcohols that may be vented from various laboratory operations. These HAP emissions are based on a list of over 300 chemicals, including 187 chemicals defined by the CAA and additional chemicals regulated by the CDPHE. Potential emissions values reflect the operation of all sources of emissions at the STM campus and DWOP on a continuous year-round basis at full capacity. These maximum potential emissions also may be referred to by the USEPA as PTE. Actual emissions of these pollutants are much less than most PTE because most sources operate intermittently and may utilize certain control technologies.

The STM campus and DWOP also present the potential for accidental releases of toxic, highly toxic, and corrosive gases during research activities at the SERF, S&TF, and IBRF facilities. The accidental release of these gases could originate from sealed rupture disks or pressure relief valves associated with pressure monitors and auto-shutdown procedures. NREL's existing environmental management processes, procedures, facility design specifications, and programs establish requirements for the handling, storage, and use of these gases to minimize the likelihood of a release. In combination, these practices prevent adverse air quality impacts.

Table 4-4 STM Campus and DWOP Estimated Annual Air Pollutant Emissions

Type of Emission	Criteria Pollutants					GHGs			Non-criteria
	CO	NO_X	VOC	PM[1,2]	SO_2	CO_2	CH_4	N_2O	
Potential (tpy)	33.66	62.92	4.28	9.16	0.85	43,703	1.85	0.83	1.43
Estimated Actual (tpy)	5.82	13.78	0.90	2.20	0.21	7,079	0.38	0.17	0.30

[1] STM campus and DWOP estimated annual air pollutant emissions from 2012 (NREL 2012a,b,c).
[2] PM refers to particulate matter less than 10 microns in diameter (PM_{10}).

Fugitive dust emissions at the STM campus manifest in the form of emissions that are unplanned and escape from a process by a route other than a stack, chimney, or vent. A primary source of fugitive dust is windblown soil. Construction activities at the STM campus have the potential to increase fugitive dust generation by disturbing soil. Fugitive dust also may arise from street sanding during winter months. Following the 2010-2011 winter season, NREL transitioned to using a deicer to maintain roadways during the winter months, eliminating the source of fugitive particulate emissions. NREL complies with all CDPHE street sanding annual reporting requirements.

Operation of the RFHP is a source of particulate matter on the STM campus due to wood combustion. Emission of most other criteria pollutants and GHGs are dominated cumulatively by the aforementioned smaller sources including boilers, heaters, and generators.

Two water chillers using over 100 hp of compression and containing ODS are maintained at SERF on the STM campus. Each chiller contains 415 pounds of R-22 refrigerant, a Class II ODS. These chillers and associated personnel are in compliance with annual CDPHE reporting, training, and registration requirements.

STM Campus Permit Status

The STM campus maintains nine air quality permits. NREL has applied for two additional air permits from the Colorado Air Pollution Control Division (APCD). Air permits are required for the following sources:

- TCPDU thermal oxidizer at the FTLB;
- IBRF ammonia scrubber and particulate baghouse;
- RFHP operations;
- Site-wide construction particulate emissions;
- Six emergency generators; and
- One research-scale generator at ESIF.

Two APENs also are maintained at the STM campus and two APENs have been submitted to the APCD that are expected to be approved in 2014. NREL has submitted one APEN but currently maintains no air permits for DWOP. NREL compares annual emissions estimates to regulatory emissions levels that would trigger permitting activities on an annual basis. A pollutant level that exceeds 80 percent of a permitting threshold would prompt a more detailed emission accounting and an evaluation of when a permit might be required.

Currently, Title V permitting is not required for the STM campus because all individual criteria pollutant maximum potential emissions are well below the permitting threshold of 100 tpy. In addition, PSD and Title V permitting are not required for GHG emissions because the PTE GHG emissions fall well below 100,000 tpy CO_2e, and estimated actual GHG emissions fall below thresholds for the GHG Mandatory Reporting Rule. With respect to HAPs, the STM campus emits small quantities of materials from laboratory hoods. The potential HAP emissions were 1.4 tpy for the STM campus in 2012. These emissions were well below the 10 tpy individual HAP and 25 tpy total HAP permit levels.

4.3.2 Environmental Consequences

Proposed Action

Emissions from Construction Activity

Construction activities associated with the Proposed Action at the STM campus would cause a temporary increase in emissions of air pollutants. No construction activities are anticipated at DWOP.

Construction emissions would arise from the FTLB Workstations and Lab Space Additions (C) and Outdoor Test Pads (E), RSF III (H), ReFUEL Laboratory Relocation (I), REVS Facility (J), WHF Expansion (K), Metrology Laboratory (M), TriGen Central Plant (O), On Campus Renewable Energy Development (P), East Campus Infrastructure (Q), and On-site Vehicle Fuel Storage (R).

Proposed Action construction activities would cause intermittent increases in fugitive dust on the STM campus. The emissions would be caused by scraping, grading, material handling, storage, and construction equipment and vehicles traveling over dirt or gravel (unpaved) surfaces. Given the small area of the proposed construction (21.5 acres), the proximity to paved roads, and the anticipated short duration of the construction projects, potential impacts to the local air quality environment would be local and temporary. Construction impacts would be minimized through the use of BMPs, such as wetting the soil surfaces, covering trucks and stored materials with tarps to reduce windblown dust, limiting freeboard on material haul vehicles, and using relatively late-model, properly maintained construction equipment. Fugitive dust would be managed in accordance with NREL's existing Particulate Emissions Permit for construction activities issued by the CDPHE.

The Proposed Action also would include construction activities that would result in emissions of CO, NO_X, and particulate matter primarily from diesel engines. The exact types and numbers of engines that would be used for the Proposed Action and the total hours of operation for each are not yet known. Construction equipment would likely include: portable lighting, portable generator, backhoe/loaders, forklifts, asphalt paver, asphalt roller, compactors, concrete pumpers, water tanker, excavators, bulldozers, motor graders, wheel loader, cranes, concrete trucks, scrapers, and dump trucks. Based on the approximate square footage and footprint of the new buildings, the Proposed Action would be expected to have construction emissions similar to those estimated in the 2008 Final Supplement to the Final Site-Wide Environmental Assessment of the National Renewable Energy Laboratory's South Table Mountain Complex (DOE/EA-1440-S-I) 6.7 tpy CO, 32.6 tpy NO_X, and 1.4 tpy particulates (DOE 2008a).

Emissions from New and Expanded Operations

Air emissions from the operation of the proposed TBRF (B), FTLB workstation and lab space additions (C), RSF III (H), ReFUEL Laboratory Relocation (I), REVS Facility (J), WHF Expansion (K), and Metrology Laboratory (M) would be limited to those characteristic of HVAC equipment, similar to the operating emissions from other NREL research buildings. In addition, proposed additions to laboratory facilities would result in increased emissions of VOCs, HAPs, and other non-criteria gases from fume hoods and other sources. Specifically, these additions would include the clean room and liquid effluent treatment system infrastructure in S&TF (A), FTLB expansions for thermochemical process (B), organisms, and other fuel research, On-site Vehicle Fuel Storage (R), and all other additions increasing laboratory and research activities. The proposed clean room and liquid effluent treatment system infrastructure in the S&TF (A) may increase emissions of non-criteria HAPs from the escape of chemicals from the cleaning of silicon wafers. Emissions from chemicals such as hydrochloric acid, HF, or methanol during these activities may trigger APEN reporting and emissions controls. NREL continues to maintain inventories of these pollutants and would seek appropriate permitting should any emissions sources exceed required thresholds.

The four proposed 1,500-gallon ASTs, On-site Vehicle Fuel Storage (R), would slightly increase VOC emissions. Due to the size and contents of the storage tanks, cumulative emissions would be expected to be below 1 tpy for all four tanks. These tanks would require the Colorado Department of Labor and Employment (CDLE) permitting and registration prior to construction. Additional information about current storage tank management can be found in Section 4.12.

The anticipated change in emissions from DWOP operations would be negligible. Therefore, the following analysis focused on the potential change in emissions at the STM campus.

The maximum potential emissions for the STM campus with the additional operational emissions from the Proposed Action are estimated in **Table 4-5**. Additional operational emissions at the STM campus would result from the 1.5 MW stationary fuel cell and boilers in the proposed TriGen Central Plant (O). The operation of the proposed TriGen Central Plant (O) would result in the greatest increase in emissions of criteria pollutants, GHGs, and HAPs. The TriGen Central Plant (O) is tentatively planned to have a heating capacity of approximately 75 MMBtu/hr and 3,700 tons of cooling (NREL 2011b). The plant includes a 1.5-MW stationary fuel cell fueled by natural gas. Based on the current information available, the TriGen Central Plant (O) boilers and fuel cell would require CDPHE permitting and registration prior to construction based on the tentatively planned size and emissions of the equipment. This plant would likely be needed in the future to sustain additional infrastructure at the STM campus. For the purposes of this Final SWEA and future operational flexibility, DOE assumes that the TriGen Central Plant will not replace the existing plants in FTLB and SERF although it is designed to do so.

Based on the potential emissions at the STM campus and DWOP provided in **Tables 4-5** and **4-6**, emissions are below the major source designation for criteria pollutants and GHGs for Title V permitting. As specific design information becomes available regarding equipment sizes, fuel type, and runtime, a site-wide applicability determination may be necessary to evaluate cumulative emissions prior to construction.

Table 4-5 Maximum Potential STM Campus and DWOP Emissions with the Proposed Action

Type of Emission	Criteria Pollutants (tpy)					Non-criteria (tpy)
	CO	NO_X	VOC	PM[1]	SO_2	
1.5-MW Stationary Fuel Cell[2]	1.14E-03	0.23	1.14E-04	0.30	0.02	0.07
TriGen Central Plant Boilers[3]	16.43	14.78	2.21	3.06	0.24	0.76
Existing Emissions at STM Campus and DWOP	33.66	62.92	4.28	9.16	0.85	1.43
Maximum Potential Emissions at the STM Campus and DWOP	**50.09**	**77.93**	**6.49**	**12.52**	**1.11**	**2.26**

[1] PM refers to particulate matter less than 10 microns in diameter (PM_{10}).

[2] Emissions of CO, NO_X, and VOC are calculated based on emission factors and estimated efficiency of 56.5 percent from Technology Characterization: Fuel Cells (USEPA 2008). Emissions from all other pollutants are calculated based on emission factors from AP-42 (USEPA 1995) for small boilers (<100 MMBtu/hour) assuming year-round (8,760 hours per year) usage.

[3] Emissions of CO and NO_X are calculated based on emission factors from a Best Available Control Technology PSD analysis for a representative boiler with ultra-low NO_X burners (USEPA 2014a), assuming 80 percent efficiency. Emissions from all other pollutants are calculated based on emission factors from AP-42 (USEPA 1995) for small boilers (<100 MMBtu/hour) assuming year-round (8,760 hours per year) usage.

Any construction permits and notices would be obtained prior to commencing construction. An ambient air quality impact analysis may be required as part of the construction permit application, depending on the potential emissions. If a Title V operating permit is required, the application for the operating permit must be submitted within 1 year of when the source would become subject to Title V requirements. The construction and Title V permit requirements may include specific emission control technology, limits on emissions, emissions monitoring, recordkeeping, and reporting to ensure compliance.

The additional work space in buildings associated with the FTLB Workstation and Lab Space Addition (C), the relocation of the ReFUEL Laboratory (I) and Metrology Laboratory (M) would cause an influx of

traffic and traffic-related emissions as research activities are shifted onto the STM campus from other locations. The Proposed Action is estimated to add a total of 357 employees to the STM campus and 43 employees to DWOP by 2023 (see Section 4.2.2). Studies have found that chronic exposure to traffic-related air pollution may contribute to respiratory diseases, such as asthma (McConnell et al. 2010) and mortality (Jerrett et al. 2009). In 2012, it was estimated that 74.2 million miles were driven by people in the Denver region each weekday and approximately 26.3 miles per person (Denver Regional Council of Governments 2013). Therefore, the increase in traffic as a result of the Proposed Action will cause an inconsequential increase in emissions to the region and related health effects.

Conformity Review

DOE conducted a conformity review for the Proposed Action and determined that: 1) the Proposed Action would result in emissions of criteria air pollutants; and 2) these emissions would occur in an area (Jefferson County, Colorado) that the USEPA has designated as a marginal nonattainment area for O_3 and a maintenance area for CO and particulate matter. Consequently, DOE would conduct a further review of estimated emissions of these criteria air pollutants to determine the applicability of the general conformity rule and to determine if the estimated rate of these emissions would be less than or greater than the allowed thresholds.

The threshold emission rates for a marginal O_3 nonattainment area is 100 tpy of NO_X or VOC; the threshold emission rates for CO and particulates in a CO or particulates maintenance area also are 100 tpy (40 CFR 93.153).

The proposed stationary fuel cell and TriGen Central Plant (O) equipment would result in a net increase in emissions of criteria pollutants. Although the Proposed Action may trigger site-wide permitting requirements as described above, emissions from the Proposed Action alone are estimated to be below thresholds triggering a conformity determination. The maximum potential emissions estimates from the Proposed Action, including construction diesel equipment, would be well below the 100 tpy threshold emission rates and below 10 percent of the nonattainment or maintenance area's total emissions inventory for the pollutants of concern. Ten percent of 2011 Denver County emissions, which represents only a portion of total emissions in the nonattainment and maintenance areas, are 9,554 tpy CO; 1,964 tpy NO_X; 1,244 tpy particulates; and 1,775 tpy VOC (USEPA 2013a). Because the Proposed Action emissions are estimated to be well below thresholds, DOE has determined that they are exempt from further conformity determination.

Emissions of construction-generated fugitive dust is permitted under NREL's CDPHE Air Permit Number 08JE0889L, which authorizes emissions of fugitive dust at the STM campus associated with over-lot grading and associated construction activities. The general conformity rule (40 CFR 93.153(d)) provides an exemption for portions of an action that require an air emissions permit because state-permitted emissions are presumed to conform to the applicable SIP. DOE has determined that because particulate matter emissions from construction-generated fugitive dust would be permitted under CDPHE Permit Number 08JE0889L, they are exempt from the need for further conformity determination.

DOE acknowledges that there would likely be additional miscellaneous sources of criteria and non-criteria pollutants directly and indirectly attributable to the Proposed Action. For example, depending on its fuel source and usage, shuttle bus service to new facilities could be an air emission source, as would commuting construction workers, certain construction equipment, and any other additional products or services transported from off-site locations for the operation of the TriGen Central Plant (O), fuel cell, and other proposed facilities. While recognizing and acknowledging these potential additional incremental sources, DOE has determined they would not result in the Proposed Action exceeding allowed threshold levels because they would be either short-term or limited in their PTE.

Greenhouse Gases and Climate Change

The Proposed Action would constitute a short-term minor increase in the use of fossil fuels and associated GHG emissions during construction of the proposed facilities, facility expansions, and associated vehicle traffic. The Proposed Action also would result in an increase in GHG emissions from the operation of the TriGen Central Plant (O), stationary fuel cell, and increase in traffic. The estimated actual and potential GHG emissions for the STM campus and DWOP are outlined in **Table 4-6**. Under the Proposed Action, the STM campus and DWOP would emit 26,560 metric tpy CO_2e (29,277 tpy CO_2e) in actual GHG emissions based on 4,000 hours per year expected usage for the plant. These estimates would be above thresholds for the GHG Mandatory Reporting Rule of 25,000 metric tpy CO_2e (27,500 tpy CO_2e). The maximum potential GHG emissions would be just below permitting thresholds of 100,000 tpy CO_2e for the PSD and Title V GHG Tailoring Rule. Upon finalization of equipment and design for the Proposed Action, NREL would determine applicability of the GHG Mandatory Reporting Rule and PSD and Title V Tailoring Rule and comply with all regulations. The GHG Mandatory Reporting Rule requires the development of a GHG Monitoring Plan for monitoring, recordkeeping, and quality assurance of GHG emissions reporting.

Table 4-6 STM Campus and DWOP Estimated Annual GHG Emissions with the Proposed Action

Type of Emission or Metric	GHGs (tpy)		
	CO_2	CH_4	N_2O
Potential (tpy)	92,012	2.86	1.11
Estimated Actual (tpy)	29,138	0.85	0.40
Global Warming Potential (GWP)[1]	1	25	298
Potential CO_2e tpy (metric tpy)	92,415 (83,838)		
Estimated Actual CO_2e tpy (metric tpy)	**29,277 (26,560)**		

[1] GWP is a measure of how much heat a GHG can trap in the atmosphere compared to CO_2. GWPs are used to estimate the impacts of cumulative GHG emissions and are often expressed in terms of CO_2e. Total GHG CO_2e is calculated by multiplying the emissions of each GHG by its GWP and summing these CO_2e emissions for each GHG. GWPs are taken from the November 29, 2013 update in the Federal Register, Volume 78, Page 71909, Table 2 – GHGs with Revised GWPs for Table A-1.

The additional emissions from the Proposed Action would likely have an inconsequential contribution to long-term global climate change. For context, the estimated GHG emissions in the State of Colorado for 2013 are approximately 127,000,000 metric tpy CO_2e (CDPHE 2013). Therefore, GHG emissions from the Proposed Action would represent a de minimis increase compared to existing statewide emissions. Furthermore, estimated total GHG emissions from construction equipment in CO_2e would be approximately 0.01 percent of the CO_2e estimated to be emitted by the U.S. in 2011 (USEPA 2013a).

Per guidance from the CEQ, it is currently not useful for the NEPA analysis to attempt to link speculative climatological changes, or the environmental impacts thereof, to the particular project or emissions, as such a direct linkage is difficult to isolate and to understand (CEQ 2010). At present, there is no methodology that would allow DOE to estimate the specific effects, if any, that this small incremental increase in GHG emissions would have on the atmosphere or climate change.

The Proposed Action also may be affected by climate change in a variety of ways. Climate change can affect the integrity of a structure by exposing it to a greater risk or frequency of intense heat waves, drought, severe wildfires, flooding, or intense storms. Climate change also may exacerbate the

environmental effects of the Proposed Action, resulting in more severe consequences than what is reasonably estimated. However, per CEQ guidance, it is currently not useful to quantify climate change effects at specific geographic locations (CEQ 2010).

No Action Alternative

Under the No Action Alternative, no new construction or changes in emissions would occur beyond what has been previously approved. NREL's STM campus and DWOP would continue to operate at current conditions and no new environmental consequences would be expected. NREL would continue to track and inventory appropriate air pollutant emissions at the STM campus and make determinations regarding appropriate reporting and permitting requirements as necessary to maintain compliance with all federal, state, and local regulations.

4.4 Noise

4.4.1 Affected Environment

Sound is classified as vibrations or fluctuations in the pressure of the air that are detected by the human ear. Noise is defined as unwanted or annoying sound that is typically associated with human activities and that interferes with or disrupts normal activities. Sound and noise are measured as sound pressure levels in units of decibels (dB). Response to noise varies according to its type, its perceived importance, its appropriateness in the setting and time of day, and the sensitivity of the individual receptor. A-weighted decibels (dBA) are used to characterize sound levels that can be sensed by the human ear. "A-weighted" denotes the adjustment of the frequency range to what the average human ear can sense by reducing the value or "weight" of low frequency sounds. Noises may be harmful to humans when they occur at high levels or over long periods of time. **Table 4-7** provides a scale of A-weighted sound levels and associated noise sources for context.

Table 4-7 Sound Levels of Typical Noise Sources and Noise Environments (A-weighted Sound Levels)

Noise Source (at a given distance)[1]	Scale of A-weighted Sound Levels (dBA)[1]	Noise Environment (equivalent)	Human Judgment of Noise Loudness (relative to a reference of 70 dB)[2]
Threshold of pain	140	–	~128 times as loud
Commercial jet take-off (328 feet/100 meters)	120	–	~32 times as loud
Discotheque	110	Boiler room; printing press plant	~16 times as loud
Jackhammer (49 feet/15 meters)	90	–	~4 times as loud
Heavy truck (49 feet/15 meters)	80	Noisy urban daytime	~2 times as loud
Vacuum cleaner	70	–	Moderately loud (reference loudness)
Normal conversation (3 feet/1 meter)	60	Data processing center; department store	~1/2 as loud
Urban residence	50	Quiet urban daytime; light traffic	~1/4 as loud

Table 4-7 Sound Levels of Typical Noise Sources and Noise Environments (A-weighted Sound Levels)

Noise Source (at a given distance)[1]	Scale of A-weighted Sound Levels (dBA)[1]	Noise Environment (equivalent)	Human Judgment of Noise Loudness (relative to a reference of 70 dB)[2]
Soft whisper (7 feet/2 meters)	30	Quiet suburban nighttime/rural area	~1/16 as loud
North Rim of Grand Canyon	20	–	~1/32 as loud
Threshold of hearing	0	–	~1/128 as loud

[1] Noise sources and scale of A-weighted sound levels approximated from Occupational Safety and Health Administration (OSHA 2013).

[2] These values are logarithmic measurements. Therefore, every 10-dBA increase is perceived by the human ear as approximately twice the previous noise level.

~ = Approximately.

Sensitive Receptors

Noise sensitive receptors located in the immediate vicinity of the STM campus include residences east, west, and south of the STM campus boundary, Pleasant View Park, and wildlife. The relationship between noise and wildlife is discussed in Section 4.10. With respect to NREL personnel, DOE's Worker Safety and Health Program regulations (10 CFR 851) incorporate OSHA noise and hearing protection standards for worker exposure, and manage compliance with them.

Residential receptors in the vicinity of the STM campus include:

- Multi-family residences located approximately 50 feet (15 meters) east of the STM campus boundary.
- Single-family residences in two subdivisions located south and west of the STM campus.

The nearest residence is located approximately 50 feet (15 meters) from the southwestern boundary of the STM campus. The nearest residence to the southeastern boundary of the STM campus is located approximately 100 feet (30 meters) away. The nearest school, church, day-care center, or hospital is approximately 1.5 miles from the STM campus.

Noise sensitive receptors located at the perimeter of the DWOP, near Building 16, include residences and Applewood Park. Noise levels at these receptors are dominated by motor vehicle travel along I-70 and local roads.

Noise Regulations and Guidelines

Environmental noise regulations and guidelines for outdoor, neighborhood, and/or community noise levels have been promulgated by the USEPA, the Federal Highway Administration (FHWA), the State of Colorado, and local governments, such as Jefferson County. Although not all of these standards are directly applicable to the STM campus, they provide a general context for assessing noise issues.

The USEPA provides guideline noise levels for anticipated noise or human activity disturbance impacts in relation to industrial construction and operations in 40 CFR 201 through 211. The levels are set to define a point at which these levels and lower levels would protect people from activity interference and annoyance. Subsequent to the Noise Control Act of 1972, the USEPA set guidelines for noise in

residential land use areas. Outdoor locations “in which quiet is a basis for use” are assigned a maximum daytime noise level of 55 dBA. Indoor locations are assigned a maximum daytime noise level of 45 dBA.

DOE has accepted the OSHA noise regulations and guidelines for worker exposure, and NREL operates in compliance with all regulations related to worker health and safety. Occupational noise exposure levels are set out in 29 CFR 1910 Subpart G. These regulations and guidelines focus on noise from machinery, equipment, and tools.

The FHWA has created Noise Abatement Criteria for actions that involve federal roads for peak hourly A-weighted sound levels. An outdoor noise level of 67 dBA and indoor noise level of 52 dBA is assigned to lands that include residential, educational, and healthcare facilities. An outdoor noise level of 75 dBA is assigned for commercial and industrial areas.

The State of Colorado Noise Statute has established state-wide standards for noise level limits for various time periods and areas (C.R.S 25-12-101 through C.R.S 25-12-109). These standards can be used as guidelines for evaluating impacts. The most stringent permissible noise levels apply to residential zones, where the maximum permissible daytime (7:00 AM to 7:00 PM) non-vehicular noise level is 55 dBA. In addition, construction projects are limited to permit conditions, or 80 dBA, for the period within which the construction is to be completed or a reasonable amount of time. At nighttime (7:00 PM to 7:00 AM), the maximum noise level from non-vehicular traffic is 50 dBA, and from construction is 75 dBA in residential zones. Noise regulations in Jefferson County consider sound measured 25 feet (8 meters) from a property line for non-vehicular traffic when the wind velocity at the time and place of such measurement is not more than 5 miles (1.5 kilometers [km]) per hour, or 25 miles (40 km) per hour with a wind screen.

Jefferson County, Colorado, also maintains a Noise Abatement Policy that is consistent with the State of Colorado Noise Statute in regulating the aforementioned permissible noise levels in residential and construction areas. This policy also sets a maximum permissible noise level of 78 dBA for vehicles on private or public property that is not a road or highway.

Existing Noise Levels and Sources

The ambient noise level within the STM campus consists of sounds generated by vehicle traffic, various activities, and natural sources. Actual noise levels in and around the STM campus are affected by specific noise events, intervening topography, vegetation, and meteorological conditions, including wind speed and direction.

Although noise measurements were not taken and noise modeling not performed for this Final SWEA, observations indicate that the acoustic environment within the boundaries of the southeastern portion of the STM campus can be considered similar to that of an urban location. I-70 is a major noise source throughout the day and during sensitive late-night and early-morning periods.

The 24-hour day-night average sound levels on the STM campus are similar to levels found in suburban environments, where typically levels range from 40 to 60 dBA. Most activity and mechanical operations at the STM campus are conducted within buildings. Construction activity and routine maintenance occasionally generate additional noise.

In general, roadway noise depends upon vehicle type, speed, traffic volume, surface conditions, surface gradients, and distance to receptors. On-site light vehicle traffic contributes little to overall traffic noise at off-site locations because of the limited number of vehicles that access the STM campus, relatively low speed limits throughout the STM campus, and relatively high ambient noise levels near most sensitive receptors such as adjacent residences.

I-70 is located approximately 1,400 feet (424 meters) south of the STM campus' southeastern boundary. Based on site visits and observations, motor vehicle traffic (local buses, on-site vehicle traffic, and I-70 traffic) are the primary ambient noise sources for the southern portion of the STM campus.

Two RTD bus routes serve the STM campus, which contribute to temporary noise levels. Buses traveling between Boulder and Golden use the south access road to the STM campus and turn around by the South Entrance. This route operates during peak commuter traveling times between 6:07 AM and 9:15 AM, and 3:00 PM and 5:37 PM, on weekdays, with buses arriving approximately every half-hour to hour during these periods. Buses serving the STM campus and downtown Denver use the main access road on the east side of the STM campus and turn around just east of the SEB. This route operates throughout the day between 5:08 AM and 6:32 PM on weekdays. Buses arrive approximately every half hour, during peak commute times, and every hour mid-day (RTD 2013). Idling buses generate a temporary noise level of approximately 75 dB at 50 feet (15 meters).

Noise generated at DWOP is inconsequential relative to other local sources such as I-70.

4.4.2 Environmental Consequences

Proposed Action

Construction

Construction noise would normally occur in intervals Monday through Friday during daylight hours when new facilities were being built over a period of 10 years. An exception would be in cases where construction activity required interruption of utility services; in that case, weekend work and related short term noise may occur.

Heavy equipment such as bulldozers, graders, backhoes, excavators, dump trucks, and cement trucks would generate noise that would impact on-site workers and nearby residents, especially residents living immediately east and west of the STM campus. Construction equipment typically emits noise in the 86-dB to 94-dB range. Construction workers would use hearing protection and follow OSHA standards and procedures. Direct exposure of NREL staff to construction noise would be generally limited to times when personnel were outdoors walking to or from parked vehicles or between buildings. These noise effects would be considered short-term and minor, and would be addressed by standard practices.

Construction activities near the east, west, or south boundaries (Zones 3, 5, and 6) of the STM campus may occur close to residences, and noise could be a nuisance for some residents during construction. Construction-related noise impacts would vary with the phase of construction and would occur intermittently.

Operation

Operation of most of the proposed facilities and facility additions would not increase ambient noise levels on the STM campus or at the campus perimeter. Long-term noise that would be discernible outdoors from proposed additional operations in the FTLB Workstation and Lab Space additions (C), RSF III (H), ReFUEL Laboratory relocation (I), REVS Facility (J), WHF Expansion (K), and Metrology Laboratory (M) would be generally limited to noise from HVAC fans and similar equipment and would not adversely affect receptors. Research and development operations in the proposed Outdoor Test Pad (E), REVS Facility (J), TBRF Development (B), and WHF Expansion (K) may result in minor increases in ambient noise levels; this would be limited, though, as most operations would be contained indoors. The On Campus Renewable Energy Deployment (Q) and East Campus Infrastructure (P) development would not substantially change the current ambient noise conditions throughout the STM campus and would have no impact on off-site receptors.

The addition of up to two 100-kW wind turbines and multiple smaller wind turbines (less than10 kW) distributed within the STM campus would create new noise sources with the potential to increase ambient noise levels. Manufacturer's specifications for 100 kW turbines indicate they produce a noise level of 55 dB at 98 feet (30 meters) under windy conditions. Smaller turbines produce far lower noise levels and would not be expected to substantively impact ambient noise conditions. On windy nights, when ambient noise levels from traffic and other sources are low, turbine noise may be noticeable, and would not be expected to create noise levels that would necessitate analysis of mitigation unless one or more of the larger turbines were located at or immediately adjacent to the site perimeter, which is not likely to occur. The location of the 100-kW turbines is not specified at this time, so off-site noise levels cannot be calculated. Future wind turbine siting decisions will consider the potential for noise impacts and make sure substantial off-site noise effects are avoided.

The operation of the proposed TriGen Central Plant (O) in Zone 4, north of S&TF, would incrementally increase the ambient noise at the STM campus. Although decisions have not been made regarding equipment and layout, equipment would be installed inside a building. Therefore, operational noise to the outdoors would be attenuated as part of future processes. All operations inside the building would be in compliance with OSHA requirements. Noise impacts to operators would be reduced by the use of hearing protection equipment. The proposed location of the heating plant considered the potential for noise impacts to off-site receptors. As a rule of thumb, sound levels drop approximately 6 dBA for every doubling of distance from the source. Assuming that the loudest source of noise from the proposed plant equipment would be approximately 80 dBA at a distance of 20 feet from the plant, the plant should be constructed over 320 feet from the nearest off-site receptor for noise to be at daytime guideline levels. This estimate is likely conservative and does not take other unknown factors such as surrounding buildings and terrain into account. At the proposed location, the noise from the plant would not adversely impact off-site receptors.

The Proposed Action components also would likely cause a net increase in traffic to and from the STM campus that would be expected with additional space and research activities for staff. This change would create an inconsequential difference in noise levels. No noticeable noise increase would occur at the DWOP.

No Action Alternative

If no activities associated with the Proposed Action are completed and the STM campus continued to operate at current conditions, no environmental consequences would be expected. NREL would continue to assess noise levels and sources at the STM campus to limit public impacts and make determinations regarding appropriate requirements as necessary to maintain compliance with all federal, state, and local regulations.

4.5 Visual Quality and Aesthetics

4.5.1 Affected Environment

The visual and aesthetic characteristics of the STM campus are created by existing facilities, equipment and infrastructure, and the remaining natural conditions composed of open grassland, vegetated and rocky slopes, drainage ways, and the short grass vegetation on the mesa top.

NREL campus development planning, policy, and approval processes limit proposed improvements to specific and specialized development zones (refer to Chapter 2.0 discussions and **Figure 3-1**).

Architecture, landscape architecture, environmentally sensitive design, and sustainability principles are applied to all new development to enhance campus aesthetics and address impacts from off-site receptors. In addition, DOE must comply with all federal laws and regulations that restrict what can be designed and fire codes limit building heights or make compliance with codes expensive.

Local policies established by Jefferson County, Golden, and Lakewood reflect community sensitivity with respect to the visual qualities provided by natural resources in the STM campus. Specifically, the Jefferson County CMP characterizes North and South Table Mountain as “unique landscapes,” and states that “maintaining landscapes that have a unique visual quality” is a key to maintaining the quality of life in Jefferson County. DOE would consider these restrictions and visions when making planning decisions for campus development.

The NEPA analysis for a specific project is initiated with preliminary design concepts and an analysis of visual impacts is included in the list of environmental consideration. New designs must be shared and explained to other federal agencies and the general public. When comments are received, DOE considers those comments in the final analysis and decisions regarding campus development.

New development occurs in compliance with NREL’s SITE Operations Policies and Procedures. When preliminary building or addition designs are considered, the campus architecture, landscaping, character of the South Table Mountain area, color pallets, and building heights are integrated into the design. For larger or more complicated projects, an integrated project team (IPT) made up of subject matter experts, including environmental and sustainability concerns, are called upon and a more formal, internal design review process for all construction proposals (new facilities and modifications to existing facilities) is enacted. DOE strives to keep the STM campus a showcase for Renewable Energy Design in regards to its buildings and features. Therefore, visual impacts are always considered and new designs must be integrated into the overall campus master planning process.

Examples of the Visual and Aesthetic Character of the STM Campus

When new development is proposed, NREL policy requires the project manager to complete a “Project Manager’s Checklist.” This checklist addresses basic site development requirements and allows evaluation of the project relative to compliance with NEPA. Internal coordination involves working with

NREL's Building Manager's Handbook and NREL's Site Operations Procedures. If the project involves temporary contractors, the NREL project manager forwards the Subcontractor's Project Manual to the temporary contractors. This process includes consideration of a full range of environmental, health and safety considerations. Large projects use the IPT and design review process discussed above to evaluate and address a full range of issues during the planning and design phase of a project.

Off-site public and private vantage points include numerous sites located along and near the STM campus boundaries, and more distant locations such as those along I-70, where much of the STM campus can be seen, along with the mesa slopes and mesa top.

Public input on the visual and aesthetic effects of STM campus development has focused on keeping the mesa slopes and mesa top undeveloped, reducing development in scenic areas, and minimizing lighting to reduce off-site exposure.

NREL employs a variety of strategies to reduce night-time lighting to promote energy efficiency and reduce light pollution while balancing the safety of employees and their varying work schedules. These strategies include:

- New pole-mounted campus lights are "full cutoff fixtures" where the light is emitted downward and does not exit the fixture above the horizontal 90-degree angle.
- Many pole-mounted campus lights and all parking garage and parking lot lights have occupancy sensors to reduce on time to only when it is needed.
- Many pole-mounted campus lights that do not have occupancy sensors are on a time schedule so the lights are off from midnight to 4 A.M. and are only overridden by security when an occupant needs to go to the garage or parking area.
- The parking garage includes exterior aluminum panels to help minimize light pollution from vehicle headlights.
- Exterior building lighting is minimized to only as necessary, such as at entries and exits.
- Lighting at the mesa top facilities is limited and focused downward.

NREL's DWOP facilities are located within a landscaped, low density, three-story, suburban, office building campus. NREL's use of the DWOP involves occupancy of existing buildings and does not include exterior facilities or improvements.

4.5.2 Environmental Consequences

Proposed Action

Visual and aesthetic effects from the Proposed Action would not be expected at the DWOP because no exterior improvements are proposed there. Visual and aesthetic changes would occur at the STM campus from the installation of new facilities and equipment through 2023.

Given the uncertainty of the exact location, size, configuration and color, the visual impact of each component of the Proposed Action component is not known. Therefore, a definitive and meaningful visual impact analysis cannot be presented at this time. Prior to committing to any component of the Proposed Action, DOE and NREL would commit to using the design review process and subsequent NEPA review process to consider potential visual impacts of these actions when preliminary designs become available.

All site development and construction would occur within a rigorous design, review, and approval process. Visual impact analysis would be an integral part of this process and include campus architecture, landscaping, color pallets, building heights, and the character of the South Table Mountain

area. DOE strives to develop the STM campus as a showcase for renewable energy design and integrate this design into the existing landscape and natural resources. Mesa top building heights would generally be limited to approximately one story, and other site locations would have a height limitation of five stories. Building colors and texture would be selected to blend into the existing landscape, to the extent practicable. Lighting standards to achieve required illumination requirements, while reducing off-site visibility, would be used. On an as-needed basis, depending on location and complexity, visual modeling and analysis may be conducted to determine the potential impacts to off-site receptors and the general character of the South Table Mountain area.

As discussed in Section 1.2, this Final SWEA provides an overall NEPA baseline that is useful for tiering or as a reference when preparing project-specific NEPA review for new proposals. Prior to authorizing any component of the Proposed Action, DOE would prepare a subsequent NEPA review that would incorporate relevant information from this Final SWEA and would focus on those issues that have not been adequately addressed in this document. Therefore, that NEPA review would consider potential visual impacts. The following discussion addresses basic issues for some of the key improvements.

Based on the campus planning assumptions presented in Chapter 2.0, summarized in Section 2.5 and shown in **Figure 3-1**, the changes at the STM campus would be characterized as infill development involving 21.5 acres of potential development area. This infill development would occur in locations outside of the campus' Conservation Easement that would not substantively change views of the campus, mesa slopes, or mesa top from off-site vantage points with two exceptions. The exceptions would be the TBRF facility (B [if located in Zones 4 or 5]) and REVS (J) to be located near the on-site public trail easement and immediately adjacent to off-site condominiums.

The TBRF (B) and REVS (J) facilities would involve new buildings in the STM East Campus area (Zones 4 and 5) with a 45,000-square-foot parking lot. No design details for these buildings and the associated parking lot are available at this time so the visual characteristics of the improvements and their impact on views from off-site vantage points can only be estimated and evaluated in a general manner.

Additional improvements that may create visual issues include those proposed in high visibility areas (high on the mesa slope and on the mesa top). These improvements include minor changes to the high flux solar furnace and the TBRF (B) location. No more than two 100-kW wind turbines are proposed for the east campus (Q). Rotor heights would be no more than 200 feet. No further design details for these facilities are available at this time. No additional photovoltaic or any turbines would be added to the mesa top.

Based on STM campus planning limits, as shown in **Figure 3-1**, NREL's applicable design policies and campus development guidelines, changes to views across the STM campus from private property (adjacent condominiums), and local trails through the STM campus would be expected from improvements in Zone 5. Views of existing STM campus buildings and facilities would be replaced by views of the new facilities. Some views above and beyond STM campus facilities could be blocked depending on the height and massing of the proposed building or buildings. View disruption would be directly related to the height of the new buildings and the distance between the new buildings and the adjacent vantage points (trail alignment and condominiums). Based on the campus development perimeter delineated in **Figure 3-1**, a buffer exists between adjacent vantage points and the future buildings. Given this distance and NREL's approach to campus design, the anticipated visual effects, including potential disruption to views, would be minor and would not create unavoidable conflicts with STM campus planning policy.

No Action Alternative

The No Action Alternative would have inconsequential effects on visual quality at the STM campus and at DWOP. Installation of new facilities and equipment associated with the Proposed Action would not

occur. Most importantly, the REVs facility would not be added to the STM campus by 2023. Effects from the REVS building would be avoided.

4.6 Water Resources

4.6.1 Affected Environment

Regulatory Requirements

Applicable regulatory requirements and other agency programs directly associated with water resources on the STM campus include:

- The Clean Water Act (CWA) (including Section 404), the Safe Drinking Water Act, and designated beneficial uses and water quality standards administered by CDPHE; and
- Storm water permit requirements for construction activities from the USEPA 2012 Construction General Permit.

Wetlands are discussed in Section 4.9.

Surface Water

The STM campus is located in the Lower Clear Creek Watershed of the South Platte River Basin (Hydrologic Unit Code 1019000404) (Natural Resources Conservation Service [NRCS], U.S. Geological Survey [USGS], and USEPA [2010]). The average annual precipitation ranges from approximately 15 to 20 inches (National Weather Service [NWS] 2013). No perennial streams or floodplains are present within the STM campus. However, flash floods are known to occur in Colorado and could occur in the area.

Flash flood hazards have the potential not only to damage existing infrastructure but to completely destroy small structures and roads, and can be life-threatening. In addition, flash floods can erode banks of watercourses that would result in undermining building foundations and roads. Flash flood hazards can be addressed by assessing the potential for flooding and providing adequate drainage for structures and roads or avoidance of potential problem areas. Scott (1972b) mapped several watercourses present in the area that are potentially susceptible to flooding. The degree of flooding is subject to variables that include the duration and intensity of precipitation events, the amount of impervious area within the watershed, the extent of flood storage areas, and channel characteristics.

Surface flows generated from precipitation events flow through multiple upland swales in a generally southeastern direction, and off the STM campus to Lena Gulch (Federal Emergency Management Agency [FEMA] 2003; USGS 2011). Lena Gulch is an intermittent stream that flows south of the STM campus toward the east and north where it joins Clear Creek, a perennial stream, and a Waters of the U.S.

A 2009 site visit by NREL and U.S. Army Corps of Engineers (USACE) staff defined and documented four major upland swale drainages in and near the STM campus: the East, Middle, Middle-West, and West drainages (USACE 2009). These drainages are depicted in **Figure 4-1**. The 2009 site visit also recognized manmade roadside and trickle channel drainages on the STM campus, and the Jefferson County easement drainage located just outside the southeastern border of the campus.

A storm water detention basin, located in Zone 6, was constructed in 2012 (see **Figures 3-1** and **4-1**). The detention basin effectively captures and detains storm water runoff from the Middle Drainage and a portion of the East Drainage catchment areas. In addition to its ability to release storm water runoff at historical flow rates to an off-site channel that ultimately discharges to Lena Gulch, the detention basin also provides passive storm water quality treatment. The detention basin was sized to accommodate storm water flows generated under South Table Mountain buildout conditions.

Figure 4-1 - South Table Mountain Upland Swale Drainages

Legend

Campus Boundary

Drainage Basin Boundary

Intermittent Stream

0 400 800

Feet

N W E S

Data Sources: USGS, NREL, AECOM, ESRI

The buildings NREL leases within the DWOP are served by a system of storm water detention basins and subsurface storm sewers designed to capture and convey storm flows to the eventual point of outflow, Lena Gulch.

Construction activities that disturb greater than 1 acre at the STM campus must obtain coverage under the USEPA's Construction General Permit for storm water discharges. This permit requires development of a Storm Water Pollution Prevention Plan that identifies potential storm water pollutants, BMPs to control those potential sources of pollution, and inspection and reporting requirements. When implemented, the measures effectively reduce erosion and sedimentation impacts and prevent the introduction of other construction-related pollutants from entrainment in storm water runoff. Current USEPA permit coverages are listed in **Appendix C**.

Groundwater

The STM campus overlies the Denver Basin aquifer system, which consists of Tertiary and Cretaceous age sedimentary rocks. This aquifer system supplies groundwater to much of the plains area along the Front Range of Colorado, with the system's administration boundary covering 6,700 square miles from Colorado Springs to Greeley (Topper et al. 2003).

From shallowest to deepest (depending on extent), the aquifers that make up the system include the Dawson, Denver, Arapahoe, Laramie, and Fox Hills aquifers. The Dawson aquifer is not present beneath the STM campus, with its northwest extent located approximately 20 miles to the southeast. The aquifer at or near the surface is the Denver Aquifer. It is the least permeable of the aquifers in the system, with wells yielding up to 200 gallons per minute (Topper et al. 2003).

Although groundwater monitoring wells are present at the STM campus, NREL personnel are not actively monitoring groundwater quality (NREL 2013). Groundwater monitoring is not currently required on the STM campus and sufficient operational practices are implemented to prevent groundwater contamination. In the event that an incident occurred which could potentially impact groundwater, monitoring and other measures would be initiated. The most recent groundwater samples were collected and analyzed in 1997. The results showed elevated concentrations of manganese and iron that did not exceed national primary drinking water standards and were within the naturally occurring variations. Results also showed no contamination from VOCs or semi-volatile organic compounds, pesticides, or herbicides (DOE 2008a).

NREL has installed two closed-loop geothermal systems to showcase renewable thermal technologies and to reduce heating and cooling costs in two buildings on-site, the SRRL and the southern SEB. These geothermal systems use multiple borings to install casings that result in the closed loop system. Borings are made to a depth between 300 and 400 feet, depending on the local geology.

Water Use

The STM campus obtains its water from an existing domestic water supply system operated by the Consolidated Mutual Water Company of Lakewood, Colorado. Specifically, water provided to the campus comes from Consolidated Mutual's Maple Grove Reservoir. The Maple Grove Reservoir is supplied by waters from tributaries of Clear Creek. Clear Creek is a tributary of the South Platte River. DOE holds no water rights for the STM campus, has no owned water supply infrastructure, such as water wells, impoundments, etc., and therefore does not use groundwater to supplement our water supply system. The Consolidated Mutual Water Company is a member of South Platte Water Related Activities Program (SPWRAP). Refer to Sections 4.9 and 4.10 and **Appendix D** for additional information about SPWRAP and the Platte River Recovery Implementation Program (PRRIP).

Current water uses for the NREL STM campus includes consumptive use, fire suppression, building heating and cooling, process water, and landscaping; current water use is estimated to be

22,855,500 gallons (70.14 acre-feet) per year. The vast majority of this water is discharged back into the South Platte River by the Metro Wastewater Reclamation District via the Pleasant View Water & Sanitation District. There is some evaporative loss, as well as infiltration to hydrologically connected groundwater and storm water runoff to surface water of Clear Creek tributaries from landscape activities.

4.6.2 Environmental Consequences

Proposed Action

Local and downstream impacts to water resources could occur during the construction phase of any of the Proposed Action components in the form of erosion, sedimentation, and contaminant transport and deposition. In many situations, impacts could remain after construction was complete in the form of increased impervious surface and storm water flow volumes.

During construction, temporary vegetative cover removal and soil disturbance of up to 21.5 acres would be expected. Precipitation events during the construction process could cause increased runoff and erosion from upland areas. In turn, these precipitation events may cause high-flow, flooding, and erosion or sedimentation impacts within downstream drainages. The potential effects would be avoided and minimized through the use of BMPs to control erosion and sedimentation. Buffers established to maintain vegetative cover around the upland drainages would help limit sedimentation and reduce flows. Furthermore, because the construction would not be implemented all at one time, these impacts would be minor and localized to specific areas, which would minimize and distribute downstream impacts.

Upon completion of construction, runoff would decrease, but would likely be greater than the existing condition due to the increase in impervious areas (e.g., paved areas, rooftops). Increased storm water runoff within the Middle Drainage basin would be captured by the existing detention basin described above, as this facility was sized to accommodate build-out conditions. Development within the East Drainage basin would be captured by permeable surfaces such as porous pavers and engineered infiltration and detention facilities. The required engineering would be considered during conceptual design and would be finalized prior to plan approval and construction. Development within the South Table Mountain West Drainage basin is anticipated to be mostly interior modifications, but may include some potential building expansions. Where increases in storm water runoff are expected, additional storm water controls would be required.

One Proposed Action component, On Campus Renewable Energy Development (P), could result in the installation of geothermal systems to supplement building heating and cooling and to demonstrate system designs. Geothermal systems are composed of closed-loop well casings that would contain environmentally friendly transfer fluids to provide energy (heating or cooling) to new or existing buildings. Several boreholes may be drilled to deploy the closed-loop well fields and would be similar to existing systems on the STM campus. Because these systems are physically isolated from groundwater resources and use environmentally safe transfer fluids, risk of groundwater is non-existent.

In the event that groundwater was encountered during excavation, groundwater would be removed and discharged to upland locations where it might infiltrate or accumulate and drain away. Any dewatering would require application of BMPs to avoid adverse effects on soils, vegetation, and existing drainage conditions and facilities.

No impacts on water resources would occur at DWOP because no exterior improvements would be anticipated.

Continued operations and projected growth at the NREL STM campus over the next 10 years are anticipated to increase the on-site water usage. The addition of new buildings or building expansion would have a corresponding work force increase (2 percent per year), an increase in demand for building

heating and cooling, consumptive use, and increased demand for research related water use. These activities would increase water usage moderately.

Estimated water usage for the STM campus is as follows:

- 2014: 22,855,500 gallons (70.14 acre-feet) per year;
- 2015: 23,776,500 gallons (72.97 acre-feet) per year;
- 2020: 38,605,500 gallons (118.48 acre-feet) per year; and
- 2023: 48,205,500 gallons (147.94 acre-feet) per year.

Potential implications of this increase in water use on the PRRIP are addressed in Sections 4.9 and 4.10.

Water use at DWOP is not expected to substantially change.

No Action Alternative

Current management at the STM campus would be maintained under the No Action Alternative. Under this alternative, there would be no construction or operation of new facilities to create new impacts to water resources, beyond what has been previously approved.

4.7 Geologic Resources

This section addresses the affected environment and impacts associated with geology, geologic hazards, mineral resources, and paleontological resources (fossils). Geologic resources underlying the STM campus and DWOP, includes the bedrock, unconsolidated deposits, and the geologic structure. Geologic hazards can pose a threat to human safety and infrastructure. Human activities may increase the risks for these hazards. Natural hazards at the STM campus include landslides, rockfalls, swelling soils, groundwater infiltration, and earthquakes. These hazards have the potential to damage roads, structures, and their foundations. Mineral resources are useful or valuable commodities that are extracted from the earth's crust. Such resources could include clay, sand, gravel, precious metals, base metals, gemstones, coal, lignite, and similar resources. The Paleontological Resources Protection Act of 2009 states that paleontological resources "means any fossilized remains, traces, or imprints of organisms, preserved in or on the earth's crust, that are of paleontological interest and that provide information about the history of life on earth". The term excludes archaeological resources as defined in Section 3(1) of the Archaeological Resources Protection Act of 1979 (16 USC 470bb(1) or any cultural item as defined in section 2 of the Native American Graves Protection and Repatriation Act (NAGPRA) (25 USC 3001) (Bureau of Land Management 2013).

4.7.1 Affected Environment

Physical Geography

The STM campus and DWOP are located in the Colorado Piedmont region at the western edge of the Great Plains province (Fenneman 1928). The STM campus is close to the boundary between the Southern Rocky Mountains and the Great Plains Provinces. The Colorado Piedmont extends north to south from the Colorado-Wyoming state line to the Arkansas River and 100 miles east of the foot of the Southern Rocky Mountains where the Colorado Piedmont is bounded by the High Plains (Trimble 1980).

The STM campus is situated on the top and south-facing slopes of South Table Mountain, a prominent local landmark. The top of South Table Mountain slopes to the south with elevations in the STM campus ranging from approximately 5,780 feet (1,752 meters) above sea level at the base of South Table Mountain to 6,030 feet (1,838 meters) at the top of the mesa.

DWOP is located east of the STM campus further from the slopes of South Table Mountain. The DWOP is not considered in this section because there are no proposed actions that would affect geologic resources at that location.

Stratigraphy

Stratigraphy is geology that deals with the origin, composition, distribution, and succession of strata. The oldest rocks in the area are meta-igneous and meta-sedimentary Precambrian rocks (Early Proterozoic; ca. 1,730-1,760 million years) that are exposed in the Front Range foothills (Kellogg et al. 2008) 2.0 miles (3.1 km) west of the STM campus. The contact between the Precambrian and younger sedimentary rocks beginning with the Fountain Formation represents a major unconformity or gap in the geologic record. The Paleozoic section is missing from Cambrian to Mississippian representing some 220 million years. **Figure 4-2** presents a map of the geologic units in the vicinity of the STM campus.

Geological Structures

The STM campus is located on the western edge of the Denver Basin, a large asymmetrical, north-south trending syncline with a steeply dipping western limb and a gently dipping eastern limb. The Golden Fault separates the Front Range to the west from the Denver Basin to the east. The Denver Basin contains about 12,000 feet (3,700 meters) of Cambrian to Cenozoic sedimentary deposits (Nelson and Santus 2011).

Geologic Hazards

The Golden Fault is considered “suspect” because there is inconclusive evidence of recent movement (less than 15,000 years), but there is possible Quaternary (<1.8 million years) movement on the fault. Quaternary displacement has not been determined with certainty (Morgan et al. 2012; Rogers et al. 1998). No Quaternary faults have been identified in the study area (Morgan et al. 2012).

The north central Colorado region is not presently a very seismically active area (Colorado Geological Survey [CGS] 2013); however, strong earthquakes have been recorded in the region. Historically, the strongest earthquake in Colorado occurred in 1882 with an estimated magnitude of 6.6 and was located in the Front Range west of Fort Collins, Colorado, approximately 45 miles (72 km) northwest of the STM campus (CGS 2013). Numerous earthquakes up to a magnitude of 4.8 were recorded at the Rocky Mountain Arsenal northeast of Denver in the 1960s, but the earthquakes were associated with deep-well injection of waste, and the tremors ceased over time after injection was discontinued.

Although there is a potential for strong earthquakes to occur (estimated to be from a magnitude of 6.5 to 7.5), the peak ground acceleration (PGA) from a strong event is predicted to be less than 10 percent of the acceleration of gravity, with a 10 percent probability of exceedence in 50 years (Petersen et al. 2008). Ground motion of less than 10 percent of gravity would be felt by people, but result in slight damage and movement of unrestrained objects (Bolt 1993). Near the basalt cap of South Table Mountain, rockfall and/or landslides could result from seismic activity.

The hazards of concern at the STM campus are expansive or swelling soils, the potential for ground water infiltration of building basements and sumps, and unstable slopes. The Denver Formation contains montmorillonite clay (swelling clay), which when exposed to moisture expands several times its original volume and can affect the integrity of structures and roads (Hart 1974; Van Horn 1976). The presence of montmorillonite does not necessarily indicate foundation hazards, especially if it is present in thin layers that are widely spaced. Montmorillonite can be present in the bedrock and in soils generated on bedrock containing swelling clays. Most of the STM campus along the slope of South Table Mountain is underlain by bedrock or soil with a high to very high swelling clay potential (Hart 1974).

Landslides are present on the north slopes of South Table Mountain and a landslide is mapped to the northeast of the STM campus along the east slope of South Table Mountain (Kellogg et al. 2008; Scott 1972a). The presence of swelling clay in the bedrock and soil also creates slope instability hazards, especially during high precipitation events. The landslides in the Denver Formation occur as rotational blocks or mass movements of debris down the slopes (Van Horn 1976). Although the slopes in the STM campus are not mapped as potentially unstable (Scott 1972a), the presence of the Denver Formation as bedrock is cause for concern with regard to unstable slopes.

Mineral Resources

The major mineral resource in the Denver Basin is oil and gas, but most of the oil and gas drilling and production activity takes place to the northeast of the STM campus in the Greater Wattenberg field, which stretches from north of Denver to Greeley, Colorado. Several oil seeps have been reported along the Mountain Front West of the STM campus, but the closest well drilled for oil and gas was located about 1 mile northeast of the STM campus.

At the northern edge of the South Table Mountain mesa, the South Table Mountain Basalt Quarries were operated in the 1930s by the City of Denver for the Work Progress Administration. In addition to providing stone from buildings and other construction at Camp George West, stone from this quarry was used for rip-rap on the banks of the South Platte River and Cherry Creek, at Denver city parks, the Denver Zoo, and road base for West Alameda Parkway over the hogback to Morrison. The quarry was abandoned in the 1950s and has not been used since (Butler 1992; Simmons and Simmons 1992).

Other mineral resources in the area include gravel, aggregate, coal, precious metals, and clay, but it is not likely that commercial resources of these materials are present on the STM campus. Scott (1972c) speculated that the basalt flows that cap South Table Mountain could provide high-grade source material for crushed aggregate.

Paleontological Resources

Federal legislative protection for paleontological resources stems from the Antiquities Act of 1906 (Public Law [P.L.] 59-209; 16 USC 431 et seq.; 34 Statute 225), which calls for protection of historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest on federally administered lands. Federal protection for scientifically important paleontological resources would apply to construction or other related project impacts that would occur on federally owned or managed lands. The National Registry of Natural Landmarks provides protection to paleontological resources.

Several miles south of the STM campus near Morrison, Colorado, there are outstanding fossil resources that have been found in the Morrison Formation. The Denver Formation that underlies the STM campus also has the potential to contain scientifically important fossil resources including fossil leaves, dinosaur tracks, petrified wood, and dinosaur and mammal bones (Scott 1972d). There are over 600 vertebrate fossils from 59 localities from the Denver Formation in the University of Colorado Museum (CDOT 2006).

4.7.2 Environmental Consequences

Proposed Action

Geological Hazards

The geologic hazards (swelling soil and unstable slopes) could present risks to buildings and structures on the STM campus. The ReFUEL Laboratory (I) located near the VTIF, the WHF Expansion (K), and the TriGen plant (O) would be constructed where steep slopes exist.

Swelling soils, groundwater infiltration, and unstable slopes have the potential to damage retaining walls, building foundations, roads, and disrupt buried utilities. The presence of swelling soil and unstable slopes require that adequate geotechnical investigations be conducted prior to any major construction, such as

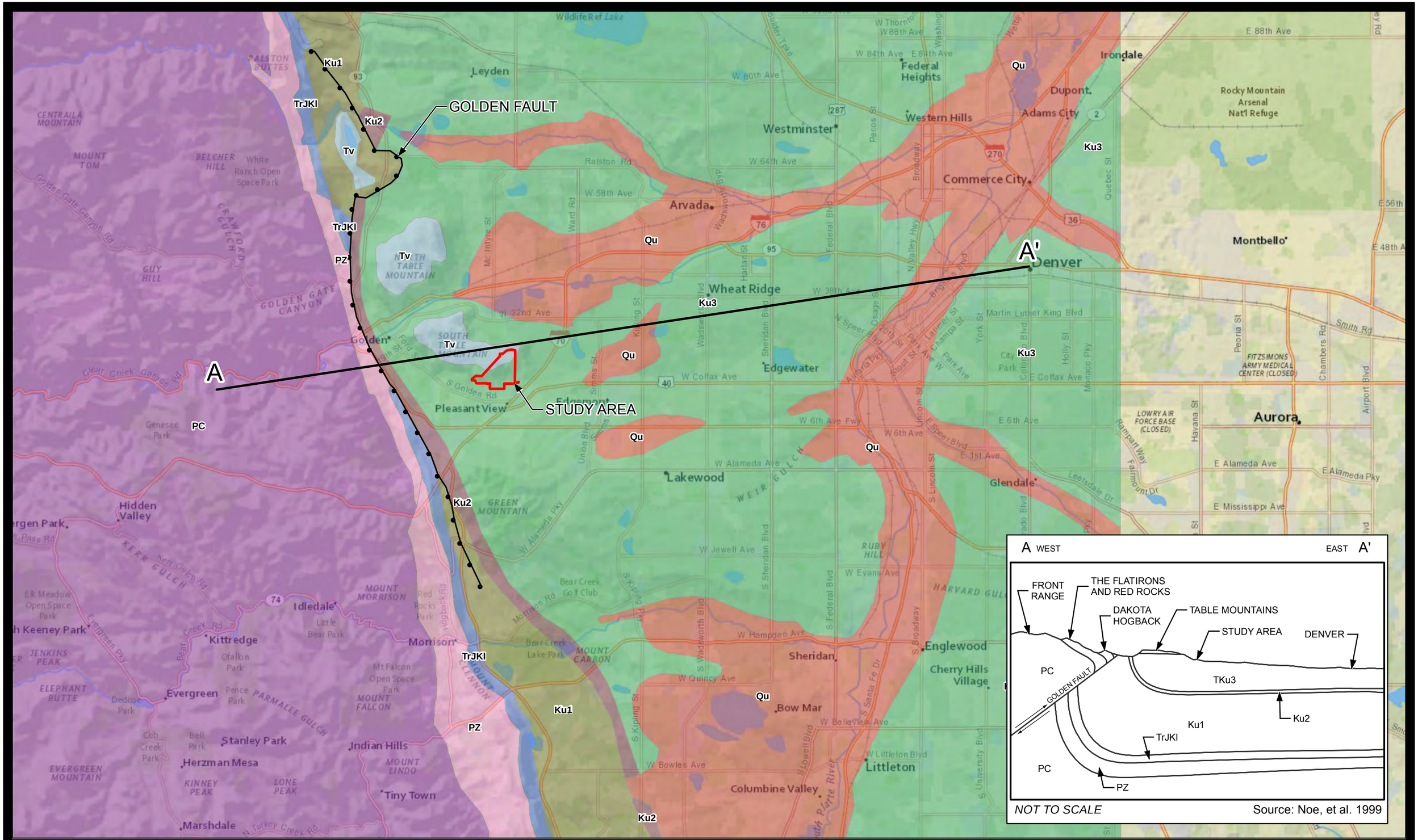


Figure 4-2 - Geologic Map & Cross Section of Project Area & Vicinity

Data Sources: USGS, NREL, AECOM, ESRI

parking lots, utilities, and structures. The risks presented by these hazards have been mitigated properly as part of STM campus development using subsurface information gathered prior to design. This information and new information gathered during the final design process should be sufficient to address geological risks and hazards.

Seismicity and related hazards do not appear to pose a strong risk given the expected low PGA at the STM campus from a large earthquake event. However, infrastructure should be built in accordance with applicable seismic design standards for the area and an eye toward avoidance of secondary hazards.

Mineral Resources

Extraction of minerals and building materials within the STM campus is not proposed and is not likely to occur in the future by DOE/NREL or others because no commercially extractable minerals are known to be present on, or beneath the STM campus. For similar reasons, the Proposed Action components would not preclude access to any viable mineral resources.

The State of Colorado retains mineral rights to the South Table Mountain campus subordinate to DOE's uses of the property. Any mineral extraction or exploration on the property would require DOE's approval.

If oil or gas were believed to be in the subsurface, the use of directional or horizontal drilling could preclude the need to drill on-site. However, given the density of urban development in the area, oil and gas drilling is a remote possibility given the setbacks and other requirements administered by the Colorado Oil and Gas Conservation Commission (COGCC) rules.

Paleontological Resources

Ground disturbing activities involving the Denver Formation, such as earthmoving and excavation, present the potential to encounter and disturb fossil resources, resulting in the destruction and/or loss of scientifically important fossil resources. The potential for adverse effects on fossil resources is unlikely given conditions on the STM campus.

No Action Alternative

The No Action Alternative would continue to pose low/acceptable risks from geologic hazards. No new risks to human safety or infrastructure would be expected. No impacts on mineral resources, resource extraction, or fossils would be expected.

4.8 Soils

4.8.1 Affected Environment

Baseline information used to characterize soils was derived from the Soil Survey Geographic (SSURGO) database review and analyses. SSURGO is the most detailed level of soil mapping done by the NRCS. The SSURGO database for Jefferson County, Colorado (NRCS 2013) is the source for the soils data in this section. The SSURGO information presented herein is generally consistent with soils information used by NREL for previous planning and environmental analyses.

This section provides context for the evaluation of potential project-induced consequences to soil associations occurring on the STM campus. The DWOP is not considered in this section because there are no proposed actions that would affect soil resources at that location.

Regional Overview

Two major subregions of soil resources are found within the STM campus. Generally, from west to east, these include the following (NRCS 2006):

- Southern Rocky Mountain Foothills; and
- Central High Plains in northeastern Colorado.

The Southern Rocky Mountain Foothills subregion is located in the west-central part of the STM campus. In this subregion, the higher grasslands and woodlands of the Colorado Piedmont extend eastward toward the Great Plains. The topography ranges from rolling to steep, and slopes commonly are strongly dissected. Deep, loamy soils dominate the landscape; these typically have thick, dark, organically enriched topsoil layers. The Central High Plains subregion is located in the eastern part of the STM campus and extends from central Arapahoe County into Weld, Morgan, and Washington counties to the north and east within Colorado. This subregion also extends southeastward into Cheyenne and Kiowa counties, Colorado. The topography is gently undulating or rolling, and the plains are somewhat dissected by streams. Steep slopes may border some of the major watercourses and remnant mesas or buttes. Hilly topography also occurs in dune fields along some of the valleys. The climate is semi-arid. Most of the soils are deep, with thin and/or light-colored topsoil layers. They generally have loamy or clayey textures with calcium carbonate accumulations. Water erosion may be severe on steep or long unbroken slopes. In some areas, deep sandy soils that are prone to wind erosion occur.

Soil Characteristics

The STM campus and DWOP area have been previously disturbed by development and construction activities. Some areas of native vegetation and soils exist. In portions of the STM campus, the soil profile has been redistributed by construction activities. A variety of soils occur across the area. This soil variability stems primarily from a variety of parent materials as influenced by topography, aspect, elevation, vegetation, and differential rates of mineral weathering. The soils were formed from alluvium, residuum, and colluvium parent materials. Soil depths range from shallow to very deep with slopes ranging from 1 to 70 percent. The pH of soils across the area ranges from neutral (7.2) to moderately alkaline (7.9). Sodium and salinity levels are low. The occurrence of soils within the area is illustrated in **Figure 4-3**.

Table 4-8 summarizes some important soil characteristics to be considered when evaluating the effects of surface-disturbing activities. Soil characteristics such as susceptibility to erosion and the potential for revegetation are important to consider when planning for construction activities and stabilization of disturbed areas. These hazards or limitations for use are a function of many physical and chemical characteristics of each soil, in combination with the climate and vegetation.

Water erosion is the detachment and movement of soil by water. Natural erosion rates depend on inherent soil properties, slope, soil cover, and climate. Approximately 29 percent of the soils within the STM campus are highly erodible to water. Wind erosion is the physical wearing of the earth's surface by wind. Wind erosion removes and redistributes soil. No highly wind erodible soils occur in the STM campus.

Soil limitations within the STM campus related to buildings with and without basements include shrink-swell potential, depth to bedrock, large stones, and steepness. In total, approximately 98 percent of the STM campus has at least one soil limitation for construction of buildings with or without basements.

Soils with limed revegetation potential have chemical characteristics such as high salts, sodium, or pH that may limit plant growth. None of the soils in the STM campus have limitations that would affect revegetation potential.

Prime farmland is land that has the best combination of physical and chemical characteristics for producing crops and is available for these uses. No prime farmland occurs within the STM campus.

Soil Map Units

- 27 - Denver clay loam, 5 to 9 percent slopes
- 28 - Denver cobbly clay loam, 5 to 9 percent slopes
- 35 - Denver-Urban land complex, 2 to 5 percent slopes
- 73 - Lavina loam, very rocky, 0 to 5 percent slopes
- 81 - Leyden-Primen-Standley extremely stony clay loams, 30 to 70 percent slopes
- 82 - Leyden-Standley-Primen cobbly clay loams, 9 to 15 percent slopes
- 148 - Standley-Leyden-Primen very stony clay loams, 15 to 30 percent slopes

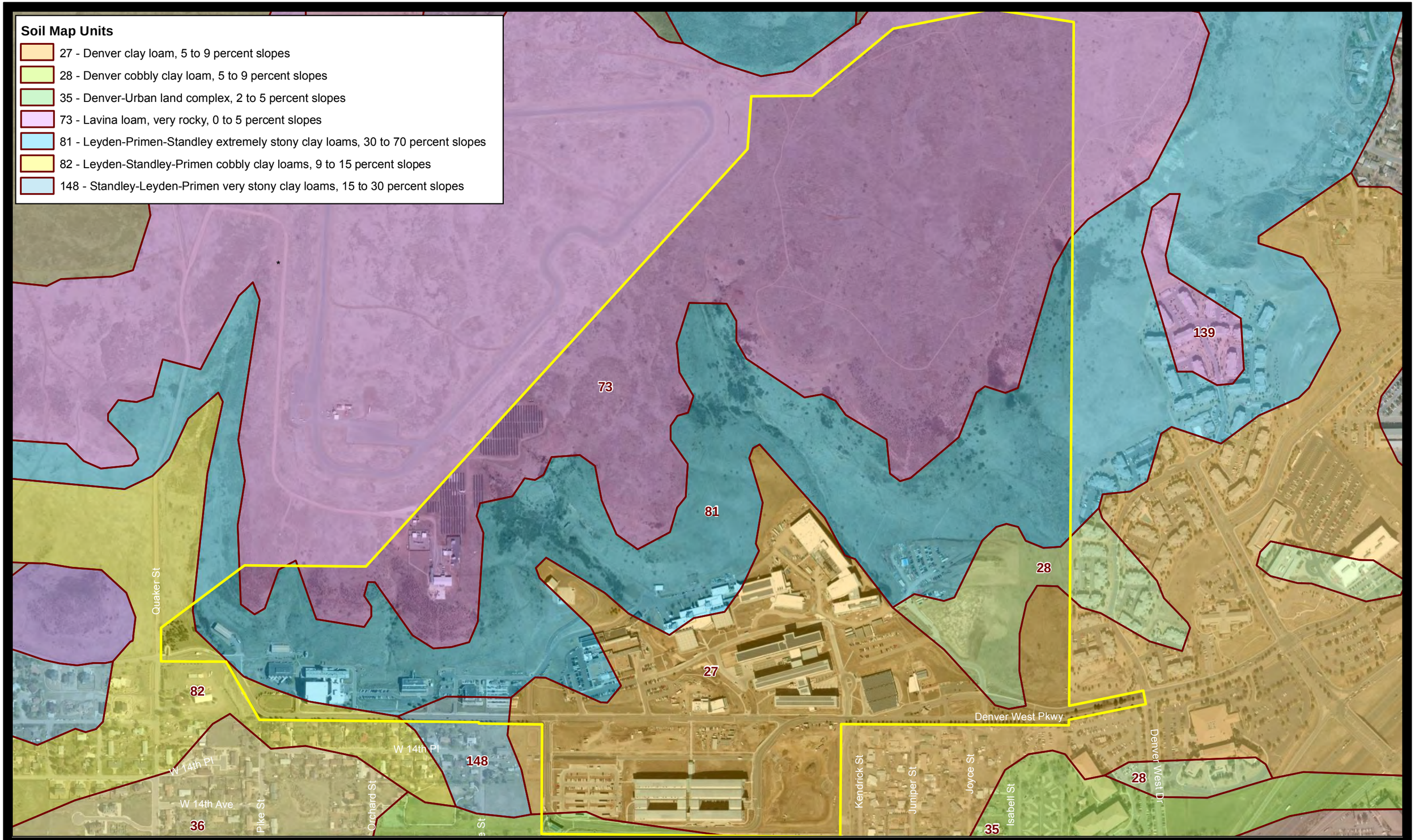


Figure 4-3 - South Table Mountain SSURGO Soil Map Units

Legend

Campus Boundary

Soil Map Unit Boundary

0 400 800

Feet

N W E S

Data Sources: NRCS, NREL, AECOM, ESRI

Table 4-8 Soil Characteristics in the Area

	Map Unit Name with Component	Map Unit Acres	Geomorphic Description	Wind Erosion	Water Erosion	LRP[1]	Compaction Prone	Shallow Bedrock[2]	Limiting Factors for Buildings Without Basements	Limiting Factors for Buildings with Basements	Limiting Factors[3]
27	Denver clay loam, 5 to 9 percent slopes	74.4	Hills, terraces, alluvial fans	Not Severe	Slight	No	Yes	No	Very Limited	Very Limited	SS
28	Denver cobbly clay loam, 5 to 9 percent slopes	11.1	Hills, terraces, alluvial fans	Not Severe	Slight	No	Yes	No	Very Limited	Somewhat Limited	SS
35	Denver-Urban land complex, 2 to 5 percent slopes	1.2	Terraces, mesas, alluvial fans	Not Severe	Slight	No	Yes	No	Very Limited	Very Limited	SS
73	Lavina loam, very rocky, 0 to 5 percent slopes	136.7	Mesas	Not Severe	Slight	No	Yes	Yes	Very Limited	Very Limited	SS, R
81	Leyden-Primen-Standley extremely stony clay loams, 30 to 70 percent slopes	95.3	Hills	Not Severe	Severe	No	Yes	Yes	Very Limited	Very Limited	SS, R, L. S
82	Leyden-Standley-Primen cobbly clay loams, 9 to 15 percent slopes	4.0	Alluvial fans, hills	Not Severe	Slight	No	Yes	Yes	Somewhat Limited	Somewhat Limited	S, SS, R
148	Standley-Leyden-Primen very stony clay loams, 15 to 30 percent slopes	1.8	hills	Not Severe	Moderate	No	No	No	Very Limited	Very Limited	S, SS, R, L

[1] LRP = Low Reclamation Potential is characterized by soils with saline or sodic properties and/or strongly alkaline or acidic pH.

[2] Shallow bedrock = Soils with lithic (hard) or paralithic (soft) bedrock above 60 inches.

[3] Limiting factors: SS = shrink-swell, S = slope, R = shallow bedrock, L = large stones.

Source: NRCS 2013.

With the exception of the Zone 2 Conservation Area, much of the area has been disturbed by previous construction and development activities.

4.8.2 Environmental Consequences

Proposed Action

Impacts to soil resources would occur in association with ground disturbing activities during and after construction of new buildings, modification of existing buildings, and excavation associated with infrastructure and utility upgrades. Assessments of soil impacts were based on understanding the range of physical and chemical soil characteristics provided in **Table 4-8**. Approximately 21.5 acres of soils would be disturbed by the Proposed Action, as shown in **Figure 4-4**.

Impacts to previously disturbed soils would occur in Zones 1, 3, 4, 5, and 6. No development that would impact soils is proposed in the Zone 2 Conservation Area or in Zone 7.

The most notable impacts to soils would occur in association with the construction of new buildings and parking lots or facilities. Zones 3, 4, 5, and 6 would be the most likely areas to have some form of building or parking development within their boundaries. The soils in these zones have one or more limitations related to building development. All of the aforementioned zones have soils that are prone to expansion (shrink-swell). The soils in Zones 4 and 5 also have limitations related to slope, shallow bedrock, and large stones. With proper engineering, potential risks and hazards associated with these limitations can be mitigated. Grading and leveling would be required to construct or expand existing buildings with the greatest level of effort required on more steeply sloping areas. During construction, the soil profiles would be mixed with a corresponding loss of soil structure. The potential for erosion would increase through the loss of vegetation cover and soil structure as compared to an undisturbed state. A permanent loss of soil productivity would be expected where new buildings are constructed due to the permanent loss of functioning soils and vegetative cover. These impacts would begin immediately as the soils are subjected to grading and construction activities and be long-term in nature.

Soils would be impacted to varying degrees as a result of proposed road construction and utility upgrades. Where surface disturbance is kept within existing roadways, additional soil impacts would be minimal. For road development, where the topography is relatively flat and grading occurs, it would be limited to the upper subsurface soil horizons. As a result, subsurface soils would not be subject to profile mixing. Where cut and fill slopes occur, the soil profiles would be mixed with a corresponding loss of soil structure. Soil compaction would impact the upper profile subsoils immediately beneath the road surface, but also would impact subsurface soils at a greater depth if fine textured soils are present. Soil compaction would result in a corresponding loss of infiltration, permeability, and soil aeration. Runoff and soil erosion may increase as a result of compaction. Increased erosion can lead to a decrease in soil fertility and an increase in sedimentation. The duration and intensity of these impacts would vary according to the type of construction activity to be completed and the inherent characteristics of the soils to be impacted. A long-term to permanent loss of soil quality and productivity would be anticipated where asphalt or concrete roads are constructed.

The type, intensity, and duration of the impacts associated with the installation of utility lines (electric, water, and pipelines) would be variable, based on construction phasing. Direct effects would be short-term. Profile mixing and soil structure disruption would occur with trenching and backfilling. Erosion potential would increase while soils are loose with no protective cover. The linear nature of the disturbances, coupled with the presence of adjacent vegetation and NREL revegetation commitments, would serve to decrease wind and water erosion potential.

Long-term to permanent impacts to soils associated with structures and parking lots needed for operations would occur on less than 21.5 acres of soil disturbance. Environmental protection measures as listed in Section 2.2 would help to reduce the impacts to adjacent soils and maintain soil productivity

PROPOSED ACTION	
A	S&TF PV Research Modifications
B	FTLB - Thermochemical Biofuels Research Facility (TBRF)
C	FTLB - Workstation and Lab Space Addition
D	FTLB - Expansion for Algae and Other Research Organisms for Fuel
E	Outdoor Test Pad (Zones 1, 3, 4, 5 & 6) - Not Mapped
F	Internal Reconfiguration of the Thermal Test Facility
G	ESIF Security Enhancements
H	Research Support Facility III
I	ReFUEL Laboratory Relocation
J	Renewable Energy Vehicle Systems (REVS) Facility
K	Waste Handling Facility Expansion
L	NREL SITE Operations Support Space
M	Metrology Laboratory Relocation (Zones 4 or 6) - Not Mapped in Zone 4
N	High Flux Furnace Upgrade
O	TriGEN Central Plant
P	On Campus Renewable Energy Deployment (Zones 3, 4, 5 & 6)*
Q	Additional Infrastructure at the East Campus
R	On-Site Vehicle Fuel Storage**

*Proposed action P calls for PV to be added in multiple locations throughout the STM campus.

**Proposed action R calls for storage tanks to be added in existing parking lots in Zone 4. (Two examples are mapped.)

Soil Map Units

- 27 - Denver clay loam, 5 to 9 percent slopes
- 28 - Denver cobbly clay loam, 5 to 9 percent slopes
- 35 - Denver-Urban land complex, 2 to 5 percent slopes
- 73 - Lavina loam, very rocky, 0 to 5 percent slopes
- 81 - Leyden-Primen-Standley extremely stony clay loams, 30 to 70 percent slopes
- 82 - Leyden-Standley-Primen cobbly clay loams, 9 to 15 percent slopes
- 148 - Standley-Leyden-Primen very stony clay loams, 15 to 30 percent slopes

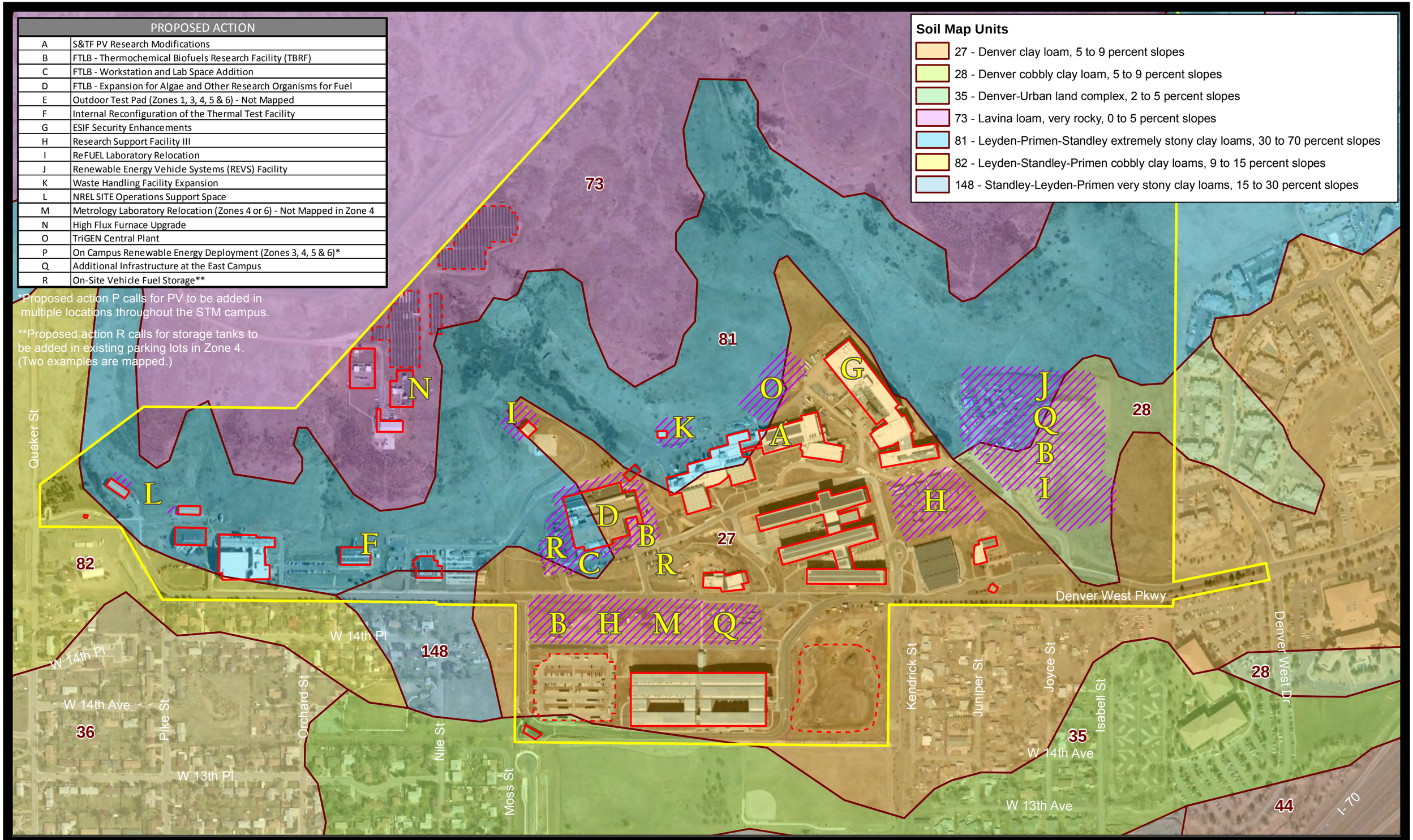


Figure 4-4 - South Table Mountain
Proposed Action Components & Soil Types

Legend

- Existing Building
- Existing Feature
- Proposed Construction
- Campus Boundary
- Soil Map Unit Boundary
- A-R Proposed Action Approximate Location

0 400 800 Feet

N W E S

Data Sources: NRCS, NREL, AECOM, ESRI

potential to the degree possible. During construction, NREL would comply with all state and federal storm water requirements and BMPs to reduce erosion and sedimentation. During operations, exposed soils not needed for operations at these sites would be revegetated to reduce erosion and sedimentation potential. These actions would reduce the intensity of the impacts to soils, as well as the time it would take to return the disturbed soils to a stable and productive state.

NREL's stormwater management procedure requires disturbed soils to be permanently stabilized following construction. Stabilization practices are intended to keep disturbed soil in place, and can include such practices as temporary vegetation, permanent vegetation, mulching, geotextiles, sod stabilization, vegetative buffer strips, protection of trees, and preservation of mature vegetation. Non-vegetated cover such as gravel or pavement, also are accepted stabilization methods. As much of the disturbed area as possible would be revegetated upon completion of rough grading. Topsoil would be stockpiled during initial excavation and replaced and revegetated as areas of the site construction are completed. Revegetation would begin within 14 days of completion of work in the area, or as soon as weather conditions allow.

Erosion and sediment controls would be implemented by NREL during construction according to the storm water and other plans developed by construction contractors and reviewed by NREL staff. Regular inspections by contractors and staff would be conducted to verify that controls are functioning properly. Any repairs or modifications to the plans are documented on an inspection report; prompt actions would be required to correct any noncompliant conditions. Management of campus areas outside active construction sites would minimize erosion, support infiltration of rain water and snowmelt, and prevent sedimentation. Vegetation and landscaping would be maintained to prevent erosion.

No Action Alternative

Under the No Action Alternative, no new construction would occur beyond what has been previously approved. Soil quality, productivity, and erosion rates associated with operation and maintenance would remain essentially static.

4.9 Vegetation

4.9.1 Affected Environment

General Vegetation

The STM Campus and the DWOP are located at the interface between the Great Plains-Palouse Dry Steppe Province, and the Southern Rocky Mountain Steppe – Open Woodlands – Coniferous Forest-Alpine Meadow Province. Vegetation types, acreage calculations, and community characterizations were compiled based on field surveys conducted in 2002 and 2010-2011 (NREL 2011c, 2008, 2003, 2002). The study area for vegetation resources is the boundary of the STM campus. The DWOP is not considered in this section because there are no proposed actions that would affect vegetation resources at that location.

Seven vegetation and land use types occur in the STM campus:

- Short Grass;
- Developed Space;
- Mixed Grass;
- Short Shrub;
- Tall Shrub;

- Ravine Shrub; and
- Wetland.

Distribution of vegetation types is influenced by variations in landscape position, soil type, moisture, elevation, aspect, and previous disturbance. With the exception of Zone 2, which has been designated a conservation easement, much of the STM campus has been disturbed by previous construction and development activities.

Descriptions of the vegetation types are provided in the following text. Species nomenclature is consistent with the U.S. Department of Agriculture-Natural Resources Conservation Service Plants Database (USDA-NRCS 2013).

Figure 4-5 illustrates the vegetation types present within the STM campus. **Table 4-9** summarizes acreages for each vegetation type within the STM campus.

Grassland is the dominant vegetation type at the STM campus. Noxious weeds are present throughout the area. Historically crested wheatgrass and smooth brome have been used in reclamation efforts. Native grass seeding mixes are now used for reclamation.

Developed Areas

Developed land covers 33 percent of the STM campus. Developed areas have been constructed over a 30-year period and include research and development facilities, office space, support buildings, and testing areas. On the perimeter of the buildings, roads, parking lots, and soil spoil piles, are areas that have been revegetated and support a mix of native grassland plants and planted ornamental revegetation species. Native and introduced weeds also are present.

Short Grass

Short grass vegetation covers 34 percent of the STM campus. This vegetation type is found on the mesa top of South Table Mountain. Dominant vegetation is blue grama (*Bouteloua gracilis*) and cheatgrass (*Bromus tectorum*). Associated species include yucca (*Yucca glauca*), prickly pear (*Optunia* spp.), and pincushion cacti (*Coryphantha* spp.). Noxious weeds and invasive species are common throughout the short grass vegetation community, including diffuse knapweed (*Centaurea diffusa*), Dalmatian toadflax (*Linaria genistifolia* subsp. Dalmatica), and alyssum (*Alyssum parviflorum*). Small hills that are well-drained often support thick stands of needle-and-thread grass (*Hesperostipa comata*) and yucca. Along the rimrock areas, and infrequently in the shortgrass, are short shrubs, such as rubber rabbitbrush (*Ericameria nauseosus*), chokecherry (*Prunus virginiana* var. *virginiana*), and skunkbush sumac (*Rhus aromatic* spp. *trilobata*). Several large hackberry trees (*Celtis laevigata* var. *reticulate*) are at the very edge of the mesa top.

Table 4-9 Vegetation and Land Use Cover Types within the STM Campus

Vegetation Type	Acres	Percent of the STM Campus
Developed Areas[1]	109	33
Grasslands		
Short Grass	110	34
Mixed Grass	73	23

Table 4-9 Vegetation and Land Use Cover Types within the STM Campus

Vegetation Type	Acres	Percent of the STM Campus
Shrublands		
Short Shrub	15	5
Tall Shrub	15	5
Ravine Shrub	3	1
Wetland	<1	<1
Total	**326**	**100**

[1] Includes development and revegetated areas that support a mix of native grassland plants and planted ornamental revegetation species. Native and introduced weeds also are present.

Source: NREL 2011c.

Mixed Grass

Mixed-grass vegetation covers 23 percent of the STM campus. This vegetation type is found on the side-slopes and at the toe of South Table Mountain. The mixed grass area grades into the shrublands and disturbed areas. Dominant vegetation includes needle-and-thread grass and western wheatgrass (*Pascopyrum smithii*). Associated species include big bluestem (*Andropogon gerardii*), side-oats grama (*Bouteloua curtipendula*), three-awn (*Aristida purpurea*), green needle grass (*Nassella viridula*), and various forb species. In two patches within the mixed grass vegetation community are areas dominated by mat muhly (*Muhlenbergia richardsonis*). It appears that the subsurface water is closer to the surface in these patches. One patch is located on a southern-facing slope near the eastern property boundary;

Grasslands

Shrublands

Conservation Easement Vegetation

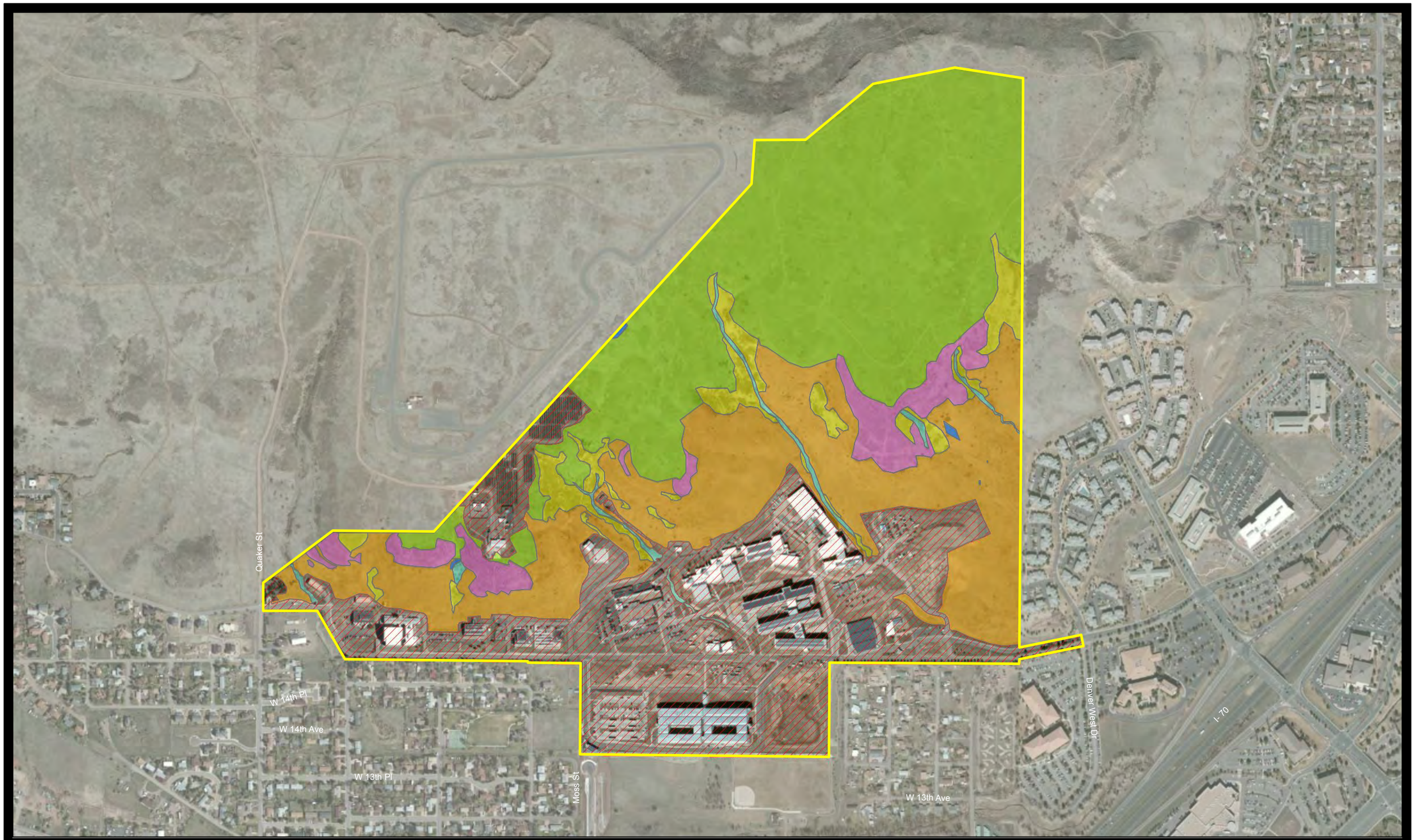


Figure 4-5 - Vegetation Types Within Study Area

Data Sources: NREL, AECOM, ESRI

the second patch is located near the southwestern-facing slope of the ravine north of the Education Center. This second patch also contains poison ivy (*Toxicodendron rydbergii*), plains cottonwood (*Populus deltoides*), skunkbush sumac, chokecherry, and snowberry (*Symphoricarpos occidentalis*).

Short Shrub

Short shrub vegetation covers 5 percent of the STM campus. This vegetation type is located on elevated flat areas within grasslands, which appear to have experienced some surficial disturbance in the past, and on the outer slopes of the ravines. Dominant species include rubber rabbitbrush or skunkbush sumac (*Rhus aromatic* spp. *trilobata*). Skunkbush sumac is more dominant in areas along the upper slopes below the mesa rim, while rubber rabbitbrush is dominant in the elevated flat areas. The understory is sparse and composed of grasses and forbs. Common understory species include cheatgrass, needle-and-thread grass, yucca, and cacti.

Tall Shrub

Tall shrub vegetation covers 5 percent of the STM campus. This vegetation type is located on the rim of the mesa, usually where volcanic cap rock is exposed. The dominant species is mountain mahogany (*Cercocarpus montanus*). The understory is sparse, with a large cover of bare soil. Common understory species include cheatgrass, needle-and-thread grass, yucca, and cacti.

Ravine Shrub

Ravine shrub vegetation covers 1 percent of the STM campus within swales and drainages on the upper to mid-slopes of South Table Mountain. These shrub communities are limited to the lower sides and bottom of the drainages. Ravine shrublands require a moderate amount of moisture and contain a higher diversity of species than the other shrub communities. Dominant species include chokecherry (*Prunus* virginiana var. *virginiana*), wild plum (*Prunus americana*), skunkbush sumac, and Wood's rose (*Rosa woodsii*). These shrubs are often in dense thickets. Cottonwoods (*Populus deltoides*), and peach-leaved willow trees (*Salix amygdaloides*) are common in the upper portions of the drainages. The herbaceous component of the drainages is diverse.

Wetlands and Riparian Habitat

Wetlands and riparian areas comprise a small percentage of the lands throughout the West, but their importance to the surrounding ecosystems and associated species is disproportionately great. Most wildlife species use riparian areas at some point in their life cycles (e.g., many migratory birds during breeding and migration seasons), and some depend almost entirely on these systems (e.g., amphibians). Wetlands and riparian areas are often rich in vegetation diversity and structure, providing food, water, shade, and cover to wildlife and livestock, in addition to acting as water purifiers, supplying groundwater recharge, and aiding in flood control.

According to the USACE's 1987 Wetland Delineation Manual, a "three-parameter" approach is required for delineating USACE-defined wetlands (USACE 1987), where areas are identified as wetlands if they exhibit hydrophytic vegetation, hydric soils, and wetland hydrology.

Within the STM campus, there are five small communities that support wetland vegetation; however, a Jurisdictional Determination by the USACE, determined that none of these small wetlands are jurisdictional and subject to the Section 404 regulations of the CWA (USACE 2009). The wetland community type covers less than 1 percent of the STM campus. The soil and hydrology of these wetlands have not been assessed. The area of on-site wetlands, from all five sites combined, is less than 0.5 acre. The five areas are located along shallow swales, in linear depressions and are associated with seeps. Common species include sedges (*Carex* spp.), rushes (*Juncus* spp.), bulrushes (*Schoenoplectus* sp.), cattails (*Typha* spp.), and peach-leaf willow. Canada thistle was noted within the seep wetland communities.

Noxious Weeds and Invasive Species

Noxious weed species can degrade and modify native communities, reduce resources for native species, and adversely affect native pollinators.

The Federal Plant Protection Act of 2000 (formerly the Noxious Weed Act of 1974) and EO 13112 of February 3, 1999, require cooperation with state, local, and other federal agencies in the application and enforcement of all laws and regulations relating to the management and control of noxious weeds. Noxious weeds in Colorado are non-native plant species that have been designated by the Colorado Department of Agriculture (CDA) due to their invasiveness, aggressiveness, or the rate at which they spread and adversely affect desired native plants or agricultural crops and rangelands.

The Colorado Noxious Weed Act (CDA 2013) states that noxious weed management is the responsibility of local governing agencies including incorporated municipalities, counties, and state and federal agencies. The CDA manages and regulates noxious and invasive species through the Colorado Noxious Weed Act, which classifies noxious weeds into three lists: A, B, and C (§ 35 5.5-101 through 119, Colorado Revised Statute [CRS] [2003]). Each list has specific control requirements, with the most stringent requirements for those species found on List A. List A species are designated for eradication. List B includes species for which state noxious weed management plans would be developed to stop the continued spread of these species. List C includes species for which state noxious weed management plans would be developed to support the efforts of local governing bodies to facilitate more effective integrated weed management on private and public lands (CDA 2013). In addition, the Act states that each county in the state shall adopt a noxious weed management plan for all the unincorporated lands within the county.

The Jefferson County Noxious Weed List defines noxious weeds for the county in three lists – A, B, and C (Jefferson County, Colorado 2013b). List A weeds are identified by the state as uncommon and are required to be eradicated. Eradication means the complete elimination of the plant prior to reproduction. List B are weeds identified as having varying populations throughout the state. Eradication zones may be established in areas where the weed is uncommon. In areas where the weed is more common, control and population containment is required. List C weeds are common throughout the state that property owners are encouraged to control.

Field surveys for noxious weeds were conducted on the STM campus in June 2010 (NREL 2011c). Common state and county listed species were found on the STM campus, including Canada thistle, cheatgrass, common teasel, narrow-leaved Dalmatian toadflax, diffuse knapweed, field bindweed, hoary cress, houndstongue, musk thistle, myrtle spurge, Russian olive, and Scotch thistle. **Table 4-10** provides a comprehensive list of the noxious and invasive species regulated by the CDA and Jefferson County, and summarizes if the species was observed within the STM campus during field surveys.

Myrtle spurge is a List A state and county listed species that requires eradication. NREL has treated the two locations where myrtle spurge occurs and anticipates that this small population should be eradicated within a few years. Additionally, NREL has implemented a noxious weed management plan to control invasive species on the STM campus. The weed management plan is an integrated approach that uses various control methods, periodic mapping, and periodic assessments of control effectiveness. The various control methods include mechanical, cultural, prevention, and herbicide treatments.

Acreages for each observed species are based on the observed cover during the June 2010 surveys. Cheatgrass and diffuse knapweed were found throughout the STM campus, and as such, acres were not provided for these species during the June 2010 surveys.

Table 4-10 State and County Designated Noxious Weeds Observed within the STM Campus

Common Name	Scientific Name	Colorado Noxious Weed List[1]	Jefferson County Weed List[2]	Observed within the STM Campus (acres)
Canada thistle	*Cirsium arvense*	B	B – CR	2.8
Common teasel	*Dipsacus fullonum*	B	B - CR	0.06
Dalmatian toadflax, narrow-leaved	*Linaria genistifolia*	B		1.3
Diffuse knapweed	*Centaurea diffusa*	B	B – ER/ B – CR	1.1
Field bindweed	*Convolvulus arvensis*	C	C	0.4
Giant reed	*Arundo donax*	--	A	
Hoary cress	*Cardaria draba/C. pubescens*	B	B – CR	0.1
Houndstongue	*Cynoglossum officinale*	B	B – CR	0.001
Musk thistle	*Carduus nutans*	B	B – CR	2.1
Myrtle spurge	*Euphorbia myrsinites*	A	A	0.1
Russian olive	*Elaeagnus angustifolia*	B	B – CR	0.04
Scotch thistle	*Onopordum acanthium*	B	B – CR	0.03

[1] The following weeds are officially designated by the Commissioner for the State of Colorado. Category A species are designated for eradication. Category B species are species for which the Commissioner, in consultation with the State Noxious Weed Advisory Committee, local governments, and other interested parties, develops and implements state noxious weed management plans designed to stop the continued spread of these species. Category C species are species for which the Commissioner, in consultation with the State Noxious Weed Advisory Committee, local governments, and other interested parties, will develop and implement state noxious weed management 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.

[2] The following weeds are officially designated by Jefferson County. List A – weeds identified by the state as uncommon and are required to be eradicated. Eradication means the complete elimination of the plant prior to reproduction. List B – weeds identified as having varying populations throughout the state. Eradication zones may be established in areas where the weed is uncommon (B – ER). In areas where the weed is more common, control and population containment is required (B – CR). List C - weeds that are common throughout the state that property owners are encouraged to control.

Special Status Species

Special status plant species are those species for which state or federal agencies afford an additional level of protection by law, regulation, or policy. Included in this category are federally listed and federally proposed species that are protected under the Endangered Species Act (ESA), or are considered as candidates for such listing by the U.S. Fish and Wildlife Service (USFWS), species that are state-listed as threatened or endangered, and U.S. Forest Service sensitive species.

The USFWS lists species in accordance with the ESA as threatened, endangered, or a candidate for listing that could potentially occur in Jefferson County. The Ute ladies'-tresses orchid and the Colorado butterfly plant are known to occur in Jefferson County. NREL periodically conducts surveys for rare plants focusing on species that are federally protected, state protected, or otherwise considered

imperiled or declining. In 2010, surveys at the STM campus were conducted and no protected species were found.

Vegetation Management

NREL's approach to vegetation management includes:

- Conserving existing ecosystems in their natural state as much as possible;
- Striving to replace disturbed vegetation with native species or with adapted, but non-invasive species when necessary;
- Implementing a program of weed management to prevent the spread of noxious weeds and implement measures to control these species;
- Implementing a sustainable landscape design and maintenance program; and
- Reseeding using pre-approved grass and forb seed mixes.

A portion of the STM campus (177 acres) is in the Zone 2 Conservation Area. The purpose of conserving this area is to avoid development, thereby protecting the site's key natural resources.

4.9.2 Environmental Consequences

Proposed Action

Minor vegetation effects would occur at the STM campus. No vegetation effects would occur at DWOP because no physical improvements are proposed at that location.

General Vegetation

Project-related surface disturbing activities include construction of new buildings, expansion of existing buildings, parking facilities, and additional infrastructure associated with new and expanded buildings and facilities. Acres of potential vegetation disturbance are listed in **Table 4-11**.

Table 4-11 Vegetation and Land Use Cover Types within the Study Area

Vegetation Type	Acres	Percent of STM Campus	Acres Disrupted[1]
Developed Areas	109	33	**16.7**[2]
Grasslands			
Short Grass	110	34	**0**
Mixed Grass	73	23	**4.7**
Shrublands			
Short Shrub	15	5	**0**
Tall Shrub	15	5	**0**
Ravine Shrub	3	1	**0**
Wetland	<1	<1	**0**
Total	**326**	**100**	**21.5**

[1] Construction disturbance footprint does not reflect restoration/revegetation.

[2] Includes a mix of outdoor developed surfaces and revegetated areas that support a mix of native grassland plants and planted ornamental revegetation species. Native and introduced weeds also are present.

As shown in **Table 4-11**, approximately 21.5 acres would be disturbed over the 10-year-period of new development under worst case conditions. The disturbance would occur entirely in the grassland (mixed grass) and developed area cover types. Development would occur primarily in Zones 4, 5, and 6. No development is proposed for Zones 2 or 7. The majority of temporary and permanent impacts would be associated with the construction of new buildings, expansion of existing buildings, and the construction of new parking facilities.

The vegetation impacts would include the permanent removal of vegetation, temporary disruption of vegetated areas, and disruption of soils during construction. NREL would revegetate disturbed areas that would support vegetation after construction is completed.

Reclamation would include re-seeding with a seed mix composed of grasses and forbs native to the local area. A list of flowering herbs, forbs, shrubs, and trees has been identified for use on the STM campus (NREL 2013). NREL would implement sustainable landscape management practices to ensure the success of revegetated areas (NREL 2013). Measures would include seeding during appropriate weather, taking appropriate measures to reduce dust, noise, and damage; decompacting any construction traffic or staging areas prior to top-soiling by tilling to 12 inches; applying *Mycorrhizal inoculum* and fertilizer as appropriate; and raking and rolling the surface prior to drilling seeds. Seed mixes are designated for South Table Mountain by land use and/or vegetation type. With reclamation efforts, the effects on vegetation would be considered minor and some portion of the disturbed area could be restored.

Wetlands

None of the Proposed Action components would directly or indirectly impact wetlands. NREL's erosion and sedimentation measures, implemented as part of their Environmental Management Activities would prevent inadvertent deposition of sediment (fill) into drainage courses.

Noxious Weeds and Invasive Plants

Surface disturbance resulting in the removal of native vegetation cover may allow for the spread of noxious weeds and invasive plant species. Implementation of NREL's environmental management activities, the use of the native seed mixes, and the weed management plan for the STM campus would minimize this impact.

Special Status Species

Under the ESA, federal agencies are required to provide documentation that ensures agency actions will not adversely affect the existence of any federally listed threatened or endangered species. The ESA requires that all federal agencies avoid "taking" threatened or endangered species, which includes jeopardizing threatened or endangered species habitat. Section 7 of the ESA establishes a consultation process with USFWS that ends with concurrence on a determination of the risk of jeopardy from a federal agency project. Consultation letters between DOE and USFWS are provided in **Appendix E**.

On May 30, 2014, DOE initiated informal consultation with the USFWS, Region 6 Mountain-Prairie Region, for compliance with Section 7 of the ESA regarding special status plants and wildlife species specific to those species with potential to occur in Jefferson County, Colorado. These special status plant species are the Ute ladies'-tresses orchid and the Colorado butterfly plant. No impacts to these special status plant species would be expected on or near the STM campus from the Proposed Action components and USFWS concurred with DOE's no effect determination on June 24, 2014.

There is potential for off-site effects due to Platte River depletions given the projected STM campus future water use (see Section 4.6). Water use at the South Table Mountain campus was determined to be greater than the 0.1 acre-feet per year de minimus quantity for consultation. Therefore, on May 21, 2014, DOE initiated formal consultation with the USFWS and submitted a streamlined biological

assessment addressing the effects of Colorado water depletions on Platte River species in Nebraska. Colorado water flow depletion presents the potential to impact the western prairie fringed orchid (*Platanthera praeclara*) in the central and lower Platte River in Nebraska. The USFWS issued a biological opinion to DOE on June 24, 2014. The USFWS determined that the flow-related adverse effects of the Proposed Action are consistent with those evaluated in the Tier 1 programmatic biological opinion for the western prairie fringed orchid and that these effects on flows are being addressed in conformance with the Colorado Plan for Future Depletions of the Platte River Recovery Implementation Program.

No Action Alternative

Under the No Action Alternative, no new construction or changes in operations or workforce would be made to the STM campus beyond what has been previously approved. Therefore, there would be no additional impacts to vegetation, wetlands, special status species, or the spread of invasive or noxious weed species.

4.10 Wildlife Resources

4.10.1 Affected Environment

Wildlife resources are defined as individuals and populations of all native free-ranging species and their required habitats. The study area for wildlife resources is the boundary of the STM campus. The DWOP is not considered in this section because there are no proposed actions that would affect wildlife resources at that location.

Habitat Types and Species Diversity

As discussed in Section 4.9, Vegetation Resources, the STM campus consists of three habitat types: grasslands, shrublands, and wetlands. Baseline descriptions of both resident and migratory wildlife include species that have either been documented within the STM campus or those that may occur in the region based on habitat associations. Wildlife species that may occur within the STM campus are typical of the grassland/shrubland communities of central Colorado. Recent wildlife surveys of the STM campus in 2010/2011 documented a total of 102 species and included 86 bird species, 11 mammals, and 5 amphibians and reptiles (NREL 2011c).

Big Game Species and Carnivores

Mule deer (*Odocoileus hemionus*) is the only big game species that has been regularly documented at the STM campus (NREL 2011c). Although mule deer commonly occur year-round within the grassland and shrubland habitat types within the STM campus, Colorado Parks and Wildlife (CPW) has not designated any of these areas as sensitive mule deer habitat types. Although limited suitable habitat for elk (*Cervus elaphus)* exists within the STM campus, two individuals were observed incidentally in 2012 while moving through shrubland habitat within the STM campus boundary (Ryon 2014). Prior to the 2012 observation, evidence of elk use of the STM campus had not been reported during formal surveys or through incidental observations. Therefore, it is likely that significant numbers of elk do not regularly occur on the STM campus. Recent black bear observations reveal that this large mammal is an infrequent visitor to the STM campus.

Multiple carnivorous mammal species have been documented within the STM campus. These species include coyote (*Canis latrans*), red fox (*Vulpes vulpes*), striped skunk (*Mephitis mephitis*), and the common raccoon (*Procyon lotor*). The majority of these species are habitat generalists and could be observed in any of the habitat types present on the STM campus. Although these species are typically reclusive in nature, some individuals may become accustomed to human presence.

Small and Non-game Mammal Species

Other mammal species that have been documented to occur in the STM campus include the mountain cottontail rabbit (*Sylvilagus nuttalli*). Recent small mammal trapping efforts documented three species: deer mouse (*Peromyscus maniculatus*), western woodrat (*Neotoma mexicana*), and western harvest mouse (*Reithrodontomys megalotis*). Although suitable habitat occurs for multiple species of voles (*Microtus spp.*) within the STM campus, no occurrences have been recorded during trapping or survey efforts.

Migratory Birds, Raptors, and Bats

Nongame birds encompass a variety of passerine and raptor species, including migratory bird species that are protected under the Migratory Bird Treaty Act (MBTA) (16 USC 703-711). Recent avian surveys have documented a total of 65 species occurring within the area (NREL 2011c). Of these species, the most common passerines included the western meadowlark (*Sturnella neglecta*), house finch (*Carpodacus mexicanus*), black-billed magpie (*Pica hudsonia*), and the feral rock pigeon (*Columba livia*). Additional avian species may be found within the STM campus during the spring and fall migration periods. Spring migration generally occurs between March and May and fall migration generally occurs between August and October. Migratory bird use on or adjacent to the STM campus may include breeding, nesting, foraging, perching, and roosting activities.

Raptor species that could potentially occur as residents or migrants within the STM campus include eagles (bald and golden), buteos (e.g., red-tailed hawk, Swainson's hawk), falcons (e.g., prairie falcon, American kestrel), accipiters (e.g., Cooper's hawk, sharp-shinned hawk), owls (e.g., great horned and eastern screech), northern harrier, and turkey vulture (Stokes and Stokes 1996). Suitable nesting habitat for raptor species is considered to be limited within the STM campus. Recent surveys conducted in 2011 did not observe any active nesting raptors (NREL 2011c).

Although multiple species of bats are common along the Front Range of Colorado and various bat species are expected to be present on and around the STM campus, no individual bats have been recorded during acoustic surveys (NREL 2011c). One incidental observation of a single big brown bat (*Eptesicus fuscus*) was made within the STM campus in 2012. No significant areas of bat roosting or maternity colony habitat have been previously identified within the STM campus.

Amphibians and Reptiles

Due to a lack of perennial water sources within the STM campus, suitable habitat for amphibian species is limited. One tiger salamander (*Ambystoma tigrinum*) was observed during field surveys in a previous study (NREL 2005). During site wide wildlife surveys in 2010-2011 field seasons (NREL 2011c) Woodhouse's toads (*Bufo woodhousii*) were recorded during night-time surveys in ephemeral ponds in the Conservation Easement on the mesa top. The calls of western chorus frogs (*Pseudacris triserata*) have been noted numerous times in the water detention pond (see **Figure 3-1**) since the spring of 2012 (Ryon 2014). This recently constructed water detention pond is intended to temporarily hold water from seasonal run-off and storm events and do not provide significant areas of aquatic habitat able to support large populations of amphibian or aquatic species.

Reptile species that have been documented to occur within the area include western rattlesnake (*Crotalus viridis*), bullsnake (*Pituophis catenifer*), plains garter snake (*Thamnophis radix*), racer (*Coluber constrictor*), six-lined racerunner (*Cnemidophorus sexlineatus*), and prairie lizard (*Sceloporous undulatus*). These species commonly inhabit grassland/shrubland habitats.

Wildlife Movement Corridors

The STM campus includes multiple unnamed drainages that serve as wildlife movement corridors. These drainages generally traverse the STM campus in a northwest to southeast direction and are ephemeral in nature. These topological features are likely utilized by all wildlife species previously

discussed as nesting and foraging habitat or when moving between areas of suitable habitat located at the South Table Mountain Park and Lena Gulch. These areas are identified by NREL as important wildlife habitats along with the conservation easement due to their ability to preserve local wildlife movement between the South Table Mountain mesa top and Lena Gulch (see **Figure 3-1**).

Aquatic Wildlife Resources

Due to a lack of suitable habitat (i.e., perennial water sources), no habitat for aquatic species is known to occur within the STM campus. As discussed above, the detention pond (see Figure 3-1) may hold water temporarily after storm events, however it does not provide suitable long-term aquatic habitat (Ryon 2014).

Special Status Wildlife Resources

Regulatory Background

Special status species are those species for which state or federal agencies afford an additional level of protection by law, regulation, or policy. Included in this category are federally listed species that are protected under the ESA. In addition, the State of Colorado maintains a list of state-protected species (CRS 33-2-105). Those species on the State of Colorado list of Threatened and Endangered species are protected specifically from actions that could result in the taking of individuals and includes many of the federal ESA-listed species. In accordance with the ESA, the project proponent, in coordination with the USFWS, must ensure that any action that they authorize, fund, or carry out would not adversely affect a federally listed species. Specific special status species regulations relevant to the proposed project are presented in **Table 4-12**.

Table 4-12 Relevant Regulations for Wildlife Species

Wildlife Species	Regulation
Wildlife (Mammals, Birds, Reptiles, Terrestrial Invertebrates)	ESA MBTA (16 USC 703 et seq.) Bald and Golden Eagle Protection Act (BGEPA) (16 USC 668 et seq.) CRS 33-2-105

Federal Threatened, Endangered, Proposed, and Candidate Species

There are currently no wildlife species listed in accordance with the ESA as threatened, endangered, or a candidate for listing, that could potentially occur within the STM campus or be impacted by project activities (**Table 4-13**). The species noted as "no potential occurrence (NPO)" in **Table 4-13** are not discussed further in this document, unless they are Platte River (downstream) species.

Table 4-13 Federal and State Threatened and Endangered Species of Jefferson County

Common Name (*Scientific Name*)	Status	Potential Occurrence	Reason for Exclusion
Birds			
Piping plover *(Charadrius melodus)*	FT	NPO[1]	No water depletions are anticipated to occur with project.
Whooping crane *(Grus americana)*	FE	NPO[1]	No water depletions are anticipated to occur with project.

Table 4-13 Federal and State Threatened and Endangered Species of Jefferson County

Common Name (*Scientific Name*)	Status	Potential Occurrence	Reason for Exclusion
Least tern *(Sterna antillarum)*	FE	NPO[1]	No water depletions are anticipated to occur with project.
Mexican spotted owl (*Strix occidentalis lucida*)	FT	NPO	Preferred habitats of late-seral, closed canopy forest or steep-sided moist canyons do not exist in the STM campus.
Burrowing owl (*Athene cunicularia*)	ST	NPO	Preferred habitat of grasslands with available mammal burrows (prairie dog colonies) do not occur within the STM campus.
Mammals			
Canada lynx *(Lynx Canadensis)*	FT	NPO	The STM campus is not within a Lynx Analysis Unit; no suitable habitat occurs within the STM campus.
Preble's meadow jumping mouse *(Zapus hudsonius preblei)*	FT	NPO	Preferred habitats of well-developed riparian vegetation with adjacent, relatively undisturbed grassland communities and a nearby water source do not exist in the STM campus. The STM campus is located within the USFWS Denver Metro Block Clearance area (USFWS 2010).
Fish			
Greenback cutthroat trout *(Oncorhynchus clarki stomias*)	FT	NPO	No suitable habitat in or near STM campus.
Pallid sturgeon *(Scaphirhynchus albus)*	FT	NPO[1]	No water depletions are anticipated to occur with project.

[1] Species not present in or near analysis area, but water depletions may affect these downstream species.

Abbreviations: FT – Federal Threatened; FE – Federal Endangered; ST – State Threatened; NPO = No potential occurrence.

Bald and Golden Eagle Protection Act

Both the bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*) are provided federal protection under the BGEPA (16 USC 668-668d). Potential for bald eagles to occur within the STM campus is considered low as this species prefers habitat of open water and adjacent large roosting trees is absent. Bald eagle occurrence is likely limited to individuals migrating through the general area in search of open water habitat. The potential for golden eagles to occur within the STM campus is considered low as the STM campus does not support significant prey populations (e.g., prairie dog colonies) and there are no known areas of suitable cliff nesting habitat. Historically, golden eagles have been infrequently observed within the STM campus and were last recorded during 2004 avian surveys (NREL 2011c).

State Threatened, Endangered, and Special Concern Species

The State of Colorado's list of threatened and endangered species was reviewed on the CPW website (CPW 2013) for their potential presence in the STM campus. Based on species' ranges and habitat preferences it was determined that only one state listed species, the burrowing owl (*Athene cunicularia*), could be a potential inhabitant in or near the STM campus.

NREL's Wildlife Management Program

NREL's Wildlife Management Program promotes responsible wildlife and habitat management, and gathers information to better consider impacts to wildlife when implementing projects on-site. NREL is committed to responsible land stewardship and the proper management of wildlife populations into the future. Many surrounding landowners, including residential neighborhoods and Jefferson County Open Space, value the benefits of maintaining wildlife habitat and opportunities to observe wildlife. NREL policy states that proper wildlife management provides an important benefit to our community. NREL biologists work with project managers and decision-makers as part of an IPT on construction projects to minimize impacts to wildlife and maintain habitat by avoiding sensitive areas and reclaiming lands once disturbance is complete. Examples of conservation measures that NREL has implemented on the STM campus include avian friendly etched window panes in areas of high bird use and installing wildlife friendly perimeter fencing according to CPW recommendation. In addition, a fundamental long-term NREL objective is to maintain wildlife movement through the STM campus by retaining linkages between the open space areas north of the campus and Pleasant View Community Park, and Lena Gulch to the south.

4.10.2 Environmental Consequences

Proposed Action

Potential effects on wildlife species were determined through consultation with CPW and USFWS. Minor and local effects on wildlife would be anticipated. The primary issues would include the loss or alteration of native habitats, increased habitat fragmentation or disruption, animal displacement, and direct loss of wildlife.

As discussed in Chapter 3.0, the Proposed Action would involve the construction of new buildings and modification of existing buildings within the STM campus (**Figure 3-1**). Approximately 21.5 acres of undisturbed and previously disturbed areas would be impacted during construction. Construction would include permanent physical improvements to the STM campus that involve buildings and equipment, utilities, and other infrastructure. The proposed activities and facilities were derived from ongoing NREL planning processes and documents. It is assumed some of the construction disturbance would be reclaimed.

Potential impacts to wildlife species from the Proposed Action can be classified as short-term and long-term. Short-term impacts would consist of temporary habitat removal and activities associated with construction. Long-term impacts would consist of the removal of or changes to wildlife habitats associated with operation (e.g., paved roads, buildings, vehicle traffic, etc.). The extent of both short-term and long-term impacts would depend on factors such as the sensitivity of the species, seasonal use patterns, type and timing of project activities, and physical parameters (e.g., topography, cover, forage).

Project construction activities at the STM campus would result in both direct and indirect impacts to wildlife species over a period of approximately 10 years. Direct and indirect impacts could include wildlife mortalities or displacement related to construction and operation activities; habitat loss, alteration, and fragmentation; and increased levels of noise, activity, and human presence. Impacts to wildlife from habitat loss and fragmentation are likely to be reduced in intensity due to the fact that the majority of construction on the STM campus consists of in-fill development of vacant lots located in a previously

urbanized setting. Although project construction would result in the short-term disturbance of up to 21.5 acres of potential wildlife habitat within the STM campus, the majority of new construction would occur in areas adjacent to previously developed lands that are therefore less suitable for wildlife in comparison to previously un-fragmented habitats. The majority of areas temporarily disturbed during construction would be reclaimed. Reclamation for each area would occur upon completion of each individual Proposed Action component.

Big Game and Carnivores

Direct impacts to big game species, primarily mule deer, and carnivores would include both short-term and permanent loss of potential forage and cover (native vegetation and previously disturbed vegetation) and an increase in habitat fragmentation within the STM campus. These impacts are anticipated to be negligible with regards to big game populations due to the fact that the majority of proposed development within the STM campus consists of in-fill construction of vacant lots adjacent to existing buildings and facilities. Short-term loss of potential big game and carnivore habitat resulting from construction activities are anticipated to be limited to a maximum of 21.5 acres.

Additional indirect impacts to big game species and carnivores would result from increases in noise levels and human presence during construction and development activities. Studies have shown that big game species tend to move away from areas of human activity and roads, thereby reducing habitat utilization near disturbance areas (Cole et al. 1997; Sawyer et al. 2009; Ward 1976). Mule deer appear to be more tolerant of human presence and activity than other big game species. Depending upon the presence of vegetative cover, mule deer displacement distances from human activity have been observed to range from 330 feet to 0.6 mile (Ward 1976). However, disturbance associated with construction activities would be short-term and it is assumed that animals would return to the area following the completion of project construction. Due to the fact that the STM campus is located within short proximity to existing urbanized areas and currently experiences moderate levels of human presence, impacts to big game species and carnivores would be anticipated to be short-term in duration and minor.

Small and Non-Game Species

Direct and indirect impacts to small game mammals would include wildlife mortalities or displacement related to construction and operation; habitat loss, alteration and fragmentation; and increased levels of noise, activity and human presence. Project construction would result in the incremental loss of up to 21.5 acres of potential habitat, until reclamation was completed and vegetation reestablished. However, in most instances, suitable habitat adjacent to disturbed areas would be available for small game mammal species until grasses and woody vegetation became reestablished within the disturbance areas.

Construction activities may result in mortalities of less mobile or burrowing nongame species within the surface disturbance area as a result of crushing from construction vehicles and equipment in addition to increased mortality rates due to increased vehicle traffic as a result of new and improved roads (Adams and Geis 1983). These temporary losses would reduce productivity for that breeding season. However, due to the large amount of suitable habitat in the surrounding area, direct impacts to small game species would be expected to be minimal.

Migratory Birds, Raptors, and Bats

Direct and indirect impacts to migratory birds, raptors, and bats may include mortalities resulting from collisions with new buildings and facility windows, and vehicles, as well as displacement related to construction and operations. Short-term loss of vegetation and other factors can lead to habitat loss, alteration, and fragmentation. In addition, increased levels of noise, increased activity, and the presence of people can create impacts. The temporary displacement of some species would last until herbaceous vegetation returns to pre-construction conditions (approximately 3 to 5 years). Long-term and minor

effects would result from collision risks associated with newly constructed facilities and windows. NREL has committed to reducing collision impacts to avian species by retrofitting existing structures or installing avian bird friendly glass in new buildings as feasible.

NREL policy includes conducting pre-construction surveys to prevent impacts on wildlife and nesting birds. In compliance with established regulations and policies to minimize the potential impact to nesting birds and their habitat, nest sites identified within the areas of disturbance would be avoided to prevent their removal during the avian breeding season in Colorado (March 15 to September 15). Because a number of variables (e.g., nest location, species' sensitivity, breeding, phenology, topographical shielding) determine the level of impact to a breeding pair, appropriate protection measures, such as seasonal constraints and establishment of buffer areas, would be implemented at active nest sites on a species-specific and site-specific basis, in coordination with CPW and USFWS. If nests, eggs, or juveniles were found, construction in such areas would be avoided until the birds fledge.

Project construction would result in the direct short-term loss of up to 21.5 acres of potential habitat, until reclamation was completed and vegetation reestablished. Due to disturbances resulting from existing facilities and STM campus activities, the extent of suitable habitat adjacent to the disturbed areas, the temporary nature of project construction, and NREL commitments, impacts to migratory bird and raptor species would be expected to be minimal.

Collision risks have been addressed in various ways at the STM campus. However, new risks would arise from the installation of wind turbines and windows of newly constructed buildings. These risks are an important issue to NREL as demonstrated by past measures to retrofit existing windows that are causing collisions and by installing, when feasible, avian friendly glass in new buildings.

The Proposed Action would include the installation of small wind turbines for research purposes. These installations would most likely be in support of NREL's ongoing research into energy integration and electric grid simulations at the ESIF. Up to two 100-kW turbines (rotor hub heights of less than 200 feet) and multiple smaller turbines (less than 10 kW) could be installed at the STM campus. The smaller turbines would be mounted on buildings or on monopoles (rotor hub heights of less than 50 feet). Avian mortalities associated with wind turbines have been observed to typically involve passerine bird and tree-roosting bat species and collision rates are generally observed to peak during the fall migration periods as individuals move across the landscape.

All wind turbines, regardless of size or generation capacity, have the potential to injure or kill birds and bats through collisions with rotating turbine blades. As the number, size, and overall operation time of turbines increase, the annual rate of potential avian collisions and fatalities would increase. The incremental effects of two 100-kW turbines and multiple smaller turbines would not be expected to result in the long-term population level decline of avian species within the vicinity of the STM campus as appropriately sited small wind turbines are not likely to pose significant risk to avian and bats species of concern (USFWS 2012). By applying mortality rates calculated by previous studies for larger wind turbines, it is estimated that the two proposed 100-kW wind turbines would result in approximately one avian and one bat mortality from collisions with the rotating turbine blades every 2.5 years (Kunz et al. 2007; Loss et al. 2013; Tetra Tech 2011). This level of impact is not anticipated to result in significant adverse population level impacts of migratory birds and bats.

Amphibians, Reptiles and Aquatic Species

Negligible effects on amphibians and aquatic species would be expected because development would occur in areas that are not suitable to associated species. It is anticipated that minor impacts from construction and operation of the proposed project to reptiles may occur as multiple snake species are commonly encountered at the STM campus. The types of impacts would be similar to those discussed above under non-game species and would include the potential conversion or loss of approximately 21.5 acres of suitable habitat. NREL policy for all reptile encounters within the STM campus is to have an

approved reptile biologist contain and relocate each individual reptile to a safe location located within the conservation easement area of the campus.

Wildlife Corridors

Established wildlife corridors would not be disrupted by planned development as shown in **Figure 3-1** and **Figure 4-1**. Each drainage corridor would be protected along with the conservation easement. Routes between the Mesa Top and Lena Gulch would remain.

Special Status Wildlife Species

Under the ESA, federal agencies are required to provide documentation that ensures that agency actions will not adversely affect the existence of any federally listed threatened or endangered species. The ESA requires that all federal agencies avoid "taking" threatened or endangered species, which includes jeopardizing threatened or endangered species habitat. Section 7 of the ESA establishes a consultation process with USFWS that ends with concurrence on a determination of the risk of jeopardy from a federal agency project. Consultation letters between DOE and USFWS are provided in **Appendix E**.

On May 30, 2014, DOE initiated informal consultation with the USFWS, Region 6 Mountain-Prairie Region, for compliance with Section 7 of the ESA, the MBTA, and the BGEPA. This informal consultation considered species that could potentially occur at the STM campus and are listed by USFWS as occurring in Jefferson County. DOE determined that there would be no impact to listed species, and those protected by MBTA or BGEPA. The USFWS concurred on June 24, 2014 with DOE's no effect determination that the Proposed Action would not likely impact the federally listed species listed in **Table 4-13**.

The potential for on-site impacts to eagles is limited to the infrequent use of the STM campus by these species and NREL's commitment to coordinate with the USFWS on proper siting and operation of the proposed small-scale wind turbines. If impacts were to occur, they would be similar to those discussed previously under Migratory Birds, Raptors, and Bats.

In the mid-1990's, USFWS researchers determined that several Platte River species (**Table 4-13**) and their associated habitats in Nebraska are threatened by Platte River water depletions caused by upstream users in Colorado and Wyoming. In 1997, the States of Nebraska, Wyoming, and Colorado and the U.S. Department of the Interior signed a Cooperative Agreement for Platte River Research and Other Efforts Relating to Endangered Species Habitats along the Central Platte River, Nebraska. In this document, the parties agreed to pursue a basin-wide, cooperative approach to improve and maintain habitat for these four threatened and endangered species. This effort culminated in the signing of the PRRIP Final Program Agreement in 2006 and the commencement of the program on January 1, 2007. As water use continues to increase in eastern Colorado, including the Front Range Urban Corridor, the Colorado portion of the PRRIP provides water flow management and funding for implementation of the individual species recovery plans and critical habitat improvement projects along the Platte River in central Nebraska.

The projected STM campus water use of the Proposed Action was determined to be greater than the 0.1 acre-feet per year and thus triggered the need for consultation under the PRRIP. On May 21, 2014, DOE initiated formal consultation with the USFWS and submitted a streamlined biological assessment addressing the effects of the Proposed Action's water depletions on Platte River species in Nebraska under the program. Based on DOE's biological assessment of the projected water use, the USFWS issued a biological opinion to DOE on June 24, 2014. The USFWS determined that the flow-related adverse effects of the Proposed Action are consistent with those evaluated in the Tier 1 programmatic biological opinion for the whooping crane, interior least tern, piping plover, pallid sturgeon, and whooping crane critical habitat and that these effects on flows are being addressed in conformance with the

Colorado Plan for Future Depletions of the Platte River Recovery Implementation Program. Therefore, no further consultations or actions are required.

No Action Alternative

Under the No Action Alternative, no activities associated with the Proposed Action would be completed and the STM campus and DWOP would continue to operate at current conditions; therefore, no additional direct or indirect environmental consequences would be expected. NREL would continue to track and inventory appropriate wildlife resource conditions at the STM campus and DWOP and make determinations regarding appropriate reporting and permitting requirements as necessary to maintain compliance with all federal, state, and local regulations.

4.11 Cultural Resources

The study area for cultural resources is the boundary of the STM campus. The DWOP is not considered in this section because there are no proposed actions that would affect cultural resources at that location.

4.11.1 Affected Environment

Regulatory Framework

Cultural resources are the nonrenewable remains of past human activity, and 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. The three major categories of cultural resources include:

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

Prehistoric and historic archaeological resources are locations where human activity has altered the landscape or left deposits of physical remains (e.g., stone tools, bottles, pottery). Prehistoric resources in the Colorado Front Range date from the Paleoindian period (approximately 12,000 years before present [B.P.]) through the Late Prehistoric Stage (approximately A.D. 1540). Prehistoric resources range from short-term campsites composed of a few artifacts to village sites and rock art. Historic resources date from the initial contact period between Europeans and Native Americans to approximately 50 years ago, and may include town sites, campsites, roads, fences, trails, dumps, battlegrounds, mines, and a variety of other features.

Architectural resources include standing buildings, dams, canals, bridges, and other structures. While most standing buildings are created principally to shelter any form of human activities, the broader definition of structure is often associated with purposes other than creating human shelter.

Traditional cultural properties are associated 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 properties can include archaeological resources, buildings, neighborhoods, prominent topographic features, and habitats that Native Americans or other groups consider essential for the persistence of their traditional culture and values.

Cultural resources are managed pursuant to the National Historic Preservation Act of 1966, as Amended (NHPA), and the Archaeological Resources Protection Act of 1979, and other statues. Section 110 of the NHPA, 16 USC 470h-2(a), defines the federal agencies' responsibility to preserve and use historic properties.

Section 106 of the NHPA requires federal agencies to take into account the effects of their undertakings on significant cultural resources, and to afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertakings. Significant cultural resources are either eligible for, or listed on, the National Register of Historic Places (NRHP). To be eligible for the NRHP, a resource must meet one or more of the criteria as defined in 36 CFR 60.4:

a) Are associated with events that have made a significant contribution to the broad patterns of our history;

b) Are associated with the lives of persons significant in our past;

c) Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; and

d) Have yielded, or may be likely to yield, information important in prehistory or history.

In accordance with Section 106 of the NHPA, DOE, in consultation with the ACHP, the Colorado State Historic Preservation Office(r) (SHPO), and other consulting parties, is responsible for determining whether a proposed action will result in adverse effects to cultural resources listed or eligible for listing on the NRHP. The Colorado SHPO is officially the “Office of Archaeological and Historic Preservation”, however, for ease of reference and because the national regulations refer to the State Historic Preservation Office(r), the acronym SHPO is used here.

Cultural Resource Protection, Inventories, and Assessments

DOE identifies and protects cultural resources in several ways:

- Integrating cultural resource management into site activities and minimizing and/or mitigating impacts to historic properties.
- Implementing procedures to manage historic properties and to protect undiscovered cultural resources and artifacts.
- Periodically conducting surveys to document presence or absence of cultural or historic resources while considering project impacts to the human environment. When surveys reveal artifacts, DOE and NREL staff works with the SHPO to determine if the artifacts are eligible for consideration as cultural or historic resources.
- Construction contractor site orientation training informs workers that in the event they discover any evidence of cultural resources during ground-disturbing activities at the STM campus, workers are to stop all work in the vicinity until a qualified archaeologist evaluates the significance of the find.

As the initial compliance step, DOE has inventoried all NREL land in order to determine if historic properties are present. The following six cultural resource inventories and assessments were conducted between 1980 and 2011:

1. A 300-acre inventory of the STM campus was conducted in 1980. The boundaries of the STM campus were mostly similar to what they are today, excluding Zone 6 (the Camp George West Parcel). Four isolated prehistoric artifacts and eight historic features were recorded. The prehistoric artifacts were determined as not eligible to the NRHP. The historic features included the amphitheater, bridge, and ammunition igloo (Building 88), a storage bunker (Building 110 [which was later determined to be constructed in 1973 and therefore not of historic age]), stone alignment, stone ditch, board structure, and check dam. At that time, it was recommended that only the amphitheater and bridge should be further studied (Nelson 1980). In 1993, the amphitheater, footbridge, and ammunition igloo were listed on the NRHP.

2. As part of the update of the 1980-1981 EA for the Solar Energy Research Institute, the SHPO requested that an in-depth historical assessment be conducted to determine if proposed activities would adversely affect the amphitheater, bridge, and ammunition igloo. No direct impacts would occur from planned ground disturbance; however, the Camp George West Historic District (Site 5JF145) was recommended as eligible to the NRHP (Forum Associates, Inc. 1988). In 1993, the Camp George West Historic District was listed on the NRHP.
3. A 246-acre inventory was conducted in 1992. This inventory included the remainder of Section 36, Township 3S (T3S), Range 70 West (R70W), north of the 1980 inventory as well as the Camp George West parcel in Section 1, T4S, R70W south of the Denver West Parkway. As a result of the inventory, components of the Camp George West Historic District were recommended as contributing to its overall significance (Sites 5JF145.66 and 5JF145.68) (Butler 1992).
4. Concurrent with the 1992 inventory, a detailed historic context was developed for the Camp George West Historic District. The report includes the history of the area from the early 1900s when it was known as the State Rifle Range. The construction of features visible today for the Colorado National Guard training in the 1920s include development of Camp George West and the Works Progress Administration construction of the amphitheater and bridge in the 1930s, post-World War II use of the area, and DOE development of solar energy development and other renewable energy sources starting in 1981 (Simmons and Simmons 1992). These historic contexts were used as the basis for the NRHP nominations and eventual listing of the amphitheater, bridge, ammunition igloo, and the historic district.
5. Fieldwork for a Historic American Building Survey/Historic American Engineering Record (HABS/HAER) Level II documentation report was completed in 2005 for two contributing features of the Camp George West Historic District (i.e., the 200-yard and 300-yard firing lines and low rock walls) on the Camp George West Parcel (Zone 6) of the STM Campus (Science Applications International Corporation 2006). This was to mitigate impacts to these features when this parcel was developed.
6. A 3.3-acre inventory was conducted in 2010, with a 0.3-acre addendum inventory completed in 2011 of non-DOE property that would be impacted by the new southern access road (Research Road) to the STM campus. The surveys extended a total of 0.3 mile from the intersection of Moss Street and South Golden Road north to the STM campus and included a 100-foot buffer. These surveys only identified two eligible features, which were the previously recorded 500-yard and 600-yard concrete firing lines (Site 5JF145.66) associated with the Camp George West Historic District (Killam 2010; Killam and Hendrickson 2011).

Archaeological Resources

There are no known significant archaeological resources within or adjacent to the STM campus.

Architectural Resources

Five significant architectural resources (two of which are included within the Camp George West Historic District) are, or were, within the STM campus boundary (**Table 4-14**).

While much of what was once Camp George West has been removed due to development throughout the years, some significant elements still remain. During its historic use, Camp George West occupied the entire current STM campus boundary.

Table 4-14 Architectural Resources Identified on the NREL's STM Campus

Site #	Description	NRHP Status	Comment
5JF145	Camp George West	Listed on the NRHP	Most of what remains is along South Golden Road.
5JF145.66	Firing Range Lines	Contributing to the district's significance	The 300-yard firing line is on DOE property. The 500-yard and 600-yard firing lines are located on Jefferson County Open Space property that is managed by the Pleasant View Metropolitan District. The 300-yard line was relocated in 2011 to the NREL storm water detention basin. The 500-yard firing line remains, as does most of the 600-yard firing line. Only about 30 feet of the 600-yard firing line was impacted by the construction of the south access road. The rest was untouched by DOE, but is in poor condition to due vegetative growth around Lena Gulch.
5JF145.68	Low Rock Walls	Contributing to the district's significance	Both historic features have been removed.
5JF842	Amphitheater and Footbridge	Listed on the NRHP	Entirely within Zone 7 with no planned disturbance.
5JF843	Ammunition Igloo	Listed on the NRHP	Entirely within Zone 7 with no planned disturbance.

Historic Amphitheater

Historic Ammunition Igloo

The boundary of the Camp George West Historic District limits the district to the south of Denver West Parkway, even though the amphitheater, bridge, and ammunition igloo are associated with the district. Development of the Camp George West parcel (Zone 6) impacted two of the firing range lines (5JF145.66 [i.e., 200- and 300-yard features)] and the two rock walls (5JF145.68). The 200-yard firing line and low rock walls have been removed, and the 300-yard firing line was salvaged and relocated to the NREL storm water detention basin in 2011. To mitigate the impact to these features from development of this parcel, DOE entered into a Memorandum of Agreement (MOA) with the Colorado SHPO in 2003 to document these features in a HABS/HAER report. While additional features of the

district are present nearby, they are located off of DOE property, most notably along South Golden Road. In 2011, DOE entered into consultations with Colorado SHPO for the new south access road to the STM campus for potential impacts to the 500- and 600- yard Camp George West firing range lines located on Jefferson County Open Space property in Pleasant View Community Park, which is administered by the Pleasant View Metropolitan District. DOE entered into a 2011 MOA with SHPO and Pleasant View Metropolitan District, and agreed to mitigate the impact by establishing an interpretative feature. The construction of the south access road impacted about 30 feet of the western extent of the 600-yard firing line and the 500-yard line was not impacted. DOE completed the interpretative feature, an informational display, in June 2013, which is located off of Research Road in Pleasant View Community Park and is accessible to the public.

Traditional Cultural Properties

There are no known traditional cultural properties within or adjacent to the STM campus.

4.11.2 Environmental Consequences

Proposed Action

Impacts to significant cultural resources can occur as a result of building or road construction, utility work, demolition, changes to a resource's setting, or use (including both noise and ground disturbing activities). These activities would occur at the STM campus.

To address the potential effects of the Proposed Action at the STM campus, DOE initiated consultations pursuant with Section 106 of the NHPA on June 4, 2014 (see **Appendix F**). SHPO's primary concern involves indirect visual impacts to the amphitheater and ammunition igloo. These effects could occur from new development near, and within the viewshed of, these resources. However, at this time, there is an insufficient level of detail available about the location and design (dimensions, architectural features, etc.) of proposed facilities near these resources to properly characterize whether effects would occur or not. As a result, DOE proposed to address Section 106 obligations by initiating future consultations, on a project-by-project basis, when individual components of the Proposed Action are funded/ authorized. SHPO concurred with this approach on June 19, 2014 (Office of Archaeological and Historic Preservation 2014). This consultation and coordination will allow for further effects analysis, including the exploration of impact avoidance, minimization and mitigation strategies as appropriate.

The following discussion provides additional analysis based on currently available information.

Archaeological Resources

No impacts on significant archaeological resources are anticipated as a result of the Proposed Action components because none are known to exist near planned improvements. Should any evidence of archaeological resources be discovered at any time during ground disturbing activities, all work would stop in the vicinity of the find and NREL's on-call archaeologist would be contacted to evaluate the significance of the find according to criteria established by the NRHP.

Architectural Resources

NREL plans no new improvements at the amphitheater, footbridge, or ammunition igloo; therefore, no physical impacts would occur to these historic resources. The proximity of new developments to these sites is clarified in **Table 4-15**.

The nearest improvement to the Camp George West Historic District (RSF III [H] and Metrology Laboratory Relocation [M]) would occur over 1,000 feet away, and would be buffered by an existing parking lot and structure, plus the adjacent park.

Table 4-15 Architectural Resources – Approximate Distance (Resource to Improvement)

Resource	Nearest Improvement	Approximate Distance (Resource to Improvement)
Amphitheater	ReFUEL (I)	200 feet
Footbridge	ReFUEL (I)	200 feet
Ammunition Igloo	WHF Expansion (K) TriGen Plant (O)	100 feet Over 200 feet

Effects to the setting, location, and historic character of the amphitheater, footbridge, and ammunition igloo from these developments are not expected to be substantive due to the existing presence of similar facilities that have already redefined the historic context for these resources. Direct impacts would be limited by the prohibition of development around these features in Zone 7. However, a formal finding under Section 106 will be determined when additional project details emerge, and will be documented through further consultation and coordination with SHPO and other consulting parties.

Traditional Cultural Properties

No known traditional cultural properties occur within the STM campus. Therefore, no impacts would be anticipated as a result of the Proposed Action.

No Action Alternative

Under the No Action Alternative, there would be no ground-disturbing activities at the STM campus, and any disturbance associated with ongoing operations would be expected to be minor and addressed by standard protocol and NREL procedures. Therefore, no historic properties would be affected by the No Action Alternative.

4.12 Hazardous Materials and Waste Management

4.12.1 Affected Environment

Hazardous materials, which are defined in various ways under a number of regulatory programs, can represent potential risks to both human health and the environment when not managed properly. The affected environment for hazardous materials and solid wastes includes air, water, soil, and biological resources within the area that potentially could be affected by a release of hazardous materials or solid wastes during storage, use, and preparation for disposal.

NREL has a variety of chemicals and materials, some of which are hazardous, for use in research activities and operational activities. Hazardous materials are stored, used, and managed in a manner that is protective of laboratory personnel, the general public, and the environment. Numerous plans and procedures are in place to minimize the potential for spills and releases, on- and off-site environmental impacts, and exposures to workers and the public. Areas of focus include: hazardous materials management, storage tank management, radiological materials and waste management, and hazardous waste management and minimization, spill prevention, and emergency response.

Regulatory Framework

Hazardous materials are substances that pose a potential hazard to human health and/or the environment if not properly managed. Hazardous wastes are hazardous materials that are no longer needed or usable and are defined as hazardous by the Resource Conservation and Recovery Act

(RCRA). NREL is subject to various federal, state, and local environmental laws and regulations, as well as EOs and DOE orders (refer to **Appendix C**).

Per RCRA, solid waste consists of a broad range of materials that include garbage, refuse, wastewater treatment plant sludge, non-hazardous industrial waste, and other materials (solid, liquid, or contained gaseous substances) resulting from industrial, commercial, mining, agricultural, and community activities (USEPA 2014b). Solid waste is regulated under different subtitles of the RCRA and includes hazardous waste and non-hazardous waste. Non-hazardous waste is regulated under RCRA Subtitle D. Regulated hazardous wastes are handled and disposed of according to RCRA Subtitle C in Title 40 of the CFR and implemented in the State of Colorado by CDPHE's Hazardous Materials and Waste Management Division through the Colorado Hazardous Waste Act under CCR 1007-3. NREL maintains unique USEPA hazardous waste generator identification numbers for each of its five facilities: STM campus, DWOP, NWTC, Joyce Street Facility, and ReFUEL.

Federal regulation 40 CFR 112, regarding Oil Pollution Prevention, is implemented by the USEPA. The regulation establishes requirements for owners or operators of facilities that drill, produce, gather, store, process, refine, transfer, or consume oil. In particular, the regulation applies to non-transportation-related facilities that could reasonably be expected to discharge oil in harmful quantities into navigable Waters of the U.S. and that have an aggregate above-ground oil storage capacity of more than 1,320 gallons. The regulation applies specifically to a facility's storage capacity, regardless of whether the tanks are completely filled. Storage capacity includes the capacity of all oil storage containers, including electrical transformers and hydraulic oil containing equipment, with a 55-gallon capacity or greater.

Hazardous Materials Management

Hazardous Chemicals

NREL has a laboratory-wide chemical management system (CMS) that serves as a centralized chemical inventory tool for managing and reporting on chemicals used at the laboratory. Standard hazard classes consist primarily of lab pack quantities of flammable liquids and solids, corrosives, toxics, oxidizers, and some pyrophoric and water-reactive materials. Drummed materials consist primarily of aqueous scrubber condensate with trace organics, consolidated organic solvents, used oil, and dilute acidic waste generated from high-performance liquid chromatography (HPLC) systems. CMS tracks hazardous materials according to type, quantity, location, hazards, and user. Hazardous waste management, as discussed previously, includes characterization, storage, transportation, and disposal of waste generated at the STM campus and DWOP.

AST/Oil Containing Equipment

The AST Management Program at NREL applies to petroleum fuel tanks and is intended to: minimize releases from tanks; confirm that safety features are present and functional; and confirm that compliance requirements are met. NREL minimizes the risk of underground soil and water contamination from storage tanks by utilizing only ASTs where storage is required. CDLE requires that ASTs 660 gallons or larger be permitted prior to installation, be inspected by the CDLE following installation, and be registered within 30 days following commencement of use. USEPA regulations require that ASTs be constructed and installed according to specific standards, be regularly inspected, that those inspections are documented, and that facilities meeting certain oil storage limits employ a Spill Prevention, Control, and Countermeasures Plan (SPCC Plan). NREL facilities store diesel fuel for emergency generators and ethanol from research activities in ASTs. The AST Management Program focuses on proper tank design, operation, training, and inspection to protect against spills and leaks. **Table 4-16** presents a listing of all of the ASTs on the STM campus and DWOP.

Two AST installation permits have been obtained (one 883-gallon diesel AST installed in August 2012 and one 2,500-gallon diesel AST installed in March 2013). Aboveground diesel storage tanks at the STM campus have secondary containment. A total of 5,399 gallons of diesel fuel is kept on-site.

Table 4-16 Aboveground Storage Tanks on the STM Campus and DWOP

STM / DWOP AST Tank Inventory and Oil Volume				
Tank #	**AST Name**	**Contents**	**Capacity (gal)**	**Spill Containment**
AST-2	SERF Standby Generator (registered)	Diesel	800	Double-walled tank
AST-3	PDU Ethanol (registered)	Ethanol/water	6,000	Single-wall, 7,500 gallons, concrete containment
AST-4	PDU Standby Generator (Big Buck)	Diesel	564	Double-walled tank
AST-5	FTLB Standby Generator	Diesel	560	Double-walled tank
AST-9	DWOP Building 16 Standby Generator	Diesel	500	Single-wall, 537 gallons concrete containment
AST-17	ESIF Research Generator #1	Diesel	173	Double-walled tank
AST-18	ESIF Research Generator #2	Diesel	336	Double-walled tank
AST-28	S&TF Standby Generator	Diesel	367	Double-walled tank
AST-30	RSF I Standby Generator	Diesel	547	Double-walled tank
AST-32	RSF II Standby Generator (registered)	Diesel	660	Double-walled tank
AST-33	Parking Garage Standby Generator	Diesel	309	Double-walled tank
AST-34	ESIF #1 Standby Generator (registered)	Diesel	883	Double-walled tank
AST-37	STM E85 Fuel Tank (registered)	E85	1,000	Double-walled, convault
AST-38	ESIF Door 3 Day Tank	Diesel	100	Double-walled tank
AST-39	ESIF Door 6 Day Tank	Diesel	100	Double-walled tank
AST-40	ESIF Research Generator #3	Diesel	440	Double-walled tank, trailer mounted

Due to the quantity of oils stored on-site, a SPCC Plan has been developed, amended, and implemented for the STM campus where oil is stored and could reasonably be expected to discharge oil into navigable Waters of the U.S. or adjoining shorelines in quantities that may be harmful. The SPCC Plan indicates the current aggregate oil storage capacity of the STM campus is 24,730 gallons. The STM campus includes AST, electric transformer, hydraulic elevator, and storage drum oil sources. NREL's SPCC Plans are updated every 3 years, or whenever there is a significant change in regulations, operations, or requirements that renders the plan incomplete or inaccurate. The SPCC Plan for the STM campus was revised in 2012 to address changes to equipment and oil inventories.

Ozone Depleting Substances (ODS)

USEPA ODS regulations do not require a comprehensive inventory of either ODS or refrigerant materials. NREL maintains an updated inventory of equipment that meets either of the two following categories:

- Contains more than 50 pounds of a Class 1 or 2 ODS and is required to meet USEPA recordkeeping and maintenance requirements; and
- Utilizes more than 100 hp of refrigerant compression, uses a Class 1 or Class 2 ODS and as such is required to be registered with the Colorado CDPHE.

NREL has two pieces of equipment at the STM campus that meets the second of these two criteria. These two pieces of equipment are large water chillers located at the SERF laboratory, each of which contains 415 pounds of R-22 refrigerant (Class 2 ODS), in addition to 392 pounds of other miscellaneous ODS. One registered chiller unit located at DWOP contains 260 pounds of R-22 refrigerant, in addition to 58 pounds of other miscellaneous ODS. This equipment and associated documentation is periodically inspected by Jefferson County for the CDPHE.

Asbestos

NREL tracks its asbestos-containing materials (ACM) with periodic inventories. The ACM is described, quantified, and assessed according to its condition. The conditions of ACM remaining on the STM campus is described as “good” with the exception of floor tile in a storage room (384) in Building 16 in DWOP due to damaged adhesive. The most recent inventory was performed in November 2012. At the STM campus and DWOP, approximately 3,000 pounds of items/materials containing approximately 6 percent asbestos are found in adhesive mastics, insulated pipe wrap, floor tile, and transite panels in laboratory fume hoods. USEPA and OSHA asbestos management regulations prescribe in-place management of ACM materials provided that they are maintained in good condition.

Radiological Materials and Waste Management

Unlike other DOE sites, NREL does not conduct work involving nuclear materials and therefore does not have legacy radiological or other contamination issues associated with past nuclear weapons production or research activities.

NREL generates low-level radioactive waste in small quantities from activities associated with solid laboratory debris and liquid research samples. NREL also uses small quantities of radioisotopes for biological labeling in research. The radioactive waste (containing small amounts of low-level isotopes) is temporarily stored at the WHF until it is shipped off-site for disposal at a proper facility as needed. Radioisotope volumes of Carbon 14 are 0.15 millicurie (mCi) contained in approximately 30 pounds of solid laboratory debris and liquid research samples and tritium at 0.03 mCi contained in approximately 15 pounds of solid laboratory debris and liquid research samples.

Waste Minimization/Pollution Prevention

NREL implements policies and programs for the acquisition of sustainable products and engages in contracts that support the objectives of EO 13514 and are consistent with all federal green procurement preference programs, including the purchase of:

- Electronics and equipment that is Electronic Product Environmental Assessment Tool (EPEAT)-registered and designated by Energy Star® or Federal Energy Management Program;
- Products manufactured from recovered materials;
- Bio-based products;
- Non-ozone depleting substances;

- Recycled content; and
- Non-toxic or less toxic alternative products.

NREL promotes employee awareness of the availability of green products, encourages the use of green products, and practices pollution prevention by substituting less hazardous products in research and operational activities. Additionally, NREL voluntarily participates in a variety of waste prevention and resource conversation programs, such as USEPA's Federal Green Challenge and WasteWise Programs, DOE's Green Buy Program, the Federal Electronics Challenge, and Colorado's Environmental Leadership Program. Collectively, these efforts reduce the amount of hazardous materials acquired, managed, and disposed.

In 2012, NREL received a DOE Green Buy Program Gold Award for purchasing 17 products in five different categories, achieving DOE's Green Buy leadership goal. NREL also achieved the Platinum-level Federal Electronics Challenge (FEC) Award. FEC is a partnership program between the Office of the Federal Environmental Executive and the USEPA. The FEC recognizes federal facilities that voluntarily lead in the area of green electronics purchasing, management, and recycling.

Waste Management

Hazardous and non-hazardous waste is generated on the STM campus in the form of solids, liquids, and gases from research activities in areas such as photovoltaic, bioenergy, wind, transportation technologies, and energy storage.

Research and development activities and general operations create a variety of waste streams, including those containing toxic chemicals or metals. These wastes are handled, stored, and disposed of to minimize the potential for health and environmental impacts that could result from a release or improper disposal

All waste-handling and disposal activities conducted at the STM campus comply with the requirements and regulations of the OSHA, RCRA, DOE, and the CDPHE. All hazardous wastes are packaged and disposed of through contracted off-site commercial treatment, disposal, and recycling firms. Many of the would-be hazardous wastes generated at the STM campus and DWOP are recycled in accordance with CDPHE universal waste regulations, including such items as used batteries, fluorescent bulbs, and computer monitors. As a BMP, many of the nonhazardous waste materials generated are handled in the same manner as the hazardous wastes. These materials, although not classified as hazardous, also are recycled or disposed of at off-site commercial treatment, storage, disposal, and recycling facilities.

Hazardous Waste

The STM campus typically falls under the category of Small Quantity Generator of hazardous waste, generating greater than100 kilograms (kg) but less than 1,000 kg of hazardous waste in a calendar month. However, due to pilot-scale research experiments, the STM campus occasionally elevates to that of a Large Quantity Generator (>1,000 kg of hazardous waste in a calendar month). This is known as episodic generation and may happen one or more times a year at the STM campus. During those times, NREL abides by more stringent Large Quantity Generator requirements in accordance with hazardous waste regulations. The DWOP facility falls under the smallest hazardous waste generator category of Conditionally Exempt Small Quantity Generator, generating <100 kg of hazardous waste in a calendar month.

Hazardous waste is handled and disposed of according to RCRA Subtitle C in 40 CFR and implemented in the State of Colorado by CDPHE's Hazardous Materials and Waste Management Division through the Colorado Hazardous Waste Act under 6 CCR 1007-3. Hazardous materials proposed for use are also assessed for the potential substitution of less hazardous products, resulting in less hazardous waste streams. Hazardous waste volumes generated from 2010 to 2012 are summarized in **Table 4-17**.

Table 4-17 Hazardous Waste Generated at STM Campus and DWOP (lbs, net weight)

Year	STM Campus Hazardous Waste	DWOP Hazardous Waste
2010	14,651	1,080
2011	19,057	1,500
2012	31,692	1,679

Non-hazardous Industrial Wastes

As previously discussed, NREL generates several types of wastes that are not classified as hazardous waste, but are recycled or disposed of at off-site commercial treatment, storage, disposal, and recycling facilities. These wastes include soil or debris with oil and/or fuel residue, nano-material bearing wastes, used oil, and miscellaneous non-hazardous laboratory chemicals and reagents. Non-hazardous industrial waste volumes generated from 2010 to 2012 are summarized in **Table 4-18**. This does not include municipal solid waste, like regular trash or garbage, which is collected and sent to local municipal solid waste landfills. Garbage generation rates are discussed below in Waste Minimization.

Table 4-18 Non-hazardous Industrial Waste Generated at STM Campus and DWOP (lbs, net weight)

Year	STM Campus Non-hazardous Waste[1]	DWOP Non-hazardous Waste[1]
2010	6,262	560
2011	5,410	480
2012	3,864	561

[1] Includes non-hazardous chemical wastes; Examples: soil/debris with oil and/or fuel residue; nano-material bearing wastes; used oil; miscellaneous non-hazardous laboratory chemicals and reagents. Excludes municipal solid waste, such as regular trash.

Non-hazardous Construction Wastes

Construction and demolition wastes and debris would be re-used or recycled to the extent practicable. These materials would generally consist of excavated soils, concrete, asphalt, wood, metal, cardboard, and various packaging materials and containers. Construction wastes not suitable for re-use or recycling would be disposed at a local landfill. Excavated soils are generally re-used on-site or at other construction projects in the Denver metropolitan area. Recent large-scale construction projects at the STM campus have demonstrated the ability to recycle between 80 percent and 90 percent of construction wastes. The remaining 10 percent to 20 percent of construction wastes that would be disposed at a local landfill is expected to have minimal impacts to the existing capacity and operational lifetime of the landfills.

Universal Waste

Universal wastes are a subset of hazardous wastes and include used batteries, mercury-containing equipment, and lamps or bulbs. Federal and state universal waste regulations are designed to promote the proper recycling of these very common types of wastes instead of managing and disposing of them as hazardous waste. The STM campus is classified as a small quantity handler of universal waste (does not accumulate 5,000 kg or more total of universal waste at any time). The majority of the universal waste (used batteries, electronics, mercury-containing devices, aerosol cans, lamps, etc.) is consolidated within each of the other five NREL facilities. Universal waste may be shipped directly from each NREL facility to a proper recycler or transferred to the STM campus for consolidation. Quantities are not

tracked by facility. The quantities below represent universal waste from all NREL facilities. Universal waste volumes generated from 2010 to 2012 are summarized in **Table 4-19**.

Table 4-19 Universal Waste Generated at STM Campus and DWOP (lbs, net weight)

Year	Universal Waste[1] (pounds)
2010	17,467
2011	33,088
2012	46,158

[1] Mercury-containing bulbs/articles, aerosol cans, batteries, electronic waste; sent for recycle.

Waste Minimization

NREL's waste minimization program includes an active recycling program. NREL collects and recycles oils, universal wastes (such as fluorescent light bulbs, batteries, and electronics), Freon from refrigeration units, and scrap metals. Wooden pallets, cardboard newspaper, office paper, books, and glass and plastic containers are some of the other materials recycled at the STM campus. NREL recycling volumes generated from 2010 to 2012 are summarized in **Table 4-20**. Garbage generation rates also are presented in **Table 4-20** for comparison purposes. NREL's waste minimization and recycling program diverts a substantial quantity of materials that would be waste to proper recycling. For example, in 2012 NREL recycled 1,837,308 pounds of various types of recyclables that could have been disposed as waste compared to 478,368 pounds of materials that were disposed of as garbage.

Table 4-20 NREL Site-wide Recycling Generated at STM Campus, DWOP, NWTC, ReFUEL, and Joyce Street Facility (lbs, net weight)

Year	Metal Recycling	Wood Recycling	Paper, Plastic, Glass, Cardboard Recycling	Garbage	Compost
2010	81,040	249,154	639,957	336,564	68,468
2011	93,827	393,308	794,093	471,631	278,549
2012	165,847	18,600	951,983	478,368	700,878

4.12.2 Environmental Consequences

Proposed Action

Hazardous materials and solid waste effects would be expected at the STM campus and DWOP from:

- Research, laboratory activities, and site operations enhancements;
- New building construction and modifications of existing buildings; and
- Infrastructure and utilities upgrades and enhancements.

New building construction and modifications of existing buildings would increase waste and hazardous materials generated by building construction activities. This would include construction waste and debris

such as concrete washout waste, lumber, building material scraps, adhesives, curing agents, solvents, various caulks, roofing materials, fuels, etc. NREL would manage these wastes by incorporating:

- Sustainable design practices such as low VOC materials,
- Construction EHS management and oversight including:
  - Green purchasing (as mentioned above);
  - Recycling;
  - Reducing the types and quantities of hazardous waste;
  - Prohibit use of asbestos containing building materials unless specifically authorized; and
  - Guidance in Subcontractor's Project Manual.

Once completed, the operation of new or modified buildings would include an increase in the storage and use of hazardous materials as described below:

- S&TF Photovoltaic Research Modifications (A) – The acids and other caustic solutions created by proposed new processes in the 156 millimeters Clean Room would be treated and either reused or disposed using the proper waste disposal protocols. NREL would be required to manage chemical wastes in a manner that would meet the requirements of the local, state, and federal requirements.
- Thermochemical Biofuels Research Facility (B) – Operation of the TBRF would include the use of hazardous materials and may result in the generation of hazardous waste. These would be similar to the types of hazardous materials managed and hazardous waste generated from existing STM campus bioenergy research and development activities. Quantities of hazardous materials to be used and waste generation rates would vary dependent upon the scale and type of research to be conducted in the TBRF at a given point in time. Overall, operation of the TBRF would result in a slightly higher overall use of hazardous materials and a small increase in the types of hazardous waste currently being generated on the STM campus.
- FTLB Modification for Algae and Other Research Organisms for Fuel (D) – The repurposing and expansion would provide additional laboratory and office space for several programs and would not be expected to increase the storage or use of hazardous materials. The additional greenhouse or grow-room space may require the use of additional lighting to support research. Used bulbs and lamps would be recycled as universal waste, as appropriate.
- ReFUEL Laboratory Relocation (I) – The ReFUEL facility research activities would necessitate the use of hazardous chemicals and would result in the creation of hazardous and non-hazardous wastes. Waste generation could be as much as 1,000 pounds of hazardous waste and 3,500 pounds of non-hazardous waste in 1 year, based on generation rates at the current off-site ReFUEL facility. This waste would include petroleum-based waste, biofuel-based waste, filters, hazardous chemicals, and electronics. Additionally, the ReFUEL relocation would increase the quantity of oils and fuels used and stored on the STM campus. Oil and fuel storage would be conducted in accordance with federal, state, and local regulations and NREL's AST and oil containing equipment management program. The SPCC Plan for the STM campus would be updated accordingly.
- REVS (J) – The REVS Facility research activities would necessitate the use of hazardous chemicals and would result in the creation of hazardous and non-hazardous wastes. Waste generation could be as much as 1,800 pounds of hazardous waste and 2,000 pounds of non-hazardous waste in 1 year based on current Building 16 (DWOP) and ReFUEL generation rates. These wastes would include petroleum-based waste biofuel-based waste, filters, hazardous chemicals, and electronics. Additionally, the REVS Facility may increase the quantity

of oils and fuels used and stored on the STM campus. Oil and fuel storage would be conducted in accordance with federal, state, and local regulations and NREL's AST and oil containing equipment management program. The SPCC Plan for the STM campus would be updated accordingly.

- WHF Expansion (K) – The expanded WHF would not generate hazardous waste, but would store hazardous waste and other waste generated from activities in other STM campus facilities. Expansion of the WHF would ensure that there is adequate space to meet future waste generation at the campus and the facility would meet or exceed the stringent requirements necessary to safely store hazardous waste and other waste, such as proper waste segregation, secondary containment, ventilation, spill response equipment, fire detection and suppression for flammable materials, alarms and monitoring systems, and communication systems.
- TriGen Central Plant (O) – In order to support these and other facilities, a new central plant may be needed. The operation and maintenance of boilers, chillers, other HVAC equipment, and the natural gas- fired fuel cell would require the use of hazardous materials, such as lubricants and oils, corrosion inhibitors, water treatment compounds, degreasers, and other types of common consumer chemical products. These would be similar to the types and quantities of hazardous materials currently used to maintain the central plants in the FTLB and SERF. This would result in a minimal increase of non-hazardous waste such as oily rags or wipes, aerosol cans that would be recycled, and extremely small quantities of hazardous wastes such as discarded consumer chemical products. The chiller systems would most likely utilize a non-ODS refrigerant such as R-134a.

In summary, the Proposed Action components would increase the storage and use of hazardous materials and the generation of solid waste from both the construction of new or modified buildings and the operations of new or modified facilities. The anticipated increase in volumes of hazardous materials and solid waste has the potential to increase the risk of spills and exposure of employees, the public, and the environment. However, these effects would be considered minor because adherence to applicable rules and regulations would occur with each new development, and because implementation of the SPCC Plan, Emergency Response Plan, and BMPs, would minimize the potential risks. Each new development would be subject to internal (DOE/NREL) review and conformance with regulatory requirements prior to and after construction.

No Action Alternative

The No Action Alternative would mean a continuation of baseline conditions, including all existing facilities and operations and previously approved facility modifications. Under the No Action Alternative, no new construction or changes in operations or workforce would be made to the STM campus or DWOP, beyond what has been previously approved. The types and quantities of hazardous materials and wastes would remain consistent with current levels; no impacts would be expected.

4.13 Socioeconomics and Environmental Justice

The following discussion focuses on social and economic conditions associated with the STM campus and DWOP, and project effects on those conditions. This section also addresses the potential for disproportionately high and adverse effects on minority, low income and other populations protected by antidiscrimination laws that could be greater than (disproportionate to) those associated with other populations.

4.13.1 Affected Environment

Employment

Recent labor force statistics are detailed in **Table 4-21**.

Table 4-21 Labor Force Characteristics

Category	Jefferson County			Colorado		
	2008	2010	2012	2008	2010	2012
Labor Force	309,492	304,783	305,325	2,731,053	2,720,492	2,743,264
Employment	295,075	278,408	282,245	2,599,724	2,475,831	2,523,535
Unemployment	14,417	26,375	23,080	131,329	244,661	219,729
Unemployment Rate (percent)	4.7	8.7	7.6	4.8	9.0	8.0

Source: U.S. Bureau of Labor Statistics 2013.

Unemployment within the State of Colorado and Jefferson County from 2008 to 2012 has risen and decreased in line with the national recession and subsequent recovery. The State of Colorado recorded a recession with unemployment reaching a high of 9.0 percent in 2010. The unemployment rate declined 1 percent to a 2012 rate of 8.0 percent. As of August 2013, the preliminary unemployment rate has continued to decline, reaching 6.7 percent, reflecting improved state and national economic conditions and other factors.

Jefferson County performed slightly better than the State, reaching a recession high of 8.7 percent in 2010 before declining to 7.6 percent in 2012. As of August 2013, the latest preliminary unemployment data for Jefferson County has shown a continued decline to 6.2 percent.

Population Growth

Population and growth data for the State of Colorado, Jefferson County, and the City of Golden were gathered from the Colorado Department of Local Affairs (DOLA) State Demography Office, which contains data as recent as 2011. The data on population change for Colorado, Jefferson County, and the City of Golden are presented in **Table 4-22**.

Table 4-22 Population Change for Colorado, Jefferson County, and the City of Golden

Jurisdiction	1990	2000	2010	2011 (estimate)	Total Change in Population 1990-2011 (%)
Colorado	3,294,473	4,338,801	5,031,298	5,118,526	55
Jefferson County	438,430	526,718	534,744	540,023	23
Golden	13,127	17,310	18,867	19,100	20

Source: Colorado Department of Local Affairs 2011.

Colorado

The State of Colorado experienced pronounced population growth from 1990 to 2011. The majority of this growth occurred from 1990 to 2000 as the state population expanded by 32 percent. Growth slowed

in the following decade, but still occurred at a notable rate of 18 percent from 2000 to 2011. The total increase in population from 1990 to 2011 was 55 percent. The state population topped 5 million in 2010.

Jefferson County

Jefferson County also experienced rapid population growth from 1990 to 2011, albeit at a slower pace than the State of Colorado. The county population expanded by 20 percent from 1990 to 2000. Population growth was 3 percent from 2000 to 2011. The total increase in population from 1990 to 2011 was 23 percent.

City of Golden

The City of Golden experienced a 32 percent increase in population from 1990 to 2000. Population growth moderated during the 2000 to 2011 timeframe, with an increase of 10 percent. The total increase in population from 1990 to 2011 was 20 percent.

Minority and Low Income Populations and Environmental Justice Considerations

Since publication of EO 12898, "Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations" in the Federal Register on February 11, 1994 (59 Federal Register 7629), federal agencies have been developing a strategy for implementing the EO. Currently, federal agencies rely on "Environmental Justice: Guidance under the National Environmental Policy Act" (guidance), prepared by the CEQ (1997), in implementing EO 12898. This guidance is found here:

http://www.energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/G-CEQ-EJGuidance.pdf

EO 12898 is intended to promote nondiscrimination in federal programs substantially affecting human health and the environment, and to provide minority and low-income communities access to public information on, and an opportunity for participation in, matters relating to human health and the environment. As required by EO 12898, federal projects must be evaluated for any disproportionately high and adverse human health or environmental effects on minority communities and low-income populations.

EO 12898 defines minority groups as American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic/Latino origin; or Hispanic/Latino. CEQ guidelines for evaluating potential adverse environmental justice effects indicate minority populations should be identified when either: 1) a minority population exceeds 50 percent of the population of the affected area; or 2) a minority population represents a "meaningfully greater increment" of the affected area population than the population of some appropriate larger geographic unit, as a whole.

The U.S. Census is the primary source for demographic data used for environmental justice evaluations. A census block group is a geographic area defined by the U.S. Census. On average, a census block group has approximately 1,500 residents. Census block groups, as well as census tracts, are more uniformly distributed in terms of the number of residents than cities or zip codes. Also, the census block group and the census tract demographic data are nearly 100 percent complete versus less than 70 percent coverage of demographic data for cities and zip codes. Therefore, census block groups and the census tracts are an excellent way to understand demographic conditions at a neighborhood scale. Census block groups are smaller than census tracts and can be further divided into census blocks for understanding locations at the block and community level.

The STM campus and DWOP are located within Census Tract 101. Census Tract 101 is divided into four blocks (**Table 4-23**).

The minority population of the area surrounding the STM campus, as a percentage, is generally less than the average composition for the State of Colorado, with some exceptions noted in **Table 4-23** in red text. These exceptions involve American Indian/Alaskan Natives percentages in the STM campus area.

Table 4-23 Racial Composition and Low-income Populations (2012)

County/State	White not Hispanic (%)	Black (%)	American Indian/ Alaska Native (%)	Asian (%)	Native Hawaiian/ Pacific Islander (%)	Other or Two or More Races (%)	Hispanic or Latino of Any Race (%)	Households Below the Poverty Level (%) (2007-2011)	Median Household Income ($) 2007-2011)
Colorado	69.6	4.3	1.6	3.0	0.2	2.8	21.0	12.5	57,685
Jefferson County	79.2	1.3	1.2	2.8	0.1	2.3	14.9	8.5	67,827
City of Golden[1]	84.4	1.2	0.6	3.8	0.1	2.3	8.2	14.5	56,926
Tract 101[1]	82.9	1.5	1.8[2]	0.2	0.0	2.7	10.9	14.7[2]	49,460[2]
Block Group 1[1]	76.3	0.6	2.8[2]	0.6	0.0	0.9	18.6	NA	NA
Block Group 2[1]	85.9	0.7	0.4	1.5	0.0	2.9	8.6	NA	NA
Block Group 3[1]	82.7	3.1	0.4	1.5	0.1	1.5	10.5	NA	NA
Block Group 4[1]	82.5	1.1	0.4	0.7	0.0	2.7	12.7	NA	NA

[1] Data are from the 2010 census. More recent estimates are not available.

[2] The red text indicates a higher percentage of American Indian/Alaskan Natives than what is typical for the State of Colorado.

Source: U.S. Census Bureau 2013, 2010.

These differences would be considered important if they could be associated with the presence of Indian Tribes or other concentrations of American Indians or Alaskan Natives that were currently subject to high and disproportionate environmental effects and/or could be subject to future high and disproportionate environmental effects. In this situation, these conditions are not present so the percentage differences are considered inconsequential.

Children's Health and Safety Risks

EO 13045, "Protection of Children from Environmental Health Risks and Safety Risks," states that federal agencies: 1) shall make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children; and 2) shall ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health or safety risks. Health and safety risks are discussed in Section 4.14.

According to the Census, 6.8 percent of the population in Colorado is under 5 years old and 24.4 percent is under 18 years old. In Golden, those percentages are 4.8 percent and 16.3 percent. In Jefferson County, those percentages are 7 percent and 10 percent. In the residential areas south of the STM campus, the percentages are similar (5.4 percent and 19.5 percent).

4.13.2 Environmental Consequences

Proposed Action

Social and Economic Effects

The Proposed Action components would result in direct and indirect socioeconomic effects. These effects would mostly result from the hiring of full-time and part-time employees for construction and facility operations, including contract employees, consultants, and others who work on the STM campus and in the DWOP and may choose to reside nearby or within the region.

The influx of construction expenditures and workers would temporarily increase economic activity and the demand for housing and social services. Economic effects would include short-term increases in local income and employment as the construction workforce procures local services near the STM campus and DWOP. The increased economic activity also would beneficially impact the local tax base, as revenues would incrementally rise from the increase in local spending. These effects would be short-term in nature and would be considered beneficial impacts.

The total number of people working at the STM campus and DWOP is anticipated to increase by up to 2 percent compounded annually over the 10-year construction period. This influence would add demand for housing and social services close to the STM campus and DWOP. These increases would be incremental, minor, and distributed over a 10-year period.

Potential for Disproportionate Social, Economic, and/or Environmental Effects

Based on an analysis of the minority and low income populations within Census Tract 101 and the magnitude of effects of the Proposed Action components as outlined in this chapter, high and disproportionate effects would not likely fall on minority and/or low income members of the community. Direct effects on nearby residents (minorities, low income households, children or other populations identified in EO 12898) would not be anticipated. Consequently, no off-site populations would be disproportionately impacted by the Proposed Action.

No Action Alternative

Under the No Action Alternative, the social and economic effects of the Proposed Action would not occur and the beneficial effects would not be realized. No adverse social or economic impacts would be linked to continuing operations as defined by the No Action Alternative.

Under the No Action Alternative, environmental justice populations would not be affected and no disproportionate effects would be anticipated.

4.14 Human Health and Safety

4.14.1 Affected Environment

NREL is committed to providing a safe and healthful workplace while protecting the surrounding community and environment. EHS policies and procedures are designed to support current research and operational needs, as well as to meet or exceed applicable federal, state, and local regulatory requirements. EHS policies and procedures are formally endorsed by institutional leadership and integrate EHS performance into workplace activities through established programs which provide clear lines of authorities and responsibilities for conducting work. All personnel have stop-work authority for any task that represents an imminent threat to safety. The objective of this approach is to emphasize that the protection of people, environment and property is of paramount importance.

NREL is committed to the principles and functions of an ISMS described in DOE Policy 450.4A, Integrated Safety Management Policy. The Laboratory's integrated safety and environmental management approach is applied as a continuous cycle with the degree of rigor appropriate to address the type of work activity and the hazards involved according to ISM guiding principles and core functions. NREL's ISMS was established to provide effective and efficient management of EHS potential hazards presented by laboratory operations. It is designed to provide an integrated perspective covering EHS performance and ensures that DOE contractors and their workers operate a safe workplace. NREL's environmental, safety, and occupational health and safety management systems are incorporated into DOE approved NREL ISMS.

NREL's ISMS also is certified to the international Occupational Health and Safety Advisory Services 18001 standard. Several key parts of the NREL ISMS are described below.

EHS Organization

NREL maintains an EHS office staffed with qualified and experienced professionals that manage comprehensive programs to recognize, evaluate, and control occupational and environmental hazards. Systematically managing EHS risks involve processes that define work scope, analyze and control hazards, perform work within controls, and continually assess and improve performance. EHS management systems include programs that identify applicable requirements and best practices, methods for conducting risk assessments, implementing a hierarchy of controls, and independent verification of program effectiveness. EHS personnel are responsible for ensuring the standards, requirements, and EHS policies are effectively translated into suitable controls for work activities.

Standards

Requirements are identified through a review of research activities, consultation with legal counsel, open communication with regulatory entities, and are periodically reviewed for changes and applicability. Awareness of these requirements facilitates the development of policies and practices that ensure regulatory requirements are met.

Risk Assessment

Facilities and operations are systematically evaluated to identify EHS hazards. Necessary controls are implemented to maintain the risk from those hazards at an acceptable level. This includes planned, existing, and unplanned hazards, risks, and occurrences. Hazard identification and control is a continuous process that incorporates integrated, systematic approaches that can be logically and consistently applied to activities and facilities. Hazard identification and control is a key component of NREL's ISMS and includes involvement of research, operations, and EHS staff. Proposed activities

associated with effort are consistent with the types of work currently conducted and within existing capabilities.

Training and Qualifications

As a component of managing risk, processes are in place to identify and implement engineering, administrative, and personal protective equipment requirements. NREL maintains well-developed and established training programs to enable workers to fully understand and conduct their duties commensurate with the hazards to which the individual worker may be exposed in his or her work assignments. All workers go through initial and recurrent training sessions to address environment, safety, and health hazards and controls associated with their work. This training, in conjunction with the established EHS procedures and programs, identifies and controls hazards to workers, the public, and the environment. Training programs also incorporate provisions for new and existing workers, contractors, and visitors. All employees and on-site subcontractors are responsible for becoming knowledgeable of and maintaining awareness of the hazards associated with their work, for contributing to the formulation of hazard controls, and for conducting their work safely in accordance with those controls. They are encouraged to identify EHS issues in their workplace, to work with their management to provide input for improvement and to resolve concerns, and to exercise stop-work authority in cases of imminent danger to the health and safety of workers or the public, or threat to the environment.

Continuous Improvement

Facility and laboratory inspections and program assessments are routinely conducted to validate conformance with internal and external requirements. These reviews are performed by a range of personnel including workers, EHS professionals, internal auditors, and external entities. Mechanisms are in place to identify and correct any deficiencies noted. As part of continuous improvement, during these reviews, and through professional development activities, programs are revised to incorporate best practices and lessons from other institutions. This provides a means of communicating internal and external operating experiences that can potentially reduce risk and improve efficiency. The purpose of developing lessons learned is to share and use experience-based information that either promotes the recurrence of desirable activities or, alternatively, precludes the recurrence of undesirable activities.

4.14.2 Environmental Consequences

Proposed Action

The Proposed Action components would incrementally increase the potential for human health and safety issues to arise at the STM campus and DWOP. These incremental effects would be caused by increasing existing and ongoing activities (more people and more processes), and by adding new and more complex activities to the existing mix of activities.

The Proposed Action components that would introduce new and/or increased health and safety issues to the STM campus include the S&TF Photovoltaic Research Modification (A), TBRF (B), FTLB Modification for Algae and Other Research Organisms for Fuel (D), ReFUEL Laboratory Relocation (I), Renewable Energy Vehicle Systems (REVS) Facility (J), the TriGen Central Plant (O), and On-site Vehicle Fuel Storage (R). The health and safety issues include: potential worker exposure to hazardous chemicals, work involving high pressure and temperatures, work involving high-energy rotating mechanical devices such as dynamometers, operation of building heating/cooling systems on a larger scale, fall protection, and hoisting/rigging during construction. Each improvement or modification would be subject to rigorous evaluations, continuous EHS oversight, regulatory compliance requirements, and permitting procedures and approvals before and after the new facilities and activities are approved, constructed, and allowed to operate. Each process and any new chemicals that may be utilized would be scrutinized by this process as a primary means of reducing human health and safety issues on-site and off-site. Given these controls, the potential for substantial human health and safety impacts would be adequately addressed and only a minor increase of potential human health and safety issues

proportionate to the increased level of activities, processes, and personnel would be expected. For example, the risk of research personnel being exposed to hazardous chemicals would increase incrementally with more research projects and more personnel, but these increases would be small, localized, and of little consequence given the evaluation of new processes and oversight that would occur as well.

No Action Alternative

The No Action Alternative would not include the Proposed Action components that incrementally increase the potential for new human health and safety issues to arise at the STM campus and DWOP. Ongoing health and safety issues would remain but would be addressed by ongoing ISMS processes to eliminate, reduce, and manage health and safety issues.

4.15 Accident Risks

4.15.1 Affected Environment

An accident is an unplanned or unintended event or sequence of events that results in undesirable consequences. Accidents may be caused by equipment malfunction, human error, or natural phenomena. Intentional destructive acts are discussed separately in Section 4.16.

NREL implements its Hazard Identification and Control Procedure (NREL 2014), along with DOE's ISMS process (see Section 4.14). NREL's procedures and policies ensure that NREL operations are "Routine Risk" or "Low Risk" and proper health and safety reviews, practices, and protocols are followed.

The estimates of event probability defined in the Event Probability Classification Table (**Table 4-24**) were developed from NREL and industry experiences and failure rate data. Event probabilities are divided into six different classes: Impossible, Extremely Remote, Remote, Occasional, Reasonably Probable, and Frequent. The annual probability estimates provided in the table are conservative; that is, they likely overestimate the occurrence of the identified accident.

Table 4-24 Event Probability Classification Table

Probability (probability that the potential consequence occurs)		
Level	**Annual Probability**	**Probability Description**
A	Frequent >1.0	Likely to occur many times during the lifecycle of the system (test/activity/operation).
B	Reasonably probable 1.0 to 0.1	Likely to occur several times during the lifecycle of the system.
C	Occasional 0.01 to 0.1	Likely to occur sometime during the lifecycle of the system.
D	Remote 0.0001 to 0.01	Not likely to occur in the lifecycle of the system, but possible.
E	Extremely remote 0.000001 to 0.0001	Probability of occurrence cannot be distinguished from zero.
F	Improbable <0.000001	Extremely unlikely to occur.

The Hazard Consequence Classification Table (**Table 4-25**) is divided into four categories: Negligible, Marginal, Critical, and Catastrophic. These estimates are based on NREL and DOE experience, general industry experience, published literature, and numeric calculations. In general, the consequence estimates are conservative; that is they overestimate the result.

Table 4-25 Hazard Consequence Classification Table

Consequence		
Category	**Description (Est. $ Lost)**	**Potential Consequences**
I	Catastrophic (equipment loss >$1,000,000)	May cause death or system loss.
II	Critical ($100,000 to $1,000,000)	May cause severe injury or occupational illness, or minor system damage.
III	Marginal ($10,000 to $100,000)	May cause minor injury or occupational illness, or minor system damage.
IV	Negligible (<$10,000)	Will not result in injury, occupational illness, or system damage.

The Risk Assessment Matrix (**Table 4-26**) combines probability (**Table 4-24**) and consequence (**Table 4-25**) into a semi-quantitative measure of risk. In this matrix, risk is divided into four risk classifications: Routine Risk, Low Risk, Moderate Risk, and High Risk. Risk is formally defined as a quantitative or qualitative expression of possible loss that considers: 1) the probability that a hazard-driven event will occur; and 2) the consequences of that event. An activity can be “Low Risk,” even if the consequences of an accident might be catastrophic (may cause death or system loss), so long as the likelihood or probability of such an accident occurring is extremely remote (i.e., annual probability of 0.000001 to 0.0001). “Routine Risk” is equated with those risks we experience during our daily lives. “Low Risk” events are those that produce minimal impact on health, safety, facilities, or the environment. “Moderate Risk” events would produce considerable impacts to the worker, facility, or the environment. “High Risk” events are those with the potential for significant on-site and off-site impacts to a large number of persons or for major impact to the environment.

Table 4-26 Risk Assessment Matrix

Failure	**Failure Frequency (per year)**	**Failure Consequence Severity**			
		Catastrophic	**Critical**	**Marginal**	**Negligible**
Frequent	>1	High Risk	High Risk	Moderate Risk	Routine Risk
Reasonably Probable	1 to 0.1	High Risk	High Risk	Moderate Risk	Routine Risk
Occasional	0.1 to 10^{-2}	High Risk	Moderate Risk	Low Risk	Routine Risk
Remote	10^{-2} to 10^{-4}	Moderate Risk	Low Risk	Low Risk	Routine Risk
Extremely Remote	10^{-4} to 10^{-6}	Low Risk	Low Risk	Routine Risk	Routine Risk
Impossible	<10-6	Routine Risk	Routine Risk	Routine Risk	Routine Risk

Source: Adapted from Appendix A of National Renewable Energy Laboratory Procedure No. 6-6.2, Hazard Identification and Control, 06/30/2006 (NREL 2014).

The hazard identification and control process is first evaluated without safety and health controls in place to determine the risk associated with an activity. Various engineering, administrative, and personal protective equipment controls are then considered and the resulting risk is evaluated. Based on the Hazard Identification and Control Procedure, activities having Low Risk and Routine Risk after controls are included would be acceptable. The NREL Hazard Identification and Control Procedure would define the scope of future hazards analysis reviews to be performed during facility design to ensure that new facility developments present acceptable risks and all appropriate measures to address risks would be identified and followed prior to facility operation.

The NREL Emergency Management Manual incorporates general emergency information and building-specific emergency preparedness plans. These documents are revised periodically to address changing circumstances, modified operations, or new information that warrants an update. Document contents and changes are routinely communicated to local responding agencies. NREL regularly conducts drills and training exercises with local law enforcement and fire districts. Facility representatives participate on the Local Emergency Planning Commission for Jefferson County.

4.15.2 Environmental Consequences

Proposed Action

The Proposed Action components that could incrementally increase the potential for new accident risks to arise at the STM campus consist of the TBRF (B), ReFUEL (I), REVS (J), and Tri-Gen (O) and are presented as an overview for accident risk discussion. It is important to note that an accident risk analysis is necessarily an iterative process in the design process; therefore, the risk scenarios, hazards, controls, mitigations, and the risks themselves may change, evolve, or be refined as the design progresses. As design and construction proceed, consistent with the Hazard Identification and Control Procedure, more detailed hazards analyses would be performed for each facility so that changes in the facility hazards and design are adequately captured and analyzed. This would ensure that facility that workers, site workers, and the general public are adequately protected from any events that may occur after the Proposed Action components become operational.

TBRF (B)

The safety and accident concerns surrounding the Proposed Action relate primarily to operation of the TBRF. The standard hazards include typical industrial hazards associated with operations of a biorefinery such as at the existing FTLB and proposed upgrades. The non-standard hazards include: operations at high temperature and pressure, use of combustible materials, and generation of hazardous products in a custom-built prototype research and development unit. The concept of the TBRF was analyzed as the Thermochemical Biorefinery Pilot Plant in the May 2008 Final Supplement to the Final Site-Wide Environmental Assessment of the National Renewable Energy Laboratory's South Table Mountain Complex (DOE/EA-1440-S-I) (DOE 2008a). The accident analysis of the Thermochemical Biorefinery Pilot Plant presented in Appendix B of DOE/EA-1440-S-I is hereby incorporated by reference.

ReFUEL (I)

There are no reasonably foreseeable accidents involving workers operating or maintaining equipment of such severity that a specific accident analysis review is warranted. DOE and industry operational experience indicate the probability and consequences of related accidents do not present risks to uninvolved workers or the general public.

The operation of the ReFUEL Facility would be similar to current practices at the existing facility. The Denver Fire Department has reviewed and approved the current system configuration. Fuel storage, blending, and transfer facilities specifically designed for safely storing and handling flammable liquids would be installed according to recognized codes and standards and local requirements. Measures to

prevent accidents and environmental incidents would include secondary containment; overfill prevention, proper grounding and static control, fire suppression, and ventilation.

Mechanical hazards such as rotating equipment would be mitigated using standard industrial safety practices.

REVS (J)

Areas of potential accident risk at REVS include the testing of batteries and hydrogen fuel integration. There are no reasonably foreseeable accidents associated with battery use and charging. DOE and industry operational experience indicate the probability and consequences of related accidents do not present risks to uninvolved workers or the general public.

Battery charging installations would be located in areas designated for that purpose. Facilities would be provided for electrolyte containment, fire protection, protecting charging apparatus from damage by nearby operations, and adequate ventilation to disperse flammable hydrogen gases and fumes from the batteries. Hydrogen and ventilation monitoring would be provided as necessary. Battery charging equipment would be equipped with devices, or otherwise designed to provide overcharge protection.

Hydrogen fuel integration and performance testing would consist of small quantities of hydrogen from compressed gas cylinders. The compression, storage, and use of hydrogen was analyzed in the November 2009 Final Supplement-II to Final Site-Wide Environmental Assessment of the National Renewable Energy Laboratory's South Table Mountain Complex (DOE/EA-1440-S-II) (DOE 2009). Portions of this analysis are directly applicable to hydrogen fuel testing and optimization of hydrogen vehicle fueling infrastructure and are provided below.

Hazard controls for hydrogen use and other safety precepts applied to hydrogen systems generally include the following:

- Providing adequate ventilation, as well as designing and operating hydrogen systems to prevent leakage, and eliminating potential ignition sources.
- Installing safety systems to detect and counteract or control the possible effects of such hazards as vessel failures, leaks and spills, embrittlement, collisions during transportation, ignitions, fires and explosions, cloud dispersions, and the exposure of personnel to flame temperatures.
- Maintaining a safe interface under normal and emergency conditions so at least two failures occur before hazardous events could lead to personal injury, loss of life, or equipment or property damage.
- Installing warning systems to detect abnormal conditions, measure malfunctions, and indicate incipient failures. Providing warning system data transmissions with visible and audible signals that have sufficient redundancy to prevent any single-point failure from disabling the warning system.
- Installing a safety valving and flow regulation that would adequately respond and protect personnel and equipment during hydrogen storage, handling, and use.
- Applying a system of verifications of equipment, power, and other system services for safe performance in the design and normal operational regimes.
- Applying a "fail-safe" system design, meaning that any single point failure from which potentially hazardous conditions are a risk must cause the system to revert to conditions that would be safest for personnel and with the lowest property damage potential.
- Subjecting all plans, designs, and operations associated with hydrogen use to an independent, safety review. Safety reviews should be conducted on effects of fluid properties, training, escape and rescue, fire detection, and firefighting.

- Performing hazards analyses to identify conditions that may cause injury, death, or property damage.

These safety controls and precepts are currently implemented at NREL, and NREL's ISMS provides a rigorous administrative structure that will ensure these safety precepts are successfully applied. No reasonably foreseeable accidents are evident at this time; however, a thorough review and process hazard assessment will be conducted during the design process, and controls will be incorporated to reduce risks to a Low level.

TriGen (O)

There are no reasonably foreseeable accidents involving workers operating or maintaining equipment of such severity that a specific accident analysis review is warranted. DOE and industry operational experience indicate the probability and consequences of related accidents do not present risks to uninvolved workers or the general public.

The operation of the TriGen does not present special or unique hazards. The hazards of delivery and combustion of flammable gases is well-documented and well-understood. Installed equipment would be commercially available units tested or certified to industry-accepted standards, and installed according to recognized codes and standards and local requirements. The operation of low-pressure hot water boilers, natural gas-supplied fuel cells, and electrical distribution equipment would present typical industrial hazards associated with high temperatures, combustion of natural gas, and hydrogen production.

The fuel cell component of the facility would be housed in a manner to prevent potential retention and confinement of hydrogen gases, thereby reducing the risk of fire or explosion. The fuel cell would be operated using natural gas at ambient pressures which would limit the volume of hydrogen present at any given time.

As previously noted, additional hazard analysis reviews will be performed during facility design and prior to operation to ensure unacceptable risks are not introduced. This may include the installation of monitoring equipment, fire suppression, etc.

No Action Alternative

The No Action Alternative would not include the Proposed Action components that would incrementally increase the potential for new accident risks to arise at the STM campus and DWOP. Ongoing accident risks would remain but would be addressed by ongoing risk management efforts.

4.16 Intentional Destructive Acts

4.16.1 Affected Environment

Sabotage and terrorism are considered intentional destructive acts. At this time, there have been no incidents of sabotage, terrorism, or any other type of intentional disruptive act at the STM campus or the DWOP. However, these risks exist at both locations, and the possibility of this occurring in the future exists.

As described in Section 4.15, various risks exist on the STM campus and within the DWOP that could be exploited by intentional destructive acts. In addition, risks from explosive, reactive, or otherwise hazardous sources could be introduced to either location from one or more saboteur or terrorist. The potential number of scenarios is limitless and the likelihood of attack is unknown at this time.

Based on recent examples of terrorism within the U.S. and around the world, but limited Colorado and Denver Federal Center examples, the probability that the STM campus and/or DWOP would experience

an intentional destructive act within the next 10 years would be considered “extremely remote,” but potentially catastrophic (see **Table 4-24**), similar to the upper bound of the potential risks of an on-site accident, and would be adequately addressed by existing management protocol and procedures (see Section 4.15).

NREL has taken numerous actions to comply with federal security requirements and guidelines. Visible examples include improved security gates and entry procedures. STM campus security is provided by three controlled gates and perimeter fencing. Although NREL has made accommodations for wildlife movement, NREL does not allow bicycle and pedestrian access by local residents or visitors through the campus due to health, safety, and security requirements. Other examples to comply with requirements and guidelines involve minimizing risks within areas where potential risks exist.

4.16.2 Environmental Consequences

Proposed Action

The Proposed Action components would incrementally add various risks to the STM campus or DWOP that could be exploited by a saboteur or terrorist. This incremental increase in risk would be considered negligible or minor because it would not measurably change the likelihood of an attack or make an attack measurably more destructive, and appropriate steps have been taken to meet federal requirements and guidelines for federal facility security.

No Action Alternative

The No Action Alternative would not add risks to the STM campus or DWOP that could be exploited by a saboteur or terrorist. The likelihood of an attack and the level of destruction anticipated from an attack would not be expected to change.

5.0 Cumulative and Other Effects

5.1 Cumulative Effects

Chapter 4.0 describes the direct and indirect effects of the Proposed Action and Alternatives. Cumulative effects address these project impacts when added to similar impacts from other past, present, and reasonably foreseeable future actions (40 CFR Section 1508.7).

Based on the land development history of the STM campus, DWOP, and the surrounding area, the temporal boundaries for the relevant past, present and reasonably foreseeable projects were defined as follows:

- **Past (1974):** Year DOE/NREL took over and thereafter began to develop the STM campus location.
- **Present (2013):** Projects under construction on December 31, 2013.
- **Future (2023):** An appropriate upper limit for "reasonably foreseeable" (on-site and off-site) projects.

A project must be fully funded now and/or must be subject to development review or be ready for construction within the next 10 years to be considered reasonably foreseeable.

The spatial boundaries were selected as the relevant, composite geographic limits found by looking at the direct and indirect effects of the Proposed Action and how similar off-site projects have or will contribute directly to similar effects. In general, the spatial boundary was determined to include effects on South Table Mountain and portions of local communities (Jefferson County, Golden, Lakewood), within approximately 1 mile of the STM campus and DWOP boundaries, focusing on connected resource areas such as habitats, watersheds, and viewsheds.

The cumulative effects analysis considered input from the scoping process and responses to inquiries specifically directed to key agencies requesting relevant past, present and reasonably foreseeable actions that should be considered. Input from local agencies was limited and did not identify any specific or unanticipated projects. Consequently, the analysis defined past, present and reasonably projects within the temporal and spatial limits defined for this analysis in general terms.

The relevant past projects that had effects similar to those of the Proposed Action and Alternatives primarily included construction of:

- The existing buildings and facilities on the STM campus;
- The Colorado State Highway Patrol driver training track and other facilities on top of South Table Mountain;
- The condominiums on the east side of the STM campus;
- The residential, commercial, office, and retail uses within close proximity to the I-70/Denver West-Marriott Boulevard interchange;
- Various local, state, and federal roadway improvements; and
- The Colorado Mills shopping center is one example of recent development in the area.

The rezoning of 14040 Denver West Circle and the associated residential development called Denver West Apartments is one example of new development going on in 2014. The project involves approximately 250 multi-family units on a 12.8 acre site.

No other substantial reasonably foreseeable off-site projects were identified that will be under construction in the next 10 years (by 2023). This occurs primarily because almost all of the land surrounding the STM campus and DWOP is already developed or has been set aside as open space (South Table Mountain, Pleasant View Community Park, and Applewood Park). This is a substantial change from conditions 10 years ago. Redevelopment of some properties may occur in the 10-year timeframe, but no substantial projects of this type are anticipated at this time.

The past improvements combined have substantially changed the native conditions of the area since the 1970s. Various impacts such as land use conversion from open space to urban conditions have occurred incrementally in the area and elsewhere over time. These changes and their impacts are the subject of individual reviews and approvals by government agencies over time.

Cumulative effects, including those from the Proposed Action, are described in the following discussions. In each case, the incremental contributions from the Proposed Action would not create effects that exceed a regulatory tolerance threshold.

5.1.1 Land Use

Open land conversion to developed uses furthers the ongoing trend of urbanization in the area. This development has reduced the amount of land available for recreation, natural viewsheds, historic preservation, and various biological values. Development also has increased noise, demand for housing, exposure to geologic risks, and impervious surfaces leading to higher storm water volumes and runoff rates. However, the development on the STM campus and surrounding areas was planned and does not stimulate unplanned development or present the potential to open new off-site areas for development. More specifically, the planned development does not create improved access to real estate, reduce development restrictions, or substantially induce new development in unanticipated areas. The Denver West Apartments would convert approximately 12.8 acres of undeveloped land to suburban uses.

5.1.2 Transportation and Traffic

New development and the associated trips generated since 1974 have increased traffic congestion along local roadways, at key local intersections, and at the I-70/Denver West-Marriott Boulevard interchange. However, the incremental impact from the Proposed Action with NREL's implemented traffic mitigation measures, in conjunction with future traffic projections for the area, including the potential for growth from infill development, would leave sufficient capacity for additional planned development in the vicinity while resulting in acceptable traffic levels in 2023.

5.1.3 Air Quality

Air pollutant emissions that contribute to area and regional air pollutant concentrations have increased since the 1970s. Considerable regional efforts and state and federal regulations have controlled these increases. The incremental air quality impact from the Proposed Action would not be expected to have any meaningful impact on Denver Metropolitan Area air quality, attainment, or climate change. However, air pollutant concentrations in the Denver Metropolitan Area are relatively close to the standard for ozone and other pollutants, so every source is scrutinized. Given the potential air quality benefits of renewable energy and energy efficiency research to be performed at the STM campus, the overall net impact on cumulative air quality would be considered minor.

5.1.4 Noise

Increased urbanization has generated higher overall noise levels. The operational noise from the Proposed Action and other noise sources are not expected to increase ambient noise levels appreciably. Noise generated during construction, from vehicle use on the STM campus and operations, plus noise from other sources is not expected to cause noise levels to exceed any cumulative noise impact standard.

5.1.5 Visual Quality and Aesthetics

Development under the Proposed Action and the Denver West Apartments would involve infill development. However, this development would not create substantial or cumulative changes in the overall character of the STM campus or surrounding area. The urban character of the STM campus would continue to increase – matching surrounding areas that have been deemed suitable for development. South Table Mountain conditions would be unchanged.

5.1.6 Water Resources

Urbanization often increases runoff volumes that add to downstream capacity inadequacies. Lena Gulch and downstream channels are conveying increased storm water volumes. Existing and future on-site detention facilities and regional efforts to address storm water drainage and flooding would effectively address this potential cumulative effect.

5.1.7 Geologic Resources

Development of the STM campus and surrounding areas with geologic and mineral resources has exposed people to hazards and reduced accessibility to mineral resources. Geologic hazards would continue to be managed and reduced to acceptable levels through building practices. Access to mineral resources would continue through existing regulations.

5.1.8 Soils

Development of the STM campus and surrounding areas has disturbed soils and removed vegetation, causing exposure of the soil, mixing of soil horizons, soil compaction, and loss of topsoil productivity. These impacts have increased runoff, and often lead to increased susceptibility of the soil to erosion and sedimentation. NREL's environmental commitments and application of BMPs on the STM campus and elsewhere would adequately address cumulative effects on soil resources.

5.1.9 Vegetation and Wildlife

Land development intensification continues to reduce available lands for native vegetation and wildlife on the STM campus and surrounding areas and often leads to the spread of noxious weeds during and after construction activities. The planned infill development on and off the STM Campus and broad efforts to control weeds and revegetated disturbed areas would minimize these effects on the STM campus and elsewhere. Long-term site planning and conservation areas would continue to reserve the most sensitive parts of the STM campus for biological uses.

Increased water use at the STM campus, as described in Section 4.6, is expected to result in off-site, downstream water flow depletions in the Platte River. Platte River water flow depletion is a regional cumulative effect that presents the potential to impact various protected species in the central and lower Platte River in Nebraska. Details about these potential incremental and cumulative effects are described and addressed in **Appendix D** and **Appendix E**. **Appendix E** includes the project's Biological Assessment and Request for Formal Section 7 Consultation prepared by DOE, and will include the Final Biological Opinion when it is issued by the USFWS

5.1.10 Cultural Resources

New development that displaces or adversely impacts the context or setting of historic buildings has occurred in the area since the 1970s. The indirect effects of the Proposed Action on the historic resources would further reduce the historic context and setting of Camp George, which was divided and had been modified in various ways since the 1970s.

DOE has initiated consultations pursuant with Section 106 of the NHPA to address incremental and cumulative indirect visual impacts to the amphitheater and ammunition igloo on the STM campus. These effects could occur from new development near, and within the viewshed of, these resources. DOE has proposed to address Section 106 obligations by initiating future consultations, on a project-by-project basis, when individual components of the Proposed Action are funded/ authorized. SHPO has concurred with this approach. This consultation and coordination will allow for further effects analysis, including the exploration of impact avoidance, minimization and mitigation strategies as appropriate (see **Appendix F**).

5.1.11 Socioeconomic and Environmental Justice

Employment opportunities and other development since the 1970s have increased local populations, economic activity, and the demand for housing in the area. Employment opportunities would increase further with new construction and facility operations.

No disproportionate effects on low income, minority, or other populations protected by civil rights laws, EO 12898 and similar regulations, would be anticipated.

5.1.12 Hazardous Materials and Waste Management

Increased industrialization in the area has brought with it increased use and handling of hazardous materials and the disposal of solid waste in landfills. The Proposed Action would contribute to these increases, leading to higher exposures and risks to workers, residents, and visitors to the area and faster rates of filling landfills. Since the 1970s, many regulations directed specifically at hazardous wastes and recycling have been enacted and are in place. These regulations would effectively address the accumulated on-site conditions and other off-site conditions.

5.1.13 Human Health and Safety, Accident Risks, and Intentional Destructive Acts

New buildings, facilities, and processes would increase health risks, introduce and/or increase safety issues, and increase the potential and magnitude of effects associated with intentional destructive acts. The net effect of these impacts caused by the Proposed Action and surrounding conditions would be considered minor given increased efforts to manage health, safety, and security at the local, state, and federal levels.

5.2 Irreversible/Irretrievable Commitment of Resources

An irreversible commitment of resources is defined as the loss of future options. The term applies primarily to the effects of use of nonrenewable resources such as minerals or cultural resources, or to those factors such as soil productivity that are renewable only over long periods. It also could apply to the loss of an experience as an indirect effect of a “permanent” change in the nature or character of the land.

An irretrievable commitment of resources is defined as the loss of production, harvest, or use of natural resources. The amount of production foregone is irretrievable, but the action is not irreversible. If the use changes, it is possible to resume production.

The Proposed Action would not have permanent irreversible impacts because future options for using the STM campus and DWOP would remain possible. A future decommissioning process could restore the area for alternative uses, ranging from natural open space to urban development.

The primary irretrievable impacts of the Proposed Action would involve the use of energy, labor, materials and funds, and the conversion of some lands from a natural condition through the construction of buildings and facilities. Irretrievable impacts would occur as a result of construction, facility operation, and maintenance activities. Direct losses of biological productivity and the use of natural resources from these impacts would be inconsequential given current conditions at the STM campus and DWOP.

5.3 The Relationship between Local Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

This discussion addresses the commitment of resources associated with the Proposed Action relative to the loss of long-term productivity associated with these commitments.

The Proposed Action would commit resources in the form of energy, labor, materials, and funds over 20 years or more. The justification for these commitments at this time is described in the project's purpose and need for the Proposed Action (see Chapter 1.0).

Long-term productivity associated with the STM campus and DWOP relates to biological value as habitat, and open space values associated with aesthetic quality and recreation. The Proposed Action would involve the use of lands where these values have already been compromised by buildings, facilities, and operations and would preserve much of the site for these purposes. For these reasons, the incremental loss of biological and open space values would be minor. Improved efficiency and increased reliance on renewable energy resources could substantially reduce reliance on coal, oil, and nuclear fuels and reduce resource productivity losses in resource extraction areas. The Proposed Action would not create significant long-term risks to public health and safety.

5.4 Unavoidable Adverse Impacts

There would be no substantial unavoidable adverse impacts caused by the Proposed Action.

6.0 List of Preparers

The following persons were primarily responsible for preparing this Final SWEA:

- Kristin Kerwin
  NEPA Compliance Officer
  Office of Energy Efficiency and Renewable Energy
  U.S. Department of Energy
- Robert V. Smith, CHMM
  NEPA Document Manager
  Office of Energy Efficiency and Renewable Energy
  U.S. Department of Energy
- Thomas Ryon
  Senior Environmental Scientist/Wildlife Biologist
  Environmental, Health and Safety
  National Renewable Energy Laboratory

Table 6-1 clarifies the name, qualifications, and primary responsibilities of NREL's consultant (AECOM Technical Services, Inc. [AECOM]).

Table 6-1 Name, Qualifications, and Primary Responsibilities of NREL's Consultant (AECOM)

Name	Qualifications	Primary Responsibilities
Brian P. Kennedy, AICP	BA, Special Major: Environmental Planning and Design, California State University, Chico, 1982 31 years of experience managing NEPA documentation and doing related technical studies. Project Manager for 2003 STM Site-Wide EA	Project Manager Transportation and Traffic Noise Visual Quality and Aesthetics Health and Safety Accident Risks Intentional Destructive Acts Cumulative and Other Effects
Terra Mascarenas	BS, Soil and Crop Science, Concentration in Environmental Science, Colorado State University Certificate of Technology, Pueblo Community College 18 years of experience	Deputy Project Manager Soils
Molly Giere	MBA, University of Dayton BS, Biology, The Ohio State University 24 years of experience	Quality Assurance Quality Control

Table 6-1 Name, Qualifications, and Primary Responsibilities of NREL's Consultant (AECOM)

Name	Qualifications	Primary Responsibilities
Steve Graber	BS, Natural Resources Management, Colorado State University BA, Economics, Colorado State University 8 years of experience	Socioeconomics Environmental Justice
Andrew Newman	MS, Environmental Policy/Natural Resource Management, Denver University BS, Conservation Biology/Wildlife Management, California State University, Sacramento 14 years of experience	Wildlife
Chris Dunne	BS, Natural Resource Management, Colorado State University 14 years of experience	Land Use
Erin Berquist	MS, Ecology, Colorado State University BA, Environmental Studies & Economics, University of Colorado 12 years of experience	Vegetation
Kim Munson	MA, Anthropology, Colorado State University BA, Anthropology, Colorado State University Heritage Resources Management - Section 106 Review, University of Nevada Integrating Cultural Resources into NEPA Compliance, National Preservation Institute Section 106: A Review for Experienced Practitioners, National Preservation Institute 22 years of experience	Cultural Resources
William Berg	MS, Geology, University of Wyoming BS, Geology, Colorado State University 25 years of experience	Geologic Resources
David Fetter	BS, Watershed Science, Colorado State University 8 years of experience	Water Resources

Table 6-1 Name, Qualifications, and Primary Responsibilities of NREL's Consultant (AECOM)

Name	Qualifications	Primary Responsibilities
April Moreland	BS, Environmental Studies, Florida State University 13 years of experience	Hazardous Materials
Steve Ensley	BS, Environmental Conservation, Northern Michigan University 8 years of experience	Geographic Information Systems
Tiffany Samuelson	MS, Meteorology, Pennsylvania State University BS, Architectural Engineering with Honors, Minor in Mathematics, University of Texas at Austin 4 years of experience	Air Quality
James Van Horne	BS, Mechanical Engineering, Colorado State University 5 years of experience	Air Quality

7.0 References

Adams, L. W. and A. D. Geis. 1983. Effects of Roads on Small Mammals. Journal of Applied Ecology 20(2):403–415.

Baseline Engineering. 2012. Level of Service (LOS) Analysis Denver West Parkway and Denver West Marriott Boulevard, Quaker Street and South Golden Road. March.

Baseline Engineering. 2009. National Renewable Energy Laboratory South Table Mountain Complex Traffic Impact Study, Revision. October.

Berg, W. R. 1962. Subsurface Interpretation of Golden Fault at Soda Lakes, Jefferson County, Colorado. Geological Notes: American Association of Petroleum Geologists Bulletin 46(5):704-707.

Bolt, B. 1993. Earthquakes and Geological Discovery. Scientific American Library, a Division of HPHLP, New York. 229 pp.

Bureau of Land Management. 2013. Paleontological Laws and Policy. Internet website: http://www.blm.gov/wo/st/en/prog/more/CRM/paleontology/paleontological_regulations.html. Accessed September 25, 2013.

Butler, W. B. 1992. Archaeological Survey of Camp George West and the Works Progress Administration South Table Mountain Basalt Quarries. Jefferson County, Colorado.

Cole, E. K., M. D. Pope, and R. G. Anthony. 1997. Effects of Road Management on Movement and Survival of Roosevelt Elk. Journal of Wildlife Management 61(4).

Colorado Department of Agriculture (CDA). 2013. Colorado Department of Agriculture. Colorado Noxious Weed List. Internet website: http://www.colorado.gov/. Accessed August 1, 2013.

Colorado Department of Labor and Employment (CDLE). 2014. Colorado Storage Tank Information System (COSTIS). Internet website: http://costis.cdle.state.co.us.

Colorado Department of Local Affairs. 2011. State Demography Office. Internet website: http://www.colorado.gov/cs/Satellite/DOLA-Main/CBON/1251590805419. Accessed October 16, 2013.

Colorado Department of Public Health and Environment (CDPHE). 2013. Draft Colorado Greenhouse Gas Inventory – 2013. Update – Including Projections to 2020 & 2030. Authors: S. Arnold, J. Dileo, and T. Takushi. December 11, 2013.

Colorado Department of Transportation (CDOT). 2006. I-25 Valley Highway Environmental Impact Statement (EIS) and ROD. Internet website: http://www.coloradodot.info/library/studies/i-25-valley-highway-EIS. Accessed September 18, 2013.

Colorado Geological Survey (CGS). 2013. Earthquakes in Colorado. Internet website: http://geosurvey.state.co.us/hazards/Earthquakes/Pages/Earthquakes.aspx. Accessed September 15, 2013.

Colorado Oil and Gas Conservation Commission (COGCC). 2013. Internet website: http://cogcc.state.co.us/. Accessed September 18, 2013.

Colorado Parks and Wildlife (CPW). 2013a. Threatened and Endangered List. State of Colorado. Internet website: http://wildlife.state.co.us/WildlifeSpecies/SpeciesOfConcern/ThreatenedEndangeredList/Pages/ListOfThreatenedAndEndangeredSpecies.aspx.

Council on Environmental Quality (CEQ). 2010. Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions. Internet website: http://energy.gov/sites/prod/files/CEQ_Draft_Guidance-ClimateChangeandGHGemissions-2.18.10.pdf

Denver Regional Council of Governments. 2013. 2012 Annual Report on Traffic Congestion in the Denver Region. May 7, 2013. Internet website: http://www.drcog.org/agendas/2012%20CMP%20Report%20-%20May%202%20.pdf

Federal Emergency Management Agency (FEMA). 2003. Flood Insurance Rate Map. Jefferson County, Colorado, and Incorporated Areas. Panel 281 of 675. Map Number 08059C0281 E. Effective date: June 17, 2003.

Fenneman, N. M. 1928. Physiographic Divisions of the United States. Annals of the Association of American Geographers XVIII(4)264-353.

Felsburg Holt & Ullevig (FHU). 2008. National Renewable Energy Laboratory South Table Mountain Facility Traffic Impact Study. April.

Forum Associates, Inc. 1988. Historical Review, Solar Energy Research Institute. Golden, Colorado.

Hart, S. S. 1974. Potentially Swelling Soil and Rock in the Front Range Urban Corridor, Colorado: Colorado Geological Survey Environmental Geology Series No. 7. 23 pp.

International Panel on Climate Change (IPCC). 2007. *Climate Change 2007: Synthesis Report*. Contribution of Working Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, New York, USA.

Jefferson County, Colorado. 2013a. Internet website: http://jeffco.us/planning-and-zoning/demographics/. Accessed October 8, 2013.

Jefferson County, Colorado. 2013b. 2013 Jefferson County Noxious Weed List. Internet website: http://www.co.jefferson.wa.us/weedboard/

Jefferson County, Colorado. 2012. Planning and Zoning Division. Jefferson County Comprehensive Master Plan. December 12, 2012.

Jerrett, M., M. M. Finkelstein, J. R. Brook, M. A. Arain, P. Kanaroglou, D. M. Stieb, N. L. Gilbert, D. Verma, N. Finkelstein, K. R. Chapman, and M. R. Sears. 2009. *A Cohort Study of Traffic-Related Air Pollution and Mortality in Toronto, Ontario, Canada*. May 2009. Environmental Health Perspectives 117: 772-777.

Johnsgard, P. A. 1988. North America Owls: Biology and Natural History. Smithsonian Institution Press.

Kellogg, K. S., R. R. Shroba, B. Bryant, and W. R. Premo. 2008. Geologic Map of the Denver West 30' x 60' Quadrangle, North-central Colorado: U.S. Geological Survey Scientific Investigations Map 3000, scale 1:100,000.

Killam, D. 2010. Class III Cultural Resource Inventory of the Proposed South Access Road, National Renewable Energy Laboratory. Jefferson County, Colorado.

Killam, D. and E. Hendrickson. 2011. Addendum to Class III Cultural Resource Inventory of the Proposed South Access Road, National Renewable Energy Laboratory. Jefferson County, Colorado.

Kunz, T. H. et al. 2007. Assessing Impacts of Wind-energy Development on Nocturnally Active Birds and Bats: A Guidance Document. The Wildlife Society – Journal of Wildlife Management 71(8):2449-2486.

Loss, S. R., T. Will, and P. P. Marra. 2013. Estimates of Bird Collision Mortality at Wind Facilities in the Contiguous United States. Biological Conservation 168:201-209.

McConnell, R., T. Islam, K. Shankardass, M. Jerrett, F. Lurmann, F. Gilliland, J. Gauderman, E. Avol, N. Küzli, L. Yao, J. Peters, and K. Berhane. 2010. Childhood Incident Asthma and Traffic-Related Air Pollution at Home and School. Childrens' Health 118(7):1021-1026. Internet website: http://www.asquifyde.es/uploads/documentos/Childhood-Incident-Asthma-and-Traffic-Related-Air-Pollution-at-Home-and-School-2010.pdf.

Morgan, M. L., V. Matthews, and L. Heerschap. 2012. Colorado Earthquake Map Server: Internet website: http://dnrwebcomapg.state.co.us/CGSOnline/. Accessed September 15, 2013.

National Renewable Energy Laboratory (NREL). 2014. Adapted from Appendix A of National Renewable Energy Laboratory Procedure No. 6-6.2, Hazard Identification and Control. June 30, 2006.

National Renewable Energy Laboratory (NREL). 2013. Environmental Performance Report 2012, Annual Site Environmental Report per the U.S. Department of Energy Order 231.1-1B.

National Renewable Energy Laboratory (NREL). 2012a. FY 2012 NREL Air Emissions Inventory. June 2012.

National Renewable Energy Laboratory (NREL). 2012b. Recording Form for Physical Assessment Data, Building 16. November 11, 2012.

National Renewable Energy Laboratory (NREL). 2012c. Recording Form for Physical Assessment Data, FTLB. November 9, 2012.

National Renewable Energy Laboratory (NREL). 2011a. *Environmental Performance Report 2011*.

National Renewable Energy Laboratory (NREL). 2011b. *Sustainable NREL Biennial Report FY 2010-2011.*

National Renewable Energy Laboratory (NREL). 2011c. 2010-2011 Vegetation and Wildlife Surveys at the National Renewable Energy Laboratory, South Table Mountain Jefferson County, Colorado. Prepared by Walsh Environmental. August 12, 2011.

National Renewable Energy Laboratory (NREL). 2008. Final Supplement to Final Site-Wide Environmental Assessment of the National Renewable Energy Laboratory's South Table Mountain Complex. U.S. Department of Energy Golden Field Office National Renewable Energy Laboratory. May 2008.

National Renewable Energy Laboratory (NREL). 2005. Wildlife Survey (Including Migratory Birds and Raptors) at the National Renewable Energy Laboratory South Table Mountain Site Golden, Colorado. Prepared by Science Applications International Corporation (SAIC). June 22, 2005.

National Renewable Energy Laboratory (NREL). 2003. Final Site-Wide Environmental Assessment of the National Renewable Energy Laboratory's South Table Mountain Complex. U.S. Department of Energy, Golden Field Office National Renewable Energy Laboratory. July 2003.

National Renewable Energy Laboratory (NREL). 2002. Vegetation Survey Report National Renewable Energy Laboratory South Table Mountain Site. Prepared by: Plantae Consulting Services. NREL/MP-190-43415. June 2002.

National Weather Service (NWS). 2013. Climate Report, National Weather Service, Boulder, Colorado. The Denver, Colorado Climate Summary for the Year of 2012. Internet website: http://www.crh.noaa.gov/bou/include/showProduct.php?product=denclm_2012.txt. Accessed October 15, 2013.

Natural Resources Conservation Service (NRCS). 2013. Soil Survey Geographic (SSURGO) Database for Jefferson County, Colorado. Internet website: http://datagateway.nrcs.usda.gov/. Accessed September 15, 2013.

Natural Resources Conservation Service (NRCS), U.S. Geological Survey (USGS), and U.S. Environmental Protection Agency (USEPA). 2010. Watershed Boundary Dataset, Geospatial Data. Internet website: http://datagateway.nrcs.usda.gov. Accessed on January 19, 2011.

Natural Resources Conservation Service (NRCS). 2006. Appendix A of National Renewable Energy Laboratory Procedure No. 6-6.2, Hazard Identification and Control. June 30, 2006.

Nelson, P. H. and S. L. Santus. 2011. Gas, Water, and Oil Production from Wattenberg Field in the Denver Basin, Colorado: U.S. Geological Survey Open-File Report 2011–1175. 23 pp + 2 plates.

Nelson, S. 1980. Historic and Prehistoric Resources. South Table Mountain. Golden, Colorado.

Noe, D. C., J. M. Soule, J. L. Hynes, and K. A. Berry. 1999. Bouncing Boulders, Rising Rivers, and Sneaky Soils: A Primer of Geologic Hazards and Engineering Geology along Colorado's Front Range: Geological Society of America Field Guide 1. Internet website: http://fieldguides.gsapubs.org/. Accessed September 18, 2012.

Occupational Safety and Health Administration (OSHA). 2013. Occupational Noise Exposure. Internet website: https://www.osha.gov/SLTC/noisehearingconservation/. Accessed October 1, 2013.

Petersen, M. D., A. D. Frankel, S. C. Harmsen, C. S. Mueller, K. M. Haller, R. L. Wheeler, R. L. Wesson, Y. Zeng, O. S. Boyd, , D. M. Perkins, N. Luco, E. H. Field, C. J. Wills, and K. S. Rukstales. 2008. Documentation for the 2008 Update of the United States National Seismic Hazard Maps: U.S. Geological Survey Open-File Report 2008-1128. 61 pp.

Perkins, D. M., N. Luco, E. H. Field, C. J. Wills, and K. S. Rukstales. 2008. Documentation for the 2008 Update of the United States National Seismic Hazard Maps: U.S. Geological Survey Open-File Report 2008-1128, 61 pp.

Regional Transportation District (RTD). 2013. Schedules. Internet website: http://www.rtd-denver.com/Schedules.shtml. Accessed October 1, 2013.

Rogers, W. P., R. M. Kirkham, and B. L. Widmann (Compilers). 1998. Fault Number 2324, Golden Fault, in Quaternary Fault and Fold Database of the United States: Internet website: http://earthquakes.usgs.gov/hazards/qfaults. Accessed September 15, 2013.

Ryon, T. 2013. Personal communication between Thomas Ryon, NREL, and Brian Kennedy, AECOM regarding wildlife data at the STM, April 28, 2014.

Sawyer, H., R. Nielson, and D. Strickland. 2009. Sublette Mule Deer Study (Phase II): Final Report 2007 Western Ecosystems Technology, Inc. Cheyenne, Wyoming.

Science Applications International Corporation (SAIC). 2006. Camp George West Level II HABS/HAER Documentation.

Scott, G. 1972a. Map Showing Landslides and Areas Susceptible to Landslides in the Morrison Quadrangle, Jefferson County, Colorado. U.S. Geological Survey Folio of the Morrison Quadrangle, Map I-790-B.

Scott, G. 1972b. Map Showing Watercourses and Areas Inundated by Historic Floods in the Morrison Quadrangle, Jefferson County, Colorado. U.S. Geological Survey Folio of the Morrison Quadrangle, Map I-790-F.

Scott, G. 1972c. Map Showing Potential Source Areas for Non-metallic Mineral Resources in the Morrison Quadrangle, Jefferson County, Colorado. U.S. Geological Survey Folio of the Morrison Quadrangle, Map I-790-D.

Scott, G. 1972d. Geologic Map of the Morrison Quadrangle, Jefferson County, Colorado. U.S. Geological Survey Folio of the Morrison Quadrangle, Map I-790-A.

Simmons, R. L. and T. H. Simmons. 1992. Historic Resources Survey. Camp George West, Golden, Colorado. Front Range Research Associates, Inc., for the City of Golden, Colorado.

Stokes, D. W. and L. Q. Stokes. 1996. Field Guide to Birds: Western Region. Little, Brown, and Company.

Tetra Tech Inc. 2011. Avian Monitoring and Mortality Report. National Wind Technology Center, Jefferson County, Colorado. October 2011.

Topper, R., K. L. Spray, W. H. Bellis, J. L. Hamilton, and P. E. Barkmann. 2003. Ground Water Atlas of Colorado. Colorado Geological Survey, Division of Minerals and Geology, Department of Natural Resources. Special Publication 53. Denver, Colorado.

Transportation Research Board, National Research Council. 2000. Highway Capacity Manual, Fourth Edition. ISBN 0-309-06681-6.

Trimble, D. 1980. The Geologic Story of the Great Plains: A Nontechnical Description of the Origin and Evolution of the Landscape of the Great Plains. U.S. Geological Survey Bulletin 1493.

U.S. Army Corp of Engineers (USACE). 2009. Letter regarding National Renewable Energy Laboratory, Drainage Review Corps File No. NWO-2009-1014-DEN. Department of the Army, Corps of Engineers, Omaha District. April 27, 2009. Littleton, Colorado.

U.S. Army Corps of Engineers (USACE). 1987. Corps of Engineers Wetlands Delineation Manual, Technical Report Y-87-1. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi.

U.S. Bureau of Labor Statistics. 2013. Local Area Unemployment Statistics. Internet website: http://data.bls.gov/pdq/querytool.jsp?survey=la. Accessed November 13, 2013.

U.S. Census Bureau. 2013. State and County Quick Facts. Internet website: http://quickfacts.census.gov/qfd/index.html. Accessed November 13, 2013.

U.S. Census Bureau. 2010. American FactFinder. Internet website: http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed November 12, 2013.

U.S. Department of Agriculture- Natural Resources Conservation Service (USDA-NRCS). 2013. The Plants Database, National Plant Data Center, Baton Rouge, Louisiana. Internet website: http://plants.usda.gov. Accessed December 2013.

U.S. Department of Energy (DOE). 2009. Final Supplement-II to Final Site-Wide Environmental Assessment of the National Renewable Energy Laboratory's South Table Mountain Complex (DOE/EA-1440-S-II). November 2009. Golden, Colorado.

U.S. Department of Energy (DOE). 2008a. Final Supplement to Final Site-Wide Environmental Assessment of the National Renewable Energy Laboratory's South Table Mountain Complex. USDOE, Golden Field Office, National Renewable Energy Laboratory. DOE/EA-1440-S-1. May 2008. Golden, Colorado.

U.S. Department of Energy (DOE). 2008b. Mitigation Action Plan for the Supplement to Final Site-Wide Environmental Assessment and Finding of No Significant Impact for the National Renewable Energy Laboratory's South Table Mountain Complex.

U.S. Department of Energy (DOE). 2003. Final Site-Wide Environmental Assessment of the National Renewable Energy Laboratory's South Table Mountain Complex and a Finding of No Significant Impact (FONSI) for proposed site development activities (DOE/EA-1440).

U.S. Department of Energy (DOE). 1994. Final Site-Wide Environmental Assessment of the National Renewable Energy Laboratory's South Table Mountain Complex and a Finding of No Significant Impact (FONSI) for proposed site development activities (DOE/EA-0850).

U.S. Environmental Protection Agency (USEPA). 2014a. Internet website: http://cfpub.epa.gov/rblc/index.cfm?action=PermitDetail.PollutantInfo&Facility_ID=27035&Process_ID=107677&Pollutant_ID=149&Per_Control_Equipment_Id=149866

U.S. Environmental Protection Agency (USEPA). 2014b. Internet website: http://www.epa.gov/oecaagct/lrca.html#Solid Wastes

U.S. Environmental Protection Agency (USEPA). 2013a.2011 National Emissions Inventory, Version 1. Research Triangle Park, North Carolina. September 2013.Internet website: http://www.epa.gov/ttnchie1/net/2011inventory.html

U.S. Environmental Protection Agency (USEPA). 2013b. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2011. EPA-430-R-12-001. April 2013. Internet website: http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2013-Main-Text.pdf.

U.S. Environmental Protection Agency (USEPA). 2008. Technology Characterization: Fuel Cells. Prepared for Environmental Protection Agency Combined Heat and Power Partnership Program. Washington, D.C. Prepared by: Energy and Environmental Analysis, Inc., an ICF Company. 1655 N. Fort Myer Dr. Suite 600. Arlington, Virginia 22209. December 2008.

U.S. Environmental Protection Agency (USEPA). 1995. *AP-42 Compilation of Air Pollutant Emission Factors.* Volume 1. January 995. Section 1.4 for Natural Gas Combustion. Internet website: http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s04.pdf.

U.S. Fish and Wildlife Service (USFWS). 2012. U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines. Internet website: http://www.fws.gov. March 2012.

U.S. Fish and Wildlife Service (USFWS). 2010. Prebles Block Clearance Map for the Denver Metro Area.

U.S. Geological Survey (USGS). 2011. National Hydrography Dataset. GIS Dataset. Reston, Virginia. Internet website: ftp://nhdftp.usgs.gov/DataSets/Staged/SubRegions/PersonalGDB/HighResolution/. Accessed April 8, 2011.

Van Horn, R. 1976. Geology of the Golden Quadrangle, Colorado: U.S. Geological Survey Professional Paper 872. 125 pp.

Ward, A. L. 1976. Elk Behavior in Relation to Timber Harvest Operations and Traffic on the Medicine Bow Range in South-central Wyoming. Pages 32-43 *In*: Proceedings of Elk-Logging-Roads Symposium. S. R. Hieb, Editor. University of Idaho, Moscow.

Western Regional Climate Center (WRCC). 2013. *Climate of Colorado*. Internet website: http://www.wrcc.dri.edu/narratives/COLORADO.htm. Accessed September 18, 2013.