Appendix B

Solar
Reasonably Foreseeable Development Scenario

SOLAR
REASONABLY FORESEEABLE DEVELOPMENT SCENARIO
WEST CHOCOLATE MOUNTAINS

1. Introduction 1

1.1 Concentrated Solar Power Technologies 2
Parabolic Trough 2
Dish-Engine 2
Power Tower 3

1.2 Photovoltaic Technologies 3

2. Available Data and Assumptions 5

3. Activities Involved in Solar Development 10

3.1 Exploration 10

3.2 Construction 10
Concentrated Solar Power Technology 10
Photovoltaic Technology 12

3.3 Surface Disturbance 14
Concentrated Solar Power Technology 14
Photovoltaic Technology 15

3.4 Total Amount of Solar Development 16

4. Operation and Maintenance Needs 17

4.1 Concentrated Solar Power Technology 17

4.2 Photovoltaic Technology 18
Scheduled Maintenance 18
Unscheduled Maintenance 18

4.3 Hazardous Materials 19
Construction (CSP and PV) 19
Operation 19

5. Decommissioning (CSP and PV) 20

6. Potential Impacts 20

6.1 Noise 20

6.2 Air Quality 20

6.3 Visual 20

6.4 Soils/Hydrology 20

6.5 Water Supply 21
Wet Cooling 21
Dry Cooling 21
Hybrid Cooling 21

6.6 Biological Resources 22

7. References 22

SOLAR
REASONABLY FORESEEABLE DEVELOPMENT SCENARIO
WEST CHOCOLATE MOUNTAINS

1. Introduction

This Reasonably Foreseeable Development (RFD) scenario has been prepared as a basis for analyzing environmental impacts resulting from future development of federal lands for solar energy projects within the West Chocolate Mountains Renewable Energy Evaluation Area (West Chocolate REEA, or the REEA). This RFD scenario is a tool the Bureau of Land Management (BLM) can use to analyze the types of impacts that could be expected under an alternative being analyzed. A RFD is not a prediction of what would happen under a specific alternative.

The RFD scenario is intended to provide the information necessary to analyze potential cumulative impacts. The disturbance for a production facility and associated infrastructure (e.g., road, pipelines, transmission lines, etc.) would be based on the facilities typical in surrounding areas.

This RFD scenario assumes that two types of solar technologies could be developed: concentrated solar power (CSP), which is also referred to as solar thermal; and photovoltaic (PV).

CSP technologies use mirrors to reflect and concentrate sunlight onto receivers that collect the solar energy and convert it to heat. This thermal energy can then be used to produce electricity via a steam turbine or heat engine driving a generator. CSP technologies include parabolic trough technology, dish-engine technology, and power tower technology (U.S. Department of Energy [DOE] 2009a).

PV systems are based on the use of semiconductors, materials that can generate small amounts of electric current when exposed to sunlight. Semiconductors are materials that hold their bonding electrons tightly in covalent bonds (and therefore act as insulators in their pure state), but that have conducting properties when combined with small amounts of impurities called dopants. In most configurations, the solar cell material is present as a thin film. Silicon, the earth's most abundant material after oxygen, is the cheapest and most frequently used semiconductor. Boron and gallium are common dopants. Research is currently ongoing using different combinations of semiconductors and dopants to increase the efficiency of solar cells for capturing the energy in sunlight. Compound semiconductor materials such as cadmium telluride have also been used for solar cells. Currently, the silicon-based solar cells that have efficiencies of about 15% are likely to be used in utility-scale PV facilities built in the United States; however, multi-junction solar cells that contain two or more semiconductors and can increase efficiency to 30% or greater will likely be used in utility-scale PV facilities in the future. Another means of increasing efficiency is to use concentrating lenses (also known as concentrating PV technology [CPV]) and tracking systems to capture additional energy from the sun over longer periods of daylight.

1.1 Concentrated Solar Power Technologies

Parabolic Trough

Parabolic trough systems consist of a large field of single-axis tracking parabolic trough solar collectors. The solar field is modular and is composed of many parallel rows of solar collectors aligned on a north-south horizontal axis. Each solar collector has a linear trough or parabolic-shaped reflector that focuses the sun's direct beam radiation on a linear receiver located at the focus of the parabola. The collectors track the sun from east to west during the day to ensure that the sun is continuously focused on the linear receiver. A heat transfer fluid (HTF) is heated as it circulates through the receiver and returns to a series of heat exchangers in the power block where the fluid is used to generate high-pressure superheated steam. The superheated steam is then fed to a conventional reheat steam turbine/generator to produce electricity. The spent steam from the turbine is condensed in a standard condenser and returned to the heat exchangers via condensate and feed water pumps to be transformed back into steam, which is traditionally released into the atmosphere, hence the large amounts of water needed on an annual basis to keep the project going. After passing through the HTF side of the solar heat exchangers, the cooled HTF is re-circulated through the solar field (National Renewable Energy Laboratory [NREL] 2003).

Each plant includes thermal storage, consisting of a dual, two-tank molten salt system, sufficient to support approximately 3.5 full load hours of electricity production. The thermal energy storage (TES) system contains a ""hot" and a "cold" storage tank connected via two parallel trains of six oil to salt heat exchangers in series. For charging the storage, the salt is heated up to approximately 386 degrees Celsius (°C), and for discharging it is cooled down again to approximately 292°C. The salt freezes at approximately 221°C. Freezing of the salt must be avoided to prevent damage of components. The freeze protection system, which uses the hot HTF, keeps the salt at a minimum temperature of 260°C. To avoid freezing of the salt in nonworking periods, the heat exchangers are equipped with electrical heat tracing. The electric output of the plant would be supplied entirely with solar energy. No electricity is generated by the use of fossil fuel in this plant complex. A small gas-fired HTF heater is used for infrequent freeze protection of the HTF in the solar field. Gas for this purpose is supplied by truck.

The HTF is a synthetic hydrocarbon liquid – diphenyl/biphenyl oxide – that has a freezing point of about 13ºC. Freeze protection is routinely accomplished by circulating HTF at a very low flow rate through the solar field using hot HTF from the storage tank as a source. Performance model results indicate that the HTF heater may be required on very cold nights in the deep winter months (Solar Millennium 2008).

Dish-Engine

Dish-engine technology focuses sunlight from a large parabolic reflector onto a receiver above the dish. Each dish is independent and includes two major elements, the solar concentrator and the power conversion unit. The solar concentrator consists of many mirror facets attached to a frame by three point-adjusting mounts that are designed in five subassembly units for ease of transport and installation on site. Two small motors are attached to the pedestal and programmed to swivel the dish on two axes, following the sun's progression across the sky during the day. The power conversion unit consists of a Stirling engine, which includes a cylinder block that incorporates four sealed cylinder assemblies along with coolers, regenerators, and heater heads.

Concentrated solar energy heats up self-contained hydrogen gas in the power conversion unit, causing the gas to expand into the cylinders, moving the cylinders, and generating electricity. This cycle is repeated multiple times as the engine runs at a steady rate and power is generated by heat transfer from the concentrated solar energy to the working gas in the engine's heater head, which converts the heat energy into mechanical motion. The generator of each unit in a utility-scale project is connected by underground transmission line to a small substation where the power can be transformed into a higher voltage for more efficient transmission across the grid (BLM 2010).

Power Tower

Solar power towers generate electric power from sunlight by focusing concentrated solar radiation on a centralized tower-mounted heat exchanger or boiler (receiver). The receiver on the top of the tower is filled with a fluid, typically molten salt, which has the ability to hold large amounts of heat. The heat is transferred to water in the same way as the parabolic trough system to produce electricity. Some designs have eliminated the molten salt step and converted water directly into steam but these systems cannot produce electricity at night whereas the molten salt method can store heat in the salts and produce electricity at night (National Joint Apprentice and Training Committee for the Electrical Industry [NJATC] 2007). This technology uses hundreds to thousands of sun-tracking mirrors called heliostats to reflect the incident sunlight onto the receiver boiler at the top of the tower. Electricity is produced by the system's solar receiver boiler and a steam turbine generator. These plants are best suited for utility-scale applications in the 30- to 400-MW ranges (NREL 2003).

1.2 Photovoltaic Technologies

The most prevalent kind of solar technology is PV panels, and the vast majority of solar panels are silicon-based. About 90 percent of PV sales are made from silicon-based solar cells (Hasan 2007). The basic unit in a PV system is the solar cell. Silicon is crystallized to create a crystal column called an ingot, which is sliced thinly and processed into cells. PV cells are made of at least two layers of semiconductor material, one with a positive charge and the other with a negative charge. When sunlight enters the cell, some of the photons from the light are absorbed by the semiconductor atoms, freeing the electrons from the cell's negative layer to flow through a circuit and back into the positive layer, producing an electric current.

PV technology generates electric power by using solar cells to convert energy from the sun's direct and diffused solar radiations directly into electricity. Two categories of PV cells are used in most of today's commercial PV modules: crystalline silicon and thin film. Cells are arranged, interconnected, covered with tempered glass, and packaged into a structure called a panel. Dozens of individual cells can be arranged together in a sealed, weatherproof package to form a panel to produce additional energy. Panels can then be fitted into an array, which produces electricity based on the number and efficiency of the panels. A PV array is, thus, a set of panels arranged in frames for mounting on the ground, rooftops, or other locations. A PV array along with other components including inverters, mounting equipment, charge regulators, and sometimes batteries for storage make up large photovoltaic systems (Aruvian's Research 2010).

CPV systems use silicon solar cells or high-performance multi-junction solar cells (typically made of aluminum, gallium, indium, nitrogen, phosphorus, antimony) and use concentrating or reflecting optical devices to concentrate sunlight that strikes the solar cells. They also usually incorporate tracking devices. Because of their higher efficiency, CPV systems also generate excess heat; therefore, some require cooling systems to dissipate the heat. The cooling systems may be passive (e.g., cooling fins) or active (e.g., forced air cooling or water cooling).

The foreseeable development described here could occur on any land within the West Chocolate REEA (64,058 acres), regardless of surface ownership. Based on modeling performed by the NREL, the follow solar energy could be developed:

Concentrated Solar Power Technology

Trough – 1,327 MW

Dish – 737 MW

Power Tower – 737 MW

Photovoltaic Technology

1% Slope or less – 737 MW

3% Slope or less – 2,857 MW

5% Slope or less – 3,306 MW

The anticipated surface disturbance for the area is summarized below (Table 1).

Table 1 Surface Disturbance for Solar Power Plants in the West Chocolate REEA*

Technology Type	BLM Disturbance (acres)	Total Disturbance (acres)
Solar Trough	1,574	6,637
Dish – Engine	1,574	6,637
Power Tower	1,574	6,637
PV		
1% Slope or less	1,574	6,637
3% Slope or less	15,743	25,603
5% Slope or less	16,954	29,758

Note:
*Within the BLM's Western Colorado (WECO) Desert Region.

2. Available Data and Assumptions

The West Chocolate REEA encompasses about 95 sections, or approximately 64,058 acres. Of this, 42 sections contain roughly 18,765 acres of surface land administered by the Bureau of Land Management (BLM: land withdrawn by the U.S. Bureau of Reclamation [USBR] not included), with the remainder being state or private land.

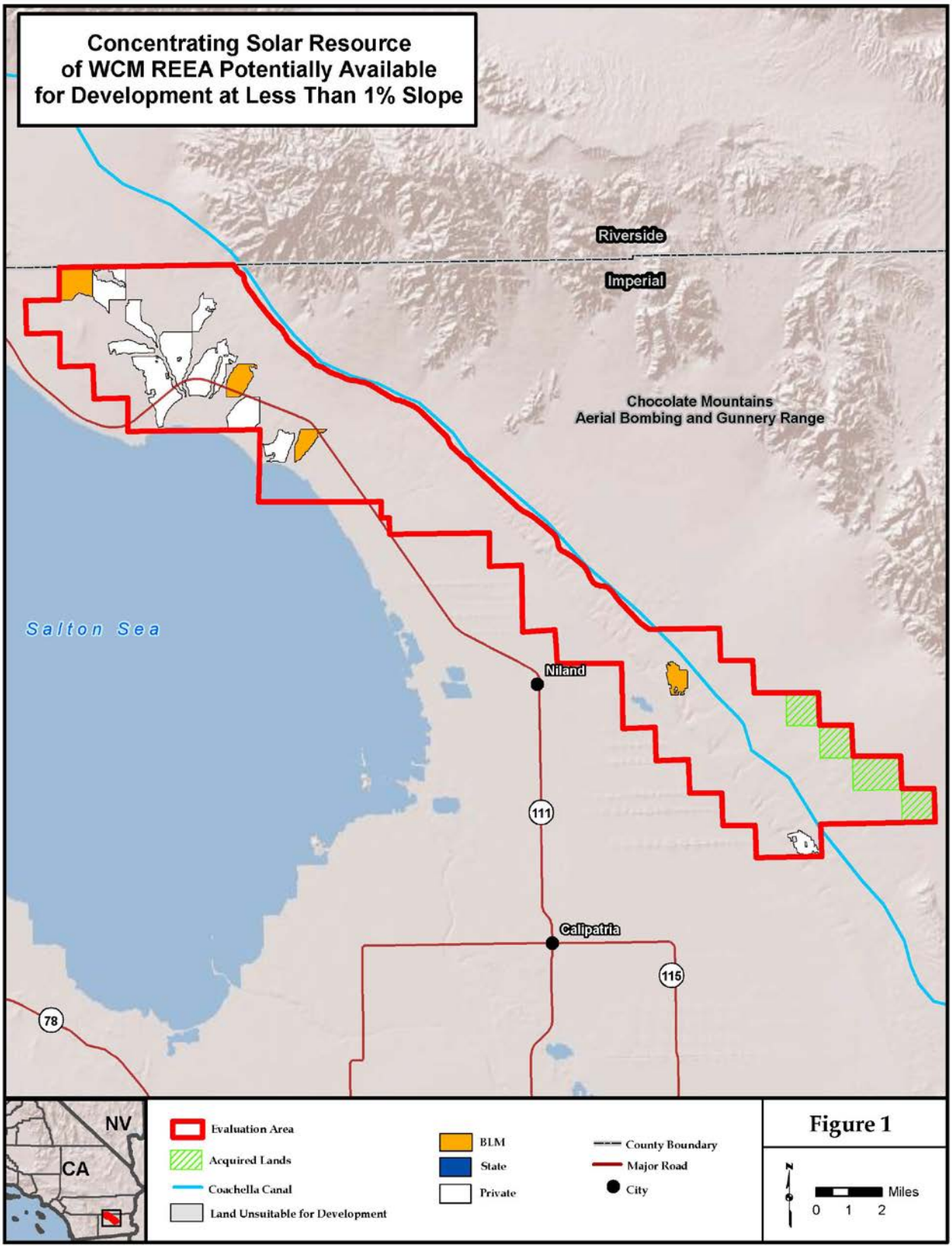
Of the 64,058 acres, 2010 modeling performed by the NREL using the above constraints revealed that only a maximum of 29,758 acres was developable for solar energy. Of the 29,758 acres, 46 sections contain roughly 9,066 acres of BLM surface land (land withdrawn by the USBR not included), with the remainder of the area being state or private land. The remainder was eliminated for reasons discussed previously in this section. To estimate the amount of anticipated development for the entire 29,758 acres which would potentially occur on BLM land, a simple ratio was developed to estimate the percentage of development that could occur on BLM-managed land. This ratio is based on the percentage of land within the West Chocolate REEA that is managed by the BLM and is available for solar ROW (30 percent [9,066 acres BLM/29,758 acres total]).

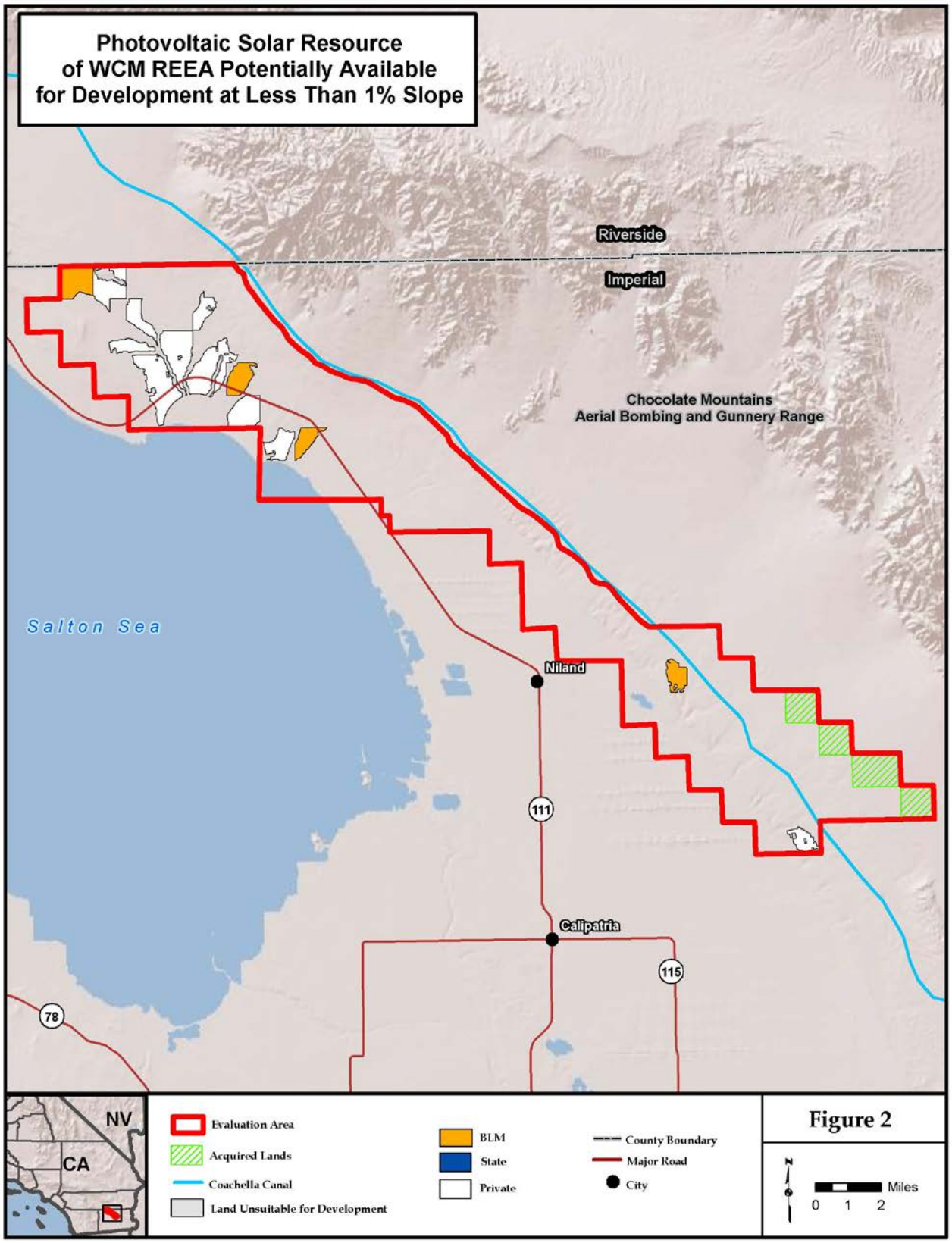
The NREL provides solar resource estimates in kilowatt hours per meter squared per day (kWh/m^2/day) for CSP and PV across the United States (Figures 1 through 4). Portions of the West Chocolate REEA are indicated as suitable land for CSP solar development and contain solar thermal resources estimated at 6.7 to 7.4 kWh/m^2/day on a scale ranging from 6 to 8.2, Portions of the REEA are indicated as suitable land for PV solar development and contain solar thermal resources estimated at 6.4 to 6.6 kWh/m^2/day on a scale ranging from 6 to 8.2.

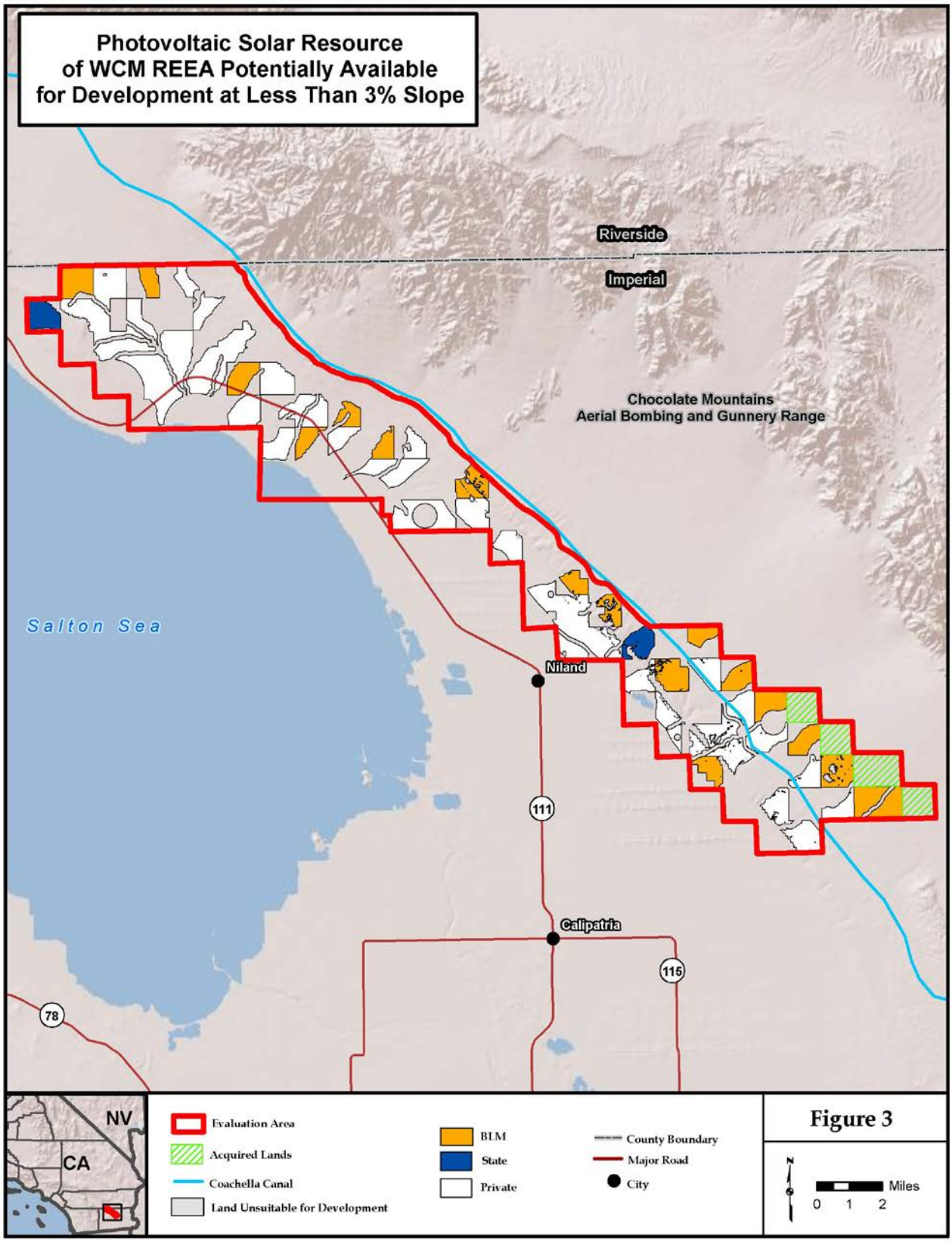
The model inputs are hourly visible irradiance from satellites and monthly average aerosol optical depth, precipitable water vapor, and ozone sampled at a 10 kilometer resolution. These factors are used to estimate the amount of solar radiation that would penetrate the atmosphere at a particular location. This 2010 NREL analysis used modeled direct normal solar radiation estimates at a 10 kilometer ground resolution. These results were further screened and results were also screened by BLM to eliminate areas subject to certain resource problems.

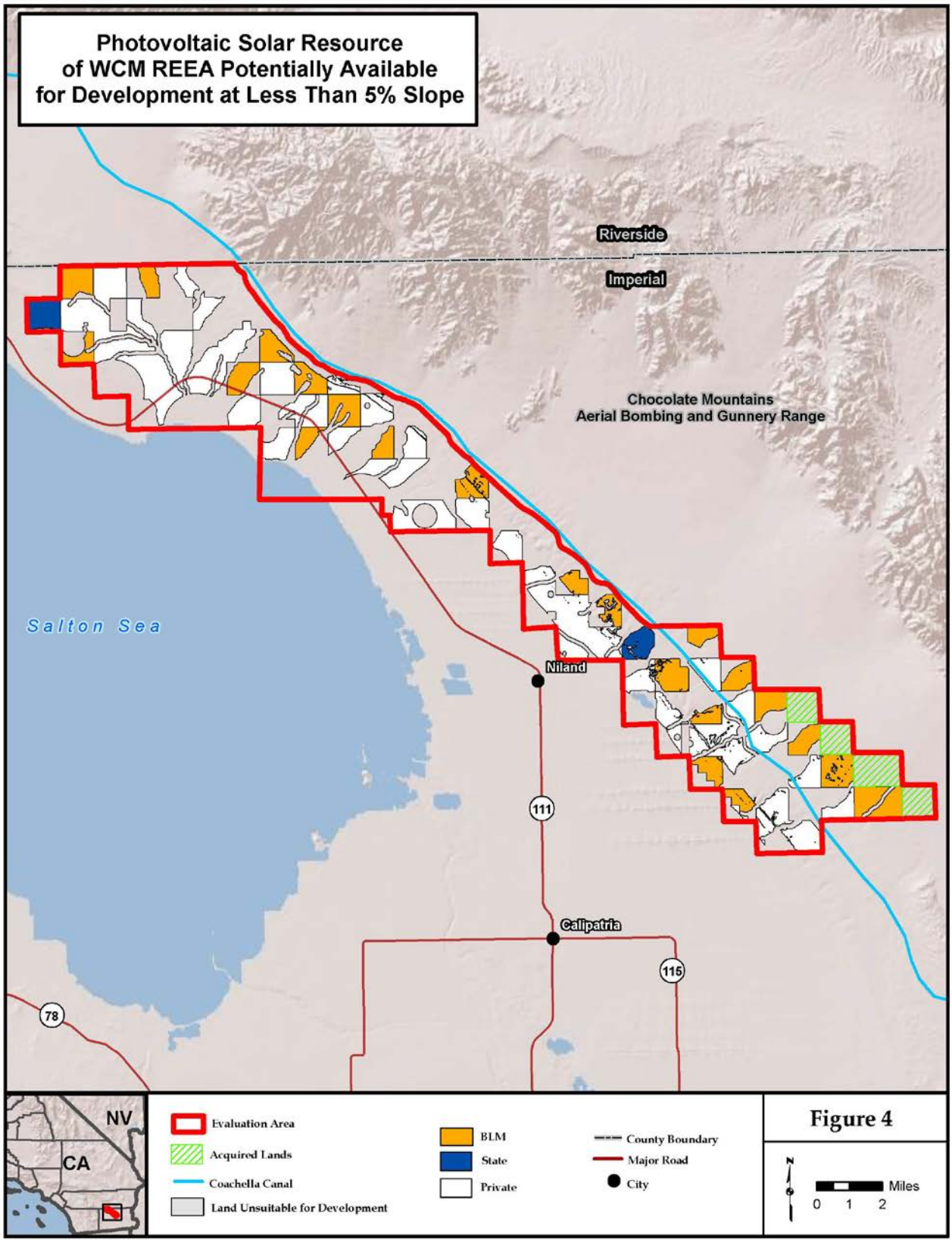
All projects located on BLM-managed land would be evaluated as part of the Federal Land Policy and Management Act (FLPMA) ROW application and National Environmental Policy Act (NEPA) processes.

This page intentionally left blank.


Concentrating Solar Resource
of WCM REEA Potentially Available
for Development at Less Than 1% Slope
Riverside
Imperial
Chocolate Mountains
Aerial Bombing and Gunnery Range
Salton Sea
Niland
111
Calipatria
115
78
NV
CA
Evaluation Area
Acquired Lands
Coachella Canal
Land Unsuitable for Development
BLM
State
Private
County Boundary
Major Road
City
Figure 1
N
Miles
0 1 2


Photovoltaic Solar Resource
of WCM REEA Potentially Available
for Development at Less Than 1% Slope
Riverside
Imperial
Chocolate Mountains
Aerial Bombing and Gunnery Range
Salton Sea
Niland
111
Calipatria
115
78
NV
CA
Evaluation Area
Acquired Lands
Coachella Canal
Land Unsuitable for Development
BLM
State
Private
County Boundary
Major Road
City
Figure 2
N
Miles
0 1 2


Photovoltaic Solar Resource
of WCM REEA Potentially Available
for Development at Less Than 3% Slope
Riverside
Imperial
Chocolate Mountains
Aerial Bombing and Gunnery Range
Salton Sea
Niland
111
Calipatria
115
78
NV
CA
Evaluation Area
Acquired Lands
Coachella Canal
Land Unsuitable for Development
BLM
State
Private
County Boundary
Major Road
City
Figure 3
N
Miles
0 1 2


Photovoltaic Solar Resource
of WCM REEA Potentially Available
for Development at Less Than 5% Slope
Riverside
Imperial
Chocolate Mountains
Aerial Bombing and Gunnery Range
Salton Sea
Niland
111
Calipatria
115
78
NV
CA
Evaluation Area
Acquired Lands
Coachella Canal
Land Unsuitable for Development
BLM
State
Private
County Boundary
Major Road
City
Figure 4
N
Miles
0 1 2

3. Activities Involved in Solar Development

Due to the wide range of solar development that could occur in the project area, the activities that could occur during solar development have been based on the development of a 50-MW PV project and a 500-MW solar trough project. These sizes were selected because of the availability of data related to development of these types of projects. PV and solar trough are the two technologies that have been fielded most widely in the United States and throughout the world.

3.1 Exploration

Because there has not been any actual development of a solar project in the area, it is assumed that some level of exploration would occur prior to full-field development. This exploration is typically limited to the placement of solar meters in the vicinity of a proposed solar project area. These meters record direct normal, global horizontal and diffuse horizontal irradiation. Temperature, humidity, wind speed, and wind direction are measured and then recorded in one minute increments. These meters are typically small, less than 1 square meter and can be installed using off highway vehicles (OHVs). They are commonly secured to a piece of concrete or other heavy object so they cannot be easily stolen. Ground disturbance is typically limited to 1 to 2 square meters.

3.2 Construction

Concentrated Solar Power Technology

Construction of a 500-MW solar trough project generally follows the sequence of site prep, grading, and road (180 days); installation of piers, solar field prep (180 days); assembly of solar collector elements (180 days); installation of the power block (180 days); and installation of buildings, evaporation ponds (180 days) (Solar Millennium 2008).

Planning, Construction Workforce Numbers, Vehicles, Equipment, Timeframes

Prior to mobilization for construction, a detailed construction plan would be developed to define the construction supervisory and technical field organizations and staffing levels required for the project. Approximately 2,100 people would be required during all phases of construction, although not all would be on site at any one time.

Site Clearing, Grading, Excavation, Temporary Fencing and Parking, and Stormwater Systems

Site work and solar field foundation preparation would include the following tasks:

- Earthwork, main entrance and construction personnel entrance roads, preparation of the solar collector assembly area, storage area, parking area and construction office area and installation of temporary and permanent site utilities.
- Construction of flood bypass channels.
- Installation of solar and piping drilled piers, sequenced with earthwork. Installation of underground piping and electrical systems would be sequenced consistent with orderly evacuation and placement of concrete foundations. Concrete foundations are

required throughout the solar field, for the turbine pedestal, for the control and maintenance buildings and for the cooling tower basins (Solar Millennium 2008).

Solar Collector and Power Block Assembly and Construction

For construction of the solar collector element assembly an assembly line would be erected in the site fabrication and storage area. Assembly line fabrication consists of assembly of the solar collector element structural steel components and the mounting of the mirror panels. For field assembly the solar collector element assembly would be transported to the field by truck and trailer and lifted with a spreader bar and crane and set on end, middle, shared or drive pylons, and then aligned (if the wind speed is less than 12 kilometers/hour). The alignment takes approximately 2 to 3 hours. The heat collector element's (HCE's) are installed (three preassembled welded sections) in the field and the ends are welded to an adjacent solar collector element. Ball joint assembly and assembly of measuring equipment would follow (Solar Millennium 2008).

For solar field commissioning, the solar collector assembly (SCA) loops would be commissioned on an ongoing basis as they are completed during the installation of the solar collection field. Power block foundations would start shortly after the start of solar field drilled piers. The power blocks would be erected and commissioned in parallel with the solar collection field (Solar Millennium 2008).

Facilities Outside the Solar Field Boundary

Construction of the evaporation pond, storm water retention pond, HV intertie, warehouse and gatehouse would run concurrent with construction of the power plants and would be commissioned to support the startup of the plants (Solar Millennium 2008).

Cleanup and Reclamation

Temporary work areas would be cleaned up and reclaimed as necessary.

Transmission Line

During construction of the transmission line there would be temporary pulling and tensioning sites, material staging sites, and concrete batch plants. There would be no grading at the pole site work areas or the pull and splicing site; rather, vegetation would be crushed (Solar Millennium 2008).

Photovoltaic Technology

Construction of a 50-MW solar PV project generally follows the sequence of planning, surveying/staking/flagging the perimeter of the project area (5 days); constructing security fencing (5 days) and access roads (5 days); clearing, grading, excavating, and installing temporary fencing and parking and stormwater systems (25 days); assembling and installing project facilities (360 days), cleaning up, and reclaiming any temporary work areas (20 days). In addition, some facilities are constructed outside the solar field boundary, and transmission lines are installed.

Planning, Construction Workforce Numbers, Vehicles, Equipment, Timeframes,

Prior to mobilization for construction, a detailed construction plan would be developed to define the construction supervisory and technical field organizations and staffing levels required for any solar PV project. On average, 20 construction and supervisory personnel are required on site for approximately a 14-month period to construct one solar PV plant, with 40 personnel being required at the peak of construction. Approximately 400 personnel would be required during all phases of construction although not all would be on site at any one time.

Surveying, Staking, and Flagging

Pre-construction survey work would consist of staking or flagging the site area boundaries, work areas (permanent and short term), cut and fill areas, access roads, transmission pole locations, and concrete pad and foundation areas.

Fencing and Access Roads

Initial construction activities would include installation of security fencing and construction of access roads and maintenance tracks.

Site Clearing, Grading, Excavation, Temporary Fencing and Parking, and Stormwater Systems

Site preparation consists of clearing, earthwork, and grading as required to construct the facility and achieve finished site grades. Grading is done to promote proper drainage and remove major scarring from previous drainage through the site. Cut and fill materials are typically in balance so that no material is either exported or imported to the site to achieve final grade. Rough site grading, excavation, and backfilling are performed using heavy-duty earth moving equipment.

Temporary fencing encloses material lay down and storage areas, and temporary parking areas are created to accommodate the construction workforce.

Typically, the solar panels would be mounted in a manner that follows the existing topography and, as a result, does not change the natural flow of water across the site. If necessary, hydraulic modeling would be completed during the design stage. Erosion control and storm drainage systems would be designed to promote sheet drainage, evenly distributing the flow of storm water across the site. A Site Grading and Erosion Control Plan would be developed and silt fences and fiber rolls would be used as necessary for drainage and to control erosion.

Solar Array/Power Plant Assembly and Construction

In a PV plant, electrical power is produced directly by solar PV arrays, each comprised of several PV panels; one leading brand of panel is approximately 40 by 55 inches. Two of these panels are placed in portrait orientation on a south-facing rack tilted at approximately 20 to 25 degrees.

After a site is graded, underground conduit, overhead transmission lines, an inverter, and transformer pads are installed. Next, the PV panel supports and frames are installed. The support members are typically driven steel piles consisting of H beams or round pipe that are driven to a depth of 3 to 5 feet, depending on soil conditions. If the soil is exceptionally loose, corrosive, or too rocky to drive the supports, different support designs that could include augured holes with

concrete fill could be required. The frame tables are then mounted to the support members. These tables consist of bolted or riveted steel members that are either built at the assembly point or fabricated in a factory and shipped preassembled to the construction site. The frame tables are aligned and fastened to the support members.

The PV panels are then set onto and secured to the frame tables. Three 135-watt (W), direct current (DC) photovoltaic panels are wired in series to a form a 1,000-volt (V) DC level string. Ten strings are then bound together in a wiring harness. Six groups of wiring harnesses are routed together into a row of panels. A single combiner box combines the electrical output of 180 panels. The output of 25 combiner boxes (4,500 PV panels) is collected at a 500-kilovolt (kV) inverter. Four 500-kV inverters and a 2-MW step-up transformer are co-located on a single concrete pad. The 480-V alternating current (AC) output of four 500-kV inverters is combined and stepped up to 33 kV in a single 2-MW transformer. Each 2-MW transformer handles the output of 18,000 PV panels. The 50-MW build out would use 180,000 PV panels.

A switchyard typically consists of a 10-foot x 12-foot concrete pad that accommodates the utility metering, the switchgear, and a protection breaker. Since the power is stepped up to utility line voltage at the solar field collector system, the switchyard does not require additional step-up transformers. From the step up transformers, the 33-kV collector system comprised of underground or overhead lines collects the output of the solar field and delivers it to the onsite switchyard, where it is metered and delivered to the 33-kV distribution system.

Cleanup and Reclamation

Temporary work areas would be cleaned up and reclaimed as necessary.

Facilities Outside the Solar Field Boundary

Construction of an electrical switchyard, communications, and a control/maintenance building would run concurrent with construction of the solar field. Even though some facilities are outside the solar field boundary, if they are located on public lands they would be authorized as part of the project ROW or authorized to the facility owner. Facilities such as power lines and switch/sub-stations are often within or near the solar field but not owned by the solar developer.

Transmission Line

A 33-kV collector system would aggregate power produced in the solar field and deliver it to an electrical switchyard. Since the electrical collector system operates at the same voltage at the transmission line, only a small switchyard meeting interconnection control and metering requirements is typically required. This equipment is located on a concrete pad approximately 10 by 12 feet.

3.3 Surface Disturbance

Concentrated Solar Power Technology

A typical ratio of land required for development of a solar trough project (solar arrays and ancillary facilities) is about 5 acres for every MW. Thus, a 500-MW solar CSP project would require approximately 2,500 acres of land. In an average solar trough energy project, approximately 90 percent of the project area is occupied by the parabolic trough solar field, and

10 percent is occupied by ancillary facilities, such as operation and maintenance (O & M) buildings, substations, access roads, and parking/laydown areas (Solar Millennium 2008). Each 500-MW solar trough development would need one or more 20-foot-wide interior access road, the placement of which would be determined by the solar field configuration.

Using this land use scenario as a model for the West Chocolate REEA, solar arrays for the development of one, 500-MW solar trough project would occupy approximately 2,000 acres, and development of related facilities would occupy 500 acres (Table 2).

Table 2 Surface Disturbance for One 500-Megawatt CSP Project

Description	Unit Surface Disturbance (acres unless otherwise noted)	Number	Total Surface Disturbance (acres)
Solar troughs	2,000	1	2,000
Access roads within site area	70	1	7
Substation switchyard	0.03	1	0.03
O & M building	0.06	1	0.06
Parking laydown area	50	1	50
230-kV transmission line	5 acres/mile	40	200
33-kV collector line	5 acres/mile	20	100
Fencing and other discretionary facilities	125	1	125
Total			**2,482.09**

Source: Solar Millennium 2008.

Photovoltaic Technology

A typical ratio of land required for development of a solar PV project (solar arrays and ancillary facilities) is about 9 acres for every MW. Thus, a 50-MW solar PV project would require approximately 450 acres of land. In an average solar PV energy project, approximately 90 percent of the project area is occupied by PV arrays, and 10 percent is occupied by ancillary facilities, such as operation and maintenance (O&M) buildings, substations, access roads, and parking/laydown areas (Chevron Energy Solutions 2009). Each 50-MW PV development would need one or more 20-foot-wide interior access road, the placement of which would be determined by the PV array configuration.

Using this land use scenario as a model for the West Chocolate REEA, solar arrays for the development of one 50-MW PV project would occupy approximately 400 acres, and development of related facilities would occupy 50 acres (Table 3).

Table 3 Surface Disturbance for One 50-Megawatt PV Project

Description	Unit Surface Disturbance (acres unless otherwise noted)	Number	Total Surface Disturbance (acres)
PV arrays	400	1	400
Access roads within site area	7	1	7
Substation switchyard	0.003	1	0.003
O & M building	0.006	1	0.006
Parking laydown area	0.5	1	0.5
230-kV transmission line	5 acres/mile	4	20
33-kV collector line	5 acres/mile	2	10
Fencing and other discretionary facilities	12.5	1	12.5
Total	500	1	**450**

Source: Chevron Energy Solutions 2009.

3.4 Total Amount of Solar Development

The solar energy RFD scenario generally identifies surface disturbance that either PV or CSP technology would cause if all land within the West Chocolate REEA is developed for solar energy, consistent with the Solar PEIS assumptions. It also generally describes the construction, maintenance and operations activities for both technologies.

While the West Chocolate REEA has significant solar energy potential, several factors would probably limit its full exploitation Therefore, in order to more accurately describe likely (i.e., reasonably foreseeable) development and associated impacts, this RFD scenario has been written to reflect real world activities. Because solar power in the West Chocolate REEA could be developed in a virtually unlimited number of ways, assumptions need to be made to allow for analysis.

Either CSP or PV technologies may be proposed, so the land requirements and construction and operational activities of each must be accurately described.

Proposals may be located only on BLM land, or may include participation of adjacent, non-BLM land to create larger or more logically arranged projects. If a project is proposed on both non-public and public lands, the project would be considered as being under a federal nexus and an environmental review including the private lands may be required.

Typical projects proposed in the region have historically been less that 50 MW in size (note: this is probably true for CSP projects on federal land because developers routinely stay below 50 MW to avoid California Energy Commission (CEC) involvement. While PV projects on federal land do not have a similar CEC nexus, these projects have tended to also be less than 50 MW in size.

Transmission would constrain future energy development, including solar, geothermal and wind. Large projects that have not entered the California Independent System Operator (CAISO) queue may not be built until new transmission capacity is built. Smaller projects may be able to fit within existing capacity. The Environmental Impact Statement (EIS) must include a thorough discussion of existing and currently planned transmission capacity to estimate when new or upgraded transmission would be needed to off-take additional power from the West Chocolate REEA.

Development would be constrained by buffers around sensitive resources, including hydrologic features, which have been incorporated into the existing RFD scenario.

Development would be constrained by slope. The RFD scenario currently includes lands that have slopes of 5 percent or less for PV and 1 percent for CSP.

The number and size of CSP projects may be limited by higher operational water requirements than PV.

CSP power tower technology may not be used in some locations due to airspace conflicts.

This RFD scenario identifies the maximum amount of land that could be developed for solar energy (CSP and/or PV) within the West Chocolate REEA. It does not take into account market factors and resource specific constraints (see above) that would likely result in a much smaller footprint in actual development. For the purpose of impact assessment across each alternative, the following assumptions would be used. Actual development may vary depending on future conditions.

The RFD scenario identifies a range of total disturbance of 13,473 acres to about 49,864 acres for PV energy. There would be approximately 13,480 acres within the West Chocolate REEA of surface disturbance for CSP technology. This includes use of adjacent, non-BLM lands for project development; BLM land usage would be considerably smaller. Using 9 acres per MW (PV) or 5 acres per MW (CSP), there could be as much as 5,540 MW (PV) or up to 2,696 MW (CSP) energy produced within the West Chocolate planning area, assuming full build out solely for solar energy. This would result in between 30 to 111 PV projects of 50 MW each and three to five, 500-MW CSP projects could be constructed. Thus, under the RFD scenario there could be a minimum of three, 500-MW projects to a maximum of 111, 50-MW PV projects or a combination thereof.

4. Operation and Maintenance Needs

4.1 Concentrated Solar Power Technology

Management and supervision of the plant would be centered within the solar field maintenance organization. Skilled personnel would be assigned to conduct expedient maintenance and mirror washing. The primary responsibility of “field operators” is to monitor, in considerable detail, the condition and repair needs of the solar fields. The O&M workforce is comprised of approximately 90 people. Equipment includes water trucks for cleaning mirrors and standard pickup trucks (Solar Millennium 2008).

4.2 Photovoltaic Technology

The operation and maintenance of a PV power plant is primarily automated. Scheduled and unscheduled maintenance activities require some staffing throughout the life of the power plant. The main operations and maintenance needs are panel washing and inverter inspection, as well as vegetation control and routine inspection of switchgear. Plants typically have a staff of only five full time staff during regular operations, including a security officer during non-business hours. The power components of PV solar power plants are turned on in the morning and off at night automatically.

Maintenance equipment includes all-terrain vehicles capable of going inside the array for physical inspection and parts replacement. PV solar power plants are well known for being almost maintenance-free, but there are some large maintenance tasks, such as panel washing, that require the presence of full-time personnel for the duration of the task. Outside contractors, in addition to the full time staff, are often used to conduct these activities. Panels are typically washed on a quarterly to semi-annual basis, depending on the long-term needs of the project owners. Inverter maintenance consists of inspection of intake air ducts, cooling fans, and refrigeration units and is conducted approximately monthly. Inspection of seals, connections, and enclosure are conducted yearly. Scheduled maintenance may involve the manufacturer of equipment such as the inverter.

Scheduled Maintenance

The following activities are conducted regularly:

- Solar panel cleaning (quarterly)
- Array visual and infrared inspection
- Vegetation mowing (as needed)
- Inverter maintenance
  - Inspection of intake air ducts, cooling fans, and refrigeration units (monthly)
  - Inspection of seals, electrical connections (torque setting), and transformer and/or inductor enclosure (yearly)
- Switchyard maintenance

Unscheduled Maintenance

Exposure to the elements and equipment failures require the following maintenance activities:

- Solar panel replacement
- Troubleshooting, repair, and eventual replacement for:
  - Inverters
  - Switchyard equipment
  - Digital Control Systems

4.3 Hazardous Materials

Construction (CSP and PV)

During construction, any necessary storage of diesel fuel, gasoline, motor oil, hydraulic fluid, and coolant are kept on site in above-ground tanks in a location with secondary containment and spill prevention countermeasures in place. These tanks are removed upon completion of construction and no permanent storage of these petroleum products occurs after construction is completed. A spill prevention control and countermeasure (SPCC) plan would be prepared, in accordance with all applicable BLM and California regulations.

Operation

Concentrated Solar Power Technology

- Typical chemicals on-site include the following:
- Diphenyl/biphenyl oxide
- Caustic (Sodium hydroxide)
- Acid (Sulfuric acid)
- Algaecide (Slimicide C-31) or chlorine equivalent
- Oxygen Scavenger (Powerline 1405)
- Liquid Propane Gas
- Lubricating Oil

Oil-Filled Transformers

Secondary containment structures would be provided around any oil-filled transformers located outdoors, STG lube oil tanks, HTF overflow and expansion vessels and any other oil containing tanks over 55 gallons without double walls or vendor supplied secondary containment. The containment would be sized to contain 125 percent of the fluid in the transformer or vessels with appropriate freeboard required per code. Additional equipment (such as HTF pumps, feedwater pumps, etc.) would be provided with 6 inch tall curbs as appropriate. Containment designs would be based on manual cleanup, with a portable sump pump (Solar Millennium 2008).

Heat Transfer Fluid

HTF, diphenyl/ biphenyl oxide (trade name Therminol or Dowtherm), requires periodic make-up due to the minor fluid degradation that occurs during the cyclic operation as well as due to the effects of vaporization (losses from pump seals, valve packings, and other mechanical joints), and unplanned spillage. The HTF make-up quantity projected is based on annualized losses of 2percent by volume (Solar Millennium 2008).

Heat Transfer Fluid Spill Remediation

The HTF fluid for the solar fields would be diphenyl/biphenyl oxide. Dowtherm A and Solutia VP-1 are commercial products that have been used in trough plants to date, and one of these products would be used in this project. The diphenyl/biphenyl oxide mixture (CAS numbers

101848 and 92524, respectively) is not classified as a hazardous material by the U.S. Dept. of Transportation, nor is it listed under U.S. Environmental Protection Agency (EPA) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations. However, this material, when discarded, may be a hazardous waste as that term is defined by the Resource Conservation and Recovery Act (RCRA), 40 CFR 261.24, due to its toxicity characteristic. Occasional small spills of HTF do occur, primarily due to equipment failures (Solar Millennium 2008).

Photovoltaic Technology

Solar PV projects do not typically generate, store, use, or release any toxic substances regulated under the federal Toxic Substances Control Act (TSCA) or similar state or local laws and regulations. No hazardous chemicals or extremely hazardous substances as defined by the Emergency Planning and Community Right to Know Act (EPCRA) are typically present at the project sites in excess of the quantities for which reporting is required under Section 312 of EPCRA. Stockpiles of petroleum products, coolants, antifreeze, diesel fuel, gasoline, cleaning solvents, and used petroleum products are housed and stored at the O&M facilities. Maintenance personnel are typically trained in the procedures of spill prevention and countermeasures, and keep spill kits on their service vehicles for immediate use in the event of a spill.

Solar panel towers provide secondary containment, in the event a leak occurs, no petroleum products escape the solar panel housing and tower. The transformer foundations are placed on grade and designed to provide containment of 125 percent of the volume of cooling oil in the transformer in case of a leak. No petroleum products containing polychlorinated biphenyls (PCBs) are used.

5. Decommissioning (CSP and PV)

The expected project life is 30 years. Given the unique and extreme levels of solar radiation at this site, it is highly plausible that new and improved solar power generating technology would be deployed at the site to continue clean and renewable power generation. However, should the site be removed from power generation service, the site would be made suitable for reclamation. All equipment, buildings, concrete foundations, and driven piles would be removed from the site. Consistent with BLM requirements, a detailed decommissioning plan would be developed in a manner that both protects public health and safety and is environmentally acceptable.

6. Potential Impacts

6.1 Noise

Significant increases in local noise levels could occur during the construction phase of solar projects due to truck traffic and noise resulting from the construction of the solar panels and ancillary structures. However, this increase in noise is short term, concluding at the end of construction. The operation phase does not produce significant noise impacts.

6.2 Air Quality

Diesel engine exhaust, dust from trucks, and dust generated during construction grading are the primary impacts to air quality from the construction of solar energy projects. Exhaust emissions can be controlled by approved emission control devices on each vehicle, and dust emissions can be mitigated by periodic watering of roads. Dust during grading can be minimized by watering the surface prior to grading. Commercially available bonding agents can be applied after grading is complete to prevent dust during periods of high winds.

6.3 Visual

Solar panels are typically sited using terrain to obstruct visual impacts to the extent possible.

6.4 Soils/Hydrology

Solar projects introduce a larger percentage of impermeable surfaces (e.g., solar panels) to project areas than do other renewable energy projects. Increased surface runoff results; however, with a drainage plan that meets all federal CWA standards, these impacts can be mitigated to a less than significant level.

6.5 Water Supply

In all thermal power plants (regardless of the energy source), heat is used to boil water into steam, which runs a steam turbine to generate electricity. The exhaust steam from the generator must be cooled prior to being heated again and turned back into steam. This cooling can be done with water (wet cooling) or air (dry cooling), or a combination of both (hybrid cooling). Water cooling is the most efficient. PV, concentrating PV, and dish-engine solar plants are not thermal cycle plants and therefore do not require water for cooling. CSP plants using parabolic trough, linear Fresnel, and power tower technologies must use one of the following forms of cooling:

Wet Cooling

Heat is dissipated from the power plant through evaporation, most often via a cooling tower. Wet cooling is the most common cooling method for power plants, as it is the most efficient and cheapest cooling method available. All CSP systems currently in operation use wet cooling.

Dry Cooling

Heat from the condenser is rejected using fans and ambient air. A significant temperature difference between the outside air and the exhaust steam is needed for an adequate heat exchange, limiting performance on hot summer days. Dry cooling systems have greater capital costs in comparison to wet cooling, but significantly reduce total water consumption.

Hybrid Cooling

The hybrid approach involves constructing both a wet and a dry cooling system. These systems can either operate in parallel or switch from dry cooling to wet cooling during the hottest hours of the day. Hybrid systems conserve less water than dry cooling but are more expensive than either alone (SEIA 2010).

6.6 Biological Resources

The West Chocolate REEA is within the southern extent of the habitat region for the federally listed desert tortoise. Mitigation measures approved by the U.S. Fish and Wildlife Service (USFWS) for desert tortoise would be required with any solar energy development in the area. Additionally, surveys for rare plants and other special status species such as the burrowing owl would be required prior to construction.

7. References

Aruvian's Research. 2010. Trends in the Global Solar Photovoltaics Industry. April 2010.

Black & Veatch. 2009. Renewable Energy Transmission Initiative (RETI) Phase 1B Final Report. January.

Bureau of Land Management (BLM) and California Energy Commission (CEC). 2010. Draft Project Description for the Ridgecrest Solar Power Project. February 28, 2010.

Chevron Energy Solutions. 2009. Lucerne Valley Solar Plant – File # CACA 49561 Plan of Development. Revision 4 submitted to United States Department of the Interior, Bureau of Land Management, Barstow Field Office, Barstow, California. June 23.

Department of Energy (DOE). 2009a. "Concentrating Solar Power." http://www1.eere.energy.gov/solar/csp_program.html (accessed August 17, 2010).

Hasan, Russell. 2007. "The Solar Silicon Shortage and Its Impact on Solar Power Stocks". http://www.solarhome.org/newsthesolarsiliconshortage.html (accessed September 3, 2010).

National Joint Apprentice and Training Committee for the Electrical Industry (NJATC). 2007. Photovoltaic Systems. American Technical Publishers, Inc. Homewood, Illinois.

National Renewable Energy Laboratory (NREL). 2003. Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts. Subcontractor Report from Sargent & Lundy LLC Consulting Group, Chicago, IL

_____. 2010a. Concentrating Solar Power Prospects of West Chocolate Mountain Map. September.

_____. 2010b. Photovoltaic Power Prospects 5 Percent Slope or Less Prospects of West Chocolate Mountain Map. September.

_____. 2010c. Photovoltaic Power Prospects 3 Percent Slope or Less Prospects of West Chocolate Mountain Map. September.

_____. 2010d. Photovoltaic Power Prospects 1 Percent Slope or Less Prospects of West Chocolate Mountain Map. September.

Solar Millennium, LLC. 2008. Updated Plan of Development, Amargosa – Farm Road Solar Project. BLM Land Use Application, File #NVN-84359. Revised Submission November 26, 2008.

This page intentionally left blank.