BLM

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT

Biological Assessment

May 2010

Amargosa Farm Road Solar Energy Project

APPLICANT

Solar Millennium, LLC

GENERAL LOCATION

Amargosa Valley, Nevada, south of U.S. Highway 93 and west of State Road 373

BLM CASE FILE SERIAL NUMBER

N-084359

PREPARING OFFICE

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BIOLOGICAL ASSESSMENT

FOR THE
AMARGOSA FARM ROAD
SOLAR ENERGY PROJECT
(NVN-084359)

Prepared for and under the Direction of:

Bureau of Land Management
Pahrump Field Office

Prepared by:

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On Behalf of:

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May 20, 2010

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1.0 INTRODUCTION

This Biological Assessment (BA) has been prepared in accordance with legal requirements set forth under Section 7 of the Endangered Species Act (ESA) (16 United States Code [U.S.C.] 1536(c)) to address potential effects of the proposed Amargosa Farm Road Solar Energy Project (Project) on federally listed threatened and endangered species, their designated critical habitat, and species proposed for or candidates for federal protection. Specifically, this BA addresses the potential effects associated with the construction, operation, and maintenance of the proposed Project on the following federally listed species: Desert Tortoise (Mojave population) (*Gopherus agassizii*), Devils Hole Pupfish (*Cyprinodon diabolis*), Ash Meadows Amargosa Pupfish (*Cyprinodon nevadensis mionectes*), Warm Springs Pupfish (*Cyprinodon nevadensis pectoralis*), Ash Meadows Speckled Dace (*Rhinichthys osculus nevadensis*), Ash Meadows naucorid (*Ambrysus amargosus*), Ash Meadows milkvetch (*Astragalus phoenix*), spring-loving centaury (*Centaurium namophilum*), Ash Meadows gumplant (*Grindelia fraxinopratensis*), Ash Meadows ivesia (*Ivesia eremica* [=*I. kingii* var. *eremica*]), Amargosa niterwort (*Nitrophila mohavensis*), Ash Meadows blazing star (*Mentzelia leucophylla*), and Ash Meadows sunray (*Enceliopsis nudicaulis* var. *corrugata*). The BLM is the lead federal agency for the Section 7 consultation and will submit this BA to the U.S. Fish and Wildlife Service (USFWS) as part of a request for formal consultation, informal consultation, or a combination thereof, on the species listed above; this BA will also be submitted on behalf of the US Army Corps of Engineers for any activities authorized from issuance of a Section 404 permit. The BLM is also the lead federal agency for National Environmental Policy Act (NEPA) compliance and an Environmental Impact Statement (EIS) is being prepared concurrent with the ESA Section 7 consultation.

Solar Millennium, LLC (Proponent) has submitted a right-of-way application for 6,320 acres to construct and operate two 232-megawatt (MW) dry-cooled solar power plants equipped with thermal energy storage capability and associated ancillary facilities. The site was selected due to its high solar insolation, relatively flat terrain, and contiguous acreage that are in close proximity to existing infrastructure. Facilities located within the Project area would occupy a footprint of approximately 4,350 acres and would include solar fields, power blocks, an office and maintenance building, parking area, lay-down area, switchyard, and a stormwater detention basin.

At this time, it is anticipated the proposed Project would be built in two separate phases, with the construction of the first phase beginning in 2010, or immediately following issuance of the BLM right-of-way grant and other federal, state, and local permits and approvals. Project construction is expected occur over a total of 39 months. The Proponent would phase construction so that the first power plant would be operational approximately 1 year before the second power plant becomes operational. The following summarizes the effects determinations of the Proposed Action:

- Desert Tortoise – May affect and is likely to adversely affect.
- Desert Tortoise critical habitat – No affect.
- Devils Hole Pupfish – May affect, but is not likely to adversely affect.
- Ash Meadows Amargosa Pupfish – May affect, but is not likely to adversely affect.

- Ash Meadows Amargosa Pupfish critical habitat – May affect, but is not likely to adversely affect.
- Warm Springs Pupfish – May affect, but is not likely to adversely affect.
- Warm Springs Pupfish critical habitat – May affect, but is not likely to adversely affect.
- Ash Meadows Speckled Dace – May affect, but is not likely to adversely affect.
- Ash Meadows Speckled Dace critical habitat – May affect, but is not likely to adversely affect.
- Ash Meadows naucorid – May affect, but is not likely to adversely affect.
- Ash Meadows naucorid critical habitat – May affect, but is not likely to adversely affect.
- Amargosa niterwort – May affect, but is not likely to adversely affect.
- Amargosa niterwort – May affect, but is not likely to adversely affect.
- Ash Meadows blazing star – May affect, but is not likely to adversely affect.
- Ash Meadows blazing star – May affect, but is not likely to adversely affect.
- Ash Meadows gumplant – May affect, but is not likely to adversely affect.
- Ash Meadows gumplant – May affect, but is not likely to adversely affect.
- Ash Meadows ivesia – May affect, but is not likely to adversely affect.
- Ash Meadows ivesia critical habitat – May affect, but is not likely to adversely affect.
- Ash Meadows milkvetch – May affect, but is not likely to adversely affect.
- Ash Meadows milkvetch critical habitat – May affect, but is not likely to adversely affect.
- Ash Meadows sunray – No affect.
- Ash Meadows sunray critical habitat – No affect.
- Spring-loving centaury – May affect, but is not likely to adversely affect.
- Spring loving centaury – May affect, but is not likely to adversely affect.

1.1 PURPOSE

The State of Nevada has established a Renewable Portfolio Standard (RPS) that all public utilities must meet by investing in, and partnering with, commercial project developers to purchase renewable generated power, and participate in turnkey projects and/or co-development of renewable projects. The RPS mandates that 25 percent of retail sales come from renewable resources by 2025. It is expected that at least 1,000 MW of new solar power will be required annually to meet this need.

The Proponent's objectives and purpose of the proposed Project are to:

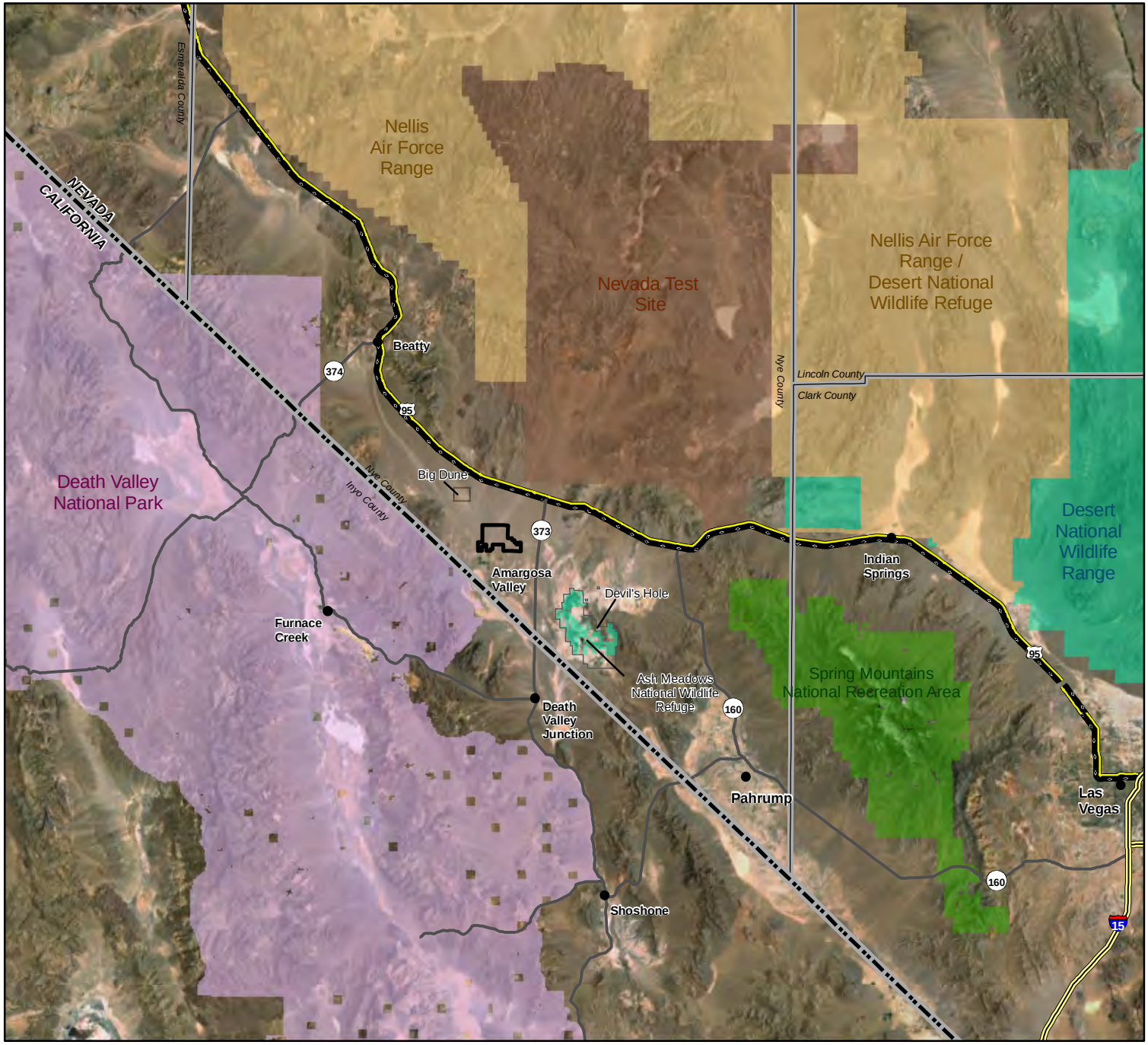
- Develop a utility-scale parabolic trough solar thermal energy facility that optimizes power generation efficiency and provides energy at a reasonable and competitive cost
- Construct and operate an environmentally compatible, economically sound, and operationally reliable solar power generation facility that will contribute approximately one million MW hours of clean, renewable solar energy per year to meet renewable energy goals
- Locate the Project in an area with high solar insolation (i.e., high intensity of solar energy)
- Minimize environmental impacts, infrastructure needs, and costs by locating the plant near existing infrastructure, such as a transmission line, a substation, an adequate water supply, and highways/access roads, and by using designated corridors to the maximum extent possible
- Develop a power-generation facility with the flexibility to continue producing electricity when the solar resource is not optimal (i.e., during cloud cover and early evening hours) to better match the load demands of utility offtakers

1.2 PROJECT DESCRIPTION / PROPOSED ACTION

The Proponent proposes to construct, operate, and maintain two 232-megawatt (MW) solar power plants equipped with thermal energy storage capability, and associated ancillary facilities located in Nye County, Nevada, approximately 80 miles northwest of Las Vegas and 360 miles southeast of Reno, west of Highway 373, on BLM administered land. Some portions of the proposed Project would be located on private property, including a 40-acre parcel at the south end of the Project area, and possibly, the water pipeline(s), to supply water to the proposed Project (Figure 1-1). The legal land description of the area covered by the Project's right-of-way number NVN-84359 is described in Table 1-1 below.

Table 1-1 Legal Description of Proposed Project

Township (T)	Range (R)	Section/Portion
T16 South	R48 East	Sec. 1 and 12 – all
T16 South	R48 East	Sec. 2, 11, 13, and 14 – Partial Section
T16 South	R49 East	Sec. 6, 7, and 17 – all
T16 South	R49 East	Sec. 5, 8, 9, 16 18 – Partial Section



Amargosa Farm Road Solar Energy Project (NVN-84359)

Project Vicinity
Figure 1-1

LEGEND

Project Area

Surface Management

- Department of Defense
- Department of Energy
- National Park Service
- US Fish and Wildlife Service
- US Forest Service

General Reference Features

- Interstate
- US Highway
- State Highway
- State Boundary
- County Boundary
- City / Town

Source: Surface Management - BLM, 2007;
Ash Meadows - USFWS, 2005;
Highways, Imagery - ESRI, 2009

May 2010

0 10 20 Miles

The plant will consist of a conventional steam Rankine-cycle power block, a parabolic trough solar field, a heat transfer fluid and steam generation system, a nitrate salt thermal energy storage system, as well as a variety of ancillary facilities (sometimes referred to collectively as "balance-of-plant"), such as conventional water treatment, electrical switchgear, administration, warehouse, and maintenance facilities. A general site plan is shown on Figure 1-2. The electric output of the plant will be provided entirely by solar energy. No electricity will be generated by the use of fossil fuel.

The Proponent submitted a right-of-way application to the BLM Pahrump Field Office to construct and operate the proposed Project on BLM-managed land in Amargosa Valley, Nevada. The initial right-of-way application and subsequent Plan of Development erroneously stated the area of the right-of-way to be 7,810 acres. The actual area, by legal description is 7,630 acres. On August 6, 2009, the Proponent sent a letter to the BLM requesting a reduction in the acreage from 7,630 acres to 6,320 acres. The footprint of the Project is anticipated to occupy approximately 4,350 acres. It is the Proponent's intent to relinquish any unused portions of the right-of-way back to the BLM.

As shown on Figure 1-2, the solar field will occupy the majority of the Project footprint. The final layout will be determined based on engineering design and in consideration of resource constraints and opportunities. General facility dimensions are listed in Table 1-2.

Table 1-2 Preliminary Facility Dimensions

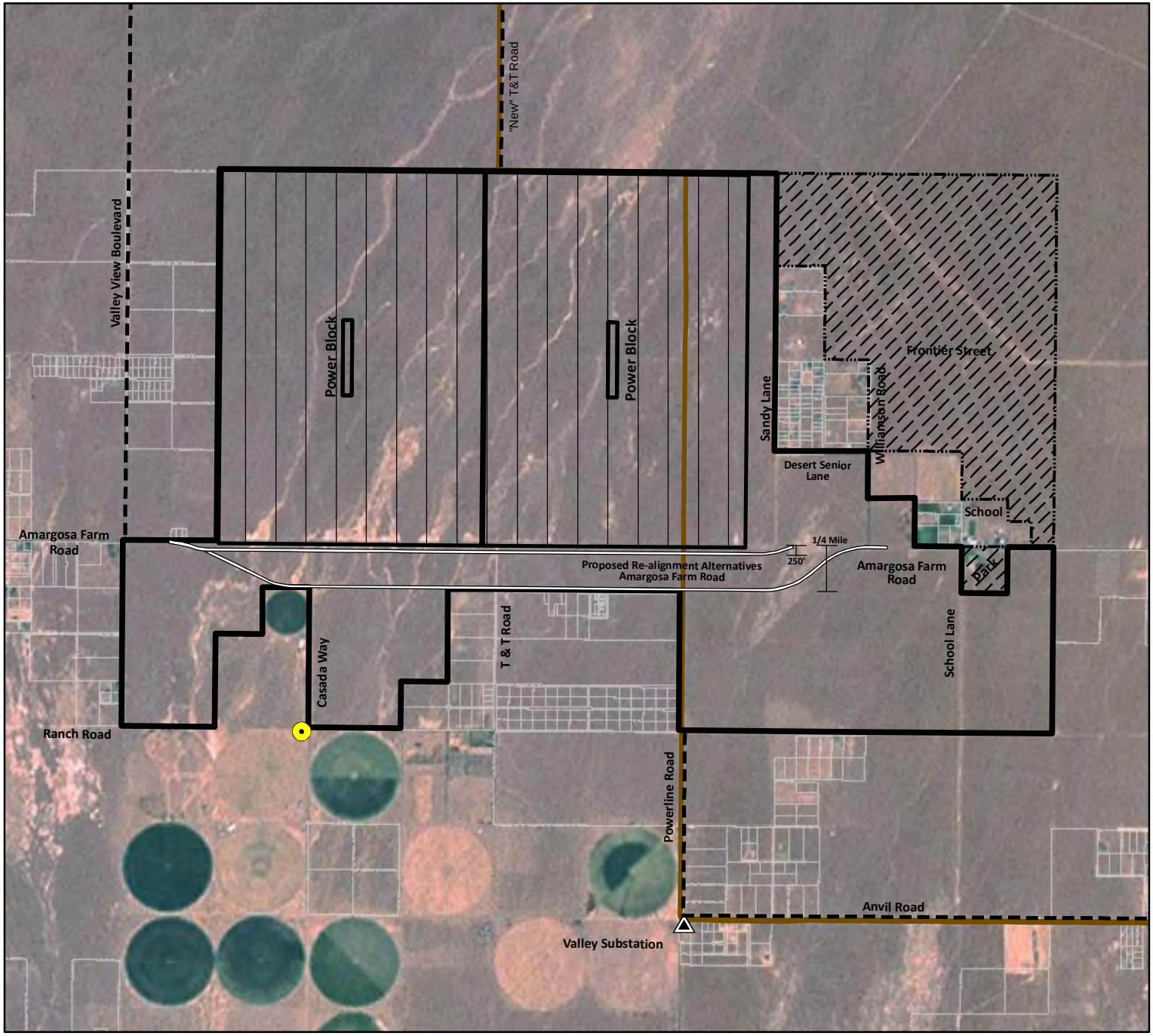
Project Component	Approximate Dimensions / Acreage
Solar Fields	Two fields, approximately 7,800 feet east-west by 11,000 feet north-south. Each field has a collector aperture area of approximately 2 million square meters. 1,970 acres
Power Blocks	Located in the center of the solar field; approximately 2,500 feet x 490 feet x 144 feet high (28 acres each)
Switchyard	400 feet x 400 feet (3.7 acres)
Assembly Hall/Maintenance Building	330 feet x 130 feet x 35 feet (1 acre)
Office	100 feet x 30 feet x 12 feet (.06 acres)
Parking Area	250 feet x 100 feet (0.5 acres)
Stormwater Detention Basin	1,200 feet x 1,200 feet (33 acres) – providing 122-acre-feet of storage assuming 4-foot-deep basin
Bioremediation Area	400 feet x 800 feet (7.3 acres)

Table 1-2 Preliminary Facility Dimensions	
Project Component	**Approximate Dimensions / Acreage**
Fencing	Wind fencing on east and west sides of facility: 30 feet high x approximately 11,000 feet long per side Perimeter fencing on north side of facility: 8 feet high x approximately 15,500 feet long Perimeter fencing on south side of facility: 8 feet high x approximately 17,500 feet long

The location of certain Project facilities (assembly hall, administration building, laydown area, septic field, detention basin(s), and switchyard) depends on realignment of Amargosa Farm Road. The Proponent is currently working with Nye County Public Works Department to realign Amargosa Farm Road either 250 feet or 0.25 miles (1,320 feet) south of the existing roadway. The realigned portion of Amargosa Farm Road would extend from the vicinity of Sandy Lane to Valley View Road; a distance of approximately 3.5 miles. If the road is realized 250 feet south, the facilities would be located south of Amargosa Farm Road; which would separate the solar fields from these facilities. If the road is realized 1,320 feet (0.25 miles) south, the facilities would be located north of Amargosa Farm Road; thereby keeping the Project components entirely north of Amargosa Farm Road. Preliminary Project site plans depicting the two alignment alternatives are provided in Figures 1-3 and 1-4.

The proposed Project includes the construction and operation of two 232- MW dry-cooled solar power plants equipped with thermal energy storage capability and associated ancillary facilities. Facilities located within the Project area would occupy approximately 4,350 acres and would include solar fields, power blocks, an office and maintenance building, parking area, lay-down area, switchyard, and a stormwater detention basin. Additional elements of the proposed Project would include access roads and optional water pipelines. The proposed Project would utilize parabolic trough solar thermal technology to produce electrical power using steam turbine generators fed by solar steam generators. The main element of a parabolic trough power plant is the solar field. The solar field consists of numerous parallel rows of solar collectors, arranged on a north-south axis. The solar collectors follow the path of the sun from east to west during the day to keep the sun's rays continuously focused on a receiver tube. The reflectors consist of parabolic mirrors made from transparent, silver-coated glass, which concentrate the incident solar radiation 80-fold, focusing it onto the receiver tube in the solar collector. The receiver tube contains a heat transfer fluid, which is a temperature-stable synthetic oil in a closed circuit that can be heated to temperatures of up to 400 degrees Celsius. Once heated, the oil is pumped to a centrally located power block, where it flows through a heat exchanger.

The remainder of the process is similar to the steam cycle used in conventional power plants. The steam produced by the heat exchanger is used to drive a turbine connected to a generator, which produces electricity to be fed into a substation. The steam in the turbine condenses back into the water and the water is re-circulated through the solar field. With solar thermal technology, the heat is stored (referred to as thermal storage) and used during periods of cloud cover and up to 4.5 hours after sundown.



Amargosa Farm Road Solar Energy Project (NVN-84359)

General Site Plan
Figure 1-2

LEGEND

- Initial Right-of-way Limits (November 2007)
- Revised Right-of-way Limits (August 2009)
- Lands Released from Consideration for Project
- Proposed Solar Field
- Alternative Access Road
- Proposed Project Well
- Existing Substation
- Existing Transmission Line (<230kV)
- Private Parcel Line

Note: The Power Block contains the steam turbine, salt storage tanks and other power generating equipment as described in the Plan of Development.

Source: Project Facilities - Solar Millennium, 2009; Wells - Nevada State Engineer, 2008; Substation, Transmission Line - Platts, 2009; Imagery - ESRI, 2009

May 2010

0 0.5 1 Miles

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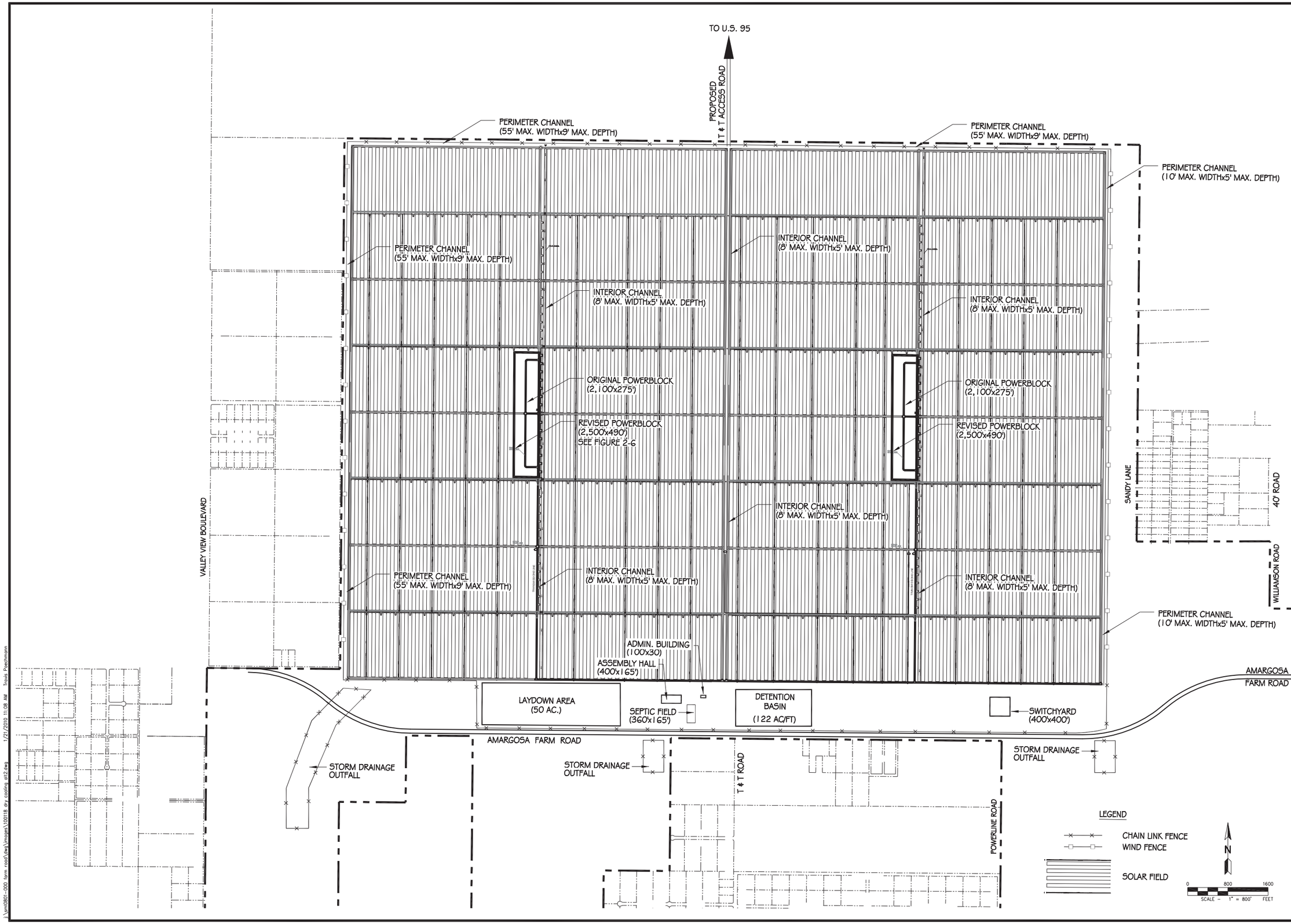

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NO.	DESCRIPTION	DATE	BY	APP. DATE	APP.

SOLAR MILENNIUM, LLC.

AMARGOSA FARM ROAD SOLAR PROJECT

FIGURE 1-3 REROUTE OPTION 1

DATE: 01-21-10
DRAFTER: NL
DESIGNER: NL
CHECKED: BDP
PROJECT NO. SML0801.000

Fig 1-3
SHEET 1 OF 1

####

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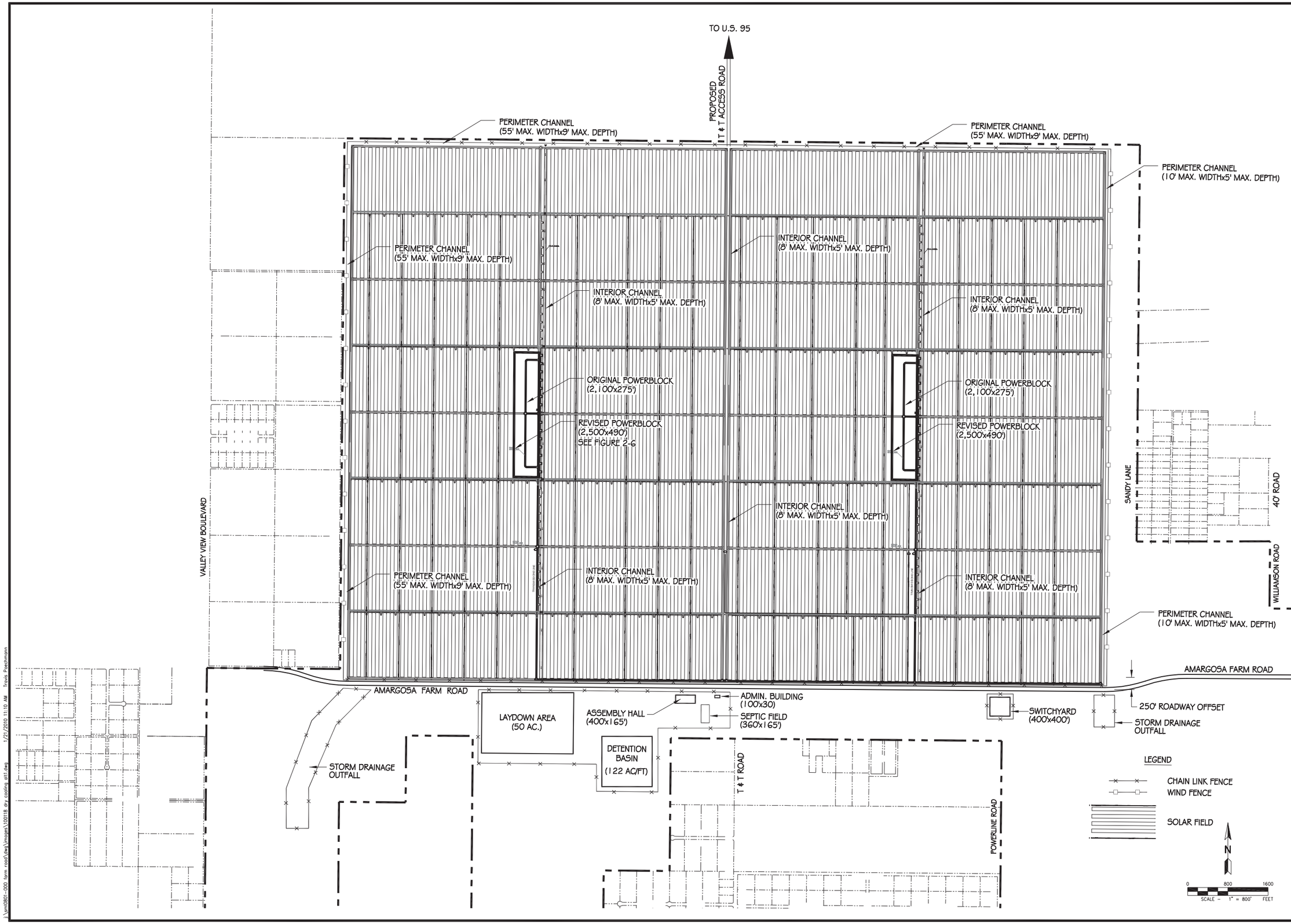

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NO.	DESCRIPTION	DATE	BY	APP. DATE	APP.

SOLAR MILLENNIUM, LLC.

AMARGOSA FARM ROAD SOLAR PROJECT

FIGURE 1-4 REROUTE OPTION 2

DATE: 01-21-10
DRAFTER: NL
DESIGNER: NL
CHECKED: BDP
PROJECT NO. SML0801.000

Fig 1-4
SHEET 1 OF 1
####

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The solar field and support facilities perimeter will be secured with a combination of chain-link and wind fencing. Chain-link, metal-fabric security fencing, 8-feet tall, with 1-foot barbed wire (or razor wire) on top will be installed along the north and south sides of the facilities. Thirty-foot tall wind fencing comprised of A-frames and wire mesh will be installed along the east and west sides of each solar fields. The wind fence would be designed to serve two purposes; protect the solar field from blowing dust and sand, and to partially screen the solar facilities from the surrounding properties. Controlled access gates will be located at the site entrance. The lower portion of all fencing will be designed to be tortoise-proof. Designs will be consistent with USFWS recommendations provided in the Draft Revised Recovery Plan for the Mojave Population of the Desert Tortoise (USFWS 2008).

At this time, it is anticipated the proposed Project would be built in two separate phases, with the construction of the first phase beginning in the fourth quarter of 2010, or immediately following issuance of the BLM right-of-way grant and other federal, state, and local permits and approvals. The entire facility, once built out, would operate for 30 years or more.

1.2.1 Construction of the Proposed Project

Construction will be managed by Solar Millennium. Several dozen major and minor subcontractors will be hired to undertake the myriad of mechanical, civil and electrical construction tasks. Prior to mobilization for construction, a detailed construction plan will be developed to define the construction supervisory and technical field organizations and staffing levels required for the Project. Major milestones of the planned construction schedule are as follows:

- Begin construction: fourth quarter 2010
- Unit #1 start of commercial operations: mid 2013
- Unit #2 start of commercial operations: by mid 2014

Project construction is expected to occur over a total of 39 months. The Proponent would phase construction so that the first power plant would be operational approximately 1 year before the second plant becomes operational. Project construction will require an average of 650 employees over the entire 39-month construction period, with manpower requirements peaking at approximately 1,300 workers in Month 17 of construction. The construction workforce will consist of a range of laborers, craftsmen, supervisory personnel, support personnel, and management personnel.

Temporary construction parking areas will be provided within the power plant site adjacent to the laydown area. The plant laydown area will be used throughout the build out of the two solar units. The construction sequence for plant construction includes the following general steps:

- Site Preparation: This includes detailed construction surveys, mobilization of construction staff, grading, and preparation of drainage features. Grading for the solar field, power block, and drainage channels will be completed during the first 24 months of the construction schedule. Pre-construction survey work will consist of staking/flagging right-of-way and site area boundaries, work areas (permanent and short

term), cut and fill staking, access and roads, transmission structure centers, foundation structure staking, and desert tortoise/endangered plants offsets. Staking/flagging will be maintained until final cleanup or reclamation.

- Linears: This includes the site access road and telecommunication line. The site access road and telecommunication line will be constructed during the first 6 months of the construction schedule in conjunction with site-preparation activities.

- Foundations: This includes excavations for large equipment, footings for the solar field, and ancillary foundations in the power block.

- Major Equipment Installation: Once the foundations are complete, the larger equipment will be installed. The solar field components will be assembled in an on-site erection facility and installed on their foundations.

- Balance of Plant: With the major equipment in place, the remaining fieldwork will be piping, electrical, and smaller component installations.

- Testing and Commissioning: Testing of subsystems will be conducted as they are completed. Major equipment will be tested once all supporting subsystems are installed and tested.

1.2.2 Operations and Maintenance

The Project will be staffed 24 hours a day, 7 days per week. A total estimated workforce of 100 full-time employees will be needed to staff the first phase of the project (Unit #1). When the second of the 2 units comes online, the full-time staff will increase to 180. The operations workforce would consist of plant operators and maintenance technicians working 12-hour shifts, and administrative personnel working 8-hour shifts per day.

Maintenance activities during operations will include daily inspection of field components, condition assessment of critical equipment, and routine lubrication of equipment. Some specialized maintenance would be performed by the equipment provider or other specialist contractors. Long-term maintenance would be performed against a defined service and replacement schedule.

Mirror washing is done at night and involves a water truck spraying treated water on the mirrors in a drive-by fashion. It is expected that the mirrors will be washed weekly in winter and twice weekly from mid- spring through mid-fall.

Under normal circumstances, the plant switchyard would be controlled remotely, and routine inspections by personnel would occur on a monthly basis or as needed under emergency conditions. In addition, all of the switchyard structures will be inspected from the ground on an annual basis for corrosion, misalignment, and foundation condition. Ground inspection will include the inspection of hardware, insulator keys, and conductors. This inspection will also check conductors and fixtures for corrosion, breaks, broken insulators, and bad splices.

Road maintenance would be performed as needed. Paved roads would be swept, sealed, and/or overlaid as needed. Grading and drainage would be maintained for gravel and earthen roads.

1.2.3 Decommissioning

The lifespan of the proposed Project is expected to span at least 30 years. At the end of the Project's useful lifespan, the facilities will either be repowered or decommissioned. Due to the excellent solar resource at the Project site, repowering is a viable option. This may involve replacing the existing parabolic troughs with components that are more efficient, thereby extending the useful lifespan of the Project. Decommissioning will adhere to the requirements of appropriate governing authorities and will be in accordance with all applicable federal, state, and local permits, including any reclamation requirements BLM specifically adopts for utility-scale solar projects. For this particular site, the decommissioning process will involve steps to dismantle and remove equipment, stabilize soil and drainages, and regrade and reshape features as necessary. 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.

1.2.4 Water Supply and Use

To fully address the potential impacts the proposed Project may have on federally listed wildlife and plant species within or near the Ash Meadows National Wildlife Refuge (NWR), it is necessary to describe the Project's proposed water supply and use in greater detail.

The Project will be dry-cooled. The Project's various water uses include water for solar collector mirror washing, makeup for the SSG (solar steam generator) feedwater, dust control, water for cooling plant auxiliary equipment, potable water and fire protection water.

1.2.4.1 Water Requirements

The estimated operational water requirements for the power plant are presented in Table 1-3. The average total annual consumptive water usage is estimated to be about 400 acre-feet per year (afy), which corresponds to an average flow rate of about 248 gallons per minute (gpm). Usage rates will vary during the year and would be higher in the summer months when the peak maximum flow rate could be as much as about 50 percent higher. Equipment sizing would be consistent with peak daily rates to ensure adequate design margin.

Table 1-3 Summary of Operational Water Usage	
Rate of Use	**Annual Average (afy)**
Power Cycle Heat Rejection	0
Power Cycle Makeup Water *	101
Mirror Wash Water	200
Domestic Potable Water	9
Dust Suppression Water	45
Ancillary Equipment Heat Rejection	146
Consumptive Use Totals (rounded)	400
* Power cycle makeup will be recycled. However, unless the cycle is 100% efficient, there will be some water usage beyond this approximated water requirement.	

1.2.4.2 Water Source

Solar Millennium has filed an application with the Nevada Division of Water Resources (NDWR) Nevada State Engineers Office to change the place and manner of use of an existing certificated water right near the Project site. The water right has an annual duty of 603 afy which has been pumped approximately 413.88 afy on average over the last 25 years (see Table 1-4).

Solar Millennium intends to drill a new well and move the point of diversion to a location just west of the current well. This will allow for redundancy should one of the wells fail. Meters will be placed on both wells to ensure there is no exceedance of the permissible annual duty.

Table 1-4 Project Well

Application No.	Certificate No.	Location	Annual Duty (afy)	25-year Average Pumpage (afy)
15893	5717	NE ¼ NE ¼ Sec 23, T16S, R48E	603.00	413.88

A new pipeline will be constructed from the new well to the Project site. Pipeline diameters will vary by need and would be sized upon final engineering design. It is estimated the pipeline size will range from 8 to 14 inches, depending upon the required flows.

A main waterline line will be constructed from the new point of diversion, located approximately 50 feet southwest of the northeast section corner of Section 23, Township 16 South, Range 48 East. The line will depart the point of diversion (across a private right-of-way) and head in a northeasterly direction approximately 100 feet to fall within the proposed Project right-of-way; it

will then head in a northerly direction to the Project power blocks, assembly hall and office building. The proposed pipeline lies on private land and within the proposed right-of-way.

During the anticipated 39 months of construction, the Proponent anticipated requiring up to 600 afy, or 1,950 acre-feet. To accommodate this, the Proponent will lease 600 afy from the water rights holder for the Project well. Once construction is completed, the Proponent will continue to lease 400 afy from the water rights holder and will relinquish back to the holder the remaining 200 afy. The Proponent will lease 400 afy for the remainder of the life of the Project and will acquire existing water rights totaling no less than 204 afy from within Basin No. 230 (Amargosa Desert Hydrographic Basin) as a minimization measure (See Section 5.1 below).

1.2.4.3 Water Treatment

For uses requiring treated water, the groundwater will first be treated by reverse osmosis (RO) or an electrodialysis reversal (EDR) process in a single treatment unit prior to being directed to a water storage tank. Up to three covered water tanks would be constructed on site. These include a RO concentrate/dust control storage tank totaling 750,000 to 1.1 million gallons, and treated water storage tanks, 1 in each power block, each totaling 250,000 to 600,000 gallons. Each tank will be a vertical, cylindrical, field-erected steel tank supported on foundations consisting of either a reinforced concrete mat or a reinforced concrete ring wall with an interior bearing layer of compacted sand supporting the tank bottom.

Water used for power cycle feedwater makeup, mirror washing, ancillary equipment heat rejection, and domestic uses would require treatment for reduction of total dissolved solids (TDS). This type of treatment process is known as desalination, and can be accomplished by either thermal processes (evaporation/condensation) or membrane processes such as RO or EDR. Given the concentration of TDS in the source water, it is unlikely that thermal processes would be cost effective. Accordingly, only membrane processes are considered here. Since RO and EDR produce similar product water quality and waste streams, further discussion here will reference only RO for simplicity. Selection of the process to be used at the Project would be made during the final design process.

Membrane desalination processes split the feed stream into two streams: (1) a product water stream (permeate) with reduced salinity and (2) a concentrate stream containing the majority of the salts that were in the feed stream. Desalination processes are usually designed to operate with the highest safe recovery (recovery is the fraction of feed water recovered as permeate) in order to minimize water loss, since the concentrate would normally be considered a waste stream. In this case, the highest safe recovery is 92 percent.

In order to provide the demineralized water quality needed for power cycle makeup, it would be necessary to provide ion exchange demineralization as a final treatment step after RO. Ion exchange demineralization can be done using either permanently installed equipment or portable demineralizers. Because permanently installed equipment requires regeneration on site, which requires storage and disposal of significant quantities of sulfuric acid and sodium hydroxide (caustic), portable demineralizers will be taken off-site for regeneration at the supplier's facility, so no on-site storage of chemicals and disposal of regeneration wastes is required. This would eliminate the need to store regeneration chemicals on site and minimize on-site production of

hazardous wastes. These demineralizers would be provided as forklift-moveable fiberglass bottles that would be traded out when exhausted and returned to the supplier for regeneration. Demineralization systems would be installed at each power block to minimize piping and provide the best water quality.

The steam purity specification is based on the VGB *Guidelines for Feedwater, Boiler Water, and Steam Quality for Power Plants/Industrial Plants* R450Le, issued in 2004. It is anticipated that all of the power-cycle make-up water will be recycled and reused as feed to the RO system. This would reduce the salinity of the RO feed and improve the RO recovery.

Because of the very low TDS of the makeup to the ancillary equipment heat rejection cooling tower, it is expected that blowdown would not be required. Rather, drift (windblown mist) would provide the necessary salt removal. If blowdown is required, it would be recycled to the RO system. It may be more advantageous to recycle the power cycle makeup water to the ion exchange demineralizer rather than to the RO. This modification will be evaluated during final design.

Water from the site groundwater well may require treatment to meet public health requirements for domestic potable water supplies. Based on the assumed water quality, it is expected that both TDS and fluoride concentrations must be reduced, which indicates the need for a desalination process. Following desalination, the water would require addition of chlorine to prevent growth of pathogenic organisms. Use of a solid calcium hypochlorite system is recommended.

1.2.4.4 Water Needs during Construction

Water needs for construction related activities include:

- Dust control for areas experiencing construction work as well as mobilization and demobilization
- Dust control for roadways
- Water for grading activities associated with both cut and fill work
- Water for soil compaction in the utility and infrastructure trenches
- Water for soil compaction of the site grading activities
- Water for soil stockpile sites
- Water for the various building pads
- Water for concrete pours on site

The predominant use of water during construction will be for grading activities, which will occur at a steady rate of work each month. The grading schedule for the site would be spread to cover

the total construction period. This will mean that water use will be steady and without definable peaks.

Average construction water use at the site is estimated to be about 752,000 gallons (about 2.3 afy) per working day. Total construction water use for the duration of the Project is estimated to be about 600 afy. Construction water will be sourced from Project well as described in Section 1.2.4.2 above. Potable water during construction will be brought to the site in trucks and held in day tanks.

1.2.4.5 Water Needs during Operations

To facilitate dust and contaminant removal, water from the primary desalination process, RO water, would be used to spray clean the solar collectors on a weekly or as-needed basis, determined by the reflectivity monitoring program. This mirror washing operation is done at night and involves a water truck spraying demineralized water on the mirrors in a drive-by fashion. It is expected that the mirrors will be washed weekly in winter and twice weekly from mid- spring through mid-fall. The mirrors are angled down for washing therefore water doesn't accumulate on the mirrors. Wash water falls from the mirrors to the ground and, due to the small volume, soaks in with no appreciable runoff. Remaining rinse water from the washing operation is expected to evaporate on the mirror surface. The water production facilities would be sized to accommodate the additional solar mirror washing demand of about 200 afy.

1.2.5 Waste Generation and Management

Project wastes would be comprised of non-hazardous wastes including solids and liquids and lesser amounts of universal wastes. The non-hazardous solid waste would primarily consist of construction and office wastes, as well as liquid and solid wastes from the water treatment system. The non-hazardous solid wastes would be trucked to the nearest landfill, which is a Class I landfill located in Pahrump with no limit to the amount of daily waste. Alternate disposal location is Las Vegas if a Class II or Class III landfill is required. Non-hazardous liquid wastes would consist primarily of domestic sewage, and reusable water streams such as RO system reject water, boiler blowdown, and auxiliary cooling tower blowdown. To manage the non recyclable non-hazardous domestic sewage wastes, a septic tank and leach field would be installed.

1.3 DATA COLLECTION

Biological data were initially collected during the biological inventory for the proposed Project. Data sources for special status species included scientific literature, existing agency files, and agency contacts. During early coordination meetings, agency personnel were asked to provide information on potential or known occurrences of sensitive wildlife and plant species, as well as habitats of special concern within the Project area. Agencies that provided biological information included the BLM, USFWS, Nevada Natural Heritage Program (NNHP), and the National Park Service (NPS). Tierra Data conducted site-specific field surveys as part of the biological inventory within the Project's right-of-way grant (NVN-84359), which included mapping of vegetation communities, invasive weed mapping, rare plant and wildlife surveys, and wetland

delineation. In addition, recent efforts in 2009 have included interdisciplinary team meetings with the BLM, USFWS, and the NPS, as well as field reconnaissance to the Project site. Individuals from each of these offices have participated in discussions and meetings to determine the content of the BA. Based on this input, additional literature reviews have been conducted and information has been compiled for the 13 federally listed species addressed in this BA.

The surveys conducted by Tierra Data in 2009 documented vegetation communities, flora and fauna, and sensitive species known to occur, or with the potential to occur within or near the Project area. No other field surveys have been requested from the BLM in support of the Project.

1.4 GROUNDWATER PUMPING MODEL (SOURCE: GEOTRANS, INC. 2010)

A numerical groundwater flow model was used to evaluate the potential regional effects to water resources associated with the proposed Project. The groundwater flow model was also used to simulate existing pumping in the Amargosa Basin. The following sections provide a summary of the groundwater modeling and predictive scenarios. The complete groundwater model report can be found in Appendix A.

1.4.1 Groundwater Model Background

Groundwater flow modeling was performed using the Death Valley Regional Flow System (DVRFS) Model (Belcher 2004). The DVRFS model is the only existing numerical model of the study area. This model was calibrated to both pre-pumping and pumping conditions. The Amargosa Basin is one of the areas covered by the model in which there has been significant pumping; water-level changes measured in the area were used to guide calibration of the model.

Documentation of the DVRFS model and report is available online (http://pubs.usgs.gov/sir/2004/5205/). In addition to the report itself, there are many supporting documents on geologic and hydrologic investigations performed to support development of the model. Hydrologic investigations relevant to the Amargosa Desert include measurements of evapotranspiration at Ash Meadows, in Death Valley, and in Oasis Valley; estimation of evapotranspiration at Franklin Lake playa and near Franklin Well (Amargosa River); construction of a dataset for pumping in the Amargosa Desert (and other areas); and measurement of groundwater recharge underneath the Amargosa River and irrigated fields in the Amargosa Farms area.

The model is developed with MODFLOW-2000, using a grid with a lateral spacing of 1,500 meters, and a variable vertical spacing. There are 16 model layers, with an interpretation of the water table used as a reference surface from which to base the elevation of the upper model layer. A large number of layers are needed to capture the geologic complexity incorporated into the geologic framework model, which is itself a simplification and interpretation of the actual geology. The model assumes that all layers are fully saturated and that dewatering does not occur. Thus, transmissivities do not become smaller with drawdown, and the model is approximately mathematically linear. Because the Drain package is used to simulate springs, the model would not be strictly linear if drawdown is sufficient to cause water levels in a cell to decrease below the specified elevation of a drain. In addition, if drawdown is sufficient to cause

appreciable decreases in the saturated thickness of the aquifer being pumped, the model will tend to underestimate the drawdown and overestimate the productivity of the aquifer.

The model was calibrated using a non-linear regression technique which optimizes modeling parameters to minimize the objective function, which was the sum of squared weighted residuals. A residual is defined as the difference between the observed (or estimated) value for a calibration target, and the corresponding simulated value. Hydraulic heads, water-level changes, discharge rates in spring areas, and lateral boundary fluxes were used as calibration targets. As the objective function represents the entire model, rather than concentrating on the Amargosa Farms and Ash Meadows areas, the agreement of simulated water-level change and measured change at Devils Hole is reasonable, but could be improved.

Following publication of the DVRFS report, a minor error was detected in the geologic model in the Oasis Valley area. The simulations reported here were performed with the updated model, which was downloaded from the web site provided above. Also, the modeling pumping and return flow datasets were updated in 2003 to include updated estimates of groundwater withdrawal and return flow from irrigation (Moreo and Justet 2008). This updated dataset was also used in the simulations reported here.

1.4.2 Groundwater Model Limitations

As stated earlier, the DVRFS model is the only existing numerical groundwater flow model of the study area. Before evaluating predictions of drawdown at Devils Hole or change in discharge at Ash Meadows using the DVRFS model, the reader needs to be aware of the limitations of using a regional-scale groundwater model to evaluate potential water resource impacts at springs or other sites (e.g., Devils Hole) that are local in scale (feet). These limitations include 1) model grid size (1,500 m x 1,500 m), 2) calibration to regional groundwater flow conditions, 3) estimates in historic pumping dataset and 4) simplification of geology. The DVRFS model report states "the use of the [DVRFS] model to address regional-scale issues or questions is the most appropriate use of the model." Thus, using the DVRFS model to predict hydraulic heads or water-level change at Devils Hole is not an appropriate use of the model. However, the DVRFS model gives you a qualitative sense of how water levels change over time at a given location, not quantitative.

Before conducting predictive modeling simulations, it is important to compare calculations of water-level change at Devils Hole with measured changes. Provisional water-level data after 1989 was received from NPS (2006). Several features should be noted:

- Both the measurement dataset and the simulated levels show declining water levels prior to the start of significant pumping in the Ash Meadows area. The simulated rate of decline is faster than the observed rate. The model is also slower to respond to changes in pumping rates.

- The effects of pumping in Ash Meadows are readily apparent in both the measurements and simulated results beginning in approximately 1970, but the simulated change is greater than the measured change.

- In the original 1998 model, during three periods beginning approximately in 1975, 1987, and 1998, there are simulated declines that do not occur in the measured values. The model values do not recover as much as the measurements following cessation of nearby pumping. In the updated 2003 model, the simulated decline starting around 1975 still remains to a lesser degree, but the other two declines have been corrected. We suspect there is still an error in the historical pumping dataset prepared by the USGS for the 1975 period.

- The effects of seasonal barometric changes, seasonal pumping, and earthquakes are not incorporated in the model.

- Beginning in 1989, until 2003, the updated 2003 model simulates a decline in water levels.

In summary, the DVRFS model over-predicts the drawdown caused by historical local pumping by approximately 30 percent.

1.4.3 Groundwater Model Simulations and Assumptions

After updating the USGS DVRFS model through 2003 with the revised pumping and return flow dataset, groundwater modeling scenarios using this updated model were conducted. Based on discussions with Project team members, the following modeling scenarios were simulated as part of this Project:

- Run existing DVRFS model an additional 200 years past the transient calibration period with 2003 pumping (i.e., existing pumping).
- Same as Scenario 1, except add the Proposed Action of groundwater withdrawal of 400 afy from the proposed project well south of the site from 2010-2039 (i.e., Proposed Action).

The following assumptions were made during the modeling scenario simulations:

- No climatic effects – The current recharge dataset was used for the 200-year simulations. The effect of water rights users irrigating more or less due to climate than 2003 amounts was not estimated.
- The Project groundwater withdrawal of 400 afy was added to the 2003 pumping dataset.
- Water infiltration from mirror washing was not accounted for because it is unknown what amount would ultimately end up as groundwater recharge.

1.4.4 Groundwater Model Results

The water-level contours indicate that the potentiometric surface of the valley fill indicates a broad and gently sloping gradient from the northeast toward the central axis of the valley and southwest toward the Funeral Mountains.

Within the Amargosa Basin, the most rapid water level declines occurred in the Amargosa Farms area, which is consistent with observed water level changes from other studies (Kilroy 1991). Devils Hole is approximately 15 miles from the proposed pumping, and the simulated drawdown at Devils Hole in 2003 from existing regional pumping is approximately 1.8 feet.

1.4.4.1 Scenario 1 (Existing Pumping) Results

For Scenario 1 (existing pumping), 2003 pumping and return flow was repeated every year for the next 200 years to determine the change in water levels at Devils Hole. Drawdown is predicted to be more than 5 feet over a large area. However, the drawdown is predicted to decrease rapidly in the Ash Meadows discharge area. The drawdown is buffered by the reduction in spring discharge that occurs with declines in water level. Simulated water levels at Devils Hole decline over 13 feet after 200 years, due to existing pumping. Note "time zero" is assumed to be the simulated water-level elevation on December 31, 2003 from the model, not pre-development conditions.

1.4.4.2 Scenario 2 (Proposed Action) Results

For the Proposed Action, the 400 afy of groundwater withdrawal was extracted from a single Project well. Pumping from this well is assumed to start in 2010 and concludes in 2039 since the Project life is 30 years. Table 1-5 shows the proposed groundwater withdrawal from the Project well.

Table 1-5 Proposed Groundwater Withdrawal from the Project Well

App. No.	Easting (m)	Northing (m)	Duty (afy)	Proposed w/d (afy)	Model Row	Model Column	Model Layer
15893	542362.42	4044948.68	603	400	116	71	1

The model results from the Proposed Action scenario show simulated water levels at Devils Hole decrease by less than 0.05 of a foot or 0.6 of an inch after 200 years. It is important to keep in mind that this reduction in water levels is approximately 30 percent higher due to the model overpredicting water level declines at Devils Hole historically. The DVRFS model calibration to hydraulic head change is also not accurate to 0.05 feet. The DVRFS model report considers the model fit to hydraulic heads to be good if the difference between simulated and observed hydraulic heads is less than 10 meters (Belcher 2004).

The DVRFS model is also not designed to exactly measure drawdown at a spring location several miles away, such as Devils Hole, because of its 1) grid size [1,500 meters x 1,500 meters], 2) emphasis on calibration to regional groundwater conditions, 3) estimates in historic pumping dataset, and 4) simplification of geology. Thus, the regional model has a limited capability to accurately evaluate incremental changes in pumping tens of miles away on Devils Hole; however, it is the only groundwater flow model available.

Recently, groundwater withdrawal from the well (e.g., from 2005 to 2007) has been 603 afy, the full duty. During construction, the Project will draw upon the full duty of 600 afy. During operation, the Project will draw upon only 400 afy with the remainder of the duty relinquished back to the rights holder. There will be a small difference between conversions from an agricultural to industrial beneficial use; however, it is impossible to quantify how much recharge, if any, will be derived from mirror washing.

Studies have been performed on irrigation return flow adjacent to the property (Stonestrom et al. 2003; Stonestrom et al. 2007), but give a range of values for recharge from two different methods: 1) 0.1 to 0.5 meter/year (4 to 20 inches/year) from vertical profiles of water potential and environmental tracers; and 2) 9 to 22 percent of infiltrated irrigation from chloride mass-balance estimates. The reason the model does not show zero water-level change at Devils Hole due to Project pumping is due to the USGS estimate for 2003 groundwater withdrawal from the well being lower than the current use of 603 afy.

1.4.4.3 Ash Meadows Discharge

The USGS code ZONEBUDGET was used to evaluate the changes in water movement for the Amargosa Basin. Under the present-day pumping rates, the model predicts that only minor changes to the discharge rate at Ash Meadows would have occurred by 2003, the end of the model calibration period. When the present-day pumping is continued into the future, the model predicts that impacts to the discharge will occur. In 2203, the discharge is predicted to be reduced from approximately 18,095 afy to 15,607 afy. When the Project pumping is added, the discharge rate in 2203 is predicted to be reduced to only 15,600 afy or a difference of 7 afy or 0.05 percent.

1.4.5 Groundwater Model Summary

Comparison of simulated and observed changes in water levels at Devils Hole through 2003 indicated that the model overestimated the change in water level caused by pumping in Amargosa Basin. There may be an error in the historical pumping dataset that affects this comparison. Although the model could be improved by additional work, specifically in the Amargosa Desert and Ash Meadows areas, the pumping estimates developed for the model are reasonable.

The simulations predict that pumping from the Project well will cause water levels in Devils Hole to decline less than 0.05 of a foot after 200 years. When considering these predictions, it is important to recognize that the model over-predicted the decline in water levels caused by pumping in the Amargosa Basin and cannot accurately predict hydraulic heads or water-level changes at Devils Hole due to its original objective of modeling groundwater flow at a regional scale. The results of these simulations should be regarded as a qualitative assessment of how hydraulic heads may change over time with a given set of circumstances and assumptions.

The model predicts that the Project pumping will reduce the discharge rate from springs at Ash Meadows an amount of 7 afy or 0.05 percent.

Groundwater pumping in the Amargosa Farms area has caused tens of feet of drawdown near the pumping wells. Simple modeling using the Theis equation and superposition, coupled with regression procedures, indicates that the pumping in the Amargosa Farm area is the primary cause of the present-day drawdown at Devils Hole.

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2.0 STUDY AREA AND ENVIRONMENTAL SETTING

The Project is located in the southern portion of Nye County, Nevada near the California state line, and covers approximately 6,320 acres of relatively monotypic habitat.

2.1 PHYSIOGRAPHIC PROVINCE

The Project is within the Basin and Range Physiographic Province, occupying the southwestern interior of North America. This province consists of north-south trending basins (such as Amargosa River Basin, Yucca Flat, and Frenchman Flat basins) bordered by relatively long, narrow mountain ranges such as Yucca Mountain. The basins were formed between 12 and 8 million years ago by settling blocks of the earth's crust alternating with and bordered by other blocks now eroded to form the existing long narrow ranges (Smiley et al. 1984; Hall 1995). Lithology (rock type) of the bedrock outcrops in the Amargosa River Basin is varied. The bedrock consists primarily of rhyolitic volcanic ash falls and flows of Tertiary age, and carbonate, quartzite, and argillite that range from Cambrian to Devonian in age. In the area of the Project, the valley fill material is comprised of outcrops of carbonate and other clastic rocks (Claassen 1985; Stewart and Carlson 1977).

The surface-drainage area of the Amargosa Desert is about 4,163 square miles and elevations range from 2,198 to 7,874 feet above mean sea level (amsl). The mean annual precipitation corresponding to these elevations is 2 to 15 inches, and the mean annual temperatures range from 42 to 60 degrees Fahrenheit (Claassen 1985). Precipitation in Nevada is highly variable temporally and spatially. Winter storms and summer monsoons are the two seasonal weather patterns that bring precipitation to Nevada (Houghton et al. 1975). During some winters, relatively warm storms originate from the central and tropical Pacific Ocean. These storms have large amounts of moisture and can cause flooding (Freidman et al. 2002). During the summer, prevailing southwesterly winds bring monsoonal moisture from the Gulfs of Mexico and California. In the Project area, precipitation averages 4.2 inches annually with annual extremes from less than one inch to more than 10 inches.

Soils are generally characterized as well-drained secondary soils with low to very low available water holding capacity (Tierra Data 2009). These soils are weathered from bedrock on the mountains, medium to coarse textured soils on alluvial fans and terraces and fine-grained, alluvial soils on the valley floors. Infiltration rates of the alluvial basin soils are low because the downward movement of water commonly is impeded by calcium-carbonate-cemented layers, fine grained playa deposits, and less commonly, silicified hardpans that form within the soils over time (Beatley 1976).

Specifically, there are four soil map units described for the Project including, (1) Yermo, hot-Yermo-Arizo association, (2) Shamock gravelly fine sandy loam, 2 to 4 percent slopes, (3) Sanwell-Sanwell, warm-Yermo association, and (4) Lewdlac-Yermo association (USDA, NRCS 2009a). The Yermo series consists of deep, well drained soils that formed in mixed, moderately coarse textured, calcareous, gravelly or cobbly alluvium. Yermo soils develop on long, smooth, alluvial fans or uplands and have slopes of 1 to 50 percent. The Arizo series consists of very deep excessively drained soils that formed in mixed alluvium. These soils are on recent alluvial

fans, inset fans, fan apron, fan skirts, stream terraces, floodplains of intermittent streams and channels. Slope ranges from 0 to 15 percent. The Shamock series consists of moderately deep over a duripan, well drained soils that are on fan remnants, alluvial plains and relict alluvial flats. Shamock soils formed in mixed alluvium and have slopes from 0 to 4 percent. The Sanwell series, found on alluvial flats, are typically very deep and well drained, with slopes from 0 to 8 percent. These soils form in coarse lacustrine sediments. The Lewdlac series consists of shallow over a strongly cemented duripan, well drained soils that formed in quartzite-rich mixed alluvium over reworked lacustrine sediments. The Lewdlac soils are on relict alluvial flats and have slopes of 0 to 8 percent. Finally, the Yermo, hot-Yermo-Arizo association comprises approximately 96 percent of the Project area, while Lewdlac-Yermo association and Shamock gravelly fine sandy loam comprises approximately 3 percent 0.7 percent respectively (USDA, NRCS 2009a; USDA, NRCS 2009b).

2.2 PLANT COMMUNITIES

Within the Amargosa Desert, the type of vegetation depends on the degree of slope, slope aspect, and precipitation. Steep slopes, especially south or west facing slopes have little to no vegetation, while at lower elevations on gently sloping alluvial fans support desert scrub. Higher density cover exists at elevations near 4,921 feet and lower density cover exists at lower elevations. Scattered juniper and sage are the dominant woody plants from about 4,921 feet to about 5,905 to 6,889 feet where pinyon pine begins to dominate (Claassen 1985). Within the Project, elevation ranges from 2,358 to 2,500 feet amsl.

One of the warm temperate extensions of the North American Desert is best known as the Mojave Desert, which is the smallest of the four North American deserts, characterized by predominately winter rainfall. It is intermediate between Great Basin desert scrub to the north and Sonoran desert scrub to the south (Brown 1994). Plants and animals occupying Mojave desert scrub are similar to those observed in the Lower Colorado River Valley Subdivision of Sonoran desert scrub, particularly within the creosote bush series, and *Larrea tridentata-Ambrosia dumosa* association. These open-plant communities occupy areas characterized by gravelly bajadas and inconspicuous low plains.

Other plants typically associated with this biome include box-thorn (*Lycium andersonii*), Mormon tea (*Ephedra* spp.), and ratany (*Krameria* spp.). The Mojave desert is especially rich in ephemeral plants, many of which are endemic. These short-lived plants are attuned to winter conditions and those that germinate and grow in response to summer conditions (Brown 1994). Seed germination of winter annuals is triggered by critical rains between late September and early December, usually arriving in one storm; however, if the storm arrives too early in the year, germination will be ineffective unless temperatures have shifted from summer to autumn (Brown 1994).

Within the creosote bush series of Mojave desert scrub (Photo 1) there are a variety of plant communities possessing more or less distinctive Mojave associates. In the Project area, *Larrea tridentata-Ambrosia dumosa, Larrea tridentata-Atriplex polycarpa, Larrea tridentata-Lepidium fremontii,* and *Larrea tridentata-Ambrosia dumosa-Atriplex polycarpa* are the co-dominant associations (Tierra Data 2009).

Photo 1 Creosote bush series of Mojave desert scrub

In the Project area, *Larrea tridentata-Ambrosia dumosa* association is found on mostly flat, gravelly desert pavement with herbaceous growth limited to beneath the shrub canopies or in close proximity. Primroses, *Brassica* spp. and desert puffballs are occasionally seen. Wildlife is more diverse and abundant in this association than others within the series including, numerous lizards, jackrabbits, rodents, and burro sign. The only Desert Tortoise burrows observed in biologic surveys for this project were found in this association (Tierra Data 2009).

The second association is *Larrea tridentata-Atriplex polycarpa* and is located primarily in the southern portion of the Project area. The variety of herbaceous plants are similar to those in creosote bush-white bursage (=burrobush) association (Photo 2), but is distributed more sparsely. Wildlife occurs less frequently as well (Tierra Data 2009). The *Larrea tridentata-Lepidium fremontii* association occurs in isolated small patches primarily in the northeastern portion of the Project. The overall shrub canopy is much lower than in the other associations, with less herbaceous cover distributed throughout. Finally, *Larrea tridentata-Ambrosia dumosa-Atriplex polycarpa* occurs in a few small patches on the west end of the Project area.

Photo 2 *Larrea tridentata-Ambrosia dumosa* association within the creosote bush series

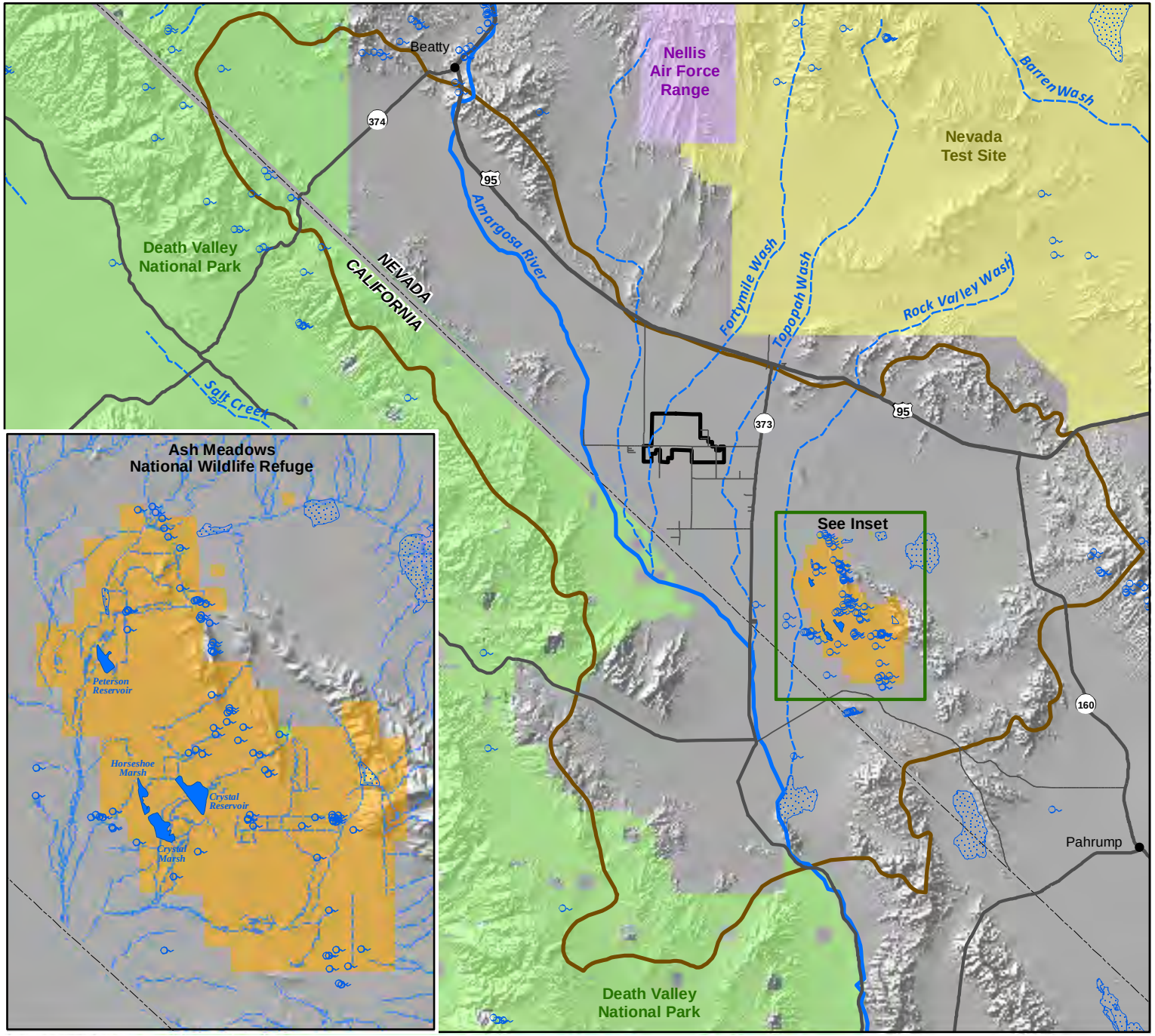
In addition to the upland plant communities noted above, two wetland biomes occupy narrow strips along margins and bottoms of many washes that traverse the uplands. These are the Riparian Scrublands along the periphery of washes and the Interior Strand along the sandy/gravelly wash bottoms (Photo 3). Within riparian corridors, the vegetation is similar to adjacent upland vegetation but occurs more abundantly and denser. Riparian trees include desert willow (*Chilopsis linearis*) and catclaw (*Acacia greggii*), the shrubs are generally the same as those found in the uplands, but cheesebush, also called white burrobrush (*Hymenoclea salsola*), occurs on rare occasions along the wash banks. Along the well-defined banks of Fortymile Wash, *Atriplex polycarpa* occurs more abundantly than in the uplands (Tierra Data 2009).

Photo 3 Riparian Scrublands along periphery of washes and Interior Strand along the sandy/gravelly wash bottoms

2.3 HYDROLOGICAL CHARACTERISTICS

2.3.1 Surface Water

The Project is situated within the Amargosa River drainage system (Figure 2-1). The Amargosa River is a major drainage component of the unique closed-basin, hydrological regime known as the Great Basin. Fortymile Wash and Beatty Wash are the major tributaries to the upper Amargosa River, which drains through several small, populated areas downstream and eventually terminates in Death Valley (USGS 1995). Fortymile Wash drains the southern part of Pahute Mesa, the western part of Jackass Flats, and the eastern slopes of Yucca Mountain (USGS 2001). Flow of the Amargosa River is ephemeral except in a few relatively short reaches where discharging springs maintain small, perennial base flows. North of its intersection with Highway 95, Fortymile Wash is moderately confined, shifting to several poorly-defined distributary channels south of the highway. This pattern persists downstream to its confluence with the Amargosa River, where the system loses streamflow due to higher infiltration and evaporation. The Amargosa River is moderately confined upstream from Big Dunes, but downstream, the river splits into several channels that are poorly defined through the Amargosa Valley farm area (USGS 1995). The change in flow patterns and channel geometry characteristics causes uncertainty regarding flow continuity within and between the two drainages (USGS 1995).



Amargosa Farm Road Solar Energy Project (NVN-84359)

Surface Water Flow
Figure 2-1

LEGEND

- Project Area

Water Resources

- Amargosa Desert Hydrographic Basin (230)
- Reservoir
- Playa
- River
- Wash
- Spring/Seep

General Reference Features

- Ash Meadows National Wildlife Refuge
- Death Valley National Park
- Nevada Test Site
- Nellis Air Force Range
- US Highway
- State Highway
- Local Road
- State Boundary

Source: Water Resources - USGS, 2005,2006;
Ash Meadows - USFWS, 2005;
Land Ownership - BLM, 2007;
Local Roads - Terra Spectra, 2009;
Highways - ESRI, 2005

May 2010

0 6 12 Miles

However, the data collected during the floods in 1995 and 1998 indicated that (1) Fortymile Wash is capable of flowing directly to the Amargosa River, and (2) the river was capable of flowing from its source to Death Valley (USGS 1995). In addition to the Fortymile Wash, other major Amargosa River tributaries include Carson Slough, located in the Ash Meadows NWR vicinity and China Ranch Wash and Salt Creek, both of which are located south of Tecopa, California.

Amargosa River seldom flows along its entire length, and runoff is infrequent because the basin receives an average of only 4.2 inches of precipitation per year. Short reaches of the river, primarily north of Beatty, Nevada and near Tecopa, California, consistently flow from summer and winter rains and spring discharge. During extreme flood events in 1995 and 1998, data was collected from continuous surface water monitoring sites, and it was shown that streamflow durations generally ranged from 12 to 36 hours and varied according to tributary subbasin sizes. Channel erosion was less severe in Fortymile Wash and its large tributaries than in the smaller washes. The flood of 1995 caused high streamflows that resulted in severe channel scour and erosion (USGS 2001). This flood was the result of heavy precipitation of relatively short duration that occurred mainly in the higher altitudes near Yucca Mountain, while the flood of 1998 was attributed to persistent, widespread precipitation over several days which eventually caused streamflow in most major tributaries to Fortymile Wash and the Amargosa River (USGS 2001). Surface water flows have been classified into cataloging units, geographic areas representing part or all of a surface drainage basin, a combination of drainages basins, or a distinct hydrologic feature. The Project is within the Upper Amargosa, which encompasses approximately 3,340 square miles in California and Nevada (USGS 1981).

The nearest surface water impoundments are Peterson Reservoir, Crystal Reservoir, Lower Crystal Marsh, and Horseshoe Reservoir in the Ash Meadows NWR, located approximately 10 miles southeast of the Project. The largest of these is Crystal Reservoir, a manmade impoundment. This reservoir captures discharge from several springs in the area with a capacity of about 1,500 acre-feet. Crystal Reservoir and other smaller pools in the Ash Meadows NWR drain to Amargosa River through Carson Slough (USGS 2001).

2.3.2 Groundwater

Generally, regional groundwater flow has two main flow systems; the first is the valley or basin fill aquifer, which is relatively shallow and local, and groundwater movement is restricted to individual basins; the second is the carbonate aquifer, a deeper, regional aquifer capable of interbasin flow.

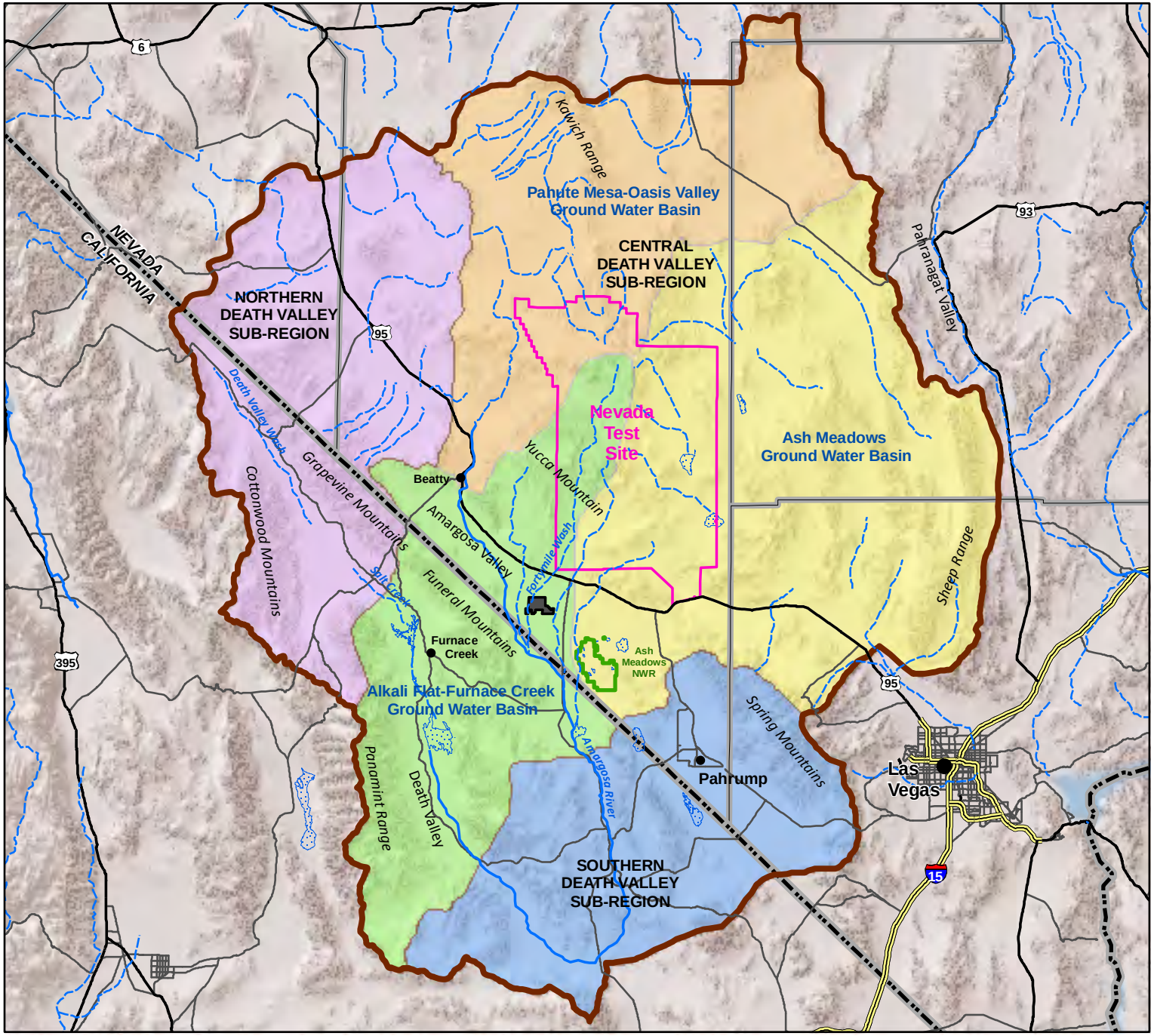
The regional carbonate aquifer is comprised of two main units of carbonates, separated in places by a clastic aquitard. Similar units are present throughout the Basin and Range province, but are isolated from each other. The carbonate system present in Amargosa Valley is part of a corridor of carbonate units that stretches from eastern Nevada to the Death Valley area in a general northeast/southwest trend. Groundwater flow through the regional system is generally from the northeast to the southwest, and interbasin flow is believed to be common.

The local valley, or basin, fill aquifers are isolated units comprised of alluvial materials that collect in the valleys after eroding from surrounding uplands.

The confining layer separating the basin fill from the carbonate aquifers is not present or impermeable throughout the entire region, resulting in some connection and exchange between the two flow systems. Despite being heavily studied, this connection is not well understood. Flow between the two systems is generally upwards, with the regional carbonate aquifer feeding the local basin fill aquifers in some locations. The source of most springs in the area, including those in Death Valley National Park and Ash Meadows NWR, is thought to be the regional carbonate aquifer.

The Death Valley Regional Flow System (used as the basis for modeling groundwater flow for the Project) encompasses portions of southern Nevada and eastern California (Figure 2-2). Encompassing an area of approximately 62,137 square miles, the Death Valley Regional Flow System contains complex geology and hydrology (USGS 2006). The hydrology is influenced by the geology and climate and varies with time. Generally, groundwater moves through permeable zones under the influence of hydraulic gradients from areas of recharge (areas where water infiltrates from the surface and reaches the saturated zone) to areas of discharge (locations where groundwater reaches the surface) in the regional system (Belcher 2004). Current groundwater discharge in the Death Valley Regional Flow System is from seeps and spring flow from the regional carbonate-rock aquifer and local systems, evapotranspiration, pumpage for irrigation, mining, public supply, commercial, and domestic uses, and subsurface flow out of the regional flow system (Belcher 2004).

Groundwater flow within the Death Valley Regional Flow System is divided into subregions that are further divided into sections, and the sections are grouped into groundwater basins. These divisions are based on locations of recharge areas; regional hydraulic gradients; distribution of aquifers, structures, and confining units that affect flow; and location of major discharge areas (Belcher 2004). The Project area is located within the Central Death Valley Subregion. In this subregion, the dominant flow paths are associated with major regional or intermediate discharge areas and have been grouped into three groundwater basins: (1) Pahute Mesa-Oasis Valley basin, (2) Ash Meadows basin, and (3) Alkali Flat-Furnace Creek basin. The Project is situated within the Alkali Flat-Furnace Creek basin. Groundwater is derived from recharge on Pahute Mesa, Timber and Shoshone Mountains, and the Grapevine and Funeral Mountains. Additional recharge may occur as throughflow from Sarobatus Flat, Oasis Valley, and Ash Meadows. Recharged groundwater then moves through volcanic rock aquifers in the north and carbonate rock aquifers in the south towards discharge areas in the southern and southwestern portions of the basin (Belcher 2004). Within the Alkali Flat-Furnace Creek basin, the Project is further divided into the Amargosa River Section. Recharge to this section is predominantly by throughflow in the basin-fill sediments from Oasis Valley, Crater Flat, Fortymile Canyon and Wash, and Specter Range sections (Belcher 2004).



Amargosa Farm Road Solar Energy Project (NVN-84359)

Death Valley Regional Flow System Model Figure 2-2

LEGEND

- Project Area
- Death Valley Regional Flow System
- Northern Death Valley Sub-region
- Southern Death Valley Sub-region

Central Sub-region Ground Water Basin

- Alkali Flat-Furnace Creek
- Ash Meadows
- Pahute Mesa-Oasis Valley

General Reference Features

- Interstate
- US Highway
- Major Road
- River
- Wash
- State Boundary
- County Boundary
- City / Town
- Playa

Source: DVRFS - USGS, 2004
Roads, Boundarys, Hillshade - ESRI, 2009

May 2010

0 10 20 Miles

3.0 SPECIES ACCOUNTS

The 13 species listed under the Endangered Species Act (1974) that are the focus of this assessment include: 1 reptile, 4 fish, 1 invertebrate, and 7 plant species. The distribution of these species relative to the Project area is shown in Figure 3-1. This section contains an account of each species covered in this BA.

3.1 REPTILES

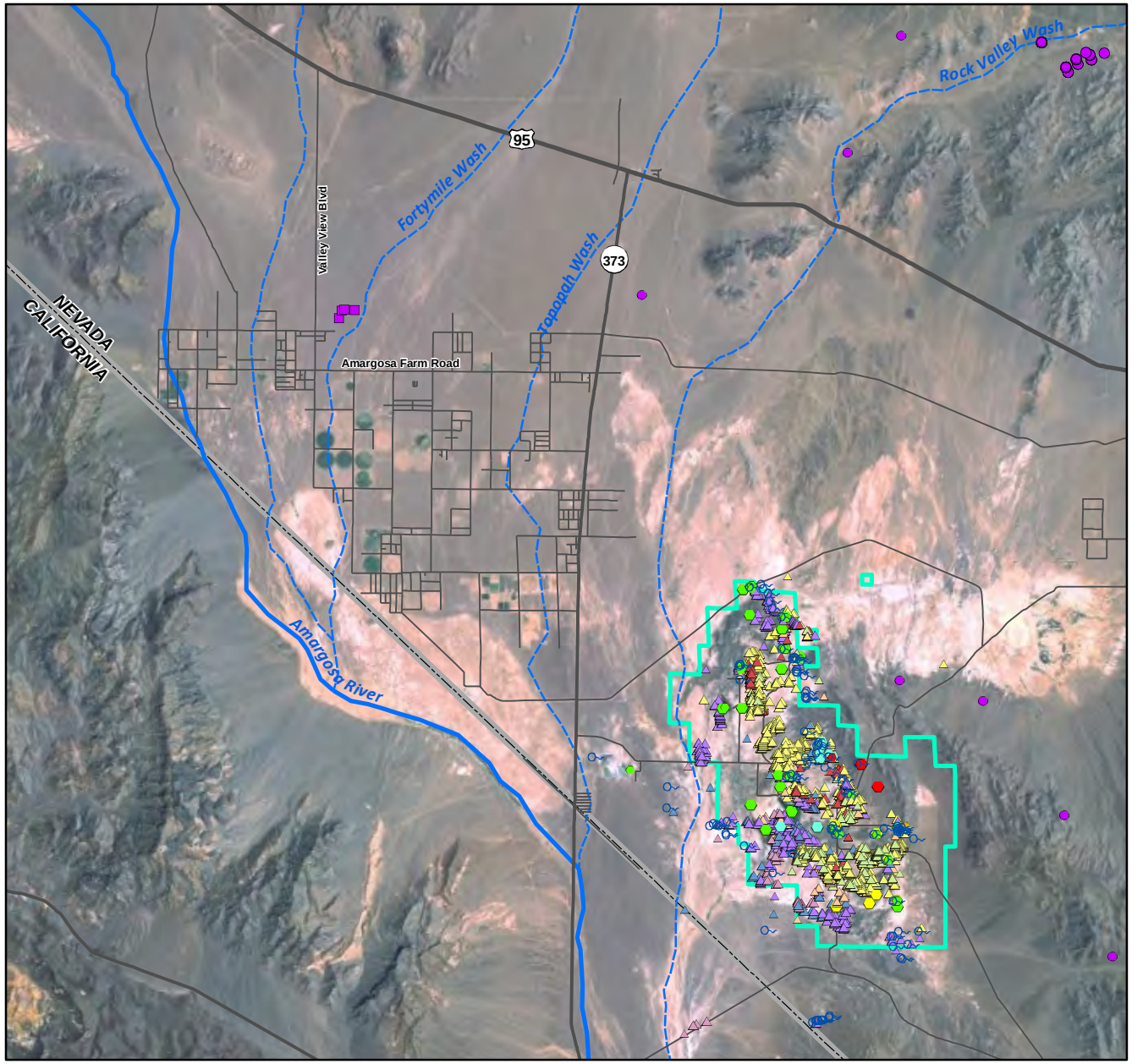
3.1.1 Desert Tortoise (Mojave population)

3.1.1.1 Regulatory Status

The Desert Tortoise (*Gopherus agassizii*) consists of two geographically dissimilar populations: the Mojave and Sonoran. The Mojave population is defined as those tortoises north and west of the Colorado River and west of Beaver Dam Slope, Utah, and is distributed throughout southern Nevada, southeastern California, the Beaver Dam Mountains and Virgin River area of southwestern Utah, and northwestern Arizona. The Sonoran population is found in most of Arizona, western New Mexico, and south through Sonora to northern Sinaloa, Mexico. The Sonoran population of Desert Tortoises also occurs on Isla Tiburon, in the Sea of Cortez (Germano et al. 1994).

Major declines and die-offs of Desert Tortoises were observed in the Mojave Desert in the 1980s, leading to the emergency listing of the Mojave population of Desert Tortoise as endangered on August 4, 1989 (54 FR 32326-32331). On October 13, 1989, the USFWS published a proposed rule to list the Mojave population as endangered (54 FR 42270-42278), but because the emergency rule expired on April 2, 1990, it was necessary to publish the final rule on that day, to prevent a lapse in protection for the tortoise. On April 2, 1990, the USFWS published a determination of threatened status for the Mojave population of Desert Tortoise with no Critical Habitat determination at that time (55 FR 12178-12191).

The Mojave population has been divided into six distinct population segments or recovery units, based on presumed evolutionary history (those population segments are sometimes deemed ESUs or evolutionarily significant units). Each recovery unit has been delineated based on variations in genetic, morphological, ecological, physiological, and behavioral traits (USFWS 2008), and a recovery plan was adopted in 1994 (USFWS 1994). Currently a revised recovery plan is being developed and is in draft form (USFWS 2008). A total of 6.4 million acres of Critical Habitat was designated in 1994 (59 FR 5820-5866). Within those six management units, Desert Wildlife Management Areas were identified, where populations of tortoises facing similar threats would be managed with the same strategies (59 FR 5820-5866).



Amargosa Farm Road Solar Energy Project (NVN-84359)

Species Overview
Figure 3-1

LEGEND

- Project Area
- Ash Meadows National Wildlife Refuge
- US Highway
- State Highway
- Local Road
- State Boundary
- Wash
- River
- Spring/Seep

Species

- Amargosa Niterwort
- Ash Meadows Blazing Star
- Ash Meadows Gumplant
- Ash Meadows Ivesia
- Ash Meadows Milkvetch
- Ash Meadows Sunray
- Spring-loving Centaury
- Ash Meadows Naucorid
- Ash Meadows Speckled Dace
- Warm Springs Pupfish
- Ash Meadows Amargosa Pupfish
- Devil's Hole Pupfish
- Desert Tortoise
- Desert Tortoise Burrow (Class IV)

Source: Species Data - BLM, 2009, NDOW, 2007, NNHP, 2006,TierraData, 2009; Local Roads - TerraSpectra, 2009; Ash Meadows - USFWS, 2005; Highways, Imagery - ESRI, 2009

May 2010

0 2.5 5 Miles

The California and Nevada State Natural Heritage Programs have listed Desert Tortoises as imperiled, and in Utah they are considered critically imperiled (NatureServe 2009). The Desert Tortoise is protected by the State of Nevada (NNHP 2009). The Mojave population is on the watch list of species in Clark County, Nevada, and it is considered sensitive by the BLM and USFS (NNHP 2009).

3.1.1.2 Species Description

The Desert Tortoise was first described by Cooper in 1863 as *Xerobates agassizii*, named after the iconoclastic Harvard professor Louis Agassiz. Over the years, scientists assigned it to different genera including, *Scaptochelys* (Bramble 1971), *Xerobates* (Lamb et al. 1989), and *Gopherus* (Crumley 1994), the genus under which it is now recognized.

The Desert Tortoise has a domed carapace and a relatively flat, unhinged plastron. Adults will reach a carapace length of 8 – 15 inches and shell height of 4 – 6 inches. Adults typically weigh 8 – 15 pounds. When hatchlings emerge from their eggs, they are approximately 2 inches long (Ernst et al. 1994).

The Desert Tortoise is greenish-gray to dark brown with tan scute centers. Their forelimbs have heavy, conical scales and are flattened for digging and burrowing. Hindlimbs are more elephantine. When limbs pull in, they block the openings of the shell (Ernst et al. 1994).

3.1.1.3 Status and Distribution

Population densities of the Desert Tortoise are decreasing in many areas, particularly in the western Mojave Desert (Corn 1994). According to a U.S. Geological Survey (USGS) report by Berry and Medica (1995), density estimates in 1990 ranged from approximately 13 to 168 adult tortoises per square mile depending on location. A study in southeastern Nevada found a density of approximately 17 tortoises per square kilometer (44 per square mile), and most populations discussed in that report showed a downward trend (Berry and Medica 1995).

Although population density studies have been conducted for many years in several areas throughout the Desert Tortoise's range, inconsistencies in sampling techniques, study scale, and study goals make long-term population trend determinations impracticable. Those data may however provide a general overview of the species' range-wide status and demonstrate considerable declines at the local level (USFWS 2008). Beginning in 2001 (1999 in the Upper Virgin River Recovery Unit) annual range-wide monitoring was initiated (USFWS 2006a). Results from the first 5 years of this program estimated a population density low of 2 to 8 tortoises per square mile for the NE Mojave Recovery Unit and a high of 44 to 78 tortoises per square mile for the Upper Virgin River Recovery Unit (USFWS 2006a). The Project area is located within the NE Mojave Recovery Unit. Because this monitoring program is designed to measure long-term population trends, the first 5 years of the program are essentially to establish baseline densities and variability between years and between recovery units (USFWS 2006a).

3.1.1.4 Life History

Tortoises of the Mojave population are found primarily in Mojave desert scrub. They are generally associated with communities dominated by creosote bush and other sclerophyll shrubs and small cacti (Germano et al. 1994). Some parts of their range may contain abundant Joshua trees (*Yucca brevifolia*). In the Mojave Desert, the terrain is generally gently rolling alluvial fans with sandy or gravelly soils (Ernst et al. 1994).

Adequate burrowing substrate and thermal cover plant species are a crucial habitat component for Desert Tortoises. In the Mojave population, Desert Tortoises will construct their own burrows to avoid extreme hot or cold temperatures. They often excavate burrows under vegetation, up to 33 feet deep. Elevations at which tortoises occur in the Mojave population range from below sea level in Death Valley, California, up to about 5,000 feet at Yucca Mountain, Nevada (AZGFD 2001).

The annual reproductive cycle of the Mojave Desert Tortoise begins in February or March when they emerge from hibernation. Mating generally takes place in the spring and may last into fall (Ernst et al. 1994). Between one and 14 eggs are laid in an excavated nest near a shrub or burrow entrance between May and July (Ernst et al. 1994). Incubation generally lasts for 90 to 120 days. Egg hatch rates vary, but hatchling and juvenile mortalities are assumed to be very high, and it has been estimated that only one hatchling for every 15 to 20 nests will survive to reach sexual maturity (Lawler no date). Average age of reproductive viability of females is primarily a function of animal size, but is usually between the ages of 12 and 25 years (USFWS 1994). Females produce from one to three clutches of eggs per year (Turner 1986).

Desert Tortoises are herbivores, consuming a wide variety of plant materials including dicot annuals, grasses, herbaceous perennials, trees, shrubs, sub-shrubs/woody vines, and succulents (AZGFD 2001). A study of their food habits in the Mojave Desert found that they used 43 plant species, including 37 annuals and 6 perennials. The diet showed a very strong preference for native plants (95.3 percent), and some of their preferred food plants were uncommon to rare (Jennings 1997). A study of juvenile tortoises found differences in diet between wet and dry summers. During a very dry summer, tortoises were observed foraging on only three species, but they used 15 species during a wet summer (Spangenberg 1995). Tortoises may forage selectively, sampling several possibilities before consumption (Oftedal 2002, Van Devender et al. 2002). Selective food preferences for individual tortoises within a population make plant diversity an important constituent of tortoise habitat (Tracy 2001). Desert Tortoises also ingest rocks, bones, and soil, possibly to maintain intestinal bacteria, to provide additional minerals, or as gastroliths to aid digestion (Esque and Peters 1994; Stitt and Davis 2003).

3.1.1.5 Threats to the Species

Desert Tortoises are facing numerous threats to their survival. Livestock grazing, recreational off-highway-vehicle (OHV) use, military training activities, urban development, disease, and increases in predation are some of the factors that affect tortoise survival by reducing or fragmenting available habitat, causing population declines (Lovich 1999). Additional threats include illegal collection of tortoises as pets, vandalism (shooting, crushing or mutilation), road-kill mortality, and use as human food (USFWS 1994; Stitt and Davis 2003).

The presence of livestock may affect tortoise habitat in several ways. Tortoises, their eggs, and hatchlings can be killed directly by trampling and collapsing burrows. Livestock also trample vegetation (e.g., creosote bush) that is utilized by tortoises to shade burrows, pallets, and for thermoregulation. Impacts from grazing include damage to soils crusts and cryptogamic soils leading to increased erosion, decreased water infiltration due to soil compaction, and an increase in exotic annual vegetation, which compromises plant diversity and density, and increases fire fuel (USFWS 1994). Removal of native vegetation by livestock grazing allows the infiltration and proliferation of exotic plants on disturbed soils. Some of these invading exotic species include filaree (*Erodium cicutarium*), tumbleweed (*Salsola iberica*), split grass (*Schismus barbatus*), Arab grass (*S. arabicus*), cheat grass (*Bromus tectorum*), and red brome (*Bromus rubens*) (USFWS 1994), and are of decreased nutritional quality relative to native species (Oftedal 2002).

Invasion by exotic plants can have a negative impact on tortoises due to the changes that are effected in the native plant community. Red brome, for example, a European import, competes with native perennial grasses, shrubs, and annuals. Recurrent fires due to the presence of exotic ephemerals, such as red brome, can reduce the abundance and diversity of native forbs on which the tortoises depend (NPS 2009). Increased fires also aggravate habitat fragmentation, which is a major contributor to tortoise population declines (USFWS 1994).

Effects to tortoises and tortoise habitat by OHV use include mortality by crushing on the surface or in burrows, collapsing of burrows, destruction of soil crusts and compaction of soils, soil erosion, proliferation of weeds, increase in wild fires, and damage or destruction of plants used for food, water, and thermoregulation (USFWS 1994). A study of food preferences found that the preferred plant species were often found in washes and on hills. These areas also are heavily used by recreational OHVs (Jennings 1997). Since tortoises are very particular in their food plant selection, reduction of available food sources due to damage from recreational OHVs can force the tortoise to change their diets. This may result in additional energy expenditures searching for acceptable food sources. When tortoises are forced to switch foods, they accrue a long-term digestive deficit due to the lag time in adjustment of their gut microflora to the new food source. Their effective feeding season is thus shortened (Tracy 2001).

Urban development has affected tortoises and tortoise habitat through habitat fragmentation and destruction. The construction of roads leads to habitat destruction, habitat fragmentation, road kills, and increased human access into formerly remote areas. The proliferation of landfills and illegal dumping subsidizes increased population densities of predators, including Common Ravens (*Corvus corax*), Coyotes (*Canis latrans*), and feral domestic dogs (*Canis familiaris*). These effects are greatest nearer to human settlements (USFWS 1994). Gila Monsters (*Heloderma suspectum*), snakes, skunks, and foxes are also tortoise egg predators (Ernst et al. 1994).

While predators are not normally a concern for tortoise populations in an undisturbed ecosystem, the perturbation of an ecosystem can cause predators to become a management issue. Increasing populations of generalist native predators have resulted in an increased rate of mortality of hatchling and juvenile tortoises. The USFWS's Breeding Bird Survey Program showed a 15-fold increase in raven populations in the Mojave Desert for the 20-year period from 1968 to 1988 (BLM et al. 1989). This surge in the raven population was attributed to increases in perching and

nesting structures. The food supplies listed were road-kills, landfills, trash, garbage dumps, and agricultural developments. The perching structures listed were fence posts, power poles and towers, signs, buildings, bridges, and freeway access ramps. Elevated perches were historically scarce in the Mojave Desert, and such man-made substitutes provide perching sites for predatory birds. Farrell (1989) documented ravens utilizing power line towers for perches while consuming juvenile tortoises (USFWS 1994). Human predation in the form of highway mortality and the illegal removal of adult tortoises for pets are also factors in the decreasing numbers of Desert Tortoises (Lovich 1999; 59 FR 5820-5866). Tortoises will urinate in response to harassments and this jeopardizes their survival through the summer due to water loss (Averill-Murray et al. 2002).

The manipulation of populations and/or individual tortoises during earlier conservation efforts was mostly unsuccessful. This may have been due to a lack of information regarding tortoise ecology, or poor planning. The translocation of in-situ tortoises and reintroduction of captive tortoises to the wild by the public are ongoing management problems. The historic lack of success of reintroductions can be attributed to several factors. Relocated tortoises often attempt to return to their home ranges (Blythe et al. 2004) and they face increased vulnerability to predators and potential antagonistic responses from resident tortoises. Perhaps the largest problem facing potential relocation efforts is the potential for the spread of diseases, especially upper respiratory tract disease (URTD), and genetic pollution.

Recently, URTD has been found to be a significant contributor to tortoise mortality, and this disease is widespread in the Mojave population. URTD is caused by a bacterium (*Mycoplasma agassizii*), and it may be aggravated by simultaneous infections from other bacteria. URTD has been reported in a variety of tortoise species from around the world. It is likely that it has been spread through the wild populations by the release of infected, captive tortoises (Jacobson 1992). One of the main reasons for the emergency listing of Mojave Desert Tortoises in 1999 was the observed die-offs of populations due to URTD.

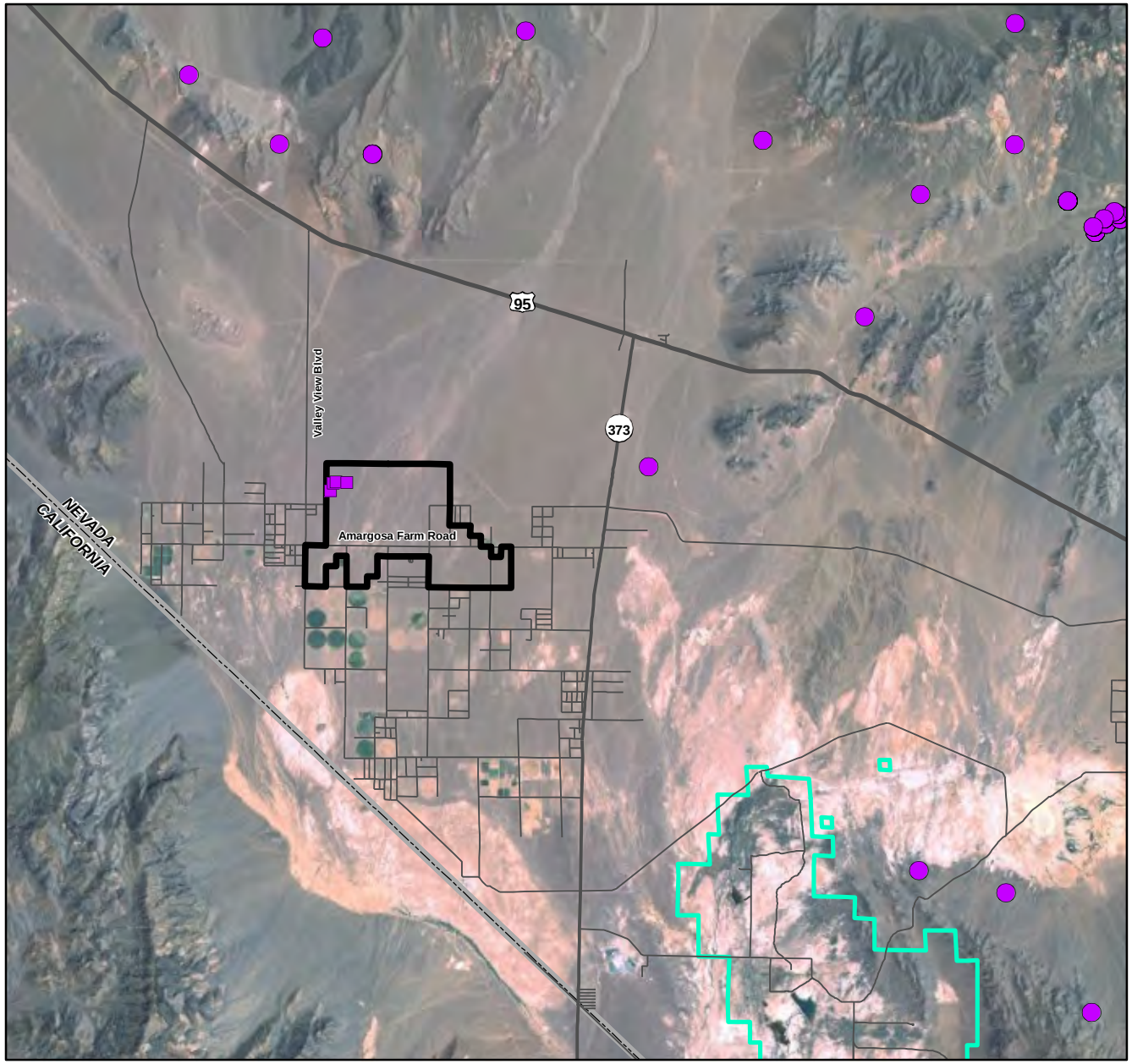
Groundwater withdrawal may cause the development of large fissures (Koehn Dry Lake, Saltdale, California) which act as pit-fall traps that can capture tortoises. Tortoises can also be trapped in utility trenches. Railroad tracks fragment tortoise habitat and their movements may be constrained by train rails (Edwards et al. 2004; 59 FR 5820-5866).

3.1.1.6 Species in the Project Area

A small Desert Tortoise population is known to exist approximately 25 miles to the northwest of the Project area near Beatty, NV. Desert Tortoise surveys conducted in 2006 (Knight and Leavitt 2006) and in 2007 (Converse Consultants 2008) for proposed mining operations, indicate population densities of 0-10 tortoise per square mile. The Department of Energy, Nevada Test Site is located northeast of the Project, and has been extensively surveyed for Desert Tortoise over many years (Rautenstrauch and O'Farrell 1994). These surveys have indicated low to very low densities of Desert Tortoise.

To the south and east of the project site, in the Pahrump Valley and an area known as Johnny, surveys were conducted over years that also indicated low densities of Desert Tortoise (Tierra Data 2009).

Desert Tortoise surveys were conducted within the footprint of the proposed Project from late March through May, 2009. Four Class 4 burrows were observed on the 7,670 acres surveyed during a time when tortoises would have been most active (Figure 3-2). Class 4 burrows are burrows with deteriorated condition that are probably utilized by Desert Tortoise. No dead or live tortoises were observed nor were any shells, scutes or bone segments of dead tortoise detected in washes or ponding areas during high water events. Generally, even if no other tortoise sign is detected during survey activities, tortoise remains can be found in washes (Tierra Data 2009).



Amargosa Farm Road
Solar Energy Project
(NVN-84359)

Desert Tortoise
(Gopherus agassizii)
Figure 3-2

LEGEND

- Project Site Boundary
- Ash Meadows National Wildlife Refuge
- US Highway
- State Highway
- Local Road
- State Boundary

Species

- Desert Tortoise
- Desert Tortoise Burrow (Class IV)

Source: Burrows - TierraData, 2009;
Tortose Locations - NDOW, 2007, NNHP, 2006;
Local Roads - TerraSpectra, 2009;
Ash Meadows - USFWS, 2005;
Highways, Imagery - ESRI, 2009

May 2010

0 2.5 5 Miles

3.2 FISH

3.2.1 Devils Hole Pupfish

3.2.1.1 Regulatory Status

The Devils Hole Pupfish (*Cyprinodon diabolis*) was listed by the USFWS as an endangered species on March 11, 1967 (32 FR 4001). The species was listed as critically endangered by the State of Nevada on January 1, 1969 (USFWS 1980). The species is currently listed as a protected species by the State of Nevada (NNHP 2009).

Maintaining the water level of Devils Hole is critical to the survival of the species. In 1976, the U.S. Supreme Court upheld the rights of the National Park Service to maintain the water levels at Devils Hole at no more than 2.7 feet below the copper marker (a copper washer in the wall of Devils Hole) over the water right holders in the vicinity of Devils Hole (426 U.S. 128, Cappaert vs. U.S.; USFWS 1980; USFWS 1990).

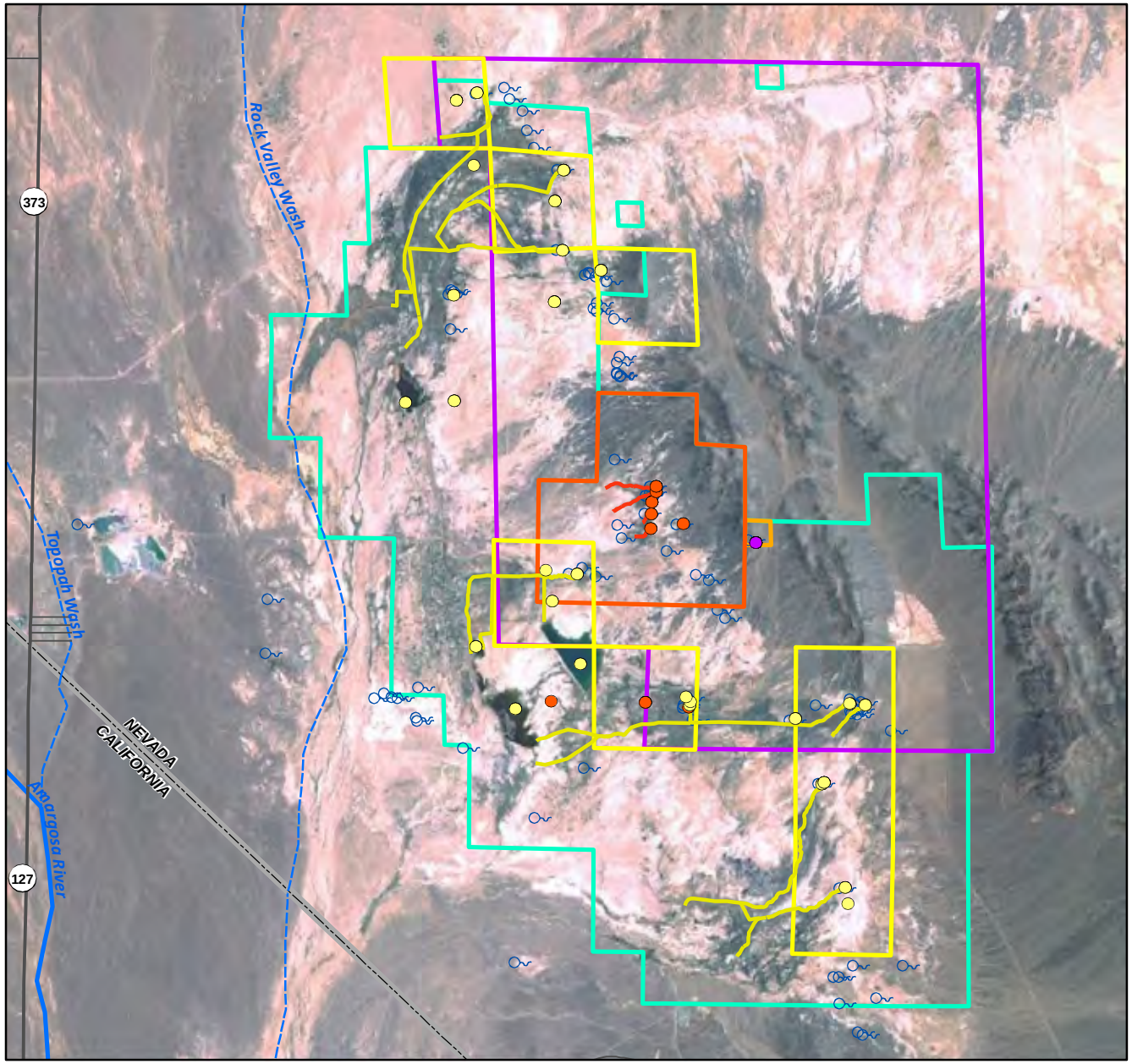
3.2.1.2 Species Description

The Devils Hole Pupfish is among the smallest of the pupfish species reaching a maximum length of 0.98 inches. The body shape is similar to that of other pupfish as it possesses a large head and eyes and a long anal fin. However, this species lacks pelvic fins and vertical bars that are typical in other *Cyprinodon* species. The male Devils Hole Pupfish is typically a pale blue color with breeding males becoming a solid dark blue with a black terminal band on the caudal fin, violet gill covers, and a brownish to silver colored back. The females lack ocellus on their dorsal fin and are colored yellowish-brown along the back (Baugh and Deacon 1983, USFWS 1990, USFWS 2009a, USFWS 2009b).

3.2.1.3 Status and Distribution

This species is endemic to a single limestone cave called Devils Hole, which is located at the east-central boundary of the Ash Meadows NWR (Figure 3-3). The species has been isolated from other pupfish for an estimated 10,000 – 20,000 years (Soltz and Naiman 1978), and has always been small in numbers fluctuating from a maximum of 553 fish in the summer to a minimum of 127 fish in the winter (USFWS 1990). The population reached a low of 38 individuals in 2006 for reasons that are not clear (Hillyard and Van Breukelen 2009), but it appears the decline is not correlated with declining water levels. However, studies are on-going to determine what may be impacting the species (Wilson et al. 2009).

Small refugium populations have been established in the Amargosa Pupfish Station in Ash Meadows NWR and in facilities constructed by the Bureau of Reclamation located near the base of Hoover Dam along the Colorado River (USFWS 1990). Despite these efforts, none of the refugia were able to sustain a viable population of Devils Hole pupfish and no longer remain active (Mapula et al. 2009).



Amargosa Farm Road Solar Energy Project (NVN-84359)

Cyprinodon Species Distribution in Ash Meadows NWR
Figure 3-3

LEGEND

- Ash Meadows National Wildlife Refuge
- Devil's Hole (National Park Service)
- State Highway
- River
- Local Road
- Spring/Seep
- Wash
- State Boundary

Species

- Devil's Hole Pupfish *(Cyprinodon diabolis)*
- Ash Meadows Amargosa Pupfish *(Cyprinodon nevadensis mionectes)*
- Warm Springs Pupfish *(Cyprinodon nevadensis pectoralis)*
- Devil's Hole Pupfish Critical Habitat
- Amargosa Pupfish Distribution
- Amargosa Pupfish Critical Habitat
- Warm Springs Pupfish Distribution
- Warm Springs Pupfish Critical Habitat

Source: Species Data - USFWS, 2009; NDOW, 2007; Ash Meadows, Devil's Hole - USFWS, 2005; Local Roads - Terra Spectra, 2009; Springs - USGS, 2006; Highways, Hydrology, Imagery - ESRI, 2009

May 2010

0 1 2 Miles

3.2.1.4 Life History

The species inhabits the limestone cave known as Devils Hole. Essential habitat for this species encompasses 21,760 acres of the area where groundwater removal most influences the water level in Devils Hole. This extends northwest of Devils Hole to within approximately 8 miles of the Project area. This species is highly dependent upon a limestone shelf where feeding and spawning are focused. This shelf can become unusable to the pupfish should the water level drop too low (Soltz and Naiman 1978). The Devils Hole Pupfish is an opportunistic feeder. During the fall and summer months, the pupfish primarily feeds on diatoms, but also feeds on algae (*Spirogyra*) and invertebrates such as amphipods, ostracods, and protozoa. Less frequent food items include beetles (*Stenelmis* sp.), a turbellarians (*Dugesia* sp.), and snails (*Tryonia* sp.) (Baugh and Deacon 1983, USFWS 1990).

Spawning occurs year-round due to the relatively constant water temperature of 32 degrees Celsius maintained in Devils Hole (Baugh and Deacon 1983). Spawning peaks in the spring during the maximum photoperiod (USFWS 1990), and eggs are fertilized when deposited onto a limestone substrate ledge where they incubate (Baugh and Deacon 1983, USFWS 1990).

3.2.1.5 Threats to the Species

The primary threat to the Devils Hole Pupfish is decreased spring discharge due to pumping of surface and groundwaters for agriculture and other activities in the Amargosa Valley (USFWS 1980). By the late 1960s, ranching in the area altered most springs with heavy machinery, cleared extensive areas of riparian and marsh vegetation, decreased spring discharge by pumping surface and groundwaters, diverting water into earthen and concrete-lined ditches, and impounding waters. The population of the Devils Hole Pupfish declined to fewer than 150 individuals following these activities (USFWS 1980).

Much of the spawning and foraging activities of the pupfish occurs within 6.5 by 13 foot ledge. If water levels drop below that ledge, the Devils Hole Pupfish could suffer extreme population declines.

3.2.1.6 Species in the Project Area

The Devils Hole Pupfish does not occur within the Project area. The entire population is known only from Devils Hole is located approximately 15 miles southeast from the center of the Project area. Devils Hole and the Project area are located within the Nevada portion of the Amargosa Desert Hydrographic Basin (#230), which is a part of the Death Valley Hydrographic Region (#14).

3.2.2 Ash Meadows Amargosa Pupfish

3.2.2.1 Regulatory Status

The Ash Meadows Amargosa Pupfish (*Cyprinodon nevadensis mionectes*) was emergency listed as endangered on May 10, 1982 (47 FR 19995-19999). This listing was in effect until January 5, 1983 at which time a second emergency listing and a proposal of endangered status with Critical Habitat were published concurrently (48 FR 608-625). A determination of endangered status and Critical Habitat was published on September 2, 1983 (48 FR 40178-40186). Critical Habitat was designated at Fairbanks, Rogers, and Longstreet Springs and three unnamed springs in the northwest corner of Section 23, T17S, R50E; Bradford, Jackrabbit, Big, and Point of Rocks Springs; Crystal Pool; and their outflows areas. All Critical Habitat for this subspecies is located within the Ash Meadows NWR (48 FR 40178-40186). The species is listed as a protected species by the State of Nevada (NNHP 2009).

3.2.2.2 Species Description

The Ash Meadows Amargosa Pupfish is a short, deep, slab-sided fish with a long head and strongly arched nape. This subspecies has low fin-ray and scale counts relative to other *Cyprinodon* species. The breeding males are iridescent silver-blue with a yellowish-olive color along the back anterior to the dorsal fin (Soltz and Naiman 1978).

3.2.2.3 Status and Distribution

The Ash Meadows Amargosa Pupfish tends to occupy relatively large habitats that are 14.5 to 79 feet in diameter and are relatively warm with constant temperatures of 24 to 30 ^{o}C (Soltz and Naiman 1978). The subspecies is known to have been extirpated from Bole, Deep, and Forest Springs (48 FR 40178-40186). In 1990, this subspecies was known to occupy 10 spring areas and was established in clay ponds within Ash Meadows NWR. Population estimates from June 1982 reported 568 individuals from Jackrabbit Spring and 1,189 individuals from Big Spring. Estimates from July 1983 reported 1,189 individuals from Jackrabbit Spring and 1,822 from Big Spring (USFWS 1990).

Surveys were conducted between fall 2007 and summer 2008. These surveys resulted in a minimum population of 5,635 individuals captured in the winter of 2008. The highest number of individuals was detected in the summer of 2008 resulting in 8,346 individuals within the Ash Meadows NWR. The largest populations were consistently located in the Crystal and Fairbanks Springs systems in addition to the outflow from Peterson Reservoir. Additional large populations were located in the Kings, Jackrabbit, Big, and Longstreet Springs (Figure 3-3) (USGS 2008).

3.2.2.4 Life History

Like other pupfish, the Ash Meadows Amargosa Pupfish is omnivorous, a subspecies thought to be similar to that of the Amargosa Pupfish (*C. n. amargosae*) which also feeds primarily on a mixture of algae and detritus throughout the year. Small invertebrates are consumed opportunistically (Naiman 1979).

Spawning typically occurs from February to September, but can occur year-round when conditions are suitable. Spawning peaks in the spring with females depositing one or two eggs at a time in a substrate of silt, sand, detritus, and/or algae (Soltz and Naiman 1978).

3.2.2.5 Threats to the Species

The subspecies is endemic to a very small area that is dependent upon the integrity of the Ash Meadows ecosystem including undisturbed flows from the Ash Meadows basin aquifer. Alteration of surface and groundwater flows could greatly impact the pupfish's population survival or growth (48 FR 40178-40186).

Introduction of nonnative predatory organisms such as Largemouth Bass (*Micropterus salmoides*), Red Swamp Crayfish (*Procumbarus clarkii*), and Bullfrog (*Rana catesbeiana*) are an additional threat because these exotics are known predators of the Ash Meadows Amargosa Pupfish. Other introduced species such as the Sailfin Mollie (*Poecilia latipinna*), Convict Cichlid (*Archocentrus nigrofasciatus*), and Mosquitofish (*Gambusia affinis*) are known to outcompete and replace the pupfish (48 FR 40178-40186; USGS 2008). Intensive efforts to remove Sailfin Mollies and Convict Cichlids were undertaken in 2008, and based on the most recent surveys, have failed to capture either of these species indicating removal efforts may have been successful (USGS 2008; McKelvey and Taylor 2009).

3.2.2.6 Species in the Project Area

The Ash Meadows Amargosa Pupfish does not occur within the Project area. Its known range is located within the Amargosa Desert Hydrographic Basin (#230). The Project area is also located within the Nevada portion of this Basin, which is a part of the Death Valley Hydrographic Region (#14). Fairbanks Spring is the closest known population of Ash Meadows Amargosa pupfish to the Project area. It is located approximately 11 miles southeast from the center of the Project area.

3.2.3 Warm Springs Pupfish

3.2.3.1 Regulatory Status

The Warm Springs Pupfish (*Cyprinodon nevadensis pectoralis*) was listed as endangered without Critical Habitat on October 13, 1970 (35 FR 16047-16048). The species is listed as a protected species by the State of Nevada (NNHP 2009). Essential habitat includes all known populations and is located entirely within the Ash Meadows NWR (USFWS 2009c).

3.2.3.2 Species Description

The Warm Springs Pupfish is the smallest of the subspecies of pupfish, with a shorter, deeper body and more numerous pectoral fin rays and displays the strongest tendency towards reduction and loss of pelvic fins. Breeding males appear similar to the Ash Meadows Amargosa Pupfish with readily seen yellow on the nape (Soltz and Naiman 1978).

3.2.3.3 Status and Distribution

Warm Spring Pupfish habitat is relatively small, the water is less than 6.5 feet in diameter and 4 feet deep and is relatively warm with constant temperatures of 30 to 33 ^{o}C (Soltz and Naiman 1978). This pupfish is isolated from other subspecies; found only in the Warm Springs Complex of Ash Meadows NWR (Figure 3-3). These springs have been isolated from other water bodies for several hundred years. This pupfish historically occupied seven springs within the complex, but one such spring (Mexican Spring) dried up in 1973 and is no longer inhabited (Soltz and Naiman 1978). Currently, the Warm Spring Pupfish occupies North Scruggs, South Scruggs, Marsh, North Indian, South Indian and School Springs (Sada and Mozejko 1984).

Surveys were conducted between fall 2007 and summer 2008. These surveys revealed a minimum population of 322 individuals captured in the spring of 2008. The highest number of individuals was detected in the fall of 2007 revealing 765 individuals within the Ash Meadows NWR. The School Springs underwent restoration during the survey period and was not surveyed completely, which may account for the low numbers found during the two seasons, as this spring complex showed the largest numbers prior to initiation of restoration work. Also, during restoration, exotic species such as Red Swamp Crayfish and Mosquitofish (*Gambusia affinis*) were eradicated, after which pupfish numbers increased at Warm Springs (USGS 2008).

3.2.3.4 Life History

Like other pupfish, the Warm Springs Pupfish is omnivorous, and is thought to be similar to that of the Amargosa Pupfish (*C. n. amargosae*) which also feeds primarily on a mixture of algae and detritus throughout the year. Small invertebrates are consumed opportunistically (Naiman 1979).

Spawning typically occurs from February to September, but can occur year-round when conditions are suitable. Spawning peaks in the spring with females depositing one or two eggs at a time in a substrate of silt, sand, detritus, and/or algae (Soltz and Naiman 1978).

3.2.3.5 Threats to the Species

This pupfish is endemic to a very small area that is dependent upon the integrity of the Ash Meadows ecosystem including undisturbed flows from the Ash Meadows basin aquifer into the Warm Spring Complex.

Introduction of nonnative predatory organisms to pupfish habitat such as Mosquitofish, Red Swamp Crayfish, and Bullfrog are an additional threat. These species, in particular, are known to prey upon and/or out-compete the Warm Springs pupfish (USFWS 1990). Intensive efforts to remove Mosquitofish and Red Swamp Crayfish from the School Springs system were undertaken in January 2008. Surveys following eradication of these species indicate an increase in Warm Springs Pupfish populations in addition to confirming complete eradication of Red Swamp Crayfish and Mosquitofish (USGS 2008). A major goal of Ash Meadows NWR is the continued eradication of Red Swamp Crayfish and Mosquitofish from the Warm Springs Complex in 2009-2010 including from the North and South Indian Springs. If these goals are achieved, only one spring system within the Warm Springs Complex (the South Scruggs Spring system) will contain these non-native invasive species (Weissenfluh et al. 2009).

3.2.3.6 Species in the Project Area

The Warm Springs Pupfish does not occur within the Project area. Its known range is located within the Amargosa Desert Hydrographic Basin (#230). The Project area is also located within the Nevada portion of this Basin, which is a part of the Death Valley Hydrographic Region (#14). The entire population is only known from the Warm Springs Complex located approximately 14 miles southeast from the center of the Project area.

3.2.4 Ash Meadows Speckled Dace

3.2.4.1 Regulatory Status

The Ash Meadows Speckled Dace (*Rhinichthys osculus nevadensis*) was emergency listed as endangered on May 10, 1982 (47 FR 19995-19999). This emergency listing was in effect until January 5, 1983 at which time a second emergency listing and proposal of endangered status with Critical Habitat were published concurrently (48 FR 608-625). A determination of endangered status with designated Critical Habitat was published on September 2, 1983 (48 FR 40178-40186), which included Bradford Springs, Jackrabbit Spring, Big Spring, and their outflows, all of which are located within the Ash Meadows NWR (48 FR 40178-40186). The species is currently listed as a protected species by the State of Nevada (NNHP 2009).

3.2.4.2 Species Description

The Ash Meadows Speckled Dace is a small fish with a maximum length of 3.9 inches and varies widely in their coloration. Typically the dorsum is olive-gray that blends ventrally to a golden color (USFWS 1990). The subspecies has black speckles and splotches covering the body with one or two distinct lateral stripes (Soltz and Naiman 1978; USFWS 1990). The degree of speckling and completeness of the lateral stripes varies between the isolated populations. It has a slightly overhung snout and small fins (Soltz and Naiman 1978).

3.2.4.3 Status and Distribution

The Ash Meadows Speckled Dace is thought to have historically occupied the same springs and outflows as Ash Meadows Amargosa Pupfish, which tends to occupy relatively large habitats that are 14.5 to 79 feet in diameter and are relatively warm with constant temperatures of 24 to 30 ^{o}C (Soltz and Naiman 1978; USFWS 1990). In 1990, this fish was known to occupy four springs within Ash Meadows NWR including Bradford, Big, Tubbs, and Jackrabbit Springs. Population surveys were conducted in June 1982 and July 1983 that resulted in an estimated total population of 500 individuals within AMNWR (Figure 3-4) (USFWS 1990).

Surveys were conducted between fall 2007 and summer 2008. These surveys revealed a minimum population of 1,009 individuals captured in the summer of 2008. The highest number of individuals was detected in the winter of 2008 revealing 1,552 individuals within the Ash Meadows NWR. Ash Meadows Speckled Dace were located in five spring complexes including, Bradford 1 Spring, Bradford 2 Spring, Forest Spring, Jackrabbit Spring, and Point of Rocks Spring. Point of Rocks and Forest Springs each resulted in fewer than 10 individuals during each

survey period. The two systems with the highest population sizes were Bradford 1 Spring and Jackrabbit Spring. Surveys in Big and Tubbs Springs, which historically maintained populations of Ash Meadows Speckled Dace, failed to locate any individuals (USGS 2008).

3.2.4.4 Life History

Like other speckled dace, the Ash Meadows Speckled Dace is omnivorous, feeding on bottom surfaces for insect larvae, crustaceans, diatoms, snails, and algae as would be expected from their downward-shaped mouth (Soltz and Naiman 1978). Occasionally mid-water or surface food or insects will be consumed (USFWS 1990).

Spawning primarily occurs during the spring but a second spawning can occur in the summer. Spawning occurs over stream riffles where eggs are fertilized as they drift into the substrate (Soltz and Naiman 1978, USFWS 1990).

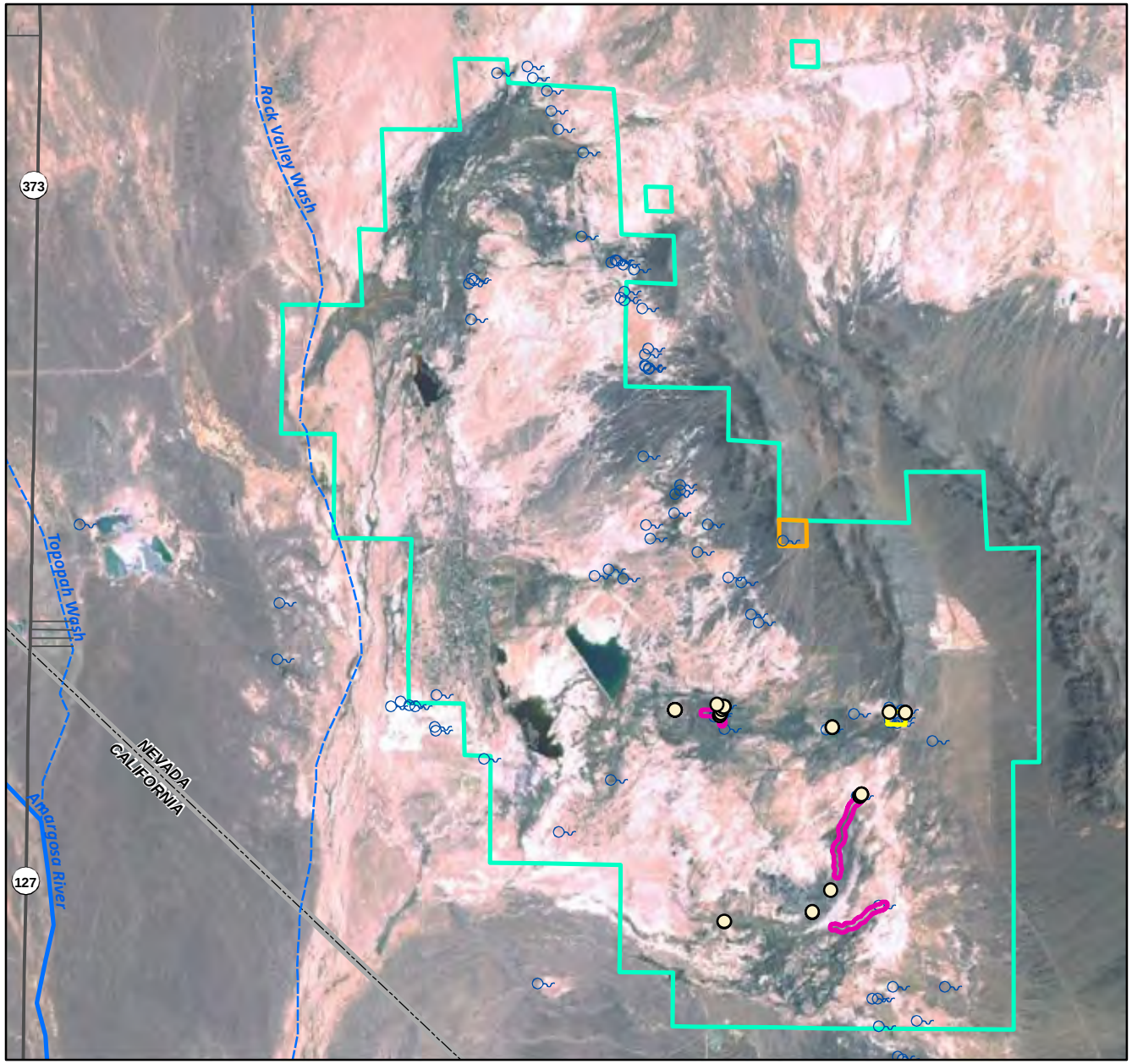
3.2.4.5 Threats to the Species

The subspecies is endemic to a very small area that is dependent upon the integrity of the Ash Meadows ecosystem including undisturbed flows from the Ash Meadows basin aquifer.

Introduction of nonnative invasive organisms to the habitat such as Largemouth Bass, Mosquitofish, Red Swamp Crayfish, and Bullfrogs are an additional threat. These species, in particular, are known to prey upon and/or outcompete the Ash Meadows Speckled Dace (USFWS 1990; USGS 2008). Intensive efforts to remove Largemouth Bass, Mosquitofish and Red Swamp Crayfish from the southern springs have been ongoing since the 1990s and more intensive during 2007 and 2008 (USGS 2008). Current restoration efforts at Fairbanks and Soda Springs are expected to provide reintroduction opportunities for expanding the current range of the Ash Meadows Speckled Dace into the northern springs of the Ash Meadows NWR from where the speckled dace was historically known (Andress et al. 2009; Bio-West 2009).

3.2.4.6 Species in the Project Area

The Ash Meadows Speckled Dace does not occur within the Project area. Its known range is located within the Amargosa Desert Hydrographic Basin (#230). The Project area is also located within the Nevada portion of this Basin, which is a part of the Death Valley Hydrographic Region (#14). Bradford Springs is the closest known population of Ash Meadows Amargosa Pupfish to the Project area. It is located approximately 17 miles southeast from the center of the Project area.



Amargosa Farm Road
Solar Energy Project
(NVN-84359)

Ash Meadows Speckled Dace and Naucorid Distribution
Figure 3-4

LEGEND

- Ash Meadows National Wildlife Refuge
- Devil's Hole (National Park Service)
- State Highway
- Local Road
- Wash
- River
- Spring/Seep
- State Boundary

Species

- Ash Meadows Speckled Dace
- Speckled Dace Critical Habitat
- Naucorid Critical Habitat

Source: Species Data - USFWS, 2009, NDOW 2007;
Ash Meadows, Devil's Hole - USFWS, 2005;
Local Roads - Terra Spectra, 2009; Springs - USGS, 2006;
Highways, Hydrology, Imagery - ESRI, 2009

May 2010

0 1 2 Miles

3.3 INVERTEBRATES

3.3.1 Ash Meadows Naucorid

3.3.1.1 Regulatory Status

The Ash Meadows naucorid (*Ambrysus amargosus*) was listed as threatened with designated Critical Habitat on May 20, 1985 (50 FR 20777-20794). Critical Habitat includes Point of Rocks Springs and their immediate outflows (50 FR 20787).

3.3.1.2 Species Description

The Ash Meadows naucorid is a member of the family *Naucoridae* which are commonly called creeping water bugs. The species has an average adult length of 0.24 inches (Parker et al. 2000). The species is a dull brown color with scattered dark yellow markings on the head, thorax, and legs. It is a flightless insect with hind legs modified for swimming and raptorial forelegs for capturing prey (Dominguez 2006).

3.3.1.3 Status and Distribution

Originally, the Ash Meadows naucorid was only known from an area at Point of Rocks Springs where flowing water passes over rock and pebble substrates (Figure 3-4) (USFWS 1990). Water diverted from Point of Rocks Springs to aid recovery efforts for the Devils Hole Pupfish resulted in a reduction of suitable habitat for the Ash Meadows naucorid. In 1997, Ash Meadows naucorids were introduced into the Kings Pool outflow and later into the channel 16-33 feet below Kings Pool. Additional individuals were added in 1998 to supplement the fledgling population. By 2002, the population of naucorids in Kings Pool was extinct. In February 2009, water which had previously been diverted to the Devils Hole Pupfish refuge was returned to its original flow in the main stream channel at Point of Rocks. This nearly doubled the discharge and expanded the suitable habitat for naucorids. Reintroductions are being proposed to reestablish naucorids throughout their historic range (Parker et al. 2009).

3.3.1.4 Life History

Naucorids feed by piercing the exoskeleton of invertebrates and sucking out the body fluids. Feeding trials showed that *Hyalella* (amphipods), *Elmidae* larvae, and baetid mayfly nymphs were selected for while elmid beetle adults, snails and flatworms were not consumed (Parker et al. 2000).

Population levels peak in the spring and summer in response to reproduction activities. Fecundity is low with females only producing approximately seven eggs at a time. Selection of oviposition substrate is not clear, however, researchers have noted that eggs have been found on gravel, pebble and cobble substrates as well as from submersed vegetation, but no eggs have been reported from coarse sand or boulder substrates. Ash Meadows naucorids have five nymphal instars. Individuals may overwinter as adults or late instar nymphs (Parker et al. 2000).

3.3.1.5 Threats to the Species

The Ash Meadows naucorid is endemic to a very small area that is dependent upon the integrity of the Ash Meadows ecosystem including undisturbed flows from the Ash Meadows basin aquifer. Its current range is greatly reduced from its known historic range due to channelization of the springs' outflow for agricultural diversion in addition to other flow-restricting alterations made at Point of Rocks Springs.

3.3.1.6 Species in the Project Area

The Ash Meadows naucorid does not occur within the Project area. Its known range is located within the Amargosa Desert Hydrographic Basin (#230). The Project area is also located within the Nevada portion of this Basin, which is a part of the Death Valley Hydrographic Region (#14). The entire population is only known from Point of Rocks Spring located approximately 18 miles southeast from the center of the Project area.

3.4 PLANTS

3.4.1 Amargosa Niterwort

3.4.1.1 Regulatory Status

The Amargosa niterwort (*Nitrophila mohavensis*) was first proposed endangered under the Endangered Species Act on October 13, 1983 with six other rare plants and one insect species in Ash Meadows, Nevada and California (48 FR 46590-46598). It was finally listed as Endangered with designated Critical Habitat on May 20, 1985 (50 FR 20777-20794). The plant was included in a recovery plan at Ash Meadows with 11 other federally listed species in 1990 (USFWS 1990). In addition to federal protection, it is fully protected in Nevada, is a BLM Special Status Species in Nevada, and is considered endangered by the Nevada Native Plant Society (NNHP 2001). Designated Critical Habitat is located in Inyo County, California, approximately two miles northeast of the Amargosa River along Ash Meadows Road, approximately 0.75 miles south of the California-Nevada state line (USFWS 1990).

3.4.1.2 Species Description

The Amargosa niterwort was first collected by J.C. and A.R. Roos in 1955 (50 FR 20777-20794) and described by Munz and J.C. Roos in 1955 (48 FR 46590-46598; 50 FR 20777-20794). This small, four inch tall perennial herbaceous plant is a member of the goosefoot family, that is comprised of a group of herbs or shrubs that are often succulent or scurfy, often weedy and frequently of saline or subsaline places (Munz 1974). The characteristic which identifies *Nitrophila* from other genera is the presence of sepals, that are strongly imbricate, scarcely united, and strongly chartaceous. The leaves are opposite and united at the base (Munz 1974). The Amargosa niterwort is one of two species included in the *Nitrophila* genus, and is identified by its 5-8 centimeter (cm) stems that are erect from extensive heavy underground root-stocks, round-ovate leaves, small, inconspicuous pink flowers and shiny black seeds (Munz 1974). *N.*

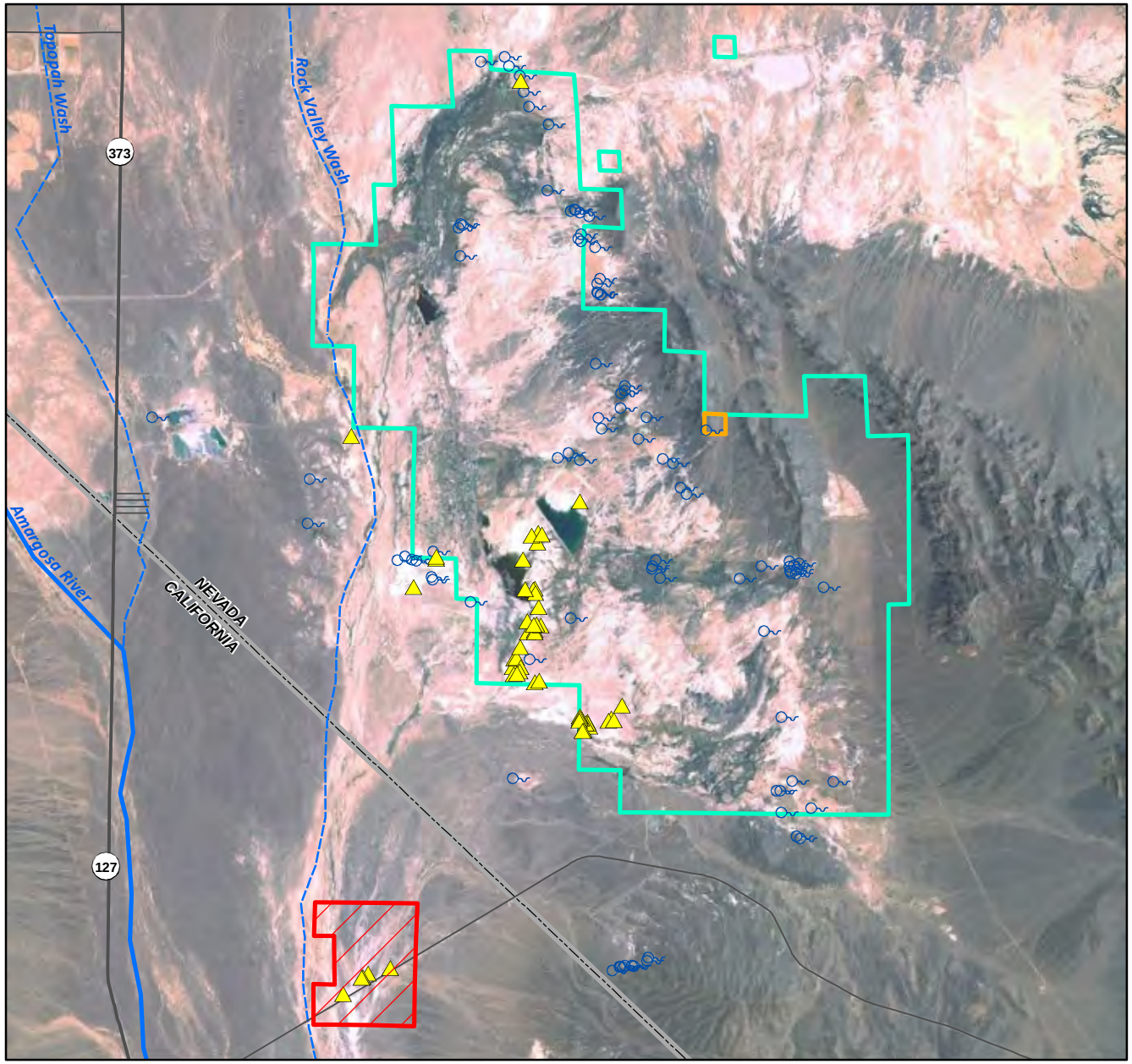
mohavensis appears to be restricted to heavy alkaline mud in habitats at approximately 2,050 feet in elevation.

3.4.1.3 Status and Distribution

The Amargosa niterwort occurs in colonies of individuals linked by their large, rhizomatous roots in highly alkaline, moist, salt-encrusted clay soils within the southern portion of Carson Slough in Nevada and California. Carson Slough is a large and extensive marsh into which the waters from Fairbanks Spring drain, but has been obliterated due to the present large-scale exploitation of water resources for agricultural purposes. Only a few remnants of the marshland and its vegetation are known to exist today. The Slough was not botanically surveyed prior to its destruction and there is no basis upon which to judge how many rare or possibly endemic species may have been lost (CMI 1996).

When the species was listed in 1985, it was known from one location, the type locality, in the Southern end of Carson Slough, approximately three miles northeast of Death Valley Junction, California (Beatley 1977; USFWS 2007a). Since the listing in 1985, five additional populations have been documented, totaling six populations; two in California and four in Nevada. In Nevada, populations were found at Crystal Reservoir, Central Carson Slough 1 on the Ash Meadows NWR boundary line, Central Carson Slough 2 outside of the Refuge, and the Refuge West Entrance, north and south side of Spring Meadows Road (Figure 3-5). During surveys conducted by USFWS and USGS in 2005 and 2006, the species was found at five of the six known locations. During surveys conducted at the Refuge West Entrance in 2006 resulted in no plants found. Currently, this population is likely extirpated from the location (USFWS 2007a). The most important *Nitrophila mohavensis* population is located in the Lower Carson Slough in California, but the Crystal Reservoir population in Nevada represents the second most important population for the species. According to USFWS (2007a), the size and extent of the Crystal Reservoir population is not well characterized, but it appears to be the second most important population with respect to the number of ramets observed. Ramets are the above-ground stems, that are the most visible to the naked eye, but they may not represent true numbers of plants because they reproduce underground as rhizomes, along which multiple ramets emerge.

The population at Crystal Reservoir occupies larger acreage than at Lower Carson Slough, but the population is smaller and less dense. In a 2005 survey conducted by Caicco (2005), the niterwort occupied approximately 25-30 acres. The remaining populations of niterwort in Nevada and California represent approximately two percent of the known distribution of ramets (USFWS 2007a). Based on available data, according to USFWS, the Lower Carson Slough population may be declining due to the species' inability to recover from impacts resulting from development activities (e.g. peat mining, water diversions, and groundwater pumping associated with large-scale farming) in the Refuge and Upper Carson Slough) during the 1950s and 1960s. It also appears the extent of the Lower Carson Slough and Tecopa populations are also decreasing. According to USFWS (2007a), little or no data are available to suggest trends for the populations at Tecopa and the Refuge West Entrance.



Amargosa Farm Road
Solar Energy Project
(NVN-84359)

Amargosa Niterwort Distribution
Figure 3-5

LEGEND

- Ash Meadows National Wildlife Refuge
- Devil's Hole (National Park Service)
- State Highway
- Local Road
- Wash
- River
- Spring/Seep
- State Boundary

Amargosa Niterwort

- Plant Location
- USFWS Critical Habitat

Source: Species Data - USFWS, 2009; BLM, 2009; NNHP, 2006; Ash Meadows, Devil's Hole - USFWS, 2005; Local Roads - Terra Spectra, 2009; Springs - USGS, 2006; Highways, Hydrology, Imagery - ESRI, 2009

May 2010

0 1 2 Miles

3.4.1.4 Life History

There is little known about the life history of Amargosa niterwort, but it is known to be a long-lived perennial, reproducing underground. Its presence appears to be limited to areas that are highly alkaline in moist salt-encrusted clay soils. Observations indicate it is an extremely hardy plant that is tolerant of high soil salinity and alkalinity, and because of this, few other plant species occupy the habitat where it grows (USFWS 1990). Large rhizomatous roots connect many seemingly individual plants within a colony. Flowering occurs in late spring (NNHP 2001). Elevations documented for the species occur between 2,100 and 2,160 feet amsl.

The niterwort is confined to specific habitat that is restricted to extremely local areas within or near the Carson Slough, where saline and alkaline sinks occur near the terminuses of seepage from springs that lie many miles to the north and east in Ash Meadows (50 FR 20777-20794).

Ash Meadows is a fragile ecosystem dependent on water, which enters a vast underground aquifer system. The water is known as fossil water because it takes thousands of years to move through the ground. The fault system blocks the flow of water, forcing it to the surface into 30 seeps and springs (Desert Gazette 2009). The hydrological and soil conditions at these sites make them uniquely suitable for Amargosa niterwort. Little is known regarding the subsurface flows in the Central and Lower Carson Slough that currently support the majority of the niterwort. A groundwater study conducted by Rowley in 2003, determined that groundwater entering Lower Carson Slough comes from three or four flow paths within the Death Valley Flow system that includes Ash Meadows subbasin and/or Alkali Flat Furnace Creek Ranch subbasin (Rowley 2003).

3.4.1.5 Threats to the Species

A significant portion of plant habitat in Ash Meadows was eliminated in the 1960s when Carson Slough was drained to facilitate peat mining, then large scale farming shortly thereafter. Even though Amargosa niterwort habitat was not plowed, free-flowing water to its habitat was halted by upstream plowing and reduction of spring flows resulting from groundwater pumping (48 FR 46590-46598). According to Reveal (1978), Amargosa niterwort is sensitive to disturbance and does not reestablish itself at sites where salt crust overlying the soil has been disturbed. The Nevada population lies in a remote area where the disturbance has been limited to trampling by wild horses and soil compaction by off-road vehicles (USFWS 1990).

Throughout the species' range, three major threats have been identified by USFWS (2007a): (1) Ecosystem-based alteration, particularly habitat loss by changes in groundwater availability, (2) direct and indirect impacts resulting from surface mining, and (3) direct and indirect impacts resulting from raised construction of Ash Meadows Road. Currently, three of the four Nevada population sites face the threat of interruption of water supply to habitat. The fourth site at Crystal Reservoir appears to be secure from the threat. Impacts to the niterwort due to groundwater pumping may not be immediately evident. Slow population declines can take years and trends may be masked by other factors such as annual variations in precipitation (USFWS 2007a). The Amargosa Valley is located approximately 10 miles northwest of the Ash Meadows NWR within the adjacent Alkali Flat/Furnace Creek hydrologic subbasin; however, none of the Nevada population sites are within this subbasin (USFWS 2007a). Given the proximity and

predicted flow paths, the Central and Lower Carson Slough populations of Amargosa niterwort likely receive water from both the Ash Meadows and Alkali Flat hydrologic subbasins (USGS 2002). The hydrology that supports the Crystal Reservoir population is poorly understood because at the time the Reservoir was constructed in 1970s, it was unknown whether the niterwort already existed there (USFWS 2007a).

The second major threat to all Ash Meadows species, including Amargosa niterwort, is habitat loss or degradation from surface mining. Mining directly and indirectly threatened the Lower Carson Slough population in California, and the four niterwort populations on the Refuge, which are on BLM and USFWS lands with public minerals. The third threat is from habitat degradation from construction of Ash Meadows Road. In the late 1999 and early 2000, the California Department of Transportation (CalTrans) improved Ash Meadows Road where it crossed the Lower Carson Slough and Amargosa niterwort habitat. CalTrans raised the roadbed, which altered sedimentation patterns in the Carson Slough during thunderstorms or rare high flow events (USFWS 2007a). Other threats to the niterwort include trampling by wild horses and OHV activity, invasive species and fire, and damage to Crystal Spring Dam.

3.4.1.6 Species in the Project Area

The Amargosa niterwort is not found within the Project area, although the plant populations at Ash Meadows NWR share some groundwater-related commonalities. The Ash Meadows Hydrographic Basin (includes the Ash Meadows NWR) and Alkali Flat-Furnace Creek Basin (where the proposed Project is located) are connected by the Central Death Valley subregion of the Death Valley Regional Groundwater Flow System.

3.4.2 Ash Meadows Blazing Star

3.4.2.1 Regulatory Status

The Ash Meadows blazing star (*Mentzelia leucophylla*) was listed as threatened with designated Critical Habitat on May 20, 1985 (50 FR 20777-20794). The plant was included in a recovery plan at Ash Meadows with 11 other federally listed species in 1990 (USFWS 1990). In addition to federal protection, it is fully protected in Nevada, is a BLM Special Status Species in Nevada, and is considered threatened by the Nevada Native Plant Society (NNHP 2001). Critical Habitat consists of 1,240 acres in Ash Meadows at four locations; two along and just east of Carson Slough and two east of Carson Slough in close proximity to Devils Hole (50 FR 20777-20794).

3.4.2.2 Species Description

The Ash Meadows blazing star (*Mentzelia leucophylla*) was first collected in 1898 by Carl Purpus, and described by Brandegree in 1899 (USFWS 1990). Initially, the plant collected by Purpus was included with *M. oreophila* as a single species by Darlington in 1934 and Abrams in 1951. The reverse synonomy was published by Jepson in 1936 and Munz and Keck in 1959. Taxonomy of the species was in question until the issue was resolved in a status report completed by Reveal in 1977.

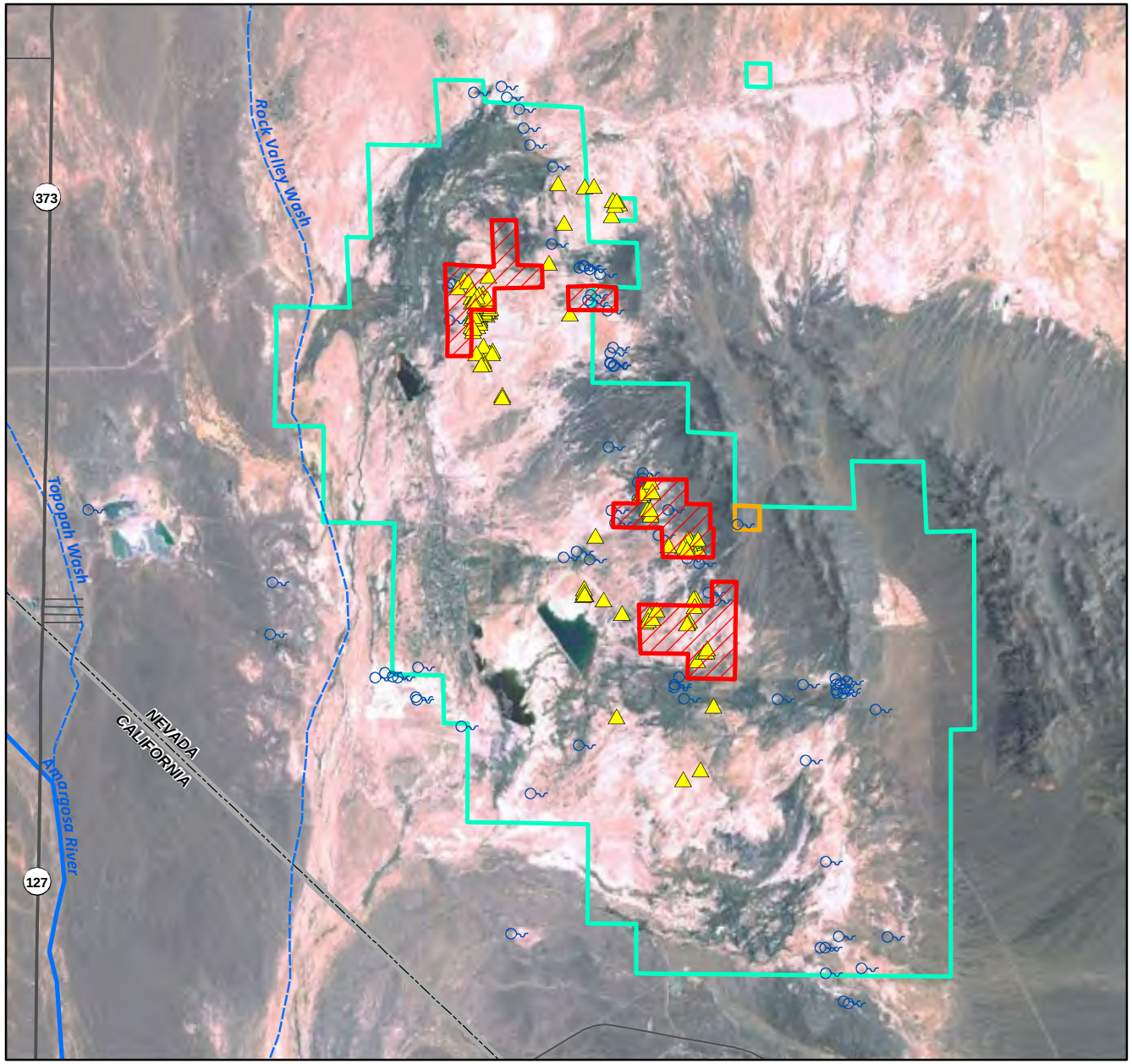
This small biennial or short-lived perennial is a member of the stick-leaf (blazing star) family that is comprised of a group of herbs that are pubescent with barbed or sometimes stinging hairs. The characteristics which most readily identifies *Mentzelia* from other genera is the presence of three placentae, seeds that are 1-4 millimeters (mm), white to golden yellow flowers, and never with stinging hairs (Munz 1974). *M. leucophylla* has leaves that are densely covered with white hairs (NNHP 2001). Flowers are few, small, opening only briefly from June to September. In addition, the stems are covered with an epidermis that peels in long segments. Leaves are mainly basal, linear-oblong, 6-8 cm long, 1 cm wide, rigid, densely tomentose with strongly revolute margins. The seeds are flat and narrowly margined (Knight and Clemmer 1987).

3.4.2.3 Status and Distribution

The Ash Meadows blazing star occurs exclusively in Nye County, and is endemic to Ash Meadows. The local distribution of small populations suggests the species is extremely vulnerable to any land disturbance (USFWS 1990). It has been suggested that past development for agriculture is believed to have eliminated some populations within their range (Reveal 1978). Few individuals occur at any one site, with fewer than 200 individuals estimated on the refuge; however, because the species blends in well with the landscape, plants may be missed during surveys. Currently, four populations occur in Nevada, all of which are within designated Critical Habitat. They include (1) Purgatory Spring, (2) Old Rooker Ranch-Cold Spring, (3) North County Road, and (4) Marsh to Bradford springs (Knight and Clemmer 1987) (Figure 3-6).

3.4.2.4 Life History

Mentzelia leucophylla is a small biennial or short-lived plant that occurs only in Ash Meadows, in clay soils of spring areas, especially along canyon washes where *Atriplex* is common, at elevations ranging from 2,200-2,300 feet amsl (Beatley 1976). Mozingo and Williams (1980) suggests, in addition to clay soils, it also occurs in sandy or saline clay soils in plant communities dominated by, *Atriplex confertifolia*, *Haplopappus acradenius*, *Cryptantha confertiflora*, *Enceliopsis nudicaulis* var. *corrugata*, and *Astragalus phoenix*, at elevations 2,200-6,500 feet amsl. USFWS (50 FR 20777-20794) suggests that the species is associated with upland alkaline soils found in arroyos and on knolls only within the more xeric portions of Ash Meadows. However, this uncommon plant is often found with Ash Meadows milkvetch and Ash Meadows sunray According to USFWS (1990), the Ash Meadows blazing star is probably the rarest of all plant species endemic to Ash Meadows. Although little is known about its life history or habitat requirements, it is known to occupy alkaline soils in dry washes and on barren bluffs distributed along the eastern edge of Ash Meadows. Bright yellow flowers bloom from late May into September and are open only for brief periods in late afternoon (NNHP 2001).



Amargosa Farm Road
Solar Energy Project
(NVN-84359)

Ash Meadows Blazing Star Distribution
Figure 3-6

LEGEND

- Ash Meadows National Wildlife Refuge
- Devil's Hole (National Park Service)
- State Highway
- Local Road
- Wash
- River
- Spring/Seep
- State Boundary

Ash Meadows Blazing Star

- Plant Location
- USFWS Critical Habitat

Source: Species Data - USFWS, 2009; BLM, 2009; NNHP, 2006; CNDDB, 2009;
Ash Meadows, Devil's Hole - USFWS, 2005;
Local Roads - Terra Spectra, 2009; Springs - USGS, 2006;
Highways, Hydrology, Imagery - ESRI, 2009

May 2010

0 1 2 Miles

3.4.2.5 Threats to the Species

According to USFWS (50 FR 20777-20794):

> "Existing populations have been greatly reduced from those known to have occurred 15 years ago by habitat disturbance during road construction, cropland development, and peat mining in Carson Slough. Threats to its existence include alteration of storm drainage patterns through arroyos by road construction, habitat destruction in locations where road construction activities are proposed, and the trampling by wild and free-roaming horses".

The blazing star is narrowly confined to a spring-fed desert wetland area with extreme saline soils. Eight sites are known in Nevada, which are threatened by development. Agricultural development and the associated large-scale exploitation of the region's water resources have destroyed large portions of the local native flora (NatureServe 2009).

The local distribution of small populations suggests the species is vulnerable to any level of disturbance. In addition to trampling by wild and free-roaming horses and agricultural development, the USFWS (1990) also suggests trampling by other livestock and disturbance caused by off-road vehicle travel as major threats to these small, fragile populations.

3.4.2.6 Species in the Project Area

The Project area is located approximately 10 miles northwest of known locations of the species in Nevada at Ash Meadows and Carson Slough. The blazing star is not found within the Project area, although the plant populations at Ash Meadows NWR share some groundwater-related commonalities. The Ash Meadows Hydrographic Basin (includes the Ash Meadows NWR) and Alkali Flat-Furnace Creek Basin (where the proposed Project is located) are connected by the Central Death Valley subregion of the Death Valley Regional Groundwater Flow System.

3.4.3 Ash Meadows Gumplant

3.4.3.1 Regulatory Status

The Ash Meadows gumplant (*Grindelia fraxino-pratensis*) was listed as threatened with designated 1,968 acres of designated Critical Habitat for the species under the Endangered Species Act on May 20, 1985 (50 FR 20777-20794). The plant was included in a recovery plan at Ash Meadows with 11 other federally listed species in 1990 (USFWS 1990). In addition to federal protection, it is fully protected in Nevada, is a BLM Special Status Species in Nevada, and is considered endangered by the Nevada Native Plant Society (NNHP 2001). Designated Critical Habitat is located in Inyo County, California and Nye County, Nevada, at 11 locations east of Carson Slough, and one site on the west side of the Slough (USFWS 1990).

3.4.3.2 Species Description

The Ash Meadows gumplant was first collected in 1965 by Beatley, and described by Reveal and Beatley in 1971 (50 FR 20777-20794). This tall (28-40 inches) biennial (or short-lived perennial) herbaceous plant is a member of the sunflower family, the largest family of vascular plants, with possible 950 genera and 20,000 species, chiefly herbaceous, and world-wide in distribution (Munz 1974). There are one to three stems arising from a woody root-stock. The stems are glabrous, leafy, and openly branched in their upper halves. The leaves are leathery, dark green, and dotted with resinous glands. Basal leaves are oblanceolate and 4 to 7 cm long while the stem leaves are oblanceolate to oblong and 1.5 to 5.0 cm long. The leaf edge is entire to somewhat toothed at the apex (Mozingo and Williams 1980).

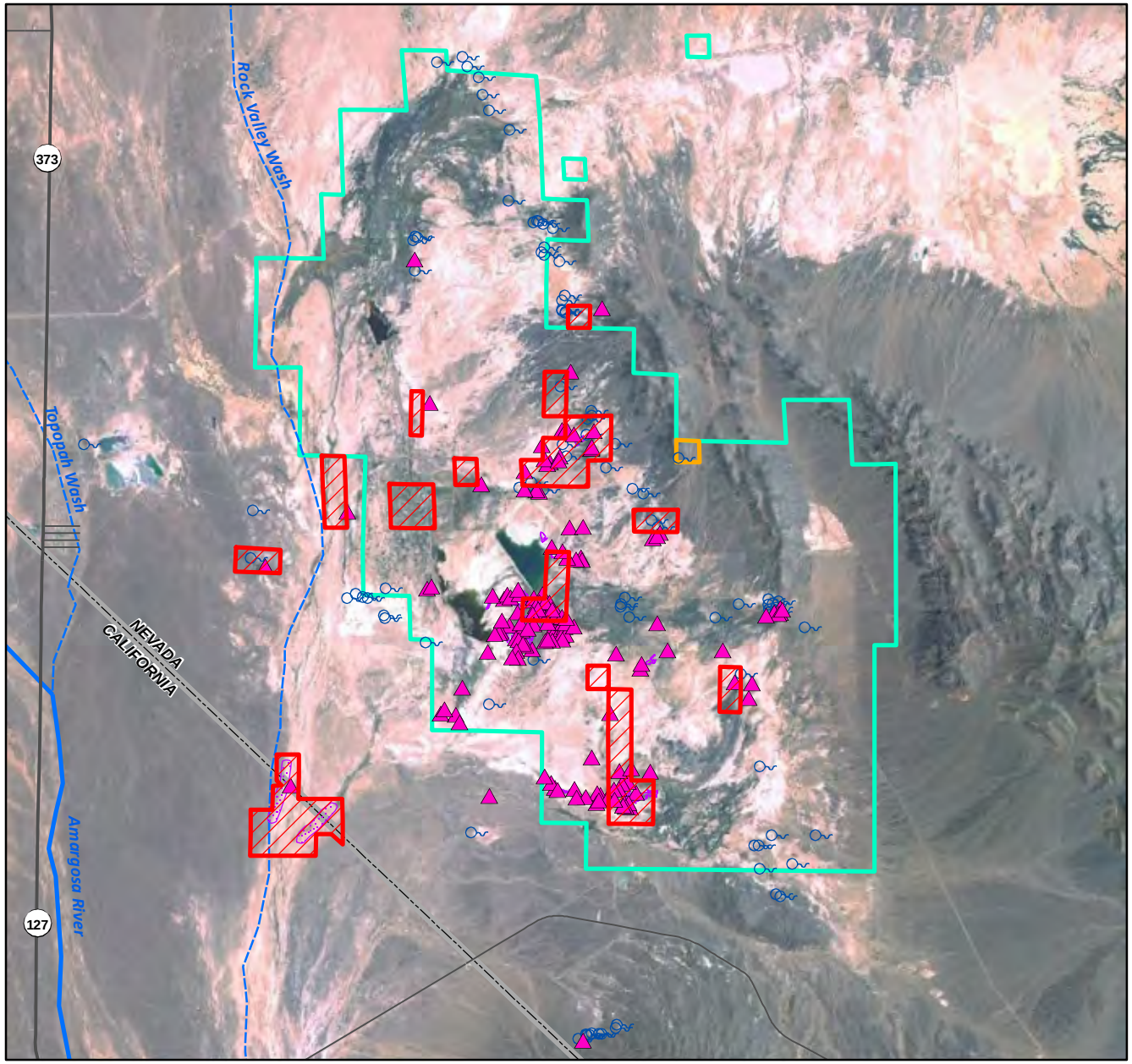
3.4.3.3 Status and Distribution

The Ash Meadows gumplant is endemic to the Ash Meadows area in Nye County, Nevada and Inyo County, California, and is concentrated in three main populations and several smaller ones, covering approximately 2,260 acres (BLM and USFWS 2000a), mostly within the boundaries of the Ash Meadows NWR, but one population occurs outside the wildlife refuge, but within the Ash Meadows Area of Critical Environmental Concern (ACEC) managed by the BLM (Figure 3-7). This large population extends approximately one mile into Inyo, California. Most of the populations were surveyed in 1998, and plants were confirmed at all sites identified in 1985; however a few small populations on private lands were not surveyed and six new sites were discovered during the 1998 surveys (Glenne 1998; Alexander 1998). Based on survey history, it appears the gumplant has increased its distribution since the species was listed in 1985, probably due to the conversion of some agricultural lands back to a natural state, and the species ability to recover in disturbed habitats (USFWS 2007b; Mozingo and Williams 1980).

According to USFWS (2007b), there is little quantitative or demographic data to describe trends for the Ash Meadows gumplant. In 2000, the entire population, based on visual estimates of 81,000 plants, was likely a serious underestimate of the total number of plants actually present. A 2002 survey conducted in California found approximately 241,514 (+ or – 69,660) plants on 88 acres.

3.4.3.4 Life History

The Ash Meadows gumplant is a biennial or short-lived perennial that occurs generally in moist saltgrass flats and near stringer washes and pools with high water table, at elevations ranging from 2,070 to 2,320 feet amsl (CBD 2009). It has been associated with ash-screwbean mesquite woodlands and desert shadscale scrub vegetation. It occasionally occurs on open alkali clay soils in drier shadscale habitats (BLM 2009). According to NNHP (2001), the gumplant occurs in open, flat, whitish, strongly alkaline, moist and hard to sometimes dry and powdery clay soils in or bordering meadows and shallow drainages near springs and seeps. It sometimes occurs in disturbed and somewhat weedy areas in creosote bush-bursage and shadscale zones in ash-mesquite woodlands, shadscale scrub, or saltgrass meadows with *Prosopis* spp., *Fraxinus* spp., *Atriplex confertifolia*, *Centaurium namophilum*, *Distichlis spicata*, *Sporobolus airoides*, *Baccharis emoryi*, *Iva acerosa*, *Tamarix ramosissima*, and *Cirsium mohavense*. Best population development is on moist intact soils (Knight and Clemmer 1987). The meadow ecosystem



Amargosa Farm Road
Solar Energy Project
(NVN-84359)

Ash Meadows Gumplant Distribution
Figure 3-7

LEGEND

- Ash Meadows National Wildlife Refuge
- Devil's Hole (National Park Service)
- State Highway
- Local Road
- Wash
- River
- Spring/Seep
- State Boundary

Ash Meadows Gumplant

- Plant Location
- Plant Population
- USFWS Critical Habitat

Source: Species Data - USFWS, 2009; BLM, 2009; NNHP, 2006; CNDDB, 2009;
Ash Meadows, Devil's Hole - USFWS, 2005;
Local Roads - Terra Spectra, 2009; Springs - USGS, 2006;
Highways, Hydrology, Imagery - ESRI, 2009

May 2010

0 1 2 Miles

occupied by Ash Meadows gumplant is also commonly associated with spring-loving centaury (*Centaurium namophilum*), yerba mansa (*Anemopsis californica*), western niterwort (*Nitrophila occidentalis*), and California loosestrife (*Lythrum californicum*). Additional species associated with the gumplant in shadscale scrub include desert isocoma (*Isocoma acradenius*), alkali rabbitbrush (*Chrysothamnus albidus*), and sealight (*Saueda* spp.) (Cochrane 1981).

New leaves of the gumplant start growing in June or July, and budding occurs from July through August. Beginning in June, the plant produces daisy-like bright yellow flowers, with fruit produced in early October. The seeds are very light and can be blown by the wind for a long distance. Seeds that fall near the parent plant may also be transported by water during winter rains or summer flash floods. Mammals, birds, and ants may also aid in seed dispersal. The germination date of seeds is unknown (CBD 2009).

3.4.3.5 Threats to the Species

Throughout the species' range, three major threats have been identified by USFWS (2007b): (1) Loss of habitat from groundwater pumping; (2) invasive non-native species; and (3) surface mining. During the 1985 final rule to list the Ash Meadows gumplant, interruption of water supply was identified as a major threat to the species.

The second largest threat to the Ash Meadows gumplant, and all native flora, is the infestation and establishment of non- native species. According to Pimental et al. (2005), approximately 42 percent of all threatened and endangered species in the U.S. are at risk because of non-native species. Because agricultural land is common throughout the area, noxious weeds commonly associated with agriculture include Russian knapweed (*Acroptilon repens*), five hook bassia (*Bassia hyssopifolia*), Malta star thistle (*Centaurea melitensis*), yellow star thistle (*Centaurea solstitialis*), and hoary cress (*Cardaria draba*) (USFWS 2006b). The weeds directly compete with native species for water, nutrients, and sunlight, and alter ecosystem processes such as nutrient cycling and fire regime. The adaptations of noxious weeds present on the Ash Meadows NWR allow them to out-complete native flora and colonize undisturbed habitat (USFWS 2007b). The wet meadows are particularly vulnerable to invasion by noxious weeds because it provides favorable conditions to invade sites that are occupied by the gumplant. The agricultural fields adjacent to large populations of Ash Meadows gumplant are infested with Russian knapweed, bassia, and Malta star thistle (USFWS 2007b).

Fire facilitated by non-native species is a threat that was not identified in the 1985 listing document. Where weeds are present, anecdotal observations suggest fire appears to provide an opportunity for non-native plants to expand on the wildlife refuge where most of the gumplant exists. Because weeds alter fire regimes by increasing the ease with which fires spread through riparian corridors and along spring channels, they destroy native plants and their habitats. The hardier non-natives typically prevent regrowth and colonization of native plants after fires, causing reduction in native plant cover and diversity (USFWS 2007b).

Surface mining has remained a threat to the Ash Meadows gumplant since it was listed in 1985. Direct impacts to the plant as result of mining include loss of habitat. Indirect impacts are caused by diverting or draining water away from its habitat during mining operations (USFWS 2007b). However, there are plans to withdraw BLM and USFWS lands with public minerals, so the threat

caused by surface mining is looking more optimistic for the species. Other threats to the gumplant include trampling by cattle and wild horses, OHV activity, and potential stochastic and natural catastrophic events (USFWS 2007b).

3.4.3.6 Species in the Project Area

The Project area is located approximately 10 miles northwest of known locations of the species within or adjacent to the Ash Meadows NWR. The Ash Meadows gumplant is not found within the Project area, although the plant populations at Ash Meadows NWR share some groundwater-related commonalities. The Ash Meadows Hydrographic Basin (includes the Ash Meadows NWR) and Alkali Flat-Furnace Creek Basin (where the proposed Project is located) are connected by the Central Death Valley subregion of the Death Valley Regional Groundwater Flow System.

3.4.4 Ash Meadows Ivesia

3.4.4.1 Regulatory Status

The Ash Meadows ivesia (*Ivesia eremica*[*=I. kingii var. eremica*]) was listed as threatened with designated Critical Habitat under the Endangered Species Act on May 20, 1985 (50 FR 20777-20794). The plant was included in a recovery plan at Ash Meadows with 11 other federally listed species in 1990 (USFWS 1990). In addition to federal protection, it is fully protected in Nevada, is a BLM Special Status Species in Nevada, and is considered threatened by the Nevada Native Plant Society (NNHP 2001). Designated Critical Habitat is located at five general locations east of Carson Slough (large and extensive marsh) in Nye County, Nevada (50 FR 20777-20794).

3.4.4.2 Species Description

The Ash Meadows ivesia (*Ivesia eremica[=I. kingii var. eremica]*) was first discovered by Coville and Funston on March 2, 1891 near Watkins Ranch, south of Devils Hole in north Ash Meadows, Nye County, Nevada (Beatley 1976; Knight and Clemmer 1987). It was originally described as *Potentilla eremica* in 1892, because remains of spent flowers were collected in mid-winter and was thought to be *P. santolinoides*, but was later changed to *Ivesia eremica.* Coville and Funston found *Ivesia* only in one location east of Watkins/Collins Ranch in an alkaline limestone marsh with *Spartina gracilis*, *Anemopsis californica*, and *Schoenus nigricans* (Beatley 1977). As of 1987, the taxonomy of the species and genus has been controversial. The *Horckelia-Ivesia-Potentialla* complex went through revision, and *Ivesia eremica* became the accepted name of the plant, although some botanists question whether this taxon is distinctive enough to be maintained as a discrete variety of the species *I. kingii*. The species as a whole is extremely variable and somewhat rare (NNHP 2001).

This tall, prostrate perennial herb is a member of the rose family. It grows from an erect thick woody root that bears a basal tuft of grayish pubescent leaves. The leaves are pinnately compound with 60 pairs of imbricate leaflets covered by an appressed-hirsute tomentum. (Knight and Clemmer 1987). Flowering stems are about 9 cm long and bear white flowers from August

to October (NNHP 2001). Plants occur as solitary clumps not exceeding 1.9 inches high and 9.75 inches in diameter (USFWS 1990).

3.4.4.3 Status and Distribution

As of 1987, seven populations were located in Ash Meadows. They included: (1) Old Rooker Ranch; (2) Shaft-Chalk springs; (3) Mary Scott-Indian-School-Crystal Pool springs; (4) Crystal Pool/Amargosa Reservoir; (5) Collins Ranch; (6) Bluffs west of County Road; and (7) Tubbs-Love ranches (Knight and Clemmer 1987). According to USFWS (1985), existing populations were smaller and less numerous than those known historically because of habitat eliminations during agricultural development From 1987 through 2001, eight occurrences were mapped totaling 3,862 plants covering approximately 9.1+ acres (NNHP 2001), but are now more widely distributed (Figure 3-8).

3.4.4.4 Life History

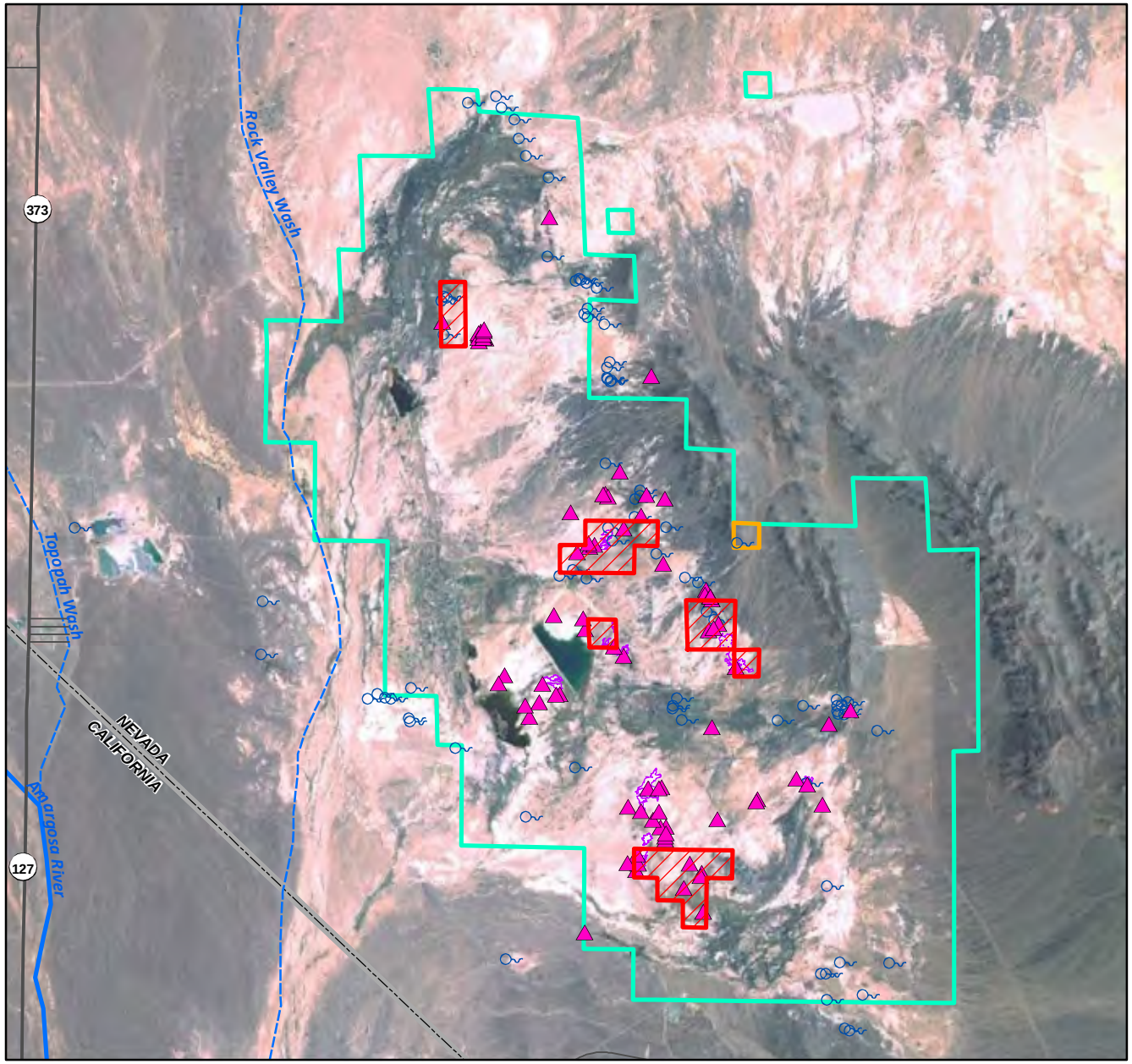
There is little known about the life history of Ash Meadows ivesia, but it is known as a matted perennial herb that flowers from September to October. All other stages including germination, leafing, budding, fruiting and fruit dispersal and dissemination agents are unknown (CMI 1996).

Ash Meadows ivesia is associated with highly alkaline, clay lowlands or depressions where soil moisture remains high from perched groundwater maintained by springs and seeps (50 FR 20777-20794). It occurs only in the mesic, meadow areas of just north and east of Ash Meadows at elevations ranging from 2,200- 2,300 feet amsl (CMI 1996). The flat, mesic, meadow areas with white, alkaline clay soils are remnants of Pleistocene age lakes. The ivesia is associated with *Distichlis spicata* var. *stricta*, *Centaurium namophilum*, *Haplopappus acradenius*, *Spartina gracilis*, *Juncus balticus*, and *Cordylanthus tecopensis* (Knight and Clemmer 1987). According to NNHP (2001), Ash Meadows ivesia occurs in open, moist to saturated, whitish, heavy, to chalky soils on flats, drainages, and bluffs near springs and seeps, in saltgrass meadow, shadscale, and ash-mesquite vegetation with *Atriplex confertifolia*, *Prosopis* spp, *Cirsium mohavense*, *Fraxinus velutina*, *Anemopsis californica*, and *Iva acerosa*.

3.4.4.5 Threats to the Species

Threats to the Ash Meadows ivesia include trampling by cattle, wild horses, and sheep, and spring diversions and groundwater pumping resulting in the drying of soils and elimination of its habitat (USFWS 1990). The existing populations are smaller and less numerous than those known historically because of habitat eliminations during agricultural development, including cropland development, spring alteration, and stream channelization and diversion, and during road construction occurring with municipal development (50 FR 20777-20794).

Groundwater depletion, drying ivesia habitat, poses the greatest threat to the existence of the species. Its dependence on perched groundwater issuing from seeps and springs or their outflows makes it extremely vulnerable to decreases in spring discharge that result in less water seeping to areas distantly removed from water sources (50 FR 20777-20794). In addition, road construction



Amargosa Farm Road
Solar Energy Project
(NVN-84359)

Ash Meadows Ivesia Distribution
Figure 3-8

LEGEND

- Ash Meadows National Wildlife Refuge
- Devil's Hole (National Park Service)
- State Highway
- Local Road
- Wash
- River
- Spring/Seep
- State Boundary

Ash Meadows Ivesia

- Plant Location
- Plant Population
- USFWS Critical Habitat

Source: Species Data - USFWS, 2009; NNHP, 2006;
Ash Meadows, Devil's Hole - USFWS, 2005;
Local Roads - Terra Spectra, 2009; Springs - USGS, 2006;
Highways, Hydrology, Imagery - ESRI, 2009

May 2010

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could eliminate populations by passing through habitat or interrupting drainage patterns and drying areas that were previously moist. Approximately 45 percent of the known populations occur on the Ash Meadows NWR.

3.4.4.6 Species in the Project Area

The Project area is located approximately 10 miles northwest of known locations of the species in Nevada at Ash Meadows. The Ash Meadows ivesia is not found within the Project area, although the plant populations at Ash Meadows NWR share some groundwater-related commonalities. The Ash Meadows Hydrographic Basin (includes the Ash Meadows NWR) and Alkali Flat-Furnace Creek Basin (where the proposed Project is located) are connected by the Central Death Valley subregion of the Death Valley Regional Groundwater Flow System.

3.4.5 Ash Meadows Milkvetch

3.4.5.1 Regulatory Status

The Ash Meadows milkvetch (*Astragalus phoenix*) was proposed threatened under the Endangered Species Act on October 13, 1983 with six other rare plants and one insect species in Ash Meadows, Nevada and California (48 FR 46590-46598), and finally listed as threatened with designated Critical Habitat on May 20, 1985 (50 FR 20777-20794). The plant was included in a recovery plan at Ash Meadows with 11 other federally listed species in 1990 (USFWS 1990). In addition to federal protection, it is fully protected in Nevada, is a BLM Special Status Species in Nevada, and is considered threatened by the Nevada Native Plant Society (NNHP 2001). Designated Critical habitat includes nine small areas east of Carson Slough at Ash meadows in Nye County, Nevada. This designation includes 1,200 acres of dry, hard, white, barren saline, clay flats, knolls, and slopes, which is the only suitable habitat for the plant (USFWS 2009d).

3.4.5.2 Species Description

The Ash Meadows milkvetch was first collected in Ash Meadows by Carl Anton Purpus in 1898. His original specimen was left unnamed until botanist Art Cronquist (1972) collected and named a second better specimen in 1966. It was finally described by Rupert Barneby in 1970 (Barneby 1970). This low, mat-forming perennial herb is a member of the legume or pea family, which is comprised of 450-500 genera and many thousands of species, many of great economic importance for food, forage, dyes, and wood (Munz 1974).

The plant forms mounds that are up to 40-50 cm across. The older stems characteristically have a flaking bark. The leaves, which are densely covered with coarse, white hairs, are 1.5 to 3.5 cm long and bear 2 to 3 ovate to obovate leaflets which are 3 to 7 mm long. The stipules are 2 to 3 mm long, pubescent on the outer surface and glabrous on the inner surface. The pinkish to purple flowers are borne on short, erect stems in a mat and commonly number only one or two per inflorescence. No other species occurs within the known range of *Astragalus phoenix* with which it could easily be confused. The flowers are very similar to those of *A. newberryi* Gray, but the

latter is vegetatively very different in that it does not form the dense mound of foliage typical of *A. phoenix* (Mozingo and Williams 1980).

3.4.5.3 Status and Distribution

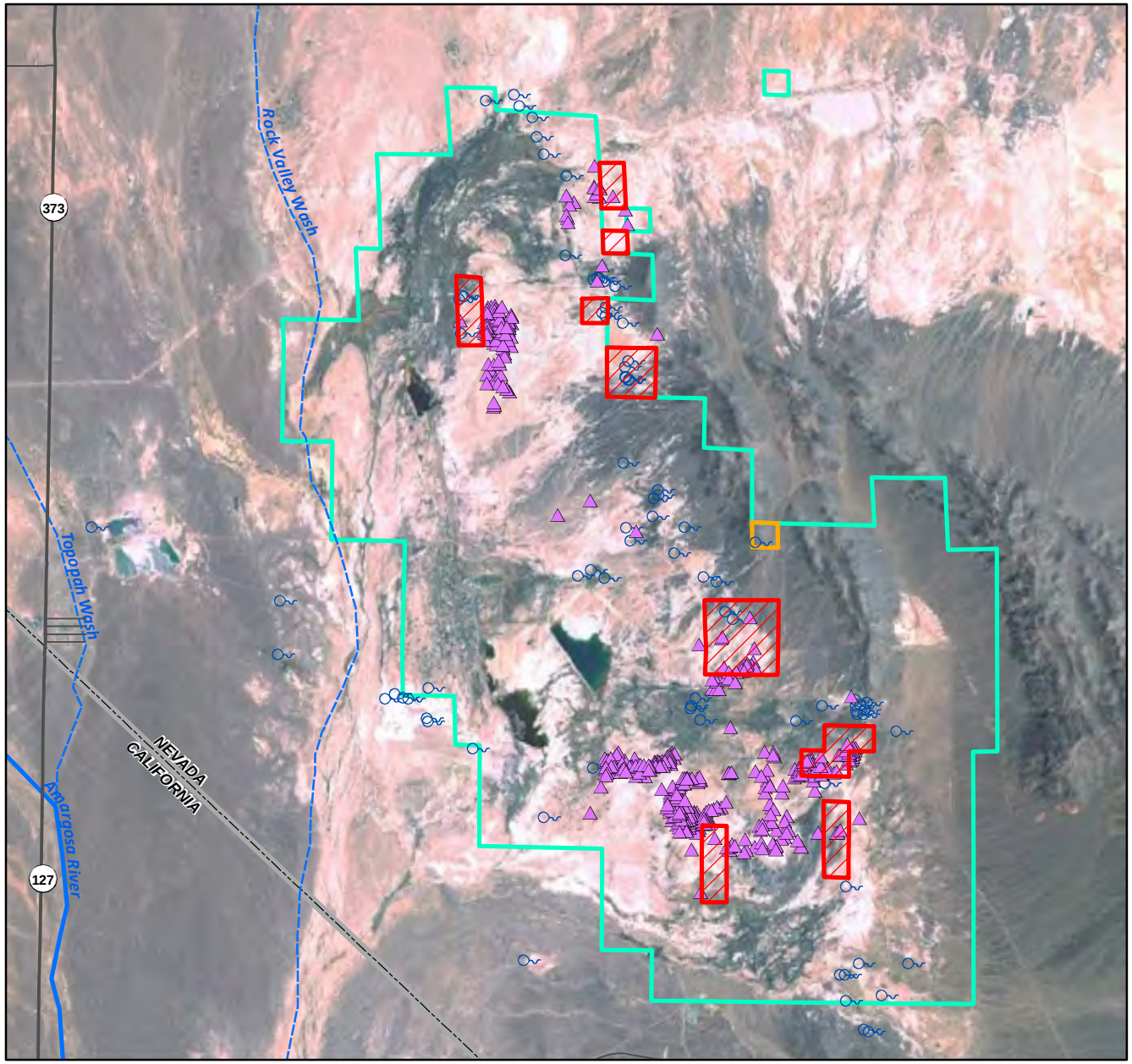
The Ash Meadows milkvetch is endemic to the Ash Meadows area in Nye County. Its range includes the Ash Meadows NWR, a small portion of the BLM Ash Meadows ACEC adjacent to the northeastern refuge boundary, and private lands within the refuge boundary. The plant was originally known from six sites in spring areas of north and east Ash Meadows (Beatley 1976). Two years later, Reveal (1978) estimated the population to contain 1,000 individuals. Cochrane (1981) identified 19 localities at which the milkvetch had been reported. Knight and Clemmer (1987) reported the species at six sites, which represented subpopulations of one historically larger, biological unit growing as adaphic endemics. In 1998, survey efforts concentrated on the six sites identified by Knight and Clemmer in 1987, and the total population was estimated to be about 1,800 plants on 847 acres (BLM and USFWS 2000b.).

Refuge-wide surveys of listed and rare plants, including, Ash Meadows milkvetch, were begun in 2008. As a result of these surveys, the total population on the wildlife refuge is estimated at 11,643 individuals on about 800 acres (Bio-West 2008a) (Figure 3-9). According to Bio-West (2008a), a large area on public land occupied by the milkvetch was newly discovered adjacent to a previously known population on private land in 2008. The occupied area at most other previously reported sites was also extended.

3.4.5.4 Life History

The life history and habitat requirements of Ash Meadows milkvetch are largely unknown (USFWS 1990), but appear to be consistent with a stress-tolerant life history as described by Grime (1977). It is known to be a long-lived perennial composed of spreading branches that eventually form large, pulvinate mounds. Both foliage and fruit are matted with dense, grayish hairs. The plants accumulate air-borne particles, becoming partially buried by maturity (Knight and Clemmer 1987).

Stress-tolerant plants are typically long-lived with low annual production, except during favorable conditions (Grime 1977). According to Reveal (1978), winter and early spring rains are required to produce large numbers of flowers, but some flowering occurs each year regardless of climatic conditions. Flowering occurs in early spring from March to late May with fruit forming in April and lasting to June-July. It appears that population growth is constrained by low seed output per plant when precipitation is low. The opposite is generally true when there is above average precipitation. However, in a study conducted by Pavlik et al. (2006), seedlings were not observed at four of the six known sites during a year with above average precipitation. It was suggested that either the seed bank was depleted or the species was dependent on the most extreme and infrequent precipitation events. Wind and water appear to be the primary vectors for dispersal of seeds, and these seeds typically remain within the leaves and branches of the parent plant (USFWS 2009b).



Amargosa Farm Road
Solar Energy Project
(NVN-84359)

Ash Meadows Milkvetch Distribution
Figure 3-9

LEGEND

- Ash Meadows National Wildlife Refuge
- Devil's Hole (National Park Service)
- State Highway
- Local Road
- Wash
- River
- Spring/Seep
- State Boundary

Ash Meadows Milkvetch

- Plant Location
- USFWS Critical Habitat

Source: Species Data - USFWS, 2009; NNHP, 2006;
Ash Meadows, Devil's Hole - USFWS, 2005;
Local Roads - Terra Spectra, 2009; Springs - USGS, 2006;
Highways, Hydrology, Imagery - ESRI, 2009

May 2010

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Stress-tolerant species, like Ash Meadows milkvetch are generally slow to recover from disturbance, and given the little known life history of the plant and its naturally low rate of reproduction, it is unlikely that severely disturbed habitat has recovered. However, the slow population increases are probably the result of new protections implemented at Ash Meadows since it was established as a wildlife refuge (USFWS 2009d).

The Ash Meadows milkvetch grows between 2,200 and 2,300 feet elevation amsl, and appears to be restricted to flats and knolls of hard, white, alkaline clay soils in the Ash Meadows area (Knight and Clemmer 1987). The specific hydrological requirements for the species are largely unknown, but surface and subsurface groundwater that reaches the surface through capillary action may be an important habitat determinant for at least some of the populations of the species. The primary constituent elements of designated critical habitat consist of the biological and physical attributes essential to the species' conservation within those areas (USFWS 2009d). Those elements include hard, white, barren, saline, clay flats, knolls, and slopes (USFWS 2009d). Plant species associated with the Ash Meadows milkvetch include, saltgrass, shadscale, Ash Meadows blazing star, Alkali golden bush (*Isocoma acradenius*), and Ash Meadows sunray (*Enceliopsis nudicaulis* var. *corrugata*) (Knight and Clemmer 1987).

3.4.5.5 Threats to the Species

The threats to Ash Meadows milkvetch are consistent with those of other Ash Meadows plants and ecosystem including: (1) Present and threatened destruction, modification, or curtailment of habitat or range (e.g. groundwater withdrawal, surface mining, proposed road construction); (2) inadequacy of existing regulatory mechanisms; (3) other natural or manmade factors affecting continued existence (e.g. trampling by wild horses) ; (4) non-native species; (5) rabbit herbivory of flowers and fruits; (6) off-highway vehicles; (7) stochastic events affecting species with restricted ranges or small population sizes; and (8) climate change (USFWS 2009d).

At the time of listing, groundwater development was a major threat to the milkvetch and the entire Ash Meadows ecosystem. The milkvetch depends, in part, on near-surface water for its survival. Water levels in Devils Hole stabilized after groundwater pumping on the refuge stopped in 1975; however, the water level in Devils Hole declined 7 cm between 1988 and 2004, and increased again after a wet year. As groundwater pumping at Ash Meadows decreased, it increased in the Amargosa Valley, and is currently occurring in some areas of the basin at about twice the rate predicted to be sustainable (USGS 2005).

Habitat loss or degradation from surface mining occurs in the Ash Meadows area. New mineral claims and subsequent mining could cause direct loss of Ash Meadows milkvetch habitat, as well as indirect impacts by diverting or draining water away from occupied habitat. Surface mining of a valid existing mining claim on private land within the wildlife refuge, therefore, poses a significant threat to one of the six known populations of Ash Meadows milkvetch. Alteration of the local groundwater table because mining could negatively affect this population and adversely modify its critical habitat on adjacent public land (USFWS 2009d).

New proposed road construction is not a threat to the milkvetch; however, some populations along the Ash Meadows Road may have been affected by the disruption of surface flows due to

prior road construction. The species is found on the floor of washes and water has been identified as one of the vectors by which its seed may be distributed (Reveal 1978).

Non-native species impact approximately 42 percent of all federally listed and rare plants in the U.S. (Pimental et al. 2005). They compete directly with native species for water, nutrients, and sunlight, and indirectly by altering ecosystem processes such as nutrient cycling and fire regimes (Brooks et al. 2004). The flats and knolls of hard, dry, alkaline clay that support the Ash Meadows milkvetch is a harsh environment, so weeds have not been identified as a major threat to the species. However, salt cedar (*Tamarix ramosissima*), Russian knapweed, five hook bassia (*Bassia hyssopifolia*), Malta star thistle, yellow star thistle, and hoary cress are noxious weeds that could potentially threaten Ash Meadows milkvetch (USFWS 2006c).

3.4.5.6 Species in the Project Area

The Project area is located approximately 10 miles northwest of known locations of the species in Nevada at Ash Meadows. The Ash Meadows milkvetch is not found within the Project area, although the plant populations at Ash Meadows NWR share some groundwater-related commonalities. The Ash Meadows Hydrographic Basin (includes the Ash Meadows NWR) and Alkali Flat-Furnace Creek Basin (where the proposed Project is located) are connected by the Central Death Valley subregion of the Death Valley Regional Groundwater Flow System.

3.4.6 Ash Meadows Sunray

3.4.6.1 Regulatory Status

The Ash Meadows sunray (*Enceliopsis nudicaulis* var. *corrugata*) was first proposed as threatened under the Endangered Species Act on October 13, 1983 with six other rare plants and one insect species in Ash Meadows, Nevada and California (48 FR 46590-46598), and was listed as threatened with designated Critical Habitat on May 20, 1985 (50 FR 20777-20794). The plant was included in a recovery plan at Ash Meadows with 11 other federally listed species in 1990 (USFWS 1990). In addition to federal protection, it is fully protected in Nevada, is a BLM Special Status Species in Nevada, and is considered threatened by the Nevada Native Plant Society (NNHP 2001). Approximately 1,760 acres of Designated Critical Habitat are located in the Ash Meadows area in Nye County, Nevada, approximately 10 miles southeast of the Project area (USFWS 1990). It includes nine locations, comprised of three main subpopulations, along and east of Carson Slough and in the vicinity of Devils Hole. Some of this area overlaps with Critical Habitats for the Ash Meadows milkvetch and Ash Meadows blazing star (USFWS 1990).

3.4.6.2 Species Description

Ash Meadows sunray was described in 1972 from specimens collected by Cronquist in 1966 in north Ash Meadows (Cronquist 1972; Beatley 1976). This medium-sized perennial shrub is a member of the sunflower family, the largest family of vascular plants, with a possible 950 genera and 20,000 species, chiefly herbaceous, and world-wide in distribution (Munz 1974). It forms

clumps 4 to 16 inches high from a stout, woody root-stock. The leaves, which are densely tomentose with fine grayish-white hairs, are relatively small, with a blade about 0.4 to 1.4 inches long. They are ovate to subcircular in shape. The leafless flower stalks bear individual heads with disks 0.8 to 1.4 inches across. The ray flowers number 11 to 23 and possess yellow corollas 2 to 2.5 cm long. The disk flowers are strongly compressed. The silky-pubescent achenes bear 2 short awl-shaped awns connected by a whorl of short, fused scales, but sometimes the pappus are absent on the achenes. This variety appears as a geographically peripheral phase of the species *E. nudicaulis*, and is distinctive in habitat and morphological features (CMI 1996). The varietal name, *corrugata*, refers to its strongly ruffled-corrugate leaves (Mozingo and Williams 1980).

3.4.6.3 Status and Distribution

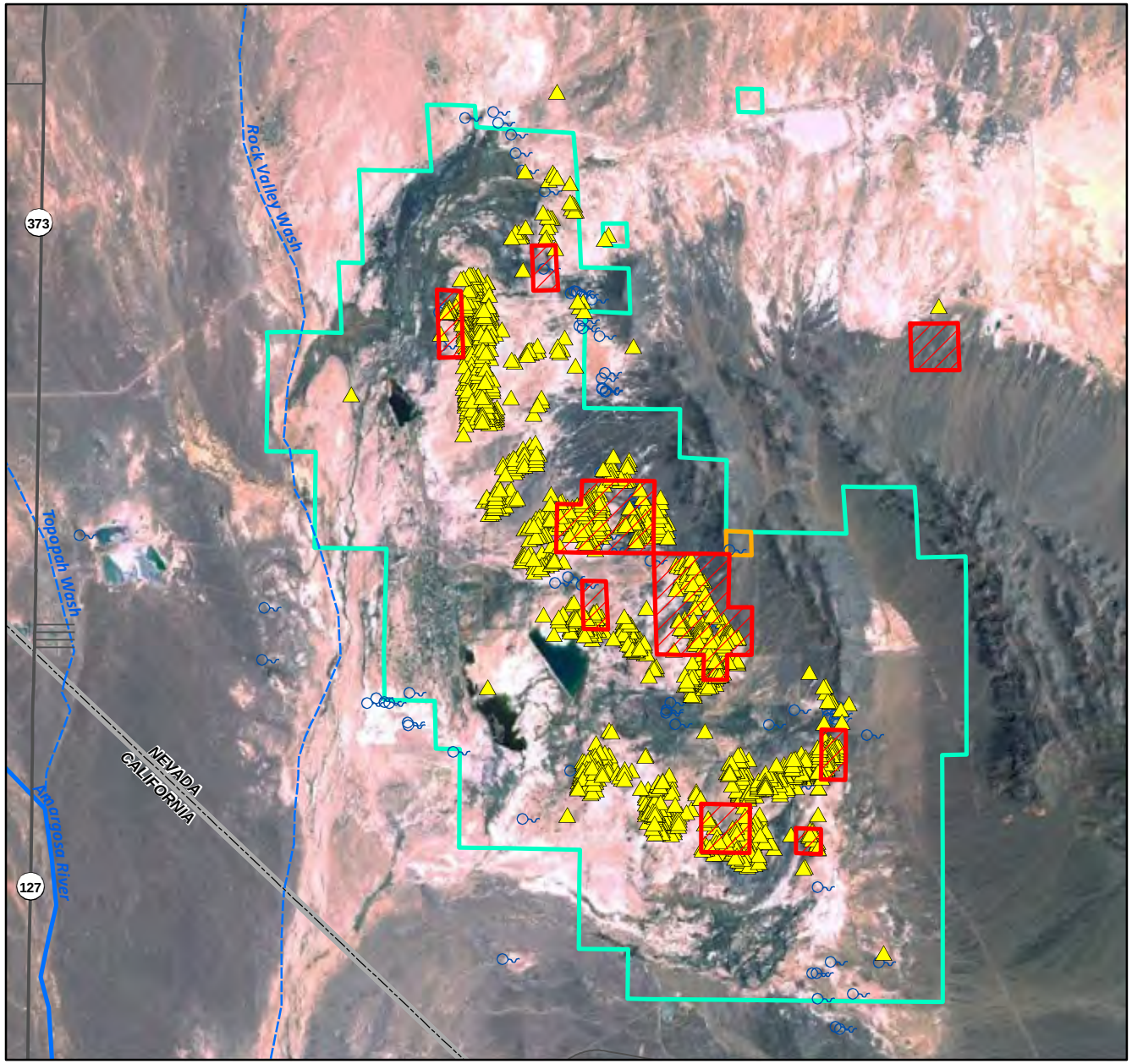
This variety of sunray is found in local populations in or near limestone mountain ranges or limestone outcrops. Historically, the plant occupied the southern end of Monitor Range, northern Belted Range, and the foothills of Quinn Canyon Range at elevations ranging from 3,300 to 6,400 feet amsl. (Beatley 1976). The elevational range was also reported from 2,300 to 2,410 feet in Mozingo and Williams (1980). The Ash Meadows sunray is endemic to Ash Meadows where it occupies dry washes and weathered saline soils. According to USFWS (50 FR 20777-20794):

> "It is one of the more common species of plants endemic to Ash Meadows but its populations have been reduced during the past 15 years by habitat elimination for agricultural production, the initial phases of PEC's development, and road construction."

PEC (Preferred Equities Corporation) is a real estate developer that purchased land in Ash Meadows during the 1980s.

In the late 1980s, the sunray was found throughout the Ash Meadows NWR, and was the most widespread of the rare species, but populations were destroyed during road construction, land leveling for crops, and alterations for municipal development between 1970 and 1985 (USFWS 1990: USFWS 2009b).

At Rogers-Purgatory-Longstreet springs along Carson Slough, the habitat is variably disturbed from clay mining and off-road vehicle use. There are two distinct populations in this area. In central Ash Meadows, the populations are very large but are somewhat fragmented occurring from the terrace overlooking Old Rooker Ranch to Collins Ranch and southwest to Amargosa Reservoir. This area is riddled with roads, off-road vehicle tracks, agricultural fields, and other human-caused disturbances (Knight and Clemmer 1987). Within the southeast portion of Ash Meadows, sunray populations and habitat run from west of the county dirt road to Jack rabbit Spring and south nearly to Big Spring. The area is disturbed by county and private roads, private ranches, and natural and altered drainage patterns from the springs (Knight and Clemmer 1987) (Figure 3-10).



Amargosa Farm Road
Solar Energy Project
NVN-84359)

Ash Meadows Sunray Distribution
Figure 3-10

LEGEND

- Ash Meadows National Wildlife Refuge
- Devil's Hole (National Park Service)
- State Highway
- Local Road
- Wash
- River
- Spring/Seep
- State Boundary

Ash Meadows Sunray

- Plant Location
- USFWS Critical Habitat

Source: Species Data - USFWS, 2009; BLM, 2009; NNHP, 2006; Ash Meadows, Devil's Hole - USFWS, 2005; Local Roads - Terra Spectra, 2009; Springs - USGS, 2006; Highways, Hydrology, Imagery - ESRI, 2009

May 2010

0 1 2 Miles

3.4.6.4 Life History

There is little known about the life history and habitat requirements of the Ash Meadows sunray, particularly the reproductive phenology except that flowering occurs between April and May. It flowers coincidentally with the Ash Meadows milkvetch. A single plant usually produces a number of flowering stalks, each supporting an individual yellow flower (USFWS 1990).

It typically occurs in whitish, poorly drained, alkaline soils along dry washes or on pale, hard limestone outcrops. The region within which this plant grows is relatively dry; rainfall in Ash Meadows averages three to five inches per year, falling mainly in the autumn and winter with some sporadic summer rains (CMI 1996). *Enceliopsis* is generally a common component of the perennial flora. Much of the lower elevation alkali clay soils have underlying water table making the habitat inappropriate for *Enceliopsis* distribution. This is particularly true along the western and southern borders of the wildlife refuge (Knight and Clemmer 1987). It occupies habitats of the Ash Meadows milkvetch and Ash Meadows blazing star in addition to areas that are more densely vegetated with *Ambrosia dumosa*. According to Mozingo and Williams (1980), individuals are restricted to dry, upland areas outside the influence of water from seeps and springs. In CMI (1996) and Knight and Clemmer (1987), Ash Meadows sunray is associated with *Atriplex confertifolia*, *Haplopappus acradenius*, *Arctomecon merriami*, and *Cryptantha confertifolia*.

3.4.6.5 Threats to the Species

Recent losses of habitat due to agricultural and municipal/residential development activities, land clearing for road construction, groundwater removal and surface spring diversion and local mining activities, all have threatened the species habitat and ultimately their survival. Ash Meadows remained largely intact until 1967 when PEC purchased large tracts (approximately 20 square miles) in the northern and eastern regions. In their attempt to farm the land, they plowed large areas of land and installed pumps at the springs. These alterations virtually obliterated the natural features of the area including Carson Slough and its surrounding vegetation. Corporate farming failed in the area and it was abandoned in 1975 (CMI 1996).

Currently, the plant is threatened primarily by large-scale destruction of the native flora over large portions of the Ash Meadows area caused by continued agricultural development, road construction, and off-road vehicle activity (CMI 1996). Habitat destruction and mineral development has broken the hard, xeric alkali clay slopes of the upland topography into sporadic patterns (Knight and Clemmer 1987). The sunray's distribution appears to be limited to a particular edaphic condition in washes weathered saline soils. Any further loss of its habitat would probably be detrimental to the species survival (CMI 1996).

3.4.6.6 Species in the Project Area

The Project area is located approximately 10 miles northwest of known locations of the species in Nevada at Ash Meadows. The Ash Meadows sunray is not found within the Project area, although the plant populations at Ash Meadows NWR share some groundwater-related commonalities. The Ash Meadows Hydrographic Basin (includes the Ash Meadows NWR) and

Alkali Flat-Furnace Creek Basin (where the proposed Project is located) are connected by the Central Death Valley subregion of the Death Valley Regional Groundwater Flow System.

3.4.7 Spring-Loving Centaury

3.4.7.1 Regulatory Status

The variety of spring-loving centaury (*Centaurium namophilum* var. *namophilum*) was proposed endangered under the Endangered Species Act on October 13, 1983 with six other rare plants and one insect species in Ash Meadows, Nevada and California (48 FR 46590-46598). However, USFWS later did not accept the validity varietal designations for *C. namophilum*, so the entire species was listed as threatened with designated Critical Habitat on May 20, 1985 (50 FR 20777-20794). The plant was included in a recovery plan at Ash Meadows with 11 other federally listed species in 1990 (USFWS 1990). In addition to federal protection, it is fully protected in Nevada, is a BLM Special Status Species in Nevada, and is considered threatened by the Nevada Native Plant Society (NNHP 2001). Approximately 1,840 acres of designated Critical habitat are scattered in or adjacent to Ash Meadows in Nye County, Nevada, approximately 10 miles southeast of the Project area (USFWS 1990).

3.4.7.2 Species Description

The taxonomy of the spring-loving centaury has been a contentious issue since the 1970s. The spring-loving centaury was first collected in 1891 by Coville and Funston, while on the Death Valley expedition (Knight and Clemmer 1987), but was not described until 1973 by Reveal, Broome, and Beatley (Reveal et al. 1973; 50 FR 20777-20794). According to Broome (1981), the plants collected from the Furnace Creek area in Death Valley closely resembled specimens of C. *namophilum* var. *namophilum* found in Shoshone and Tecopa in Inyo County, but due to certain morphological characteristics, the specimens were likely to be a second variety; *C. n.* var. *nevadense*. During Broome's survey in 1981, she also found *C. n. namophilum* near Beatty, Nevada, although Morefield (1991) did not relocate it, but found several populations of *C. exaltatum* and *C. calycosum* instead. Intermountain flora and Jepson Manual treatments combined *C. n. nevadense* with *C. exaltatum*, and *C. n. namophilum* became a valid taxon without varietal distinctions. It is now officially identified as *Centaurium namophilum*, and is currently restricted to Ash Meadows (USFWS 2009e; Knight and Clemmer 1987; 50 FR 20777-20794; USFWS 1990).

This annual herb is a member of the pea family, comprised of over 65 genera and 600 species, is widely distributed, but most abundant in temperate regions. A colorless bitter juice is a distinguishing characteristic of the family (Munz 1974). The spring-loving centaury is an erect, annual herb, up to 18 inches tall with flowering stems borne from the base and flowering lateral branches. Stems and herbage are glaucous and the leaves are opposite, not forming basal rosettes. Stems are yellowish to tannish with internodes up to 4 cm long. Inflorescences extend more than half the length of the plant, and are paniculate-cymose (Knight and Clemmer 1987). Flowers are deep rose-pink above and below. The throat is yellowish with five dark purple spots below the juncture of adjacent petals (Reveal et al. 1973).

3.4.7.3 Status and Distribution

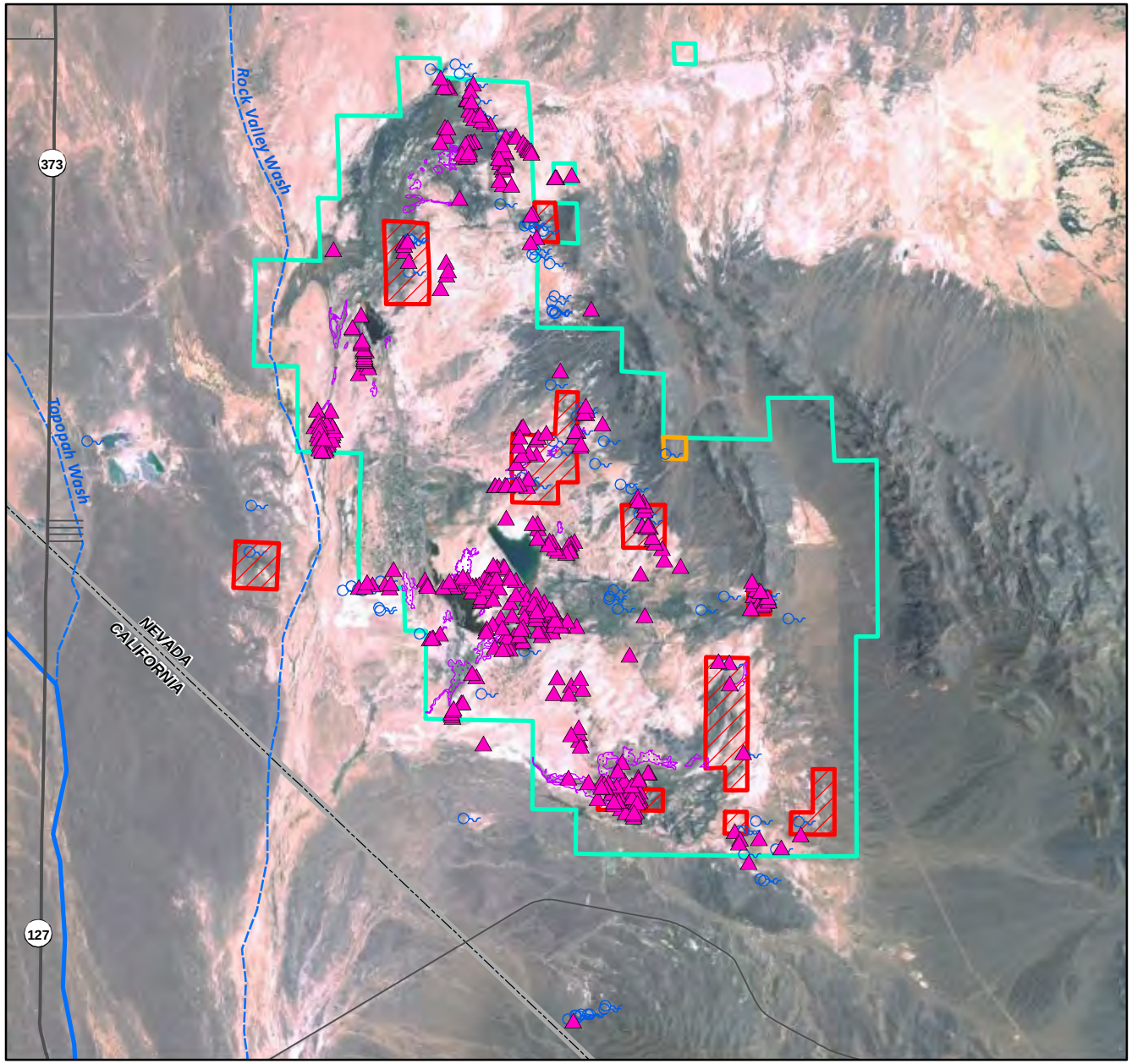
Historically, the plant probably occupied all the springs and seeps in the northern and eastern sections of Ash Meadows until development in the 1960s through 1980 reduced its distribution to small isolated patches. Cochrane (1981) identified 17 localities at which the plant had been previously observed, and Knight and Clemmer (1987) reviewed data and identified seven general areas from which the species had been reported. In 1998, surveys targeted those seven locations, and as a result, the population was estimated to be approximately 175,000 plants on 522 acres (BLM and USFWS 2000c).

The centaury is endemic to the Ash Meadows area of Nye County, Nevada. Its range includes the Ash Meadows NWR and adjacent public and private land. On public land managed by the BLM, the plant is found entirely within the Ash Meadows ACEC. Beginning in 2008, rangewide surveys are conducted for all rare plants throughout the Ash Meadows NWR. As a result of the survey effort for spring-loving centaury, the total population is estimated to be 4,468,571 individuals on about 800 acres (Bio-West 2008b). The likely reasons for the increase from 1998 to 2008 is most likely due to better, more comprehensive survey effort, natural fluctuations in the population size of an annual species, and differences in estimation protocols (USFWS 2009e).

According to Bio-West (2008b), the plants confirmed in the 2008 surveys were found at most of the previously recorded sites. In addition, distribution range of the plants in 1998 was extended in most locations to connect populations that were once believed to be separate. They found the plant to be widespread throughout the wildlife refuge in habitats that included seasonally flooded wetlands to seasonally moist alkali meadows, and the edges of some alkali scrub-shrub communities. In addition, they concluded that any habitat with surface or subsurface water was potential habitat for the species. The species has apparently extended beyond the wildlife refuge as well, but it is important to note, while the numbers have increased at most locations, other smaller populations reported in 1998 have apparently disappeared.

Based on the 2008 survey effort conducted by Bio-West (2008b), the current distribution includes six major subpopulations with additional minor subpopulations. They include: (1) Purgatory-Rogers-Longstreet-Five springs-North Carson Slough- T17S, R50E, Sections 10, 14-16, 20-23; (2) Scruggs-Mary-Scott-Indian School-Crystal-marsh springs- T17S, R50E, Sections 7-10,and 15-18; (3) Unmapped seep west of South Springs Meadow road- T18S, R50E, Sections 14 and 23; (4) Point of Rocks Springs- T18S, R51E, Sections 7 and 12; (5) Jackrabbit-Big springs- T18S, R51E, Sections 18-19 and west from Big Spring extending into T18S, R50E, Sections 14, 22-24; and (6) last Chance-Bole-Brahma springs- T18S, R51E, Sections 20, 29, and 30 (USFWS 2009e) (Figure 3-11).

The land and management of spring-loving centaury within the wildlife refuge is 50 percent USFWS land, 45 percent BLM land, and 5 percent private land. No data are available for populations outside the wildlife refuge within the BLM Ash Meadows ACEC (USFWS 2009e.)



Amargosa Farm Road
Solar Energy Project
(NVN-84359)

Spring-loving Centaury Distribution
Figure 3-11

LEGEND

- Ash Meadows National Wildlife Refuge
- Devil's Hole (National Park Service)
- State Highway
- Local Road
- Wash
- River
- Spring/Seep
- State Boundary

Spring-loving Centaury

- Plant Location
- Plant Population
- USFWS Critical Habitat

Source: Species Data - USFWS, 2009; BLM, 2009; NNHP, 2006; Ash Meadows, Devil's Hole - USFWS, 2005; Local Roads - Terra Spectra, 2009; Springs - USGS, 2006; Highways, Hydrology, Imagery - ESRI, 2009

May 2010

0 1 2 Miles

3.4.7.4 Life History

The life history and habitat requirements of spring-loving centaury are largely unknown, but general observations indicate it is an annual species that flowers during the late summer and autumn (USFWS 1990). According to Reveal et al. (1973), each flower develops into a narrow, linear seed capsule containing about 50 seeds, of which one plant can produce thousands. Like other plants, it likely has certain controls that delay germination, allowing it to persist in the soil seed bank for long periods (USFWS 2009e). The seeds are small (0.07 cm to 0.09 cm) and are easily dispersed by wind, water, and animals. Similar to other plants, most seed probably remains near the parent plant.

According to USFWS (2009b), it is unknown whether the centaury is self compatible or requires pollination, but based on the present distribution and population numbers, pollination probably does not limit reproduction. Even though little is known or understood about the centaury's life history, it is probably consistent with other species that have adapted to disturbed habitats (ruderal), like agriculture and other human-caused activities that impact habitats. Grime (1977) described ruderal plants with similar life histories as being adapted to disturbance, where the relative proportion of energy devoted to seed production is high, and capable of recovering from disturbance more quickly than other species.

The spring-loving centaury grows at elevations between 2,070 to 2,320 feet amsl in alkaline clay soils where water availability is a limiting factor (Pavlik and Manning 1986). It prefers moist to wet clay soils along the banks of streams or in seepage areas, habitat similar to that of Ash Meadows gumplant (USFWS 2009b). Where found, it occurs in abundance and is associated with *Cordylanthus tecopensis*, *Distichlis spicta* var. *stricta*, *Baccharis emoryi*, *Fraximus velutina*, and *Prosopis* (Knight and Clemmer 1987), and *Pyrrocoma* spp., *Juncus balticus*, *Anemopsis californica*, *Nitrophila occidentalis*, *Atriplex* spp, *Tamarix* spp., *Typha* spp., and *Iva* spp. (NNHP 2001). According to Reveal et al. (1973) in USFWS (2009b), the plant typically grows in wet saltgrass meadows near springs and streams and occasionally in low uplands at seeps. Currently, the quantity of water discharged from the springs in the Ash Meadows area is stable and perennial. The amount of available habitat is expected to remain relatively constant from year to year except during high rainfall years where the number of individuals and extent of suitable habitat on drier sites would likely increase, because of increased soil moisture (USFWS 2009e).

3.4.7.5 Threats to the Species

The threats to spring-loving centaury are consistent with those of other Ash Meadows plants and ecosystem. They include: (1) Present destruction, modification, or curtailment of habitat or range (e.g. groundwater withdrawal, surface mining, non-native species; (2) overutilization for commercial, recreational, scientific, or educational purposes (e.g. disease or predation); (3) inadequacy of existing regulatory mechanisms; (4) other natural or manmade factors affecting continued existence (e.g. vulnerability to environmental uncertainty, and climate change) (USF WS 2009e).

The spring-loving centaury depends on the outflow of springs and near-surface water for its survival, so local groundwater pumping negatively affects populations of the species (USFWS 2009e). At the time of listing, groundwater development was a major threat to the entire Ash Meadows ecosystem. Water levels in Devils Hole stabilized after groundwater pumping on the Ash Meadows NWR stopped in 1975; however, the water level at Devils Hole declined 7 cm between 1988 and 2004, and increased again after a wet year.

Habitat loss or degradation from surface mining occurs in the Ash Meadows area. New mineral claims and subsequent mining could cause direct loss of spring-loving centaury, as well as indirect impacts by diverting or draining water away from occupied habitat. Surface mining of a valid existing mining claim on private land within the wildlife refuge, therefore, poses a significant threat to about 50 percent of the known occurrences of the centaury within the wildlife refuge that are open to public minerals. The existing claims do not occur near any of the large populations of the plant, so mining doesn't pose a significant threat to those populations (USFWS 2009e).

Non-native species impact approximately 42 percent of all federally listed and rare plants in the U.S. (Pimental et al. 2005). They compete directly with native species for water, nutrients, and sunlight, and indirectly by altering ecosystem processes such as nutrient cycling and fire regimes (Brooks et al. 2004). Over 100 non-native species, approximately 16 percent of the total flora, occur on Ash Meadows NWR. Of the total, six species could potentially threaten the centaury including salt cedar, Russian knapweed, five hook bassia, Malta star thistle, yellow star thistle, and hoary cress (USFWS 2006d). The wet meadows and old agricultural fields that support the species are also favorable conditions for non-native, noxious weeds. There are about 4,460 acres of old agricultural fields on Ash Meadows NWR, and some of these fields are nearly monocultures of non-native noxious weeds; however, approximately 315 acres or roughly 10 percent of spring-loving centaury habitat is threatened by non-native noxious weeds (USFWS 2009e).

Since the final listing rule was published for spring-loving centaury, laws and regulations were interpreted as simply providing recognition of the species' status, but no legal protection was afforded to the individual plants or their habitats. As a result of weak interpretation and enforcement of these laws and regulations in Nevada where the plant occurs, it further threatened the species' survival. Since the final listing rule was published, regulations have been strengthened and new regulatory mechanisms have been developed to protect and conserve the spring-loving centaury (USFWS 2009e).

Other natural or manmade factors affecting the species' continued existence include vulnerability to environmental uncertainty and climate change. Environmental uncertainty includes extreme flash flooding, which could affect the species, but because its distribution creates population redundancy, flash flooding does not appear to be a serious threat to the centaury. The same holds true for climate change. Based on current climatic modeling, the southwestern U.S. is likely to experience increased frequency of regional drought in response to elevated levels of atmospheric carbon dioxide. The aquifer that supports the centaury is recharged from precipitation in the same area. If precipitation decreases significantly in the area, it could affect the plant, but to what level climate change will have on the local aquifer that supports the ecosystem and the plant is

unknown. Monitoring groundwater change would be important to identifying climate change as a potential threat (USFWS 2009e).

3.4.7.6 Species in the Project Area

The Project area is located approximately 10 miles northwest of known locations of the species in Nevada at Ash Meadows. The spring-loving centaury is not found within the Project area, although the plant populations at Ash Meadows NWR share some groundwater-related commonalities. The Ash Meadows Hydrographic Basin (includes the Ash Meadows NWR) and Alkali Flat-Furnace Creek Basin (where the proposed Project is located) are connected by the Central Death Valley subregion of the Death Valley Regional Groundwater Flow System.

4.0 EFFECTS ANALYSIS

4.1 INTRODUCTION

Federal regulations define the effects of a project action on federally listed species as direct and indirect, together with the effects of other activities that are interrelated or interdependent with the action (50 CFR §402.02). Direct effects are defined as the immediate effects of the action on the species or its habitat. Indirect effects are those effects that are caused by or result from the action that are later in time, and are reasonably certain to occur. Interrelated effects are those effects that are part of a larger action and dependent on the larger action for their justification. Interdependent effects are those effects that have no independent purpose apart from the action under consideration.

Also addressed in this section are cumulative effects. These are the effects of future non-federal (state, local governments, or private) activities on endangered and threatened species or critical habitats that are reasonably certain to occur within the action area of the federal activity, subject to consultation. They may occur from individually minor to collectively significant actions taking place over time.

For the purposes of this BA, direct effects to a species or its habitat may result from ground-disturbing activities, particularly during construction. Indirect effects to a species, or its habitat, may occur as a result of increased traffic, diversion of a water source, or long term groundwater pumping. They are foreseeable and often occur later in time or space. Interrelated and interdependent effects to a species or its habitat can result from increased traffic in the area.

Impacts to a resource can either be long-term or short-term in duration. In general, ground disturbance and habitat loss from project facilities are considered long-term impacts; that is, persisting for more than 10 years. Short-term impacts result from activities associated with the construction.

The following sections discuss direct and indirect effects, together with the effects of other activities that are interrelated or independent with the action. Also discussed are cumulative effects of any known future non-federal action on the species being assessed by this document.

4.2 REPTILES

4.2.1 Desert Tortoise (Mojave population)

4.2.1.1 Direct and Indirect Effects

Desert Tortoise habitat is present throughout the Project area and much of the surrounding valley. However, this habitat has historically supported a very low density of tortoises. Vegetation surveys in 2009 found very few forbs, grasses, or other potential food sources for tortoise within the Project area. The closest known extant population is located near Beatty, NV. Surveys in 2009 failed to detect sign that would suggest tortoises currently inhabited the Project

area. Four Class 4 burrows were located in the northwestern corner of the Project area. All four burrows had debris and spider webs covering the entrances, and showed no sign (scat, tracks, or loose soil) of use during the previous year. Additionally, no carcasses or bones were located within the Project area despite careful surveying of all washes.

Construction of the Project will result in the complete removal of approximately 4,350 acres of low density tortoise habitat. The entire Project area will be surrounded by tortoise-exclusion fencing. This fencing will be maintained accordingly to prevent Desert Tortoises from accessing the Project area. Due to the flood control channel surrounding the Project site inside the fencing, any breaches of the fence by Desert Tortoise would likely result in take of the individual tortoise. This being the case, the fence will be inspected frequently and any necessary repairs will be made expediently.

Indirect effects include increased traffic in and out of Amargosa Valley during construction and operation of the facility, which could increase the potential for vehicle collisions and subsequent injury or death to tortoises. However, due to the low density of tortoises in the vicinity, this impact is expected to be low.

Where the construction workers currently reside would determine patterns of traffic increase. The average construction workforce is estimated at 650 individuals per day, resulting in an increase of approximately 1,300 average daily vehicle trips on US 95 or NV 373 if each worker drove alone to and from the Project site. Traffic levels are expected to peak during month 17 of the 39-month construction period. Peak workforce levels are estimated at 1,300 individuals per day, resulting in an increase of approximately 2,600 average daily vehicle trips on US 95 if each worker drove alone to and from the Project site. Other roads in the vicinity of the Project area could potentially see increased traffic from workers travelling to and from the Project site to area services and other work-related activities.

The proposed Project is expected to employ a total of 180 workers during operation, or an estimated increase of 360 daily vehicle trips on US 95, if each worker drove alone to and from the Project site.

Increased vehicle use can result in the introduction of noxious weeds. Seeds and spores from weeds can become attached to vehicles and be transported to a new location. Noxious weeds can invade areas and reduce the amount of native vegetation that provides forage for Desert Tortoises. The Project will develop a Noxious Weed Management Plan in accordance with BLM standards. Included in the noxious weed plan will be stipulations regarding construction, restoration, and operation (e.g., use of weed free materials, washing of equipment).

Additional aspects of the Project can result in increased predation to the Desert Tortoise. Ravens and other predators are attracted to areas with trash and litter. To minimize these attractants, total enclosed containment shall be provided for all trash. All employees will be directed to utilize these containers or remove all trash from the site.

Ravens and other raptors utilize elevated structures for perching which can result in increased tortoise predation. The solar facility will be completely surrounded by fencing, topped by coiled barbed wire. Thus, the fencing is unlikely to be utilized as a suitable perching structure. Other

facility structures may be utilized by ravens and raptors for perching; however, as there are already existing trees, buildings, and power poles, it is unlikely that this will result in a sizable increase in tortoise predation by avian predators.

There are no interrelated or interdependent effects to the Desert Tortoise. The construction of new or improved access roads for the Project will not provide increased access for other reasonably foreseeable future projects in the area,

4.2.1.2 Cumulative Impacts

Potential cumulative impacts to the Desert Tortoise and its habitat are associated with additional solar power facilities and increased development within the Amargosa Valley.

The proposed Project will occur on public land within the BLM right-of-way application NVN-84359. There are no other future non-federal actions planned within the Project action area; however, there are proposed projects that would contribute to regional increased tortoise habitat disturbance and loss (See Draft Environmental Impact Statement (DEIS) Chapter 4.16-Cumulative Impacts).

4.3 SPECIES OCCURRING AT ASH MEADOWS NATIONAL WILDLIFE REFUGE

Impacts were found to be similar to all species under analysis from the Ash Meadows NWR. The direct, indirect, and cumulative impacts to Devils Hole Pupfish, Ash Meadows Amargosa Pupfish, Warm Springs Pupfish, Ash Meadows Speckled Dace, Ash Meadows Naucorid, Amargosa niterwort, Ash Meadows blazing star, Ash Meadows gumplant, Ash Meadows ivesia, Ash Meadows milkvetch, Ash Meadows sunray, and Spring-loving centaury are reported jointly.

4.3.1 Direct and Indirect Impacts

Groundwater pumping in Amargosa Valley is known to be a primary threat to the species of Ash Meadows NWR. In 2007, the Nevada State Engineer issued Ruling 5750 which stated that the groundwater basin is over-appropriated. Intensive groundwater pumping may result in a decline in populations and habitat curtailment as it results in drying of the soils and decreases in spring flow, as well as potential changes to water and soil chemistry and water temperature. All the Ash Meadows NWR species considered in this BA are dependent, at least in part, on groundwater or near-surface water for survival. It is reasonable to assume that regional groundwater pumping contributes to changes in their habitat over time. The rate of groundwater extraction in the Amargosa Valley due to regional development undoubtedly has a cumulative effect on these species over the long term, but to what degree is currently unknown.

The only exception to this assessment is the Ash Meadows sunray. It has been suggested (Knight and Clemmer 1987) that the Ash Meadows sunray does not depend on high water table to survive, so regional groundwater pumping would not contribute to changes in plant habitat over time. The rate of groundwater extraction in the Amargosa Valley due to regional development is not a significant issue for the sunray. Ground disturbance is the sunray's most significant threat.

Construction and operation of the solar facilities will require a dedicated water supply. The primary potential water source is diversion of agricultural water from an existing well on the southwest of the Project site (see Figure 1-2).

The Death Valley Regional Flow System Model (DVRFS) was used to simulate the effect on Devils Hole water levels of maintaining regional pumping at 2003 levels for the years 2003 to 2203. The was then run adding the 400 afy that would be used for annual Project operations at the proposed pointo f diversion for the years 2010 to 2039. The Theis simulation indivates that the water level at Devils Hole would decrease by less than 0.05 feet (0.6 of an inch) after 200 years when 400 afy is added to the regional groundwater extraction in addition to the 13 feet reduction project by the model if pumping remains at 2003 levels. The model predicted that discharge of the springs in Ash Meadows would decrease from the present-day amount of 18,095 afy to 15,607 afy as a result of maintaining current pumping levels between 2003 and 2203. When Project pumping is added, the 2203 discharge rate at Ash Meadows would be reduced to 15,600 afy, or a difference of 7 afy.

Limitations of the DVRFS model include suspected inaccuracies within the historical pumping dataset used to calibrate the model, as well as simplifications of the regional geology and groundwater flow. The principal limitation, however, is that the model is regional, with a grid size of 1,500m x 1,500m, and is accurate to several vertical meters. It is calibrated to the regional flow system, and its most appropriate use is to address regional-scale issues, as opposed to changes at a local scale (i.e. Devils Hole). Thus, the regional model has a limited capability to accurately evaluate incremental changes in pumping tens of miles away on Devils Hole, but it is the only numerical groundwater flow model available (GeoTrans 2010) (See Section 1.4 for a more detailed discussion on the groundwater modeling conducted for the Project). Because of this, model results should be used as a qualitative tool as opposed to predicting an exact response.

The change in manner of use of the existing water right from irrigation and agriculture to industrial may result in a loss of groundwater recharge to the basin. Literature indicates that recharge due to agricultural practices in Amargosa Valley ranges between 9 and 22% (Stonestrom et al. 2007). The primary water uses during operations would be for washing solar mirrors, ancillary equipment heat rejection, and the power cycle. It is unknown what amount of infiltration occurs as a result of washing solar mirrors, and the other uses will not have any infiltration associated with them. Assuming the above range is accurate, and return of water used in mirror washing activities is zero, the loss of recharge to the system due to operations would be between 36 and 88 afy. Over the expected life of the Project, this could result in a cumulative loss of 1,080 to 2,640 acre-feet.

The Proponent is acquiring and foregoing use of no less than 204 afy of existing water rights within the Basin No. 230 (Amargosa Desert Hydrographic Basin). The annual duty of the water right to be leased is 603 afy. Between the years 1983 and 2008, the annual average use of this duty was 413.88 afy. Pending permitting by the Nevada State Engineer, the Proponent will lease 400 afy for project operations, while the water right holder retains the remaining 203 afy to be used for agriculture purposes. If the water right holder continues to use this right, the overall pumping in the basin will be increased because the full permitted duty will be used annually, thereby increasing the overall pumping in the groundwater basin. By purchasing additional water

rights totaling no less than 204 afy, the Proponent will offset the continued use of permit 15893, potentially benefitting area resources.

4.3.2 Cumulative Impacts

Potential cumulative impacts to the species of Ash Meadows NWR and their habitats are associated with additional solar power facilities and increased development within the Amargosa Valley. The proposed project will occur on public land within the BLM right-of-way application NVN-84359. There are no other future non-federal actions planned within the Project action area; however, there are proposed projects that would contribute to regional groundwater pumping in Amargosa Valley (See DEIS Chapter 4.16-Cumulative Impacts).

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5.0 MINIMIZATION MEASURES

5.1 INTRODUCTION

Minimization measures developed for the Project follow both a generic and selectively committed approach.

Generic minimization measures are those that apply to the Project as a whole and are typically part of the project description. Selectively committed measures are applied on a case-by-case basis, in specific impact locations. The overarching purpose of both sets of measures with respect to biological resources was to reduce impacts to biological resources, as well as special status species, resulting from the construction, operation, and maintenance of the Project, where possible. Generic and selective minimization measures related to the avoidance and mitigation of impacts to species addressed in this BA are set forth below. These and other measures will be imposed and adhered to through conditions in the Construction, Operation, and Maintenance (COM) Plan being developed by the BLM and the Proponent. During construction, these measures will be monitored by a Compliance Inspection Contractor (CIC) who will review the applicability of these measures and make final determinations regarding their implementation.

Measures that would be applied in all Project areas as applicable:

1. All construction vehicle movement outside the right-of-way would be restricted to pre-designated access, contractor acquired access, or public roads.

2. The limits of construction will be predetermined, with activity restricted to and confined within those limits.

3. Prior to construction, all supervisory construction personnel would be instructed on the protection of ecological resources. To assist in this effort, the construction contract would address: (a) federal and state laws regarding plants and wildlife, including collection and removal; (b) the importance of these resources and the purpose and necessity of protecting them.

4. Minimization measures that will be developed during the consultation period under Section 7 of the Endangered Species Act (1974) will be adhered to as specified in the Biological Opinion (BO) of the USFWS.

5. Hazardous materials shall not be drained onto the ground or into streams or drainage areas. Total enclosed containment shall be provided for all trash. All construction waste, including trash and litter, garbage, other solid waste, petroleum products, and other potentially hazardous materials, shall be removed to a disposal facility authorized to accept such materials.

6. Prior to construction, a Noxious Weed Management Plan will be developed in accordance with BLM standards. Included in the noxious weed plan will be stipulations regarding construction, restoration, and operation (e.g., use of weed free materials, washing of equipment).

5.2 DESERT TORTOISE

Minimization measures designed specifically to reduce impacts to the Desert Tortoise have been developed to assist in the formal consultation process. These measures would be applied through conditions in the COM Plan to avoid and minimize impacts to the tortoise. In order to lessen and/or avoid impacts to Desert Tortoises, the following minimization measures would be applicable.

Measures that would minimize mortality or injury of Desert Tortoises due to construction or maintenance activities and operation of heavy equipment:

1. Authorized Tortoise Biologists shall be present during all construction and maintenance (e.g., emergency repairs) activities where one or more pieces of heavy construction equipment are being used until appropriate fencing or other barriers are in place to preclude Desert Tortoises from entering the work area.

2. Prior to construction, a plan establishing handling, holding, and relocation procedures for tortoises will be developed. The plan will be developed in consultation with BLM and USFWS and will be approved by those agencies. The plan will include, at a minimum: (a) a protocol for moving tortoises above ground in construction areas; (b) a protocol for excavating and relocating tortoises found in burrows in areas flagged for disturbance; and (c) the techniques for constructing artificial burrows for relocated tortoises. The plan would account for the time of year and temperature ranges. The purpose for deferring the development of the plan is to ensure the use of the most current and effective techniques available at the time of construction.

3. Construction and maintenance vehicles will not exceed a speed of 25 miles per hour in tortoise habitat, except where posted otherwise (e.g., US 95).

4. All construction sites and access roads shall be clearly marked or flagged at the outer limits prior to the onset of any surface-disturbing activity. All personnel shall be informed that their activities must be confined within the marked or flagged areas.

5. Construction sites and access roads shall be surveyed by Authorized Tortoise Biologists no more than 15 days prior to the initiation of construction. Surveys shall provide 100 percent coverage of the construction area. All Desert Tortoise burrows, and other species' burrows that may be used by Desert Tortoises, will be excavated to determine the occupancy of each burrow by tortoises.

6. Desert Tortoises and eggs found within construction sites will be removed by Authorized Tortoise Biologists, in accordance with the most current protocols identified by the BLM and USFWS.

7. Any excavated holes related to construction (i.e., foundations) left open overnight will be covered or tortoise proof fencing will be installed to prevent the possibility of tortoises falling into the open holes.

8. Anyone on the right-of-way within Desert Tortoise habitat will be required to check under their vehicle before driving away. This includes all construction equipment and the area under vehicles should be checked any time a vehicle is left unattended, as well as in the morning before any construction activity begins.

Measures that would minimize predation on tortoises by ravens drawn to construction areas:

9. Trash and food items will be removed daily by construction workers and placed in raven-proof containers.

Measures that would minimize destruction of Desert Tortoise habitat, such as soil compaction, erosion, or crushed vegetation, resulting from construction or maintenance activities:

10. Within Desert Tortoise habitat, construction and maintenance workers will strictly limit their activities and vehicles to construction areas and routes of travel that have been identified and/or flagged to eliminate adverse impacts to Desert Tortoises and their habitat. Aside from these areas, workers may not drive cross-country. All workers will be instructed that their activities are restricted to previously identified, flagged or cleared areas.

Measures that would be taken to ensure compliance with measures contained within the Biological Opinion:

11. The project proponent will designate a CIC, who will be responsible for overseeing compliance with protective stipulations for the Desert Tortoise and for coordinating compliance with the BLM. The CIC will have the authority to halt activities of construction equipment that may be in violation of the stipulations.

12. All construction and maintenance workers will participate in a tortoise-education program. The program will be developed by the Project proponent prior to the beginning of construction. The program will be submitted to the USFWS for review and approval prior to implementation. The program will include, at a minimum, the following topics: (a) the occurrence of Desert Tortoises; (b) the sensitivity of the species to human activities; (c) legal protection for Desert Tortoises; (d) penalties for violations of federal and state laws; (e) general tortoise activity patterns; (f) reporting requirements; (g) measures to protect tortoises; and (h) personal measures employees can take to promote the conservation of Desert Tortoises.

13. The USFWS and BLM will be notified within three days of any tortoise death or injury caused by project activities. Notification will include the date, time, circumstances, and locations of any injury or death.

14. The CIC and on-site biologist will prepare a report for the BLM and USFWS no later than 90 days after completion of construction within Desert Tortoise habitat. The report will document the effectiveness of the tortoise mitigation measures, the number of tortoises excavated from burrows, and the number of tortoises moved from construction sites. The report will make recommendations for modifying or refining the stipulations, to enhance benefits to the tortoise or to reduce needless hardship on the project proponent.

The report will include an estimate of the actual acreage of habitat disturbance caused by crushing and blading versus the estimates prior to construction.

5.2.1 Habitat Compensation for the Desert Tortoise

The objective of habitat compensation is to ensure that there is no net loss of habitat quality for the tortoise. The ultimate objective of such compensation is to ensure that the number and viability of regional populations is not diminished. Compensation for the loss of habitat is required by applicable endangered species laws, regulations, and agency policies, including BLM Desert Tortoise protection policies, and will be applied to the Project.

The decision regarding the distribution and appropriate use of mitigation remuneration for the disturbance of Desert Tortoise habitat will be determined through consultations between the USFWS and BLM and will be included in the BO. The actual per acre rate of remuneration will also be determined through consultation between the BLM and USFWS and will be included in the Project BO.

5.3 SPECIES OCCURRING AT ASH MEADOWS NATIONAL WILDLIFE REFUGE

Minimization measures designed specifically to reduce impacts to the species occurring at Ash Meadows have been designed to assist with informal consultation for those species. In order to lessen and/or avoid impacts to these species, the following minimization measures would be applicable. Any breach in adherence to these measures would invalidate the determination of effects described below, therefore warranting reinitiation of Section 7 consultation.

1. The Proponent will acquire no less than 204 afy of existing water rights (MWR – Minimization Water Rights) from within Basin No. 230 (Amargosa Desert Hydrographic Basin).

    a. Acquisition of the MWR shall meet the following criteria:

        i. These water rights shall be geographically closer to Devils Hole and Ash Meadows than the two municipal Nye County Wells situated at Lathrop Wells (See measure #3 below).

        ii. Preference would be for the acquisition of senior water rights coming from the 7,000 acre feet available in Basin No. 230; preference (in terms of manner of use) for acquisition of these rights would be from existing agricultural use.

        iii. The average historical use of the acquired water rights shall be equivalent to the permitted annual duty of those rights. If water rights meeting this criterion are unavailable, water rights shall be acquired such that the cumulative historical pumping average is no less than 204 afy.

2. These water rights will be held by the Proponent until such time that a Memorandum of Understanding (MOU) is consented on between BLM, USFWS, NPS, and Nye County.

A consensus from all parties will need to be reached within 5 years of acquisition due to the requirement of the State Engineer to show proof of beneficial use of the water rights. The Minimization Water Rights shall be indefinitely retired by the Proponent if an MOU is not signed within the 5 year period.

a. The 4-party MOU shall instruct that the acquired water rights not be used until such time that all four parties are in consensus that use of the MWR would result in discountable and negligible impacts to the Ash Meadows species and Devils Hole.

b. Through details yet to be determined by the MOU, Nye County, in cooperation with the other MOU signatories and other appropriate agencies shall perform studies to better understand how the use of the MWR would impact area resources. These include Devil's Hole, Ash Meadows, and overall local and regional water levels. The details and ultimate goals of the studies shall be agreed upon by Nye County, BLM, NPS, and USFWS.

    i. Upon completion of the studies to be determined by the MOU, if results of those studies demonstrate negative effects to the Ash Meadows species and Devils Hole in association with continued pumping of all or a portion of the MWR, then all or a portion of the MWR shall be retired indefinitely.

    ii. Upon completion of the studies to be determined by the MOU, if results of those studies demonstrate no negative effects to the Ash Meadows species and Devils Hole, in association with continued pumping of all or a portion of the MWR, then all or a portion of the MWR shall be available for use by Nye County, pending State Engineer approval.

        1. A consenus that no negative effects would result from the use of the MWR would need to be reached from all parties in the MOU.

    iii. If no conclusive evidence is available at the time that the State Engineer requires proof of beneficial use of the MWR, then those water rights shall be retired indefinitely.

3. Upon signing of the MOU, the ownership of the MWR would be transferred to Nye County. The Proponent would move the point of diversion of the combined MWR to one of two municipal Nye County wells situated at Lathrop Wells (SE ¼ Section 18, T 15S, R 50E), near the intersection of US Hwy 95 and NV Hwy 373, in accordance with Nevada State Engineer's Order 1197.

4. The Proponent shall meter all wells for construction and operation of the proposed project and meter wells for the additional acquired water rights to ensure that ground-water pumping is not impacting the local water table. Furthermore, quarterly reports will be filed with the Nevada Division of Water Resources and with the BLM.

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6.0 DETERMINATION OF EFFECTS

6.1 DESERT TORTOISE

The project may affect the Desert Tortoise, but is not likely to jeopardize the continued existence of the species.

The minimization measures described above will be effective in reducing impacts to the Desert Tortoise and its habitat. All measures restricting ground disturbing activity also will be effective at reducing the potential for incidental take during construction. Indirect impacts associated with the potential for increased public (recreation) access that may affect the Desert Tortoise will be reduced by controlling access in key locations to the right-of-way. Additional key minimization measures developed specifically for the Mojave Desert Tortoise identified in Section 5 include, but are not limited to, educational programs, parking and storing equipment in previously disturbed areas, following pre-construction procedures for handling, holding, and relocating tortoises, and not exceeding speed limits of 25 miles per hour from March 1 through November 1.

As part of the additional recommended minimization measures, trash and food items will be removed daily by construction workers and placed in raven-proof containers. To prevent mortality, injury, and harassment of Desert Tortoises and damage to their burrows and cover sites, no pets shall be permitted in any Project construction area, unless confined or leashed.

6.2 SPECIES OCCURRING AT ASH MEADOWS NATIONAL WILDLIFE REFUGE

The Project may affect, but is not likely to adversely affect the species occurring at Ash Meadows NWR (with the exception of the Ash Meadows Sunray) nor their associated critical habitats. This determination is based in part on the results and analysis of the DVRFS Model, as well as expected adherence to the minimization measures described above.

Analysis using the DVRFS Model found that use of the selected well for the Project will result in a reduced discharge rate from springs at Ash Meadows NWR of 7 afy or 0.05% less than the projected spring discharge after 200 years. Additionally, it was found that pumping by the Project would cause water levels in Devils Hole to decline less than 0.05 feet after 200 years.

6.2.1 Ash Meadows Sunray

The Project will not affect the Ash Meadows sunray or its habitat. This determination is based on the species' habitat requirements. The plant appears to be restricted to dry, upland areas outside the influence of water from seeps and springs; therefore the sunray would not be affected by groundwater pumping.

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7.0 REFERENCES

Alexander, J. 1998. Nevada native species site survey reports. April and May 1998 *In*: USFWS. 2007b. Ash Meadows Gumplant (*Grindelia fraxino-pratensis*), Five-Year Review: Summary and Evaluation.

Andress, R.J., S. McKelvey, C.R. Baldino, D. Weissenfluh, and G.G. Scoppettone. 2009. Hydrologic and aquatic habitat restoration at Fairbanks and Soda Springs, Ash Meadows National Wildlife Refuge to improve habitat quality for the Ash Meadows pupfish, C*yprinodon nevadensis mionectes*, Ash Meadows speckled dace, *Rhinichthys osculus nevadensis*, and thermal endemic invertebrate species. Presented at the 2009 Annual Symposium of the Desert Fishes Council, Death Valley, CA.

Arizona Game and Fish Department (AZGFD). 2001. *Gopherus agassizii*. Unpublished abstract compiled and edited by the Heritage Data management System, Arizona Game and Fish Department, Phoenix, Arizona. 8p. Internet site: http://www.gf.state.az.us/w_c/edits/documents/Gophagas.fi_001.pdf. Accessed: November 12, 2009.

Averill-Murray, R.C., A.P. Woodman and J.M. Howland. 2002. Population ecology of the Sonoran Desert tortoise in Arizona. Pages 109-134 *in* The Sonoran Desert Tortoise: Natural History, Biology, and Conservation, T.R. Van Devender, Ed. University of Arizona Press, Tucson.

Barneby, R.C. 1970. A new Astragalus (Fabaceau) from Nevada *In*: Knight, T.A. and G.H. Clemmer. May 1987. Status of populations of the endemic plants of Ash Meadows, Nye County, Nevada. A report to U.S. Fish and Wildlife Service, Great Basin Complex, Reno, Nevada in cooperative agreement with Nevada Division of Forestry, Department of Conservation and Natural Resources and Nevada Natural Heritage Program, Carson City, Nevada. Project Agreement No. 86-2-1. 100 pp.

Baugh, T. and J.E. Deacon. 1983. The Most Endangered Pupfish. Freshwater and Marine Aquarium. June 1983.

Beatley, J.C. 1977. Endangered plant species of the Nevada test Site, Ash Meadows, and Central-Southern Nevada. U.S. Energy Research and Development Administration-Contract E (11-1)-2307.

_____. 1976. Vascular plants of the Nevada Test Site and Central-Southern Nevada: ecologic and geographic distributions. Technical Information Center, Office of Technical Information, Energy Research and Development Administration, U.S. Department of Commerce, Springfield. 308 pp.

Belcher, W.R., ed. 2004. Death Valley regional ground-water flow system, Nevada and California—Hydrogeologic framework and transient ground-water flow model: U.S. Geological Survey Scientific Investigations Report 2004-5205. 408 pp.

Berry, K.H. and P. Medica. 1995. Desert Tortoises in the Mojave and Colorado Deserts. Pages 135–137 in Our Living Resources: A Report to the Nation on the Distribution, Abundance, and Health of U.S. Plants, Animals, and Ecosystems, E.T. LaRoe, G.S. Farris, C.E. Puckett, P.D. Doran and M.J. Mac, eds. U.S. Department of the Interior, Washington.

Bio-West, Inc. 2009. Environmental Assessment for Fairbanks Spring and Soda Spring Restoration, EA #84550-10-01. Logan, Utah.

Bio-West, Inc. 2008a. Ash Meadows National Wildlife Refuge vegetation mapping and rare plant survey. Draft progress report submitted to U.S. Fish and Wildlife Service by Bio-West, Inc. *In*: USFWS. 2009d. Ash Meadows milkvetch (*Astragalus phoenix*) Five Year Review: Summary and Evaluation. 33 pp.

_____. 2008b. Ash Meadows National Wildlife Refuge vegetation mapping and rare plant survey. Draft progress report submitted to U.S. Fish and Wildlife Service by Bio-West, Inc. *In*: USFWS. 2009e. Spring-loving centaury (*Centaurium namophium*), Five-Year Review: Summary and Evaluation.

Blythe, A.K., D.E. Swann, R.J. Steidl and E.W. Stitt. 2004. Movement patterns of translocated desert tortoises. Page 80 *in* The Proceedings of the Desert Tortoise Council, D.K. Duncan, G. Stewart, T.B. Egan, M. Tuegel and D. Pond, eds. The 28th Annual meeting and Symposium of the Desert Tortoise Council; February 21-23, 2003, Las Vegas, Nevada. Wrightwood, California: Desert Tortoise Council, Inc. 183 pp.

Bramble, D.M. 1971. Functional Morphology, Evolution, and Paleontology of Gopher Tortoises. PhD Dissertation. U.C. Berkeley.

Brooks, M.L., C.M. D'Antonio, D.M. Richardson, J.B. Grace, J.E. Keeley, J.M. DiTomaso, R.J. Hobbs, M. Pellant, and D. Pike. 2004. Effects of invasive alien plants on fire regimes. Bioscience 54(57):677-688 *In*: USFWS. 2009d. Ash Meadows milkvetch (*Astragalus phoenix*), Five-Year Review: Summary and Evaluation.

Broome, R.C. 1981. A new variety of Centaurium namophilum (Gentianaceae) from the Great Basin. Great Basin Naturalist 41:192-197.

Brown, D.E., ed. 1994. Biotic Communities: Southwestern United States and Northwestern Mexico. University of Utah Press, Salt Lake City, Utah. 287 pp + appendices.

Bureau of Land Management (BLM). 2009. Fact Sheet for Ash Meadows gumplant (*Grindelia fraxino-pratensis*). Accessed on November 12, 2009. Website available at: http://www.blm.gov/ca/pa/ssp/plants/grindelia_fraxino_pratensis%20-plant.html.

BLM and U.S. Fish and Wildlife Service (USFWS). 2000a. Environmental Assessment for the Proposed Land and Mineral Withdrawal at Ash Meadows National Wildlife Refuge, Nye County, Nevada *In:* USFWS. 2007b. Ash Meadows Gumplant (*Grindelia fraxino-pratensis*), Five-Year Review: Summary and Evaluation.

_____. 2000b. Environmental Assessment for the Proposed Land and Mineral Withdrawal at Ash Meadows National Wildlife Refuge, Nye County, Nevada *In*: USFWS. 2009d. Ash Meadows Milkvetch (*Astragalus phoenix*), Five-Year Review: Summary and Evaluation.

_____. 2000c. Environmental Assessment for the Proposed Land and Mineral Withdrawal at Ash Meadows National Wildlife Refuge, Nye County, Nevada *In*: USFWS. 2009e. Spring-loving centaury (*Centaurium namophilum*), Five-Year Review: Summary and Evaluation. 32 pp.

BLM, USFWS, and California Department of Fish and Game. 1989. Environmental Assessment for Selected Control of the Common Raven to Reduce Desert Tortoise Predation in the Mojave Desert, California. Bureau of Land Management, Riverside, California.

Caicco, S. 2005. Threatened and Endangered Plant Species- 2005 Field Survey Report. U.S. Fish and Wildlife Service, Ash Meadows National Wildlife Refuge, Nye County, Nevada.

Center for Biological Diversity (CBD). 2009. Natural history of Ash Meadows gumplant (*Grindelia fraxino-pratensis)*. Website accessed on November 12, 2009. Available at: http://biologicaldiversity.org/species/plants/Ash_Meadows_gumplant/natural_history.html.

Claassen, H.C. 1985. Sources and Mechanisms of Recharge for Ground water in the West-Central Amargosa Desert, Nevada-A Geochemical Interpretation. Hydrology of Nuclear Test Sites. U.S. Geological Survey Professional paper 712-F. Prepared in cooperation with the U.S. Department of Energy. United States Government Printing Office, Washington.

Cochrane, S.A. 1981. Unpublished status report on *Grindelia fraxino-pratensis* Reveal and Beatley *In*: USFWS. 2007b. Ash Meadows gumplant (*Grindelia fraxino-pratensis*) Five Year Review: Summary and Evaluation. 20 pp.

Converse Consultants. 2008. Canyon resources reward mine biological assessment, Nye County, NV. CR Briggs Corporation.

Conservation Management Institute (CMI). 1996. A research center within the College of Natural Resources at Virginia Tech Website. Draft Ivesia, Ash Meadows. Accessed November 17, 2009. Available at: http://fwie.fw.vt.edu/WWW/esis/lists/e701036.htm.

Corn, P.S. 1994. Recent Trends of Desert Tortoise Populations in the Mojave Desert. Pages 85 – 93 *In:* Biology of North American Tortoises, R.B. Bury and D.J. Germano, eds. Fish and Wildlife Research Publication #13.

Cronquist, A. 1972. A new variety of *Enceliopsis nudicaulis* (Ateraceae) from southern Nevada. Bull. Torrey Bot. Club. 99:246-248.

Crumley, C.R. 1994. Phylogenetic systematic of North American tortoises (genus *Gopherus*): Evidence for the classification. Page 7-32 *In:* Biology of North American Tortoises, R.B. Bury and D.J. Germano, eds. Fish and Wildlife Research Publication #13.

Desert Gazette. 2009. National Wildlife Refuges-Ash Meadows website available at: http://digital-desert.com/ash-meadows/ash-meadows.14.0.html.

Dominguez, C. 2006. Insect Conservation Biology: *Ambrysus amargosus*, Ash Meadows Naucorid. Available online at: http://courses.cit.cornell.edu/icb344/abstracts/Ash-meadows-naucorid.htm.

Edwards, T., E.W. Stitt, C.R. Schwalbe and D.E. Swann. 2004. *Gopherus agassizii* (desert tortoise) movement. Herpetological Review 35 (4): 381-382.

Ernst, C.H., J.E. Lovich and R.W. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington.

Esque, T.C. and E.L. Peters. 1994. Ingestion of Bones, Stones, and Soil by Desert Tortoises. Pages 105-111 *in* Biology of North American Tortoises, R.B. Bury and D.J. Germano, eds. U.S. Department of Interior, Fish and Wildlife Research Publication 13.

Farrell, J.P. 1989. Natural history observations of raven behavior and predation on desert tortoises. Proceedings of the Symposium of the Desert Tortoise Council 1989.

Freidman, I., J.M. Harris, G.I. Smith, and C.A. Johnson. 2002. Stable isotope composition of waters in the Great Basin. United States: 1. Air mass trajectories: Journal of Geophysical Research, v. 107, no. D19, 4400, doi:10.1029/2001JD000565 *In:* T.J. Lopes. 2006. Quality of Nevada's Aquifers and their Susceptibility to Contamination, 1990-2004. Scientific Investigations Report 2006-5127. Prepared in cooperation with the State of Nevada Department of Conservation and Natural Resources, Division of Environmental Protection. U.S. Department of the Interior and U.S. geological Survey. 51 pp.

GeoTrans, Inc. 2010. Groundwater Modeling Services to Support the Amargosa Road Solar Power Project EIS Technical Memorandum.

Germano, D.J., R.B. Bury, T.C. Esque, T.H. Fritts and P.A. Medica. 1994. Range and habitats of the desert tortoise. Pages 73-84 *in* Biology of North American Tortoises, R.B. Bury and

D.J. Germano, eds. U.S. Department of the Interior, Fish and Wildlife Research Publication #13.

Glenne, G. 1998. Nevada native species site survey reports. June and September 1998 *In*: USFWS. 2007b. Ash Meadows Gumplant (*Grindelia fraxino-pratensis*), Five-Year Review: Summary and Evaluation.

Grime, J.P. 1977. Evidence for the existence of three primary strategies in plants and its relevance to ecological and evolutionary theory. The American naturalist 111(982): 1169-1194 *In*: USFWS. 2009d. Ash Meadows milkvetch (*Astragalus phoenix*) Five Year Review: Summary and Evaluation. 33 pp.

Hall, E. R. 1995 Revised. Mammals of Nevada. University of Nevada Press, Reno. 710 pp.

Hillyard, S. and F. Van Breukelen. 2009. The Devils Hole Pupfish, another canary in the global climate change coal mine? Presented at the 2009 Annual Symposium of the Desert Fishes Council, Death Valley, CA.

Houghton, J.G., C.M. Sakamoto, and R.M. Gifford. 1975. Nevada's climate and weather: Nevada Bureau of Mines and Geology Special Publication 2. 78 pp.

Jacobson, E. 1992. The Desert tortoise and upper respiratory tract disease. A special report prepared for the Desert Tortoise Preserve Committee, Inc. Desert Tortoise Preserve Committee Internet site: http://www.tortoise-tracks.org/publications/jacobson.html. Accessed: November 12, 2009.

Jennings, W.B. 1997. Habitat use and food preferences of the desert tortoise, *Gopherus agassizii*, in the western Mojave Desert and impacts of off-road vehicles. Pages 42-45 *in* Proceedings of Conservation, Restoration, and Management of Tortoises and Turtles – An International Conference, J. Van Abbema, ed. New York Turtle and Tortoise Society. Available online at: http://www.tortoise-tracks.org/publications/jennings.html.

Kilroy, K.C. 1991. Ground-Water Conditions in Amargosa Desert, Nevada-California, 1952-1987. U.S. Geological Survey Water Resources Invesitgations Report 89-4101.

Knight, T.A. and G.H. Clemmer. 1987. Status of populations of the endemic plants of Ash Meadows, Nye County, Nevada. A report to U.S. Fish and Wildlife Service, Great Basin Complex, Reno, Nevada in cooperative agreement with Nevada Division of Forestry, Department of Conservation and Natural Resources and Nevada Natural Heritage Program, Carson City, Nevada. Project Agreement No. 86-2-1. 100 pp.

Knight and Leavitt Associates. 2006. A biological report on the Mojave Desert Tortoise for a proposed 4.8 acre material pit, Nye County, NV. Bureau of Land Management.

Lamb, T., J.C. Avise, and J.W. Gibbons. 1989. Phylogeographic patterns in mitochondrial DNA of the desert tortoise (*Xerobates agassizii*), and evolutionary relationships among North American gopher tortoises. Evolution 43:76-87.

Lawler, H.E. No date. A Natural History of the Desert Tortoise, *Gopherus [Xerobates] agassizii*. International BioPark Internet site: http://www.biopark.org/Destort1.html. Accessed: November 12, 2009.

Lovich, J. 1999. Synopsis of conservation information on the desert tortoise. U.S. Geological Survey, Western Ecological Research Center Internet site: http://www.werc.usgs.gov/hq/synopsis.htm. Accessed: November 12, 2009.

Mapula, J., O. Feuerbacher, S. Bonar, and K. Wilson. 2009. Laboratory replication of Devils Hole algal and zooplankton communities. Presented at the 2009 Annual Symposium of the Desert Fishes Council, Death Valley, CA.

McKelvey, S. and K. Taylor. 2009. Conversation between Sharon McKelvey (FWS), Kathie Taylor (Argenta Ecological Consultants), and Alison Pruett (EPG) on 23 November 2009 at Ash Meadows National Wildlife Refuge.

Morefield, J.D. 1991. Unpublished field survey for *Centaurium namophilum*. Reveal, Broome and Beatley in the vicinity of Beatty, Nye County, Nevada, 10-11 July 1991.

Moreo, M.T. and J. Justet. 2008. Update to the ground-water withdrawals database for the Death Valley regional ground-water flow system, Nevada and California, 1913-2003. U.S. Geological Survey Data Series 340, 10p.

Mozingo, H.N. and M. Williams. 1980. Threatened and Endangered Plants of Nevada: An Illustrated Manual. Submitted to U.S. Fish and Wildlife Service, Portland Oregon and U.S. Bureau of Land Management, Reno, Nevada. 268 pp.

Munz, P.A. 1974. A Flora of Southern California. University of California Press, Berkley California. Pg 351.

Naiman, R.J. 1979. Preliminary food studies of Cyprinodon mascularius and Cyprinodon nevadensis (Cyprinodontidae). Southwest Naturalist 24:538-541.

National Park Service (NPS). 2009. Desert tortoise. Internet site: http://www.nps.gov/moja/planning/tort.htm. Accessed: November 12, 2009.

_____. 2006. Personal communication with Jennifer Back.

NatureServe. 2009. An Online Encyclopedia of Life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at: http://www.natureserve.org/explorer. Accessed: multiple dates in 2009.

Nevada Natural Heritage Program (NNHP). 2009. Nevada Sensitive Animal List. Internet site: http://heritage.nv.gov/sensanim.htm. Accessed: November 12, 2009.

_____. 2001. Rare Plant Fact Sheet. Available at: http://heritage.nv.gov/atlas.

Oftedal, O.T. 2002. Nutritional Ecology of the Desert Tortoise in the Mojave and Sonoran Deserts. Pages 194 – 241 *in* The Sonoran Desert Tortoise: Natural History, Biology, and Conservation, T. R. Van Devender, ed. University of Arizona Press, Tucson.

Parker, M.S., D.S. Weissenfluh, S. Goodchild, C.R. Baldino, L. Simons, C. Lundblad, and P. Cunningham. 2009. Habitat restoration and long-term conservation of Ash Meadows naucorids. Presented at the 2009 Annual Symposium of the Desert Fishes Council, Death Valley, CA.

Parker, M.S., G.G. Scoppettone, and M.B. Neilsen. 2000. Ecological investigation of two naucorid species (Ambrysus amargosus and A. relictus) endemic to thermal springs of the Ash Meadows National Wildlife Refuge. U.S. Fish and Wildlife Service, Southern Nevada Field Office. Document Control Number 14320-8-6002.

Pavlik, B.M., A.E. Stanton, and M. Bernegger. 2006. Managing Populations of Rare Plants at Ash Meadows National Wildlife Refuge. Demographic Survey and Habitat Quality Assessment to Recover *Astragalus phoenix.* Unpublished report prepared for the U.S. Fish and Wildlife Service, December 2006 *In*: USFWS. 2009d. Ash Meadows milkvetch (*Astragalus phoenix*), Five-Year Review: Summary and Evaluation.

Pavlik, B.M. and E.A. Manning. 1986. Endangered Species Information System Species Workbook Part II-Species Biology. Workbook compiled for the spring-loving centaury *In*: USFWS. 2009e. Spring-loving centaury (*Centaurium namophium*), Five-Year Review: Summary and Evaluation.

Pimental, D., R. Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *In*: USFWS. 2007b. Ash

Meadows gumplant (*Grindelia fraxino-pratensis*) Five Year Review: Summary and Evaluation. 20 pp.

Rautenstrauch, K.R. and T.P. O'Farrell. 1994. Relative abundance of desert tortoises on the Nevada test site. Department of Energy. EGG 11265-2039. Available at: http://www.osti.gov/bridge/servlets/ purl/10121823-ojdq5a/native/10121823.pdf

Reveal, J.L. 1978. Status report on *Nitrophila mohavensis* Munz and Roos (Amargosa niterwort). Unpublished report to U.S. Department of Interior.

Reveal, J.L., C.R. Broome, and J.C. Beatley. 1973. A new *Centaurium* (Gentianaceae) from the Death Valley region of Nevada and California *In*: USFWS. 2009e. Spring-loving centaury (*Centaurium namophium*), Five-Year Review: Summary and Evaluation.

Rowley, P.D. 2003. Geologic Controls ion the Hydrology of the Lower Carson Slough Area, Amargosa Desert, Nye County, Nevada and Inyo County, California. Report prepared for the Bureau of Land Management, Barstow, California. October 2003.

Sada, D.W. and A. Mozejko. 1984. Environmental Assessment: Proposed acquisition to establish Ash Meadows National Wildlife Refuge, Nye County, Nevada. U.S. Department of the Interior, Fish and Wildlife Service, Portland, Oregon.

Smiley, T. L., J. D. Nations, T.L. Pewe, and J.P. Schafer. Eds. 1984. Landscapes of Arizona: The Geological Story. University Press of America, New York.506 pp.

Soltz, D.L. and R.J. Naiman. 1978. The natural history of the native fishes in the Death Valley system. Natural History Museum of Los Angeles County, California, 30:1-77.

Spangenberg, E.K. 1995. Plants Eaten by Juvenile Desert Tortoises in the Central Mojave Desert. Paper presented at the National Biological Service Desert Tortoise Symposium, 1995. Internet site: http://www.tortoise-tracks.org/publications/ksplants.html. Accessed: November 12, 2009.

Stewart, J.H. and E. Carlson. 1977. Million-Scale Geologic Map of Nevada. Nevada Bureau of Mines and Geology: Map 57. Mackay School of Mines, University of Nevada, Reno.

Stitt, E.W. and C. Davis. 2003. *Gopherus agassizii* (Desert Tortoise). Caliche Mining. Herpetological Review. 34 (1): 57.

Stonestrom, D.A., D.E. Prudic, M.A. Walvoord, J.D. Abraham, A.E. Stewart-Deaker, P.A. Glancy, J. Constantz, R.J. Laczniak, and B.J. Andraski. 2007. Focused Ground-Water Recharge in the Amargosa Desert Basin, USGS Professional Paper 1803 – Ground-Water Recharge in the Arid and Semiarid Southwestern United States – Chapter E, p. 107-136.

Stonestrom, D.A., D.E. Prudic, R.J. Laczniak, J.C. Akstin, R.A. Boyd, and K.K. Henkelman. 2003. Estimates of deep percolation beneath native vegetation, irrigated fields, and the Amargosa River channel, Amargosa Desert, Nye County, Nevada: U.S. Geological Survey Open-File Report 03-104, 83 p.

Tierra Data. 2009. Biological Resources Surveys for Amargosa Farm Road Solar Project. Unpublished.

Tracy, C.R. 2001. Recovering the Desert Tortoise with Science and creative management. University of Nevada Biological Resources Research Center Internet site: http://www.brrc.unr.edu/data/ docs/nbisp96/nbitort.html. Accessed: November 12, 2009.

Turner, Frederick B. 1986. Management of the Desert Tortoise in California. *in*: Management of the Desert Tortoise in California: Proceedings of the Symposium; 1985 March 3-5; Malibu, California. In: Herpetologica. 42 (1): 57-58.

United States Department of Agriculture, Natural Resources Conservation Service (USDA, NRCS). 2009a. Custom soil resource report for Nye County, Nevada, Southwest Part.

ASPP Soil Survey Report. Accessed on September 25, 2009. Available at: http://soils.usda.gov.

_____. 2009b. Soil Classification. Accessed on December 5, 2009. Available at: http://soils.usda.gov/technical/classification.

USFWS. 2009a. Devils Hole Pupfish. Internet website: http://www.fws.gov/desertcomplex/pupfish/devilshole.htm. Accessed on: November 12, 2009.

_____. 2009b. Desert National Wildlife Refuge Complex: Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges: Final Comprehensive Conservation Plan and Environmental Impact Statement: Clark, Lincoln, and Nye Counties, Nevada. USFWS, Pacific Southwest Region, Sacramento, California. 401 pp. +appendices. Available online at: http://www.fws.gov/ desertcomplex/ccp.htm.

_____. 2009c. Shapefiles provided by Ash Meadows National Wildlife Refuge for Rare Plants, Ash Meadows Naucorid, Ash Meadows Amargosa Pupfish, Warm Springs Pupfish, and Ash Meadows Speckled Dace.

_____. 2009d. Ash Meadows milkvetch (*Astragalus phoenix*), Five-Year Review: Summary and Evaluation.

_____. 2009e. Spring-loving centaury (*Centaurium namophium*), Five-Year Review: Summary and Evaluation.

_____. 2008. Draft revised recovery plan for the Mojave Population of the desert tortoise (*Gopherus agassizii*). USFWS, California and Nevada Region, Sacramento, California. 209 pp.

_____. 2007a. Amargosa Niterwort (*Nitrophila mohavensis*) Five Year Review: Summary and Evaluation. 26 pp.

_____. 2007b. Ash Meadows gumplant (*Grindelia fraxino-pratensis*) Five Year Review: Summary and Evaluation. 20 pp.

_____. 2006a. Range-wide Monitoring of the Mojave Population of the Desert Tortoise: 2001-2005 Summary Report. Report by the Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service, Reno, Nevada.

_____. 2006b. Integrated Pest Management Plan for Ash Meadows National Wildlife Refuge *In*: USFWS. December 2007b. Ash Meadows gumplant (*Grindelia fraxino-pratensis*) Five Year Review: Summary and Evaluation. 20 pp.

_____. 2006c. Integrated Pest Management Plan for Ash Meadows National Wildlife Refuge *In*: USFWS. December 2009d. Ash Meadows milkvetch (*Astraglaus phoenix*) Five Year Review: Summary and Evaluation. 20 pp.

_____. 2006d. Integrated Pest Management Plan for Ash Meadows National Wildlife Refuge *In*: USFWS. December 2009e. Spring-loving centaury (*Centaurium namophilum*) Five Year Review: Summary and Evaluation. 32 pp.

_____. 1994. Desert tortoise (Mojave Population) recovery plan. USFWS, Portland, Oregon. 73 pp. + appendices.

_____. 1990. Recovery plan for the endangered and threatened species of Ash Meadows, Nevada. USFWS, Portland, Oregon. 123 pp.

_____. 1980. Devils Hole Pupfish Recovery Plan. USFWS, Portland, Oregon. 46+ pp.

United States Geological Survey (USGS). 2008. Relative abundance and distribution of fishes and crayfish at Ash Meadows, Nye County, Nevada: Annual Report – Draft 2008. Western Fisheries Research Center, Reno Field Station, Reno, Nevada.

_____. 2006. Ground-Water Modeling of the Death Valley Region, Nevada and California. USGS Fact Sheet 2006-3120.

_____. 2005. Selected Ground-Water Data for Yucca Mountain Region, Southern Nevada and Eastern California, January-December 2003 *In*: USFWS. 2007b. Ash Meadows gumplant (*Grindelia fraxino-pratensis*) Five Year Review: Summary and Evaluation. 20 pp.

_____. 2002. Trend analysis of groundwater levels and spring discharge in the Yucca Mountain Region, Nevada and California. 1960-2000. Water Resources Investigations Report 02-4178.

_____. 2001. Flooding in the Amargosa River Drainage Basin, February 23-24, 1998, Southern Nevada and Eastern California, including the Nevada Test Site. USGS Fact Sheet 036-01.

_____. 1995. Overview of runoff of March 11, 1995, in Fortymile Wash and Amargosa River, Southern Nevada. USGS Fact Sheet FS-210-95.

_____. 1981. Hydrologic Unit Map- State of Nevada. 1:500,000 scale map. Prepared in cooperation with the U.S. Water Resources Council, Reston, Virginia.

Van Devender, T.R., R.C. Averill-Murray, T.C. Esque, P.A. Holm, V.M. Dickinson, C.R. Schwalbe, E.B. Wirt and S.L. Barrett. 2002. Grasses, Mallows, Desert Vine, and More: Diet of the Desert Tortoise in Arizona and Sonora. Pages 160 – 193 *in* The Sonoran Desert Tortoise: Natural History, Biology, and Conservation, T.R. Van Devender, ed. University of Arizona Press, Tucson.

Weissenfluh, D.S., C.R. Baldino, S.D. McKelvey, R.J. Andress, G.G. Scoppettone, and B. Hobbs. 2009. Aquatic invasive species within Ash Meadows National Wildlife Refuge since 2008: Updates, challenges, and goals. Presented at the 2009 Annual Symposium of the Desert Fishes Council, Death Valley, CA.

Wilson, K., M. Bower, and D.B. Gaines. 2009. Conceptual influence model guides research, monitoring, and management of the Devils Hole pupfish *Cyprinodon diabolis*. Presented at the 2009 Annual Symposium of the Desert Fishes Council, Death Valley, CA.

Appendix A

Groundwater Modeling Report

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Groundwater Modeling Services to Support the Amargosa Road Solar Power Project EIS Technical Memorandum

by
GeoTrans, Inc.

Introduction

The purpose of this report is to document the results of modeling simulations performed to evaluate the potential hydraulic effects of pumping 400 afy on nearby water resources, such as Devils Hole which is the only naturally occurring habitat for the Devils Hole Pupfish and discharge at Ash Meadows, for the EIS. Figure 1 shows the location of the Project area. Modeling was performed using the Death Valley Regional Flow System (DVRFS) Model (Belcher, 2004). The DVRFS model is the only existing model of the study area. This model was calibrated to both pre-pumping and pumping conditions. The Amargosa Basin is one of the areas covered by the model in which there has been significant pumping, and water-level changes measured in the area were used to guide calibration of the model. As with any model, improvements can always be made, and the predictive results should be evaluated accordingly.

Model Background

This model was developed by the U.S. Geological Survey (USGS) over a period of approximately eight years. The effort was funded primarily by the Department of Energy (DOE) through programs at the Nevada Test Site and at Yucca Mountain, with support and review by other Federal Agencies, including the National Park Service. The present model was developed in two phases. The first phase was the development of a three-dimensional flow model to simulate pre-development (steady-state) conditions, using geologic models developed separately by a contractor for the Underground Testing Area (UGTA) Project and by the USGS for the Yucca Mountain Project. The second phase of the DVRFS model development involved construction of a new geologic model, and development and calibration of the resulting new flow model to both pre-development and post-development conditions. The model produced from the second phase has commonly been called the "transient" model. GeoTrans was instrumental in the development of the UGTA model, and represented the UGTA Project during the development of the DVRFS model by the USGS. GeoTrans worked closely with the USGS, reviewing many of the products and modeling datasets, but did not perform any of the actual development effort.

In the following discussion, the term "model" will generally apply to the three-dimensional USGS DVRFS transient flow model.

Documentation of the model (DVRFS report) is available online (http://pubs.usgs.gov/sir/2004/5205/). In addition to the report itself, there are many supporting documents on geologic and hydrologic investigations performed to support

development of the model. Hydrologic investigations relevant to the Amargosa Desert include measurements of evapotranspiration (ET) at Ash Meadows, in Death Valley, and in Oasis Valley; estimation of ET at Franklin Lake playa and near Franklin Well (Amargosa River); construction of a dataset for pumping in the Amargosa Desert (and other areas); and measurement of groundwater recharge underneath the Amargosa River and irrigated fields in the Amargosa Farms area.

The model is developed using MODFLOW-2000, using a grid with a lateral spacing of 1,500 meters, and a variable vertical spacing. There are 16 model layers, with an interpretation of the water table used as a reference surface from which to base the elevation of the upper model layer. A large number of layers is needed to capture the geologic complexity incorporated into the geologic framework model, which is itself a simplification and interpretation of the actual geology. The model assumes that all layers are fully saturated, and that dewatering does not occur. Thus, transmissivities do not become smaller with drawdown, and the model is approximately mathematically linear. Because the Drain package is used to simulate springs, the model would not be strictly linear if drawdown is sufficient to cause water levels in a cell to decrease below the specified elevation of a drain. In addition, if drawdown is sufficient to cause appreciable decreases in the saturated thickness of the aquifer being pumped, the model will tend to underestimate the drawdown and overestimate the productivity of the aquifer.

The model was calibrated using a non-linear regression technique which optimizes modeling parameters to minimize the objective function, which was the sum of squared weighted residuals. A residual is defined as the difference between the observed (or estimated) value for a calibration target, and the corresponding simulated value. Hydraulic heads, water-level changes, discharge rates in spring areas, and lateral boundary fluxes were used as calibration targets. As the objective function represents the entire model, rather than concentrating on the Amargosa Farms and Ash Meadows areas, the agreement of simulated water-level change and measured change at Devils Hole is reasonable, but could be improved with additional work.

Following publication of the DVRFS report, a minor error was detected in the geologic model in the Oasis Valley area. The simulations reported here were performed with the updated model, which was downloaded from the above web site. Also, the modeling pumping and return flow datasets were updated in 2003 to include updated estimates of groundwater withdrawal and return flow from irrigation (Moreo and Justet, 2008). This updated dataset was also used in the simulations reported here.

Model Limitations

As stated earlier, the DVRFS model is the only existing groundwater flow model of the study area. Before evaluating predictions of drawdown at Devils Hole or change in discharge at Ash Meadows using the DVRFS model, the reader needs to be aware of the limitations of using a regional-scale groundwater model to evaluate potential water resource impacts at springs or other sites (e.g., Devils Hole) that are local in scale (feet). These limitations include 1) model grid size (1,500 m x 1,500 m), 2) calibration to

regional groundwater flow conditions, 3) estimates in historic pumping dataset and 4) simplification of geology. The DVRFS model report (p. 350) states "the use of the (DVRFS) model to address regional-scale issues or questions is the most appropriate use of the model." All the model results presented here are not accurate to the feet scale, but several meters. The DVRFS model gives you a qualitative sense of how water levels change over time at a given location, not quantitative.

Before conducting predictive modeling simulations, it is important to compare calculations of water-level change at Devils Hole with measured changes. Figure 2 shows the comparison through 2003, the end of the updated pumping and return flow dataset. Provisional water-level data after 1989 was received from National Park Service (NPS, 2006). Several features should be noted:

1. Both the measurement dataset and the simulated levels show declining water levels prior to the start of significant pumping in the Ash Meadows area. The simulated rate of decline is faster than the observed rate. The model is also slower to respond to changes in pumping rates.
2. The effects of pumping in Ash Meadows are readily apparent in both the measurements and simulated results beginning in approximately 1970, but the simulated change is greater than the measured change.
3. In the original 1998 model, during three periods beginning approximately in 1975, 1987, and 1998, there are simulated declines that do not occur in the measured values. The model values do not recover as much as the measurements following cessation of nearby pumping. In the updated 2003 model, the simulated decline starting around 1975 still remains to a lesser degree, but the other two declines have been corrected. We suspect there is still an error in the historical pumping dataset prepared by the USGS for the 1975 period.
4. The effects of seasonal barometric changes, seasonal pumping, and earthquakes are not incorporated in the model.
5. Beginning in 1996, until 2003, the model simulates a decline in water levels.

In summary, the model overpredicts the drawdown caused by historical local pumping by approximately 30%. Because of an apparent error in the pumping dataset, it is not definite whether the model would produce an effect from other, more distant pumping, but the later time results suggest that it would.

Model Simulations and Assumptions

After updating the USGS DVRFS model through 2003 with the revised pumping and return flow dataset, GeoTrans conducted several groundwater modeling scenarios using this updated model. Based on discussions with Project team members the following modeling scenarios were proposed and/or simulated as part of this Project:

1. Run existing DVRFS model an additional 200 years past the transient calibration period with 2003 pumping (i.e., No Action).

2. Same as Scenario 1 except add the proposed action of 400 afy from the existing three wells south of the site from 2010-2039 (i.e., Proposed Action).
3. After transient calibration period, incrementally decline Amargosa Farms pumping to stabilize water levels at Devils Hole.
4. After transient calibration period, turn off injection wells in Amargosa Farms.
5. After transient calibration period, reduce recharge in Amargosa Farms based on Stonestrom et al. 2003 and 2007 findings.

Scenarios 3 through 5 were added to examine the effects of reducing groundwater withdrawal and change in return flow and recharge from the Amargosa Farms area on Devils Hole water levels.

The following assumptions were made during the modeling scenario simulations:

1. No climatic effects – The current recharge dataset was used for the 200 year simulations. The effect of water rights users irrigating more or less due to climate than 2003 amounts was not estimated.
2. The Project groundwater withdrawal of 400 afy was added to the 2003 pumping dataset since the USGS estimate for 2003 was below the duty (1,328 afy) minus the Project pumping (400 afy) for the three wells. It is assumed that existing pumping from the three wells plus the 400 afy from the Project would not exceed the duty of 1,328 afy in the 200 year simulations.
3. Water infiltration from mirror washing was not accounted for because it is unknown what amount would ultimately end up as groundwater recharge.

Model Results

Figure 3 shows the simulated water-level elevation at the end of 2003 based on the revised pumping and return flow datasets. The water level contours indicate that the potentiometric surface of the valley fill indicate a broad and gently sloping gradient from the northeast toward the central axis of the valley and southwest toward the Funeral Mountains.

Figure 4 shows simulated drawdown contours at the end of 2003. This map represents the change in water level from pre-development (1912) to 2003. Within the Amargosa Basin, the most rapid water level declines occurred in the Amargosa Farms area, which is consistent with observed water level changes from other studies (Kilroy, 1991). Devils Hole is approximately 15 miles from the proposed pumping and the simulated drawdown at Devils Hole in 2003 is approximately 1.8 ft.

<u>Scenario 1 Results</u>
For scenario 1 (no action), 2003 pumping and return flow was repeated every year for the next 200 years to determine the change in water levels at Devils Hole. Figure 5 shows change in simulated water-level contours from 2003 to 2203. Drawdown is predicted to be more than 5 feet over a large area. However, the drawdown is predicted to decrease

rapidly in the Ash Meadows discharge area. The drawdown is buffered by the reduction in spring discharge that occurs with declines in water level.

Figure 6 shows that simulated water levels at Devils Hole decline over 13 feet after 200 years due to existing pumping. Note "time zero" is assumed to be the simulated water-level elevation on December 31, 2003 from the model, not pre-development conditions.

Scenario 2 Results

For the proposed action, the 400 afy of groundwater withdrawal was divided between the three Project wells. Pumping from these three wells is assumed to start in 2010 and concludes in 2039 since the Project life is 30 years. Table 1 shows the proportion of pumping between the three wells. All wells were pumped from Layer 1 in the model since Layer 1 was thicker than the depth of any of the three wells.

Table 1. Proposed Groundwater Withdrawal from Project Wells

App. No.	Easting (m)	Northing (m)	Duty (afy)	Proposed w/d (afy)	Model Row	Model Column	Model Layer
15702	542358.48	4045750.11	175	53	116	71	1
15893	542362.42	4044948.68	603	183	116	71	1
43873	542762.50	4044550.36	545.38	164	117	71	1

Figure 7 shows the simulated water-level decline from the existing pumping and the Project pumping from 2003 to 2203. An additional 400 afy of pumping reduces simulated water levels at Devils Hole by less than 0.05 ft or 0.6 in after 200 years. Recall this reduction in water levels is approximately 30% higher due to the model overpredicting water level declines at Devils Hole historically (See Figure 2). Also, the DVRFS model calibration is not accurate to 0.05 ft but meters and is not designed to exactly measure drawdown at a spring location several miles away, such as Devils Hole because of its 1) grid size (1,500 m x 1,500 m), 2) calibration to regional groundwater conditions, 3) estimates in historic pumping dataset and 4) simplification of geology. Thus, the regional model has a limited capability to accurately evaluate incremental changes in pumping tens of miles away on Devils Hole, but it is the only groundwater flow model available.

Recently, groundwater withdrawal from the three Project wells (e.g., from 2005 to 2007) has been reported as 1,328 afy, the full duty. The Project withdrawal of 400 afy should result in a minimal effect on Devils Hole water levels in addition to the existing pumping in the basin. The water rights owners will use 928 afy for agriculture and 400 afy will be used for the Project. There will be a small difference between the shift from an agricultural to industrial beneficial use; however, it is impossible to quantify how much recharge will be derived from mirror washing. Studies have been performed on irrigation return flow adjacent to the property (Stonestrom et al. 2003 and 2007), but give a range of values for recharge from two different methods: 1) 0.1 to 0.5 m/yr (4 to 20 in/yr) from

vertical profiles of water potential and environmental tracers and 2) 9-22% of infiltrated irrigation from chloride mass-balance estimates. The reason the model does not show zero water-level change at Devils Hole due to Project pumping is due to the USGS estimate for 2003 groundwater withdrawal from the three wells being lower than 928 afy.

Scenario 3 Results

Figure 8 shows the effect on simulated water-level change at Devils Hole of incrementally (i.e., 10%) reducing groundwater withdrawal within the Amargosa Basin. In order to stabilize water levels at Devils Hole, pumping in the basin would have to be reduced between 80 and 90% from 2003 levels. Thus, pumping an additional 400 afy would have a negligible effect on the stabilization and/or recovery of water-level changes at Devils Hole. Even if all pumping in Amargosa Basin ceased after 2003, recovery of water levels at Devils Hole would not start occurring for approximately 37 years and take longer than 88 years to fully recover.

Scenario 4 and 5 Results

Figure 9 shows the effect of turning off return flow to the valley-fill deposits from irrigation in the model. Simulated water-level change at Devils Hole would increase approximately an additional 2.3 feet or 18% due to shutting off return flow. Scenario 5, which is reducing recharge to the valley-fill deposits based on the 2003 and 2007 Stonestrom et al. (Stonestrom) studies, was not simulated because the result would fall between the two curves on Figure 9. As discussed earlier, Stonestrom measured the amount of infiltration beneath an irrigated field adjacent to the Project site. The amount of infiltration was measured between 0.1 and 0.5 m/yr. Changing the recharge in the model to any amount in this range would produce a water-level change curve that would fall between the two curves on Figure 9.

Ash Meadows Discharge

Discharge occurs at Ash Meadows because of the presence of the water-bearing carbonate aquifer exposed in the low-lying hills northeast of the discharge area, and the presence of an impediment to flow that causes water levels to be elevated to the land surface. Dudley and Larson (1976) indicate that groundwater flows southwestward toward Ash Meadows in the carbonate aquifer under confined conditions. Water is forced upward "along faults that segment the hills east of Ash Meadows. This produces a mound of unconfined water which discharges laterally into shallower local aquifers."

The USGS code ZONEBUDGET was used to evaluate the changes in water movement for the Amargosa Basin including discharge at Ash Meadows. Under the present-day pumping rates, the model predicts that only minor changes to the discharge rate at Ash Meadows would have occurred by 2003, the end of the model calibration period (Figure 10). When the present-day pumping is continued into the future, the model predicts that impacts to the discharge will occur. In 2203, the discharge is predicted to be reduced from approximately 18,095 acre feet per year (afy) to 15,607 afy. When the Project

pumping is added, the discharge rate in 2203 is predicted to be reduced to only 15,600 afy or a negligible difference of 7 afy or 0.05%.

Results of other hydrologic studies

It would be reasonable to ask whether the historical water-level changes calculated by the model are consistent with the conclusions of other investigators. Two recent investigations evaluated Devils Hole water levels and concluded that pumping, rather than climatic changes, was the cause of historic declines in water levels. The first (Fenelon and Moreo, 2002) evaluated water level changes in wells over a large area that included the Amargosa Desert and Ash Meadows. They considered pumping, changes in recharge rates, earthquakes, and barometric pressure changes as factors that would cause water levels to change. Figure 17 of their report shows the correlation between pumping in the Amargosa Farms area and downward water-level trends over the period of 1992 to 2000 in the Amargosa Farms area. In the Devils Hole area, they consider whether pumping in the Amargosa Farms area could impact Devils Hole water levels, but do not conclude that it has. They also conclude that pumping from well Army 1 near Mercury, NV (see Figure 1) has not impacted Devils Hole water levels based on the lack of response to a reduction in production from Army 1 that began in 1994. They also note that Devils Hole may still be recovering from the pumping in Ash Meadows. The slow recovery to local pumping would suggest that responses to reduction of pumping much further away would be difficult to measure, especially with other stresses changing.

Bedinger and Harrill (2006) evaluated changes in Devils Hole water levels using a regression procedure. They constructed simple Theis models of drawdown caused by pumping at Ash Meadows, the Amargosa Farm area, and Army 1. Temporal changes in pumping rates at these three areas were calculated through superposition. A regression procedure, with water level at Devils Hole as the dependent variable, was used to calculate the relative effects of pumping in these three areas. They determined in a preliminary analysis that consideration of climate variability explained very little of the variability in Devils Hole water levels. The Theis solutions were calculated using hydrologic parameters that might be considered appropriate for the aquifers, but they could not successfully determine these values during “model calibration” because of parameter correlations. They determined that the pumping at Ash Meadows, the Amargosa Desert (Amargosa Farms area) and Army 1 explained 98% of the variability in the annual mean water levels over the period 1962 through 2002. Based on the figures in their report, and the regression parameters, the drawdown in 2002 caused by Ash Meadows pumping was approximately 0.25 feet (and decreasing because of the almost complete cessation of this pumping in 1978), by Amargosa Desert pumping was approximately 0.5 feet (and increasing), and by Army 1 pumping was approximately 0.2 feet (and decreasing because of decreases in pumping rates beginning in 1995).

Summary

1. Comparison of simulated and observed changes in water levels at Devils Hole through 2003 indicated that the DVRFS model overestimated the change in water

level caused by pumping in Amargosa Basin. There may be an error in the historical pumping dataset that affects this comparison. Although the model could be improved by additional work specifically in the Amargosa Desert and Ash Meadows areas, the pumping estimates developed for the model are reasonable.

2. The simulations predict that the three Project wells will cause water levels in Devils Hole to decline less than 0.05 ft after 200 years. When considering these predictions, it is important to recognize that the model overpredicted the decline in water levels caused by pumping in the Amargosa Basin and is not accurate to 0.05 ft but meters due to its original objective of modeling groundwater flow at a regional scale.
3. The model predicts that the Project pumping will reduce the discharge rate from springs at Ash Meadows a negligible amount of 7 afy or 0.05%.
4. Groundwater pumping in the Amargosa Farms area has caused tens of feet of drawdown near the pumping wells. Simple modeling using the Theis equation and superposition, coupled with regression procedures, indicates that the pumping in the Amargosa Farm area is the primary cause of the present-day drawdown at Devils Hole.

Abbreviations or Acronyms

afy – acre-feet per year
DOE – Department of Energy
DVRFS – Death Valley Regional Flow System
ET – evapotranspiration
ft – feet
in – inches
m – meters
UGTA – Underground Testing Area
USGS – United States Geological Survey
yr – year

References

Belcher, W.R., ed., 2004, Death Valley regional ground-water flow system, Nevada and California—Hydrogeologic framework and transient ground-water flow model: U.S. Geological Survey Scientific Investigations Report 2004-5205, 408 p.

Bedinger, M.S., and Harrill, J.R., 2006, Analytical-regression stage analysis for Devils Hole, Death Valley National Park, Nevada, J. of American Water Resources Association, Vol. 42, No. 4, p. 827-839.

Dudley, W.W., Jr., and Larson, J.D., 1976, Effect of irrigation pumping on desert pupfish habitats in Ash Meadows, Nye County, Nevada: U.S. Geological Survey Professional Paper 927, 52 p.

Fenelon, J.M. and Moreo, M.T., 2002, Trend analysis of ground-water levels and spring discharge in the Yucca Mountain region, Nevada and California, 1960-2000, U.S. Geological Survey Water-Resources Investigations Report 02-4178, 94 p. http://pubs.er.usgs.gov/usgspubs/wri/wri024178

Kilroy, K.C. 1991. Ground-Water Conditions in Amargosa Desert, Nevada-California, 1952-1987. U.S. Geological Survey Water Resources Investigations Report 89-4101

Moreo, M.T., and Justet, J., 2008, Update to the ground-water withdrawals database for the Death Valley regional ground-water flow system, Nevada and California, 1913–2003: U.S. Geological Survey Data Series 340, 10 p.

NPS (National Park Service), 2006, Personal Communication with Jennifer Back.

Stonestrom, D.A., Prudic, D.E., Laczniak, R.J., Akstin, K.C., Boyd, R.A., and Henkelman, K.K., 2003, Estimates of deep percolation beneath irrigated fields, native vegetation, and the Amargosa River channel, Amargosa Desert, Nye County, Nevada: U.S. Geological Survey Open-File Report 03–104, 83 p.

Stonestrom, D.A., Prudic, D.E., Walvoord, M.A., Abraham, J.D., Stewart-Deaker, A.E., Glancy, P.A., Constantz, J., Laczniak, R.J., and Andraski, B.J., 2007, Focused Ground-Water Recharge in the Amargosa Desert Basin, USGS Professional Paper 1703—Ground-Water Recharge in the Arid and Semiarid Southwestern United States—Chapter E, p. 107-136.

Addendum to Groundwater Modeling Services to Support the Amargosa Road Solar Power Project EIS Technical Memorandum

by
GeoTrans, Inc.

An additional modeling scenario (Scenario 6) was performed using the updated 2003 DVRFS groundwater flow model to simulate the change in water levels at Devils Hole. Scenario 6 is identical to Scenario 2 except the 400 afy of groundwater withdrawal for the Project will be extracted from one well (Application No. 15893) instead of three wells. This well (Application No. 15893) is located northwest of one of the Project wells (Application No. 43873) and in the adjacent model grid cell to the north (see Figure 3); thus; Project groundwater withdrawal has been shifted farther away from Devils Hole. As shown in Table 1, the full duty for this well is 603 afy. Thus, the proposed groundwater withdrawal of 400 afy is less than the full duty for this well. It should be noted that the other Project well (Application No. 15702), which is located farther away from Devils Hole than the other two Project wells cannot be used to pump 400 afy since its duty is only 175 afy (see Table 1).

Model results for Scenario 6 show the water level at Devils Hole increases between 0.0003 and 0.0007 ft from 2010 (Project start date) to 2203 (end of 200 year simulation) when compared to Scenario 2 (three Project wells). One would expect an increase in water level at Devils Hole due to Project groundwater withdrawal being moved farther away from Devils Hole, but the actual quantity is uncertain due to the limitations and assumptions of the model. Also, simulated discharge at Ash Meadows did not change when simulating pumping from one Project well versus three Project wells.

In summary, even though the simulated water level at Devils Hole increases due to pumping from one Project well versus three project wells, the simulated water level decline at Devils Hole after 200 years is still less than 0.05 of a foot, and discharge at Ash Meadows still declines 7 afy over the same 200-year period as stated in the EIS.

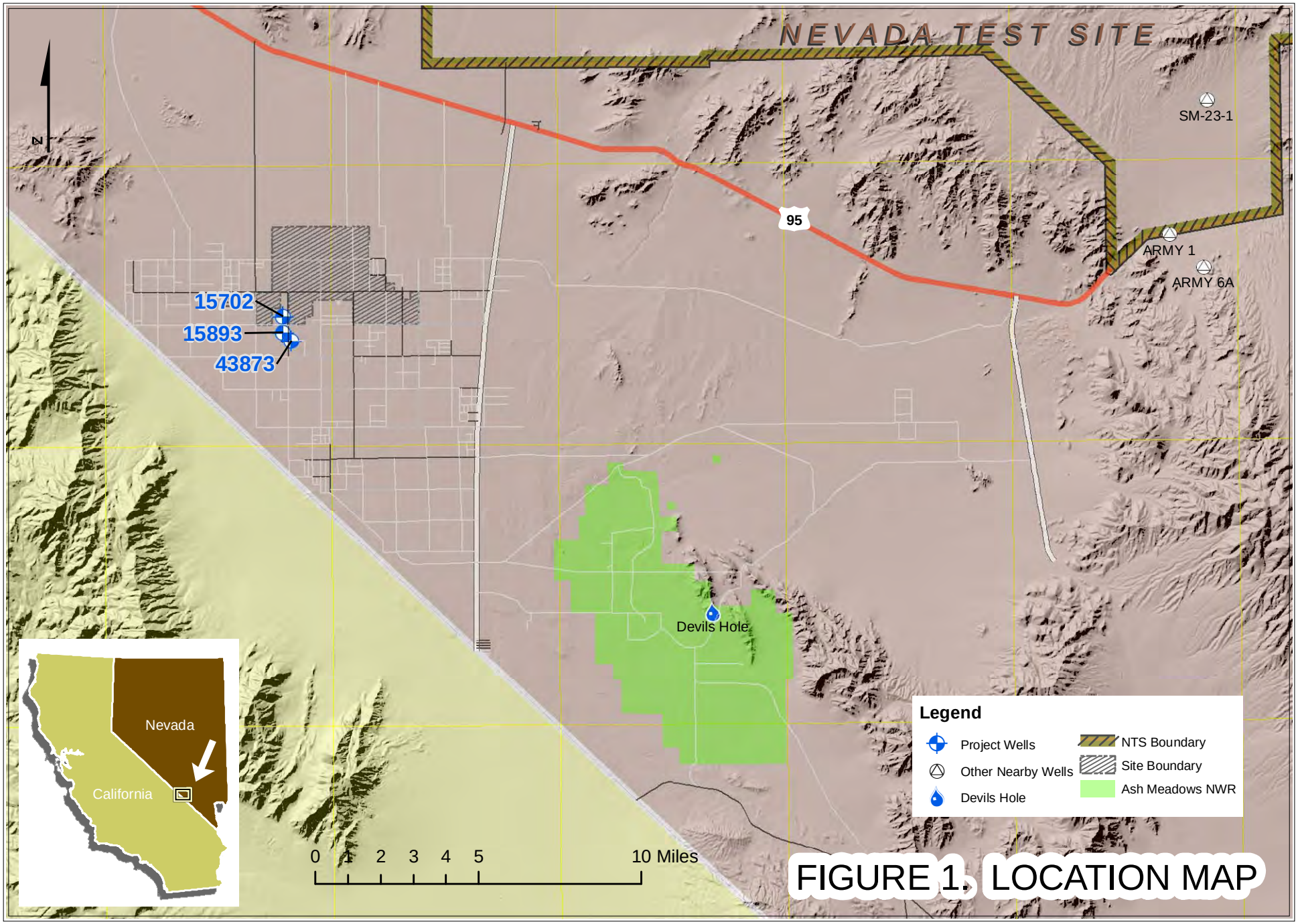
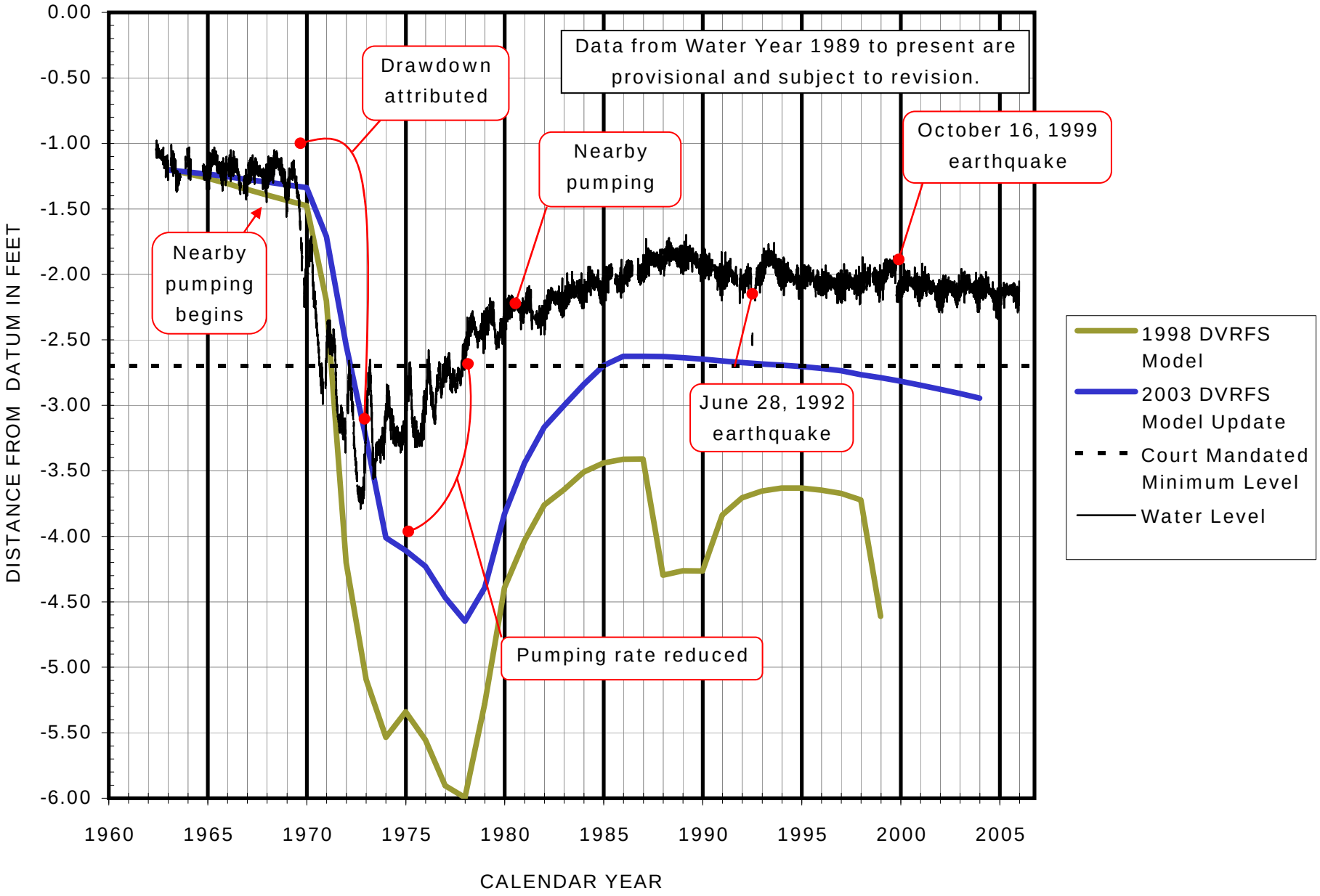


FIGURE 1. LOCATION MAP

Figure 2. Level of Pool in Devil's Hole
Daily Mean (5/23/1962-12/31/2005)



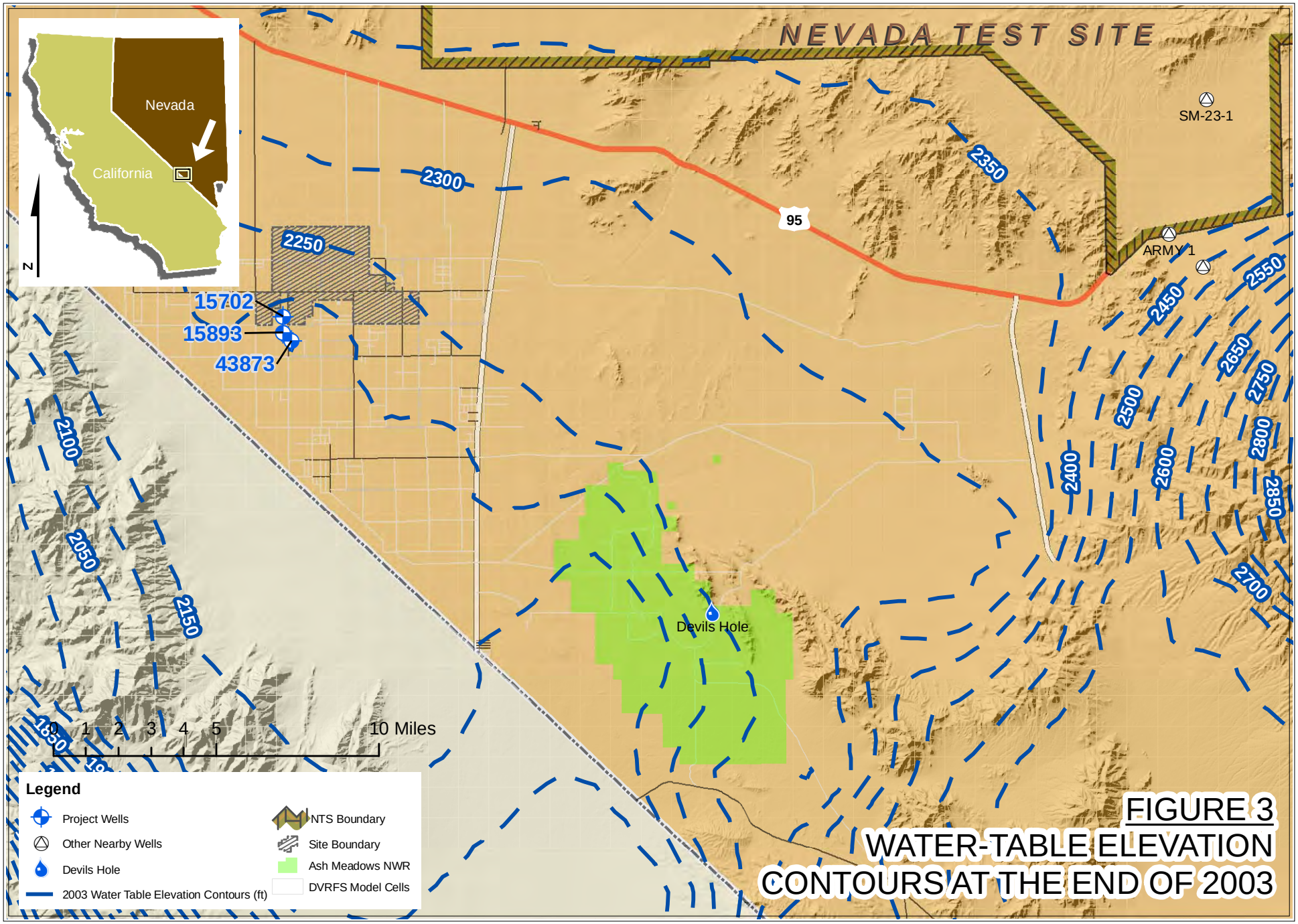


FIGURE 3
WATER-TABLE ELEVATION CONTOURS AT THE END OF 2003

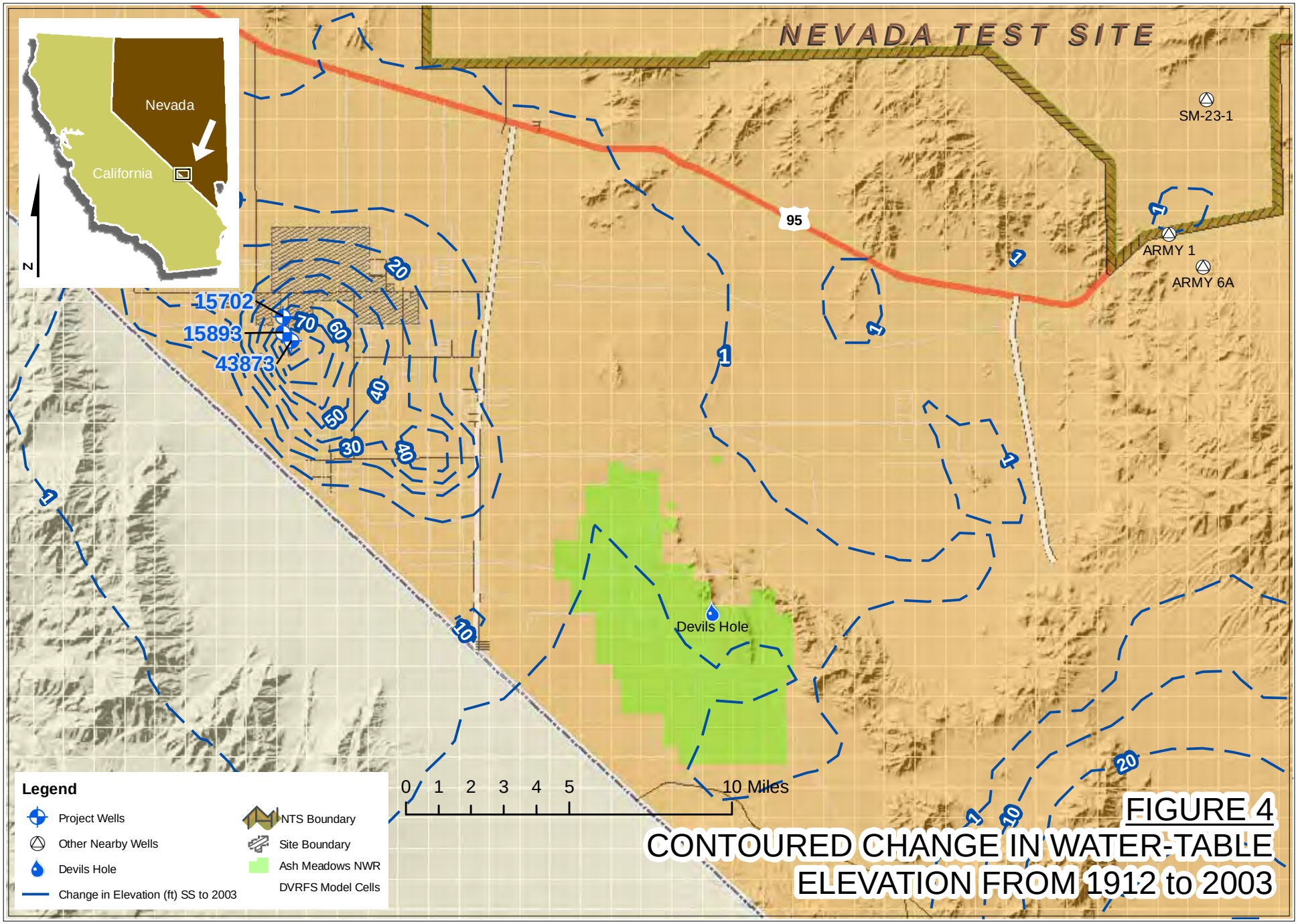


FIGURE 4
CONTOURED CHANGE IN WATER-TABLE ELEVATION FROM 1912 to 2003

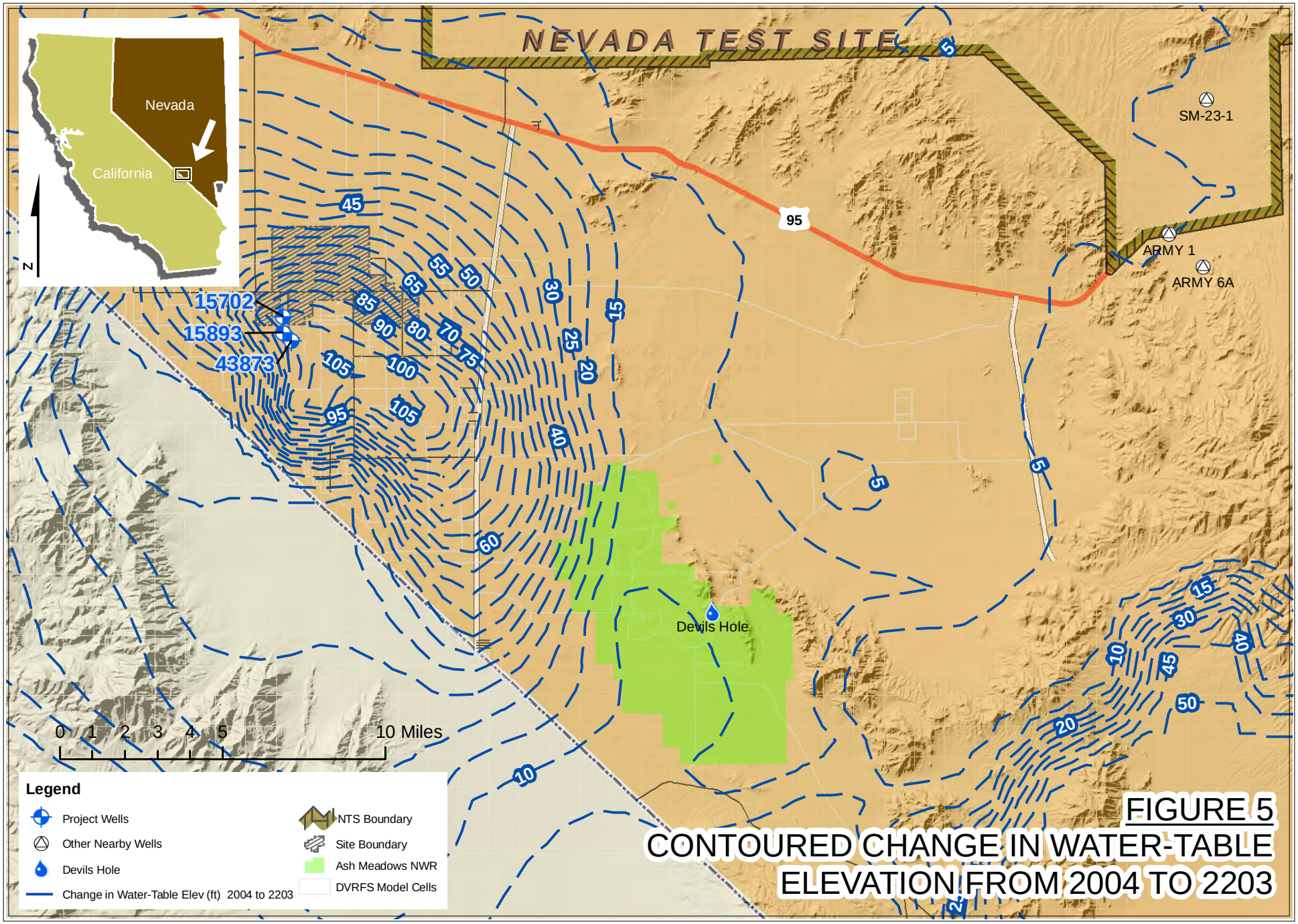


FIGURE 5
CONTOURED CHANGE IN WATER-TABLE ELEVATION FROM 2004 TO 2203

Figure 6. Change in Water-Level Elevation at Devil's Hole from 2003 to 2203

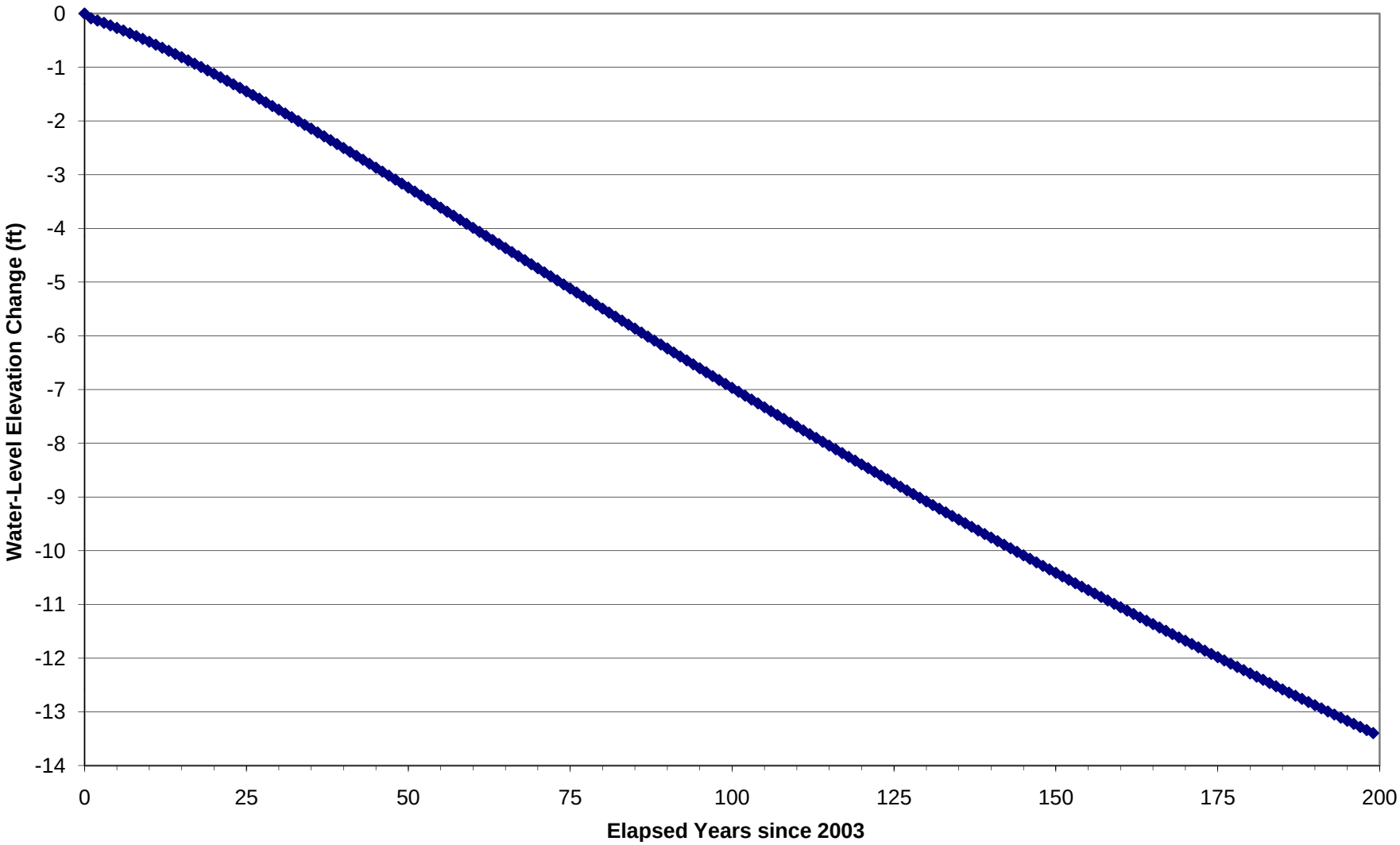


Figure 7. Change in Water-Level Elevation at Devil's Hole from Proposed Action Pumping from 2003 to 2203

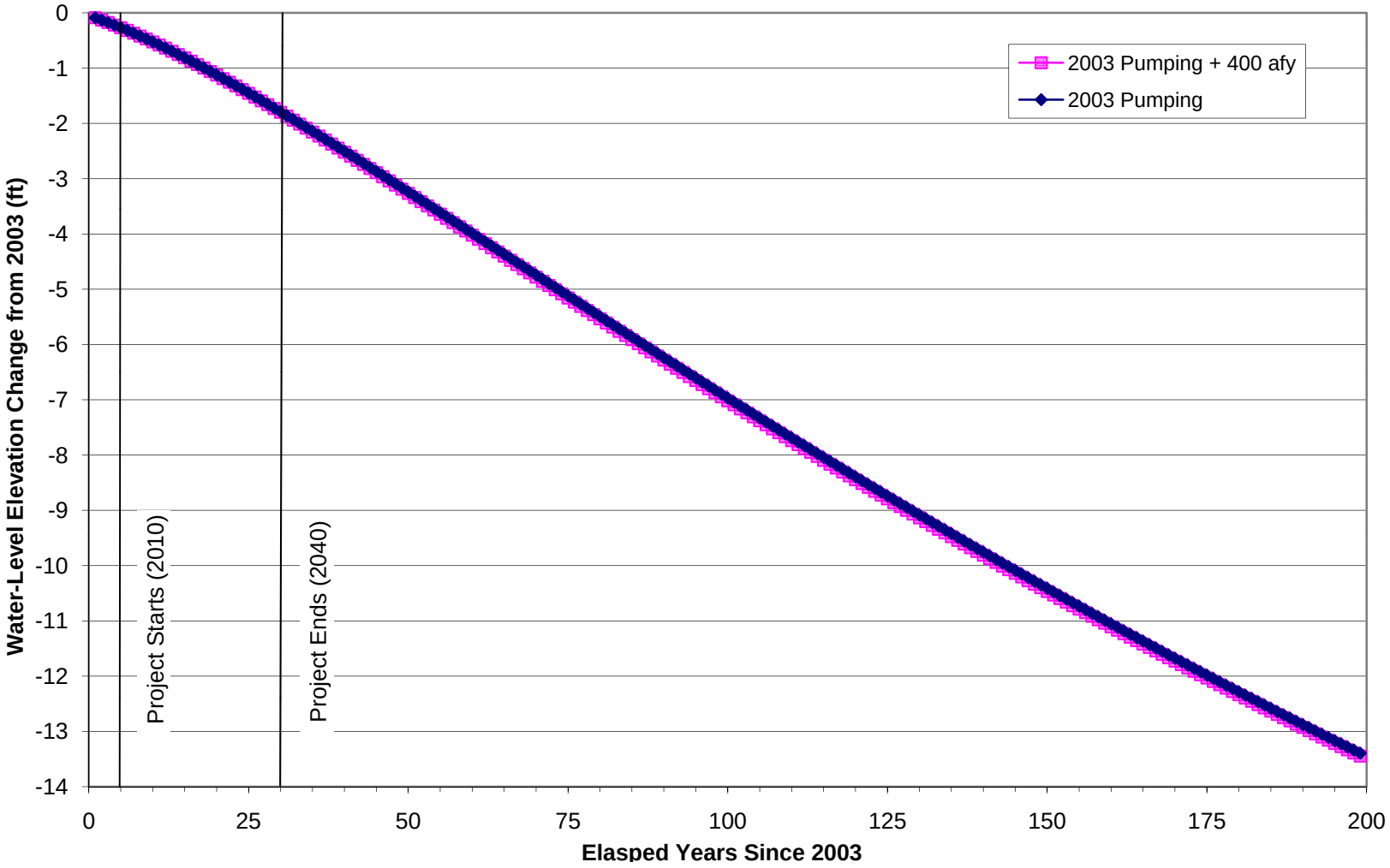


Figure 8. Effect of Reduced Amargosa Basin Pumping on Devil's Hole Water Levels from 2003 to 2203

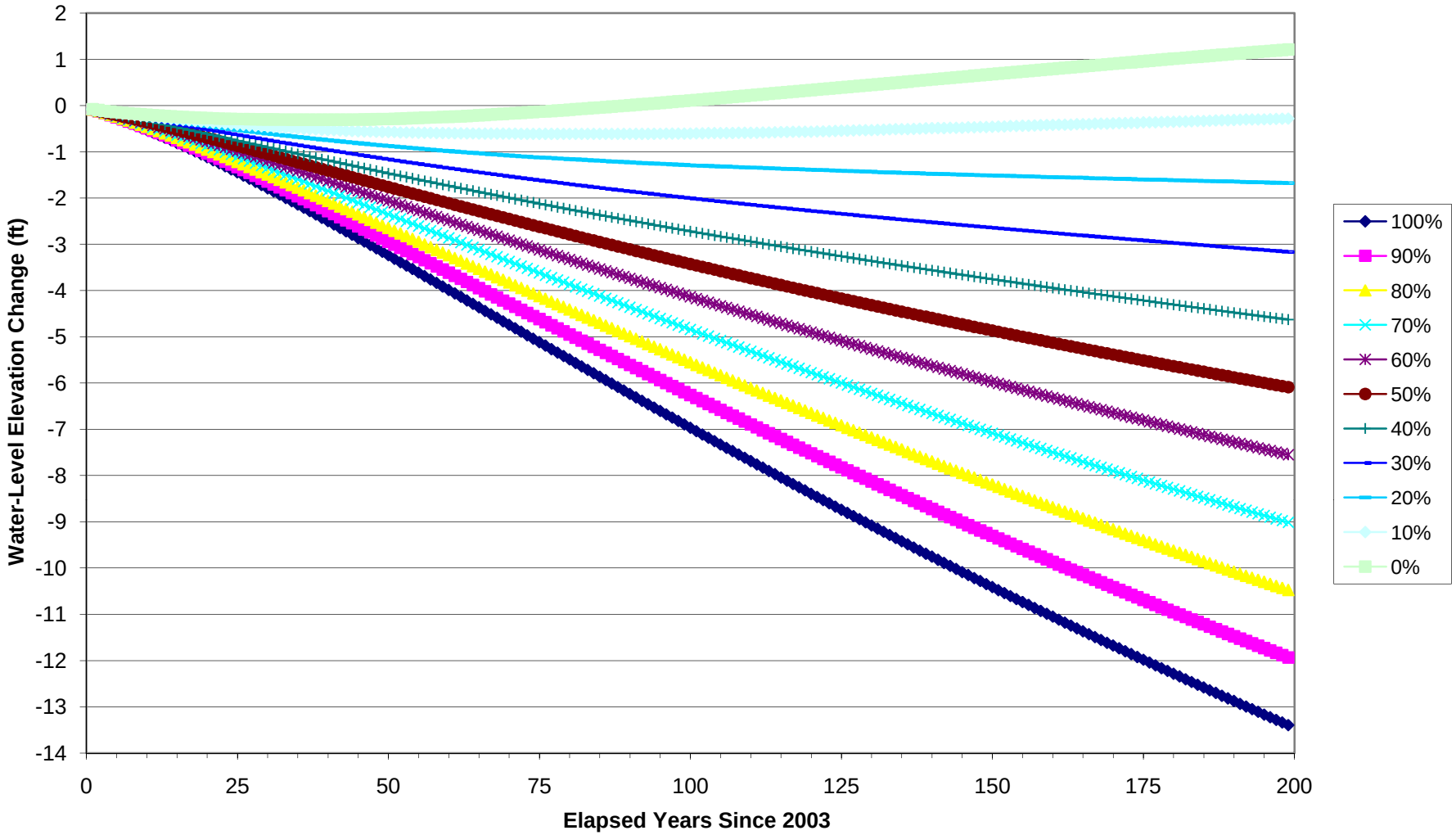


Figure 9. Effect of No Return Flow in Amargosa Basin from 2003 to 2203

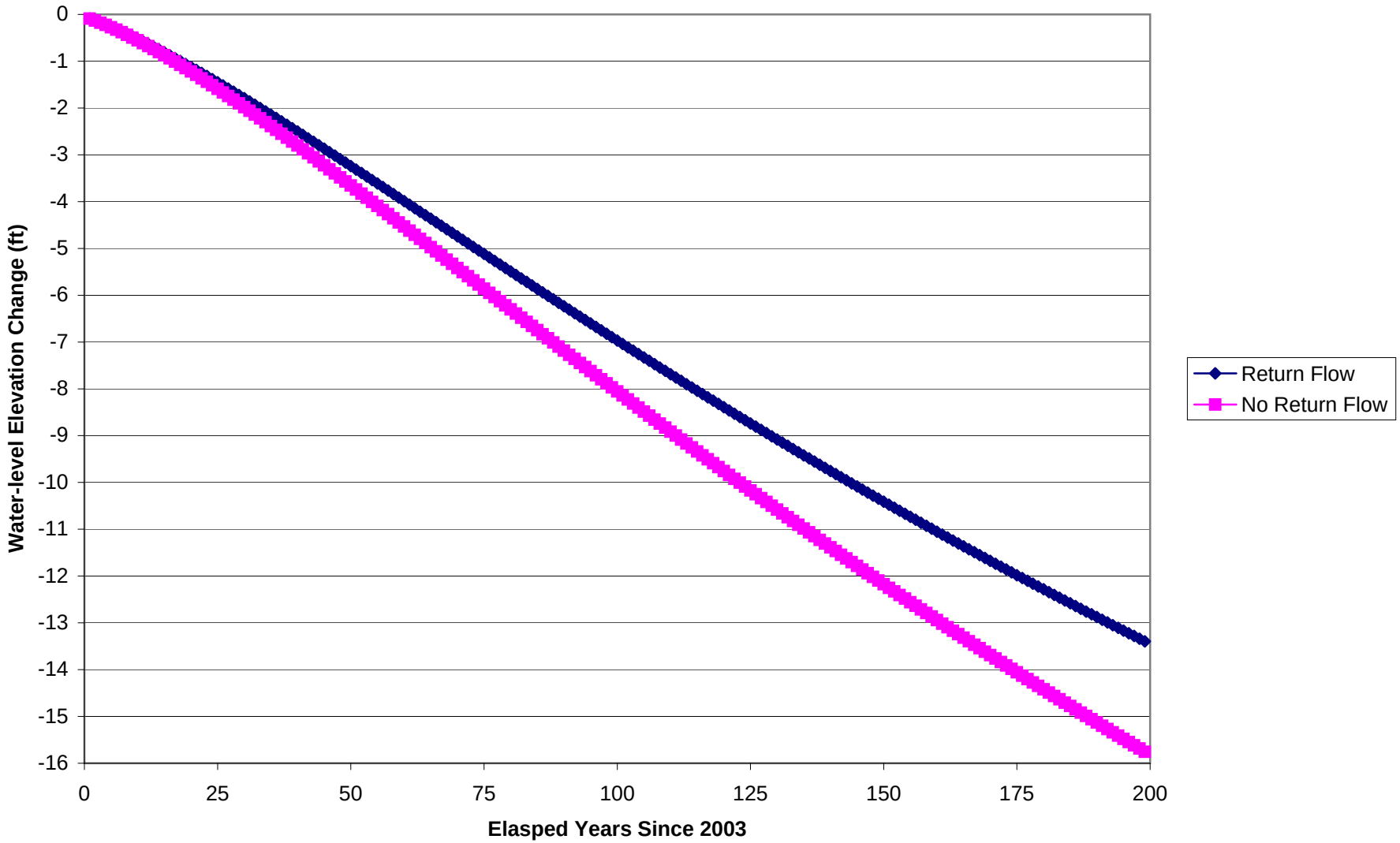
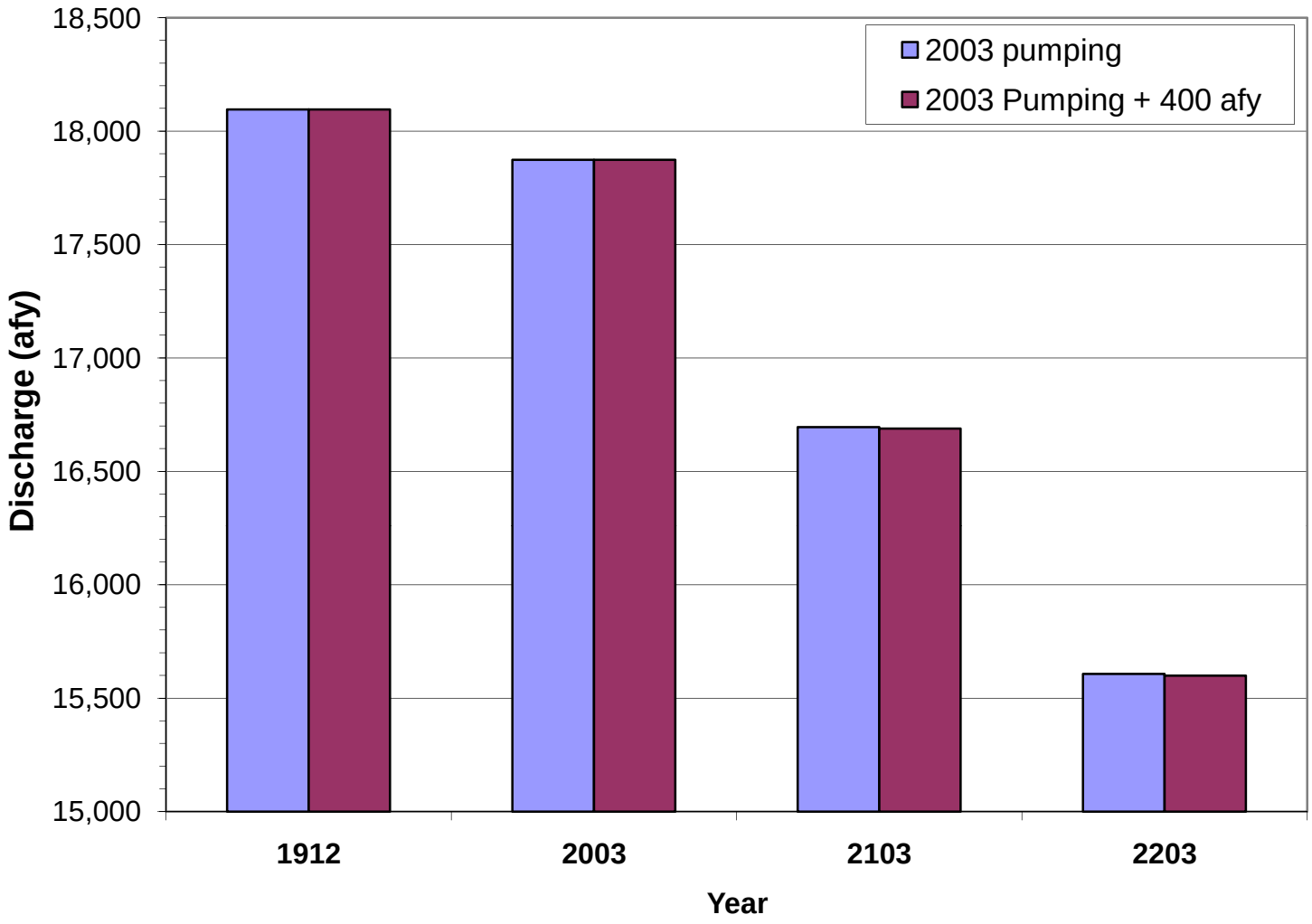



Figure 10. Comparison of the simulated effects of 2003 pumping, and 2003 pumping plus project pumping, on the discharge at Ash Meadows