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May 17, 2012

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Mike Monasmith
Senior Project Manager
Systems Assessment & Facility Siting Division
California Energy Commission
1516 Ninth Street, MS-15
Sacramento, CA 95814

Subject: Data Response, Set 1D-7
Hidden Hills Solar Electric Generating System (11-AFC-2)

Dear Mr. Monasmith:

On behalf of Hidden Hills Solar I, LLC; and Hidden Hills Solar II, LLC, please find attached an electronic copy of Data Response Set 1D-7.

Please call me if you have any questions.

Sincerely,
CH2M HILL

John L. Carrier, J.D.
Program Manager

Encl.

c: POS List
Project file

Data Response Set 1D-7

Hidden Hills

Solar Electric Generating System

(11-AFC-2)

Application for Certification

Hidden Hills Solar I, LLC; and Hidden Hills Solar II, LLC

May 2012

With Technical Assistance from

CH2MHILL®

IS061411043744SAC

Hidden Hills Solar Electric Generating System (HHSEGS)

(11-AFC-2)

Data Response, Set 1D-7
(Response to Data Request 105)

Submitted to the

California Energy Commission

Submitted by

Hidden Hills Solar I, LLC; and Hidden Hills Solar II, LLC

May 17, 2012

With Assistance from

CH2MHILL
2485 Natomas Park Drive
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Attachments

Introduction

Attached is Hidden Hills Solar I, LLC, and Hidden Hills Solar II, LLC (collectively, “Applicant”) response to the California Energy Commission (CEC) Staff’s Data Request 105 for the Hidden Hills Solar Electric Generating System (HHSEGS) Project (11-AFC-2). The CEC Staff served Data Request Set 1D on December 6, 2011. The Attachment submitted in response to this data request is numbered to match the data request.

Cultural Resources (105)

NATURAL AND CULTURAL CONTEXTS

Paleoenvironment

BACKGROUND

The paleoenvironmental context of the potential archaeological landscape that encompasses the ancient mesquite groves, springs, and seeps across portions of the step fault zone is critical to understanding the chronology of the use of this area, the age of related archaeological sites, and the relative importance that this zone may have played in the broader ecological milieu of Pahrump Valley over the last several millennia. Although the *Environmental Setting and Depositional Environment* and *Late Quaternary Environmental Changes* subsections of the AFC Supplement B, *Cultural Resources* section provide very useful contextual information on the historical geomorphology and the paleohydrology of the project site at regional and valley-wide scales, staff needs information more specific to the probable local foci of past Native American activity.

DATA REQUESTS

105. Please develop and submit, for staff review and approval, a research design for the investigation of the paleohydrology, aboriginal water management, paleoecology, and ethnobotany of the portion of the step fault zone that stretches from Mound Spring to Stump Spring. The research design should include collaboration among professionals in the disciplines of Quaternary geology or science, geoarchaeology, economic or ethnobotany, and Great Basin or Southwest archaeology. The research design should, at a minimum, set out contexts, theory, and field methods appropriate to the investigation of the research themes above, and other themes as appropriate to establish the character and relative importance of the step fault zone, through prehistoric and historic times, for the acquisition, preparation, and consumption of multiple, key natural resources. It should facilitate the acquisition of information on the age of the mesquite groves and coppice dunes that encase them, whether the mesquite trees exhibit any physical evidence that would indicate whether and how the groves were actively managed, the antiquity of the use of springs and seeps in the step fault zone and the chronology of their flow rates, whether physical evidence exists that would indicate whether and how flows may have been actively managed in the pursuit of such goals as increasing surface flows or irrigating horticultural plots, and how the predominant vegetation associations along the step fault zone may have changed through time.

Response: In Applicant's December 27, 2011 letter, the Applicant objected to this data request as burdensome and not reasonably necessary for the Commission decision in this proceeding. Without waiving this objection, Applicant provides the following response.

As explained in a previous response to this Data Request filed by Applicant on January 6, 2012, the level of effort requested by CEC staff is unnecessary to adequately characterize the cultural resources potentially affected by HHSEGS. The project footprint is located almost 2 miles from the closest of the areas discussed above. This objection notwithstanding, at the December 17, 2011 workshop, CEC Staff indicated it would be helpful to have a better understanding of the frequency of shallow groundwater-coppice dune systems in the valleys of the northeastern Mojave Desert, and that the knowledge would be helpful in putting the characteristics of the step fault zone in perspective. At a Status Conference on January 24, 2012, CEC Staff and Applicant were directed by the Committee to meet for the purpose of discussing data requests to which Applicant has objected (including DR 105 and 106), to determine how to resolve differences in opinion between Applicant and Staff. Applicant met with Staff immediately following the Status Conference on January 24, 2012, and again, with Staff and the Bureau of Land Management on April 10, 2012. As a result of these meetings, Applicant has agreed to the multi-disciplinary study of the landforms and associated resource values in a limited portion of the Stateline Fault System (SFS) or Step-Fault Zone, immediately adjacent to the proposed HHSEGS development.

A research design has been prepared based on discussions during these meetings and is provided as Attachment DR105-1. A figure identifying the location of cultural and paleontological resources within the SFS (Confidential Figure DR105-5) has been filed under a repeated application for confidential designation.

Attachment DR105-1
Research Design: Landforms and Resource Complexity of an Oasis System in the Northern Mojave Desert

Attachment DR105-1

Research Design: Landforms and Resource Complexity of an Oasis System in the Northern Mojave Desert

Hidden Hills Solar Energy Generating Station (HHSEGS)

(11-AFC-2)

Prepared for

Hidden Hills Solar I, LLC, and Hidden Hills Solar II, LLC

Prepared by

W. Geoffrey Spaulding, M.S., Ph.D.

May 2012

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2485 Village View Drive, Suite 350
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Figures

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Tables

Note-

This is a summary document. In keeping with its narrative nature, references are provided at the end of the text, rather than as citations.

Acronyms, Abbreviations & Glossary

ACC	air-cooled condenser
AFC	Application for Certification
amsl	above mean sea level
BLM	U.S. Bureau of Land Management
bolson	The floor of a closed valley; a topographic basin
B.P.	before present
ca.	circa
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
COC	Condition of Certification
GPS	global positioning system
Hydric	Referring to saturated or thoroughly wet conditions; the opposite of xeric
km	kilometer
kV	kilovolt
lithoid tufa	rock-like calcium carbonate deposit formed by emergent groundwater
LORS	laws, ordinances, regulations, and standards
Mesic	literally "moderate" but connoting "moist" in the desert
MIS	marine oxygen isotope stages
MW	megawatt
MWh	megawatt hours
mya	million years ago
NEPA	National Environmental Protection Act of 1969
OPLMA	Omnibus Public Land Management Act of 2009
B.P.	before present (by convention, 1950)
PFYC	potential fossil yield classification
Project	Hidden Hills SEGS
SFS	Stateline Fault System or Step-Fault Zone
tufa	calcium carbonate formed by emergent groundwater; differing from caliche in that it contains little to no ground mass

U.S.C.	United States Code
Xeric	Referring to very dry conditions
kyr	thousand years

SECTION 1

Introduction

California Energy Commission (CEC) Staff have expressed concern regarding the potential for the Hidden Hills Solar Electric Generating System (HHSEGS or project) to indirectly affect an area that has been variously termed the “step-fault zone” or “Stateline Fault System” (here considered synonymous and abbreviated SFS), which lies to the east of the project in Nye and Clark county, Nevada. Cultural resources staff of the Pahrump Field Office of the Bureau of Land Management (BLM) concur with CEC Staff regarding the need to better understand the cultural, paleontological and biological resources values of the SFS (Figure DR105-1). Consultations with members of the Pahrump Band of the Southern Paiute, as well as preliminary biological, hydrogeological, cultural and paleontological resources assessments all point to the SFS area as a zone where a number of potentially sensitive resources may cluster. Therefore, while not waiving its prior objection to Data Request (DR) 105 and notwithstanding the fact that the SFS and the study area located in Nevada, in a technical meeting between CEC, BLM and Applicant’s cultural resources staff it was agreed that the portion of the SFS proximal to the HHSEGS would be identified for more detailed study. The purpose of this technical memorandum is to identify the limits of that study area, provide a review of the landforms as well as the distributions of certain key resources within that area, and to identify certain investigations moving forward that would better characterize those resources.

The geographical location of the Hidden Hills SEGS and the study area in the northeastern Mojave Desert is shown in Figure DR105-1. The relative position of the study area immediately east of the Hidden Hills SEGS, the California-Nevada boundary, and the Tecopa Road are shown in Figures DR105-2 and -3, along with landforms in the study area that will be discussed in greater detail.

1.1 History and Hydrographic Context

Since the first Europeans crossed the forbidding desert separating the Colorado Plateau from Coastal California, travelers, as well as historians and naturalists, have been aware of valley bottom oases through this country, where perennial discharge from artesian springs offered surcease from the brutal aridity of the Mojave Desert. The springs of Moapa, Las Vegas (Spanish for *the meadows*, referring to the lush, productive wet meadows adjacent to spring orifices), the Pahrump Valley, and Tecopa (Figure DR105-1) were also the site of Southern Paiute villages and were crucial in their subsistence practices and well as serving as a residential focus. Between the valley bottoms and the foot of the surrounding mountains the terrain of the Mojave Desert presents an utterly waterless landscape. Ephemeral washes and other erosional features that speak of torrential, yet infrequent, downpours have little relevance to survival on a daily basis in the Mojave Desert. Reliable perennial water sources such as the valley bottom artesian springs provide a rare source of free water (as opposed to moisture bound in the flesh of animals and plants), critical to the survival of larger animals as well as humans in the region.

The valley-bottom springs of the northern Mojave Desert are considered to be artesian because, at least historically, they were typified by modest to vigorous discharge, indicating appreciable head pressure. This head pressure is a consequence of the confined nature of the aquifer from which the waters arise. The regional Paleozoic carbonate aquifer lies at some depth (normally hundreds of feet) below the surface in most areas, and is a saturated zone hosted largely within permeable

Paleozoic carbonate rocks, which dominate the geology of the region.[1] Precipitation falling on the adjacent high mountains, most notably the Spring Mountains and the Sheep Range (Figure DR105-1) provides recharge through these carbonate rocks to the regional aquifer that is measured in thousands, if not tens of thousands, of acre-feet per year. The minimum elevation of these mountains is approximately 5,000 feet above sea level (asl), while the valley bottoms are on the order of 2,000 to 3,000 feet asl. The amount of recharge, plus the elevational gradient from recharge to discharge in a confined aquifer sealed by hundreds to thousands of feet of alluvium and fanglomerate[2], provides the head pressure at the artesian springs. The springs themselves are made possible by a complex series of faults that bound individual blocks of crust in these valley bottoms. Typically the faults are found near the toes of the alluvial fans extending from the surrounding mountains, and they border axial basins in the valleys that are closed (such as the Pahrump Valley), or occur along major lineaments such as the Eglington Scarp and Corn Creek Fault Zone in the upper drainage of the Las Vegas Valley.

During the last glacial age, which extended from about 85,000 to 10,000 BP[3], the climate of the Southwest was much different than that of the present. The vast alluvial fans supported sagebrush steppe, perhaps with abundant bunch grass, and the surrounding mountains were covered with expanded woodlands. Increased precipitation due to altered storm tracks, and lowered evaporative loss in a colder climate, led to much greater recharge to the confined aquifer than at present, and the direct results were vastly expanded wetlands in the valley bottoms. These expanded wetland habitats were densely vegetated and captured considerable (tens of feet of accumulation) thicknesses of eolian silt, carbonate rich to start with but further infused with calcium carbonate ($CaCO_3$) by waters in the phreatic zone that, coming as they do from the Paleozoic carbonate aquifer, are supersaturated with respect to calcite. The importance of dense vegetation in the phreatic zones created by shallow groundwater in the vicinity of these valley margin faults will be discussed further, below.

At the end of the last glacial age, recharge to the Paleozoic carbonate aquifer declined drastically, and many valley-bottom oases shrank dramatically, or collapsed altogether. The spring areas became denuded as riparian vegetation died off, and with postglacial desertification progressing few plants, other than species of saltbush, could gain hold on these carbonate-rich silts. The resulting white to buff badlands indicating ancient spring deposits extended over square miles in some Mojave Desert valleys, such as Pahrump and Las Vegas. It was in these paleospring sediments that an expedition from the American Museum of Natural History in 1933 recovered the remains of extinct Pleistocene megafauna, including camel, horse and mammoth, as well as ephemeral but suggestive evidence of human occupation. These finds were located near Indian Springs and, more extensively, in the Upper Las Vegas Valley in the vicinity of Tule Springs. Along with The Meadows themselves (*Las Vegas*), and the springs feeding Duck Creek in Henderson, Tule Springs was one of several spring complexes that survived into the historic era in the Las Vegas Valley.

Subsequent to initial radiocarbon dates by the relatively unreliable solid-carbon method on material from the 1930s collection at Tule Springs, a major research project was mounted there in 1962 that combined the efforts of archaeologists, palynologists, geochronologists and paleontologists in an interdisciplinary investigation of these rich paleospring deposits. Results were published in 1967

[1] The Carboniferous to Permian Bird Spring Formation alone presents more than 18,000 feet of stratigraphic thickness in the vicinity of the Spring Mountains

[2] Lithified alluvium that commonly comprises most of the bajadas at depth in this region

[3] Since most chronometric control has been provided by radiocarbon dating, ages reported here are provided in radiocarbon years before present (BP), The reader is cautioned that, particularly for the terminal Pleistocene, large differences exist between the radiocarbon and the sidereal calendars.

and, while further evidence of human presence dating to the Pleistocene failed to materialize, the resulting paleoecological and geochronological reconstructions provided profound insights into the Late Quaternary history of the northern Mojave Desert. Subsequent to this pioneering research, in the late 20th century paleohydrologic investigations associated with studies of the proposed Yucca Mountain nuclear waste repository focused analysis on the geology of the sediments, as well as on regional syntheses. The former used fossil mollusks, diatoms, ostracodes, stable isotope ratios, and sedimentology to breakdown the complex of habitats, from relatively dry phreatophyte flats, to anoxic spring pools and rushing streams that typified these oases. The regional syntheses compared the paleospring deposits at Tule Springs to those in different valleys of the Mojave Desert and found strong evidence for the synchronous response of these systems to the same regional climate changes. Additional studies at the turn of the century suggest that even relatively low-order late Holocene climate changes have left a record of former more extensive spring discharge during the Little Ice Age, with fewer records during the preceding Medieval climatic anomaly of the late Middle Ages.

1.2 The Study Area

The study area lies near the bottom of the Pahrump Valley, which is a large intermontane valley in the northern Mojave Desert shown in Figure DR105-1. The Mojave Desert itself is a largely arid region where precipitation in the valleys rarely exceeds 5 inches annually, and spells of more than a half a year without rain are common. Desert scrub is the prevailing vegetation type, with saltbush (*Atriplex* spp.) species dominating the carbonate- and salt-rich substrates of the valley floors, and creosote bush (*Larrea tridentata*) – white bursage (*Ambrosia dumosa*) scrub on the gravelly substrate of the alluvial fans extending down to the axial basins from the surrounding mountains. Above about 3,200 feet elevation yucca become increasingly important components of the desert scrub, and creosote-white bursage vegetation gives way to more diverse shrub assemblages. Cool-temperate desert scrub above about 4,500 feet elevation is dominated by blackbrush (*Coleogyne ramosissima*) with Joshua-tree (*Yucca brevifolia*) and Mojave yucca (*Y. schidigera*) visually the most prominent members of this plant community. Above about 5,500 feet elevation woodland becomes increasingly common. First dominated by juniper alone (*Juniperus californica*; *J. osteosperma*) and then at higher elevations by juniper and piñon (*Pinus monophylla*) together with an understory of black sagebrush (*Artemisia nova*). Woodland vegetation is sparse to absent in the smaller mountains of the area, such as the Kingston and Nopah ranges, but it is widespread on the lofty Spring Mountains, which also support forests of ponderosa pine and white fir (*Pinus ponderosa* and *Abies concolor*) in canyons and on protected slopes above 7,000 feet elevation.

1.2.1 Regional Physiographic Setting and Paleoclimatic Trends

The HHSEGS lies in the Basin and Range physiographic province; so named because it is typified by numerous (more than 100) linear mountain ranges, most oriented north-south and separated by arid basins. The region extends south from southeastern Oregon between the Sierra Nevada and the Wasatch Range of Utah, and then east from the Peninsular Range of southern California to the Guadalupe Mountains of West Texas. A portion of this region, lying primarily in Nevada and western Utah, is called the Great Basin because all waterways drain internally to dry basins. No streams lying within the Great Basin reach the Pacific Ocean or the Gulf of California. The HHSEGS site lies within Pahrump Valley, the internally drained basin lying immediately west of the Spring Mountains in Clark and Nye Counties, Nevada, and Inyo County, California (see Figure DR105-1). Because this basin is internally drained, it lies within the southwestern portion of the hydrographic Great Basin, while also being located in the floristically defined Mojave Desert.

For much of the Paleozoic, about 550 to 240 million years ago (mya), the region lay off the western margin of North America, frequently in relatively shallow marine environments. Sediments deposited in these seas are now represented primarily by limestone and dolomite, with more limited quartzites and shales. They comprise tens of thousands of feet of Paleozoic carbonate rocks boldly exposed by uplift in the surrounding mountains, such as the Spring Mountains to the east of the HHSEGS. These Paleozoic marine rocks are separated by a hiatus from Early Mesozoic (Triassic to Jurassic) estuarine and continental sediments, which are exposed primarily in the Spring Mountains and farther east. A period of crustal compression followed in the Late Mesozoic, the most remarkable result of which is the Keystone Thrust in the Spring Mountains. Here, a large slab of Paleozoic rock is thrust *over* a layer of much younger Mesozoic, each crustal slab being many thousands of feet thick. Compression was followed by crustal extension beginning during the Middle Tertiary (Miocene), about 22 mya. Normal and strike-slip faulting, as well as associated volcanic activity, during the Basin and Range orogeny ultimately transformed the regional topography to that typical of the province today. Beginning late during this Basin and Range Orogeny, and continuing into the Quaternary (the last 2 million years), uplift of the Sierra Nevada, as well as Transverse and Peninsular Ranges of California, led to a strengthened rain shadow, and desertification of the interior resulted as precipitation declined.

Progressive desertification during the Quaternary led to the development of the current, biogeographically defined Mojave Desert. However, it is important to note in the context of this study that warm-desert environments typical of the present have been the exception rather than the rule over at least the last 0.7 million years (the Middle and Late Pleistocene, and the succeeding Holocene). Interglaciations like the current Holocene (the last 14,000 years) last for relatively brief periods of time while intervening glaciations endure for more than 50,000 years. During each of these cycles, global climate and terrestrial environments changed radically. Instead of warm-desert scrub, during the last ice age the Mojave region was occupied by steppe shrubs and coniferous woodland. Periods of maximum recharge to the aquifer, and hence maximum discharge of the valley bottom spring habitats, appear generally coincident with glacial stages (although there was an exception during the last deglciation), and drying and spring extinction coincident with hot, dry Interglaciations. Several lines of geological evidence also support the notion that each of these “pluvial” climatic events was diminished relative to its predecessors as the rain shadow cast by the mountains in the west continued to intensify. So, for example, pluvial lakes appear to have been more extensive, and paleospring discharge more widespread, during the preceding Illinoian glacial age (Marine Oxygen Isotope [MIS] Stage 6), than during the last, Wisconsin glacial age (Stage 2-4).

1.2.2 Geological and Environmental Setting

The HHSEGS project area has the general shape of a right triangle with the legs of the triangle running north-south and east-west, and the hypotenuse lying parallel to the California-Nevada border (see Figure DR105-1). The fault scarps that comprise the most prominent manifestation of the Stateline Fault System (SFS) run approximately parallel to and on the Nevada side of the border. Visible scarps associated with the SFS comprise two (or three) successively higher-elevation, subparallel lineaments, from about 0.25 mile to about 2.2 miles northeast of the border (Figures DR105-2, DR105-4).

To the east of the SFS scarps lies the west bajada, or alluvial fan complex, of the Spring Mountains, and to the west is the axial basin of the Pahrump Valley (termed the Pahrump Bolson for purposes of this report). This basin marks the position of the graben, or down-warped segment(s) of crust, that lies to the west of the SFS. With its ultimate sink at Pahrump Playa, about 3.5 miles northwest, Pahrump Bolson is the current depo-basin along this part of the SFS. The scarps just over the state line in Nevada mark the presence of chiefly low-angle normal faults. These faults channel artesian water from the deep Paleozoic carbonate aquifer to the surface, and springs still discharged historically at a few localities (e.g., Stump Spring, Mound Spring, Browns Spring). But, as noted above, during Pleistocene glaciations these fault lineaments hosted vastly enlarged spring discharge systems, with associated pools, wet meadows, and streams. They would have been heavily vegetated oases and prime watering spots for large Pleistocene vertebrates in what was otherwise a glacial-age shrub steppe. The range of habitats that radiated from these hydric centers, and those that persist today and can still be attributed to shallow ground water, will be discussed in greater detail in the next section.

SECTION 2

Context and Processes

2.1 Study Objectives

The goal of this landform inventory and research design is to provide boundaries, an inventory, and attainable research objectives for the near future. It shares some theoretical orientation with other approaches to archaeology in the Desert West that invoke economies of scale, optimal foraging strategies, and adaptive behavior in response to a rigorous and resource-limited environment. Simply put, due to its aridity the Mojave Desert possesses a very low carrying capacity, with few and low-quality resources scattered widely across an arid landscape. In the desert environment harvestable resources are famously restricted to certain times (seasonally distributed, and only during favorable years), and certain habitats (e.g., seed grasses in the sand sheets, mescal (*Agave utahensis*) on the lower montane slopes, piñon (*Pinus monophylla*) in the higher mountains). In between there are vast bajadas and desert basins where, for most of the year and in most years, there are no plant resources in harvestable amounts, and only small vertebrates (rodents, lagomorphs and some of the larger hepetofauna) as reliable prey. Moreover, the relative abundance of small vertebrates in the desert is tightly linked to vegetative productivity. Near the oases and better-watered arroyos, vegetative productivity is greater and small mammal density is accordingly higher. Vegetative productivity in marshy environments is several orders of magnitude (in grams of carbon fixed per unit area) greater than that of desert scrub, and resource availability varies accordingly. The fact that these well-watered habitats are separated by many tens of miles of arid desert scrub, imposes an extreme ecological heterogeneity on the landscape. It can best be paraphrased as "*A few areas (and some seasons) are **very** important.*" Trite as it may sound, application of this principal allows quick understanding of why the SFS is important to native groups in the area, as well as continuing to be important as relative islands of biotic productivity and habitat diversity in what is otherwise an ocean of low-productivity, relatively homogenous desert scrub.

To aid Staff in its analysis of the potential impacts to the SFS from the HHSEGS, CEC Staff provided the following data request:

105. Please develop and submit, for staff review and approval, a research design for the investigation of the paleohydrology, aboriginal water management, paleoecology, and ethnobotany of the portion of the step fault zone that stretches from Mound Spring to Stump Spring. The research design should include collaboration among professionals in the disciplines of Quaternary geology or science, geoarchaeology, economic or ethnobotany, and Great Basin or Southwest archaeology. The research design should, at a minimum, set out contexts, theory, and field methods appropriate to the investigation of the research themes above, and other themes as appropriate to establish the character and relative importance of the step fault zone, through prehistoric and historic times, for the acquisition, preparation, and consumption of multiple, key natural resources. It should facilitate the acquisition of information on the age of the mesquite groves and coppice dunes that encase them, whether the mesquite trees exhibit any physical evidence that would indicate whether and how the groves were actively managed, the antiquity of the use of springs and seeps in the step fault zone and the chronology of their flow rates, whether physical evidence

> exists that would indicate whether and how flows may have been actively managed in the pursuit of such goals as increasing surface flows or irrigating horticultural plots, and how the predominant vegetation associations along the step fault zone may have changed through time.

While not waiving its objection to this data request and notwithstanding the fact that the SFS and study area are located in Nevada, Applicant has agreed to the multidisciplinary study of the landforms and associated resource values in a limited portion of the SFS, in Nye and Clark county, Nevada, to the east of the HHSEGS site (Figure DR105-1).

2.2 Pace and Magnitude of Late Quaternary Climatic Changes

The vast dry lakes of the desert West, as well as the extensive glacial moraines of the Sierra Nevada and the Rocky Mountains, have long held the attention of geographers and archaeologists as evidence of major climatic change in this dominantly arid to semi-arid landscape. In the late 19^{th} century the correlation between glacial advances and the filling of the Great Basin pluvial lakes was first demonstrated, and the classical "glacio-pluvial" model equating pluvial episodes in the desert West with Northern Hemisphere glaciations was established. This model has since held sway among North American Quaternary scientists, while others (French, German, and some British geographers) appreciate that, at lower latitudes, pluvial climates appear synchronized with insolation (radiant energy from the sun) maxima during the summer season, which in turn drives the intensity and inland penetration of summer monsoonal rains. Global climate dynamics and latitudinal position determine whether a particular desert region's pluvial climates are synchronized principally to glacial-deglacial climatic changes, or to variations in the strength and intensity of the monsoon. Because the study area lies in a relatively northerly latitude at about 36° N, the climatic effect of continental glaciations, particularly changes in dominant circulation patterns and lower temperatures, had the most profound environmental impacts in the Mojave Desert. The imprint of a shorter but nevertheless significant "monsoonal pluvial" is also preserved in the environmental record of the area.

Marine oxygen isotope stages (MIS) have become the benchmark for understanding global climate change during the Pleistocene, since their chronology is well controlled and they closely track the fluctuations of continental ice sheets on the planet. These changes are in turn controlled, via a complex series of feedbacks, to the orbital mechanics of the planet, as changes in the attitude of the Earth to the sun affect the season and intensity of solar radiation. Since the Middle Pleistocene, about 700 thousand years (kyr) there have been seven glacial-intergalcial climate cycles on the planet. The next-to-the last glacial age, the Illinoian (MIS 6) ended precipitously about 130 kyr and the succeeding Sangamon Interglaciation (MIS 5) lasted until about 80 kyr. The last, or Wisconsin glaciation brought continental ice sheets south to the latitude of Tacoma in Washington state, Des Moines in the Midwest, and New York on the East Coast. To the north, on the Canadian shield from Pacific to Atlantic, was a vast and continuous continental ice sheet more than 2 kilometers (km) high. During the Wisconsin there was also a montane ice cap on the Sierra Nevada which, at its maximum, was about 400 km long.

Vegetation during the last glacial maximum was dominated by xerophytic woodland and subalpine forest similar to the mountains of the north-central Great Basin at present. Sagebrush-bunchgrass steppe occupied the bajadas instead of creosote bush and, as discussed elsewhere, valley bottom spring systems were more extensive and basins generally much less arid. Closed basins supported perennial or long-lived intermittent lakes, with shorelines that were later obliterated by encroaching alluvial fans.

The change from glacial to interglacial climate was once viewed as a simple transition from "pluvial" to arid conditions over the space of some thousands of years, but evidence has existed since the 19th century that this view is incorrect and overly simplistic. Deglaciation began relatively early and by 16,000 years before present (B.P.) much of the Sierra Nevada was ice-free. Many pluvial lakes also dried early, by 17,000 B.P., only to refill for a final series of high-lake stands in the period roughly 13,000 to 9,000 B.P.

Vegetation changes by about 13,000 B.P. brought an end to steppe vegetation in the northern Mojave Desert, although woodland remained widespread at lower elevations throughout the Southwest until the end of the early Holocene at about 8,000 B.P. Sagebrush had vanished, and instead large quantities of succulents (yucca, agave, and cacti) were being incorporated into the packrat middens of the time (ca. 12,000 to 8,000 B.P.). Succulents thrive in the monsoonal deserts of the Southwest today, and this succulent-dominated early Holocene Mojavean vegetation is also considered a facultative (involving Mojavean clades rather than the immigration of Sonoran Desert succulents) vegetational response to substantially increased monsoonal rainfall. Stable isotope studies also point to the tropical provenance of precipitation that fell in the deserts during the final pluvial episode of the desert West, which occurred during the transition from MIS 2 to MIS 1, a time of global deglaciation. The orbitally-driven northern-hemisphere summer insolation peak about 9,000 B.P., promoting intensified monsoonal circulation and perhaps increasing the frequency of tropical storms, is what caused this last pluvial event. It ended relatively late, by about 8,000 B.P., at the same time the last woodlands vanished from the desert scrub habitats of the Mojave Desert.

Accompanying the early Holocene drying of the lakes, the failure of spring systems, and the upslope retreat of woodland, were some major geomorphic readjustments to the landscape, the magnitude of which was seldom appreciated until the late 20th century. Post-Pleistocene desertification, the replacement of woodland by sparse scrub, and resultant slope instability apparently led to widespread stripping of the hillsides of the desert West. Alluvium, in vast quantities, moved into the desert valleys during the early Holocene, by about 8,000 B.P. The fine-grained component of this material was then reworked and redistributed during the increasingly arid late-early and middle Holocene, but never again was such a large source of sediment made available for eolian transport as that which occurred during the "early Holocene stripping event."

Great Basin archaeologists have longed argued about the nature and environmental impacts of postglacial climate change, as well as their effects on prehistoric human populations. Suffice to say that middle and late Holocene climate changes (the last 8,000 years) were an order of magnitude less pronounced than those involved in the Pleistocene-Holocene transition. Nevertheless, because moisture is already a limiting factor in this desert region, relatively small changes in effective moisture can be expected to have disproportionately large impacts on ecosystems, their carrying capacity, and consequently on human populations. Although there are arguments to the contrary, middle Holocene climate (the "Altithermal" of some authors) appears to have been more arid than at present, and there is widespread evidence of deflation and few sedimentary sequences can be found that date to this period. Sand dunes in the valley, presuming they existed, apparently were mobile and left no record.

The middle Holocene period of maximum aridity ended between about 5,200 to 4,500 B.P. when both the packrat midden record from the surrounding mountains and the stratigraphic record from the valley floors speak to increased effective moisture. Basal dates on archaeology from coppice dunes in the Las Vegas Valley as well as the Amargosa Desert are of this period, and speak to the establishment of long-lived mesquite clones to anchor these dunes. The history of mesquite coppice dunes prior to this apparent "post-Altithermal" stabilization is unknown, although the first fossil evidence for mesquite in the northern Mojave Desert dates to 8,500 ± 120 B. P. (macrofossils from a packrat midden in Sandy Valley) and 8,080 ± 40 B. P. (carbonized wood from Moapa River gravels). Its post-glacial immigration into the northern limits of its range is to be expected from subtropical genera like mesquite (*Prosopis*), catclaw acacia (*Acacia greggii*), and desert willow (*Chilopsis linearis*), all elements of desert riparian flora in the area. However, mesquite is by far the dominant riparian species in the current study area, and the only one apparently capable of forming clones that stabilize relatively large sand dunes.

Excursions of the climate norm to more mesic, and more xeric periods highlight the paleoclimatic record of the Mojave Desert over the last 4,000 B.P. There appears to have been a period of erosion and deposition of relatively thick silt units in the arroyos near Tule Springs and the Eglington Scarp during the last millennium in the Las Vegas Valley, while short-lived pluvials are recorded by desert lakes, and packrat middens, during the "Neoglaciation" (ca. 3,800 to 3,200 B.P.) and during the Little Ice Age (ca.300 to 400 B.P.). There are records that suggest modest expansions of marshes in the Amargosa Desert and springs elsewhere during these mesic periods, and contractions of wetlands and spring failure during xeric episodes, such as that which occurred during Medieval Climatic Anomaly from ca. 800 to 1300 B.P.

2.3 Dominant Environmental Processes in Landform Development

The SFS is a tectonically active rift zone composed of a number of basins extending more than 100 miles in a northwest-southeast direction. Within this zone basins are constantly being created and destroyed. For example, the position of the current depo-basin in the Pahrump Valley (centered on Pahrump Dry Lake) is evidently many miles to the west of where it was during the Plio-Pleistocene. Similarly, at one time a basin may have connected Pahrump Valley with the Amargosa Desert to the northwest, integrating it into the Amargosa River system. In the vicinity of the HHSEGS the most prominent manifestations of the SFS are the dissected scarps of low-angle normal fault that rise to the east in Nevada (Photo DR105-1). Springs occur along these scarps as deeper groundwater under pressure is channeled along the faults and rises to the surface. Springs are few now, but were likely more numerous even within the last few centuries[4], and the broad distribution of paleospring sediments, badlands of fine-grained carbonate-rich silts that accumulated under hydric conditions throughout the lower Pahrump Valley, speaks to their abundance during the Late Pleistocene.

2.3.3 Emergent Groundwater and Related Environments

2.3.3.1 Phreatophyte Flats and Spring Discharge Areas

A range of habitats is produced by one spring system that varies from the spring pools and stream channels associated with the actual discharge orifice, to wet meadow, to dry meadow or what is commonly termed in this region phreatophyte flat. Phreatophyte flats are areas where the ground surface is generally dry, but the soils are saturated at shallow depth and the vegetation is relatively dense and tall, composed of shrubs such as tall sagebrush (*Artemisia tridentata tridentata*) in the

[4] Jones et al. (2004) note the apparent expansion of water sources in the Mojave Desert during the Little Ice Age, beginning in about the fifteenth century.

floristic Great Basin to the north, and quail bush (*Atriplex torreyi*) and tamarisk (*Tamarix aphylla*; a non-native species and aggressive colonizer on saturated soils) in the Mojave Desert. The identification of different environments in areas of spring discharge is important to understanding the geological record of these systems, as Quade and Pratt (1986) first pointed out. Phreatophyte flat deposits comprise wide areas of massively bedded, carbonate rich silts that contain common to abundant tufa concretions. These concretions are the result of calcium carbonate precipitation in the soils zone as groundwater, super-saturated with respect to calcite, reaches shallow depth and enters the vapor phase while still in the soils column, or is taken up by plant transpiration. Tufa nodules, frequently pseudomorphic after roots and insect burrows, are common on deflated surfaces developed on old phreatophyte flat deposits (Photo DR105-2).

Phreatophyte flats are considered to be accretionary landforms where vegetation and soil conditions are conducive to the accumulation of desert loess, eolian silt that is common in this arid land. However, the denser the vegetation, the more efficiently this regional dust is trapped, and springs with their dense riparian vegetation trap so much desert loess that mounds of earth accumulate, and the term “spring mound” is frequently applied to these constructional features. The eponymous Mound Spring is an example in Pahrump Valley. The largest active spring mounds known to this author in the desert West are along the San Andreas Fault Zone in the Salton Sink, as shown in Photo DR105-3 where a spring mound rises more than 50 feet above its surrounding, saline phreatophyte flat. Spring orifices, whether they are located on a spring mounds or not, are also typified by massive ledges of lithoid tufa (Photo DR105-4). Thus, even though actual discharge orifices are rarely located in paleospring deposits, the proximity of lithoid tufa ledges indicates a former discharge area, with associated hydric environments likely to have occurred nearby, such as spring-fed pools and stream channels.

Paleontological materials are frequently encountered in two rather distinct stratigraphic contexts in paleospring deposits; the green- to grey-colored clays of spring pools, and in fluvial sands and gravels of spring-fed streams. They have been found in other contexts as well, but spring pool and stream environments were not only relatively common near discharge orifices, they also produced the type of depositional environment conducive to fossil preservation. Cultural materials are rarely, if ever, encountered in the older (>8,000 B.P.) paleospring deposits of the Mojave Desert. This is in stark contrast to, say, southeastern Arizona, where early Holocene and terminal Pleistocene alluvial sequences have yielded a relatively well-documented Early Archaic and PaleoIndian archaeological record. However, surface finds along the ancient shorelines of pluvial lakes in the Mojave and southern Great Basin deserts clearly indicate human presence during the terminal Pleistocene. Therefore similar-age paleospring deposits in Pahrump Valley, as elsewhere, should not be overlooked in the continuing quest for evidence of the first humans in the Mojave Desert.

2.3.3.2 Mesquite Coppices and Sand Dunes

Groundwater need not be emergent to have strong effect on local environments along the scarps of the SFS. And eolian capture by vegetation is a process that not only relates to the accumulation of carbonate-rich silts (chiefly during the Pleistocene) in these environments, but also to the more recent, Holocene-age sand dunes uniquely placed along the fault scarp lineaments of the SFS. Shallow groundwater is widely thought to support the mesquite (*Prosopis juliflora; P. glandulosa*) coppices that anchor the sand dunes along the fault scarps, and it is likely that these mesquite coppices are clones with one to a few genetic individuals occupying a single dune. Despite the aridity of the northern Mojave Desert, sand dunes are relatively rare across the landscape, and the mesquite-coppice dunes (often shortened to just “coppice dunes”) are among the most singular landforms in the vast, relatively flat plains represented by these valley bottoms (Photo DR105-5).

Frequently, springs or shallow wells lie nearby, because both are associated with shallow groundwater.

Mesquite also occurs in thickets along the arroyos that cut through the most prominent scarps of the SFS. Since they are incised some tens of feet below ground surface, the floors of the arroyos are that much closer to the groundwater table, and phreatophytic mesquite grows in luxuriant thickets along these water courses. However, although frequently incorrectly referred to as “bosque,” these mesquite do not form a true canopy, and rather comprise dense thickets of arborescent shrubby vegetation, instead of a gallery forest with the overarching canopy of a bosque. Other riparian plants are rare to absent. At Stump Spring, for example, the limbs of a cottonwood (*Populus* sp.) tree are scattered about but no cottonwoods remain alive, and a reconnaissance revealed only one willow (*Salix* sp.) in the arroyo where the spring is thought to have emerged.

Mesquite die-back likely leads to deflation of coppice dunes, as sand is entrained in the prevailing wind and blown elsewhere. It is unlikely that under the current geomorphic regime there exists enough mobile sand to replace that which is blown off a devegetated dune. However, the dynamics of sand dunes in the SFS are complicated to the extent that widespread colonization of the dunes by an exotic annual grass (*Schismus* sp.) appears to lend some stability to dune faces that lack, or have lost, a mesquite cover (Photo DR105-1). During field reconnaissance Mormon-tea (*Ephedra nevadensis*) and creosote bush clones were also observed anchoring smaller sand hummocks and dunes. But, other than mesquite, *Schismus* grass appears to play the most prominent role anchoring dune surfaces that may otherwise be exposed to deflation.

When they are deflated, or rolled back by the wind, the bases of coppice dunes can reveal ancient occupational surfaces. By the 1960s in the upper Las Vegas Valley, deflation exposed what constituted the first “open air” archaeological sites (as opposed to rock shelter sites) of substantial antiquity (to 5,200 B.P.) in the Mojave Desert. The earliest dates on these sites in both the Amargosa Desert as well as the Las Vegas Valley, range from 4,500 to 5,200 B.P. and they appear to document the stabilization of these coppice dunes at the end of the mid-postglacial thermal maximum, or Altithermal as previously discussed in Section 2.2. So, in contrast to the paleospring deposits that have thus far failed to yield an archaeological record, important site records extending back to the Middle Archaic have come from the base of coppice dunes in the Amargosa Desert and Las Vegas Valley. Similar expectations appear appropriate for the dunes of the SFS.

2.3.4 Descriptive Geology of the Stateline Fault System

When viewed from the Pahrump Basin, or bolson, the first (western-most) fault scarp along the SFS appears to be a rather unimpressive line of higher ground rising behind coppice dunes that are discontinuously distributed at its foot (Photo DR105-1). The broken nature of this terrain is attributable not only to discontinuous fault lineaments, but also to the erosion that has occurred since the last major uplift. Scarps have been smoothed, and arroyos channeling runoff from the east have breached the high ground in a number of places. Theses arroyos provide cross-sections though the sediments, which are displaced upward along the fault scarps, and these stratigraphic sections in turn provide valuable opportunities to better understand the paleoenvironmental and recent geological history of this complex area (Photo DR105-6).

As the hanging walls of the SFS scarps continue to rise, the uplifted terrain sheds alluvial sediment, which is deposited to the west chiefly on relatively small alluvial fans that spread out onto the bolson of Pahrump Valley. These alluvial fans differ in composition from the coarse clastic fans of the Spring Mountains. Rather than Paleozoic limestone, a chief constituent of the alluvium streaming off the SFS is reworked eolian sand, most of it likely eroded off the dunes. Some of this sand is then re-entrained by the wind to be (re)deposited closer to the SFS as sand sheets, and perhaps (re)added to dunes as well. While some sand sheets are dispersed and may represent relictual dune systems, others are limited to areas immediately downwind of washes transporting sandy alluvium onto the bolson (Photo DR105-1; Figure DR105-2). It is likely that this combination of alluvial-to-eolian reworking of sand is a continuous process, and may be responsible for the relatively extensive sand sheet habitat immediately to the west of the western-most fault scarp (Scarp 1 in Figure DR105-4), and perhaps even for the maintenance of its associated coppice sand dunes (Figure DR105-2).

The capping geological unit on the hanging (up-side) walls of the fault scarps is frequently an alluvium that has been referred to as the older alluvium of the Spring Mountains. It is dominated by clasts of Paleozoic carbonate rock along with occasional specimens of Mesozoic rock, which also occurs in the Spring Mountains. In areas where erosion of fine-grained paleospring sediments has led to the development of badland topography, this distinctive black alluvial gravel often rests unconformably atop the white to buff outcrops as a relictual mantle. In areas to the east of the last (eastern-most) fault scarp, it is clear that earlier in the Holocene these sediments were completely overridden by the gravelly toes of the Spring Mountains alluvial fan. This transgression of alluvium across older surfaces near the valley bottom would have been correlated with Unit F time (early to middle Holocene) in the Tule Springs chronology of Haynes and Quade, and likely relates to the early Holocene stripping event of other authors. Alluvial clasts derived from the older alluvium extend out onto the bolson to the west from the fault-scarp hills, but quickly attenuate in both size and number the farther out onto the bolson they travel.

In the HHSEGS project area in California, alluvial fans extending off the SFS and into the bolson cover most of the east portion of the site (refer to Figure DR101-1, previously filed with Data Response Set 1D). This sand-rich alluvial blanket covers a much older stratum termed Quaternary basin fill (Qbf). To the west out on the Pahrump bolson, the white, carbonate-rich Qbf is exposed at the surface. It can also be traced to the east in arroyo cuts and excavations below a blanket of much younger, primarily late Holocene sandy alluvium (Qa1, Qa2 in Figure DR101-1). The older basin fill constituting Qbf includes green clay facies and clay-tufa areas that are likely relict paleospring discharge and lacustrine sediments. But the sediments of the valley floor are highly altered, and no fossil material has yet been encountered in unit Qbf of the Pahrump bolson. *However*, the same or similar lacustrine units are exposed, and appear much better preserved, along arroyos cutting through Scarp 1 (Photo DR105-6a). These older sediments, uplifted and exposed by erosion include lacustrine units, and some sediments sufficiently gypsiferous that selenite crystals are evident in massive lacustrine clays. These older Pleistocene, and perhaps even Pliocene basin fill sediments are presumably correlative with the basin fill sediments that occur at depth in the bolson, on the down-dropped (footwall-side) of the fault scarp.

SECTION 3

Landforms and Resources

The genesis and distribution of the landforms in the study area are the result of the interaction between linked climatic and hydrologic processes on a template provided by largely independent tectonic processes. Of the latter, faulting is the most easily emphasized but other associated crustal deformation may also be occurring. Bulging of relatively small crustal blocks, the down-drop of others, and the erosional and depositional accommodations made in response are evident on this relatively young, and in the geological sense frequently renewed, landscape. A listing of landforms present in the study area is provided in Table DR105-1.

3.1 Eolian Landforms and Fault Scarps

Arguably the youngest landscape features are also among the most notable in the SFS, the sand dunes. If they possess the same chronology as those in the Amargosa and Las Vegas Valley, a tenable assumption—given what is known of synchroneity of climatic change at the subregional level—is that the sand dunes were established in their current locations between about 5,500 and 4,500 B.P. There is some legitimacy to the question “What came first, the mesquite or the sand dune?” but current wisdom is that the dunes themselves are held in place by mesquite coppices and that, without the mesquite, the dunes would not be stabilized, and would not accumulate at their current locations. This is supported by the simple observation that, while sand sheets can be found in a number of areas, dunes or dunes fields in the classic sense of wind-sculpted barren sand hills are not present anywhere else in the immediate area, only in association with the fault scarps.

Figure DR105-2 presents the initially mapped distribution of sand dunes and sand sheets in the study area. They are divided into three classifications (Table DR105-1) that are not necessarily entirely distinct from one another:

- Those dune and sand sheet concentrations that that appear well-developed vertically, have densely clustered dunes, and that support dense vegetative growth relative to the surrounding desert scrub (thick yellow line in Figure DR105-2).
- Areas where dunes are more subdued and widely dispersed, and the interconnecting sand sheet apparently thinner and more discontinuous (thick orange line in Figure DR105-2)
- Sand sheets lacking distinct dunes but that have hummocky, sandy surfaces, usually associated with major drainages or downhill from dune systems. Only some of these are discernable using available remote imagery (red lines in Figure DR105-2). Sand sheets downhill from dune systems of Scarp 1 (Figure DR105-4) often support robust populations of bunch grasses (galleta and rice grass)

It appears evident at this level of analysis that the west-most fault scarp of the SFS (Scarp 1 in Figure DR105-4) is the most “active” in that it supports the greatest extent of mesquite which, in turn, anchor the largest and best developed expanses of sand dune and sand sheet habitat (Figure DR105-2). A simple groundwater-driven interpretation is that shallow groundwater is closest to the surface in the vicinity of the lowest and western-most fault scarp (Figure DR105-4). Farther to the

TABLE DR105-1.
Landform types that are considered in detail in this report.

LANDFORM TYPE	Figure, Color, Symbol	NOTES
EOLIAN LANDFORMS		
Coppice Dune / Sand Sheet	Fig. DR105-2, yellow	Dunes supporting mesquite coppices that are, or were recently, alive. Interdunal areas are relatively limited.
Discontinuous dunes and sand sheets	Fig. DR105-2, orange	May be largely older dunes, or dunes on older (outboard) terraces. Interdunal areas are expansive.
Sand sheets as colluvial/fluvial mantles	Fig. DR105-2, red	Often closely associated with a major wash or arroyo, or area of debouchment.
Spring mounds	not shown	Can these be discriminated from fine-grained alluvium in all cases?
EROSIONAL LANDFORMS		
Debouchments	Fig. DR105-3, green	Silt-rich floodplains supporting dense annual growth during some seasons, giving them a low albedo
Arroyo with/without mesquite thicket	Fig. DR105-3, blue	Criterion to separate arroyos from washes is that generally they must have a depth exceeding 10 feet; only channels exceeding 10 feet in depth are mapped
Washes, channels, and drainages	Shown in part by mesquite distributions	Includes both active (those with a thalweg and/or OHWM) and abandoned drainages with geomorphic significance
Badlands	not shown	Can be considered a subset of the arroyo and wash category, since it is the headward expansion of these erosional features in soft sediment that create the badland landforms of small buttes and mesitas or barren, erodible fine-grain sediment.
BIOGENIC LANDFORMS		
Mesquite Coppices and Thickets	Figs DR105-2, DR105-3; green	Thickets are chiefly of the floors of arroyos and desert washes; coppices are as noted above under eolian landforms
Tufa mounds	not shown	None currently known; accretion of lithoid tufa is a biogenically mediated process in most known circumstances.

TABLE DR105-1.
Landform types that are considered in detail in this report.

LANDFORM TYPE	Figure, Color, Symbol	NOTES
OTHER LANDFORMS		
Fault scarps, especially hills attributable to eroded fault-scarp hanging-walls	Confidential Figure DR105-5	Can be mantled by tufa ledges and sand sheets
Alluvial fan surfaces, major or minor	not shown	Major alluvial fans extend east from the Spring Mountains and are the dark surfaces that become attenuated in the eastern portion of the study area in the remote imagery base used for Figures DR105-2 and DR105-3. Minor alluvial fans extend though the SFS and distribute sandy alluvium on surfaces across the Hidden Hills SEGS in California, and are shown as surfaces Qa1 and Qa2 in Figure DR 101-1, previously submitted.
Relict surfaces (aka “lag surfaces”)	not shown	Mesa tops, surfaces well-armored with older alluvial gravels; can intergrade with alluvial fan surfaces upslope
Colluvial slopes	not shown	Particularly on the flanks of scarps and more prominent hills

east within the SFS the land rises several times over a relatively short distance (Scarps 2, 3a and 3b; Figure DR105-4), and while there are additional dune fields there, they are more sparsely distributed over the extent of the study area (Figure DR105-2). Along the Tecopa Road transect the relative elevational gain at the headwall of Scarp 1 is the lowest (in part thanks to roadway design), while relative uplift associated with Scarp 2 is more than three times greater (ca. 37 feet versus 129 feet; Table DR105-2).

TABLE DR105-2
Metrics Associated with the Profile Displayed in Figure DR105-4.

Scarp or Other Point of Interest	Approximate Distance NE from E Edge of Bolson (mi)	Elev (ft)	Cumulative height gain (ft)	Incremental gain (ft)
East edge of Bolson at State Line	0	2,698	0	-
Scarp 1 Headwall	0.35	2,735	37	37
Scarp 2 Headwall	1.7	2,864	166	129
Scarp 3b Headwall	2.49	2,940	242	76
Gravels of Toe of Spring Mountains Alluvial fan	3.4 to 4.4	2,955 to 2,994	257 to 296	15 to 54

Spring mounds, the other type of eolian landform listed in Table DR105-1, are also to be expected along fault traces, but none have yet to be inventoried in the study area. Some coppice dunes along the Eglington Scarp fault system in the northern Las Vegas Valley were found to be cored by spring mounds when denuded during urban development in the 1990s.

3.1.1 Ethnobotanically Important Resource Distributions

Dunes and sand sheets support high-ranked plant resources in relatively high density, in a restively discrete area. As noted above, galleta and rice grass both thrive on sand sheets, and both are noted in the ethobotanical literature as being important seed resources. During reconnaissance to date, the densest stands have been noted on dispersed sand sheets below (west of) the dunes of Scarp 1 (Figures DR105-2, and -5). Not all these sand sheets are discernable with currently available remote imagery, however.

Honey mesquite (*Prosopis glandulosa* var. *torreyana*) produce pods that are rich in sugars, and the flour made from pulverized pods was a nutritious staple of Southern Paiute diet. Of course, competition with the local fauna for the nutritious pods would have necessitated careful attention to the phenology of the plant, in order to capture the pods at their ripest but not before they are lost to non-human seed predators. Milling stations developed in travertine along a well-known spring system in the Ash Meadows area is thought to have been for mesquite pods.

3.1.2 Management Implications

Since the excavations of dune sites at Corn Creek in the Upper Las Vegas Valley in mid-20th century, it has been recognized that deflation, the movement of a sand dune or sand sheet front away from an area, can expose important cultural resources. Lying at the base of a dune, or even just a hummock, occupation surfaces protected from surface processes (but *not* from bioturbation) for centuries or millennia are exposed by wind erosion. Subsequent site degradation by surface erosion and unauthorized collection inevitably follows. Die-back of mesquite coppices due to shallow groundwater retreat is therefore an important cultural resources concern to the extent that it exposes the windward-faces of coppice dunes to deflation. As noted above this potential for deflation appears mitigated to a certain extent by the thickness of introduced *Schismus* grass on many dune and hummocky sand sheet surfaces (Photo DR105-1).

Dune systems of scarps farther to the east are more ephemeral, and appear to have been either poorly developed to start with, or to have undergone the most deflation since their establishment. It is not known whether this might correlate with older archaeological sites being exposed by deflation of sand sheets or dunes associated with the scarps farther east, relative to those associated with the dunes of Scarp 1 (Figure DR105-4), but the possibility is intriguing. A recent cultural resources survey through a relatively limited section of dune and sand sheet associated with Scarp 1 suggests that some, but not all, interdunal areas exposed by deflation reveal concentrations of cultural resources material (Confidential Figure DR105-5).

The author is familiar with other areas in the northern Mojave Desert where extensive sand sheets supporting robust stands of galleta and rice grass also appear to possess a relatively dense archaeological site distribution, and many of these sites have the quantities of broken groundstone and fire-cracked rock that accord with seed processing in that sort of a resource-rich area. This, however, is not the case so far in the SFS. Sand sheets to the west of Scarp 1 have been subjected to limited cultural resources inventory, and this site type has not been encountered to date. Analysis of the sites encountered in the interdunal areas is on-going, but groundstone is not reported to be an important component of the tool assemblages of those sites.

3.2 Erosional Landforms

Differential uplift along fault scarps results in erosional down-cutting by the drainages that channel runoff to the Pahrump Bolson from higher country to the east. The floors of these erosional cuts, where they exceed 10 feet in depth relative to the surrounding terrain, are designated arroyos in this study (Figure DR105-3; Table DR105-1). Both the shallower washes and deeper arroyos frequently support mesquite thickets, as their floors are incrementally closer to shallow groundwater than the surrounding terrain. Major drainages also channel shallow groundwater runoff downstream from major spring systems, such as the arroyos that run downhill from Stump and Hidden Hills Springs[5]. They end in debouchments on the bolson floor (Figure DR105-3) that are usually silt-rich and support dense annual vegetation; hence their dark color in remote imagery.

Arroyos tend to erode into fault scarp zones within the SFS, where local uplift is being cut by corresponding erosional channels, so arroyos sometimes appear as clusters in an area is experiencing relatively rapid Quaternary uplift (Figure DR105-3). Less deeply incised washes continue both up- and downstream from the fault scarps, with those supporting mesquite thickets easily visible (Figure DR105-3). Many washes that appear pronounced in the eastern portion of the study area are actually barely incised into the surface, and might more appropriately be considered relict drainage systems. Some appear to have been cut-off by tectonic blocking, and others by stream piracy in a tectonically active area. Some debouchments appear on the landscape because gradient is lost in an area, possibly due to tectonic bulging but certainly due to chocking of the area with fine grained sediment (Figure DR105-3).

[5] Both wash systems are noted in journals of mid-19th century travelers through the Pahrump Valley on the Old Spanish Trail – Mormon Road, one regarding shallow wells that could be dug near its mouth, another for the plentiful forage available, presumably were it merged with a sand sheet.

3.2.3 Resource Distributions Important to Interpreting the Archaeological Record

Mesquite thickets in arroyo and wash bottoms likely provided an important source of pods during favorable years. Along with the nearby dunes, this productive vegetation would have supported a relatively high density of small game. In the Eglington Scarp area in the northern Las Vegas Valley, silt-rich arroyo in-fills dating to the last thousand years or less (Unit G of Haynes) contain frequent evidence of burning of the associated mesquite thickets. Theories invoking late prehistoric intensification are brought to mind, and mesquite thickets are a high-productivity ecosystem that could be exploited episodically given a persistently shallow groundwater table, especially during the Little Ice Age.

3.2.4 Management Implications

Setting the surface hydrologic (including jurisdictional) importance of washes and arroyos aside for this study, we focus here in the biological, paleontological and geoarchaeological importance of arroyos cutting through the scarps of the SFS. They are biologically important potential habitats, not only for the mesquite thickets they support, but also for the abundance of caves and habitable cavities provided by resistant overhangs along their walls (Photos DR105-4, and -6b). They can also provide high-potential exposures of geoarchaeologically and paleontologically important sedimentary sequences. Given appropriate magnetic chronometric control, the tectonics of the area could be better understood.

Headward cutting appears evident in remote imagery of the eastern portion of the study area, and exposure of paleontologically sensitive badlands to accelerated erosion from off-highway vehicle impact can be seen in the northeastern portion of the study area. Paleontological resources are actually often quite scarce in these sediments since they appear to relate primarily to phreatophyte flat deposition. Nevertheless, impacts to paleontological resources from accelerated erosion are a potential concern, and the high scientific value of some arroyo exposures is beyond doubt. In the Las Vegas Valley careful study of similar exposures has provided insight into prehistoric lifeways of the area.

3.3 Biogenic Landforms

These landforms are few and are limited to mesquite coppices themselves, and to tufa mounds and ledges which, although rock-hard (lithoid) are accumulations of biotically-mediated tufa ($CaCO_3$) deposited in or near an actively discharging spring orifice. Tufa ledges have been noted during reconnaissance of limited areas of both Scarps 1 and 2. Some are directly overlain by coppice dunes or sand sheets, while many others are exposed by headward or lateral arroyo cutting. Because they mark the location of active groundwater discharge, areas peripheral to tufa ledges, when exposed, could reveal green clays associated with spring-fed pools, or stream channels. Both types of sediment have yielded important paleontological materials in the Tule Springs area of the Las Vegas Valley paleospring systems.

A “chicken-or-egg” debate awaits anyone choosing to determine clearly whether mesquite coppices are biogenic or eolian landforms. They are, in fact, both. The questions that arise from their biotic identity, however, are those like: how old are they? Are they typically clones? How deeply are they rooted? The history of these vegetative entities must be tightly linked to the environmental history of the immediate area, as described above. A deductive approach to the question of their antiquity must rest on the following points:

- Mesquite is of subtropical affinity, reaches its historic northern limit in the Mojave Desert, and was not present in the region during the last glacial age.
- The earliest records for mesquite in the region (one from a packrat midden near the floor of Sandy Valley) are between 8,000 and 8,500 B.P., the same period when many other desert thermophiles arrived in the region from their glacial-age refugia in the south
- The earliest records of sand dune stabilization (and by inference mesquite coppices) are about 3,000 years later (between 5,000 and 5,500 B.P.). The preceding middle Holocene thermal maximum, the Altithermal of some authors, was apparently too arid to permit dune stabilization (or, of course, such evidence has yet to be found).
- If shallow groundwater elevation in the SFS declined during the Altithermal, as seems likely due to lower precipitation and recharge to the Spring Mountains, then it must have returned to a level high enough to support the establishment and persistence of mesquite coppices by 5,000 B.P.
- If the coppices are largely composed of clonal individuals, then many may be on the order of 5,000 years old.

An alternative hypothesis (there are several) to the deduction that mesquite clones in the SFS may be up to 5,000 years old is that they may be up to 8,000 years old[6], if the mesquite that arrived in the millennium prior to the beginning of the Altithermal successfully rooted during the last centuries of spring discharge activity in the area, successfully survived the ensuing middle Holocene thermal maximum, and were available to stabilize sand dunes when climatic conditions began to permit, about 5,000 to 5,500 B.P.

3.3.1 Management Implications

Die-back of mesquite clones is normally attributed to groundwater draw-down due to well-pumping in the Pahrump Valley, a phenomenon which peaked in the late 1960s and 1970s before the federally mandated restriction on agricultural pumping was implemented. The mitigating effect of that restriction can be seen in well logs from the area, although the increase in domestic and municipal groundwater usage accompanying the expansion of Pahrump's population into the tens of thousands has recently served to place further demands on groundwater resources. Mesquite habitats are rare in this region, are a concern of land managers, and the potential antiquity of these clones lends further emphasis to that concern. However, it should be noted that there are a number of hydrogeological factors that make it highly unlikely that pumping by the HHSEGS facility will affect groundwater elevation in the SFS[7].

3.4 Other Landforms

Other than Quaternary geologists, landforms such as colluvial slopes, lag surfaces and alluvial fans draw no one's particular attention. They occupy a substantial portion of the study area, however, and because of their vastness the alluvial fans actually provide natural, first-order geomorphic boundaries. One major boundary is the toe of the bajada (alluvial fan complex) of the Spring Mountains, seen in the remote imagery (Figures DR105-2, -3, and -5) as the attenuation of the lobes

[6] As noted previously, the reader is cautioned that this report uses radiocarbon years for all "B.P. ages" less than 50,000 Radiocarbon years deviate from calendar years particularly prior to ca. 8,000 B.P.

[7] See Data Responses 47 through 49 in Data Response Set 1A; and Data Responses 82 and 83 in Data Response Set 1C.

of low-albedo alluvium entering the study area from the east. This is marked on the ground by a broad plain of very low gradient between the end of the western terminus of the alluvial fan and the first fault scarp associated with the SFS (Scarp 3b in Figure DR105-4). White to buff, carbonate rich silts that comprise the high-albedo surfaces from that point west are all paleospring deposits in the broad sense. Currently they are mostly assigned unknown paleontological potential (PFYC = 3b) but, after field inventory, it is likely that most will be assigned low paleontological sensitivity (PFYC = 2) because they constitute phreatophyte flat deposits: Silt rich eolian sediments that accumulated under relatively mesic but nevertheless aubaerial conditions not conducive to fossil preservation.

3.4.1 Resource Distributions Important to Interpreting the Archaeological Record

Relict or lag surfaces of the hills associated with fault Scarp 1 are often mantled by low-albedo gravels that constitute an older alluvial unit, now isolated miles west of the toe of the Spring Mountains alluvial fan. It contains chiefly Paleozoic carbonate rocks in a range of sizes and with poor sorting typical of alluvium of the Spring Mountains, although due to their antiquity the proportion of resistant chert and quartzite clasts to erodible limestone is greater than in younger alluvium. Consequently the colluvial slopes below these gravel outcrops have served as a toolstone source for prehistoric peoples, and field inventories have established that adventitious toolstone testing as chert or other siliceous cobbles are encountered, constituted a chief form of resource exploitation in this habitat. The fact that many of these colluvial slopes lie immediately above areas of relatively extensive sand sheet supporting relatively dense stands of galleta grass has been noted. But little evidence of plant resource exploitation in the form of groundstone tools or resource processing areas has been encountered in inventories to date.

3.4.2 Management Implications

The extensive areas of alluvial fan and phreatophyte flat surface in the approximately eastern half of the study area present substantially less landform diversity than the western half. The influence of the scarps of the SFS, and the transition from bolson to basin-margin habitat, result in much greater landform diversity in response to a dynamic tectonic environment. Between this zone and the toe of the Spring Mountains bajada to the east is a broad area of well-defined but normally relatively shallow drainages incised into white to buff phreatophyte flat deposits. Inventory of this area, analysis of the few arroyo profiles that provide good chronosequences, and assessment of reported fissuring and aggressive head-wall erosion are activities that can contribute to a better understanding of the resources associated with other landform types, particularly in the eastern portion of the study area where the more remarkable landforms are scarce to absent.

SECTION 4

Regional Comparisons

Below we provide a listing and general comparisons of the spring and dune complexes of the SFS with other spring systems in the region. As noted in the discussion of the geological and hydrological context of the SFS, the mountains that provide recharge to the groundwater basin of the Pahrump Valley also do the same to that of the Ash Meadows area, the Las Vegas Valley, and so forth. And in each case there are valley-margin faults that channel artesian groundwater to the surface, or near-surface, creating wetlands of greater or lesser extent.

A better understanding of the abundance and distribution of shallow groundwater-coppice dune systems, as well as perennial springs in the valleys of the northeastern Mojave Desert[8], is helpful in putting the resources of the SFS in perspective. A list of the major coppice dune and shallow groundwater systems in the northeastern Mojave Desert is provided in Table DR105-3. Some, such as the Las Vegas and Amargosa Desert systems, were extensive and covered square miles of area prior to 20th century groundwater draw-down. Others, such as Coyote Springs Valley and Shadow Valley, may have supported riparian areas of a few acres during years of high groundwater recharge but, during normally dry years, were at best the site of a few seeps and shallow wells. Sandy Valley is included because of its extensive coppice dunes and mesquite thickets; at this level of analysis no named springs have been identified in this valley. This listing references inferred pre-1950 conditions.

TABLE DR105-3.
A list of Spring and Coppice-Dune Systems in the Northeastern Mojave Desert

Coyote Springs Valley (ca. 114°58’ W, 36°50’N)
Representative riparian areas: Coyote Springs (extinct)

Las Vegas Valley (ca. 115°10’ W, 36°10’N)
Representative riparian areas: Duck Creek, “The Meadows” (Las Vegas), Tule Springs, Eglington Scarp (extinct), Corn Creek Springs

Indian Springs – Three Lakes Valley (ca. 115°40’ W, 36°35’N)
Representative riparian areas: Cactus Spring, Indian Springs, Silver Flag Alpha (extinct)

Amargosa Desert (ca. 116°20’ W, 36°30’N)
Representative riparian areas: Point of Rocks Spring, Carson Slough, Big Spring, Devils Hole, Ash Meadows

Pahrump Valley (ca. 116°00’ W, 36°15’N)
Representative riparian areas: Manse Spring, Mound Spring, Stump Spring, Browns Spring

Sandy Valley (ca. 115°35’ W, 35°45N)
Representative riparian areas: Extensive mesquite thickets and coppice dunes; no extant riparian areas.

Shadow Valley (ca. 115°42’ W, 35°28’N)
Representative riparian areas: Valley Wells, Cottonwood Spring

Middle reaches of the Amargosa River (ca. 116°14’ W to 116°09’ W, 35°53’ to 35°47’N)
Representative riparian areas: Tecopa Springs system, China Ranch, Resting Springs

Chicago Valley (ca. 116°12’ W to 116°09’ W, 36°03’ to 35°58’N
Representative riparian areas: Extinct. Extensive mesquite thickets and coppice dunes

8 For purposes of this study, the area east of the Death Valley trough, west of the Muddy River, south of the Beatty Hills, and north of the I-15 corridor.

The wetlands associated with perennial rivers in the northern Mojave Desert, such as the Virgin, Colorado and Muddy rivers are not included in this list, nor are those associated with the hydrogeological transition from volcanic to limestone terrain near the Great Basin boundary, such as the Oasis Valley north of Beatty and the White River Valley at and north of Pahranagat Lakes.

With the possible exception of Sandy Valley, where many mesquite coppice dunes appear to occur at the interface between coarse alluvium and fine grained playa sediment, all of the shallow groundwater systems listed above are along valley-bottom fault lineaments intersecting the groundwater table and channeling artesian water to or near the surface. Some of them are limited in extent, such as those in Shadow Valley west of Clark Mountain, while others were vast, reflecting not only the extent of a relatively shallow groundwater table, but also the complexity and abundance of Quaternary faults cutting deep basin fill. The most complex and extensive spring discharge systems were those of the Las Vegas Valley, and also include the extant systems of the Amargosa Desert[9]. Ash Meadows in the Amargosa Desert is the most famed of the riparian areas there, but there are many others (Table DR105-2). Where no springs existed, or during dry seasons when they ceased flowing due to water-level retreat, in areas supporting mesquite thickets water could often still be accessed by shallow, hand-dug wells.

The extent and complexity of paleospring deposits are generally mirrored by the extent of relict spring systems in those same valleys. Thus, there are many and extensive paleospring deposits in the Amargosa Desert, and they are still numerous in the northern part of the Las Vegas Valley, although they were obliterated elsewhere. In some areas the contrasting extent of paleospring deposits is remarkable, and speaks to the local extent of land surface approached by a rising water table in permissive topographic circumstances. As Jay Quade of the University of Arizona and his colleagues have described, a valley bottoming out at about 3,000 feet would present extensive terrain at about that elevation, terrain that, in turn, would be strongly affected by a water table rising from, say, 2,800 to 2,950 feet elevation in response to glacial-age recharge to the local aquifer. Pahrump Valley and the SFS is one of those areas where, in terms of area covered, the proportion of paleospring discharge sediments to recent spring systems is vast. Others that are known to this team include Indian Springs and Chicago Valley, where square miles of paleospring sediments and their attendant badlands contrast with very limited, or largely extinct, historic oases.

How these different paleospring systems and historic oases differ in their geography, paleogeography, and biology is a subject that is periodically addressed particularly in forums concerned with the biogeography of desert fishes and other aquatic organisms. The literature on the biology and biogeography of these desert oases, and the interface of this body of knowledge with paleohydrological and paleoclimatic data bases, is dispersed and much of it occurs in the grey literature alone. Much could be learned from a synthesis of pre-existing information in the grey literature (say, for example, the paleobotanical record of Las Vegas Formation sediments), perhaps in concert with a major records center, such as the Nevada State Museum.

[9] The Amargosa Desert is awkwardly named in that it is not a “desert” in the biogeographic sense. Instead, it is a large valley. It is a place name referring to a triangular desert valley between the Funeral Range on the west and the highlands of the Nevada Test Site on the east. Its apex lies near Beatty, Nevada, while the base of the triangle is formed by the hills separating the Amargosa Desert from the next valley to the south, Pahrump Valley.

SECTION 5

Research Guidelines

The HHSEGS project will potentially affect only a subset of the study area. Specifically, as shown in Figure DR105-4 ("Cultural Resources Documented Along Two Survey Corridors") only one of two studied corridors will be used for the transmission interconnection and the natural gas pipeline. It is the Applicant's understanding that the northern corridor, terminating in the northern portion of the HHSEGS common area represents the agencies' preferred alignment for these related linear facilities.

Notwithstanding the project's potential to affect only a limited portion of the study area, this report takes a broader approach, providing management recommendations for the entire study area, as opposed to focusing solely on the northern utility corridor. Of course, if deemed necessary or appropriate, the Applicant would be willing to discuss any project specific guidelines for future inquiries with the agencies.

5.1 Eolian Landforms

Sand dunes and sand sheets offer important cover to *in situ* archaeological materials that may be as old as Middle Archaic (ca. 5,200 B.P.) in age or, in terms of the paleoclimatic chronology of the region, dating to the end of the Altithermal and beginning of late Holocene climatic amelioration in the Mojave Desert. As was first recommended by researchers in the Corn Creek Dunes of the Upper Las Vegas Valley, and since pursued in various parts of the Amargosa Desert, inventory of deflated areas is important to understanding the cultural resources of these desert oases. Concerns regarding the persistence or loss of dune habitat, and consequent degradation of cultural resources, can be addressed in several complimentary and convergent ways:

- Develop a general sand budget for the dunes within the study area that relate dune stability to, not only anchoring vegetation, but also sand input and source.

  Studies of sand sheet and sand dune habitat in the Colorado Desert of California identified the frequency of discharge of alluvium, the consequent entrainment of sand from that alluvium by winds, and deposition of that sand in dune fields as components of a process, the continuity of which is vital to the maintenance of open dune fields and sand sheets. How these elements interact here is unknown, which suggests an avenue of inquiry moving forward.

- Develop and execute a cultural resources inventory of areas within and adjacent to sand dunes and dune sheets selected in a non-random fashion to represent 50 percent of those identifiable by remote imagery (Figure DR105-2). The following considerations will be included in implementation:
  - Geomorphic characterization of each site will be completed by a qualified geomorphologist or geoarchaeologist
  - Inventory of open dune surfaces will be limited to confirming their accretionary nature- Interdunal and deflated areas will be subject to intensive pedestrian overview.

  - All clasts will be considered potential manuports in the absence of a visible alluvial lag; fractured clasts (e.g. potential fcr, bst and gst) will be carefully inventoried.
  - Opportunities for obtaining radiocarbon-datable samples from exposures will be exploited
  - Sites from dunes systems associated with different fault scarps are of potentially different age, and the assemblages will be compared and contrasted with that possibility in mind.

5.2 Erosional Landforms

The arroyos cut into the fault scarps of the SFS offer exceptional opportunities to study local stratigraphy, to build a local geochronology of spring discharge events, and to gain a deeper understanding of the Late Quaternary paleoenvironments of the valley. Opportunities for understanding Plio-Pleistocene tectonics and paleoenvironmental changes further back in the geological record are evident in the exposures of older basin fill along at least one arroyo cutting Scarp 1.

- All arroyo cuts on public land within the study area (see Figure DR105-3) should be subject to concurrent paleontological resources survey and stratigraphic inventory, encompassing not only the walls of the arroyo itself but also tributaries and badlands extending out 200 feet laterally from the thalweg. Activities that should be accomplished include the following:
  - Mapping of the clean (as opposed to covered by slump or sand sheet) stratigraphic exposures by GPS
  - Preliminary stratigraphic inventory of the exposures mapped (number of units, their nature, approximate depth, soils or black mats evident, etc.)
  - Detailed inspection of the exposures for anthropogenic and paleontological materials
- Type sections that have the potential to provide key chronostratigraphic sequences for the study area should be identified and mapped in detail. These would include the terminal Pleistocene and early Holocene strata, and unique older Pleistocene exposures.

The presence or absence of tufa ledges and tufa mounds would also be noted since these features relate to active groundwater discharge. The tendency for more recent and fossiliferous paleospring deposits to be inset into older sediments which lack documented paleontological sensitivity is an important factor that needs to be taken into account during paleontological resources inventories. This is related to subsequent later Pleistocene pluvial events being less pronounced than earlier Pleistocene pluvial due to the increasing influence of the rain shadows of the Sierra Nevada and Transverse Ranges.

- Areas identified as possessing high or unknown paleontological sensitivity in the study area (Figure DR105-3) should be subject to a paleontological resources inventory.
  - To date no *in situ* fossil resources have been found in the study area
  - The results of this survey should be extended to the remaining areas characterized by high albedo, silt-rich sediments in the study area

- A screen-washing program for testing selected sediments or microvertebrates should be included in this inventory

Expectations are low for the paleontological sensitivity of most areas where paleospring deposits occur as massive, calcareous "phreatophyte flat" sediments. Similarly, older sediments have yet to yield known fossil assemblages.

5.3 Biogenic Landforms

Mesquite coppices may be of great age, and they may or may not be comprised of clones where the thicket of mesquite covering one dune is, genetically, a single individual.

- Identify the research support necessary to implement a program of DNA testing of mesquite in coppice dunes as well as arroyo thickets, to determine:
  - The genetic differentiation of single shrubs on single dunes,
  - The genetic diversity of mesquite individuals across dune fields and within arroyos

The age of mesquite establishment in this area is also important. Mesquite charcoal is relatively easily identified given sufficient sample size and a qualified laboratory. Opportunities to date the establishment of mesquite in the area through analysis of old wood, or of charcoal from stratigraphic contexts should be taken. Dating of recent dieback can also help parameterize the process of dune loss, if it is occurring at all.

- Map the extent of recent mesquite dieback in the study area.
  - Implement an age class system to discriminate between different episodes of mesquite dieback.
  - Use radiocarbon analyses to date older wood[10]
  - Inventory other shrubs and grasses contributing to dune and sand sheet stability

Given the durability of mesquite wood, it may be possible to develop a model of mesquite growth and dieback extending into the late prehistoric which, in turn, could be used as a proxy for environmental changes over the last few centuries to millennia.

Biogenic tufa mounds are currently unknown in the study area. Tufa ledges have been observed in limited areas (Photo 104-4), and they may be found to be more widespread in association with fault scarps once the outcrops exposed along all the arroyos have been mapped.

5.4 Other Landforms

The relationship between lithic procurement areas and local geology can be further elucidated by understanding the array of lithic materials that are available in the older alluvium exposed along the crests of the hills that comprise the eroded hanging walls of Scarp 1.

- Mineral suite analysis should be conducted on the cobble-sized clasts in at least three separate localities that represent outcrops or lag surfaces of older alluvium, preferably those subject to exploitation by prehistoric peoples

[10] Like many leguminous trees, mesquite wood is not thought to be amenable to tree-ring dating

- Mineral suite analysis on yet older, or at least more geologically exotic, alluvial and fluvial clasts within the HHSEGS project area will be conducted as well, and the results compared both to existing lithic analyses but also to the mineral suites from the older alluvium, above.

5.5 Data Assembly and Management

Opportunities exist for continuing the development of a process-based landform model relating terrains and their development along the SFS to cultural, biological, and paleontological resources distributions, and relative levels of sensitivity. Resources subject to loss or degradation (e.g., mesquite coppices or cultural resources exposed by deflation) can be recognized and mapped at this “mesoscale” of a polygon a few miles wide, and their status directly related to overall landform evolution and condition. Mapping at a scale sufficient to capture these resources is feasible, and desk-top utilities are readily available.

Data gained from cultural and paleontological resources inventories, geoarchaeological and geochronological investigations, can be integrated into a reference database for this area, and should be synthesized to summarize status of knowledge on the following topics relative to the SFS:

- Neotectonic history of this portion of the SFS
- History and status of sand dunes and sand sheets, closely linked to paleoecology and status of mesquite coppices
- Cultural resources site types and distributions
- Paleontological resources site types and distributions
- Geoarchaeological sensitivity of key arroyo sections

Geoarchaeological sensitivity of latest Pleistocene and early Holocene exposures, relatively common in some paleospring deposits, requires re-examination now that it is recognized that humans inhabited at least portions of the North American interior prior to 13,000 B.P.

Outside of Stump Spring, paleontological resources sensitivity of the network of paleospring deposits exposure by scarps and arroyos of the SFS has not been established. It is anticipated that it may not be high since reports of extinct animal bones from ranchers in the surrounding region are virtually unknown.

Other resource issues, such as the extent and abundance of rare gypsophilous plant species, can easily be integrated into a model of resources distribution and sensitivity across the landscape.

SECTION 6

References

Anderson, Diana. 1999. Latest Quaternary (<30 ka) Lake High-Stand Fluctuations and Evolving Paleohydrology of Death Valley. In *Proceedings of Conference on Status of Geologic Research and mapping in Death Valley National Park* U.S. Geological Survey Open-File Report 99-153, pp. 124-131.

Bull, W. B. 1991. Geomorphic responses to climatic change. Oxford University Press, Oxford, U. K.

Burchfiel, B. C., R. J. Fleck, D. T. Secor, R. R. Vincelette, and G. A. Davis. 1974. Geology of the Spring Mountains, Nevada. *Geological Society of America Bulletin* 85:1013-1022.

(U.S.D.I.) Bureau of Land Management, 2008. *Potential Fossil Yield Classification System for Paleontological Resources on Public Lands.* Instructional Memorandum 2008-009. Washington, D.C.

Cameron, C.W. 1996. An ecological model for the protection of a dune ecosystem. *Conservation Biology* 10: 888-891.

Dohrenwend, J.C., W. B. Bull, L. D. McFadden, G. I. Smith, R. S. U. Smith, and S. G. Wells. 1991. Quaternary geology of the Basin and Range Province in California. In *The Geology of North America, Volume K-2, Quaternary non-glacial geology: conterminous U.S.*, edited by R. B. Morrison, pp. 321-352. Geological Society of America, Boulder, CO.

Enzel, Yehouda, W. J. Brown, R. Y. Anderson, L. D. McFadden, and S. G. Wells (1992). Short-duration Holocene lakes in the Mojave River drainage basin, southern California. Quaternary Research 38: 60-73.

Enzel, Y., S.G. Wells, and N. Lancaster. 2003. Late Pleistocene lakes along the Mojave River, southeast California. In *Paleoenvironments and Paleohydrology of the Mojave and Great Basin Deserts* (Y. Enzel, S.G. Wells, and N. Lancaster, eds.). Geological Society of American Special Paper 368: 61-77.

Fenneman, N.M. 1931. *Physiography of Western United States*. McGraw-Hill Book Company: New York, NY.

Giambastiani, M.A., and T.F. Bullard. 2010. Terminal Pleistocene-Early Holocene Occupations on the eastern shore of China Lake, California. Pacific Coast Archaeological Society Quarterly 43: 50-70.

Glazner, A.F., J.D. Walker, J.M. Bartley, J.M. Fletcher, et al. 1994. “Reconstruction of the Mojave Block.” Pp. 3-30 in (S.F. McGill and T.M. Ross, eds.) *Geological Investigations of an Active Margin.* Geological Society of America Cordilleran Section Guidebook, San Bernardino County Museum Association, Redlands, CA.

Harvey, A.M. and Wells, S.G. 2003. Late Quaternary variations in alluvial fan sedimentologic and geomorphic processes, Soda Lake basin, eastern Mojave Desert, California. In Enzel, Y., Wells, S.G., and Lancaster, N., eds. Paleoenvironments and paleohydrology of the Mojave and southern Great Basin Deserts: Boulder, Colorado. Geological Society of America Special Papers 368, p. 207-230.

Haynes, C. V., Jr. (1967). Quaternary geology of the Tule Springs area, Clark County, Nevada. In "Pleistocene studies in southern Nevada (H.M. Wormington and D. Ellis, Eds.), pp. 15-104. Nevada State Museum Anthropological Papers 13.

Jefferson, G.T. 2003. “Stratigraphy and paleontology of the middle to late Pleistocene Manix Formation, and paleoenvironments of the central Mojave River, Southern California.” Pp. 43-60 in (Y. Enzel, S.G. Wells, and N. Lancaster, eds.) *Paleoenvironments and Paleohydrology of the Mojave and southern Great basin Deserts*. Geological Society of American Special paper 368, Boulder, CO.

Jones, T. L., G. M. Brown, L. M. Raab, J. L. McVickar, W.G. Spaulding, D. J. Kennett, A. L. York, and P. L. Walker 2004. Environmental Imperatives Reconsidered: Demographic Crises in Western North America During The Medieval Climatic Anomaly. In *Prehistoric California Archaeology and the Myth of Paradise* (edited by L. M. Raab and T. L. Jones) 12-32. The University of Utah Press, Salt Lake City.

Lancaster, N. 1997. Response of eolian geomorphic systems to minor climate change: examples from the southern California deserts. *Geomorphology* 19: 333-347.

Lancaster, N., and V. P. Tchakerian. 1996. Geomorphology and sediments of sand ramps in the Mojave Desert. *Geomorphology* 17: 151-165.

Lecce, S.A. 1990. The alluvial fan problem. In Rachocki, A.H. and Church, M., eds. Alluvial Fans: A Field Approach. John Wiley and Sons, Ltd. 391 p.

Lundstrom, S. C., S. A. Mahan, R. J. Blakely, J. B. Paces, O. D. Young, J. B. Workman and G. L. Dixon. 2002. Geologic Map of the Mound Spring Quadrangle, Nye and Clark Counties, Nevada, and Inyo County, California. U. S. Geological Survey, Miscellaneous Field Studies Map MF–2339. Version 1.0. Denver, CO.

McDonald, E.V., McFadden, L.D., and Wells, S.G. 2003. Regional response of alluvial fans to the Pleistocene-Holocene climatic transition, Mojave Desert, California. *In* Enzel, Y., Wells, S.G., and Lancaster, N., eds. Paleoenvironments and paleohydrology of the Mojave and southern Great Basin Deserts: Boulder, Colorado. Geological Society of America Special Papers 368, p. 189-205. McGraw-Hill, New York.

McFadden, L.C., W.B. Bull, and S.G. Wells. 1991. Stratigraphy and geomorphology of Quaternary piedmont deposits. In *The geology of North America, Volume K-2, Quaternary non-glacial geology: conterminous U.S.,* edited by R. B. Morrison, pp. 327-331. Geological Society of America, Boulder, CO.

Mehringer, P. J., Jr. 1967. Pollen analysis of the Tule Springs site, Nevada. In Pleistocene studies in southern Nevada, edited by H. M. Wormington and D. Ellis, pp. 129-200. Nevada State Museum Anthropological Paper 13.

Mehringer, P. J., and Warren, C. N. (1976). Marsh, dune, and archaeological chronology, Ash Meadows, Amargosa Desert, Nevada. in Elston, R., ed., "Holocene environmental change in the Great Basin." Nevada Archaeological Survey Research Paper 6: 120-150.

Menges, C. M. 2008. Multistage Late Cenozoic evolution of the Amargosa River drainage, southwestern Nevada and eastern California., In (M. C. Reheis, R. Hershler and D. M. Miller, eds.) *Late Cenozoic drainage history of the Southwestern Great Basin and Lower Colorado River region: Geologic and Biotic perspectives.* Geological Society of America Special Paper 439: 39-90. Boulder, CO.

Mifflin, M.D., and Wheat, M.M. (1979). "Pluvial Lakes and Estimated Pluvial Climates of Nevada." Nevada Bureau of Mines and Geology Bulletin 94.

Muhs, D. R. 2004. Mineralogical maturity in dunefields of North America, Africa and Australia. Geomorphology 59:247-269.

de Narvaez, C. 1995 *Paleohydrology And Paleotopography Of A Las Vegas Spring*. M. S. Thesis, Northern Arizona University, Flagstaff.

National Research Council (1992). Ground water at Yucca Mountain: how high can it rise? National Academy Press, Washington, D.C.

Nelson, S. T., H. R. Karlsson, J. B. Paces, D. G. Tingey, S. Ward, and M. T. Peters. 2001. Paleohydrologic record of spring deposits in and around Pleistocene pluvial Lake Tecopa, southeastern California. *Geological Society of America Bulletin* 113:659-670.

Pease, P. P., and V.P. Tchakerian. 2003. Geochemistry of sediments from Quaternary sand ramps in the southeastern Mojave Desert, California. Quaternary International 104: 19-29.

Quade, Jay, 1986, Late Quaternary environmental changes in the Upper Las Vegas Valley, Nevada. Quaternary Research 26: 340-357.

Quade, Jay, and Pratt, W. L. (1989). Late Wisconsin groundwater discharge environments of the southwestern Indian Springs Valley, southern Nevada. *Quaternary Research* 31: 351-370.

Quade, Jay, M. D. Mifflin, W. L. Pratt, W. McCoy, and L. Burckle (1995). Fossil spring deposits in the southern Great Basin and their implications for changes in water-table levels near Yucca Mountain, Nevada, during Quaternary time. *Geological Society of America Bulletin* 107:213-230.

Quade, Jay, R. M. Forester, and J. F. Whelan. 2003. Late Quaternary paleohydrologic and temparture change in southern Nevada. In *Paleoenvironments and Paleohydrology of the Mojave and Great Basin Deserts* (Y. Enzel, S.G. Wells, and N. Lancaster, eds.). Geological Society of American Special Paper 368: 165-188.

Reheis, M. 1999. *Extent of Pleistocene Lakes in the Western Great Basin.* Miscellaneous Fieldf Studies Map MF-2323, U.S. Geological Survey, Denver, CO.

Scheirer, D. S., D. S. Sweetkind and J. J. Miller. 2010. Multiple phases of basin formation along the Stateline fault system in the Pahrump and Mesquite Valleys, Nevada and California. *Geosphere* 6(2): 93-129.

Scott, Eric, and Cox, S.M. 2008. Late Pleistocene distribution of *Bison* (Mammalia; Artiodactyla) in the Mojave Desert of Southern California and Nevada. *In* Geology and Vertebrate Paleontology of Western and Southern North America, edited by Xaoming Wang and L. G. Barnes. pp. 359–382. Natural History Museum of Los Angeles County, Science Series No. 41. Los Angeles, CA.

Smith, G.I., 1979, Subsurface stratigraphy and geochemistry of Late Quaternary evaporites, Searles Lake, California. U.S. Geological Survey Prof. Pap. 1043. 130 pp.

Smith, G.I. (1984). Paleohydrologic regimes in the southwestern Great Basin, 0-3.2 my ago, compared with other long records of "global" climate. Quaternary Research 22, 1-17.

Smith, G. I. 1991. Stratigraphy and Chronology of Quaternary-age Lacustrine Deposits. (1991). In *The Geology of North America, Volume K-2, Quaternary Non-Glacial Geology: Conterminous U. S.*, edited by R.B. Morrison, pp. 339-346. Geological Society of America, Boulder, CO.

Smith, G.I., and Street-Perrott, F.A. (1983). Pluvial Lakes of the western United States. In "The Late Pleistocene" (S.C. Porter, Ed.), pp. 190-214. University of Minnesota Press, Minneapolis.

Rendell, H. L., and N. L. Sheffer. 1996. Luminescense dating of sand ramps in the eastern Mojave Desert. Geomorphology 17: 187-197.

Spaulding, W.G. (1985). *Vegetation and climates of the last 45,000 years in the vicinity of the Nevada Test Site, south-central Nevada*. U.S. Geological Survey Professional Paper 1329.

_____ (1986). Ice-age desert in the southern Great Basin. *Current Research In The Pleistocene* 2: 83-85.

_____ (1990). Vegetational and climatic development of the Mojave Desert: The last glacial maximum to the present. In *Packrat middens: The last 40,000 years of biotic change* (J. L. Betancourt, T. R. Van Devender, and P. S. Martin, Eds.). University of Arizona Press, Tucson. pp. 166-199.

_____ (1990). Vegetation dynamics during the last deglaciation, southeastern Great Basin, U. S. A. Quaternary Research, 33: 188-203.

_____ 1991. A middle Holocene vegetation record from the Mojave Desert and its paleoclimatic significance. Quaternary Research 35: 427-437.

_____ (1994). Paleohydrologic investigations in the vicinity of Yucca Mountain: Late Quaternary paleobotanical and palynological records. Dames & Moore, Las Vegas, Nevada.

Spaulding, W.G., and Graumlich, L.J. (1986). The last pluvial climatic episodes in the deserts of southwestern North America. *Nature* 320, 441-444.

Szabo, B. J., Kolesar, P. T., Riggs, A. C., Winograd, I. J., and Ludwig, K. R. (1994). Paleoclimatic inferences from a 120,000-yr calcite record of water-table fluctuations in Browns Room of Devils Hole, Nevada. Quaternary Research 41: 59-69.

Waters, M. R., S. L. Forman, T. A. Jennings, L. C. Nordt, S. G. Driese, J. M. Feinberg, J. L. Keene, J. Halligan, A. Lindquist, J. Pierson, C. T. Hallmark, M. B. Collins, J. E. Wiederhold. 2011. The Buttermilk Creek Complex and the Origins of Clovis at the Debra L. Friedkin Site, Texas. *Science* 331: 1599-1603.

Williams, P. A., and R. I. Orlins 1963.The Corn Creek dunes site: A dated surface site in southern Nevada. Nevada State Museum Anthropological Papers No. 10. Carson City.

Winograd, I. J. 1985. Two-million-year record of deuterium depletion in Great Basin groundwaters. Science 227: 519-522.

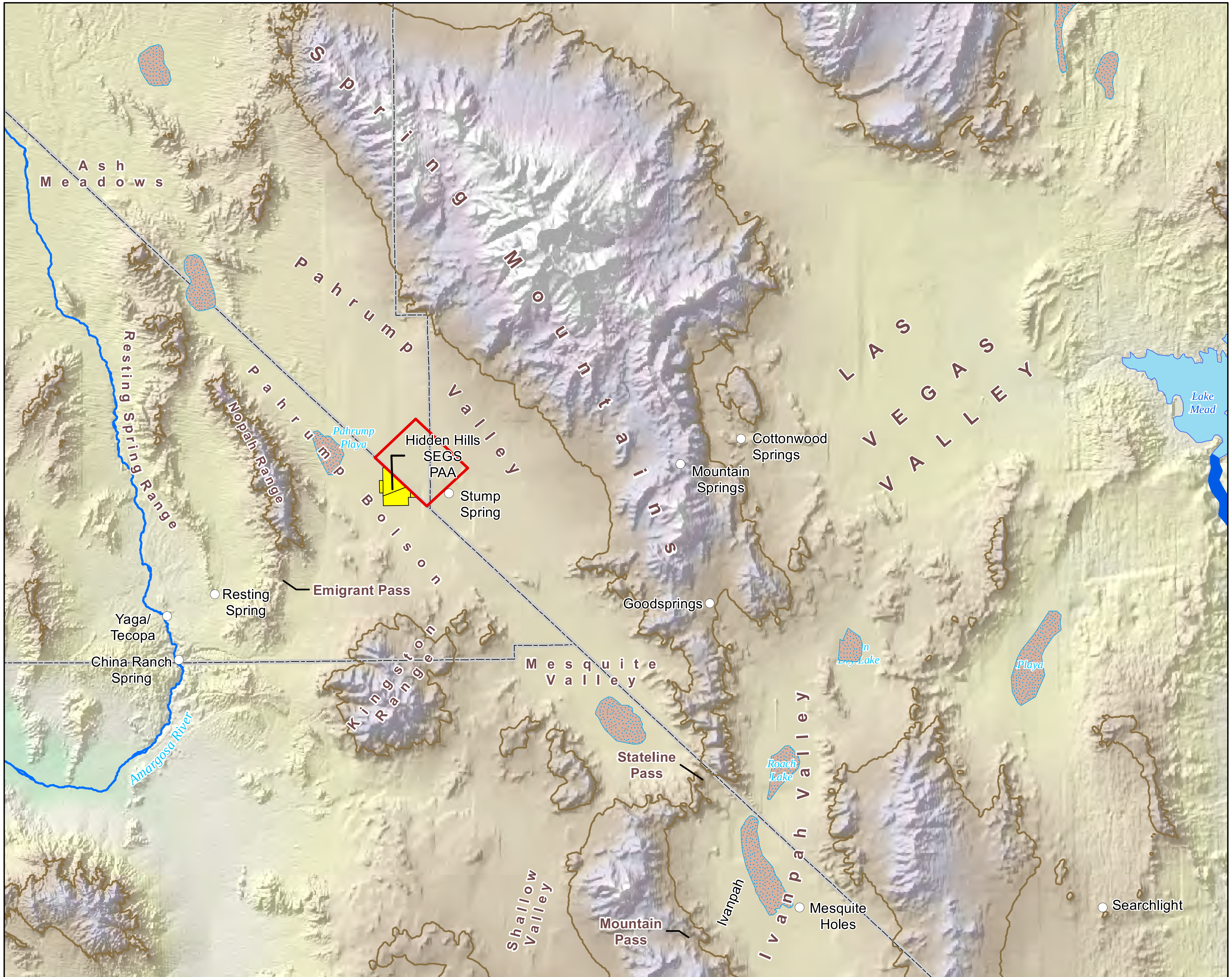
Winograd, I.J., and G. C. Doty (1980). Paleohydrology of the southern Great Basin with special reference to water table fluctuations beneath the Nevada Test Site during the late (?) Pleistocene. U. S. Geological Survey Open-File Report 80-569.

Winograd, I.J., and Thordarson, W. (1975). *Hydrogeologic and hydrochemical framework, south-central Great Basin, with special reference to the Nevada Test Site*. U.S. Geological Survey Professional Paper 712-C.

Winograd, I. J., T. B. Coplen, J. M. Landwehr, A. C. Riggs, K. R. Ludwig, B. J. Szabo, P. T. Kolesar, and K. M. Revesz 1992 Continuous 500,000-year climate record from vein calcite in Devils Hole, Nevada. *Science* 227:519-522.

Wormington, H. Marie, and Ellis, D., Eds. 1967. *Pleistocene studies in southern Nevada*. Nevada State Museum Anthropological Papers 13.

Zimbelman, J.R., and S.H. Williams. 2002. Geochemical indicators of separate sources for eolian sands in the eastern Mojave Desert, California, and western Arizona. Geological Society of America Bulletin 114: 490-496.



VICINITY MAP

LEGEND

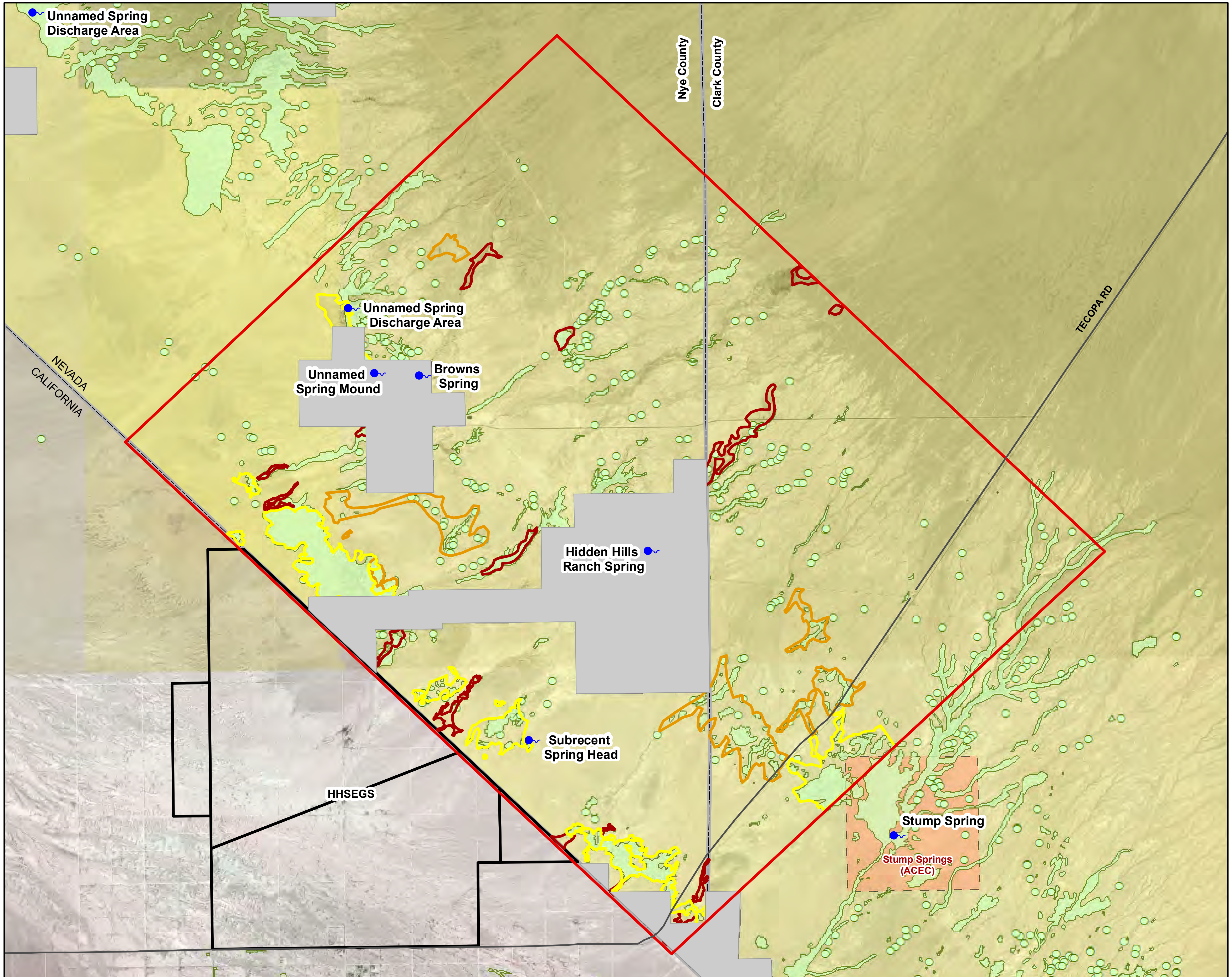
- HHSEGS Boundary
- Study Area
- Lake
- Dry Lake

N

0 3 6 12
Miles

Figure DR105-1
Vicinity Map
Hidden Hills Solar Electric Generating System

CH2MHILL.



LEGEND

- Recorded Springs/Recent Spring Mounds

Eolian Landforms

- Sand Sheet / Developed Dunes
- Dispersed, Degraded Sand Sheet/ Isolated Dunes
- Sand Sheet Associated with Fluvial/Alluvial Processes
- Groundwater Dependent Vegetation
- Study Area
- BLM Areas of Critical Environmental Concern
- HHSEGS
- County Boundary

NV Land Use

- Bureau of Land Management
- Private

Note:
Rights of ways and other encumbrances not shown.

N

0 2,000 4,000
Feet

FIGURE DR105-2
Land Use Designations and Eolian Landforms
Hidden Hills Solar Electric Generating System

SAC \\ZION\SACGIS\PROJ\SOLARPROJECTS\HIDDENHILLS\MAPFILES\2012\CULTURAL\DR105_MAPS\FIGUREDR105-2_EOLIANLANDFORMS.MXD SSCOPES 5/11/2012 9:41:26 AM

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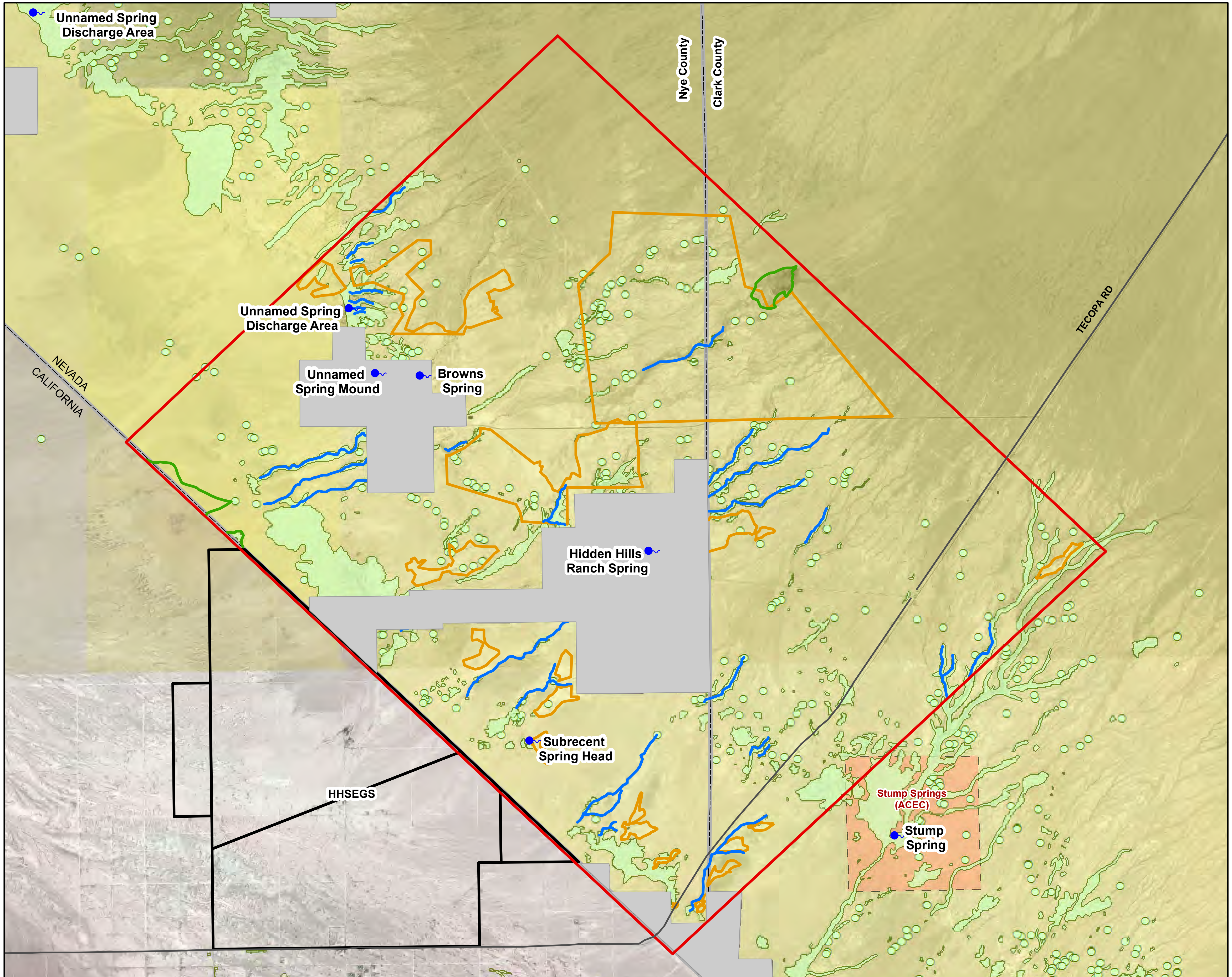


LEGEND

- Recorded Springs/Recent Spring Mounds

Fluvial Landforms

- Debouchments
- Arroyo with/ without Mesquite Thicket
- Paleontologically Sensitive Areas
- Groundwater Dependent Vegetation
- Study Area
- BLM Areas of Critical Environmental Concern
- HHSEGS
- County Boundary

NV Land Use

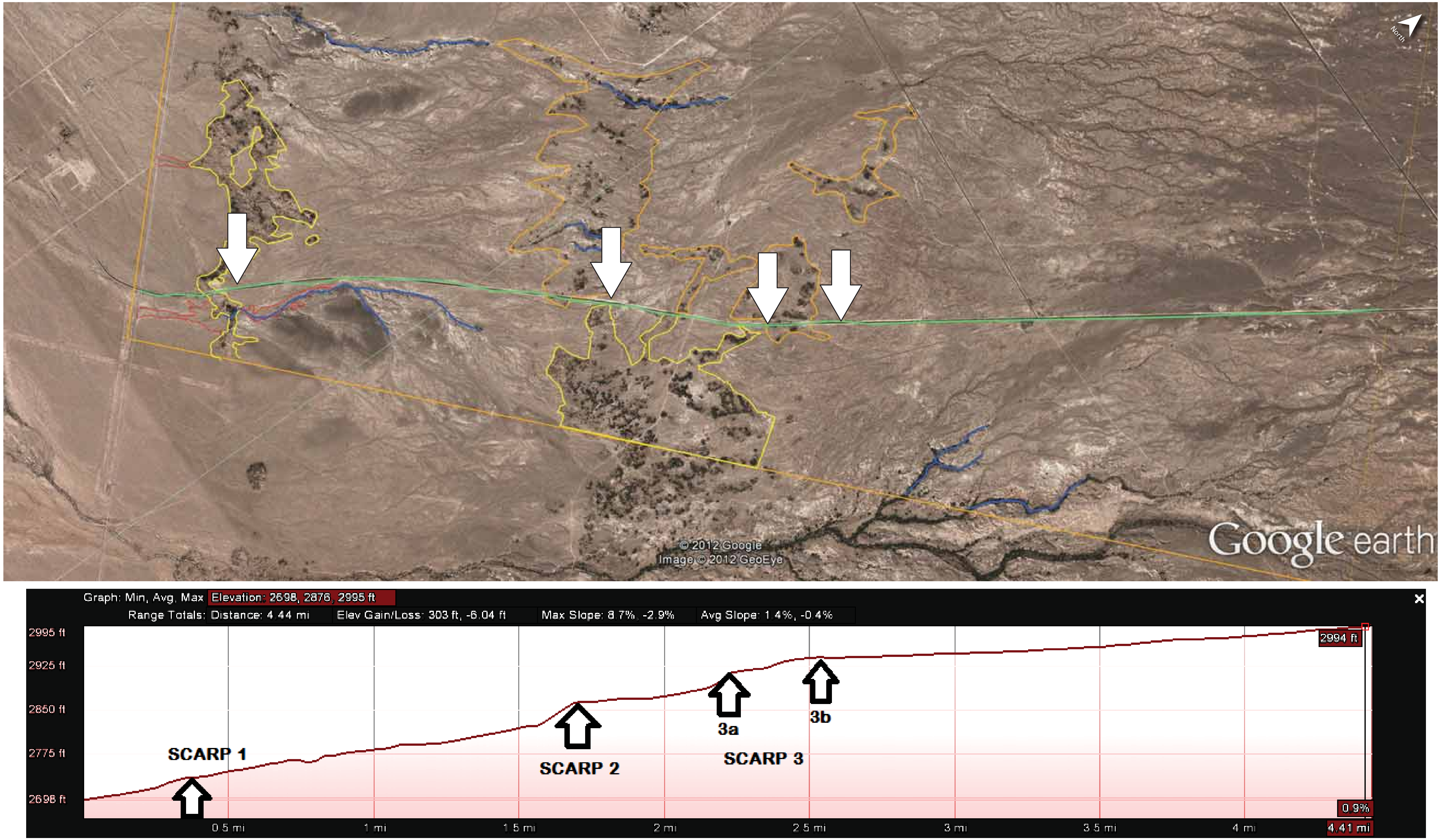
- Bureau of Land Management
- Private

Note:
Rights of ways and other encumbrances not shown.

N

0 2,000 4,000
Feet

FIGURE DR105-3
Land Use Designations and Fluvial Landforms
Hidden Hills Solar Electric Generating System



Desk-top analysis of an elevational profile along the Tecopa Road (green line, upper panel), from the California-Nevada border on the left to 4.4 miles east of that point. The distribution of sand sheets and dunes (upper panel, yellow and orange polygons) appears closely related to the position of these scarps, consistent with the hypothesis that the faults are channeling artesian water toward the surface.

FIGURE DR105-4
Elevational Profile of Study Area
Hidden Hills Solar Electric Generating System

Confidential Figure DR105-5 has been submitted under a repeated request for confidential designation as the figure identifies the location of cultural and paleontological resources within the study area.

Photo DR105-1. View east-southeast to the lowest and western-most fault scarp along the SFS, termed Scarp 1 for the purposes of this report. In the foreground perennial grasses (chiefly galleta) can be seen thriving on a relatively thick sand sheet. In the left mid-ground is a hummocky dune covered with *Schismus* grass while, behind it, are two coppice dunes supporting dark thickets of mesquite. Behind them, in turn, are the flanks of the topographic rise marking the hanging wall of the fault scarp.

Photo DR105-2. Dense popcorn tufa forming a lag concentrate in the vicinity of Scarp 1, indicating intense erosion of the soils, mostly attributable to deflation. Mechanical pencil for scale is 5 1/8″ long.

Photo DR105-3a. View south across the Durmid Plain, west of the Salton Sea in southeastern California, to a large spring mound about a half-mile away. At this distance the mound can be seen to be about one-half mile wide.

Photo DR105-3b. The same spring mound as shown in Photo DR105-3a, but from a distance of about 200 yards. The heavily vegetated mound rises about 60 feet above the surrounding alkaline flat. .

Photo DR105-4. A lithoid tufa ledge exposed on the north side of an arroyo in the SFS. It caps and protects less resistant bedded silts and clays below it. To the right of the man, across the arroyo, the linear white area reveals an exposure of the tufa ledge on the other bank, largely obscured by a sand sheet that mantles the downwind wall of the arroyo. View northwest. Note the coppice dunes in the background.

Photo DR105-5a. View north-northwest across the middle reaches of the SFS. In the mid-ground is the footwall vicinity of Scarp 2 (see Figure DR105-5). The coppice dune in the right foreground is covered chiefly with mesquite and some saltbush (*Atriplex canescens*), while the dune in the background supports less mesquite, and instead is covered chiefly by *Schismus* grass and saltbush. The Front Sight Shooting Range is the in far distance, center right.

Photo DR105-5b. View southwest across a coppice dune system west of the Stump Spring area. Tightly clustered coppice dunes in the foreground give way to more dispersed dunes in the background, farther out into the edge of the Pahrump Bolson.

Photo DR105-6a. View south to an outcrop of finely bedded lacustrine silts exposed by an arroyo cutting through Scarp1. Note that the silts are not oxidized (tending to the reddish color range), suggesting these are not playa, or dry-lake, sediments but instead represent actual lake beds. The sediments are tilted up on the west end showing the displacement typical on the hanging wall of a normal fault, which would have been immediately to the right (west) of this point prior to rupture.

Photo DR105-6b. View southeast showing the north-facing wall of an arroyo several hundred yards east of Scarp 1, showing how these drainages are incising sediments on the uplifted, or head-wall side of the scarps. In this area a massive tufa ledge can be seen exposed near the surface, indicating copious spring discharge at one time, and suggesting paleospring deposits in the immediate vicinity may possess high paleontological sensitivity. The south wall of the arroyo, in the foreground, is mantled by a thick sand sheet because it faces the prevailing winds, and only the north-facing arroyo wall in the mid-ground, is in the lee of the wind and free of mantling sand.

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APPLICATION FOR CERTIFICATION FOR THE *HIDDEN HILLS SOLAR ELECTRIC GENERATING SYSTEM*

DOCKET NO. 11-AFC-02
PROOF OF SERVICE
(Revised 5/15/2012)

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DECLARATION OF SERVICE

I, Mary Finn, declare that on May 17, 2012, I served and filed copies of the attached Hidden Hills SEGS (11-AFC-2) Data Response, Set 1D-7, dated May 17, 2012. This document is accompanied by the most recent Proof of Service list, located on the web page for this project at: www.energy.ca.gov/sitingcases/hiddenhills/index.html.

The document has been sent to the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit or Chief Counsel, as appropriate, in the following manner:

(*Check all that Apply*)

For service to all other parties:

x___ Served electronically to all e-mail addresses on the Proof of Service list;

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AND

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x___ by sending an electronic copy to the e-mail address below (preferred method); *OR*

___ by depositing an original and 12 paper copies in the mail with the U.S. Postal Service with first class postage thereon fully prepaid, as follows:

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Sacramento, CA 95814-5512
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OR, if filing a Petition for Reconsideration of Decision or Order pursuant to Title 20, § 1720:

___ Served by delivering on this date one electronic copy by e-mail, and an original paper copy to the Chief Counsel at the following address, either personally, or for mailing with the U.S. Postal Service with first class postage thereon fully prepaid:

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I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct, that I am employed in the county where this mailing occurred, and that I am over the age of 18 years and not a party to the proceeding.

Mary Finn, CH2M Hill